NATIONAL STATISTICAL SYSTEM
NATIONAL STATISTICAL INSTITUTE

STATISTICS ON RURAL DEVELOPMENT AND AGRICULTURE HOUSEHOLD INCOME

WYE CITY GROUP

Second Meeting (Rome, 11-12 June 2009)

Organisers

Istat
Istituto Nazionale di Statistica

Sponsoring societies

NATIONAL STATISTICAL SYSTEM
NATIONAL STATISTICAL INSTITUTE

Statistics on Rural Development and Agriculture Household Income

Wye City Group Meeting

Rome 11-12 June 2009

Organisers

Istat
Istituto Nazionale di Statistica

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Sponsoring Societies

sidea
Società Italiana di Economia Agraria

SIS
Società Italiana di Statistica
fondata nel 1939

*Edited by:*Edoardo Pizzoli

Editorial co-ordination and language revision: Maria Frustaci

Per informazioni sul contenuto della pubblicazione
rivolgersi al Cont@ct Centre dell'ISTAT all'indirizzo:
https://contact.istat.it//

Eventuali rettifiche ai dati pubblicati saranno diffuse
all'indirizzo www.istat.it nella pagina di presentazione del volume

Statistics on Rural Development and Agriculture Household Income

Wye City Group Meeting
Rome 11-12 June 2009

ISBN 978-88-458-1670-3

Realizzazione: ISTAT, Servizio Editoria

Stampato nel mese di marzo 2011
presso il Centro stampa dell'ISTAT
Via Tuscolana 1788 – Roma

Index

Preface and Acknowledgements

The 2nd Meeting of the Wye City Group of the United Nations Statistical Division (UNSD) focused on "Statistics on Rural Development and Agriculture Household Income" was held in Rome on June 11 and 12, 2009. Three main topics were put forward and discussed in great depth during the two-day meeting: the changing rural paradigm, emerging issues and data needs; innovation, new tools and results in rural statistics; and specific issues in rural development and household income statistics for countries at different levels of development. The purpose of the Wye city Group Meetings is to bring rural development experts together from statistical offices, institutions and universities, providers and users of statistics, from around the world. The meeting format combines formal presentations, in plenary and parallel sessions, with scientific and operational discussions. Twenty-six speakers and numerous attendees discussed the above topics during the Rome meeting.

Rural Development is of great interest to both developed and developing countries, even though prospective and specific issues can differ. Developing countries cope with poverty and migration from rural areas to urban areas and/or wealthy countries. For developed countries food security, economic and social stability and environmental policy targets are of more concern: in a word, the "sustainability" of development. This second meeting for the first time considered implications on official statistics of a changing rural paradigm in countries at different levels of development, that is without a clear cut division between developed and developing countries and their respective issues.

As in the previous meeting in York, the program was designed to lead the debate from fundamental concepts on rural development statistics, introduced in the first edition of the handbook, to applied statistics and issues in many countries.

The success of the meeting and the publications of these proceedings is the result of the collaboration of the organizers, the Statistics Division at Fao and the National Accounts Division at ISTAT, and the editorial group of Maria Frustaci, Vilma Migliorini and Daniela Rendini who reviewed the papers. We would also like to thank many people from both Institutions for their continued support. Finally, we would like to express our great appreciation to the President of ISTAT, Luigi Biggeri, and the Director of Statistics Division of Fao, Pietro Gennari, for their support and contributions to this conference.

Edoardo Pizzoli

Wye City Group: Meeting Organizers

Fay Abizadeh, Forcasting & Quantitative Analysis Division Strategic Policy Branch, Agriculture and Agri-Food Canada (AAFC)

Anna Bienkunska, Labour and Living Conditions Division, Central Statistical Office of Poland (CSO)

Mary Bohman, Economic Research Service (ERS), U.S. Department of Agriculture (USDA)

Ray Bollman, Agriculture Division, Statistics Canada

*Koen Boone***,** LEI Institute, Wageningen University & Research centre, Netherlands

Carola Fabi, Statistics Division (ESS), Food and Agriculture Organization of the United Nations (FAO)

Giuseppe Fantozzi, Agriculture and Rural Development Department, World Bank

Robert Gibbs, Economic Research Service (ERS), U.S. Department of Agriculture (USDA)

*Pippa Gibson***,** Department for Environment, Food and Rural Affairs (DEFRA), U.K.

*Berkeley Hill***,** retired, former Imperial College, University of London, U.K.

*Jan Karlsson***,** retired, former United Nations Economic Commission for Europe (UNECE)

*Naman Keita***,** Statistics Division (ESS), Food and Agriculture Organization of the United Nations (FAO)

Edoardo Pizzoli, Italian National Institute of Statistics (ISTAT)

Local Organizers

Carola Fabi	FAO – Food and Agriculture Organization of UN
Naman Keita	FAO – Food and Agriculture Organization of UN
Micaela Paciello	ISTAT – National Institute of Statistics
Edoardo Pizzoli	ISTAT – National Institute of Statistics

Introductory speech

Pietro Gennari
Director, FAO Statistics Division

Distinguished participants and colleagues,

Good morning

It gives me great pleasure to welcome you all to the second meeting of the Wye City Group on statistics on rural development and agriculture household income, jointly organized by the Italian National Institute of Statistics (ISTAT) and FAO.

I am particularly delighted to recognize so many eminent experts participating in this meeting and to see a wide representation from different regions of the world. This is a clear indication of the growing interest in the work of Wye City Group and, more generally, in agricultural and rural statistics and bodes well for the quality of the technical discussions that we will have here at FAO Headquarters over the next two days.

First of all, I would like to thank ISTAT for the excellent technical support provided for the organization of this workshop. We greatly appreciate the possibility of working together with ISTAT to develop new methodologies and to assist developing countries in strengthening their capacity of producing, disseminating and analyzing agricultural statistics. Let me thank especially Prof. Luigi Biggeri, President of ISTAT for having graciously accepted to open this second meeting of the Wye City Group.

Dear colleagues,

This meeting comes at a particular juncture in the history of FAO and its Statistics Division. During the last two years, FAO has undergone an Independent External Evaluation (IEE) assessing its role and performance, with the objective to provide recommendations that would guide the Organization through a comprehensive reform process. According to the Independent External Evaluation (IEE) "the time has come for a total re-examination of the statistical needs for the 21st century and how they can be met".

More recently an External Evaluation of FAO work in statistics has been conducted. One of the key conclusions of the final evaluation report is that national capacity in agricultural statistics has progressively deteriorated over the last decades as a result of a lack of donor interest and a parallel decline in priority and resources at the national level. Today many developing countries, especially in Africa, do not have anymore the capacity to collect even the most basic agricultural statistics. As a consequence of this lack of good quality and timely statistics, decision makers at the national and international levels face major constraints in designing, monitoring and evaluating effective policies in support of agricultural and rural development.

In addition, national and global statistical systems are not able to respond to new data needs that are emerging in the areas of the environment, global warming, rural development and food security. These issues go beyond the narrow definition of agriculture and require a better integration of agriculture statistics into the national statistical system.

In response to the findings and recommendations of the evaluation, the FAO Management and Member countries have decided to strengthen Statistics as a core function for the achievement of the strategic objectives of the Organisation. The Statistics Division is collaborating closely with other FAO Departments to prepare a new Corporate Strategy in Statistics which is expected to better coordinate the different statistical work streams within the organization in order to enhance the efficiency of the FAO statistical system.

In partnership with major national and international organizations, FAO is also leading the international effort for the development of a strategy to improve agricultural and rural statistics. Under the auspices of the United Nations Statistical Commission, a working group of national and international representatives has been formed to prepare this strategy, with the FAO Statistics Division and the UN Statistics Division serving as secretariat for the initiative.

The strategy aims to identify a core set of national indicators which each country will pledge to provide on an annual basis, responding to the growing demand of information from national and international decision makers and reflecting agreement reached among national and international statistical organizations, donors, and other stakeholders under a United Nations mandate.

Another key element of this strategy is the integration of agriculture into the national statistical system, with the adoption of common methodologies that will improve the quality and consistency, across countries and over time, of the statistics provided. In particular an integrated survey framework will be established to provide a linkage between agriculture holdings and households, between agricultural production and other rural economic activities, between demographic, economic and environmental variables.

The Wye City group, in promoting the adoption of international standards in statistics for rural areas and agriculture household incomes, can greatly contribute to the development of the global strategy. In addition, the Group's attention to rural development issues and policies for rural and regional economic development can help FAO in identifying policy-relevant indicators to respond to users' needs in this area.

This second meeting of the Wye City group consequently comes to a very opportune time and FAO is very happy to host it. As you know, this second meeting of the Group will focus on issues related to the revision of the handbook Rural Households' Livelihood and Well-being: Statistics on Rural Development and Agriculture Household Income. The first handbook documented good practices in rural development statistics from the perspective of the developed countries, demonstrating the use by different institutions of a very large number of indicators for monitoring purposes. In accordance with the global strategy for statistics, this meeting could explore the possibility to identify a subset of core indicators for the measurement of rural development and agricultural household income that can suit a wider range of countries, including least developed countries and transition economies.

Dear colleagues,

I am confident that the workshop will achieve the objectives I have outlined. In this regard I would like to express my deep appreciation and thanks to all those who have already contributed to the success of this meeting by submitting papers of excellent quality. The organising committee has received a very large number of valuable contributions from different organizations and countries and have tried to give voice to the great variety of country analysis and issues, especially from developing countries, to expand the scope of the forthcoming debates that I hope you all will find very productive.

Let me therefore wish you fruitful deliberations and an enjoyable stay in Rome!

Thank you very much for your attention.

Introductory speech

Luigi Biggeri
President of National Institute of Statistics (ISTAT)

It is an honour and pleasure for me to be here and to give some short introductory remarks at this Second meeting of the Wye City Group On Statistics on Rural Development and Agriculture Household Income, organized jointly by FAO and ISTAT.

It is evident that the growing awareness of the impact of globalisation and climate changes has led to greater understanding of the information needs required to analyse different social interrelated developments rather than isolated ones.

This is particularly true in the rural world and probably it has led to overcome the traditional distinction, at least in official statistics, between agricultural and non agricultural sector.

To this end, let me recall the pleasant experience I had from 1987 to 2000 with FAO, as Senior Project Advisor within the projects aimed at carrying out the First Agricultural Census in China, which has certainly been the world's largest and more complex statistical survey so far.

At that time I was convinced, as national and international statistical organisations stated, that the census could be conducted only in agricultural sector. But the pilot surveys and the frequent visits to the country sites as well as long discussions with my Chinese colleagues convinced me and FAO that is not possible to consider agriculture as a separate sector when taking actions and decisions regarding rural areas.

Therefore the First Chinese Agricultural Census was really a Rural Census, maybe the first rural census.

I am very satisfied that since then at an international level agricultural statistics have been enlarged by adding statistical knowledge of the rural world and its development, thus recognising the important role of rural areas.

Nevertheless, at present the interrelation between agriculture and land use, rural development, environmental sustainability and overall well-being is considered not to be fully reflected in available statistical information.

My concern is the relatively low priority given to agricultural and rural statistics by global statistical community together with the worrying situation in developing countries especially in this domain.

In fact, the number of international and supranational organisations involved in agricultural and rural statistics is currently rather limited.

Fortunately, the International Conferences of Agricultural Statistics (ICAS), one of which was held in Rome, are carrying out particularly important activities, in order to bridge the gap between statistical information available and the needs and lack of analysis in this field of statistics. Furthermore, the work and seminars organized by the Wye Group on Rural Development contribute to this aim.

The objective of the Group, which is holding its Second Meeting, is the promotion of the refinement and adoption of international standards in statistics for rural areas and agriculture household incomes. Within this mandate, the city group would consider challenges to consistency of adoption of comparable methods of data collection across countries; give special focus to the application and value of the data standards in developing countries.

The Wye City Group (WCG) has been formed as a successor to the IWG.AGRI Task Force on Statistics on Rural Development and Agricultural Household Income which started its work in 2003 (Genève, Switzerland).

During the final IWG.AGRI Task Force meeting in June 2005 at FAO; there was the submission of the *handbook Rural Households' Livelihood and Well-being: Statistics on Rural Development and Agriculture Household Income*. The handbook was subsequently published to the UNECE website (www.unece.org/stats/rural), with printed copies available in 2007.

The Handbook gives an excellent overview of possible statistics on Rural Households.

As result of their collaboration on the handbook, statisticians and economists in national statistical offices, especially in North America, Western Europe, and in multilateral institutions have an established, shared interest in improving methods for collecting data on rural development, communities, and farm and non-farm households. Such information is becoming of increasing importance as policy for agriculture broadens, as rural issues rise up the political agenda, and as the structure of farming and rural areas evolves.

The objective of this Meeting is to further develop discussion on the topics and assess and explore the potential for the use of improved statistics as policy-relevant indicators and in empirical analysis of policies for farm and rural households, natural resources, and regional economic development, and determine the need for any changes or updating to the handbook and, if indicated, organize and execute the revision.

According to the programme, the sessions tackle different topics, ranging from "Changing Rural Paradigm: Emerging Issues and Data Needs" to "Innovation, New Tools and Results in Rural Statistics" and "Some Issues in Rural Development and Household Income Statistics for Countries at Different Levels of Development".

It is worth noting that such issues as the definitions of rural areas, rurality and agricultural household income, are of interest not only to "rural" countries where the contribution of the agricultural sector to the country's economy is considerable but they also arouse great interest in countries with a prevailing industrial economy (see for example the papers presented at the Plenary Session 3 *"Farm Families, Rural and Urban Non-Farm Families and the Incidence of Low Income in Canada"* or *"The Changing Nature of Family Farms in the U.S. and Europe: Implications for Data Collection").*

The importance of rural areas shows how fundamental these issues are even in a country like Italy (see the table). Following the OECD definition, rural areas in Italy account for more than 27 percent of the territory and 10 percent of the population. It is, therefore, a significant phenomenon.

OECD CLASSIFICATION	Distribution of population (Italy)	Distribution of areas (Italy)
Pre-dominantly Urban	50	23
Intermediate	41	50
Pre-dominantly rural	10	27
Total	**100**	**100**

Moreover, it is clearly evident that the experts attending this conference have once and for all gone beyond the division between those caring for statistics and agricultural economy and those caring for economic and/or social statistics, which can still be found sometimes in institutions and universities.

Such a result was already longed for at the 38th session of the Statistical Commission, where the document presented by FAO highlighted that the most important challenge for agricultural statistical systems in developed countries is their integration with social statistics. This integration could be achieved both by enhancing the production of statistics by type of territory (rural areas vs. other areas) and by looking for a definition of rural family to be consistent with the social context of developed countries. Furthermore the European CAP reform and international protocols on environment are changing the role of agriculture and forestry in the social, economic and environmental frameworks.

In addition to the several papers presented at this conference, the importance of baseline indicators within the framework of the CAP policies for rural development (i.e. those indicators that each country has to produce every two years) proves how significant statistics is for measuring rural development in Europe. More than 30 of those indicators measure the effect on the environment, agricultural sector competitiveness, life quality as well as the services available for people living in rural areas.

It is interesting to emphasize that many of the conference contributions concern technologies (see for example Plenary Session 2 ranging from remote sensing to the use of open source software). Apparently, these reports show that compared to the past innovations in technology allow to more easily solve some of the problems concerning the possibility to observe some phenomena or to make use of adequate data processing and dissemination tools. This means both the re-orientation of financial resources and the achievement a higher degree of standardization in production processes in the various countries, thus favoring the exchange of experiences and tools.

There are also papers in which the methodological aspect seems to prevail at least from the title. Different methodological tools are proposed for proper analysis and measurement of huge social issues (as for example Parallel Session 3 "Measuring Under-nourishment: Comparison Analysis between Parametric and Non-parametric Methods Based on Burkina Faso Agricultural Survey").

Although studying new aspects often requires specific data collection and stresses costs sustainability for National Institutes for Statistics, the agenda of the conference points out that new requirements can sometimes be met by mainly focusing on technological and methodological tools designed for the integration of different data sources set up for specific purposes.

Apparently, this is easier for those EU Member Countries where statistical processes are highly standardized. Their databases already allow to produce high-quality statistics for different sectors, such as rural areas, by using proper methodologies for statistical matching, for example, for small area estimation.

Nonetheless, highly specialized meetings such as this one serve as a way to spread the use of the so-called best practices in extremely different social and organizational contexts.

During the 38th meeting of the Statistical Commission the search for methodologies allowing integration of diverse sources was considered as a strategic issue, even though it seemed to refer to housing and agricultural censuses only, as shown in the paragraph V "Endorse the FAO approach to the integration of agricultural censuses with other census and surveys and, in particular, with the population and housing census": "The census projects are moving the first steps in many countries and the achievement of synergies and efficiencies in carrying out such demanding surveys is surely one of the main concerns for most NSIs. The need for observing new aspects of agriculture such as rural development, environmental impact of agricultural activities, the integration between agricultural and population censuses, etc. could produce prohibitive costs and a huge statistical burden if only traditional census is considered. New solutions are now under investigation and we invited FAO to be in touch with those NSIs that are proposing new methodologies for the next censuses in order to evaluate the coherence of the proposed solutions with its principles and recommendations for such fundamental surveys."

Statistics on these sectors should be characterized by full coherence and usability for assuring international comparability.

This meeting pays close attention to this issue and at the same time many countries, among which there is Italy, are already devoting resources and knowledge to it (for example the release on ISTAT's website of a new information system on agriculture or the introduction of rural areas in the new national statistics atlas.

The focus on the quality of statistics on rural development assigns once again a leading role to official statistics, regardless of its organisational structures.

Within this framework FAO contribution is extremely significant as shown by this initiative, as well as the on-going update and harmonization of statistics disseminated through FAOSTAT and COUNTRYSTAT.

Concluding these short introductory remarks, I would like to thank FAO and ISTAT staff, the speakers and all participants. I am sure that their very high professional qualification will allow us to achieve the main objectives of the Meeting.

SESSION 1

Plenary Session

Changing Rural Paradigm: Emerging Issues and Data Needs

Chairman: *Robert Gibbs, ERS*

Report on Plenary Session 1:

Changing Rural Paradigm: Emerging Issues and Data Needs

Chairman: Robert Gibbs, USDA-ERS

Overview: This session discussed the growing complexity of the relationship between agricultural endeavour and well being in both OECD and non-OECD countries. All of the papers by and large drew upon international comparisons to address issues related to changes in governance structure; the changing nature of traditional agricultural activity; and the changing allocation of labour across this traditional notion of agriculture and "non-agricultural" activities. A common theme was the need to reconsider the kinds of data needed to understand and monitor these trends both for research and policy implementation.

Rural Areas Definition for Monitoring Income Policies: The Mediterranean Case Study

Giancarlo Lutero, Paola Pianura, Edoardo Pizzoli, ISTAT

The authors examine the determinants of the large rural-urban differences in income levels across countries in the Mediterranean basis. An interesting feature of this spatial differentiation is that it occurs across areas that are geographically and often culturally similar. Rural-urban differences are identified consistently across countries, thus demonstrating the value of such territorial divisions for economic classifications and policy consideration.

Both authors and audience noted a number of key data needs that would allow a fuller accounting of international comparisons of well-being. The authors identified a number of important differences in the way data are collected as having potentially strong effects on the results of their analysis. Audience members discussed the extent to which the income differences were related to the density of agricultural density, a metric not easily captured by available data.

Ownership, Governance, and the Measurement of Income for Farms and Farm Households: Evidence from National Surveys

James Johnson (ERS), Mitchell Morehart (ERS),
Krijn Poppe (LEI),
David Culver (Agriculture and Agri-Food Canada),
Cristina Salvioni (University of Pescara)

The traditional view of agricultural decision making focused on the centrality of the single farm owner and associated household. A contemporary understanding acknowledges a far more complex view in which multiple owners, households, and other stakeholders share in both the decisions and the agricultural returns in ways not well captured by many farm surveys. The authors examine this changing governance structure in agriculture across the US, Canada, the Netherlands, and Italy, drawing from national surveys in each country. They document that the single owner/decision-making unit is still numerous in terms of share of farms owned, but contribute a disproportionately small share of production.

Diversification and Multifunctionality in Italy and the Netherlands: a Comparative Analysis

Laura Aguglia (INEA),
Roberto Henke (INEA),
Krijn Poppe (LEI),
Aide Roest (LEI),
Cristina Salvioni (University of Pescara)

In response to the crisis in the productivist model of agriculture, producers have increasing diversified their economic activities, including those with strong ties to farming, those that are tied only by the use of a common resource, and those related to off-farm activity. To understand how contemporary producers are maintaining income and remaining part of the rural development fabric, the authors draw upon the classification of activities proposed by Van Der Ploeg and Roep, and use Dutch and Italian FADN data to examine and compare the diffusion of broadening, deepening and pluriactivity strategies in the two countries. Results show that farmers in both the Netherlands and Italy widely rely on the strategies examined, but that the mix and frequency of strategy utilization varies, partly due to available information. Much of the discussion centred on the characterizations of the strategies, e.g., whether pluriactivity was really an expansion of activity from farming to off-farm, but often (or perhaps, more often) occurred in the opposite direction.

Data Sources and Quality Improvements for Statistics on Agricultural Household Incomes in 27 EU Countries

Berkeley Hill

Two paradigms that have driven agricultural data collection and analysis in the past – the centrality of agriculture in rural economic activity, and the dominance of the single-owner farm unity – have been fundamentally reconsidered in recent years. The author traces the efforts of European countries to recast their survey efforts in light of the changed realities and the challenges that have prevented full implementation of key initiatives. A critical role is played by the introduction of new member states into the EU, many of which have quite differences farm ownership structures, institutions, and employment activity.

Discussion

A common theme of the presentations was the significant limitations of current data to capture the emerging trends in agricultural management and household well-being identified in the session. For example, in the Lutero paper, a number of participants argued that wealth would be a stronger measure of long-term wellbeing than income, while acknowledging that data collection for wealth metrics is often inadequate. Even when the metric is correct, differences in the way data are gathered to produce indicators may prevent a full and accurate picture of international differences in economic processes. It was generally agreed, however, that a suboptimal measure is better than none at all.

There was also a general discussion about the challenge of collecting data that may be used to derive politically sensitive results. Statisticians serve the needs of policy makers, who are likely to be more sensitive to the conflict occasionally motivated by analysis; yet policy makers must also design and implement programs and policies that reflect emerging reality.

Ownership, Governance, and the Measurement of Income for Farms and Farm Households: Evidence from National Surveys

James Johnson
Economic Research Service, USDA, 1800 M St., N.W., Washington, D.C, USA
jjohnson@ers.usda.gov

Mitchell Morehart
Economic Research Service, USDA, 1800 M St., N.W., Washington, D.C., USA
Morehart@ers.usda.gov

Krijn Poppe
LEI, P.O. Box 29703, 2502 LS The Hague, Netherlands
Krijn.poppe@wrl.nl

David Culver
Agriculture and Agri-Food Canada, 930 Carling Avenue, Ottawa, Ontario K1A 0C5
David.Culver@AGR.GC.CA

Cristina Salvioni
University of Pescara, Italy
Cristina.salvioni@fastwebnet.it

Abstract: *A large majority of farms in the Netherlands, Italy, Canada, and the United States are family owned businesses. National census and survey data extend information about the extent of multiple households and owners engaged in farm businesses. Multiple owners are relatively common in each of the countries. Even among farms structured as proprietorships two or more owners may be part of a farm's ownership structure. Households and owners of farms also may not completely overlap. Examination of recent data reveals that many farms are structured so that a wide range of owners also interact with a variety of persons or entities to make farm business decisions. Expansion of farm governance structures to include additional parties may affect claims on farm output and income. The message is that agriculture is dominated by far more complex business arrangements than traditional models of business development would suggest. A result is that data collection and income measurement, both for farms and farm households, has become more complex. When household estimates of income are developed from farm-based surveys, care must be used to first correctly measure a farm's income and then to correctly distribute it to stakeholders engaged in the business.*

Keywords: farm, farm household, farm businesses, farm ownership structures, farm governance structures, farm income, farm-based surveys.

1. Introduction

A long-standing perspective viewed farms as a one-farm, one-farmer, one-household, low-debt form of business organization. In this view of farming, the farm and farm household were closely intertwined (Heady; Harrington & Manchester). Around the kitchen table of the farm where they live, they manage the farm and take the risks (Gasson and Errington, 1993, de Haan, 1993). Their reward for this is a "family farm income". Sociologists have stressed that the interaction between family and farm means that a family farm is more than a professional occupation; it reflects a life style (Calus, 2009). The simplicity of this bundled model of organizational structure gave clarity to the sourcing of farm inputs and to the distribution of returns (Boehlje, 2007). Everything flowed through the highly integrated farm-household unit or, in today's terms, the "agricultural household".

Economists have explained that the interaction between family and farm means that there is no clear way to allocate total family farm income as a reward for labour, capital, management and risk as a marginal reward for each of these inputs: the total return determines the decisions, not the marginal ones. This goes back to the agricultural household model developed by Chayanov in his Theory on Peasant Economy: decisions on production, consumption and the allocation of time over farm work, household work and leisure are integrated. At the macroeconomic level, traditional sector accounting frameworks provide a cross-walk between farm production accounts and household income and outlay accounts. The link comes from farm operating surpluses being transferred to the farm household as a source of income that originates from farming (Carlin). But, the underlying assumption is typically, once again, one-farm, one household.

For decades it has been recognized that this bundled or "one-owner" model of business formation is only one of many ways to develop farm businesses. While today's agriculture includes frequent use of more complex organizational forms, "one-owner" farms exist in large numbers and may even dominate in the public view of agriculture. Though numerous, "one-owner" farms generally account for a much smaller than proportionate fraction of output and income than their share of farm numbers. Instead, Censuses and national surveys show that output and income are concentrated on farm units with more complex forms of business organizational structures. Increasingly, farms, especially larger farms, include multiple individuals, households, families, or other entities collaborating in ownership or decision making. In this vein, complex farm organizations do not originate from the size of business or legal structure, but, instead, arise from the stakeholders and business arrangements that form the farm's input sourcing, decision, and control structures. This expanded view of input sourcing, decision making, and control has been characterized as an unbundled approach to farm organization where multiple households or other entities co-exist within the boundaries of the farm firm (Boehlje 2007b).

The Handbook on Rural Households' Livelihood and Well-Being takes up the issue of which households and sources of income in establishing a conceptual framework for measurement of household income. Importantly, the "Handbook" recognizes the presence of multiple households and use of business arrangements that introduce other entities into "a household's farming activities" (United Nations 2007). The "Handbook" in particular recognizes that many family-owned and operated farm businesses may be organized to have their own legal status and indicates that households found on family farms arranged as corporations should be treated as if they were proprietorships or partnerships. The Handbook focuses mostly on recognizing households on more complex farms as agricultural households and on the accounting of income from both farm and nonfarm sources and less on what the presence of multiple households may mean for the actual measurement of income for either the farm or farm household.

This paper takes up this issue by examining the complex relationships that may exist between farms and farm households in 21st century agriculture. We first pay attention to how organizational structures differ among farms and across countries and how they correspond with legal form of business, particularly for proprietor forms of business development. The paper then examines differences among farms in the number of households or other entities that may share in output or income and demonstrates how an assumption of one household even on proprietor farms may result in erroneous estimates of income. For farms organized as more complex legal entities we investigate ways that the business may reward farmers and farm households for the use of assets, including wages for labour and management inputs and dividends or other payments for use of equity capital. The paper concludes with a discussion of measurement issues for farms and farm households, and identifies necessary adjustments for data collection.

2. Ownership, Management, Governance: an Organizational Perspective for Farm Businesses

Five lines of empirical work underpin our approach to examining farm business ownership, management, and governance structures. These lines of inquiry confirm that: 1) Farm households increasingly feature a diverse bundle of economic and financial activities that transcend farming and rural sectors of national economies. 2) Household members may selectively participate as stakeholders in family businesses as owners, managers, or employees. Moreover, farms are generally accepted as being predominantly family businesses. 3)

Farm businesses, even farms of relatively modest economic size, increasingly operate in an input sourcing environment where production assets may be obtained from a variety of owners of the business and other suppliers. 4) Leadership and management, or decision making structures have devolved from largely centralized control units to include a variety of governance control options, strategies, and reporting mechanisms, and 5) The unbundling of input sourcing and devolution of governance structures expands the number of claimants to farm output and income.

Farm household diversity arises in part from decisions to participate in a broad set of farm and non-farm economic activities. Household members allocate resources, ranging from labour to entrepreneurial skills to either farm or off-farm activities. Off-farm work of farmers and members of farm households is well documented and has been an accepted characteristic of farming for many decades. Likewise, sources and levels of off-farm income and total household income have been documented through surveys and Censuses in many countries. It is also generally accepted that income from farm sources provides an incomplete perspective of the income situation of the majority of farm households, even the household of operators of very large farming enterprises.

In some countries, for example the United States, a larger share of operators declare their primary occupation to be something other than farming. In the most recent Census of Agriculture, released in February, 2009, only 45 percent of farmers reported farming as their primary occupation (USDA, 2009)[1] . Increasingly, farm spouses also work off farm. The tendency may be to think of off-farm work as being associated with smaller farm operations. But, even on very large farms a substantial number of operators declare non-farm occupations. For example, nearly one-out-of ten operators of farms with over $1,000,000 in sales in the United States reported a non-farm occupation in 2007. And, an even larger share of spouses located on large farms work off-farm than operators themselves. The trend of off-farm work by farm spouses is not unique for the US; the same is true for the other countries reported in this paper (Canada, the Netherlands and Italy). Higher levels of education and therefore specialization in the labour market, increased mobility by cars and perhaps even the internet (making working from home possible) are some of the drivers of this trend.

Moving beyond accounting for sources of wage and salary income, farm households also report investing in and earning income from a variety of off-farm sources. Documentation of diverse sources of household income is supported by farm households reporting balance sheets that include a wide variety of farm and non-farm assets that range from retirement accounts and other financial instruments to ownership of multiple business enterprises. In the U.S., about a fourth of the value of assets held by farm households, on average, consists of other personal, business and financial assets that are unrelated to household's farming enterprises. In Canada, approximately 12 percent of household assets are non-farm family assets (Farm Financial Survey 2007).

Farmers not only supply resources to a wide variety of non-farm uses, they acquire inputs for a wide range of non-farm sources. Purchased inputs typically consume more than 70 percent of the revenues generated from production of farm-based goods and services. The sourcing process for these inputs results in multiple business relationships that may extend over a wide geographic space, especially given that many farmers now engage in use of the Internet in their input purchasing activities (Johnson, 2008; USDA, 2009). In addition to traditional purchased inputs, farm owners and managers form their businesses to incorporate multiple linkages with a variety of households and other firms, including other farms, both within and outside their local communities (Figure 1). Some households may provide labour, managerial or other services in return for a payment established by some known arrangement. Other households, or firms, may provide infusions of equity capital in return for a share of net returns. These households or firms may or may not hold, or even want, a role in decision making. Instead they may opt to forego an active role in the business and a claim on farm returns in favor of some other payment such as a dividend. Yet other farms may be linked with other farm or non-farm businesses through some vertical or horizontal linkage or through some contractual arrangement. These relationships may be set up to affect the entire farm enterprise or a specific production activity. Vertical or horizontal linkages, whether through contract or ownership arrangement, may affect both the level and the distribution of returns generated by a farm.

A modern view of the organizational structure of farm businesses is illustrated in Figure 2. Given the unbundled approach to input sourcing typically used in farming, ownership structures may consist of one or

[1] Comparisons between countries are hindered by the definition of a farm that is the threshold to enter the census. The $ 1,000. - threshold for the US (including imputed values) is rather low compared to the EU.

more individuals, households, or other business entities. Moreover, more than one owner may reside within the same household. Likewise, there is no requirement that households holding an ownership position in a farm be part of the same family. And, firms with legal standing may also be an owner of a farm business either in its entirety or in partnership with other firms or households. The driving issue is who or what entity holds right to the use and disposition of farm resources and to the allocation of any residual earnings and not whether the holder of these rights is a specific individual, household, or other legal entity.

Management teams for farm businesses may range from the traditional single farm operator to several individuals, or in the case of farm management companies, even firms with legal standing. It is also not uncommon to find farm owner-operators developing advisory groups to provide input, even on an informal basis, into farm decisions. In today's farming, participation in joint ownership of some asset, some venture to start or share a production activity, or to engage in producing livestock or crop commodities for another farm is also relatively common. Business arrangements such as these may introduce other stakeholders into a farm's decision making structure. Many of these stakeholders may not only participate as a decision maker, at least for a selected production activity, they may also hold a claim to a share of farm output or net returns. With production contracts, for example, the farm operation most likely does not even sell the livestock or crop output. Instead, the contracting firm removes the physical production and makes payment to the farm business according to some agreed to terms. How income is ultimately distributed among households and other claimants is an outcome of the contracts and rules established to govern operation of the business.

3. Farms as Family Business Enterprises

The organizational forms that are prevalent in agriculture are motivated to some degree by economics. Different forms have their own costs and benefits. For example, industrial organizational forms in agriculture are linked to situations in developing countries where local capital and management are scarce (and brought in by multinational companies) and relatively inexpensive labour is abundant. Pollack (1985) interpreted the family farm as an organizational solution to the difficulty of monitoring and supervising hired workers (Pollack). Others stressed risk-sharing perspectives, especially in share-cropping and contract farming (Otsuka et al. 1992; Chueng, 1969). In recent years economists have stressed an incentive based, transaction costs and property rights approach from the new institutional economics discipline. Based on the work of Coase, Chueng, Demsetz, Hart and others Allen and Lueck (1998; 2002) modeled the choice of the organizational form as a trade off between specialization and moral hazard incentives. Specialization of different tasks (employing different kind of labour or out sourcing activities to specialized firms like contractors) is attractive but limited by agency costs. Seasonality, randomness of outcomes of the production process (due to imperfect control of the biological production process), and costs of supervising (also due to the spatial characteristics of a farm) limits the benefits of specialization and size. This explains why farming has generally not converted from small, family-based firms into large, factory-style corporate firms (Allen and Lueck, 1998).

A variety of definitions have been used in farm finance and structural analyses to define family farm operations (Johnson, 1993). Most attempts to define farms as family businesses use characteristics of business development and operation. For example, family farm businesses have been defined to include some minimum amount of sales and to make use of a limited amount of hired labour in relation to labour supplied by farmers and household members. This definition also excludes hired managers and certain forms of business legal organization including non-family corporations and institutional farms such as those owned by a governmental unit (Salant). In some countries, farm legislation has provided an implicit definition of family farm businesses by focusing on forms of business organization, such as non-farm owned large-scale corporate farming enterprises that were viewed as being potentially harmful to a family farm system of agriculture. Elsewhere, the perception of farms as family businesses has been more explicit. For example, farms in Great Britain have been reported to be mostly family businesses from the perspective that, "principals are related by kinship or marriage…business ownership is usually combined with managerial control and control is passed from one generation to another within the same family (Gasson et al.).

Research in the U.S. Department of Agriculture has also recently employed a definition of family farms that is grounded in business ownership (Hoppe, et al., 2008). Specifically, family farms, as currently being defined, include any farm where the majority of the business is owned by the operator – or operators on multi-operator farms – and persons related by blood or marriage, including relatives that do not reside in an operator's household. The ownership criterion as used within USDA focuses on the principal operator of the farming operation and the relatives of the principal operator. Unrelated secondary operators and their relatives do not count. Prior to this newer definition, family farm businesses included all farms, except those organized as non-family corporations or cooperatives, or farms held in estates, trust, or being operated by a hired manager. Both the new definition of family farms used at USDA and the definition advanced by Gasson, et al, utilize a concept of farms as family businesses that draws on ownership of the farm as an operating business rather than on some physical or legal attribute resulting from how owners assemble and use assets to produce agricultural goods or services.

All legal forms of business organization report farm businesses that include multiple households earning income, even farms that are classified as sole proprietorships (Figure 3 for the US, Figure 4 for Canada, Figure 5 for the Netherlands). This finding from census and national survey data underscores the importance of using an explicit measure of ownership in the identification and assessment of farms as family businesses. This is particularly the case if some number of households or individuals is assumed to have an ownership role in the business based on decisions made about how to legally structure a business enterprise. In Canada, for example, 2.4 percent of all farms organized as proprietorships report more than one household (Ag-Pop Census Linkage 2006). Census of Agriculture data from the U.S. are a little different, reporting the number of households sharing in net income of the farm. This data collection revealed that, in 2007, 18 percent of farms organized as individual or sole proprietor operations had more than one household sharing in net income. Households may be reported as sharing in net income for a variety of reasons, but, if we accept that a residual claim on earnings of the business is a reflection of ownership, these U.S. census data indicate the presence of multiple owners even on operations identified as proprietor-based businesses. A larger share of businesses organized as partnerships and corporations reported multiple households sharing net income than proprietorships reported.

One of the explanations for multiple households on even sole proprietor (or operator/spouse owned) farms is that increasingly farm businesses have multiple production locations. In the period 2003 – 2007 the prevalence of this strategy has increased in the Netherlands (Figure 6) and such farms are now responsible for 5.6 percent of total output. Farm enlargement doesn't wait anymore for the neighbor's farm coming up for sale. Some larger farms that reached economies of scale at their original location follow a replication strategy. In such cases the second or third location also may have a household, where one of the family members (not necessarily being an owner) lives.

In recent U.S. surveys, ownership has been more explicitly measured by examining the ownership interest held by operators, their households and relatives whether by blood or marriage, and even by asking outright the number of owners associated with the farm business. Based on the operators reporting an ownership interest of more than 50 percent of the business, 98 percent of farms in the U.S. were family-held businesses in 2007. The ownership interest reported by survey respondents ranged from 99 percent for individual or proprietor farms, down to 83 percent for partnerships. These census and survey-based data confirm that while farms remain largely family-held businesses, owners and the ownership stake of operators and their extended families cannot necessarily be inferred from either the legal form of the business or other attributes such as tenure. Data from the Dutch FADN, presented later in this paper, also provide a similar conclusion: farm structures become more complex, owners choose relevant legal forms of the business, but farms remain largely family-held businesses.

4. Ownership: Farm Ownership Structures Move Beyond One-Farm, One-Owner

Ownership has been described as a legal condition with economic consequences (Bostwick). The economic consequences of ownership, as ownership is used conventionally, generally include two formal rights: "the right to control the firm and the right to appropriate the firm's residual earnings (Hansmann)". Or, rephrased, the owner of a resource holds a legal right to its use and disposition (Bostwick). For our purposes, farm owners are the individuals or legal entities that hold the rights to determine how farm assets will be used in production and how any net returns earned by the business will be distributed.

Multiple individuals or households can be associated with a farm business, even those organized as proprietorships. Proprietorships, for example, can be modified when the proprietor, or owner, of the business engages in a variety of formal or informal contracts to take another party into the business through some sort of business arrangement (Thomas & Boehlje). Examples include an enterprise or wage agreement or a joint venture related to some production activity. A common example of when such a modification might occur is when a parent adjusts the business to take a son or daughter into the operation. Likewise, use of partner and corporate forms of organization introduce multiple stakeholders. The end result is that the number of households and owners associated with farms can be substantially larger than the number of businesses. Data have also been reported for the Netherlands, for example, to demonstrate that farms may feature multiple entrepreneurs (Poppe). And, agricultural censuses in Canada and the U.S. have documented the presence of multiple operators. Italy has similar data for its farm businesses as well.

More recent data from Canada, Italy, the Netherlands, and the U.S. extend information about the extent of multiple households and owners engaged in farm businesses. In Canada, proprietors report 2.4 percent of farms having two or three households. Meanwhile, partnerships operating without a written agreement report 14 percent of farms with two or three households. The share of farms with two or three households rises for family corporations and partnerships operating with a written agreement. Data from U.S. farmers show a similar pattern (Figure 7). Over 12 percent of individual or proprietor farms have two or more households sharing net income.[2] In 2007 there were approximately 2 million households of primary operators associated with family farm businesses. Joining these primary operator households were another 370,000 households of other persons, with nearly three-fourths being aligned with proprietor operations.

In Italy, 2007 data for commercial farms,[3] collected by the RICA-FADN survey, show that a majority of farms have one owner. The share of farms with multiple owners is higher though in corporations and particularly in legal partnerships (Figure 8). In addition, even among farms owned by a principal operator household there are cases in which there are more than 2 or 3 owners.

Households and owners of farms may not completely overlap. Thus, just as it may not be appropriate to look at a proprietorship form of business and allocate all business activity to one household, even if households are correctly counted, owners may still differ. This occurs because some owners may not be a part of the operator's household or even extended family. This point is illustrated in Figure 9 which shows that nearly three out of five farms in the U.S. have more than one owner while 85 percent of farms have one household. About half of all farms report multiple persons with an ownership interest within the primary operator's household. Most of this is likely operator-spouse co-ownership of the business. Still, even after accounting for household-based co-ownership, over 253,000 farm owners are not part of the principal operator's household with over 100,000 of these owners being a part of sole proprietor businesses (Figure 10). As expected, farms organized as partnerships or corporations have a larger share of multiple household arrangements and a larger share of owners that are not a part of the operator's household. A similar result is illustrated in Figure 11 for the Netherlands. Besides the classical one household – one entrepreneur (owner) situation there are households with 2 entrepreneurs (often man/spouse or father/son, but also a considerable number of 2 brothers living together) as well as households with 3 entrepreneurs (often operator, spouse, and son) and two households with 2 entrepreneurs (often father and son, but also 2 brothers). In this case, data available over a multi-year period suggests a rather stable situation.

5. Managerial Structures Evolve: From One-farm, One-manager to Multiple Person/Entity Decision Structures

While owners who direct resource use and disposition can be thought of as performing "leadership" functions (Hanson), the function of management, and by extension of operators or managers of a farm business, is to "direct and control resources in the production process" (Bostwick). Managers focus on efficiency as they approach an issue where constraints have been set. For our purposes, farm operators or managers become the individuals or legal entities that make day-to-day decisions about how the farm is operated.

It is not uncommon for several persons or even hired firms with specialized expertise in the management of farm businesses to be involved in day-to-day decisions of a farm (Figure 12). Operational management structures of farms may also reach beyond an individual and his or her household to include members of an

[2] The Census of Agriculture and the Agricultural Resource Management Survey counted households sharing net income. This count may differ from the number of households associated with a business as reported for Canada.

[3] Farms are defined as commercial when they have an economic dimension above 4 European Size Units, i.e., around $4,800 euros.

owner-operator's extended family, other individuals, businesses that provide managerial services for hire, or even persons or businesses that may provide advice or input into decisions on an informal basis. Thus, similar to ownership structures, managerial teams may include a wide variety of farm and non-farm based skill sets and experiences. Moreover, farms with highly varied, often complex, managerial structures are not confined by national boundaries to any one country. Instead, complex farm operating arrangements are arising throughout the world as farming becomes increasingly intertwined with national and international economies.

Over 3.3 million individuals were engaged in day-to-day decision making for the 2.2 million U.S. farms in 2007. In addition to managers who were actively engaged in daily decision making, about 16 percent of farms hired professional management services, and over 5 percent included informal advisors as a part of their management team. A majority of farms in the U.S. report one or two persons charged with daily management decision making, with over 97 percent of farms reporting one or two person teams. While farms with larger numbers of decision makers account for 3 percent of farms, the farms associated with these teams account for about 16 percent of the value of production and a similar share of net income.

In 2007, about three-fifths of farms reported one operator, or manager, who made day-to-day decisions. Farms with one operator were overwhelmingly organized as sole proprietor, or individual, operations. Still, one-operator farms may be organized using a partnership or corporate form of legal structure. In these cases, the single operator is most likely either a hired manager or the farm was organized such that a large share of owners, members of corporate boards of directors, or partners are not active in day-to-day business management.

Most two person farm management teams consist primarily of the person identified as the principal operator and his or her spouse. In 2007, for example, nearly 86 percent of two person teams in the U.S. consisted of an operator and spouse. Overall, two person teams accounted for 35 percent of farms and generated 38 percent of farm value of production. This differs from farms operated by a single person which generated a less than proportionate share of output. There is a decided difference between two person teams organized to include an operator and spouse and those that include an operator that farms in combination with another person with regard to size of operation and generation of output. Operator-second person teams are more likely to manage partnerships or corporate businesses, with over a third of operator-second person teams managing farms with these forms of legal structure. In comparison, only about 4 percent of farms managed by an operator-spouse unit had a partnership or corporate legal form of organization. Farms managed by an operator-second person team also tend to be larger in economic size than farms managed by an operator and their spouse. Although accounting for one-out-of-seven two person management teams, these farms generated 40 percent of output that originated from farms with two-person teams and 15 percent of output from farms in total. Dutch FADN data (Figure 13) reports a similar situation. Two-operator farms in the Netherlands have 46 percent of production and 47 percent of the total family farm income. The traditional single operator farms (45 percent of all farms) are not the majority of farms anymore[4]. Being smaller than average they produce about a third of the output and take only a quarter of the total income.

In Italy the single operator is still the dominant form of management (Figure 14). More precisely, 95 percent of commercial farms reported only one person in charge of daily management decision making. Management teams with two or more person are slightly more frequent among partnership and corporations. The percentage of farms with one operator increases when the whole population of farms, comprehensive of small, non commercial farms, is taken in account. The still limited diffusion of multiple person farm management teams is mainly due to the small dimension of farms (7 hectares on average over the entire population and 16 hectares among commercial farms).

The presence of multiple farm operators is supported by U.S. Census of agriculture data, showing in 2007 that about 58 percent of farms nationally had one operator. Moreover, Census also showed that family or individual operations – proprietorships – reported 60.5 percent with one operator, in line with the 61 percent derived from farm survey data. Perhaps more important than the share of farms with a single or multiple operator, Census data also show that the number of operators associated with farms is increasing more rapidly than the number of farms. Between 2002 and 2007, for example, the number of operators increased by about 222,000 persons or 7 percent, while the number of farms increased by about 76,000 or about 3.5 percent. Much

[4] In the Dutch Agricultural census this group still accounts for 56 percent. The difference is due to the relatively high threshold of the FADN that excludes very small farms.

of this expansion is accounted for by the increase in larger farm operations where the presence of multiple owners and operators tends to be more common.[5] In fact, a closer look at Census data reveals that the number of 1-operator farms decreased between 2002 and 2007 while the number of multiple operator businesses expanded.[6]

6. Farm Governance Structures Evolve: From Bundled Input Acquisition and Concentrated Decision Structures to More Dispersed Decisions and Unbundled Input Sourcing

Farmer's responses to Census and national surveys demonstrate a wide range of ownership and managerial structures for their businesses. Results also demonstrate that farmers utilize a variety of structures to govern their business operations. As illustrated by Calus and Huylenbroeck, farm owners can range from one to some larger number concurrent with people involved in management. How these owners and managers interact to effect control and decision making for the business and to bring labour, knowledge, and capital to the production process form a farm's governance structure (Calus and Huylenbroeck). In family economics, similar governance constructs have been draw to illustrate the overlap of family, ownership, management, and employee groups for businesses (Figure 15).

Governance structures are described as, "being concerned with how decisions about transactions are made, i.e., the exercise of authority, guidance and control, and with the allocation of income rights" (Jongeneel et al.). Re-stated, the "governance structure of a firm is based on ownership, decision making power, and control" (Calus & Van Huylenbroeck).

Poppe, et al, drew on their knowledge of legal structure, households, and persons engaged in farming to offer a preliminary perspective regarding governance of farms in the Netherlands (Poppe, et al). Recognizing that available data were not representative for the country as a whole, sample counts, absent any weighted averages or percentage distributions, were prepared to show that agricultural holdings – farms – had a range of entrepreneurs, that holdings could be associated with multiple households, and, perhaps more important to income measurement, that households and entrepreneurs held no fixed pattern across or among farms (Poppe, et al.). Some farms had one household and one entrepreneur while others had some much larger number of one or the other or both.

Further work in the Netherlands and recent data from national surveys conducted in the U.S. build on the perspective offered in both farm and family economic literature. In both countries data are now fully representative of the farm sector. Similar to survey results for the Netherlands, U.S. survey responses also indicate that farms have a wide range of owners interacting with some number of persons who were making farm business management decisions (Figure 16). The most common owner-operator combination was for one or two-owner farms to be managed by one or two individuals. Most likely these owner-manager combinations reflect either single or joint ownership by the farm operator and his or her spouse. Clearly, however, U.S. data show that many combinations of owners and persons engaged in daily decision making are not uncommon for a business.

7. Ownership, Management, Governance: Accounting for Farms' Net Income

A farm's organizational or governance structure includes aspects of business development that affect "how strategy is implemented, how the manager manages, and how work is planned and controlled" (Harling and Quail). In this context, strategy can be viewed as being, "implemented through organizational structure (Boehlje et al.)". Instead of whether a farm may be a proprietorship, partnership, or corporate form of legal business organization, the focus is centered on a farm's stakeholders. Who provides leadership, who makes longer-term and day-to-day decisions, and what are the lines of authority? Response to these questions helps identify contracts, written or unwritten, formal or informal, that exist within the farm. These contracts, or internal rules,

[5] For example the 2007 Census of Agriculture in the United States reported that farms with more than $1,000,000 in sales increase from 28,673 in 2002 to 55,509 in 2007, an increase of nearly 94 percent, while farms with between $500,000 and $999,999 increased in number by about 45 percent.

[6] The number of operators reported by the U.S. Census of Agriculture increased from 3,115,172 in 2002 to 3,337,450 in 2007. The number of farms reporting one operator decreased from 1, 325,855 in 2002 to 1,273,122 in 2007, a decline of about 7 percent during the time period.

specify the rights held by individuals, or agents, and how they will be paid (Fema and Jensen). Some stakeholders may hold a contract that specifies a fixed payment, while others earn a share of any net return generated by the farm. These latter stakeholders are typically referred to as the residual claimants or risk bearers for the business (Fema and Jensen).

The presence of an increasing number of multiple owner-operator businesses raises key questions not only about farm decision structures and who takes what decisions for current and longer term production and financing activities, but also about how managers are paid for services provided the business. These issues are important not only from the perspective of better understanding decisions ranging from farm production to technology adoption, but also from the perspective of performance measurement and reporting for farms and associated farm households. For example, how are additional, non-owner operators paid for services on farms organized as proprietorships? If these operators do not function as hired managers and earn a wage, then some arrangement, or contract, likely exists to share farm output or net income. As a result, additional households may hold claim to a share of net income even though they may not be a part of farm ownership.

Important from a measurement perspective is that multiple owner-multiple operator farms tend to account for a disproportionately large share of farm output and net income. In the U.S. for example, the 4 percent of farms with three or more owners accounted for over 20 percent of production and 16 percent of net income in 2007. Farms in the U.S. also demonstrated a range of households associated with each level of ownership interest. One owner farms, where the entire business interest was held by one person, still reported business structures where more than one household shared net income. While the most common arrangement was one or two owners with one household earning net income, other combinations are clearly present in U.S. agriculture. At least in an indirect way, survey results for 2007 are confirmed by reports from the 2007 U.S. Census of Agriculture. While the Census did not collect information about the number of owners associated with a farm, it did collect information about the number of operators and the number of households sharing net farm income. Responses to these questions show that 16 percent of one-operator farms had multiple households sharing income. Twenty four percent of multiple operator farms had multiple households sharing income (Figure 17).

We drew on guidance from prior work to devise a farm governance classification system, showing various combinations of owners and managers, to help illustrate the association of governance structures, households, and net income of farm businesses (Whatmore et al, Lockie, Campbell and Dinar, Parker). For our purposes we utilized a simple combinations of one and two owners with either one, or two or more operators, along with a catchall group that included farms with two or more owners for the US (Table 1), Canada (Table 2) and the Netherlands (Table 3)[7] The most common governance structure in all countries is the one-owner, one-operator farm, followed by two-owner, two or more operator businesses. The two-owner, two or more operator farms are primarily held and operated by an owner-operator and his/her spouse.

The United States. In the US, farms owned and operated by either a single person or by two-owners and two or more operators account for nearly three-fourths of farms and generate about three-fifths of output and net income. Even though nearly all farms organized with one-owner, one-operator or two-owners and two or more operator structures are family-owned businesses, these farms report that about one-out-of-ten farms share income. The share of farms with multiple households earning a portion of net income rises for farms with more than two owners, with 56 percent of these businesses reporting multiple households sharing income.

Beyond sharing income among multiple households, business arrangements and labour-hire decisions may also affect income measurement for farms and households. A small share of farms reports that they either participate in a production contract (about 2 percent of farms) or have a vertical linkage (less than 1 percent of farms) with another business. While currently representing a small share of farms, both of these practices may affect estimates of net income for a farm even before the distribution of any residual earnings is considered. As demonstrated in Table 1, on some farms, operators or family members may be paid a wage for labour hire or their managerial efforts. This practice is much more common on farms with multiple owners and multiple operators that it is on farms that are owned and operated by an owner-operator and his /her spouse.

[7] We recognize that more complex classification systems can be developed. Tools such as cluster analysis could be used to help organized farms into groupings. Tools such as this were not used for this paper since our purpose was simply to illustrate that owner-manager interactions frequently transcend traditional one-owner, one-operator governance systems, particularly for farms of larger economic size.

Both use of business arrangements and labour/management hire of operators and/or family members raise several issues for income measurement. The first issue is to account for how output and income that is generated by a farm is allocated to owners and stakeholders that participate in the business. Taking the case of production contracts, firms or individuals that contract with a farm to grow livestock or crop commodities under contract typically hold title to the output with the farm being paid a fee for services. Output is typically removed and sales do not show in the farm's income account. Only a fee is included. Vertical linkages, with a larger parent of affiliated firm, may generate similar output sharing issues. Here, a key question may become where revenues and costs show up in the multiple-firm arrangement. A second set of issues arises from the need to account for wages that accrue to owner-operators and household members. While wages paid a household member may be legitimate expenditures for a farm they are a source of earned income to a farm household. Keeping these farm business-household relationships straight is important to the measurement of income for both the farm and the farm household as separate entities.

Canada. The majority (57 percent) of farms in Canada are classified as sole proprietorships (Figure 4). Sole proprietorship farms generally follow the model of one owner where the farm profit is distributed to one household. Although this farm type is the most common, sole proprietorship farms account for 25 percent of the production. These farms tend to be small in size with many being part time operations. Average cash flow produced from the farm in 2005 was $10,729, which includes net farm income and wages earned on the farm paid to family members.

Partnerships are the second most common farm operating arrangement in Canada. Seventy-nine percent of partnership farms in Canada are owned by one household. The most common form of partnership is without a written agreement. These farms are generally family partnerships and usually the partnership is between spouses. On average these farms are relatively small with an average gross farms receipt of $107,360. In over eighty-six percent of the farms the income generated by the farm is distributed to one household.

Partnerships with a written agreement, which account for five percent of the farms in Canada, have more sophisticated ownership and operating arrangements. Partnerships with a written agreement may be between family members such as between brothers or non-family members. The written agreement can specify a number of issues related to management and ownership of the farm. These farms are generally larger and have average cash flow of $57,221. Over a quarter of these farms have the average cash flow distributed to two or more households. These farms are not corporations so the income from the farm is distributed as wages and salaries paid to family members and as net farm income.

In Canada 16 percent of farms are operated as corporations. The most common form of corporation is a family corporation where family members own and operate the farm. Over 80 percent of the family corporate farms are owned by one household. Family corporations are more complex, with gross farm receipts of $555,447. These farms can also be complex in their ownership and management arrangements. The income from corporate farms generally flows to the family in the form of wages paid to family members including the owner/operator and also in the form of dividends. The amount of dividends that flow to the household from the farms will depend on many factors including tax considerations and goals of the owners. Some corporate farms have also set up more complex organizations where land is rented from shareholders and money is borrowed by the farm from shareholders. In these cases the flow of income from the farm to the household is more complex.

In Canada, non-family corporations, although few in number, account for over 10 percent of the agricultural production. These farms, unlike the family corporations, have multiple shareholders. The day-to-day operating decisions of these farms are made by farm managers that are generally not owners of the farm. These farms have, on average, sales over $ 1 million and many have significantly higher sales. The farm operation is often part of a larger corporation that could operate throughout the supply chain. Farm profits are generally distributed to shareholders as dividends.

Other operating and ownership arrangements in Canada include co-operative farms where the resources are owned and pooled and are not owned by any one family. Co-operative farms general support several families. Although few in overall numbers, co-operative farms can be important in certain types of production such as western Canadian hog production.

The Netherlands. The majority of Dutch farms are partnerships, either operator/spouse or father/son. As reported above, classic sole proprietor farms count for only 46 percent of farms, a third of production and a quarter of income. Partnership farms are more dynamic and have a disproportional share of production and therefore also of subsidies (Table 3, Figure 18). This is especially the case for the group 'other partnerships' that include mostly two generations and have a farm large enough to generate an income for the next generation. Limited partnerships (a legal form in which partners have a common business, sometimes with limited liability for one of the investors) and limited companies are less important categories but especially limited companies are large. Their sales are 5 times as large as the average farm, which implies that this 3 percent of the holdings produce 12 percent of the output. These farms are especially active in horticulture, pigs, and poultry. These types of production are less subsidized. One fifth of total income in Dutch farm households is from non-farm sources. On all types of farms described in table 1 this is between € 16,000 and € 20.000 with the limited companies being the exception: only € 10,000. This makes it a relatively unimportant source of income for limited companies versus very important for sole proprietorship farms, where it amounts to one third of income.

The large size of limited companies with their high income and large cash flow (savings plus depreciation) made them huge investors in 2007. They used their cash flow to attract outside capital (equity or borrowed) of more than 1.1 million Euros: 24 percent the industry's total. It is interesting to see that only 10 percent of the limited companies support two or more households, 90 percent being a one-household farm. This is in contrast with the limited partnerships where only 73 percent of the farms support one household. This confirms the impression that the legal form of a limited company is often chosen as a risk management tool or tax management tool by a farmer, and not always as a governance structure between different investors.

Italy. In Italy the majority of commercial farms is owned and managed by a single person. Sole proprietorship is the legal status chosen by 93 percent of Italian farms; this percentage increases to 98 in the Southern regions of the country. This kind of farm operates 80 percent of total agricultural land and produces 70 percent of total agricultural production and income. The average size of sole proprietorship farms is very small both in physical (15 hectares) and economic (average net income 13000 euros) terms.

Legal partnerships account for less than 5 percent of farms in Italy. On average they operate 49 hectares and produce a net income of around 88000 euros. This kind of farm is particularly widespread in the livestock sector, especially in dairy, and shows a wider diffusion in the Northern regions, that is in regions in which agriculture in more integrated with the rest of agro-food system, hence of the economy. This is the group of farms with the highest percentage of multiple owners, while they are second to the non-family corporations in terms of multiple operators.

Non-family corporations, although less than 1 percent of total farms, account for around a quarter of the agricultural production. They are particularly frequent in the wine sector, a very industrialized sector, and among farms specialized in the production of cereals and industrial crops. In geographic terms non-family corporations are more diffused in the northern and central regions of the country. This group of farms is characterized by the highest percentage (21 percent) of farms with multiple operators. The more complex organization of these farms is explained partly by their large size, but also partly by the production of different product lines that often require technical and economic competences in fields very distant from each another. For example, this group of farms is very active in agri-tourism, as a consequence, they need an operator to take care of agricultural production, often wine, and another to manage the provision of agri-tourism services.

8. Concluding remarks

The message of this paper is that today's agriculture is dominated by far more complex business arrangements than the classic one farm – one location – one household – one family – one operator – one source of income form of business. Family businesses remain the core of the industry but by having additional sources of income and creating new governance structures (be it to support the intra-generational transfer of the farm, to increase the size of the business, or to exploit new opportunities) decision making has become more complex.

Data gathering to understand this world has also become more complex. Data collection systems (surveys like FADN, ARMS, or household surveys) should gather the complete picture of a farm business/household situation for a more exact and comprehensive measure of income and to understand decision making of the households (in case the data set is used for policy analysis). This central message is extended below for data collection activities.

Household surveys probably have fewer problems in recording the earned income of farm operator households as such. The issue is to make sure that all sources are accounted for and attention is paid to completeness. However, it is more difficult to relate household data to characteristics of farms or farming areas of countries and to sources of income (earned and unearned) and wealth. These types of data would likely be important if household income estimates are to be used to make any kind of policy assessments regarding either farm or rural economies or their contribution to the economy in general.

Where data collection efforts are is based on farm-centered surveys like ARMS or FADN a lot of attention needs to be given to the way questions related to governance structures of farms and to farm-household interactions are structured. Here the issue becomes two-fold. One is to correctly measure a farm's income – this introduces all the discussion about business arrangements and how assets are assembled. To address this issue, questions are needed to make sure that output and income flows are correctly tracked so that a farm's income can be correctly measured. Following measurement of income for a farm, stakeholders and their relationship to the farm still have to be correctly identified so that income can be distributed to parties that hold a residual claim. This raises difficult questions. Take the case of contract farming, where the sales of the farm are not the physical product (e.g. calves) but a service. Here the definition of sales may be different between a micro approach such as that utilized in the FADN / ARMS surveys and a macro approach such as that utilized in sector-wide accounting. Another issue is the leasing of farmland, machinery, or equipment that may be set up by farm families in a separate legal institution and leased to the farm. At the farm level there are no assets and only the costs of leasing production inputs. At the household level, however, rents received would be recorded along with assets and liabilities, in order to enable an accurate assessment of household income and financial status.

Bottom line, the lines of questioning in the surveys need to be developed so that farm stakeholders may be identified and related to the assets they bring to the farm, and to the roles they hold in the business, including their role in both daily management and longer term strategic oversight. Then, how they are paid for contributing to a farm has to be measured not only to derive an estimate of farm income but to correctly allocate income to individuals or other entities engaged in the business. At a minimum, how income is divided among households so that farm and off-farm sources of earnings can be correctly measured and linked is an important element of farm-household surveys in today's agriculture. Whether all this farm and off-farm information can be collected for every household associated with a farm is a question in itself.

One might question why an income measurement in a household survey or tax data set is not enough. For measuring income distributions and poverty it probably is. But our thinking is that this information is not only important for income measurement, but also to undertaking efforts to model farm adjustment, adoption, and response to government policies. The agricultural sector is an important object of agricultural, environmental, rural and – recently – energy policy with large budget and welfare impacts. Understanding the decision making and farm reaction to such policies is vital for any impact assessment. Therefore a correct and compete recording of reality in our data sets stays important. The current complexity in farm governance structures is a challenge to cope, not a reason to retreat.

References

Allen, D.W. and D. Lueck (1998). "The nature of the farm" in: *Journal of Law and Economics, 41 p. 343-386.*

Allen, D.W. and D. Lueck (2002). *The nature of the farm*. The MIT Press, Cambridge.

Boehlje, M. A. Gray, C. Dobbins, A. Miller (2007). Implementing Strategy: The Key Strategic Decisions for the Farm Business, Purdue Extension, Knowledge to Go, Farm Business Management for the 21st Century, West Lafayette, Indiana, June.

Boehlje, M. and B. Erickson (2007b). Adapting Your Management Style As Farm business Structures Change, Top Farmer Crop Workshop Newsletter, Purdue University, March.

Bostwick, D. (1969). Returns To Farm Resources, American Journal of Agricultural Economics, Vol. 51, No. 5, December, 1969, pp. 1528-1535.

Carlin, T.A. and A.G. Smith (1973). "A New Approach in Accounting for Our Nation's Farm Income", Agriculture Finance Review, Vol. 34, pp. 1-6.

Calus, M. (2009). *Factors explaining farm succession and transfer in Flanders*, PhD thesis, Ghent University, Ghent Belgium.

Calus, M. and G. Van Huylenbroeck (2005). *Attitude of Flemish farmers towards alternative business governance structures*, paper presented at the EAAE seminar on Institutional Units in Agriculture, Wye, UK, April 9-10.

Campbell, M.B. and A. Dinar (1993). Farm Organization and Resource Use, Agribusiness, Vol. 9, No. 5, pp. 465-480.

Chueng, S.N.G. (1969). *The theory of share tenancy*. University of Chicago Press, Chicago USA.

De Haan, H. (1993). "Images of family farming in the Netherlands" in: *Sociologia Ruralis* 33 (2) p. 147-166

Fema, E.F. and M. C. Jensen (1983). "Separation of Ownership and Control", *Journal of Law and Economics*, Vol. 26, No. 2, Corporations and Private Property: A Conference Sponsored by the Hoover Institution, June, pp. 301-325.

Gasson, R. and A. Errington (1993). The farm family business, CAB International, Wallingford, UK.

Gasson R., G. Crow, A. Errington, J. Hutson, T. Marsden, and D.M. Winter. (The Farm as a Family business: A Review, Journal of Agricultural Economics, Vol. 39, No. 1, pp. 1-41.

Harling, K.F. and P. Quail (1990). *Exploring a General Management* Approach to Farm Management, Agribusiness, Vol. 6, No. 5, pp. 425-441.

Harrington, D.H. and A.C. Manchester (1985). Profile of the U.S. Farm Sector, Agricultural-Food Policy Review: Commodity Program Perspectives, U.S. Department of Agriculture, Economic Research Service, AER, No. 530, pp. 25-53.

Heady, Earl O., W.B. Back and G.A. Peterson (1953) Interdependence Between the Farm Business and the Farm Household With Implications on Economic Efficiency. Research Bulletin 398, Agricultural Experiment Station, Iowa State, Ames, Iowa.

Hansmann, H. (1988). Ownership of the Firm, Journal of Law, Economics, and Organization, Vol. 4, No. 2, Autumn, 1988, pp. 267-304.

Hanson, J.C. and D.M. Johnson. Leadership and Management of Farm Businesses, University of Maryland Cooperative Extension, Fact Sheet 67.

Hoppe, R.A., P. Korb, and D.E. Banker (2008). Million-Dollar Farms in the New Century, U.S. Department of Agriculture, Economic Research Service, EIB No. 42, December.

Jongeneel, R. N. Polman, and L. Slangen (2005). Explaining the Changing Institutional Organisation of Dutch Farms: The Role of Farmer's Attitude, Advisory Network and Structural Factors, Presentation, XIth International Congress of the EAAE (European Association of Agricultural Economists), Copenhagen, Denmark, 24-27, August.

Johnson, J.D. (1993). The Viability of the Family Farm as a Business Enterprise: A U.S. Perspective, Outlook '93 Conference, Austrailian Bureau of Agricultural and Resource Economics, Canberra, Australia, February.

Johnson, J., S. Vogel, D. Brown, and P. Stenberg (2008). Farm-Rural Economy Interactions and the Data Links Need for Policy Analysis, Meeting Paper, Wye Group on Statistics on Rural Development and Agriculture Househohd Income, York, UK, April.

Lockie, S. Is Subsumption still relevant? The Question of Control in Australian Broadacre Agriculture, rural Society, Vol. 7, No. 3/4.

Neubauer, F. and A.G. Lank (1998). The Family Business: Its Governance for Sustainability, Routledge, New York.

Otsuka, K., H. Chuma and Y. Hayami (1992). Land and labour contracts in agrarian economics: theories and facts in: Journal of Economic Literature 30 pp. 1965- 2018.

Parker, T. A Multi-Level Family Business Choice Model: A Dichotomous Approach, The Coastal Business Journal, Vol. 3, No. 1, pp. 56-60.

Pollak, R.A. (1985). A Transaction cost Approach to Families and Households, Journal of Economic Literature, Vol. 23, No. 2, June.

Poppe, K.J., H. van der Veen, K. van Bommel, and W. van Everdingen (2004). Developments in the organization of the farm and their policy implications, Pacioli 12, Income issues in Farm Households and the Role of the FADN, August.

Salant, P., M. Smale, and W. Saupe (1986). Farm Viability: Results of the USDA Family Farm Surveys, U.S. Department of Agriculture, Rural Development Research Report No. 60, July.

Tagiuri, R. and J. Davis (1996). Bivalent Attributes of the Family Firm, Family Business Review, Vol. 9, No. 2, Summer, pp. 199-208.

Thomas, K.H. and M.D. Boehlje (1991). Farm Business Arrangements: Which One for You? North Central Regional Extension Publication 50, NCR Educational Materials Project, 111 N Curtiss Hall, Iowa State University, Ames, Iowa.

United Nations (2007). The Wye Group Handbook, Rural Households' Livelihood and Well-Being: Statistics on rural Development and Agriculture Household Income, New York and Geneva.

U.S. Department of Agriculture (2009). National Agricultural Statistics Service, 2007 Census of Agriculture, United States: Summary and State Data, Vol. 1, Geographic Area Series, Part 51, February.

U.S. Department of Agriculture (2009). Economic Research Service, Rural Broadband at a Glance: 2009 Edition, EIB No 47, February 2009.

Whatmore, S., R Munton, T. Marsden, and J. Little (1987). Interpreting a Relational Typology of Farm Businesses in Southern England, Sociologia Ruralis, Vol. XXVII-2/3.

Table 1.—Classification of farms by governance structure based on number of owners and operators, 2007

Item	Governance Structure: one owner and one operator	one owner and two or more operators	two owners and one operator	two owners and two or more operators	more than two owners	All
Number of Farms	821,702	51,096	406,705	667,654	84,053	2,031,210
Distribution of farms (%)	40.5	2.5	20.0	32.9	4.1	100.0
Distribution of production value (%)	25.4	2.7	16.5	35.4	20.1	100.0
Distribution of net farm income (%)	28.8	3.1	21.1	30.6	16.4	100.0
Number of Owners	801,632	47,676	813,410	1,335,307	311,539	3,309,565
Number of Owners in operator's household	799,568	47,676	406,705	667,615	83,520	2,005,085
Number of households sharing income	933,850	68,090	453,084	768,404	180,012	2,403,439
Number other households sharing income	112,147	16,994	46,379	100,750	95,959	372,229
Farms with other households sharing income (%)	12.8	28.3	9.9	13.8	56.4	14.7
Farms family owned (%)	97.3	93.3	99.4	99.6	64.0	97.0
Distribution of operators (%)	28.6	3.7	14.1	47.2	6.4	100.0
Distribution of operators within group (%)						
All	100.0	100.0	100.0	100.0	100.0	100.0
One Operator	100.0	na	100.0	na	35.8	62.0
Two Operators	na	92.3	na	97.3	27.0	35.4
Three Operators	na	*5.3	na	2.2	31.4	2.2
Four or More Operators	na	na	na	*0.5	5.8	0.5
Farms vertically linked (%)	0.5	1.6	0.2	0.6	1.5	0.5
Farms with production contracts (%)	1.4	1.6	2.3	3.2	3.1	2.2
Farms with hired mgmt services (%)	13.8	15.1	14.9	18.1	22.7	15.8
Farms with informal mgmt team members (%)	3.4	7.9	5.5	6.3	11.6	5.2
Farms with principal operator paid to work on farm (%)			1.6	1.3	11.0	1.2
Farms with spouse of principal operator paid to work on farm (%)	0.7	1.5	0.9	3.0	6.9	1.8
Farms with other members of principal operator household paid to work on farm (%)	1.5	0.8	2.8	2.1	5.0	2.1
Farms with other operators paid to work on farm (%)	0.9	3.8	1.3	1.6	12.5	1.8

Source: 2007 USDA Agricultural Resource Management Survey.

Table 2 - Sources of Income from the Farm and Number of Households per farm by operating arrangements, Canada

Sole proprietorship	Partnership without a written agreement	Partnership with a written agreement	Family corporation	Non-family corporation	Other operating arrangements
57.1% of all farms 25.6% of all production Average gross farm receipts: $82,459 Net operating income $8,520 Wages paid to family: $2,209 52.6% of farms have positive cash flow	21.1% of all farms 12.4% of all production Average gross farm receipts: $107,360 Net operating income $13,658 Wages paid to family: $2,882 52.0% of farms have positive cash flow	5.6% of all farms 7.6% of all production Average gross farm receipts: $250,301 Net operating income $49,594 Wages paid to family: $7,627 74.8% of farms have positive cash flow	14.1% of all farms 42.5% of all production Average gross farm receipts: $555,447 Net operating income $82,197 Wages paid to family: $29,403 75.9% of farms have positive cash flow	1.9% of all farms 11.0% of all production Average gross farm receipts: $1,069,521 Net operating income $138,835 Wages paid to family: $16,552 67.5% of farms have positive cash flow	0.3% of all farms 1.0% of all production Average gross farm receipts: $581,989 Net operating income $127,747 Cash wages paid to family: $4,618 54.3% of farms have positive cash flow
Average cash flow $10,729	Average cash flow $16,540	Average cash flow $57,221	Wages to family: $29,403 + Dividends	Wages to family: $16,552 + Dividends	Average cash flow $132,365
Farms with one household 127,725 (97.6%)	Farms with one household 41,600 (85.9%)	Farms with one household 9,420 (73.9%)	Farms with one household 25,555 (79.2%)	Farms with multiple shareholders	Non-household farms Multiple households
Farms with two households 2,905 (2.2%)	Farms with two households 6,155 (12.7%)	Farms with two households 2,865 (22.5%)	Farms with two households 5,355 (16.6%)		
Farms with three households 235 (0.2%)	Farms with three households 675 (1.4%)	Farms with three households 465 (3.6%)	Farms with three households 1,365 (4.2%)		

Table 3 - Sources of income and number of households by type of legal organization in The Netherlands 2007

	Sole proprietorship	Partnership man/woman	Other partnerships	Limited partnership	Limited company	Total
Farms represented	25.664	12.623	12.199	6.553	1.514	58.553
Idem in %	44,0	22,0	21,0	11,0	3,0	100,0
Subsidies [euro per farm]	13.322	15.762	29.351	16.544	17.202	17.648
Idem in %	33,0	19,0	35,0	10,0	3,0	100,0
Output (euro per farm)	219.986	326.240	407.327	564.927	1.732.970	359.659
Idem in %	27,0	20,0	24,0	18,0	12,0	100,0
Family farm income (euro per farm)	29.838	47.801	87.455	70.491	163.779	53.729
Non farm income [euro per farm]	16.593	15.929	20.132	18.173	9.094	16.893
Cash flow (euro per farm)	56.756	58.828	110.655	99.323	701.455	84.720
Idem in %	29,0	15,0	27,0	13,0	21,0	100,0
Total low of funds (euro per farm)	75.300	104.423	155.141	145.517	1.154.049	126.195
Idem in %	26,0	18,0	26,0	13,0	24,0	100,0
Distribution number of households (%):						
1 household	99,0	100,0	70,0	73,0	90,0	90,0
2 households	1,0	0,0	27,0	23,0	4,0	9,0
3 households	0,0	0,0	4,0	4,0	5,0	1,0
4 households and more	0,0	0,0	0,0	0,0	1,0	0,0

Source: Dutch FADN

Figure 1 - Farm-households allocate resources to farm and non-farm uses and source inputs from multiple farm, household, and non-farm businesses

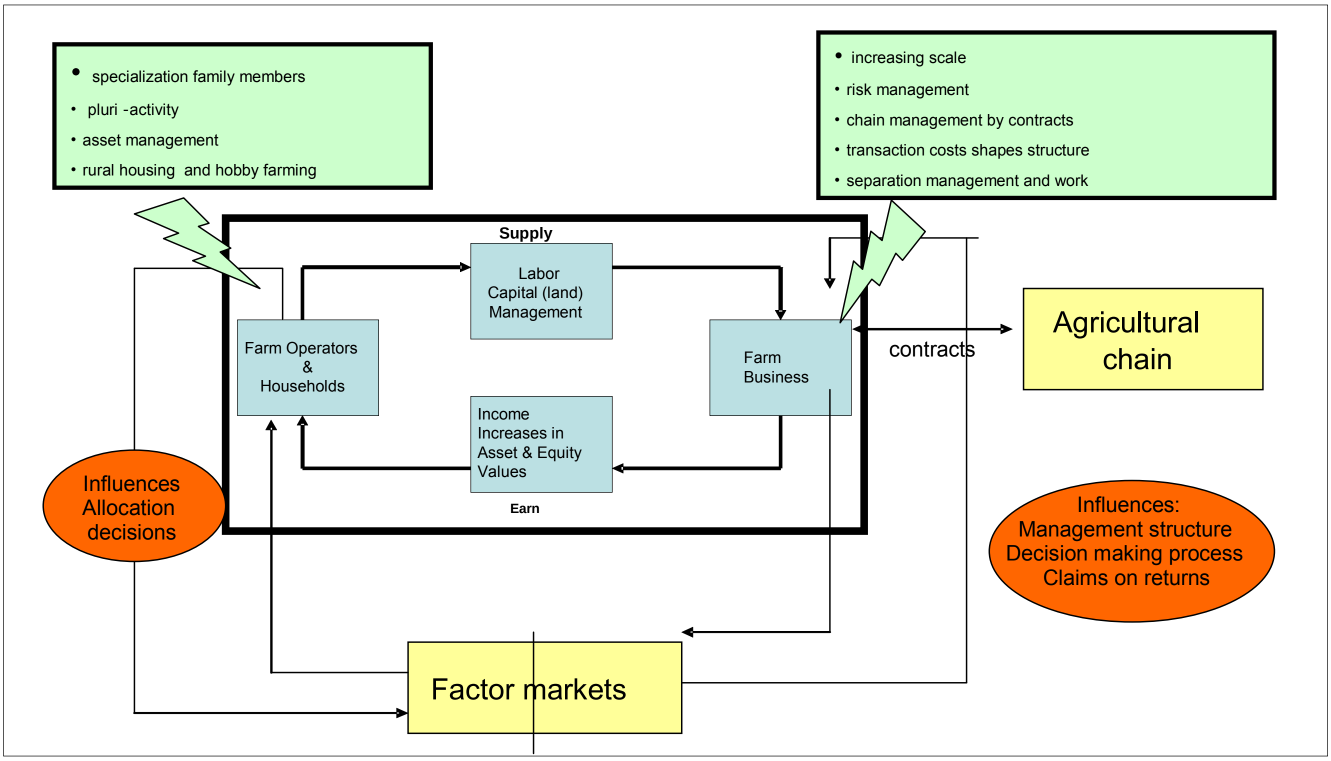


Figure 2 - Farm Organizational/Governance Structures May Range from One to Many Owners and Operators

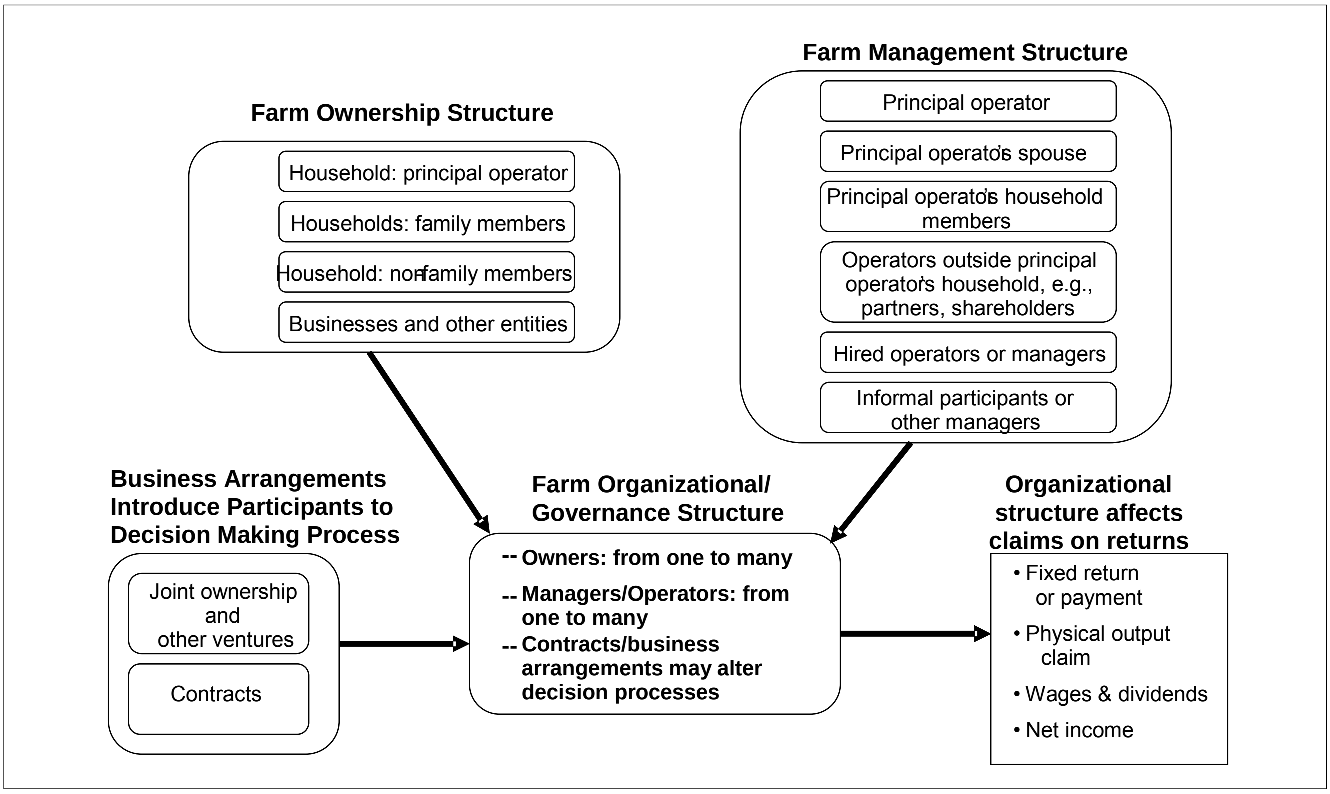
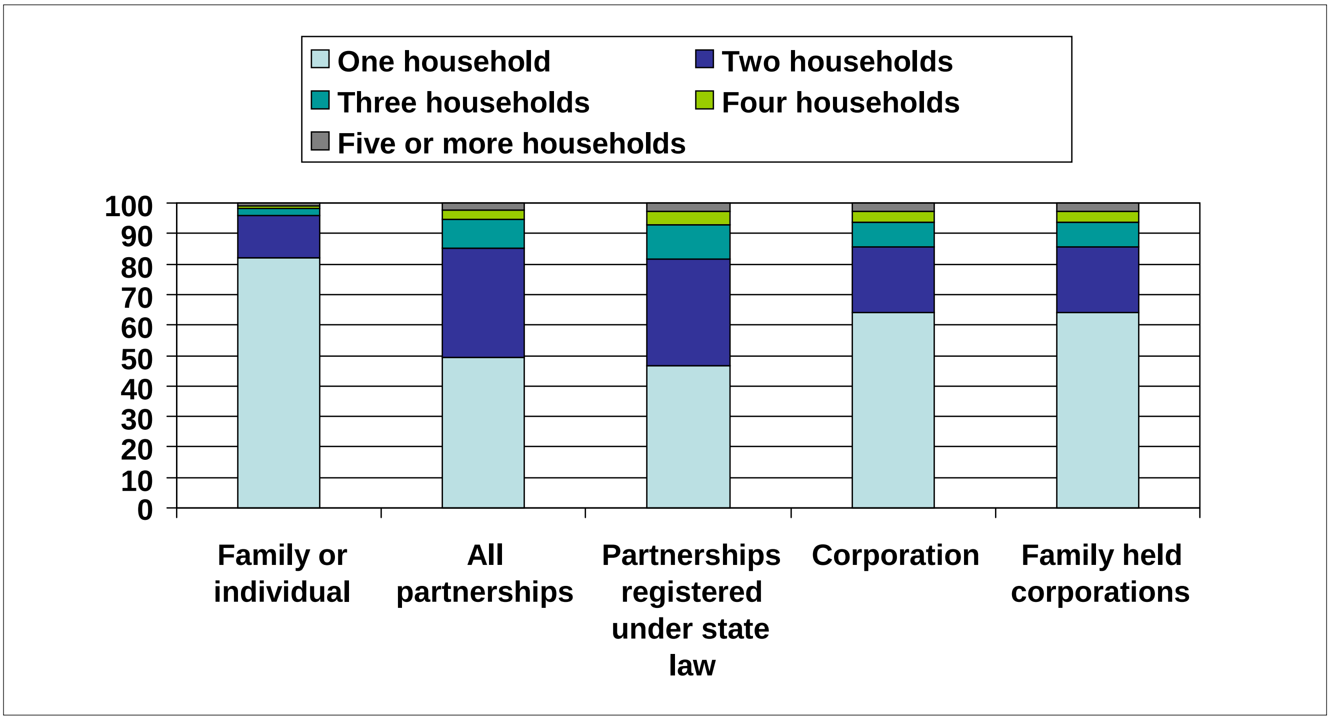


Figure 3 - Distribution of farms by type of legal organization and number of households sharing in net income of the farms



Source: Agricultural Resource Management Survey, 2007

Figure 4 - Number of households per farm by operating arrangement, Canada

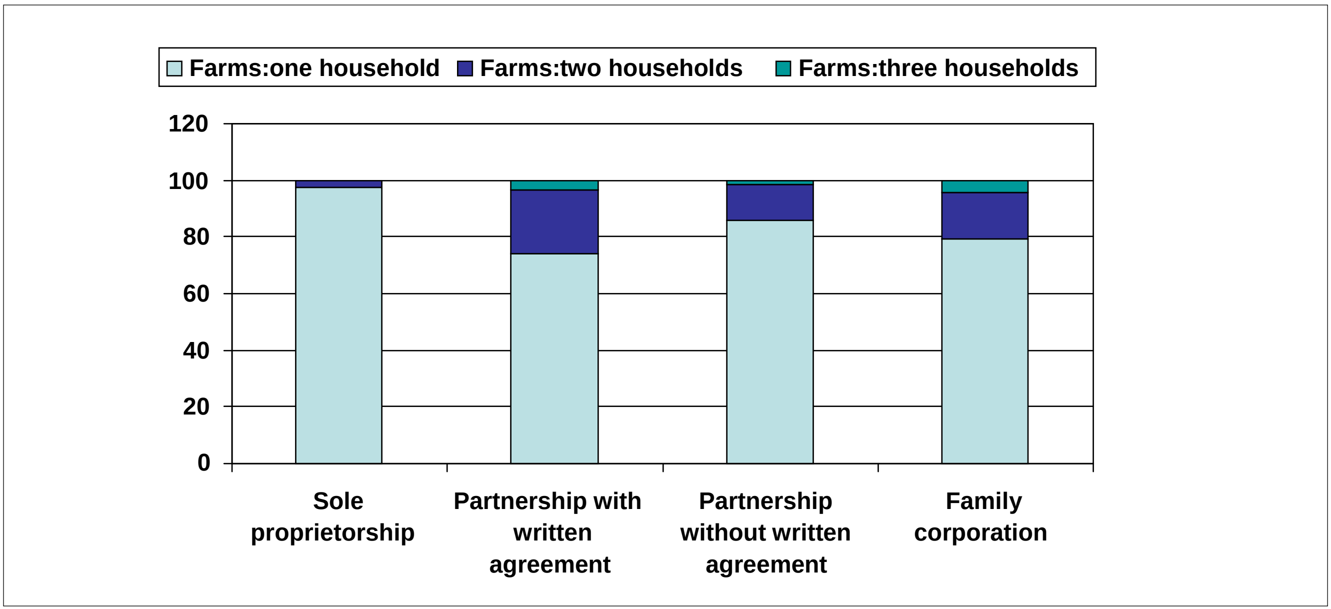
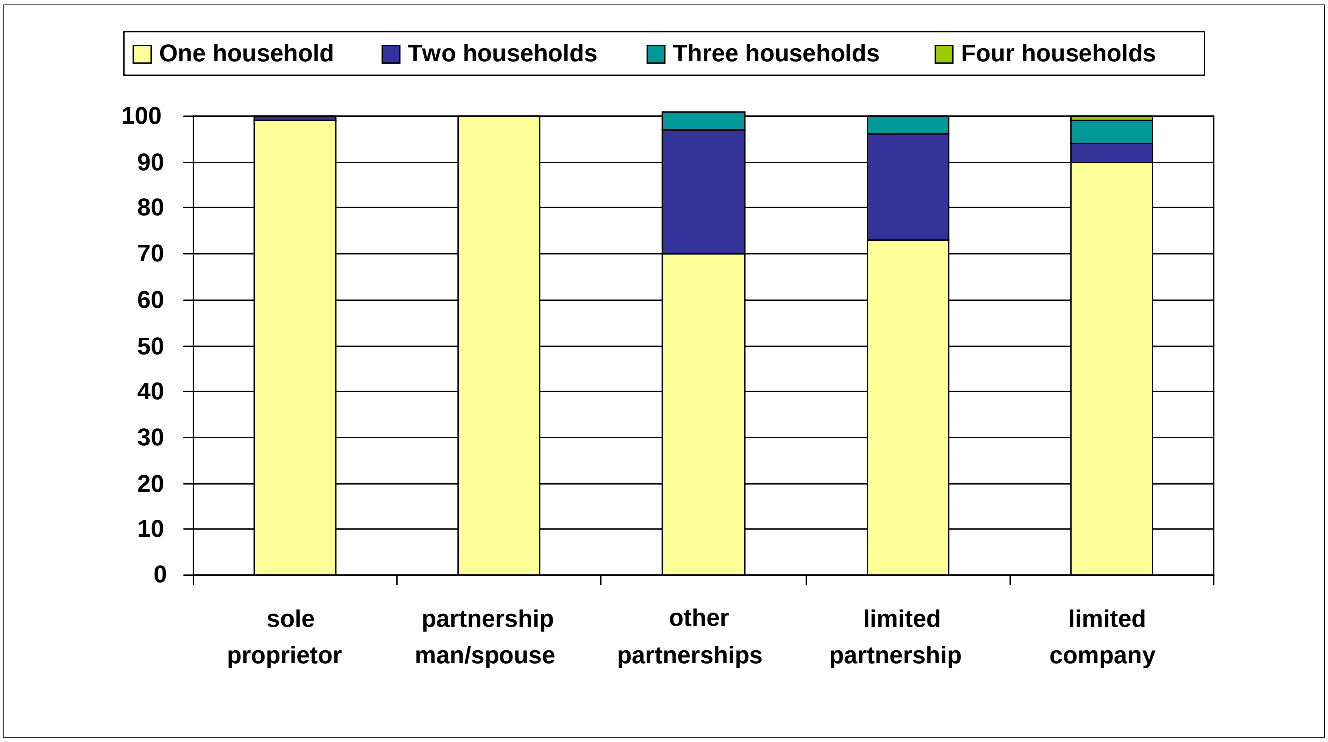
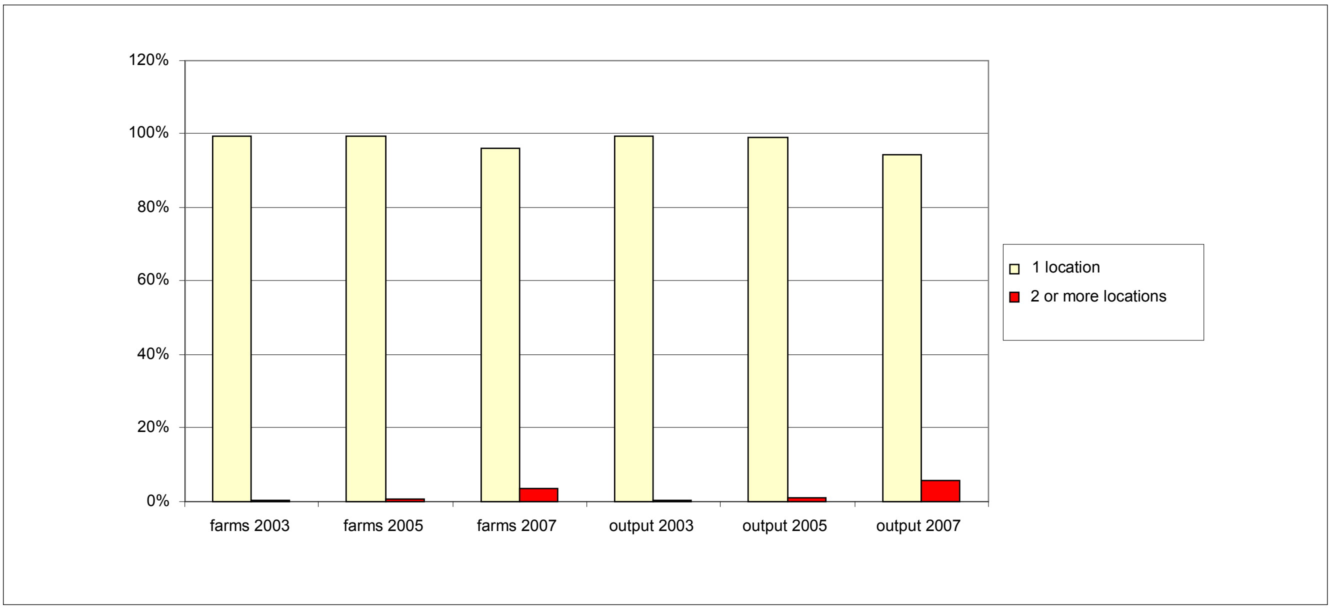


Figure 5 - Distribution of farms by type of legal organization and number of households sharing in net income of the farms in the Netherlands



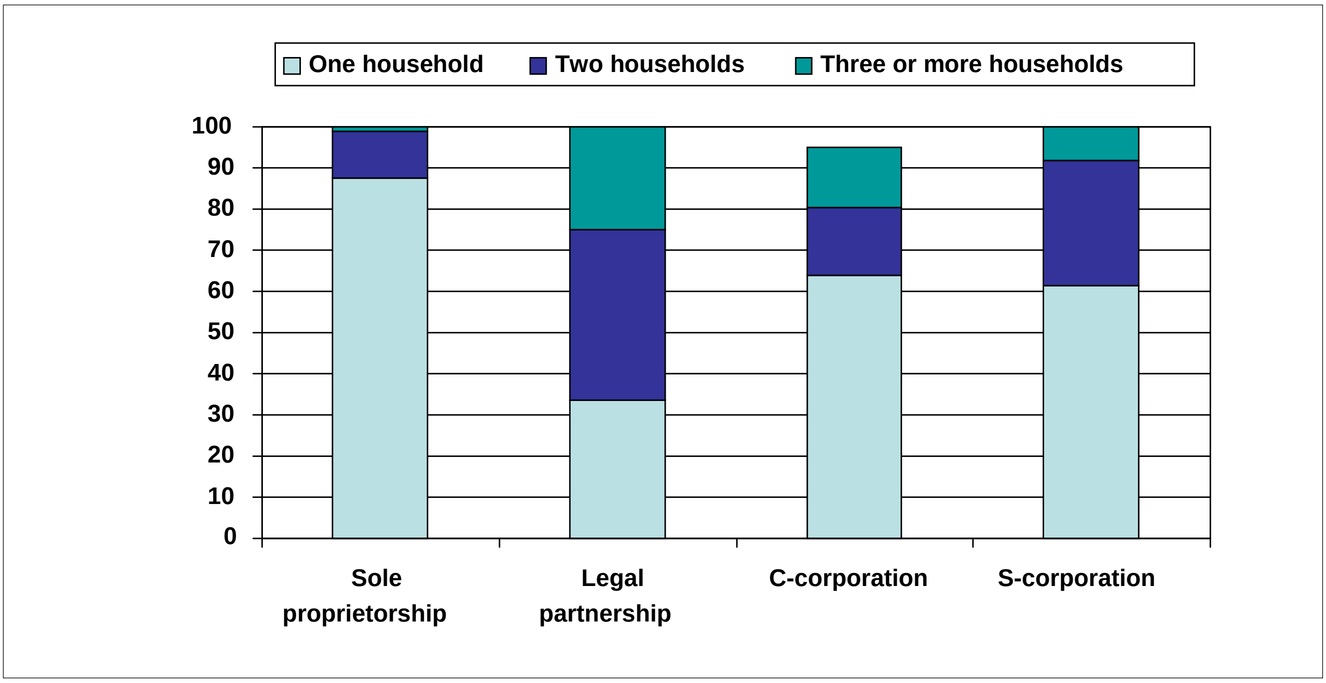
Source: Dutch FADN, 2007

Figure 6 - Number of locations (farm addresses) per farm business, the Netherlands, 2003-2007



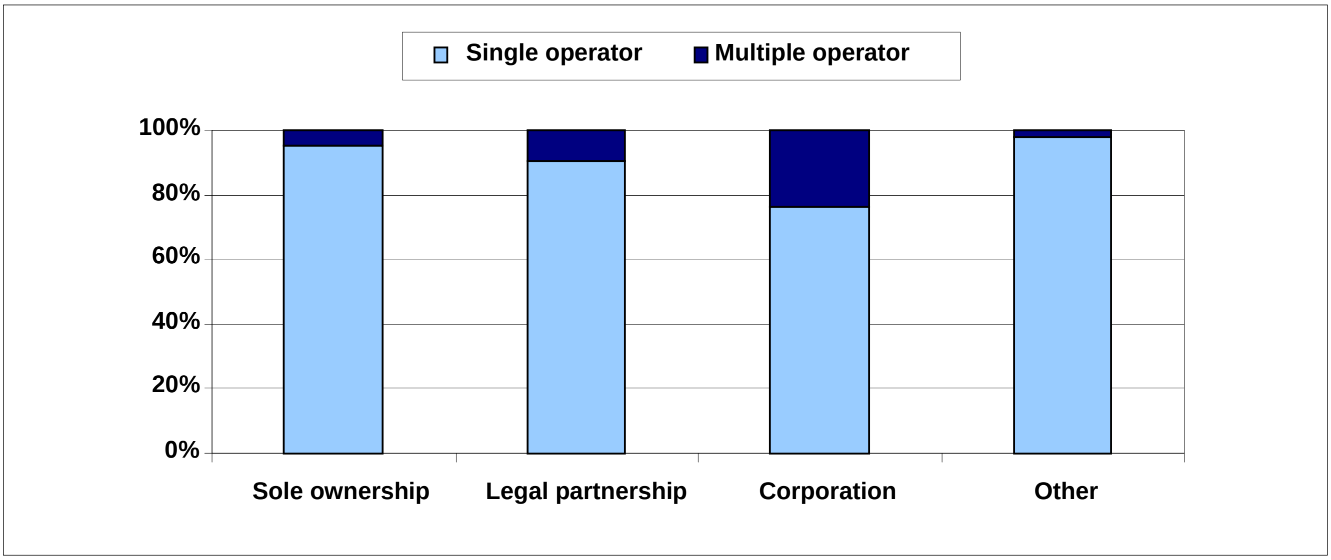
Source: Dutch FADN, 2007

Figure 7 - Number of households sharing net income, United States, 2007



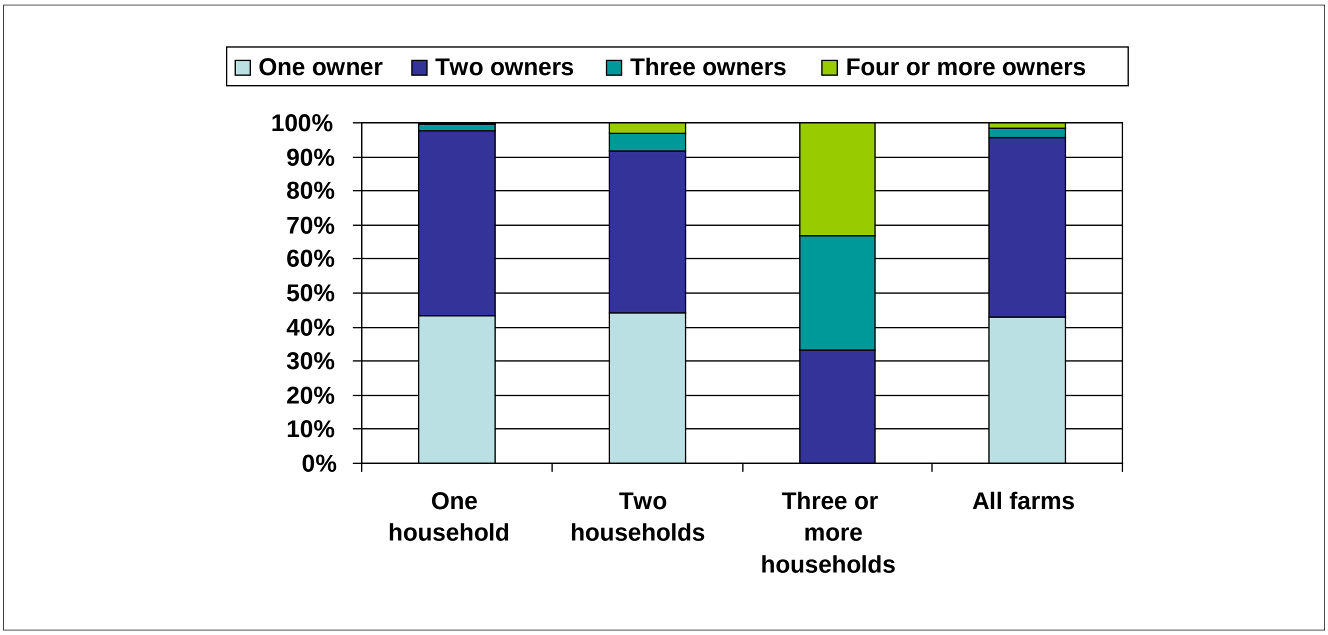
Source: Agricultural Resource Management Survey, 2007. C-corporation and S-corporations are specific legal forms of incorporation available to business owners in the U.S. S-corporation are typically viewed as small business corporations

Figure 8 - Farms by legal status and number of owners, Italy, 2006



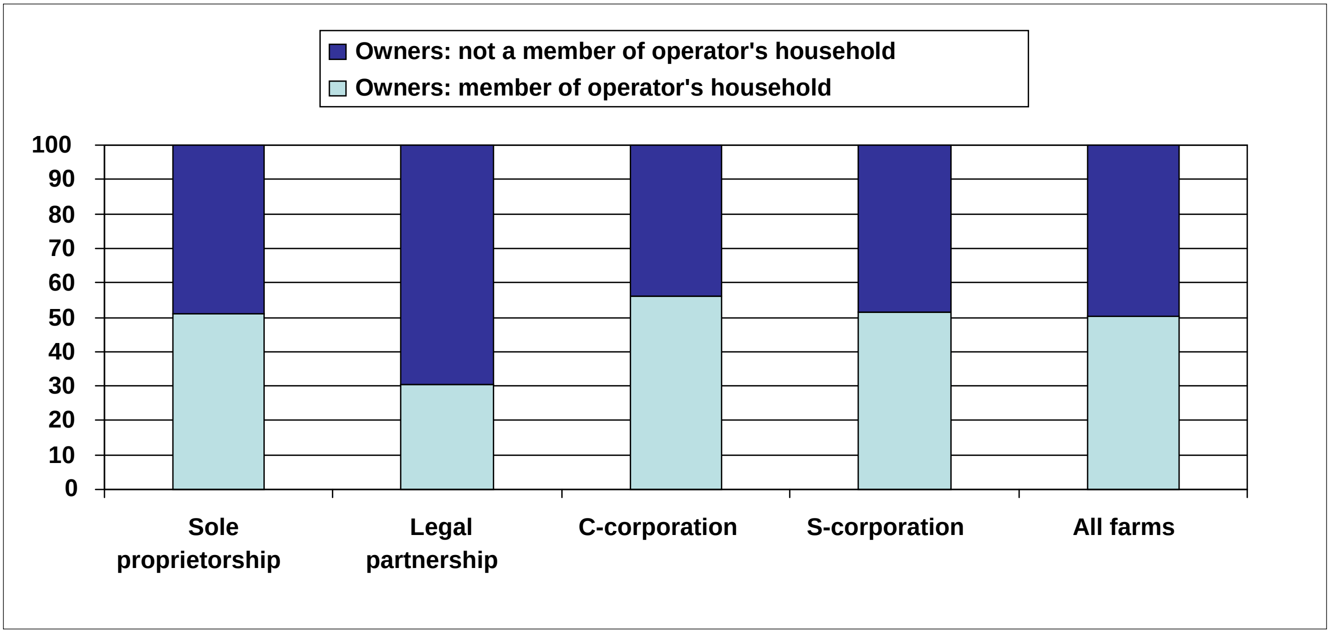
Source: Italian FADN, 2006

Figure 9 - Distribution of farm business owners by number of households associated with the farm, United States, 2007



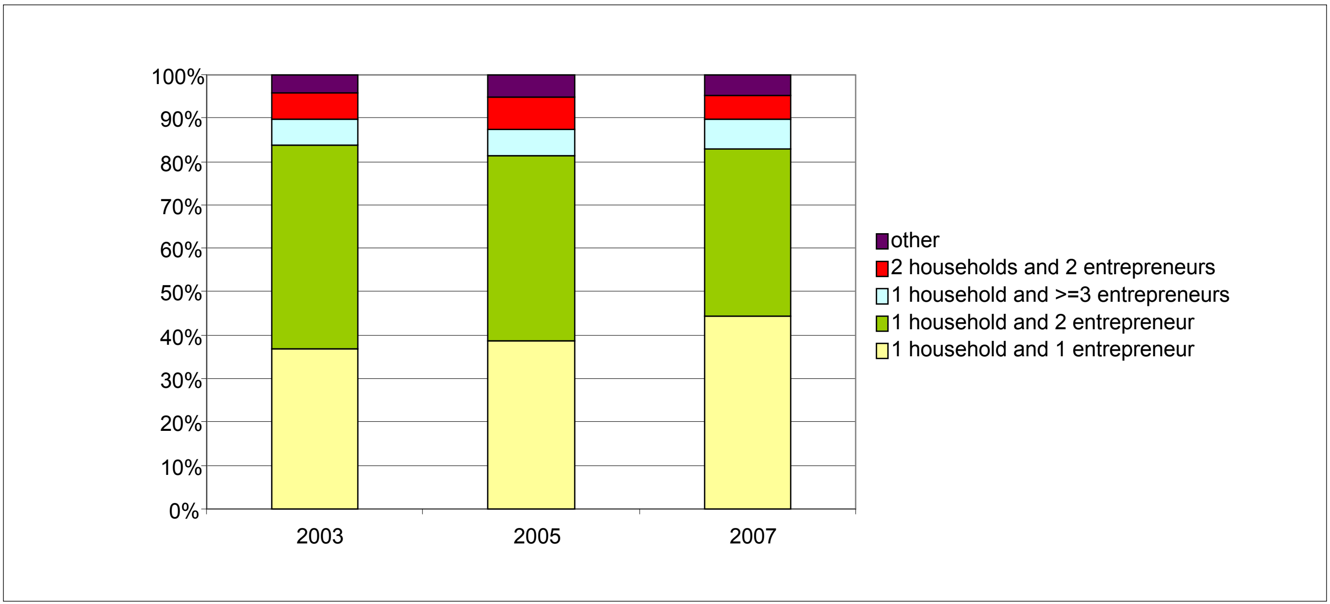
Source: Agricultural Resource Management Survey, 2007

Figure 10 - Share of farm owners that are part of the primary operator's household, United States, 2007



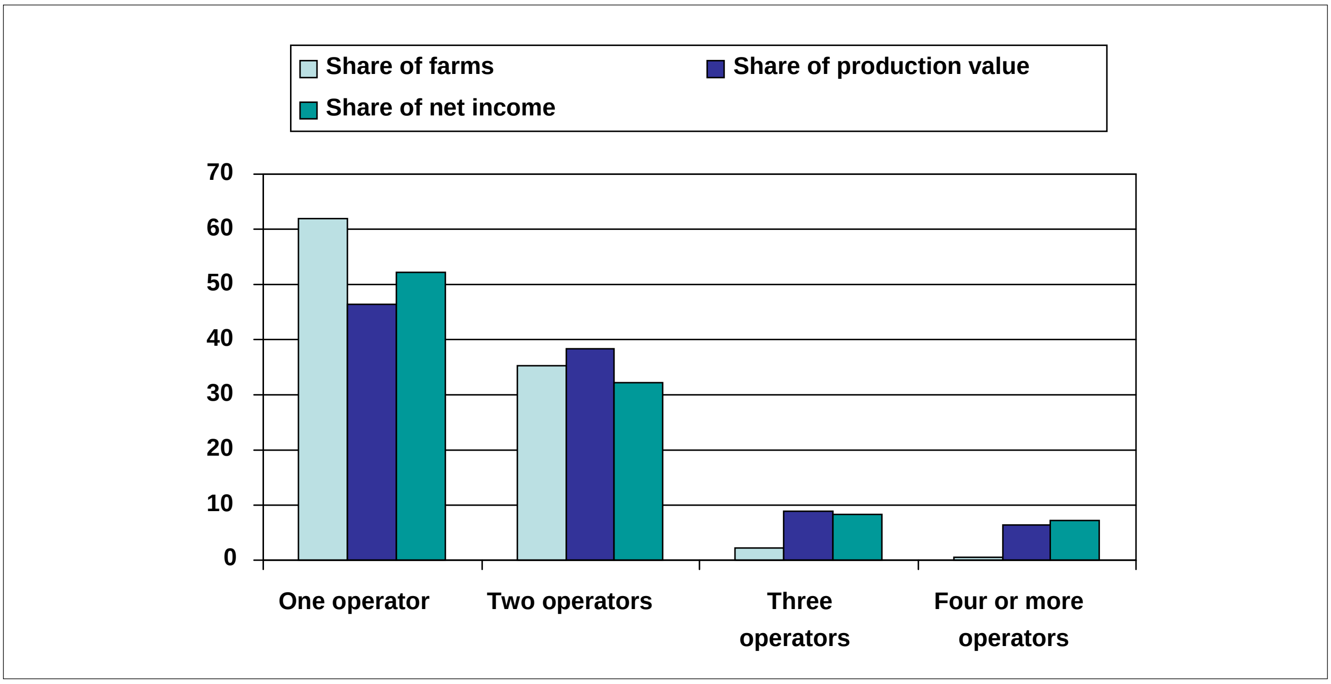
Source: Agricultural Resource Management Survey, 2007

Figure 11 - Distribution of farm businesses by number of households associated with the farm, The Netherlands, 2007



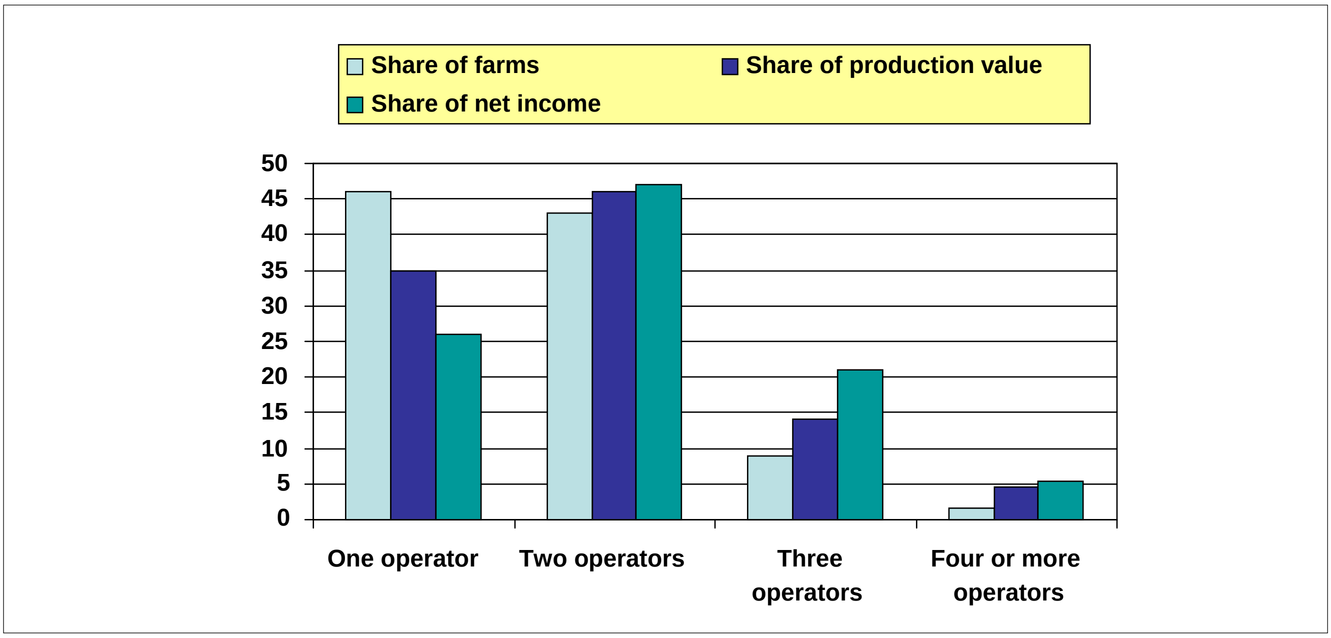
Source: Dutch FADN, 2007

Figure 12 - Farms exhibit a variety of persons engaged in daily decision making, United States, 2007



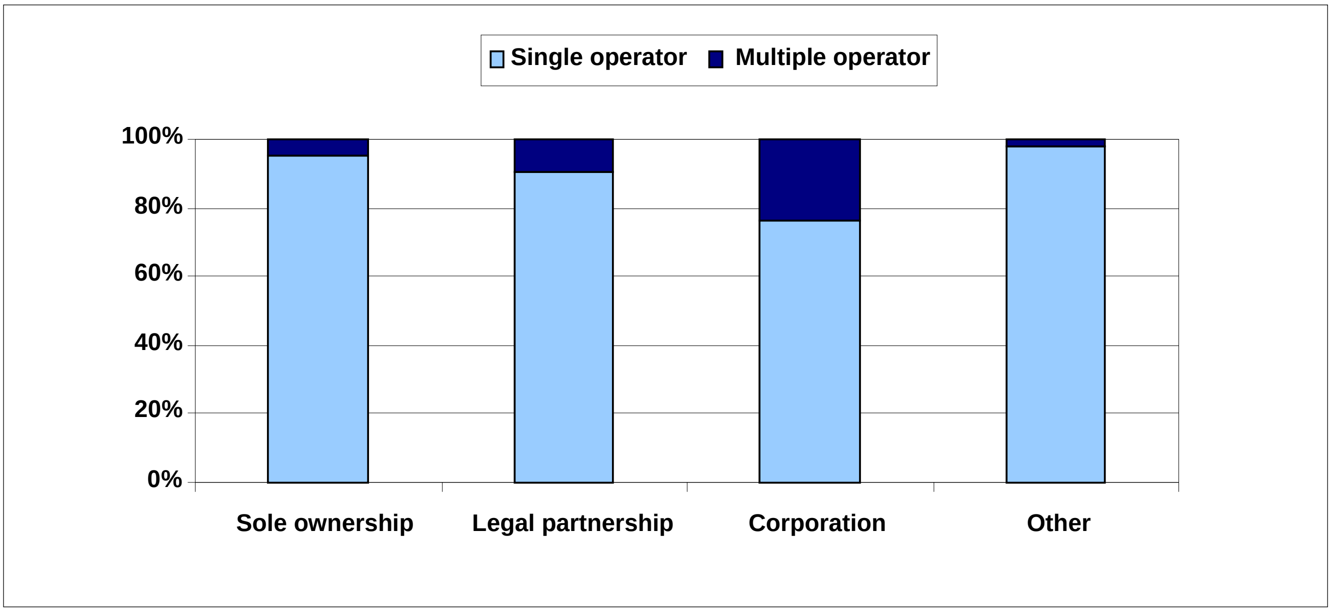
Source: Agricultural Resource Management Survey, 2007

Figure 13 - Farms with more entrepreneurs have the majority of production, the Netherlands, 2007



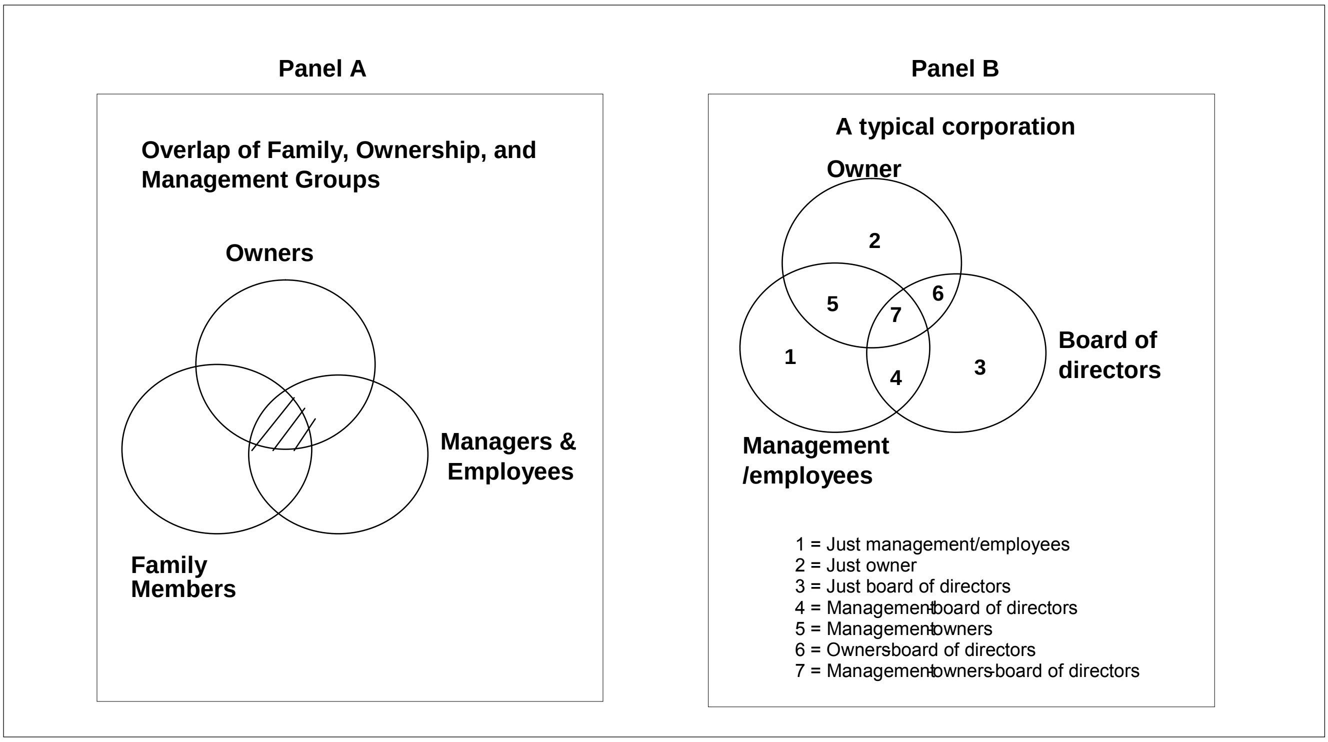
Source: Dutch FADN, 2007

Figure 14 - Distribution of commercial farms by number of operators and legal status, Italy, 2006



Source: Italian FADN, 2006

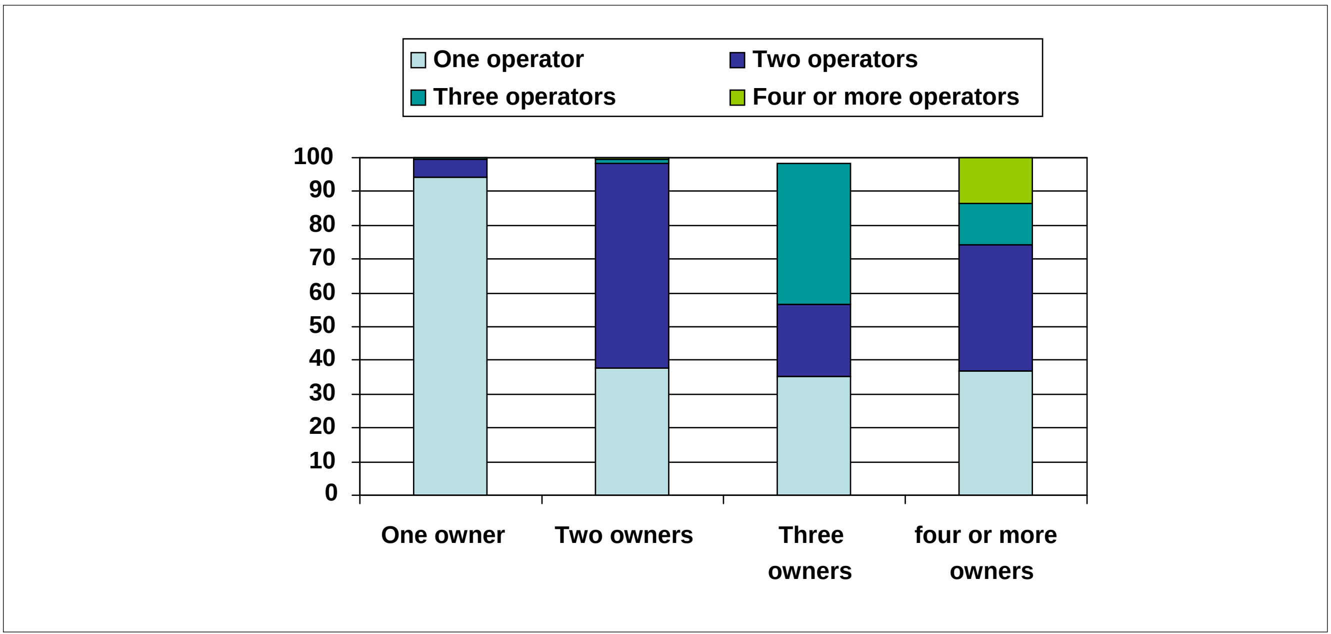
Figure 15 - Conceptual Constructs of Family and General Business Organizational Structures



Source: Tagiuri and Davis, 1996

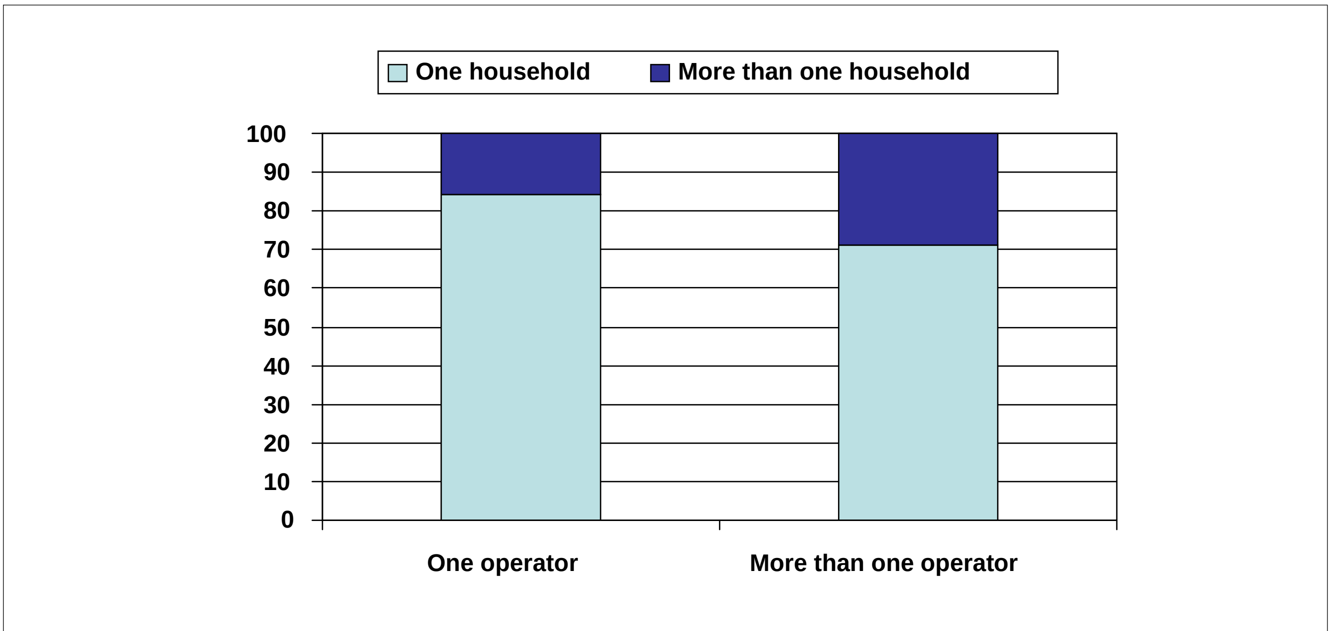
Source: Neubauer & Lank, 1998

Figure 16 - Farms include a range of owners and daily decision makers in business governance-decision structures, United States, 2007



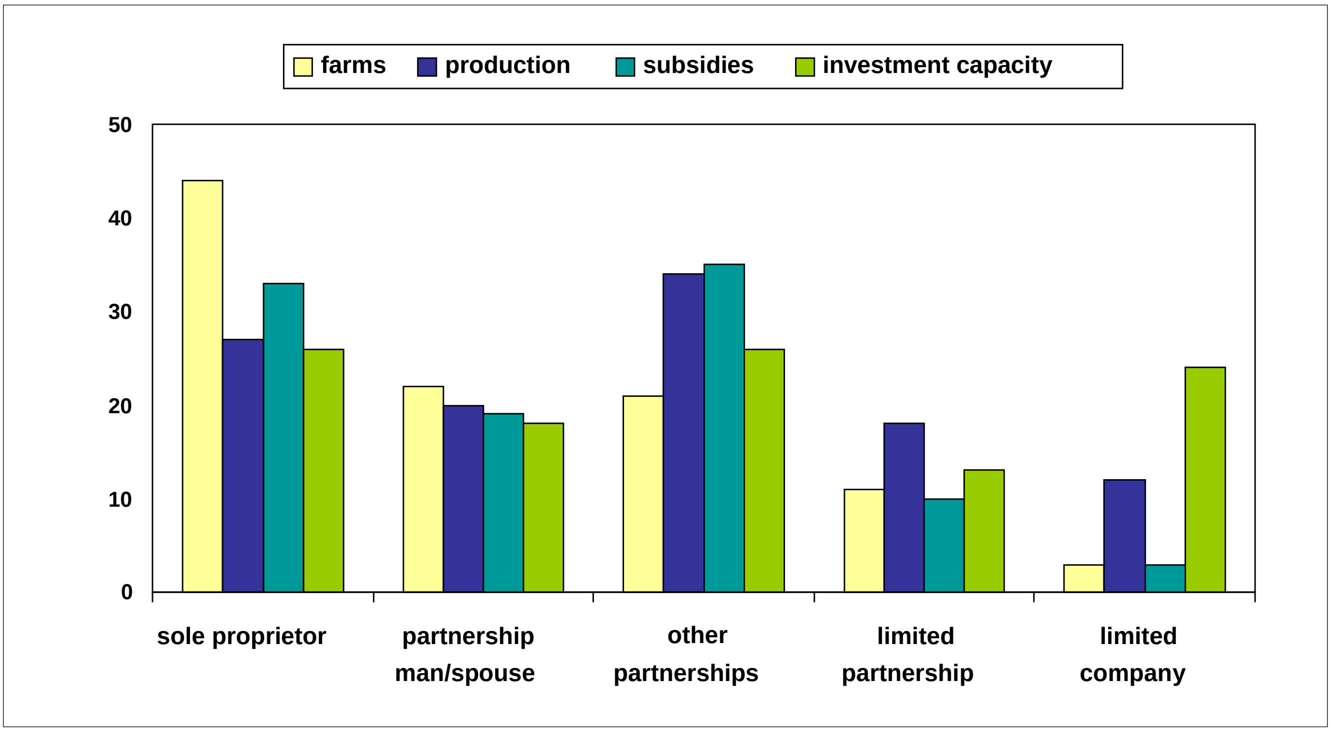
Source: Agricultural Resource Management Survey, 2007

Figure 17 - Number of households sharing net income of farms by the number of operators on a farm, 2007



Source: 2007 U.S. Census of Agriculture

Figure 18 - Share (%) of the types of farms by legal organization in production, subsidies and total flow of funds (investment capacity) the Netherlands, 2007



Source: Dutch FADN, 2007

Rural Areas Definition for Monitoring Income Policies: the Mediterranean Case Study

Giancarlo Lutero, Paola Pianura, Edoardo Pizzoli
National Institute of Statistics (ISTAT), V. Cesare Balbo 16,
lutero@istat.it, pianura@istat.it, pizzoli@istat.it

***Abstract**: Territorial classifications play a critical role to include the space dimension in official statistics oriented to policies. Economic, social and geographical differences in different areas of the same country or in a region are usually statistically significant. Policy makers would like to monitor these differences for policy planning and understand the effectiveness of interventions.*
The Mediterranean region is an interesting case to study territorial classifications as very different countries and rural/urban areas in per-capita terms meet the Mediterranean see. A study on data at country level will be done in this paper to understand the effectiveness of classifications' proposed to explain income differences.

Keywords: Rural area, Territorial classification, Income policies, Panel model

1. Introduction

Population living in rural areas is expected to have a different per-capita income profile with respect to urban one. The rural-urban classification adopted by statisticians should be suitable to highlight the difference and adequate to satisfy the needs of politicians to monitor the trends.

The Mediterranean region is an interesting case study due to the geographical homogeneity of the area on the one hand, compared to the economic differences on the other hand. In this paper, a per-capita income model is studied for the whole area, under the data availability constraint. Time series data, yearly or with higher frequency, are not available for all the countries and parametric estimates have to adequate to them. That is why a common panel assumption data is necessary and is expected to be a satisfactory solution for the objective of the paper.

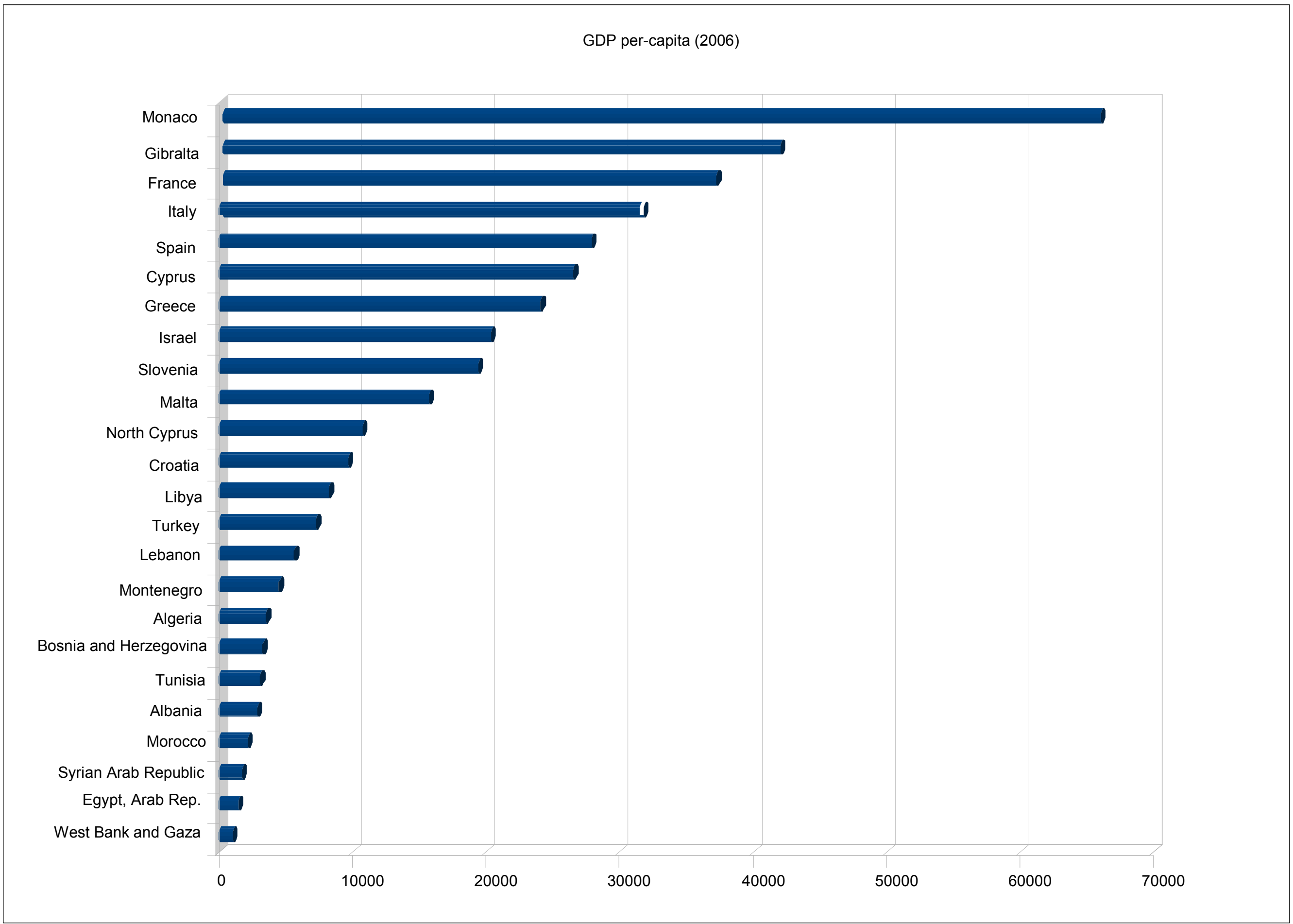
After several models specifications, estimations and diagnostic checking, different rural-urban classification variables will be introduced, one by one, in the best model selected, to test the effect on the goodness of specification and fitting.

2. Mediterranean region and data available

The Mediterranean area is politically subdivided in 24 countries, each of them with specific and hierarchical administrative subdivisions that work as a further constraint to the statistical analysis (Pizzoli et al., 2008). Among these countries, there are 8 members of European Union (EU), 2 city-states (Gibraltar, Monaco) and 3 countries with a limited political status: Gibraltar under the sovereignty of the United Kingdom, North Cyprus recognised only from Turkey and Palestinian Territory occupied by Israel.

Economic differences in the region become evident with an indicator of per-capita income (Figure 1).

Figure 1 - Per-Capita GDP in the Mediterranean Countries - Year 2006



Source: World Bank and National Statistical Offices

Data availability, in terms of number of variables and frequency of observations, is also not homogeneous in different countries. The following list of variables are selected based on this data constrain.

Table 1 - List of Variables Adopted in Panel Estimation

VARIABLE	Definition
gdppc	Gross Domestic Product (GDP) per-capita (current US$)
gcf_pc	Gross capital formation (% of GDP)
electric_power	Electric power consumption (kWh per-capita)
energy_use_kg	Energy use (kg of oil equivalent per-capita)
agricultural_la	Agricultural land (% of surface area)
for_density	Forest density (forest area over surface area)
primary_complet	Primary completion rate, total (% of relevant age group)
mobile_and_fixe	Mobile and fixed-line telephone subscribers (per 100 people)
internet_users	Internet users (per 100 people)

Data have been selected from international sources (United Nations, World Bank, FAO, EUROSTAT and CIA websites) and national statistical offices.

At a national level, GDP, Population, Population Growth and Surface area, data have been extracted from World Bank, United Nations and CIA websites, while for Agricultural land has been used FAO data source. The rest of the variables are from UN and EUROSTAT. Missing data are for southern Mediterranean countries, Balkan countries and city states.

Yearly time series from 2000 to 2007 are selected for the model. A preliminary statistical analysis of the data is the following:

Table 2.1 - Summary Statistics *(missing values were skipped)*

VARIABLE	Mean	Median	Minimum	Maximum
Gdppc	12,899.2	6,198.4	37,79	70,670.0
Electric_power	3,477.2	3,114.2	20,38	7,944.6
Energy_use__kg	1,987.1	1,642.0	15,42	4,551.1
Pop_density	1,030.1	3,84	0,13	16,769.2
For_density	0,01	0,01	-	0,04
Gcf_pc	248,429.0	103,245.0	18,664.9	1,477,000
Primary_complet	0,04	0,06	0,04	0,04
Mobile_and_fixe	0,06	0,06	0,00	0,10
Internet_users	0,01	0,01	0,00	0,08
agricultural_la	0,03	0,03	-	0,05

Table 2.2 - Summary Statistics *(missing values were skipped)*

VARIABLE	Standard Deviation	C.V.	Skewness	Ex. kurtosis
Gdppc	14,119.3	1.095,00	1.619,00	2.605,00
Electric_power	2,178.8	0,44	0,24	-1.167,00
Energy_use__kg	1,179.9	0,41	0,31	-1.027,00
Pop_density	3,368.7	3.270,00	4.196,00	16.462,00
For_density	0,00	0,67	0,52	-0.317
Gcf_pc	290,589.0	1.169,00	1.748,00	3.103,00
Primary_complet	0,00	0,52	-0.550	-1.602,00
Mobile_and_fixe	0,00	0,43	-0.081	-1.464,00
Internet_users	0,00	1.027,00	2.249,00	11.033,00
Agricultural_la	0,00	0,44	-0.084	-1.305,00

Several statistics (coefficient of variation, skewness and kurtosis, mean over median) suggest that gross capital formation per-capita (gfc_pc) has a similar probability distribution of GDP per-capita (gdppc) and it could be a good explanatory variable in the model.

Table 3, for the same variables showed above, presents the correlation matrix.

Table 3 - Correlation Coefficients *(missing values were skipped)*. **5% critical value** *(two-tailed)* **= 0.1417 for n = 192**

Gdppc	Electric_power	Energy_use__kg	pop_density	for_density	
1.0000	0.8411	0.8577	0.7112	-0.0142	gdppc
	1.0000	0.9365	0.1945	0.4350	Electric_power
		1.0000	0.0804	0.4271	Energy_use__kg
			1.0000	-0.2852	pop_density
				1.0000	for_density

gcf_pc	Primary_complet	Mobile_and_fixe	Internet_users	agricultural_la	
0.8457	-0.3415	0.4358	0.6525	-0.3088	gdppc
0.8013	-0.1443	0.8163	0.5807	-0.0842	Electric_power
0.8097	-0.2550	0.7129	0.6506	-0.0874	Energy_use__kg
0.5813	-0.3205	-0.1202	0.4367	-0.4033	pop_density
0.1894	-0.0515	0.4542	0.2697	0.1807	for_density
1.0000	-0.1296	0.3979	0.6981	-0.0816	gcf_pc
	1.0000	-0.1388	-0.1224	0.4810	Primary_complet
		1.0000	0.4362	-0.0730	Mobile_and_fixe
			1.0000	-0.1329	Internet_users
				1.0000	agricultural_la

Electric power, energy use and gross capital formation are strongly correlated with gross domestic product per-capita but also each other. These relationship will affect the model specification.

3. Rural - Urban Classification

Definition of what is rural and what is not isn’t simple: in fact, there is not a universal definition. The mostly used variable for defining “rural” is population density: a territory is rural if population density is below 150 inhabitants per square kilometre (OECD, 1994).

Several territorial classification variables are calculated on available data, based on the following criteria to discriminate between rural and urban areas:

Single indicator (population density is the default indicator);

Two combined indicators (population and agricultural density);

Multivariate clustering (two or three clusters).

Two clusters (rural – urban) seems to be a logical territorial subdivision but a previous empirical study suggested three as the optimal number of clusters (Pizzoli et al., 2007b). With the first two criteria a dummy variable (1 for rural and 0 for urban) has been generated from the continuous variable and both of them have been tested in the model. With the third criteria two dummy variables have been generated making use of all available variables in the dataset: 1 for rural and 0 for urban in the first case; 2 for rural, 1 for intermediate; 0 for rural in the second case.

Table 4 - List of Rural-Urban Variables Adopted in Panel Estimation

VARIABLE	Definition
Rural_urban2	Composite indicator 2*: real continuous number between 0 (purely urban) and 1 (purely rural)
Rural_urban3	Composite indicator 3**: real continuous number between 0 (purely urban) and 1 (purely rural)
Agr_for	Agricultural and forest land (% of surface area)
Rural_urban21	Binary variable: 1= Composite indicator 2*>0.5 (rural); 0=otherwise (urban)
Clus12	Cluster analysis 1: 1=rural, 0=urban
Clus22	Cluster analysis 2: 1=rural, 0=urban
Clus23	Cluster analysis 2: 2=rural, 1=intermediate, 0=urban
Clus32	Cluster analysis 3: 1=rural, 0=urban
Pop150	Binary variable: 1=Pop_density<150 (rural), 0=otherwise (urban)
Pop200	Binary variable: 1=Pop_density<200 (rural), 0=otherwise (urban)
Pop250	Binary variable: 1=Pop_density<250 (rural), 0=otherwise (urban)
Pop_density	Population density (total population over surface area)

* The composite indicator is a linear combination of population density and agricultural land.
** The composite indicator is a linear combination of population density with agricultural and forest land.

Dealing with rural-urban classification of administrative areas, it has to be emphasised that no one is purely rural or urban and the label that is assigned to an area has to be intended as "mainly" rural or in terms of probability of inclusion one or more rural areas (Pizzoli et al. 2008; Pizzoli et al. 2007a).

4. Panel Model

As briefly mentioned in the introduction, the proper statistical framework suitable to simultaneously parametrize territorial homogeneity and heterogeneity in terms of wealth production and distribution, is the panel modelization. Panel approach is useful to model the sectional time invariant unobserved heterogeneity among a subset of statistical units (i.e. countries or regions) with specific individual *fixed effects* parameters. In this kind of models the local intercepts μ_i are treated as unknown parameters that represent a particular realizations of stochastic processes, through the identification and the parametrization of one or more probabilistic regimes. Considering the limited availability of data in terms of temporal dimension, only the static panel modelization will be estimated For every country *i* and annual observation *t*, the fixed effects model is defined as follows

(1) $$y_{it} = \mu_i + \beta' x_{it} + u_{it} \quad E(u_{it}) = 0 \qquad E(u_{it}^2) = \sigma_u^2$$
$$i = 1,2,...N \quad t = 1,2,..,T$$

or in compact form

(2) $$Y = D\mu + X\beta + U$$

where D is a *dummy-variables* matrix in diagonal form useful for the identification of per-unit intercepts μ_i, with $i_T = (1,1,...,1)'$

$$D = \begin{pmatrix} i_T & 0 & \cdots & 0 \\ 0 & i_T & \cdots & 0 \\ . & . & \ddots & . \\ 0 & 0 & \cdots & i_T \end{pmatrix}$$

Model (2) is usually defined *OLS-dummy variables* estimator or *within estimator*. The last one is defined applying a linear operator that computes the differences between the observations and the mean within every longitudinal units.

In this context is also considered the *random effects* parametrization to compare the results in terms of diagnostics and goodness of fit. Finally categorical variables are introduced to test several rural-urban classifications. The random effects modelling is necessary because some classification variables produce multicollinearity in the fixed one. The model is specified in the following way

$$y_{it} = \alpha + \beta' x_{it} + \mu_i + v_{it}$$

$$(3) \qquad E(\mu_i^2) = \sigma_\mu^2 \qquad E(v_{it}^2) = \sigma_v^2 \qquad E(\mu_j v_{it}) = 0$$

$$E(\mu_j v_{it}) = 0 \qquad E(v_{it} v_{is}) = 0 \qquad E(\mu_i \mu_j) = 0$$

where all μ_i, in this occasion, are treated as a random sample derived from a statistical distribution.

Three statistical tests have been considered for the diagnostic analysis of the model (Baltagi, 2008). The first one is to verify the null hypothesis of just one intercept in the model:

$$H_0 = \mu_i - \mu_1 = 0 \quad i = 2, ..., N$$

The statistic is the following:

$$F = \frac{\hat{u}'\hat{u} - \hat{u}'_{wit}\hat{u}_{wit} /(n-1)}{\hat{u}'_{wit}\hat{u}_{wit} /(NT - N - k)}$$

where $\hat{u}'\hat{u}$ are the squared residuals of pooled model (the model estimated with only one common intercept) and $\hat{u}'_{wit}\hat{u}_{wit}$ the squared residuals of within estimator (the not constrained model). It is distributed as $F_{(N-1, NT-N-k)}$ under H_0.

The second one, the Breusch-Pagan test, is considered to verify if individual effects are random. It is based on Lagrange multipliers and its null hypothesis is the following

$$H_0 : \sigma_\alpha^2 = 0$$

The statistic used in this test is

$$BP = \frac{NT}{2(T-1)} \left[\frac{\sum_i \left(\sum_t \hat{u}_{it} \right)^2}{\sum_i \sum_t \hat{u}_{it}^2} - 1 \right]^2$$

where $\hat{u}_{it}$ are the residuals of pooled model and it is distributed as $\chi^2_{(1)}$ under H_0.

The Hausman test controls the consistency of GLS estimator (random effects). It verifies the null hypothesis of no correlation between the individual effects and k-regressors. The statistic is the following

$$H = \frac{\left(\hat{\beta}_{wit} - \hat{\beta}_{gls}\right)^2}{\mathrm{var}\left(\hat{\beta}_{wit}\right) - \mathrm{var}\left(\hat{\beta}_{gls}\right)}$$

that is distributed as $\chi^2_{(k)}$ under the null hypothesis.

5. Results

Several panel models for per-capita GDP are estimated, with fix and random effects, introducing available variables. The best starting model that include all 24 countries is the following.

Table 5 - Fixed-Effects Estimates. 192 observations. 24 cross-sectional units. Time-series length = 8. Dependent variable: gdppc

	Coefficient	Std. Error	t-ratio	p-value
const	4021.13.00	298.172	134.859	<0.00001
gcf_pc	0.035737	0.0011157	320.310	<0.00001

*** indicates significance at the 1 percent level

This is the diagnostic checking of the model:

Mean of dependent variable = 12899.2
Standard deviation of dep. var. = 14119.3
Sum of squared residuals = 3.87401e+008
Standard error of the regression = 1523.08
Unadjusted R^2 = 0.98983
Adjusted R^2 = 0.98836
Degrees of freedom = 167
Durbin-Watson statistic = 0.35623
Log-likelihood = -1666.11
Akaike information criterion = 3382.23
Schwarz Bayesian criterion = 3463.66
Hannan-Quinn criterion = 3415.21

Test for differing group intercepts:
Null hypothesis: The groups have a common intercept
Test statistic: F(23, 167) = 112.524
with p-value = P(F(23, 167) > 112.524) = 2.93402e-089

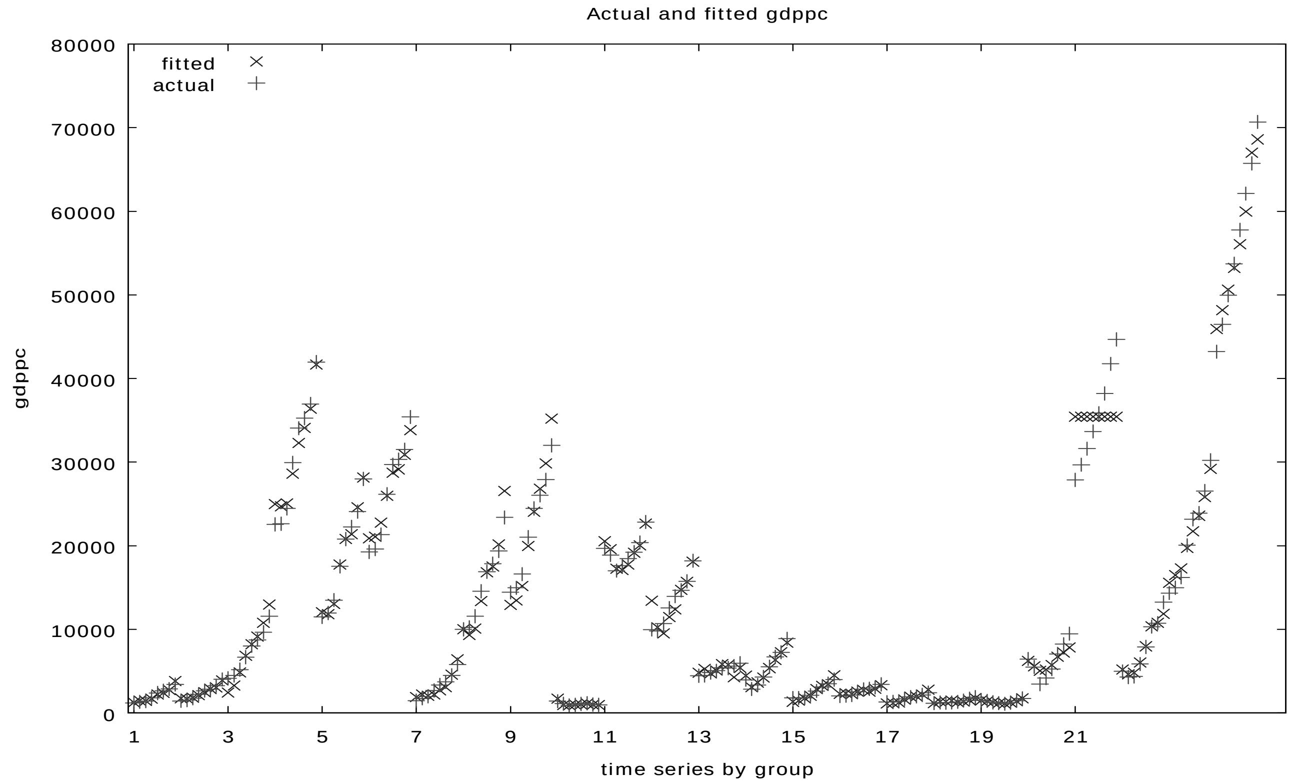
The estimated model is satisfactory from a statistical point of view: it presents a very good fitting (adjusted R^2 = 0.99) except for Gibraltar (Figure 2). As expected, a strong relationship between the *gdp per-capita* and *gross capital formation*, a key variable for economic development, has been found.

The F test statistic strongly rejects the null hypothesis of a common intercept and a *pooled model* can be used. The list of unit specific intercepts added to the common component is the following:

Table 6 - List of Estimated Per-Unit Constant *(best fixed effects model)*

Albania	7,63	Lebanon	1597.72
Bosnia and Herzegovina	642.94	Turkey	64,31
Croatia	-556.69	Algeria	-255.98
France	353,42	Tunisia	12,27
Greece	102,45	Morocco	-37.91
Italy	6647.99	Syrian Arab Republic	18,71
Montenegro	737.87	Egypt, Arab Rep.	19,06
Slovenia	11,09	Libya	133,04
Spain	-632.43	Gibraltar	35416.71
West Bank and Gaza	57.82	North Cyprus	109,02
Israel	6226.72	Cyprus	6845.63
Malta	169,39	Monaco	15809.03

Figure 2 - Fitted and Actual Plot by Observation Number *(best fixed effects model)*



The specification and fitting of the model improve introducing some omitted variables only partially available in the dataset, with the trade-off of loosing three countries.

The accepted models, after inclusion of a territorial classification variable, are the following:

Table 7 - Random-Effects (GLS) Estimates, Dependent variable: gdppc

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
const	1.177e+04*	2078	1.388e+04**	2.888e+04**	1964	24,46111
	-6660	-2743	-5384	-2434	-2875	-2554
Electric_power	2.332**	2.515**	2.471**	1.361**	2.291**	2.382**
	(0.4566)	(0.4561)	(0.4425)	(0.2552)	(0.4597)	(0.4598)
gcf_pc	0.02968**	0.02963**	0.02975**	0.03170**	0.02995**	0.02983**
	(0.001541)	(0.001541)	(0.001523)	(0.001420)	(0.001556)	(0.001552)
Primary_complet	-1400*	-1454**	-1410*	-1385**	-1553**	-1527**
	(725.7)	(724.1)	(716.7)	(628.6)	(725.1)	(725.3)
rural_urban2	-2.023e+04**					
	-9223					
agr_for		-8256**				
		-3795				
rural_urban3			-2.121e+04**			
			-6704			
rural_urban21				-2.938e+04**		
				-2277		
clus12					-5311*	
					-2747	
clus22						-4399*
						-2592
clus23						
clus32						
pop150						
pop200						
pop250						
pop_density						
n	168	168	168	168	168	168
lnL	-1696840	-1695602	-1681906	-1542283	-1705651	-1709109

Standard errors in parentheses
* indicates significance at the 10 percent level
** indicates significance at the 5 percent level

From the previous models it is possible to select the best ones:

Table 8 - Selected Models in Order of right Efficiency (*from left to right*)

VARIABLES	Model 3	Model 4	Model 12	Model 10	Model 8
Common constant	1.388e+04**	2.888e+04**	-1655	3902	2060
	(5384)	(2434)	(1171)	(3432)	(3083)
Electric_power	2.471**	1.361**	1.317**	2.206**	2.152**
	(0.4425)	(0.2552)	(0.3098)	(0.4633)	(0.4770)
Gcf_pc	0.02975**	0.03170**	0.03189**	0.03013**	0.03007**
	(0.001523)	(0.001420)	(0.001364)	(0.001563)	(0.001575)
Primary_complet	-1410*	-1385**	-1456**	-1594**	-1475**
	(716.7)	(628.6)	(626.7)	(724.3)	(730.9)
rural_urban3	-2.121e+04**				
	(6704)				
rural_urban21		-2.938e+04**			
		(2277)			
pop_density			7.602**		
			(0.7281)		
pop200				-6728**	
				(3168)	
clus32					-4878*
					(2822)
Observations (n.)	168	168	168	168	168
LnL	-1681.906	-1542.283	-1572.574	-1702.288	-1706.702
Sum of Squared Residuals (SSR)	4.88177e+009	9.26198e+008	1.32836e+009	6.22241e+009	6.55809e+009
Within' variance	2.13143e+006	2.11962e+006	1.22789e+006	2.11962e+006	2.11962e+006
'Between' variance	2.82017e+007	4.27112e+006	5.34775e+006	2.95296e+007	2.87653e+007
Akaike information criterion	3373.81	3094.57	3155.15	3414.58	3423.4
Schwarz Bayesian criterion	3389.43	3110.19	3170.77	3430.2	3439.02
Breusch-Pagan test	444.824	191.885	241.866	428.273	393.72
	(9.64932e-099)	(1.23305e-043)	(1.54097e-054)	(3.86083e-095)	(1.28226e-087)
Hausman test	2.58374	9.05077	83.7637	30.7333	
	(0.629706)	(0.0286234)	(2.77464e-017)	(9.67368e-007)	

Parameters' standard errors and tests' p-values in parentheses
** indicates significance at the 5 percent level

The best selected model with *random effects* is the following:

Table 9 - Random-Effects (GLS) Estimates. 168 observations. 21 cross-sectional units. Time-series length = 8. Dependent variable: gdppc

	Coefficient	Std. Error	t-ratio	p-value	
Const	13884.5	5383.99	2.5789	0.01080	**
Electric_power	2.47096	0.442472	5.5845	<0.00001	***
gcf_pc	0.0297517	0.00152334	19.5305	<0.00001	***
Primary_complet	-1409.84	716.739	-1.9670	0.05088	*
rural_urban3	-21209.6	6703.8	-3.1638	0.00186	***

* indicates significance at the 10 percent level
** indicates significance at the 5 percent level
*** indicates significance at the 1 percent level

This is the diagnostic checking of the model:

Mean of dependent variable = 11864.4
Standard deviation of dep. var. = 11040.6
Sum of squared residuals = 4.88177e+009
Standard error of the regression = 5455.91
'Within' variance = 2.13143e+006
'Between' variance = 2.82017e+007
theta used for quasi-demeaning = 0.902803
Akaike information criterion = 3373.81
Schwarz Bayesian criterion = 3389.43
Hannan-Quinn criterion = 3380.15

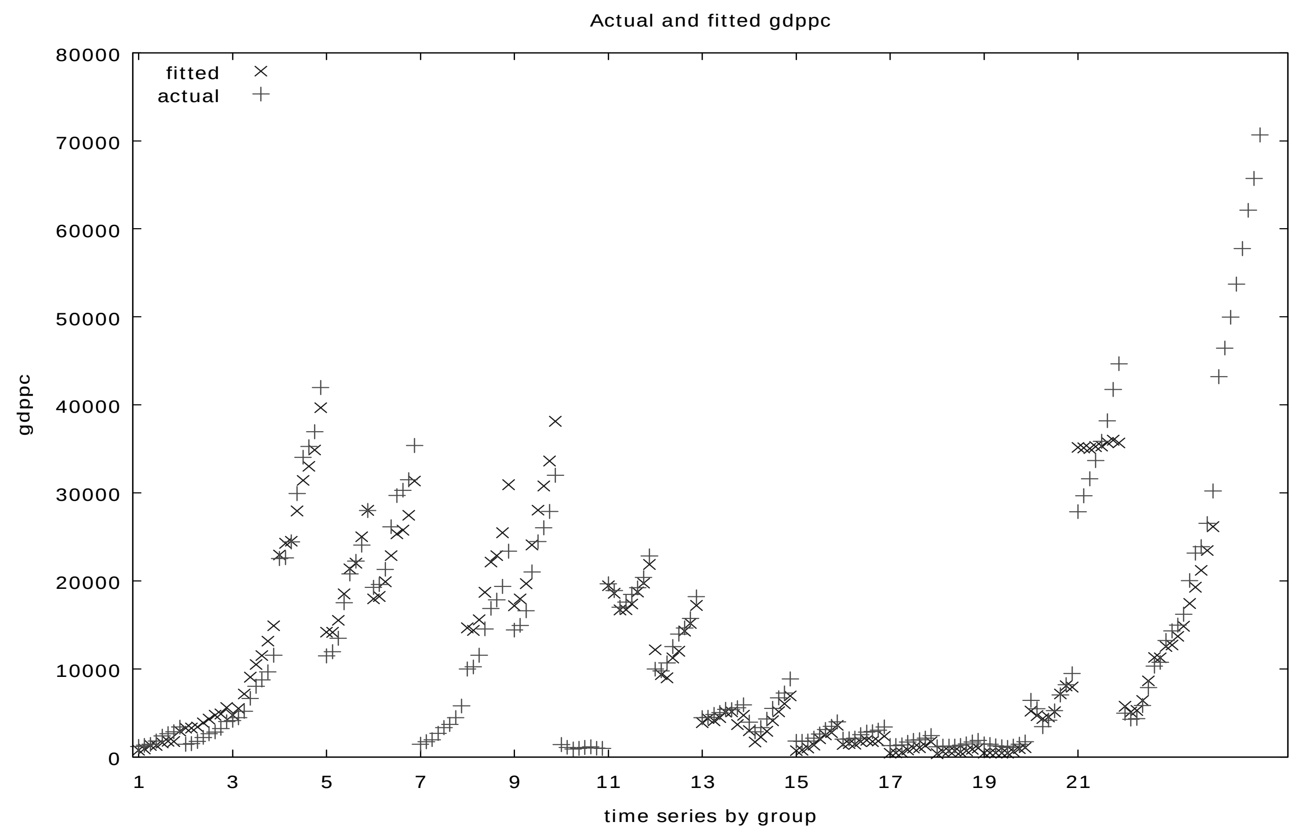
Breusch-Pagan test -

Null hypothesis: Variance of the unit-specific error = 0
Asymptotic test statistic: Chi-square(1) = 444.824
with p-value = 9.64932e-099

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(4) = 2.58374
with p-value = 0.629706

The decomposition of total variance imputes about 93% of dispersion to the differences between countries and the remaining to the inner variability. The Breusch-Pagan test gives a good response for the significance of random effects, while the Hausman test displays consistency and efficiency of the GLS estimator. As for the fixed effects model, Gibraltar' results show a low quality fitting of the data available (Figure 3).
Gross capital formation is still significant as in the fixed effects model. A further variable becomes strongly significant in the model: *electric power consumption*. This is a good proxy of energy consumption in the economy for production use and suggests a high level of total final consumption by households, associated to a high level of per-capita GDP. The introduction of a rural-urban classification variable in our best model is statistically significant and clearly highlighted the expected inverse relationship between per-capita income and rurality.

Figure 3 - Fitted and Actual Plot by Observation Number *(best random effects model)*



6. Conclusions

Even if the paper's results highlight a cross-sectional heterogeneity among the Mediterranean countries (Table 5), that is a main feature of panel models, the diagnostic analysis and fitting show that a common model for the available data is a satisfactory solution.
Several rural-urban classification variables are significant in this panel data approach. The fixed effects model estimated on the total region (24 countries) is based on a limited number of regressors due to the data constraint. Excluding three countries more regressors become significant in the model.
Comparing the significativity of classification variables a composite indicator, such as a combination of population density with agricultural density (i.e. rural_urban3 in this paper), undoubtedly improve per-capita income explanation.

References

Agresti, A. (2002). *Categorical Data Analysis*, John Wiley & Sons, 2nd edition.

Baltagi B. (2008). *Econometric Analysis of Panel Data*, John Wiley & Sons, 4th edition.

European Commission, (2005). Decimo anniversario del partenariato euromediterraneo: un programma di lavoro per far fronte alle sfide dei prossimi 5 anni.

European Union (2007). *Rural Development in the European Union. Statistical and Economic Information*, Report, November, Brussels. ec.europa.eu/agriculture/agrista/rurdev2007

FAO (2007). *Rural Development and Poverty Reduction: is Agriculture still the key?*, ESA Working Paper No. 07-02, Rome.

FAO (2007). Rural Income Generated-Activities, paper for Conference on Beyond Agriculture: The Promise of the Rural Economy for Growth and Poverty Reduction, 7th January 2007, Rome.

Hill, B. et al. (2007). The New Rural Economy: Change, Dynamism and Government Policy, IEA, London. www.iea.org.uk

Hsiao C. (1986). *Analysis of panel data,* Cambridge University Press, 1st edition

ILO (2000). Sustainable Agriculture in a Globalized Economy, Geneva.

Kusmin, L. (2007). Rural America At A Glance, Economic Information Bulletin, No. EIB-31, October, USDA, Washington.

Manera M. and Galeotti M. (2005). *Microeconometria* Carocci, 1st edition.

MIPAF (2007). Piano Strategico Nazionale per lo Sviluppo Rurale, Roma. www.politicheagricole.it

OECD (1994). Creating Rural Indicators for Shaping Territorial Policies, OECD Publications, Paris.

Pizzoli E. and Orsini M. (1999). Unobserved Revenues Estimation for Homogeneous Agricultural Firms: an Econometric Modelling Approach, in Micro- and Macro-data of Firms, Springer-Verlag.

Pizzoli E. and Xiaoning G. (2007a). How to Best Classify Rural and Urban?, Fourth International Conference on Agriculture Statistics (ICAS-4), Beijing. www.stats.gov.cn/english/icas

Pizzoli, E., Palmegiani, G. (2007b). Rural Development Statistics (RDS) for Policy Monitoring: a Rural-Urban Territorial Classification and Farmers' Income Data, AFCAS, Alger. www.fao.org/statistics/meetings/afcas2007

Pizzoli, E., Pianura, P. and Piersante, A. (2008). Implications of Rural Areas Definition on Households Income Analysis: the Mediterranean Area Case Study, SIDEA, Portici – Naples. www.depa.unina.it/sidea2008

Shephard, J. (2007). Improving the Rural Evidence Base, Ch. 2, in Rural Scrutiny Review, East Midlands Regional Assembly, November.

UN (2003). Promoting an integrated approach to rural development in developing countries for poverty eradication and sustainable development, Report of the Secretary-General.

UNDP, (2003). Human Development Report 2003, New York, USA.

UNECE, FAO, OECD and World Bank (2005). Rural Household's Livelihood and Well-Being: Statistics on Rural Development and Agriculture Household Income, Handbook, UN, New York. www.fao.org/statistics/rural

Data Sources and Quality Improvements for Statistics on Agricultural Household Incomes in 27 EU Countries

Berkeley Hill [8]
b.bhill@imperial.ac.uk

Abstract: *The paradigms of agri-centric rural economies and of mono-active farm families are now largely discredited. To serve both rural and agricultural policy statistics are needed on the overall income of agricultural households, the dominant institutional unit in EU agriculture. This paper reports a study that examined both user needs and the abilities of Member States in the enlarged EU to provide these statistics. The UNECE Handbook of 2005/2007 proved valuable in providing a template for testing the feasibility of obtaining data across EU-27. The information that was collected can be used to update what currently appears in the Handbook.*

Keywords: agricultural household income, gross and net income, disposable income, data in EU-27, rural economies, agricultural and non-agricultural economic activities, narrow and broad definition of agricultural household, socio-professional groups.

1. Introduction

The paradigms of agri-centric rural economies and of mono-active farm families are now largely discredited in developed industrialised economies. Increasingly farming households in such countries are recognised as representing a nexus of agricultural and non-agricultural economic activities. Their well-being reflects a range of incomes streams (and forms of wealth), although there is great variability in the extent to which they are farm-dependent. As residents of rural areas, farm families make a declining but often still critical contribution to the local economy, and as controllers of land use their landscape and environmental impacts can be major. The implications of the paradigm shift for statistical systems have been the subject of a slow accumulation of literature starting in the 1970s but recently culminating in an international workshop supported by the Economic Research Service of the USDA (University of London/PennState 2002), studies and conferences organised by the OECD (2003, 2005), and sessions at the three most recent International Conferences of Agricultural Statisticians. They are also manifest in the UNECE 2005/2007 Handbook dealing with statistics on rural development and agricultural household income.

In the EU Eurostat responded relatively early to changes in the way that agriculture was being viewed. Following a 1985 Green Paper on the CAP (Commission 1985) that called for a better picture of the overall incomes of farmers, Eurostat developed a methodology based in national accounting for estimating the disposable income of the complete (sub)sector of agricultural households in EU Member States (Income of the Agricultural Household Sector – IAHS – statistics). Results from this project were published from 1992. However, the Eurostat project failed to make progress beyond the mid-1990s. Only about half of the EU15 Member States used the intended macroeconomic methodology, and its key proponents (Germany, whose results went back to the early 1970s, and France) encountered increasing difficulty in applying it annually so that the latest available results became increasingly historical.

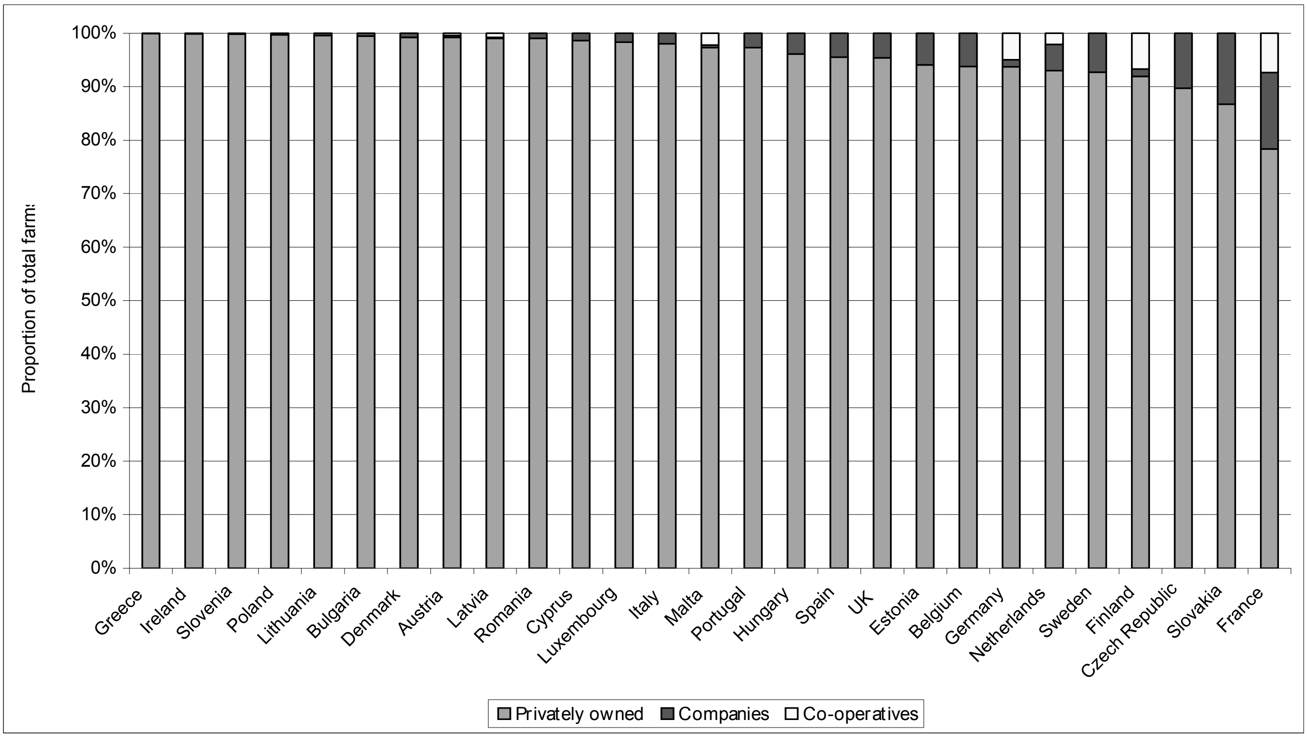
From the outset some Member States had preferred to use microeconomic methodology to generate results directly (rather than merely as distribution agents of economic aggregates). There was increasing recognition of the need for information on the distribution of incomes (such as by level of income, by farm size, by farming

[8] Emeritus Professor, University of London and consultant to Agra CEAS Consulting Ltd. 1 Brockhill Road, Hythe, Kent, UK CT21 4AB. e-mail b.bhill@imperial.ac.uk

type and by region) that the sector-level results were not designed to provide. Consequently, Eurostat suspended the IAHS statistics in 2002 (with the publication of the 2001 Report (Eurostat 2002), which also reissued the methodology and related studies).

An additional recent factor that has made the former paradigm no longer acceptable is the enlargements of the EU in 2004 and 2007 by twelve new Member States that have brought in significant numbers of institutional units that have their own legal status (companies, cooperatives etc.). While household-firms still dominate numerically (see Figure 1), consideration now has to be given to how the other forms can be treated within income statistics.

Figure 1 - Institutional forms within EU27 agriculture



In particular, many of the people working on large agricultural units would be considered by their national governments as part of the agricultural community, yet they are not self-employed and thus would not be classed as farmer in the conventional sense. Also, subsistence (as distinct from hobby) food production is part of the economic activity of households in many of these countries, some of them combining working in a large-scale agricultural unit with household plot cultivation. Thus the concept of an agricultural household has to be re-examined.

2. The 2007 data inventory and feasibility study

A review by the European Court of Auditors (ECA 2003) on the ways in which incomes in agriculture were monitored within the EU concluded that Eurostat did not have a satisfactory means by which the CAP's aim of achieving a fair standard of living of the agricultural community could be assessed. Income statistics for household-firm units was needed for this purpose. Recognising the deficiencies of Eurostat's previous IAHS statistics, the Court recommended (later endorsed by the Council (of Ministers)) that a feasibility study should be undertaken of using a uniform approach across the EU as a way of improving the quality of the statistics. In essence, this meant testing the practicality of drawing on existing microeconomic data sources or developing new ones to generate results. This study was undertaken by Agra CEAS Consulting; the present writer formed part of the research team (Agra CEAS 2007). Previous information-gathering work by Eurostat (reported in 2002), OECD (1995), ISTAT (2002) and Statistics Sweden (2006) was drawn upon where relevant.

A template for the new IAHS statistics was devised, drawing definitions from the UNECE Handbook (2005/2007)(which itself incorporated previous Eurostat work) and after consultation with a range of users (including the European Commission's Directorate-General for Agriculture and Rural Development). For households of self-employed farmers the key elements that formed the "template" for feasibility testing are shown in Box 1; special treatment applied to workers on large-scale units in the new Member States and to subsistence producers, not covered in this paper (see Agra CEAS 2007).

Box 1 - The uniform approach to statistics for agricultural households (*the "template")*

- The definition of a household that forms part of the IAHS template is the single budget unit (meaning farmer, spouse and dependants). However, in view of the use in some data sources of the dwelling unit (which might include more than one budget unit), the assessment of feasibility also asks questions about this.
- Data are needed to enable incomes per household, per household member and per consumer unit to be estimated (for agricultural households and other comparator groups).
- The method of classification is to be based on the main income of the household reference person (the individual contributing most to the household income, and normally the head of household). However, in view of the possible use of the income composition of the entire household as a basis for classification, the assessment of feasibility also asks questions about this.
- Households must be capable of selection according to the "narrow" definition, that is, where income from agriculture is the main source of income of the household reference person.
- Households must also be capable of being selected according to a "broad" definition. In view of the variety of ways in which this may be defined, the feasibility of three options are tested: (A) There is some income from agriculture; (B) A household member operates a holding that qualities for inclusion in the EU Farm Structure Survey; (C) A household member operates a holding that is eligible for the flat-rate Single Farm Payment.
- Households must be capable of selection according to the characteristics of the holding (size, farming type, and region) they operate.
- The definition of net disposable income is as recommended by the UNECE Handbook. While not being a full specification of household income, it is more practical because it omits most of the non-money items that commonly cause problems in income estimation. Both total household income and net disposable household income should be estimated.
- The data on the individual items shown in the calculation should be available.
- Income from independent activity in agriculture should be defined as in FADN/RICA. Forestry and fishing and other activities should be excluded (unless they form inseparable secondary activities).
- The value of own consumption and imputed rental values (of owned dwellings) should be included within the concept of income. Imputed rental values need to be separately identifiable because they are subject to dispute and the treatment of these is not always clear. Thus comparisons may be made excluding this item.

With regard to the definition of a household and of disposable income the recommendations that were tested for feasibility were unsurprising and follow the UNECE (2005/2007) suggestions closely. However, it became clear from interviews with policymakers and other potential users that there was a need to be able to select agricultural households in a flexible way in order to meet particular policy requirements. There was a strong requirement for results relating to households where farming was the main income source, but this was accompanied by needs to be able to gain income pictures of alternative groupings. These included all households which operated holdings that qualified for inclusion in the EU's Farm Structure Survey[9] or fell into certain size bands, regions or types of farming. In particular there was interest in the income situation of the operators of holdings eligible for support under the Single Farm Payment and households (in the new Member States) that were involved in subsistence production. To do so meant that basic data sources needed to extend to small holdings (holdings that fell below national thresholds for inclusion in the FADN/RICA) and where the holding was not the main source of income of the household (or its reference person). Thus this study went considerably further than assessing whether Member States can supply data for a given definition; for some key aspects it explore their ability to use alternatives.

In early 2007 Agra CEAS conducted a survey of statistical authorities in all EU27 countries and missions (with face-to-face interviews) to ten. Only two countries did not reply or cooperate (Belgium and Cyprus). The first task was to update the inventory of data sources that had been built up from previous work at Eurostat and

[9] More properly the EU Survey of the Structure of Agricultural Holdings. The minimum thresholds for inclusion vary between Member States.

OECD (1995, 1997), and which was already represented in the UNECE Handbook (2005/2007). The present situation is shown in Annex 1 to this paper. Four main types of data source are identified:

- **Farm accounts surveys** that in some countries collect data on household income, which is in addition to the requirements of the FADN/RICA system that is only concerned with the agricultural holding. The threshold tends to be high relative to the size spectrum encountered in the national Farm Structure Survey, and coverage of household members other that the farmer and spouse may be poor (though this is not a major problem if the concept of the single-budget household is employed, from which other financially independent adults living in the farm dwelling are excluded). Data quality is generally good, though information on off-farm income is less satisfactory than are variables related to the farming activity.
- **The EU-SILC** system (Statistics on Incomes and Living Conditions), applied in all Member States, that conducts annual surveys of a general panel of households. Income and occupation details are collected for each individual in the household. Though both the household unit and income concept can be made compatible with the IAHS template, in most Member States the number of cases where farming is the main source of income is too small for meaningful results to be estimated. There are also issues on data quality in income from self-employment.
- **Household budget surveys,** though again the numbers of agricultural cases where farming is the main source of income are too small in these general surveys, the quality of the data on self-employment may not be high, and data relate to the household unit (which is the dwelling rather than the single budget unit) and generally not to individuals within it.
- **Taxation records and income statistics registers based on them.** Though potentially covering all households, or samples of them, these are only developed as a data source for income studies (as opposed to taxation issues) in a few Member States. In others there may be legal barriers to their use as a basis for statistics. A major drawback is that, in many countries, all or some farmers are not taxed according to their accounted income but on some per hectare (or similar) standard basis. This means that actual income is not recorded. There may also be tax conventions (such as treating certain forms of government payment as tax-free) that undermine the quality of the income data as reflecting the household's spending power.

3. Assessing the way of achieving data on a uniform basis, and costs

In order to test the feasibility of using the uniform approach in all Member States specified in the template (while permitting some flexibility in terms of how data were obtained), a mix of electronic questionnaires and face-to-fact interviews was used to explore separately each aspect (definition, procedure and so on), with responses grouped into four;

- This aspect of the definition/procedure was currently in use
- It was not in use but was technically possible
- Its use requires development of the existing data source
- It requires a new data source

There is only room here to give examples of the findings. In terms of the ability to compare the households of agricultural households with those of other socio-professional groups selected in the same way (on the basis of the main source of income of the household reference person), the following responses were obtained (Table 1)

3.1 Definition of a household

Respondents were provided with two household definitions: single budget, meaning farmer, spouse and dependants; and, dwelling unit, meaning all persons resident at the same address and were asked to indicate which of the definitions is currently used, or it is technically possible to use from existing data sources, or whether a new data source would be required. The responses are contained in Table 1. The three Member

States that required a new data source in order to use the single-budget approach also needed one to apply the dwelling unit. It should be noted that in some cases there will be very little difference between these definitions due to the prevailing socio-economic conditions, for example, where young people traditionally leave home once they start earning their own income. The single budget unit appears to be a more commonly used definition and is generally considered to be the more appropriate[10].

Table 1 - Use of household definitions

	Currently used	Technically possible	Requires data source development	Requires new data source
Single budget unit	Slovenia, Finland, Estonia, Denmark, Czech Republic, Bulgaria, Austria, Poland, Malta, Lithuania, UK, Sweden, Spain, France, Greece	Romania, Ireland, Italy, Portugal, Latvia	Luxembourg, Netherlands	Germany, Slovakia, Hungary
Dwelling unit	Bulgaria, Ireland, France, Netherlands	Romania, Finland, Denmark, Czech Republic, Italy, Portugal, Greece	Estonia, Malta, UK, Sweden	Slovenia, Germany, Slovakia, Austria, Poland, Luxembourg, Lithuania, Hungary, Spain, Latvia

Note: Czech Republic answer is for SILC, FADN/RICA requires data development in both cases.

3.2 Classification of an agricultural household using a "narrow" definition

The method of selecting households that are classified as agricultural using the narrow definition (i.e. the main source of income is from agriculture) was also explored with respondents. Respondents were asked whether classification was possible on the basis of the main source of income of a reference person (normally the head of household), or according to the main source of income of the entire household. The results in Table 2 show that in most cases it is technically possible to use existing data to classify households as agricultural using either basis of classification.

Table 2 - Classification of households as agricultural, narrow definition

	Currently used	Technically possible	Requires data source development	Requires new data source
Reference person	Lithuania, Bulgaria, Latvia	Sweden, Portugal, Italy, Ireland, Malta, Poland, Austria, Czech Republic, France, Denmark, Finland, Romania, Slovenia, Netherlands, Greece	UK, Luxembourg, Estonia, Spain	Hungary, Slovakia, Germany
Household	Ireland, Poland, Denmark, Finland, Netherlands	Sweden, Portugal, Italy, Lithuania, Austria, Latvia, Estonia, Romania, Slovenia, Greece	Luxembourg, Malta, Czech Republic, Spain	UK, Hungary, Bulgaria, Slovakia, Germany

Notes:

- Austrian answer is for SILC. Data development would be necessary in the context of accounting data.
- Czech Republic answer is for SILC. For FADN, data development would be necessary to classify according to a reference persons income and a new data source would be required to classify according to total household income.
- Slovenian answers are for SILC, FADN/RICA would require the development of existing data in order to classify according to household income.

However, experience suggests that in the present stage of data development across the EU as a whole, the use of a reference person is to be preferred. In the future, the income composition of the entire household may also be used; this is in line with the recommendation of the UN's System of National Accounts (SNA) 1993. From the point of view of some users it might be preferable to provide data according to both classifications now. When data collection systems are being developed, flexibility should be built in so that at some future time a switch may be possible.

[10] It should be noted that in Italy a preference was expressed for the use of dwelling unit.

3.3 Classification of an agricultural household using a "broad" definition

Respondents in Member States were asked to comment on the approach to classifying a household as agricultural using the broad definition. To reflect the range of user needs, a number of ways of defining an agricultural household using the broad definition were put to respondents who were asked in each case to comment on usability. The uniform approach proposed contained the possibility of using all three definitions, which were as follows:

- **Broad variant A:** there is some income to the household from self-employment in agriculture.
- **Broad variant B:** a household member operates a holding that qualifies for inclusion in the EU's Farm Structure Survey.
- **Broad variant C:** a household member operates a holding that is eligible for receiving the Single Farm Payment (the main form of support following the 2003 Mid-Term Review of the CAP's *Agenda 2000,* operated from 2005).

In order to use Broad variants B and C (or any other criterion relying on holding size[11]), it is necessary to know the area of the agricultural holding, if this is known, either variant can be used and these are therefore not considered separately.

The results are presented in Table 3 which shows that in most cases these classifications are either currently used or could be used through the analysis of existing data.

Table 3 - Classification of households as agricultural, broad definition

	Currently used	Technically possible	Requires data source development	Requires new data source
Broad A	Bulgaria, Italy, Lithuania, Netherlands	Slovenia, Malta, Denmark, Austria, Portugal, Sweden, Ireland, Finland, Poland, Latvia, France, Greece	Czech Republic, Spain, Estonia, UK	Germany, Hungary, Slovakia, Luxembourg, Romania
Broad B or C	Denmark, Austria, Italy, Lithuania, Finland	Malta, Romania, Bulgaria, Sweden, Ireland, Poland, Latvia, Netherlands, Greece	Slovenia, Estonia, Portugal, UK, France	Germany, Czech Republic, Spain, Hungary, Slovakia, Luxembourg

Notes:

- Responses for Romania, Slovakia and Luxembourg were interpreted from other answers because this question was not answered directly.
- Denmark, Finland and Austria currently use Broad variant B and could technically use Broad variant C, but do not currently do so.
- The Netherlands may require some development of the data source in order to provide Broad variant C.

Only a limited number of Member States would require the introduction of an entirely new data source, and of these, only Germany and Hungary state that a new data source is required in each case. However, it should be noted that the distinction between the need to develop existing data sources and the need for a completely new data source may have been interpreted differently by respondents, an observation that applies broadly throughout the questionnaire. It is possible, for example, to consider an extension to a sample as a development of an existing data source or as a new data source and it is not always entirely clear which understanding is being used by respondents. This means that a degree of caution should be applied to answers in the final two columns.

3.4 Comparisons between socio-professional groups

In assessing whether the agricultural community has a "fair standard of living" it is necessary to be able to compare household income between socio-professional groups. Respondents were asked whether this was currently done, was technically possible using existing data, could be done by developing existing data (i.e. by increasing the sample and/or adding questions) or whether such comparisons would require a new data source. Respondents were asked to comment on a per household, per household member and per consumer unit basis,

[11] For example, in Latvia the Farm Register goes below the threshold for inclusion in both the FSS and SAP.

although in practice this made little difference to the response because if data are collected per household member then it is straightforward to produce results with respect to all three groups.

In the vast majority of cases it is technically possible to make comparisons between the agricultural sector and other socio-professional groups using existing data or with some developments to existing data sources.

However, in most Member States where it is possible to produce such comparisons, this is not currently done. A factor behind this is the inadequate current coverage of the agricultural household sector (number of cases). The robustness of such comparisons would be enhanced with a larger sample (see Table 4). The exceptions, where new data sources would need to be developed include:

- Germany, where IAHS statistics based in national accounts were discontinued in 1993 and where the respondent commented that there is currently no political interest in making this comparison, even from the farming community who might have previously wanted to draw comparisons.
- Bulgaria, where suitable information from other socio-professional groups is lacking.
- Slovakia, Hungary and Luxembourg.

Table 4 - Can comparisons be made between socio-professional groups

	Currently made	Technically possible	Requires data source development	Requires new data source
Socio-professional comparisons	Latvia, France, Finland, Lithuania, Ireland, Poland, Greece	Sweden, Portugal, Austria, Malta, Denmark, Czech Republic, Romania, Slovenia, Netherlands	Estonia, Spain, UK, Italy	Germany, Slovakia, Bulgaria, Luxembourg, Hungary

3.5 Use of income definition and ability to provide data on income components

Respondents in Member States were asked whether they could provide results based on the definitions of gross or net income taken from the 2005/2007 UNECE Handbook[12].

Net implies after the deduction of taxes and social contributions. In most cases it was possible to provide income data both gross and net either currently or with some development of existing data sources (see Table 5). Exceptions were as follows:

- Poland, where off-farm income is only collected net, as is income for other household members. This is partly because much seasonal work is not declared for tax purposes.
- The UK, where new data sources would be required to calculate net income, as the present data source does not collect information from farmers on their payments of taxes or social contributions.
- Germany, where there are concerns over the reliability of some data sources which would be needed to contribute to the calculations.
- Slovakia, Luxembourg and Hungary.

Table 5 - Use of gross or net income

	With existing data source	With new data source
Gross income	Portugal, UK, Sweden, Italy, Ireland, Lithuania, Malta, Austria, Bulgaria, Czech Republic, Denmark, Estonia, Finland, Romania, Slovenia, Spain, France, Greece	Germany, Slovakia, Hungary, Luxembourg, Poland, Latvia, Netherlands
Net income	Portugal, Sweden, Italy, Ireland, Lithuania, Malta, Poland, Austria, Bulgaria, Czech Republic, Denmark, Estonia, Finland, Romania, Slovenia, Spain, France, Latvia, Netherlands, Greece	Germany, Slovakia, UK, Hungary, Luxembourg

[12] The UNECE simplified definition was provided as a Table for consultation.

In terms of the components leading to disposable income, most Member States that could use the net income concept could provide income data for agricultural households to a reasonable degree of disaggregation, though it was not always technically possible to separate income from agriculture and income from other self-employment activities using current data sources. The main issues surrounded the imputed rental value of the owned dwelling and the methodology for valuing own consumption.

4. Costs of filling data gaps

Most countries were able to supply data on disposable income for their agricultural households from existing data systems but for eight this would require a new source (UK, Germany, Slovakia, Hungary, Romania, Lithuania, Austria, Latvia). This of course does not imply that existing datasets would be sufficient to generate results for all groups of households for which their might be policy interest. In particular, there was a lack of data for the occupiers of holdings large enough to be included in the FSS but falling below the threshold for FADN/RICA.

From the responses an assessment was made of the way forward to apply the uniform approach in each Member States (see Annex 2). Countries tended to fall into three groups:

1. Those where additional data collection would be necessary to service the use of both the narrow and broad definitions of an agricultural household. In this case a **special survey** using a hybrid of FADN/RICA and EU-SILC questions would be required (the former to give adequate data on the farming activities and the latter to cover the other forms of income).
2. Those where the narrow definition of agricultural household is well covered, but additional data collection would be necessary to cover the broad definition. In this case a **special survey** using FADN/RICA and EU-SILC hybrid questions would be necessary to extend coverage down to farms below the FADN/RICA size threshold.
3. A very few Member States where both definitions of agricultural household can be adequately covered using existing data sources. In this case minimal **additional data extraction and analysis** would be necessary to extend coverage to the broad definition.

Costs of filling these data gaps were estimated from a variety of sources, including costs of existing national FADN/RICA surveys and EU-SILC surveys, and commercial estimates. The Agra CEAS study provided a transparent basis for estimating total costs, so that parameters could be easily adjusted. National EU-SILC collection costs were taken as the initial benchmark because, where additional collection was proposed, the methodology could be expected to be similar; commercial rates tended to be of a similar magnitude. For the narrow definition case numbers were based on the sizes of existing FADN/RICA national samples, as these were already accepted by the Commission as adequate to allow a breakdown by farm sizes, types and region (though not necessarily by all three at the same time). On this basis total cost of supplying IAHS statistics using a narrow definition of an agricultural household amounted to some €11.5 million for data collection in the EU-27, to which should be added costs incurred centrally by Eurostat which (judged by known costs of EU-SILC) is likely to be of the order of €1 million annually. Estimates using the broad definition were made in similar ways though involving larger numbers of cases. Two approaches were tried to determine the sample size:

- Sampling the holdings within the FSS, but below the FADN/RICA threshold, at the same rate as those within FADN/RICA, which assumes that the structure (farm size and type) and regional dispersion is similar; and,
- Sampling 1 percent of holdings below the threshold.

The **additional** cost of providing IAHS statistics using broad definitions was estimated at between €9.1 million and €13.3 million per year, giving a total (including any survey work to cover the narrow definition) of €22 million to €26 million. The extent to which these national costs might be funded from the EU budget is not a matter that we have explored. To put these costs in context, EU-SILC costs approximately €27 million in total per year.

Obviously such figures are open to challenge. But even if huge under-estimates, they are tiny in comparison with potential gains from more efficient policy. The annual average Pillar I projected spend for the period 2007-13 is €47 billion. The OECD and others have pointed to the low transfer efficiency of previous support systems, and it is more than probable that there is poor targeting of income payments. If the better statistics led to a 1 percent saving in Pillar I each year, this would be 19 times greater than even the top of the range of estimate produced by the feasibility exercise. The case for spending the money on statistical improvements seems strong.

5. Conclusions

Without good quality statistics on the incomes of agricultural households information necessary to service the paradigm shifts in both rural and agricultural policies will be lacking. The study reported here has attempted to address the key factor that has constrained the development of such statistics in the EU – the lack of basic data that would allow a uniform approach among Member States. The findings on existing sources should allow the UNECE 2005/2007 Handbook to be updated and made more comprehensive. Furthermore, gaps have been identified and ways of filling them proposed and costed. The outcome could be a set of harmonised statistics, based on microeconomic methodology and comparable between Member States, capable of answering many of the emerging questions posed by EU agricultural and rural policy, though this depends on the political willingness to make resources available. So far Eurostat has not chosen to take these statistics further.

References

Agra CEAS (2007). *Feasibility Study on the Implementation of Income of Agricultural Households Sector (IAHS) Statistics*. Eurostat, Luxembourg.

Commission of the European Communities (1985). *Perspectives for the Common Agricultural Policy,* COM(85) 333 Final. The Commission, Brussels (also published as Newsflash 33).

Court of Auditors (2003). "Measurement of farm incomes by the Commission (Article 33(1)(b) of the EC Treaty." Special Report No. 14/2003. Luxembourg, Court of Auditors of the European Communities.

Eurostat (2002). *Income of the Agricultural Households Sector, 2001 Report*. Eurostat, Luxembourg.

Hill, B. (2000). *Farm Incomes, Wealth and Agricultural Policy*. 3rd Edition. Ashgate Publishing, Aldershot.

ISTAT (2002). TAPAS INITIATIVE 2002: Agricultural Household Income. Central Directorate of National Accounting (DCCN), Department OBS (Provision of Assets and Services), Agricultural Economic Accounting Unit (CEA). ISTAT, Rome.

OECD (1995). "Adjustment in OECD Agriculture: Issues and Policy Responses" (Also OECD *A Review of Farm Household Incomes in OECD Countries,* background paper to this publication), Organisation for Economic Co-operation and Development, Paris.

OECD (1997). *Future Developments of Economic Accounts Statistics: Issues and Directions,* OCDE/GD(97)108, Organisation for Economic Co-operation and Development, Paris.

OECD (2003). *Farm household income: issues and policy responses*. Paris: OECD. ISBN 92-64-09965-4.

OECD (2005). *Policy Brief: Farm Household Income: Towards Better-Informed Policies.* Organisation for Economic Co-operation and Development, Paris.

Statistics Sweden (2006). *Availability and feasibility of collecting data on off-farm income and other income – A Feasibility study on collection of data on off-farm income and on other income in FADN.* Statistics Sweden, Rural Economy Research Centre (Estonia) and Agricultural Economics Research Institute (Hungary). Contract reference No. AGRI-2005-401. The Commission, Brussels.

UN (1993). *System of National Accounts 1993*. Commission of the European Communities - Eurostat, International Monetary Fund, Organisation for Economic Co-operation and Development, United Nations, World Bank, Brussels/Luxembourg, New York, Paris, Washington, D.C., ISBN 92-1-16352-3.

UNECE (2005/2007). *The Wye Group Handbook: Rural Households' Livelihood and Well-Being – Statistics on Rural Development and Agricultural Household Income.* United Nations Economic Commission for Europe, Geneva (for IWG-Agri). Electronic version 2005.

University of London / The Pennsylvania State University (2002). *Workshop on the Farm Household-Firm Unit: Its importance in agriculture and implications for statistics*. Imperial College, Wye campus, April 12/13 2002. Papers available from <http://household.aers.psu.edu

Annex 1 - Inventory of existing microeconomic data sources by Member State

MEMBER STATES	Farm accounts survey	EU-SILC*	Family (household) Budget Surveys	Taxation records	Other
Belgique/Belgie/Belgium	Statistics Sweden (2006) suggests that income from outside the holding is collected, but this could not be verified in this study.	There were only 40 cases in 2004.	A survey exists, but there are few agricultural cases.	Records exist, but income is not on an account basis.	
Bulgaria			A survey exists, but agricultural cases are not identified separately.	Not applicable.	Special annual survey of holdings and livestock. Sample about 1,000.
Ceska republika/Czech Republic		There were only 64 cases of people working in agriculture, and only 18 self-employed farmers.	*No income data collected.*	Incomes not actual -revenue is declared, but costs can be estimated as a proportion of this.	
Danmark/Denmark	Formerly there were accounts surveys of the Farmers' Association (sample of 16,000); Smallholders' Association (sample of 4,600); and the Institute of Agricultural Economics (sample of 1,800). There is now only one farmer association and total number of accounts is somewhat lower, but still large. There are approximately 2,100 accounts in FADN, of which around 300 relate to horticultural holdings	There were only 109 agricultural cases in 2004.	There is a survey, but there are few agricultural cases.	The Income Statistics Register System is tax-based and is combined with an agricultural statistics register. There are 15,000 cases.	
Deutschland/Germany	There are test holdings of 11,000 which also cover household income.		There is a survey of incomes and expenditure at 5-yearly intervals.	This takes place on a 3-yearly basis. However, about half of farmers are not taxed on an accounting income basis, standards are used as an approximation.	There is an annual population microcensus.
Eesti/Estonia		There were only 103 agricultural cases in 2004.	Number of agricultural cases not indicated (likely to be small, and self-employed income on a household basis only).	*No information.*	
Ellada/Greece	Household income is not normally covered, but a pilot survey was made in 1992.	There were 642 agricultural cases in 2004.	This has been carried out every five years, but will be annual from 2006 there have been difficulties with incomes from self-employment in the past.	Taxation records only cover professional farmers (defined as having more than 50% of time self-employed in farming) who earn over €3,000 from self-employment in agriculture or receive at least €1,500 in subsidy from crop enterprises or €2,250 from livestock enterprises.	
Espana/Spain		There were only 253 agricultural cases in 2004 (similar number in 2005).	There are only about 120 agricultural cases, but there are difficulties with incomes from self-employment.	Some farmers do not pay tax based on actual incomes, and incomes may be estimated.	

MEMBER STATES	Farm accounts survey	EU-SILC*	Family (household) Budget Surveys	Taxation records	Other
France	No information on non-farm income collected in FADN/RICA. But there is periodic matching and merging at the case level of RICA results with tax data (for other incomes). The latest of these exercises were carried out for 1997 and 2003.	There were only 202 agricultural cases in 2004.	Only about 200 farmer households are covered in the BDF.	For more than 50% of farmers incomes from agriculture are not taxed on an accounts basis but under a "forfait" system (estimated income based on farm type and Department). Information on other sources of income considered reliable. There have been two levels of sample enquiry (general and agricultural), A special study was undertaken in 1990.	There was a special farm survey (CERC) in 1978.
Ireland	This is linked periodically with the Household Budget Survey.	There were only 13 agricultural cases in 2004 and there are different definitions for farm household.	Some 1,000 farmer-households were included in the 1987 survey. The income data was good and this exercise was repeated in 1994 and 1999/2000.	Farmers are not well represented under this source.	There are records of social assistance.
Italia/Italy	Questions on off-farm income have been included in RICA-REA from 1998 (the number of valid cases was 11,379 in 2000).	There were 367 agricultural cases in 2004.	This is continuous and there are many agricultural cases, however, income data are not of high quality.	Income is not on an accounts basis. The valuation is based on farm type and region.	Bank of Italy survey of households. The ISMEA 1996 Survey on agricultural households covered 1881 farms. This has not been repeated since.
Kypros/Kibris/Cyprus	Statistics Sweden (2006) suggests that income from outside the holding is collected, but this could not be verified in this study.				
Latvija/Latvia		Some 1,500 of the 3,843 cases in rural areas have 1 ha or more of agricultural land (mostly subsistence producers). Another 1,386 cases in rural areas have agricultural land (perhaps for recreational purposes).	Currently an annual survey. Of the net effective sample, 1,900 households have agricultural land, of which 150 produce for the market. Income is measured gross (not net).	Tax data for non-agricultural income might be used, if combined with FADN/RICA *(the implication is that tax data on income from farming is not usable in a direct way)*.	From 1999-2003 data was collected an income and expenditure as part of the crop and livestock survey. Sample was about 15,000 holdings.
Lietuva/Lithuania	There are 1,286 FADN/RICA cases.	In the 2004 EU-SILC there were 1,650 rural households (16% of total) but agricultural households were not separately identified.	In the 2004 HBS there were 509 agricultural households (7,586 in total).		
Luxembourg	Special questions covering household income were added in 1989 only.	There were only 78 agricultural cases in 2004 (from a total of 3,500).	There are few agricultural cases.	Most farmer's income is not on an accounts basis.	There is a poverty survey of households (CEPS).

MEMBER STATES	Farm accounts survey	EU-SILC*	Family (household) Budget Surveys	Taxation records	Other
Magyaroxzag/Hungary	Currently does not cover non-farm income, but this might be technically possible	Very small number of cases likely (not analysed).	Regular annual survey – number of agricultural cases not given, but a special pilot survey carried out (see 'other). HBS changed in 2004-05 to better reflect agriculture	Special tax arrangements for registered agricultural producers, including exemption on small levels of production, mean that tax records are not suitable as a data source on incomes.	Special pilot survey (2003) of agricultural households based in HBS but drawn from the agricultural census. 6,000 cases
Malta		Data collection started in 2005 for the reference year 2004. This data is collected on an annual basis according to EU Regulation. Only 60 households from 3,200 (2.5%) are agricultural. Small proportions from relatively small samples may give misleading results.	The most recent HBS took place in 2000 (next planned for 2008). Approximately 2,500 households were included, but no information given on the number of agricultural cases.	The NSO has not been granted access to income tax data on either the micro or macro level.	
Nederland/Netherlands	There used to be two annual surveys; one used to build the national production account (with 3,000 cases); the other was part of FADN/RICA (with 1,500 cases). These are now combined. There are currently 1,500 cases.	There are 6,500 cases in total. The number of agricultural cases is unknown.	Total sample size is 2,000, but the number of agricultural cases us unknown.	There is an annual panel study, the Personal Income Distribution Statistics. Access to further tax registers has recently been gained and the use of these in relation to agriculture is currently being studied.	
Osterreich/Austria	There is a sample of 2,500 holdings which also covers household income. 1,800-1,900 contribute to FADN.	There were 271 cases in 2005.	This is carried out once every 5 years.	For a large proportion of farmers tax payment is not based on accounting income (farmers pay 'lump sum' taxes).	
Polska/Poland	Data on five types of non-agricultural income collected from about 10,000 farmers in 2005. Results published annually.	Number of agricultural cases not known; they are combined with other self-employed.	Some 2,000 agricultural households in 2005, but problems with income data quality (collected over a month).	Only the production of a specific list of commodities is covered by the tax system. Assessment (mainly) uses a standard rate based on land and forest area, land quality and distance to market.	
Portugal		There were 367 cases in 2004.	There are difficulties with income from self-employment and this was last undertaken in 2000.	Few farms are covered.	
Romania		SILC will begin in 2007.	Results are available for 2001 to 2006. The number of cases and quality of the income data is unclear.		
Slovenija/Slovenia		1,311 cases have income from farming (2005 – 16% of all cases).	300 cases (of a total of 1,300)	Only a minority are taxed on an accounts basis. Most are on a cadastral income assessment.	
Slovensko/Slovakia		Not separately identified.	Not separately identified.		

MEMBER STATES	Farm accounts survey	EU-SILC*	Family (household) Budget Surveys	Taxation records	Other
Suomi/Finland	The Profitability Study of Agriculture (FADN/RICA Finland) covers 1,000 holdings. In principal the entire household is covered. However, Statistics Sweden (2006) notes that data collection on income from outside the holding was discontinued after 1997.	There are around 800 agricultural cases (cross-sectional EU-SILC is fully integrated with the national Income Distribution Survey).	There is a family budget survey, but the sample has been reduced since 1994.	There are three data sources: (a) Agricultural Enterprise and Income Statistics (10,500 agricultural cases in 1999) with data taken from tax forms; (b) Income and Taxation Statistics for the Finnish Farm Economy (formed by combining administrative registers); and, (c) Income Distribution Statistics (totally register-based) covering all private household-dwelling units	
Sverige/Sweden	The Farm Economics Survey (JEU) covers 1,000 holdings, but questions about non-farm incomes were dropped in 1990.	There were only 31 agricultural cases in 2004 and less than 10 in 2005.	(a) Survey of household finances (HEK) Sample of 17,000 (b) Survey of living conditions (ULF) sample of 9,000 The number of agricultural households is not known but is considered to be too small to give reliable results.	There are three data sources: (a) Taxation Statistics of Agriculture (DU), historic series ended in 1993 (2,700 agricultural cases in 1991); (b) Survey of Income Distribution (HINK), taxed based, covering all households, about 600 agricultural cases in 1992, 199 in 1997; and, (c) Annual taxation statistics for the whole population, farmers were separately identified in 1991, 1992, 1996 and 1997.	
United Kingdom	The non-farm income of farmer and spouse has been covered since 1988/89. Income is banded. Full household income data (for the principal farmer only) was collected from 2004/05, but will be published only from 2005/06. Data from the first year of collection were not regarded as being of sufficiently high quality to publish.	The UK contribution to EU-SILC, the General Household Survey, is not sufficiently developed to be actively under consideration, but it may present options for the future.	This does cover the agricultural sector, but there are few households headed by a farmer (about 60).	Less than 2,000 agricultural cases are taken from the Survey of Personal Incomes (from tax records of self-employment income). Farmers with businesses run as companies not covered.	The Family Resources Survey was introduced in 1996, but there are too few agricultural cases.

Notes: (*) 2004 is the latest year for which data are available.
Source: taken from Hill (2000) and updated incorporating basic information from Eurostat and OECD (1995) and a 2007 survey of Member States carried out under the auspices of this project.

Annex 2 - Practical way forward by Member State

MEMBER STATE	PRATICAL WAYFORWARD
Belgium	**NO RESPONSE RECEIVED.** ***ADDITIONAL*** *data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology*.
Bulgaria	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Czech Republic	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Denmark	**EXISTING** data taken from administrative registers, including Farm Structure Survey, Family Register and Tax-based Income Register.
Germany	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Estonia	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Greece	**EXISTING** data from SILC cover a relatively high number of agricultural cases. **ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Spain	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
France	**EXISTING** periodic combined use of farm accounts survey and taxation records. **ADDITIONAL** data to cover the broad definition drawn from a periodic survey of farmers below the FADN/RICA threshold (8 ESU) using a SILC methodology.
Ireland	**EXISTING** data from a periodic combination of farm accounts survey and Household Budget Survey. **ADDITIONAL** development of the HBS sample may be necessary to ensure households operating very small farm holdings are captured adequately.
Italy	**EXISTING** data drawn from several periodic surveys including RICA-REA and ISMEA.
Cyprus	**NO RESPONSE RECEIVED.** ***ADDITIONAL*** *data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology*.
Latvia	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Lithuania	**ADDITIONAL** data drawn from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Luxembourg	Luxembourg made no practical proposal. However, our understanding is that **ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology should be possible.
Hungary	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a Household Budget Survey methodology which is equivalent to a FADN/RICA and SILC hybrid. This replicates surveys that have already been carried out.
Malta	**ADDITIONAL** questions might be added to the FADN/RICA survey, but to achieve data that are compatible with SILC. Small national numbers of holdings presents special problems of mounting a separate survey (burden on respondents, and response rate).
Netherlands	**EXISTING** FADN/RICA data do not adequately cover other household members. **ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Austria	**EXISTING** data from the farm accounts survey. **ADDITIONAL** data to cover the broad definition from special survey of holdings would be needed below the threshold of the farm accounts survey (5 ESU). **OTHER** work needed on comparisons with other socio-professional groups from other surveys.
Poland	**EXISTING** data on farmer and spouse household income collected via farm accounts survey (contributor to FADN). **ADDITIONAL** data to cover the broad definition drawn from a periodic special survey covering those farms below the FADN/RICA threshold (2 ESU) drawn from holdings in the Farm Structure Survey. **OTHER** work needed on comparisons with other socio-professional groups from other surveys.
Portugal	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Romania	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Slovenia	**ADDITIONAL** survey with a FADN/RICA and SILC hybrid methodology (existing data from registers may be combined, but would only permit a broad comparison with other socio-professional groups).
Slovakia	**ADDITIONAL** data from a periodic special survey of agricultural households, drawn from agricultural holdings, following a FADN/RICA and SILC hybrid methodology.
Finland	**EXISTING** data taken from register-based income distribution statistics.
Sweden	**EXISTING** data taken from administrative registers, including Register on Incomes and Taxation.
United Kingdom	**EXISTING** data on farmer and spouse household income collected via farm accounts survey (contributor to FADN). **ADDITIONAL** data to cover the broad definition from a periodic special survey covering those farms below the FADN/RICA threshold (16 ESU in England, Scotland and Wales, 8 ESU in Northern Ireland) drawn from holdings in the Farm Structure Survey and using a FADN/RICA and SILC hybrid methodology.

Note: In Belgium and Cyprus some information on off-farm income may be available through the national farm accounts survey. However, the absence of replies from these countries leaves this unconfirmed. Bold indicates that mission took place to collect data.

SESSION 1

Parallel Session 1.a

Two Views of Diversification and Non-farm Income

Chairman: *Monica Brezzi, OECD*

Report on Parallel Session 1a: Different Views of Diversification and Non-Farm Income

Chairman: Monica Brezzi, OECD

***Overview**: The main objective of this session was to discuss different results related to non-farm income and rural livelihood diversification. The papers highlighted different characteristics and causes to explain rural income patterns especially when looking at India, where data show that female participation in rural non-farm activities has not increased, and Canada, where the increase of female labour participation in non-farm earnings is the main factor in explaining the decline in the household's agricultural earnings. The session discussed also data issues and methodological framework for refining the measurement of rural income. One paper also raised the issue of the importance of using sound statistical analysis and indicators in the decision making process.*

Rural Livelihood Diversification and its Measurement Issues: Focus India, *Rajiv Mehta, Ministry of Statistics and Programme Implementation, India*

The Wye City Group framework postulates that single income from farm activities explains the incidence of deep poverty. The paper discusses the aspects of rural livelihood diversification, blending non-farm economic activities with farm activities as the development paradigm for improving livelihood and well being of rural households. The constraints due to rural structural distinctiveness in terms of resource endowments and factors of production are highlighted as well as policy options to overcome them such as strengthening empowerment and ensuring security for enhancing opportunities of such livelihood diversification. The paper gives an extensive description of available data on the multiple dimensions of rural economic diversifications and of measurement issues in India.

Household Associated with Agricultural Holdings: Selected Socio-economic Dimensions, *Ray Bollman, Statistics Canada*

Statistics Canada's used its Agriculture-Population Linkage database over the 1971 to 2006 period to assess and study the role of these two factors in the measured increase in off-farm income of households associated with census-farms. The study addressed the possible causes over time to explain the increasing share of off-farm work and off-farm work by other family members reported by census-farm operators. Some of this increase has been due to a polarization of the structure of agricultural holdings – more larger holdings and more smaller holdings. An ancillary objective was to explain the way the Agriculture-Population Linkage is created and to enumerate the contribution of this database to agriculture and rural policy analysis.

Measuring socially and economically sustainable rural communities - a policy based approach, *Pippa Gibson*

England's Department for Environment, Food and Rural Affairs (DEFRA) has set a certain number of indicators to measure the policy objective of 'socially and economically sustainable rural communities'. The paper discusses the indicators chosen to evaluate this objective which are organized along two main components; the first one looks at mainstream policy areas ranging from education and health to poverty and housing affordability. The second one focuses on productivity, supported by a range of indicators from earnings and employment to investment and enterprise.

Rural Livelihood Diversification and its Measurement Issues: Focus India[13]

Rajiv Mehta
Additional Director General,
Survey Design and Research Division,
National Sample Survey Organisation,
Ministry of Statistics and Programme Implementation, Govt. of India
"Mahalanobis Bhawan"
164, G. L. T. Road, Kolkata, 700108, India
rajivmehta2@gmail.com

Abstract: *The rural structural distinctiveness in terms of resource endowments and factors of production often has bearings on livelihood and well-being of their people, constraining improvement in the economic conditions of farm households solely through farming operations. There is an emerging consensus that the livelihood security and well being of rural households improve with the blending of non-farm economic activities with farm activities and such diversification of rural livelihood positively impacts the farm efficiency. This paper delves into its multiple dimensions and its measurement with respective conceptual framework, indicators, data inputs from multiple sources and data limitations, with focus on analytical inferences for India. Accordingly the paper articulates the need for further studies on its different dimensions, improvement in the measurement, and data exploration for furthering the Wye Group agenda of rural livelihood development.*

Keywords: Rural households, Labour force

1. Introduction

The issues concerning rural development are largely centered on the iniquitous income, opportunities and access of its populace. These inequities assume accentuated proportions when compared with urban segments. There is fundamental structural differentiation between rural and urban segments in terms of respective factors of production due to the distinct characteristic of rural economies. On account of relatively much intense and intrinsic relationship with natural endowments, the rural economies are generally oriented to production of primary goods. There is a fair generalization in stating that aggregated income accrual to the rural households from production of such primary goods is higher than the urban households. The rural sectors, in turn are net suppliers of primary produce and generally, the net consumers of secondary and tertiary goods and services. The demographics, human and natural resource endowments and their linkages lead to varying permutations of the dichotomy of economic activities and income generation of people and the resultant inter and intra regional differentiations in livelihood and well-being.

The rural urban structural dichotomy is sharper and more dynamic in developing countries. Firstly, the urban expansion and contraction of the share of primary sector (read agriculture) in their GDP is adjunct to the overall development process. If demographic structures in a region are rigid or less dynamic than the pace of restructurings of subsectors resultant to economic growth, the rural urban divide in terms of per capita income accrual is poised for further widening. Secondly, to meet the food security of increasing population, the food factory (the primary agricultural production) would have to be operated more intensely and this process, being land based, would remain located in non urban areas. In other words, there is practically no scope of relocation of agricultural activities, a flexibility enjoyed by non-farm activities. Thirdly, in medium and long term, growth

[13] Views expressed in this paper are of author.

of agrarian segments cannot be placed at the ambitious levels of urban based and urban biased manufacturing and service sectors. It may be argued that even in the event of accelerated economic growth, as witnessed in same of the developing countries with prominent agrarian presence such as India and China, the growth ambitions from agriculture sector would need to be moderate and sustainable with concern for stress on natural resources of water and soil and due to the technological constraints.

The demographic pressure and socio economic inequalities in rural domains of developing countries further complexes the relationship between humans and endowment. For instance, about 30 percent of world population is in the developing countries of South and South – East Asia with less than 7 percent world landmass. As derived from FAO Statistics (FAO 2005) this region has almost 40 percent of world's agricultural dependent population with less than 20 percent global arable land resources. With such uneven distribution of production assets, low levels of literacy, skills, awareness and connectivity and limitations of alternative options for livelihood, the high prevalence of poverty in these regions becomes the structural corollary.

Against this background, the scope of increasing real income of farmers and bringing sustained improvement in their well being, solely through farming operations, is seriously constrained. There is concern on the incidence of deep rooting of poverty amongst the households depending on single income from farm activities (UN -Wye Group, 2007). The rural economies in developed countries are relatively more diversified and majority of their rural households have larger share of non farm income accrual. The empirical evidences of change in rural economic and activity composition of developing economies are being documented (FAO-RIGA 2007) and more rural families are earning from non-farm work, the process is slow in several regions due to limited skills and opportunities. The earnings from agriculture continue to be a fundamental source of livelihood for 90 percent of rural households, particularly the poor.

While emphasizing the catalytic role of accelerated agricultural growth for development and overall economic growth, the planning processes have also viewed (World Bank, 2008, Planning Commission of India, 2007) that such agricultural growth may not to be the source of increasing direct employment and earning per head. Considering the negligible employment elasticity to agricultural growth, creation of non-agricultural opportunities, diversification of rural economy and expansion of Rural Non Farm Employment are adjunct to the strategies of managing vulnerabilities associated to the farm sector and bringing meaningful structural change in the rural socio-economic conditions.

Any strategy towards the development and improvement of wellbeing of population therefore needs to take into account these fundamental issues in relation to agrarian structures. The scientific understanding of these differentiations becomes a prerequisite for evolving and implementing development agenda. For sustainable improvement in the rural livelihood, particularly in developing economies, studies on various aspects of the rural economic diversification are the contemporary policy requirements[14]. Since this subject takes into account a wider perspective of economic activities in rural domain, the data profile required to examine its varying dimensions is also expected to be much larger and complex. Often the statistics and indicators are not available from single source in desired format and confirming to the conceptual requirements. It necessitates the mining of rural development statistics for deriving relevant indicators needed for synthesizing rural economy, rural household livelihood and their wellbeing.

---

[14] Rural development used to be a sectoral issue with agriculture as the main focus. In many developing countries agriculture is still the corner stone of the rural economy. In the OECD countries, on the other hand, it has more and more become a territorial concept, dealing with spatial differences in problems and perspectives, opportunities and options. It is also a multisectoral concept, concerned with a wide range of demographic, economic, social and environmental issues. It stresses the importance of cross-sectoral, horizontal integration of activities and policies. Finally, rural development is a dynamic concept, concerned with medium to long term changes and adjustments in technology and ecology, economy and society. Rural indicator should therefore provide information on a variety of economic and social factors.- The Wye Group Handbook 'Rural Households Livelihood and Well-Being' United Nations 2007-pp. 10.

2. Rural Economic Diversification - Multiple dimensions

The term "Economic Diversification" relates to the production of diverse goods and services in a production boundary. In turn, it also relates to pursuance of diverse economic activities by the people of a geographic domain for producing larger range of goods and services. Eventually, the diversity of production and economic activities of the people results into income flows from diverse sources. Such diversification is triggered by the use of resources for production of goods and services from available alternative choices. Often the process of alternative choices also takes into account the efficiency of resource use as well as the opportunity of resource use. Resource allocation itself may get triggered, generally by economic forces, though sometimes there may be non economic reasons, compelling the people to undertake alternative activities. The study domains of economic diversification therefore are certain production boundaries on time and space, and require appropriate observational units and quantitative indicators. Lately, the subject is involving the social scientists to assess its incidence and impact on well being of populace.

As stated above, there is general acknowledgement that not only the economic condition of rural household improves with the blending of non-farm economic activities with farm activities; it has positive impact on efficiency of their farm enterprises. It integrates with the multiti-pronged strategy in the framework of action against poverty, stimulating enhancement of entitlement and access. The **opportunities, empowerment and security** are the three factors that have complimentary and supplementary role in neutralization of economic deprivation. These three factors are also closely associated with the process of economic diversification. If the opportunity of doing multiple activities enhances returns and exposure and thereby empowers the economic and social wellbeing, the empowerment through literacy, skill, knowledge, awareness, resources and connectivity improves the capacity and scope of harnessing the opportunities. The resultant derivatives are augmented remuneration and returns from diverse sources, contributing to stability of economic condition, security, reduction in vulnerability and risk mitigation. Therefore, studies on different dimensions of diversification of rural economy, improvement in the measurement, factorization and impact and exploration of its indicators are needed for furthering rural livelihood development and well-being.

One of the basic forms of rural economic diversification is the **crop diversification**. The diversified cropping pattern in a region emerges due to allocation of arable land resources for cultivation of number of alternative crops. The Indian agrarian space is endowed with diversity of agro-climatic conditions and varying degree of augmentation of farming resource through irrigation infrastructure, crop specific farming technologies, diversified demand and post harvest linkages. Such on farm diversification helps in reducing farming risk due to climatic, market and other such aberrations and often improves resource use efficiency (Joshi et al 2007). However, the crop diversification has been subjected to resource endowment of farmers in terms of land, water, technology, seeds and soil besides externalities such as agro climatic conditions, sustainability and the response to market (Haque 1999, Mehta 2005). The skewed distribution of infrastructure such as road, transportation, market, post harvest handling, irrigation and power are found to be the impediments for both horizontal and vertical diversification[15]. Nevertheless, the crop diversification not only indicates the options and opportunities of cropping, it also harmonises the supply to demand of diverse commodities and in the process diffuses the price volatility in the market.

These studies have assessed the dynamics of crop diversification on aggregate allocation of arable land to different crops in a region as well as diversified value of output and related inferences. One may note that in India, at micro level, the operational holding size is small (Average operational holding is 1.3 Hectares) and individual farmers have limited scope of diversification in his farms.

An extension of the same to more meaningful form of **farm sector diversification** is through animal husbandry, poultry and fisheries and its measurement in terms of value of outputs. It has been widely acknowledged that in semi arid central and western India having lesser scope of multiple cropping, animal

[15] Horizontal crop diversification: addition of more crops to the existing cropping systems, which is the broadening of the base of the system., Vertical crop diversification: the extent and stage of industrialization of the crops with practicing of enterprises like agro-forestry, dryland horticulture, medicinal and aromatic plants, other high value and economic shrubs.

husbandry reduces the vulnerability of farmers. In the regions where forward integration of small cattle holders has been strengthened by institutions such as cooperatives, the economic conditions of farmers have improved. The cooperatives, self help groups and other institutions of marketing etc. have stimulated the process of on-farm and off-farm diversification by putting the opportunity, empowerment and security as the rural development package. The extension of farming activities to certain on farm post harvest operations not only adds to the farm gate value creation it also expands the production entrepreneurship of the farmers to services.

From the point of view of diversification of economy in the production boundary, one may also look into the existence of enterprises in the rural areas and producing non agricultural goods and services. In India, there is a significant presence of small and tiny non agricultural enterprises in the rural areas. There is preponderance of informal and unorganized enterprises in the rural economy, both in terms of their number as well as workforce. Out of total own account enterprises (without hired workers), 11.1 million (92 percent) non agricultural manufacturing and 9 million (91 percent) of service sector (excluding domestic trading) enterprises are located in rural sector (NSS 62nd and 63rd Round, reference period 2005-06 and 2006-07 respectively). However, in terms of GDP, these rural enterprises have much smaller share.

The rural non agricultural entrepreneurial diversification may not be simply assessable in terms of their number and GDP share. There are aspects of economy of scale, operating efficiency and technology used in the corresponding large enterprises located in industrial hubs, which are not easily measurable but impinge on efficacy of rural non farm diversification.[16]

The diversification through crops and on and off farm production offers limited perspective of rural economic diversification. It is confined to the production boundary of agriculture and allied sector and producing entrepreneurial units of the farms. Without undermining the significance of such diversification, that eventually strengthens integration of farming with post farming and off-farming activities, the economic gain to its stakeholders will be restricted to the growth potential of farm sector. For the rural economy to sustain in the long run, the scope of its diversification would necessitate expansion to the wider dimensions of **livelihood diversification**. The vulnerability of livelihood in rural agrarian segments of developing countries has been acknowledged and the livelihood security is one of the central theme needing attention in the liberalized and market reformed agricultural trade regime. The rural livelihood diversification therefore is an integral dimension of development agenda for strengthening rural livelihood and sustaining livelihood security.

There are two ways to look into livelihood diversification. One, the individuals and / or their groups perform different activities. In other words, the individuals are capable to engage in the alternative choices in the labour market and undertake different forms of rural employment; both farm as well as nonfarm. From the point of view of rural development, the **rural employment diversification** is considered to be driving force (UN-Wye Group 2007). Two, the **rural income diversification** enabling individuals or households to have income sourced from the diversified sources. There is differentiation in employment diversification and income diversification as both are broadly complementary but may not necessarily be synonymous. The employment diversification is measured in terms of labour force participation in diverse industries and occupation. The wages and remunerations from different employment would add up to income. However, the income diversification is more comprehensive, since it would also account for transfer payments (rents, interests, dividends etc.) to individuals.

As stated above, the crop and farm diversification have potential to augment income and strengthen livelihood. But due to its confinement to labour participation in the farm related activity, it remains diversified in the limited sense. Further, the domain of crop and on farm diversification is the production boundary of primary goods, hence the stability and security of livelihood remains vulnerable despite such diversification. The domain of rural livelihood may extend beyond the rural production boundary. The commutation of rural

[16] In all countries, establishment size, in terms of persons employed, is smaller in rural than in urbanized regions. The average size of establishments differs considerably and systematically among types of regions and countries, the smallest establishments are found in predominately rural regions. As a result, the average size and structure of enterprises and establishments in relation to employment change should be highlighted. In the context of industrial structure, it should be noted that specialization in many rural economies has made them particularly vulnerable to business cycles and resource depletion, for instance in mining and forestry. OECD study quoted in The Wye Group Handbook 'Rural Households Livelihood and Well-Being' United Nations 2007-pp. 31.

people to urban neighborhood for their work and jobs as well as income transfers from urban to rural add to the wider dimensions of livelihood diversification. Following sections delve on measurement issue concerning rural livelihood diversification with specific reference to India.

3. Rural Livelihood Diversification: Some measurement issues

The livelihood, either in terms of income or activity participation, is the issue to be measured first in its micro existence where it relates to the individuals residing in different population domains. However, from the point of view of generation of statistics on socio economic characteristics, an individual is identified through the household. *"A central feature of the household is that there is a high degree of pooling of income and expenditure. This means that assessment at the level of the household is more meaningful in representing the potential command over goods and services than would be the case if the incomes of the individual members were treated separately. (The Wye Group Handbook 'Rural Households Livelihood and Well-Being' United Nations 2007-pp. 181)"*

Household is a multi activity unit. It is the matrix of individuals and the activities pursued by them. The rural farm households (there are issues in defining the term farm household) in the context of their farm and non farm own account enterprises are the managerial units with varying degree of participation of their members. The household labour force surveys (example, National Sample Survey in India, illustrated in next section) dissect the household to capture the labour force and the work participation of its members in different industries and occupation. Hence the derivatives of livelihood diversification in terms of employment and labour force participation can be easily derived from these results. There may still be need to develop composite indicators of work participation for the household, aggregating multiple activities pursued by the members of the households. The labour force enquiry, generally accounts for multiple activities performed by individuals.

There are limitations and constraints in deriving household income and its distribution over individuals as well as in the industry- occupation classifications. The estimation of household income requires assessment of financial flows in the matrix of individuals and the activities within the households. These financial flows may accrue from the wage work, imputations of non wage work and flows from the savings and stocks. When the household activities are unorganized, informal and overlapping as is the case for farm related activities mixed with off farm and non farm activities, accounting such flows becomes difficult during survey investigations. It also needs to be appreciated that in such a complex ambit of financial flows, income derivations would need certain concepts and definitions. The survey cost, informant fatigue and qualitative aspects of data also pose constraints in data generation endeavourers. Comparatively, the methodologies, indicators and data on labour force participation are stabilized and standardized in the periodic labour force enquiry. However, measurement of diversified income of rural household appears to be most relevant for assessing rural livelihood diversification, though it is felt that it may require considerable effort to generate data for this purpose.

As stated earlier, various indices measuring diversification of rural economy such as crop and farm diversification and rural livelihood diversification, both in terms of work participation in economic activities as well as income diversification require distinct sets of data. A synopsis of the same is given in Table1.

Table 1 - Metadata for measurement of rural economic diversification *(reference India)*

DIVERSIFICATION MEASURES	DATA REQUIRED	DATA SOURCE
I. Crop Diversification a. In terms of Area b. In terms of Value of output	Season-wise, crop-wise area crop-wise value of output apportioned season-wise (National – sub-national)	Agricultural Statistics National Account Statistics
II. Farm Sector Diversification	Crop-wise, subsector-wise (Crops, Horticulture, Livestock, Fisheries, forestry) value of output (National – sub-national)	National Account Statistics
III. Livelihood Diversification		
a. Employment Diversification	Population work participation rates in different activities (aggregate, household classified) (National – sub-national)	NSSO labour force surveys
b. Income Diversification	Income accrual from different economic activities (aggregate, household classified) and transfer payments (National – sub-national)	Data limitation

It is also important to have a perspective of various indicators of rural diversification. Table-2 gives indices of diversification[17] in respect of federal states on India. Different scholars may arrive at different value of the index, depending upon the combinations of factors taken into consideration. In the following illustration, the index value for farm sector diversification will increase if one takes crops in segregation of foodgrains, oilseeds and other crops. Therefore, for any comparative inference, some degree of uniformity and harmonization of data would be necessary. This however, is subjected to harmonized availability of data for different domains.

Table 2 - Different rural diversification indices *(India – sub national)*

STATE CATEGORY *(Sub National)*	Diversification Measures: Crop Diversification Index *				Other Explanatory Indicators (% incidence of rural poverty) (2004-05)
	Area based (2000-01)	Value based	Farm Sector Diversification (2004-05)#	Livelihood Diversification Employment Diversification (2004-05) $	
			RICE-WHEAT STATES		
Punjab	0.730	0.721	0.534	0.665	6
Haryana	0.800	0.810	0.546	0.663	9
Uttar Pradesh	0.801	0.878	0.590	0.509	32
			RICE DOMINANT STATES		
Bihar	0.708	0.912	0.726	0.400	33
Orissa	0.725	0.876	0.696	0.524	40
West Bengal	0.742	0.909	0.728	0.577	24
			OTHER STATES		
Andhra Pradesh	0.893	0.903	0.707	0.469	8
Gujarat	0.906	0.925	0.653	0.424	14
Karnataka	0.943	0.935	0.716	0.330	12
Madhya Pradesh	0.906	0.916	0.592	0.321	30
Maharashtra	0.940	0.943	0.716	0.358	22
Rajasthan	0.909	0.912	0.609	0.500	14
Tamil Nadu	0.889	0.897	0.706	0.546	17

* Mehta (2005)
# Authors computation using National Account Statistics (Diversification group Crop, Horticulture, Livestock and Fisheries)
$ Authors computation using NSS Employment Unemployment survey (61st rd) (Diversification group: agriculture, mining & quarrying, manufacturing, electricity and water supply, construction, hospitality, transport and communication, other services)
! *Data Source*: Planning Commission

[17] Simpson Index of Diversity: ($1 - \sum P_i^2$) where, P_i is the proportionate area of i^{th} crop activity or enterprise or value in the gross cropped area or total value of output. The index scales in the range of 0 to 1 with the degree of crop diversification in the respective geographical domain.

Above analysis reveals some interesting inferences on rural diversification. The indices of rural livelihood diversification are invariably lower than the indices of crop diversification. Punjab and Haryana, the agriculturally advanced regions of India have prominence of seasonal mono-cropping pattern and this is reflected in the lower values of their indices of crop diversification. These regions are also having high cropping intensity, that provides more time engagement to farm households in agricultural activities. Yet, these regions also have relatively higher livelihood diversification. Incidentally, both these states have low prevalence of rural poverty. Contrary to this, the regions of Madhya Pradesh, Maharashtra and Bihar have more diversified agriculture but low livelihood diversification. These states have high prevalence of rural poverty. Though, the livelihood diversification in terms of work participation in different economic activities explains the rural economy more comprehensively, something still remains un-explained in the absence of income data, since it not only captures returns from the activity participation, it also accounts for transfer payments, that is quite significant well being factor in some regions. Moreover, above indices are based on aggregates. The household labour force data can be organized to assess household-wise aggregate status of livelihood diversification, making it more relevant to the household as an economic and entrepreneurial entity.

The next section provides empirical analysis of rural livelihood diversification in terms of employment in India, based on the results of National Sample Survey Organisation (NSSO) of India. The NSSO conducts nationwide multistage stratified sample surveys on various socio-economic aspects and is the prime source of data on key rural development indicators. The scope, subject and indicator coverage of NSSO surveys is given in Appendix - 1.

4. NSS concepts and measurement of Rural Livelihood Diversification

The quinquennial Employment and Unemployment Surveys (EUS) of NSSO provide national and sub national temporal data on Labour Force Participation Rate (LFPR) and Worker Population Ratios (WPR) since the 27th round (October 1972 - September 1973) and the results of latest available 61st round (July 2004 - June 2005) are seventh quinquennial in this series. These surveys follow comparable and established concepts of usual and current activity status in the industry / occupation classification of the activity of persons, compatible with ILO concepts. The sample size of NSS 61st round EUS was 79,306 sample households in 7,999 sample villages and 45,374 sample households in 4,602 sample urban blocks.

The NSS concepts identify labour force in terms of activity status of persons, that is the activity participation of a person in economic and non-economic activities during the reference period. It identifies the person through household as defined in NSS concepts[18]. In this process, it is possible that the location of activity may be different from location of household. Further, in EUS, NSS captures the economic domain in which the economic activities are performed by the person, following the National Industrial Classification (NIC 1998). The nature of occupation and operations are classified under the National Classification of Occupations (NCO 1968). Accordingly, the activity participation is segregated in economic domain of agricultural and non agricultural enterprises, besides identifying the self employed labour force in agriculture and agricultural labour.

The published results of NSS do not classify farm households which inter-alia may imply all households with at least one member active in the industry and /or occupation classification of agriculture. The NSS 61st round results do classify households in (a) economic classification depending upon major income share from the activities of all the active members and (b) occupation classification depending upon the aggregate major time disposition of all the active members of the household. Thus the households classified under "Self employed in agriculture households" and "agricultural labour households" may not be the total domain of farm households. Though, the segregation of farm households in the NSS sample is possible through re-tabulation of unit-wise

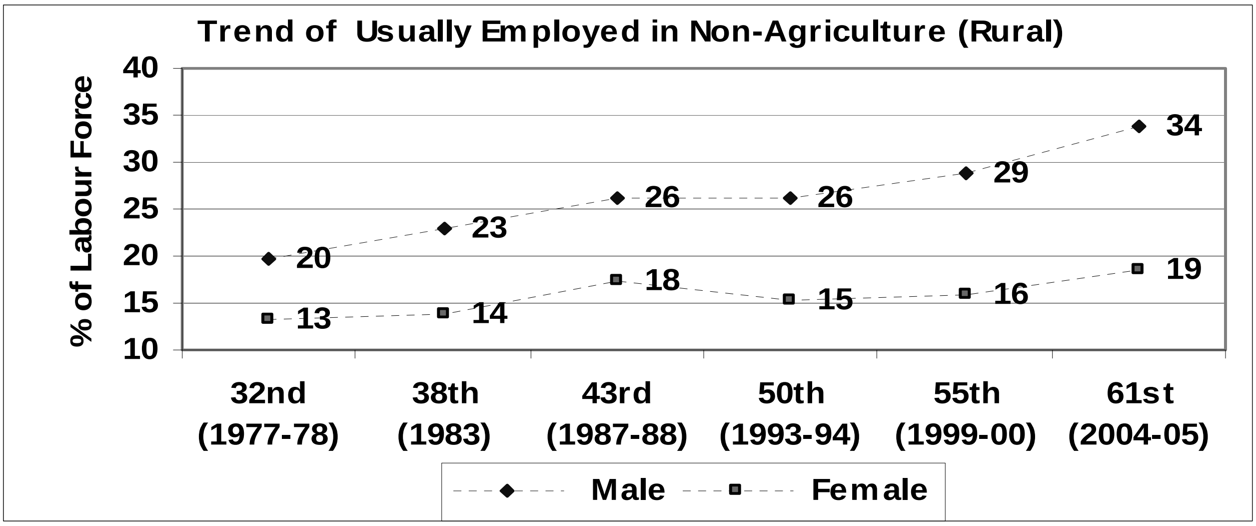
[18] A group of persons normally living together and taking food from a common kitchen constitutes a household. A household may contain one or more members. Members of a household may or may not be related by blood, marriage or adoption to one another. For further details and interpretations of household definition "Concepts and Definitions Used in NSS" may be referred.

data, the Rural Non Farm Employment (RNFE) indicators and the inferences can be drawn from the available results, keeping in view the aforesaid conceptual considerations (Mehta 2007).

The usual activity status of the persons (reference period 365 days) in the EUS is identified in the industry and occupation classification either as primary activity, or as secondary activity, in terms of time disposition and not in terms of income generation. If the activity of a person is tertiary in nature, it is not getting reflected. However, the tertiary activities are captured in the current daily activity status (reference period 7 days). In the present analysis, **LFPR (**Labour Force Participation Rate) is taken on principal usual activity basis i.e. on the basis of major time disposition in the activities in the reference period of preceding 365 days. The inferences can also be drawn from the standardized concepts of current daily and current weekly status simultaneously available from the NSS surveys. Some key inferences on RNFE and rural livelihood diversification for the Nation and sub national (federal states) level are as follows:

a. Over the years, there is an increasing trend of RNFE, particularly for males. During 2004-05, usually active male labour force in non-agriculture was 34 percent, 5 percent points higher than in 1999-2000 (55^{th} Round). This was highest percentage point increase during any other quinquennial intervals of NSS Employment Unemployment Surveys (Figure 1).

Figure 1 - Trend of LFPR in RNFE



b. The trend of RNFE has accelerated in recent years. Incidentally, this period coincides with the period of economic liberalization and with accelerating growth of overall economy. However, the trend is not gender neutral and female participation in RNFE has not shown any significant increase over the decades.

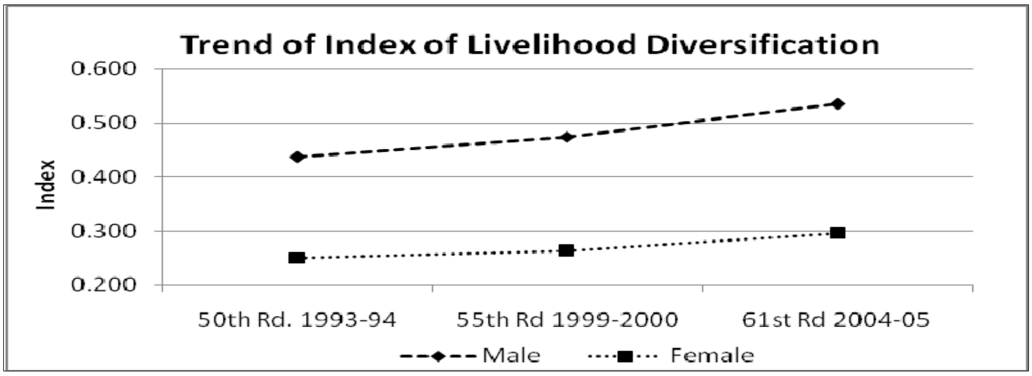
c. Despite the constraints of agriculture sector to further absorb the workforce, the rural employment continues to be predominantly agrarian and 66.5 percent of usually employed male persons, 83.3 percent female persons and 70.8 percent of all persons are engaged in agriculture (Table 3). There is slow but steady decline in rural work participation in agriculture. The work participation in non agriculture is also becoming diversified and the progression of rural livelihood diversification over the NSS rounds is reflected by its index. The pace of diversification in respect of females is much slower compared to the male counterparts (Figure 2).

Table 3 - Percent distribution of usually employed persons by broad industry division

BROAD INDUSTRY DIVISION	Male			Female		
	50th Rd (1993-94)	55th Rd (1999-00)	61st Rd (2004-05)	50th Rd (1993-94)	55th Rd (1999-00)	61st Rd (2004-05)
Agriculture	74.1	71.4	66.5	86.2	85.4	83.3
Mining and Quarrying	0.6	0.6	0.7	0.4	0.3	0.3
Manufacturing	7.0	7.3	7.9	7.0	7.6	8.4
Electricity, Water, etc.	0.3	0.2	0.2			
Construction	3.2	4.5	6.8	0.9	1.1	1.5
Trade, Hotel & Restaurant	5.5	5.8	8.3	2.1	2.0	2.5
Transport, Storage & Communication	2.2	3.2	3.8	0.1	0.1	0.2
Other Services	7.0	6.1	5.9	3.4	3.7	3.9
All	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**
Livelihood Diversification Index	0.437	0.475	0.535	0.250	0.263	0.297

Data Source: NSS 61st Round Report no. 515

Figure 2 - Trend of rural livelihood diversification for male and female labour force



d. Amongst the non-farm activities, perceptible change in the activity status is witnessed in service sector mainly in construction, trade, hotel and restaurant. The impulses to increase RNFE in manufacturing and transport, storage and communication have been relatively weak. Rather, there is a decline in the LFPR in other services in rural areas.
e. There is also a varying sub national pattern in absorption of LFPR in RNFE in the industry divisions (Table 4). Construction sector is most widely absorbing industry division outside agriculture, particularly of male labour force. At sub national level, in Kerala the distribution of LFPR in RNFE is most well distributed over the industry groups. However, in general, manufacturing and services, the two main growth derivers of overall economy, are not having that pronounced a role in stimulating rural labour force engagement.

Table 4 - Dominant industry divisions contributing to LFPR in RNFE in States

BROAD INDUSTRY DIVISION	States with 10% or more LFPR in RNFE in broad industry divisions		
	Male	Female	Persons
Mining and Quarrying			
Manufacturing	Gujarat (10), Haryana (12), J&K (10), Kerala (10), TN (13),	J&K (30), Jharkhand (10), Kerala (24), Orissa (17), TN (15), WB (29)	J&K (12), Kerala (14), Orissa (11), TN (14), WB (12)
Electricity, Water, etc.			
Construction	Haryana (13), HP (19), J&K (10), Jharkhand (15), Kerala (15), Punjab (14), Rajasthan (14), Tripura (12), Uttaranchal (11)		Haryana (11), HP (11), Jharkhand (11), Kerala (12), Punjab (13), Rajasthan (11), Tripura (12)
Trade, Hotel & Restaurant	Assam (12), Haryana (11), Kerala (12), Tripura (12), WB (12)		Assam (11), Kerala(13), Tripura(11), WB (10)
Transport, Storage & Communication	Kerala (10),		
Other Services	J&K (11), Kerala (10), Tripura (26)	Assam (10), J&K (12), Kerala (23), Punjab (36), Tripura (36), WB (12)	J&K (12), Kerala (13), Tripura (26)

Source: Author's compilation from NSS 61st Round Report no. 515 (Figures in bracket are % LFPR)

f. The NSS results, besides measuring the activity status and LFPR for persons, also provide useful information on household type, taking into account the aggregate of economic activities pursued by the household members. Table 5 gives the distribution of rural households in household type, classified as major economic contribution from the numerous activities pursued by the active household members.

Table 5 - **Percentage distribution of households by household type** *(Rural)*

HOUSEHOLD TYPE	% households
1. Self-employed in Agriculture	35.9
2. Self-employed in Non-Agriculture	15.8
3. Total self-employed (1+2)	**51.7**
4. Agricultural labour	25.8
5. Other labour	10.9
6. Total Rural labour (4+5)	**36.7**
7. Others	11.6
8. All	**100.0**
9. Agricultural Households (1+4)	**61.7**

Data Source: NSS 61st Round Report no. 515

g. The rural activity profile in the NSS results is also available in the segregation of land ownership of the households. Table 6 gives the distribution of households and household activity type according to land ownership. There is skewed distribution of self employment and rural labour in non-agriculture for the households with land ownership less than one hectare. The percentage of these household types is 85.5 and 83.8 respectively corresponding to 71 percent of the total households belonging to such marginal land ownership. In the household categories owning land more than one hectares, the distribution of self employed households in non-agriculture is relatively lower. Amongst the landless, the propensity of households in non-agricultural labour type and of other activities is higher. This indicates the significance of "push factor" in RNFE prevalent in the preponderant land marginalization in the agrarian economy.

Table 6 - Percentage distribution of rural households by size class of land owned

SIZE CLASS OF LAND OWNED (hectares)	Household distribution	Household Type in economic activity class		
		Self employed in non agriculture	Rural labour non-agriculture	Other Household
Land less	6.6	6.7	11.9	20.5
Less than 1HA	71.0	85.5	83.8	68.5
1-2 HA	11.7	4.7	2.8	6.1
2-4 HA	7.2	2.2	1.1	3.4
More than 4HA	3.5	0.1	0.5	1.6
All Classes	**100.0**	**100.0**	**100.0**	**100.0**

Data Source: NSS 61st Round Report no. 515

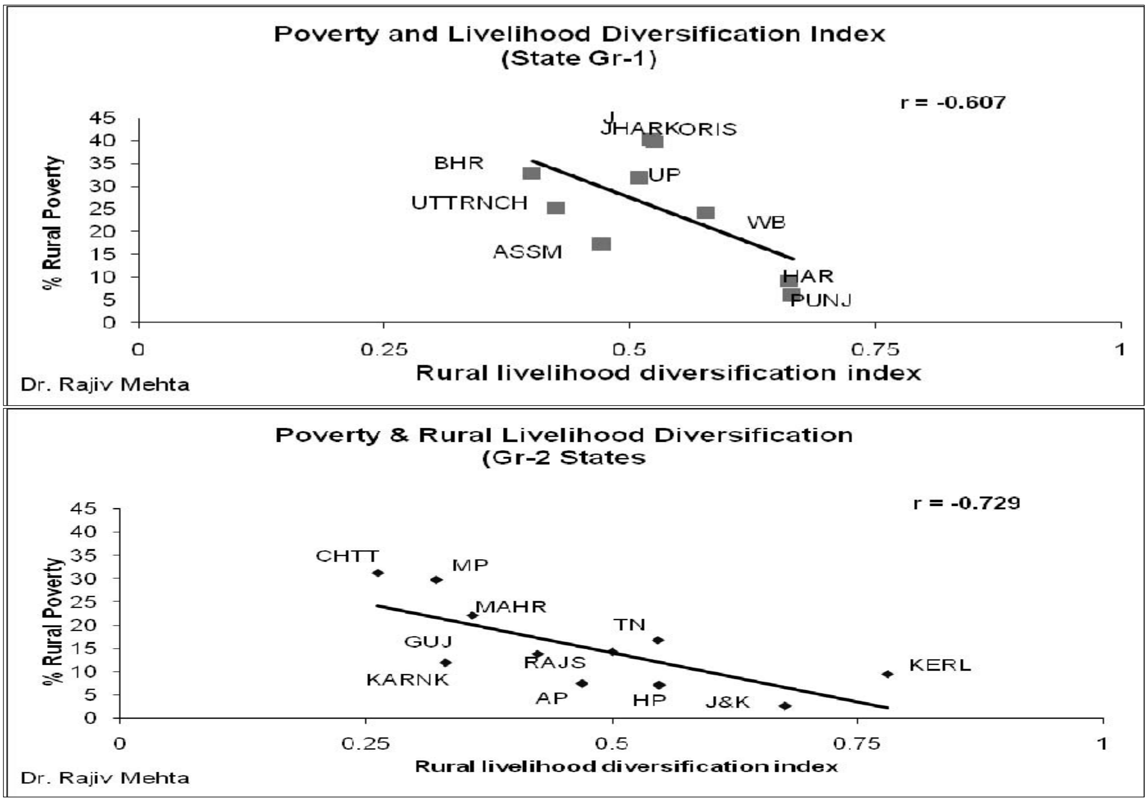
h. **Development correlates of rural diversification:** As stated earlier, RNFE is considered to be an important development catalyst, particularly for defusing the rural poverty (Jha, 2006) and ushering inclusiveness in the growth process. The index of rural livelihood diversification is the composite indicator for labour force participation in agriculture and various non agricultural activities. Though the cause and effects of poverty incidence has multiple dimensions, there are evident correlations in index of rural livelihood diversification and rural poverty incidence (measured through 61st Round consumer expenditure survey).

The agrarian space of the country is very heterogeneous. This heterogeneity brings down the correlation between the considered parameters. Therefore, the correlation has been worked for the states grouped in two broad and more homogenous groups.[19] The states of indo-gangetic plane are traditionally agrarian with prominence of food grain cultivation. The cropping pattern of these states is also subjected to the specific policies and technology intervention, focused on food security. In the other group of states, the agriculture has been more diverse and market oriented. The key inferences are summarised below.

- Rural poverty and index of rural livelihood diversification are negatively correlated. This negative correlation improves on segregation of states in the broad homogenous groups (Figure 3). Moreover, in respect of Group – 2 states, where the agriculture is less dependent on assured irrigation, crop diversification is generally higher and agriculture is more susceptible to vagaries of nature; the negative correlation between incidence of poverty and the index of rural livelihood diversification is more pronounced.
- While the poverty and illiteracy are positively correlated there exists negative correlation between illiteracy and rural livelihood diversification substantiating the role of education and skill in diversification of activity profile of rural India. In the economically better states like Punjab and Haryana with lower incidence of rural poverty, agriculture is relatively advance and more intensive and crop diversification is low due to dominance of rice and wheat in the cropping pattern. Yet, the livelihood diversification is 0.665 and 0.663 respectively compared to national aggregate of 0.535 for the NSS 61st round reference year 2004-05. Amongst the major States, the index of rural livelihood diversification is highest in case of Kerala (0.780) and state also has high rural literacy and low incidence of rural poverty.

[19] Group-1 (States of Indo Gangatic plane): Assam, Bihar, Haryana, Jharkhand, Orrisa, Punjab, Uttranchal, Uttar Pradesh (UP), West Bengal (WB) Group-2 (Other than Group 1): Andhra Pradesh (AP), Chhatishgarh, Gujarat, Himachal Pradesh (HP), Jammu & Kashmir (J&K), Karnataka, Kerala, Madhya Pradesh (MP), Maharashtra, Rajasthan, Tamil Nadu (TN).

Figure 3 - Relationships between incidence of rural poverty and livelihood diversification



5. Concluding observations

The Handbook of Rural Household's Livelihood and Wellbeing was a significant milestone in documenting the dichotomy of rural and urban economies as well as agrarian and non agrarian professions in a comprehensive logical framework. In the process, it had dealt at length on the needs of data and indicators for measuring conditions of rural household economies. There is a realistic realization on limitations of generalization of these perspectives over the countries, particularly for developed and developing countries, yet the standardization of measurements in broad coverage of concepts and definition is also acknowledged. This stepping-stone provides scope for further profiling the statistical indicators on livelihood stability and security of rural and particularly farm households. Measurements of rural livelihood diversification and its impact on and relationship to empowerment, opportunity and security of rural population is an important area to be focused in furthering the agenda of Wye Group.

The present paper has emphasized the data needs for deeper synthesis of rural economic composition. There is relatively a better availability of data and inferences on livelihood measurement in terms of work participation as compared to income assessment for the rural households. This may not be a generalization, yet may be holding in case of several statistical systems. However, the household income data definitely enhances the scope of such analysis and resultant policy inferences. There are problems in generating rural household income data in the disaggregation of the income sources. This is more so in cases of preponderances of informal, unorganized and mixed activities in households. Nevertheless, given the complementary nature of these two alternative approaches, the indicators on rural livelihood diversification may be further improved and taken amongst the development indicators.

For profiling the indicators of rural livelihood diversification, certain aspects that may need to be specifically considered are the dynamic assessment of status of rural non-farm employment in the national and sub-national context; major non-farm activities undertaken by the rural households; identify stimulants of rural diversification in terms of empowerment and opportunity for the rural population and their indicators, measures taken for promotion of rural non-farm employment and responses; interventions for capacity building of farm households through HRD, knowledge dissemination, awareness, etc.; institutional support mechanism to encourage and facilitate non-farm employment such as marketing, credit, etc.; provision of infrastructure, specially for promoting diversified employment; extent of involvement of local government bodies, NGOs, cooperatives and policy and programme intervention to facilitation and stimulation of rural non-farm employment.

References

FAO (2007). *Rural Income Generating Activities: A Cross Country Comparison.*

FAO (2005). *FAO Statistical Yearbook 2005*.

Government of India (2001). *Report of the Task Force on Employment Opportunities*, Planning Commission.

Government of India (2006). *Towards a Faster and More Inclusive Growth - An Approach Paper for 11th Five Year Plan*, Planning Commission.

Government of India (2006). *Results of Employment and Unemployment Survey,* NSS report 515 National Sample Survey Organization, Ministry of Statistics and Program Implementation, New Delhi.

Government of India (2006). *Concepts and Definitions Used in NSS,* NSS Golden Jubilee Publication, National Sample Survey Organization, Ministry of Statistics and Program Implementation, New Delhi.

Haque T (1999). Small Farms Diversification: Problems and Prospects, *Proceedings of National Workshop on Small Farm Diversification: Problems and Prospects*, T. Haque (Ed), National Centre for Agricultural Economics and Policy Research 1999.

Joshi P. K., Gulati Ashok, and Ralph Cummings Jr. (Eds.) (2007). *Agricultural Diversification and Small Holders in South Asia*, Academic Foundation, New Delhi.

Jha B. (2006). *Rural non-farm employment in India: Macro-trends, Micro-evidences and Policy options*, Institute of Economic Growth Working Paper.

Mehta Rajiv (2005). *Dynamics of Crop Diversification - A Quantitative Analysis,* CACP Working Paper Series No. 1-2005, Commission for Agricultural Costs and Prices, Ministry of Agriculture, Govt. of India: http://dacnet.nic.in/cacp/

Mehta Rajiv (2007). Rural Non Farm Employment (RNFE) and its Measurement through National Sample Surveys on Employment Unemployment*, National Seminar on the results of NSS 61st Round*, National Sample Survey Organisation, Govt. of India, New Delhi: http://mospi.gov.in/nsso_4aug2008/web/nsso/cpd/seminar/seminar_61R.pdf

United Nations (2007). The Wye Group Handbook 'Rural Households Livelihood and Well-Being'

World Bank (2008*). World Development Report "Agriculture and Development".*

Appendix 1

National Sample Survey Organisation
(Please visit NSSO website at www.mospi.gov.in)

The National Sample Survey Organisation (NSSO) is the part of Ministry of Statistics and Programme Implementation, Govt. of India and has been conducting nationwide sample surveys on various socio-economic aspects since its inception in 1950. These surveys are conducted in the form of rounds extending normally over a period of one year though in certain cases the survey period was six months. The NSSO is the main source of large range of rural development statistics. The results of NSSO are generated both for the rural and urban sectors. The subject coverage and corresponding major indicators in the NSSO rounds are:

- **Consumer Expenditure**: Level and Pattern of Household Consumer Expenditure; Differences in Level of Consumption among Socio-Economic Groups; Nutritional Intake; Commodity-wise Consumption; Adequacy of Food; Use of Energy and Durable Goods; etc.
- **Employment-Unemployment and Migration:** Labour Force Parameters by age, sex, industry / occupation classification, Employment / Unemployment Situation among Religious Groups; Unemployment Situation among Social Groups; Employment / Unemployment Situation in Cities and Towns; Participation of Indian Women in Household Work and other Specified Activities; Non-Agricultural Workers in Informal Sector etc. Nature, Reason and other Aspects of Migration;
- **Household Wealth / Finance**: Household Assets and Liabilities; Household Indebtedness; Household Borrowings and Repayments; Household Capital Expenditure;
- **Health & Hygiene**: Morbidity and Treatment of Ailments; Health Care and Condition of Aged; Maternal and Child Health Care; Profile of disabled Persons; Housing condition, drinking water, sanitation and hygiene; Conditions of urban slums; etc.
- **Education**: Literacy and Levels of Education; Attendance in Educational Institution: Its Level, Expenditure on Education (64th Rd.), Status of Education and Vocational Training; Economic Activities and School Attendance by Children; etc.
- **Non Agricultural enterprises**: **Manufacturing**: Size, Employment and Other Key Estimates; Salient Features; Assets and Borrowings of Enterprises; **Trade**: State Level Results for Small Trading Units; **Services**: Salient Features and Characteristics of Enterprises in Unorganized Service Sector; etc.; **Informal Sector**
- **Land Holdings, Livestock Holdings and other agrarian issues**: Household Ownership Holdings; Seasonal Variation and Other Aspects; Consumption by Farmer Households; Access to Modern Technology for Farming; Income, Expenditure and Productive Assets; Some Aspects of Farming; Cultivation of Selected Crops; Ownership of Livestock etc.
- **Others**: Common Property Resources; Travel by Indian Households; Village facilities in India, Culture, Prices, Situation Assessment of Farmers etc.

Households Associated with Agricultural Holdings: Selected Socio-economic Dimensions

Ray D. Bollman
Statistics Canada
Ottawa, Ontario K1A 0T6
Ray.Bollman@statcan.gc.ca

Outline:

Keyword: household, agricultural holding, family farm, Canadian agriculture-population linkage database.

1. Introduction

The socio-economic situation of family farms and farming families remains an on-going public concern, and hence a public policy concern, in most countries.

Canada has had, since 1971, a unique database that includes the characteristics of family farms and the characteristics of farming families. This database is constructed by a micro-record linkage of the Census of Agriculture questionnaire and the Census of Population questionnaire for the household for each operator of an agricultural holding. This "Agriculture-Population Linkage" database exists for the census years of 1971, 1981, 1986, 1991, 1996, 2001 and 2006.

In order to showcase the analytic capacity of this dataset, we shall highlight findings from an investigation of the following topics:

- Understanding household earnings: patterns and change over time
- Typology of farmers versus a typology of farms
- Labour supply generated by census-farm operator households
- Typology of households by farm<>non-farm work patterns
- Do young(er) operators have agricultural-related post-secondary education?

2. What is the Agriculture-Population Linkage database?

In Canada, the quinquennial Census of Population and the quinquennial Census of Agriculture are enumerated on the same day by the same team of enumerators[20]. For each household where a Census of Agriculture questionnaire is dropped off (following an affirmative response to the question concerning whether any member of this household produced any agricultural products intended for sale), the enumerator records a unique identifier (indicating province, electoral district, enumeration area and household number) on both the Census of Population questionnaire and the Census of Agriculture questionnaire. The two questionnaires then follow independent data capture, editing, imputation, verification and publication processes. After each questionnaire is judged to be internally consistent by each of the Census of Agriculture team and the Census of Population team, then the Agriculture-Population Linkage database is constructed using the unique identifier that is placed on each of the two questionnaires. The initial step of asking the enumerator to record the same identifier on each questionnaire ensures a high rate of successful linkages.

An overview of these procedures[21] is presented in Appendix A.

3. Previous studies

A list of selected studies, based in whole or part on the Agriculture-Population Linkage database, is presented in Appendix B.

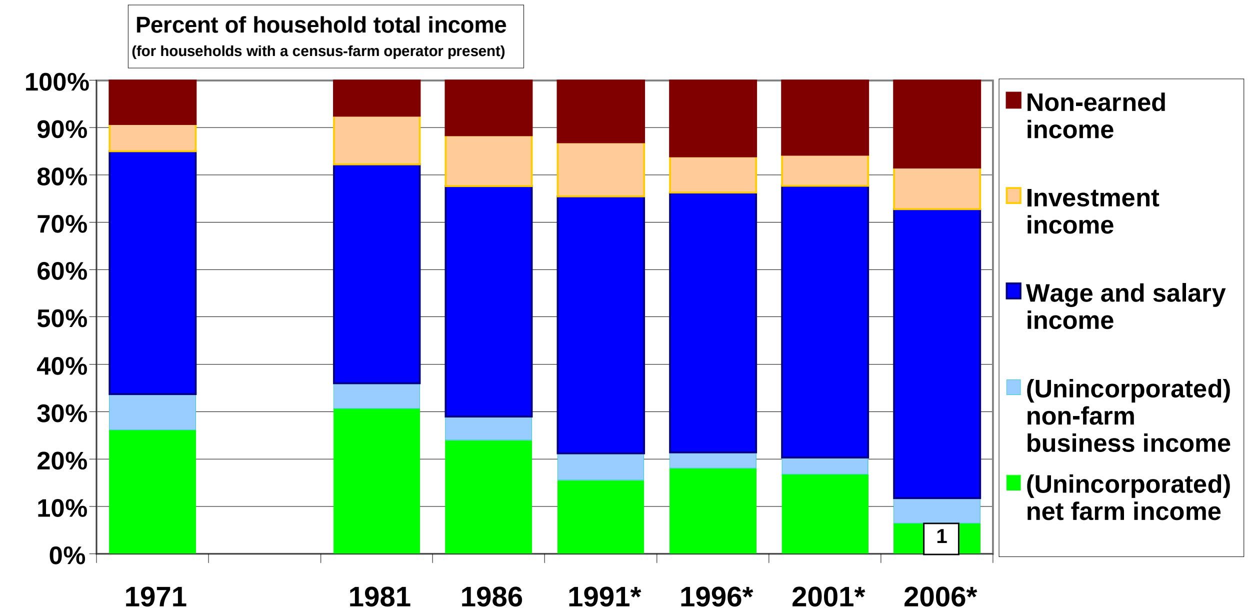
4. Topic #1: Understanding household earnings: patterns and change over time

When we look at the distribution of income by source for all households with a census-farm operator present, we see the well-known pattern:

a)unincorporated net farm income is a small share of the total household income;
b) over time, this share has decreased (Figure 1).

[20] The methodology will change for the collection of the 2011 Census of Agriculture but a 2011 Agriculture-Population Linkage database will still be constructed.
[21] Our discussion focuses strictly on the situation in Canada. As noted by Keita (2004), the situation is very different in different countries.

Figure 1 - The contribution of (unincorporated) net farm income to the total income of households with a census-farm operator present has declined (although constant in the 1990s), Canada



1. There was a break in the farm income series in 2006 because 79% of the operators chose the option to have Statistics Canada obtain their income data from their income tax form and the latter did not have rounded income estimates (e.g. $20,000) and the latter had more operators reporting the maximum loss of $-8,750 that is allowed for a taxfiler with non-farm earnings as the major source of income. Statistics Canada. (2008) **Break in the Agriculture-Population Linkage net farm income data series** (Ottawa: Statistics Canada, Catalogue no. 95-633) (http://www.statcan.gc.ca/pub/95-633-x/2007000/6500081-eng.htm).
* More than one operator per census-farm may be reported and, if they live in different households, there will be more than one household per census-farm.
Includes households with operators of proprietorship, partnership and family incorporated farms (covering, in 2001, 98% of census-farms and 88% of agricultural production).
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

To understand these patterns, a number of factors should be taken into consideration:

1. what is the impact of changes in the way that farm earnings are paid to household members?
2. what is the distribution of households according to the size of the farm business with which they are associated? How has this distribution changed over time?
3. what is the impact of an increase in participation of females in the "formal" (or "measured") labour force?

4.1 The way farm earnings are received by household members

Over time in Canada, the share of census-farms that are incorporated has been increasing over time. In 2001, family incorporated census-farms[22] represented 12 percent of all census-farms but contributed 34 percent of aggregate gross revenue of census-farms (Table 1). In Canada, in each of census data and survey data and tax filer data, each member of a household reports the income received from each source. The only identifiable farm income source is:

> *"**Self-employment: (b) Net farm income** gross receipts minus expenses), including grants and subsidies under farm-support programs, marketing board payments, gross insurance proceeds."* (Statistics Canada, 2007)
> (These are the words from the questionnaire for the 2006 Census of Population, which provides the household income data for the Agriculture-Population Linkage).

[22] All tabulations in this paper concerning the Agriculture-Population Linkage exclude households associated with widely-held or non-family corporate farms or farms with "other" types of legal organization (such as institutional farms, co-operative farms, Hutterite Colonies, etc.). In 2001, these holdings represented 2 percent of all census-farms and contributed 13 percent of aggregate gross farm revenue.

This is unincorporated net farm income. An individual receiving earnings from an incorporated farm would receive earnings as:

a) wages and salaries (which would include management fees); and / or
b) dividends (which is a component of "investment income").

Table 1 - Number of census-farms and share of production by type of legal organization of the census-farm, Canada, 2001

LEGAL ORGANIZATION OF THE CENSUS-FARM	Number	Percent of total	Aggregate gross revenue ($million)	Percent of total
Proprietorship	142,915	58	11,320	30
Unwritten partnership	54,090	22	5,635	15
Written partnership	16,080	7	3,649	10
.. Subtotal: unincorporated family farms	**213,085**	**86**	**20,604**	**54**
.. Family corporation	28,855	12	13,026	34
.. Subtotal: all "family farms"	**241,940**	**98**	**33,631**	**88**
Non-family corporation	4,150	2	4,437	12
Other	830	0	231	1
All census-farms	**246,920**	**100**	**38,299**	**100**

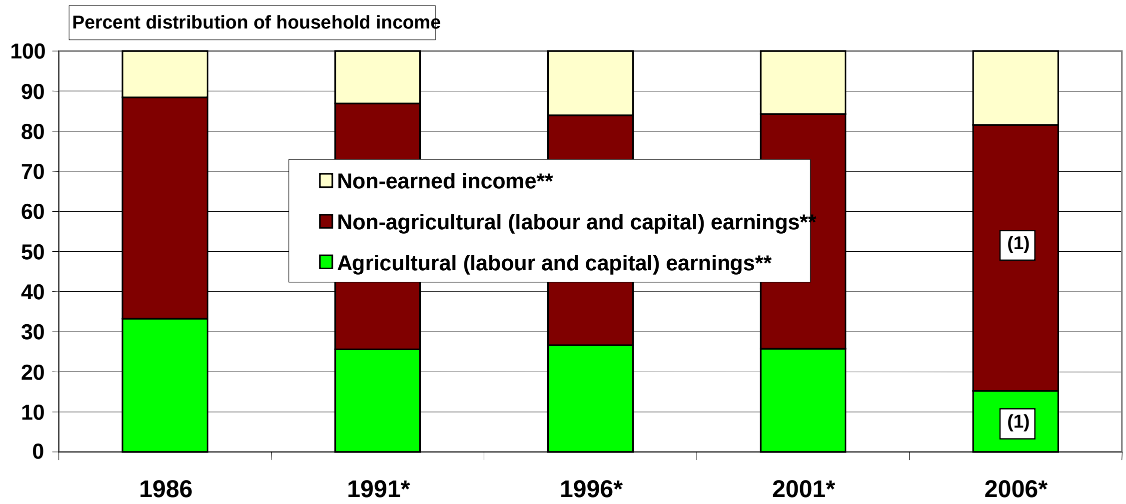
Source: Statistics Canada, Census of Agriculture, 2001.

As shown by Ehrensaft and Bollman (1992) and Fuller and Bollman (1992) for the 1986 Agriculture-Population Linkage, the analytic conclusions may be misleading if analysts fail to adjust their data for this feature of income reporting. Misleading conclusions were shown to be most likely for households associated with larger farms as these holdings are more likely to flow some farm earnings to household members as "farm wages." Also, larger holdings are more likely to be incorporated – and thus the only way for individuals to receive farm earnings is as wages or as dividends.

Using the data available from the Agriculture-Population Linkage, we follow Ehrensaft and Bollman (1992) and use an algorithm that uses the information from the Census of Agriculture questionnaire on "wages paid to family members" to estimate the portion of wages and salaries received by household members that may be designated as "agricultural earnings." This calculation is applied to all households (whether associated with unincorporated or incorporated farms). A similar calculation is made to estimate the portion of investment income received by household members that may be designated as "agricultural investment income." See Ehrensaft and Bollman (1992) for details of this calculation.

With the estimation of household "agricultural (labour and capital) earnings" and "non-agricultural (labour and capital) earnings", we see that among all households with a census-farm operator present, that the share of household income from "agricultural earnings" varied between 26 percent and 33 percent of total household income over the 1986 to 2001 period (Figure 2). The income data for the 2006 Census of Population were assembled with a different methodology and the results, particular for unincorporated net farm income and for unincorporated net non-farm business income, are not comparable with previous years (Statistics Canada, 2008d).

Figure 2 - Agricultural (labour and capital) earnings were 26% to 33% of the total income of census-farm operator households from 1986 to 2001, Canada



1. There was a break in the farm income series in 2006 because 79% of the operators chose the option to have Statistics Canada obtain their income data from their income tax form and the latter did not have rounded income estimates (e.g. $20,000) and the latter had more operators reporting the maximum loss of $-8,750 that is allowed for a taxfiler with non-farm earnings as the major source of income.Statistics Canada. (2008) **Break in the Agriculture-Population Linkage net farm income data series** (Ottawa: Statistics Canada, Catalogue no. 95-633) (http://www.statcan.gc.ca/pub/95-633-x/2007000/6500081-eng.htm).

* More than one operator per census-farm may be reported and, if they live in different households, there will be more than one household per census-farm.

** Total household income is allocated as "agricultural" and "non-agricultural" earnings and non-earned income according to the algorithm of Ehrensaft *et al.* (1992).

Source: Statistics Canada. Agriculture-Population Linkage, 1986 to 2006.

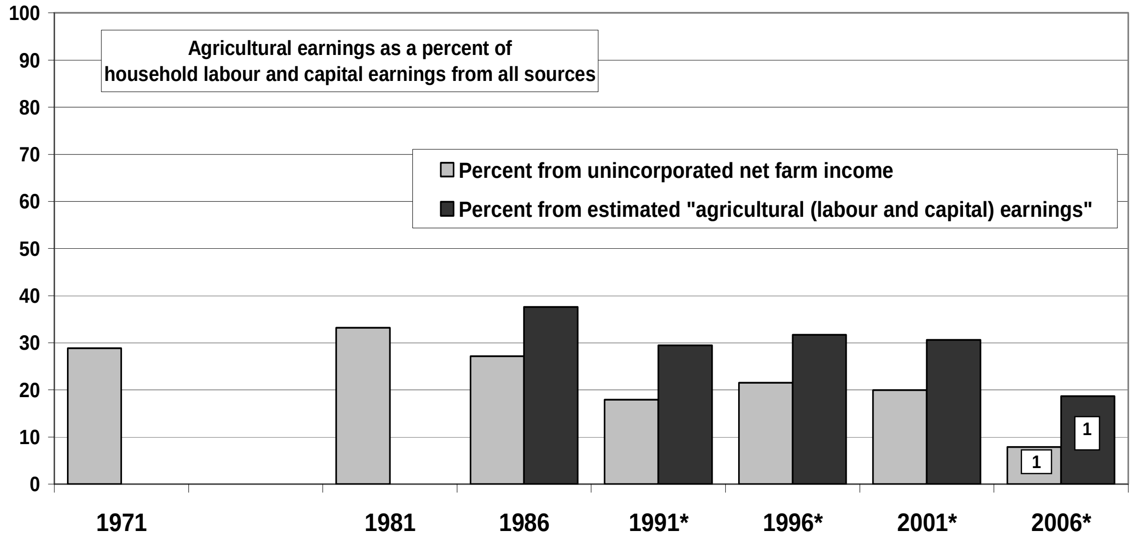
The bottom line, when we consider all households with a census-farm operator present, is:

a) Using the data "as reported" (Figure 1), the share of household income coming from "net farm income" declined from 24 percent in 1986 to 17 percent in 2001, a decline of 7 percentage points.
b) Using the "estimated" data on "agricultural earnings" and "non-agricultural earnings" (Figure 2), the share of household income coming from "agricultural earnings" declined from 33 percent in 1986 to 26 percent in 2001, a decline of 7 percentage points.
c) Thus, the "estimated" data appear to reflect the same trend as the "reported" data but certainly indicate a higher level of "agricultural earnings" received by census-farm operator households.

One factor to note in Figure 1 and Figure 2 is the (albeit relatively small) increase in the share of household income derived from non-earned income. Non-earned income includes government social transfer payments (Old Age Security pension, Guaranteed Income Supplement, Canada Pension Plan and Quebec Pension Plan benefits, Employment Insurance benefits, Canada Child Tax benefits and "other" income from government sources) plus "other" income (retirement pensions, superannuation and annuities and 'other' money income, such as alimony, bursaries, etc.). In 1971, non-earned income represented 9 percent of the income of households with a census-farm operator present and this increased to 18 percent in 2006. Hence, we re-do our calculation to show the level and trend of agricultural earnings as a percent of total household (labour and capital) earnings.

As already noted, "reported" unincorporated net farm income is lower than the "estimated" agricultural (labour and capital) earnings but both items show a similar trend over time (Figure 3).

Figure 3 - Among all households with a census-farm operator present, farm earnings have contributed less than 40% of household earnings from all sources, Canada, 1971 to 2006



1. There was a break in the farm income series in 2006 because 79% of the operators chose the option to have Statistics Canada obtain their income data from their income tax form and the latter did not have rounded income estimates (e.g. $20,000) and the latter had more operators reporting the maximum loss of $-8,750 that is allowed for a taxfiler with non-farm earnings as the major source of income. Statistics Canada. (2008) **Break in the Agriculture-Population Linkage net farm income data series** (Ottawa: Statistics Canada, Catalogue no. 95-633) (http://www.statcan.gc.ca/pub/95-633-x/2007000/6500081-eng.htm).
* More than one operator per census-farm may be reported and, if they live in different households, there will be more than one household per census-farm.
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

During the 1990s, unincorporated net farm income represented about 20 percent of household earnings and the estimated “agricultural (labour and capital) earnings” represented about 30 percent of household earnings.

4.2 Structure of agricultural holdings by business size

To understand the inter-relationship between the source of income of households associated with an agricultural holding and the size of the farm business, we develop a classification of agricultural holdings according to their anticipated capacity to provide a minimum level of living for household members. Households associated with agricultural holdings below this threshold would be expected to report non-agricultural earnings to provide adequate household income.

We adopt the definition of a “viable farm” from the 1969 report of the federal task force on agriculture (Canada, 1969) which indicated a “viable farm” would be a farm able to provide a minimum level of living for a farming family.[23] As a proxy for this “minimum level of living for a farming family”, we have selected the Statistics Canada low income cut-off for a rural family of four (Statistics Canada, 2008a). We use the ratio of realized net farm income (plus the wages paid to family members which is treated as a farming expense in the farm accounts) per dollar of gross farm revenue as published by Statistics Canada (annual) to estimate the level of gross farm revenue that would be anticipated to generate a level of net farm income to meet the low income cut-off. We show four size classes of gross farm revenue for agricultural holdings:

[23] “’Viable farm’, if it means anything, means a farm which, with current management, produces an income greater than the poverty level of income.” (Canada, 1969, p. 21)

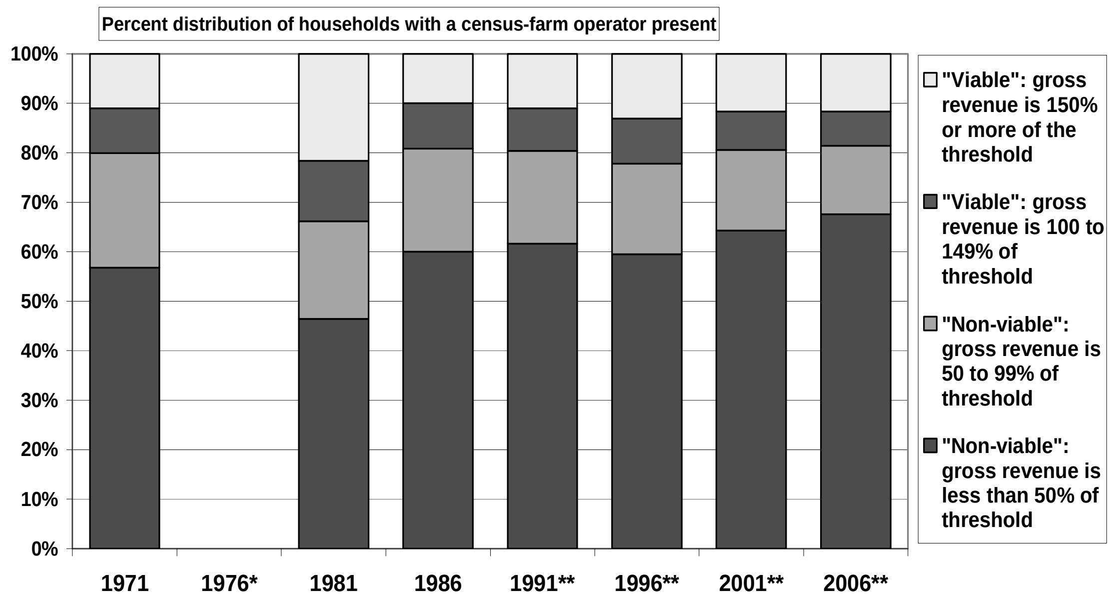
a) holdings with less than one-half of the gross farm revenue to be “viable”;
b) holdings with 50 percent to 99 percent of the level of gross farm revenue to be “viable”;
c) holdings with 100 percent to 149 percent of the level of gross farm revenue to be “viable”; and
d) holdings with 150 percent or more of the level of gross farm revenue to be “viable.”

The important finding from this classification is that there has been virtually no change in the structure of agricultural holdings according their anticipated capacity to generate net farm income above the low income cut-off (Figure 4). In most census periods since 1971, 80 percent of census-farm operator households have been associated with an agricultural holding that is “non-viable”. Specifically, these holdings would not be anticipated to generate a level of net farm income that met the Statistics Canada low income cut-off.

Thus, we would suggest that it is not a change in the structure of agriculture holdings over time that is driving the change in structure of household income.

Among the 80 percent of households associated with agricultural holdings anticipated to generate a net farm revenue less than the low income cut-off for a rural family of four, non-agricultural earnings would be expected to be relatively higher – and agricultural earnings would be expected to be a relatively lower share of household total labour and capital earnings.

Figure 4 - Since 1986, 80% of census-farms have been “non-viable[1]”, Canada

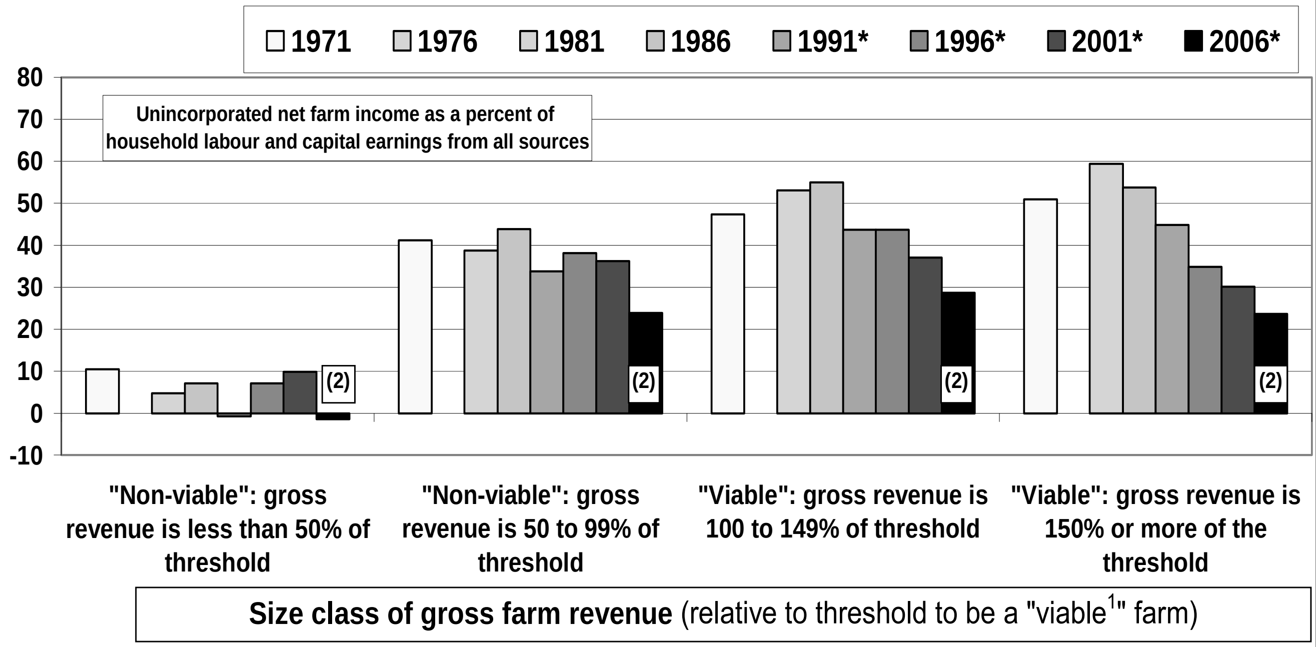


1. "Viable" and "non-viable" census-farms are defined according to the definition provided by Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture). Specifically, a holding able to generate adequate income for a rural family of four.
* Data were not tabulated for 1976 as there was no Agriculture-Population Linkage in 1976.
** Starting in 1991, up to three operators could be identified for each census-farm. If an operator lived in different households, we will have more than one household per census-farm. Includes households with operators of proprietorship, partnership and family incorporated farms (covering, in 2001, 98% of census-farms and 88% of agricultural production).
Source: Statistics Canada. Agriculture-Population LInkage, 1971 to 2006.

For households associated with census-farms with gross revenue less than 50 percent of the threshold, a very small share of household earnings is reported as “unincorporated self-employment net farm income” (Figure 5). For households with gross revenue more than 50 percent of the threshold to be “viable”, unincorporated net farm income generates 30 percent to 60 percent of household labour and capital earnings (depending upon the business size of the farm and depending upon the year) (Figure 5).

The group of households with gross revenue of 50 percent to 99 percent of the threshold to be “viable” is (essentially) equivalent to saying that they are anticipated to generate net farm income to meet the low income cut-off for a rural family of two (not a family for four, which is the basis for the delineation of these thresholds). Note that among the households associated with the larger farms, unincorporated net farm income has declined from 59 percent of household labour and capital earnings in 1981 to 24 percent in 2006. We expect that part of this decline is due to the way agricultural earnings are received by the members of the farming household.

Figure 5 - For households associated with holdings with gross revenue 150% or more of the "viable[1] " threshold, "unincorporated net farm income" has declined from 59% to 24% of household total earnings, Canada



** Starting in 1991, up to three operators could be identified for each census-farm. If the operators lived in different households, we will have more than one household per census-farm.
1. "Viable" and "non-viable" census-farms are defined according to the definition provided by Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture). Specifically, a holding able to generate adequate income for a rural family of four.
2. There was a break in the farm income series in 2006 because 79% of the operators chose the option to have Statistics Canada obtain their income data from their income tax form and the latter did not have rounded income estimates (e.g. $20,000) and the latter had more operators reporting the maximum loss of $-8,750 that is allowed for a taxfiler with non-farm earnings as the major source of income. Statistics Canada. (2008) **Break in the Agriculture-Population Linkage net farm income data series** (Ottawa: Statistics Canada, Catalogue no. 95-633) (http://www.statcan.gc.ca/pub/95-633-x/2007000/6500081-eng.htm).
Includes households with operators of proprietorship, partnership and family incorporated farms (covering, in 2001, 98% of census-farms and 88% of agricultural production).
Source: Statistics Canada. Agriculture-Population Linkage, 1986 to 2006.

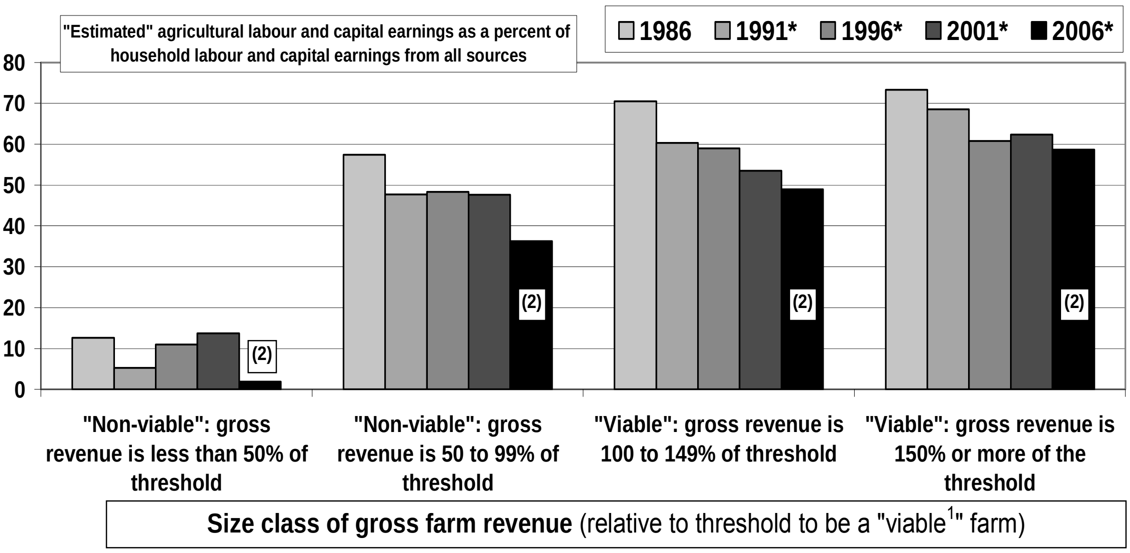
When we calculate our “estimated agricultural labour and capital earnings”, we see:

a) the larger the farm, the higher the share of household labour and capital earnings that is estimated to be agricultural earnings (Figure 6);
b) although there is a drop in this share over time, for households associated the larger farms, estimated agricultural labour and capital earnings in 2006 represented 59 percent of household earnings (compared to the 24 percent generated by unincorporated net farm income as shown for these households in Figure 5).

Thus,

1. using an "estimated agricultural labour and capital earnings" shows that households associated with "viable" farms appear to generate at least one-half of their earnings from the farm (Figure 6);
2. but this share appears to be declining for households associated with each size of farm; and
3. no relationship is expected nor evident for the majority of households (60 percent in 1986 and 68 percent in 2008) associated with farms with gross revenue less than 50 percent of the threshold to be "viable".

Figure 6 - For households associated with holdings with gross revenue 150% or more of the "viable[1]" threshold, "agricultural earnings" have declined from 73% to 59% of household total earnings, Canada, 1986 to 2006



** Starting in 1991, up to three operators could be identified for each census-farm. If the operators lived in different households, we will have more than one household per census-farm.

1. "Viable" and "non-viable" census-farms are defined according to the definition provided by Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture). Specifically, a holding able to generate adequate income for a family of four.

2. There was a break in the farm income series in 2006 because 79% of the operators chose the option to have Statistics Canada obtain their income data from their income tax form and the latter did not have rounded income estimates (e.g. $20,000) and the latter had more operators reporting the maximum loss of $-8,750 that is allowed for a taxfiler with non-farm earnings as the major source of income. Statistics Canada. (2008) **Break in the Agriculture-Population Linkage net farm income data series** (Ottawa: Statistics Canada, Catalogue no. 95-633) (http://www.statcan.gc.ca/pub/95-633-x/2007000/6500081-eng.htm).

Includes households with operators of proprietorship, partnership and family incorporated farms (covering, in 2001, 98% of census-farms and 88% of agricultural production).

Source: Statistics Canada. Agriculture-Population Linkage, 1986 to 2006.

4.3 Increasing labour force participation rates of women

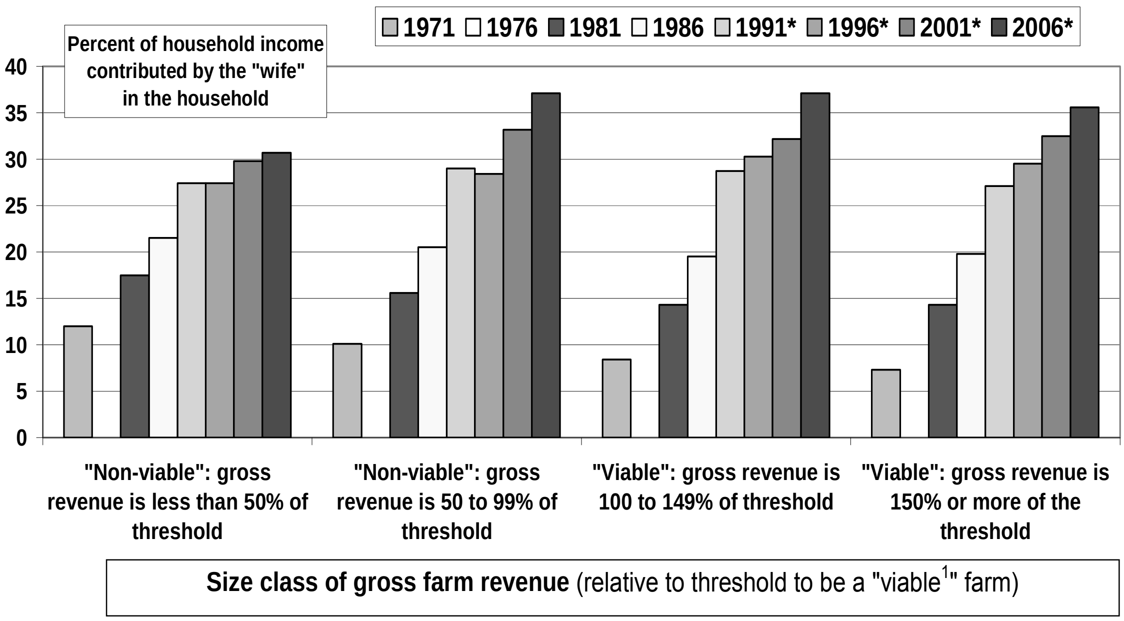
One important contributing factor to the change in the mix of earnings over time in all Canadian households is the increasing participation of women in the (formal or measured) labour market. The contribution to total household income by the "wife" in the household with an operator present has increased from between 7 percent and 12 percent in 1971 to between 31 percent and 37 percent in 2006 (Figure 7). This share and the increase in share is similar for all households, regardless of the size of the associated farm business.

To summarize,

1. there has been no change in the structure of census-farm operator households in terms of their association with agricultural holdings anticipated to generate agricultural earnings above the low income cut-off;
2. thus, it would appear that a changing farm structure is not driving a decline in household agricultural earnings.

3. agricultural earnings, as a percent of total household earnings, is declining for households associated with each size of farm business.
4. the contribution to household income by the “wife” has increased in a similar fashion for households associated with each size of farm business.
5. Thus, it would appear that the increase in the labour force participation by women in census-farm operator households is part of the explanation for an increase in the share of household earnings generated from non-farm earnings.

Figure 7 - Within households associated with each class of farm “viability[1]”, the share of household income contributed by the “wife” has increased in a similar fashion, Canada, 1971 to 2006



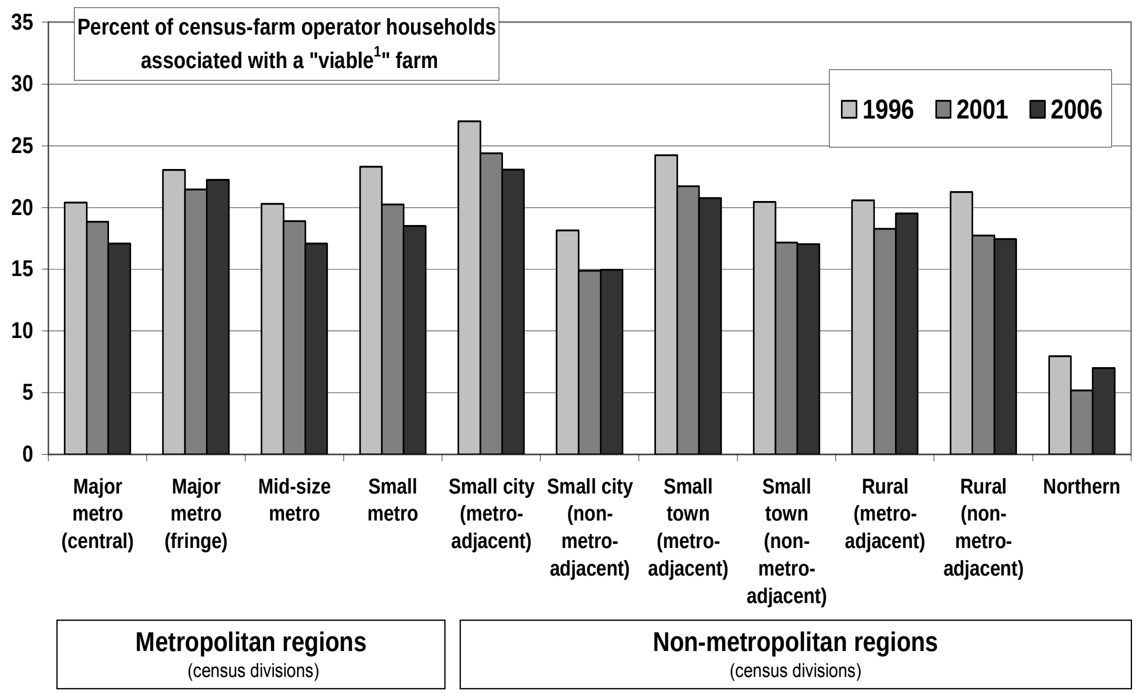
** Starting in 1991, up to three operators could be identified for each census-farm. If the operators lived in different households, we will have more than one household per census-farm.
1. "Viable" and "non-viable" census-farms are defined according to the definition provided by Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture). Specifically, a holding able to generate adequate income for a rural family of four.
Includes households with operators of proprietorship, partnership and family incorporated farms (covering, in 2001, 98% of census-farms and 88% of agricultural production).
Source: Statistics Canada. Agriculture-Population Linkage, 1986 to 2006.

4.4. Regional patterns

Contrary to expectations, the incidence of off-farm work by census-farm operators is higher for operators who are further from a larger urban centre (Alasia et al*.,* 2008). One advantage of the Agriculture-Population Linkage is that a large sample size (one-fifth of all census-farm operator households) provides considerable geographic detail. The multivariate analysis by Alasia et al. (2008) held constant farm variables, operator variables and household variables to determine the independent impact of distance from a city on the probability of the operator participating in off-farm work.

Here, we use simple tabulations to discuss the household share of earnings that are generated by the farm across the urban-to-rural gradient[24]. First, we note that the recent decline in the share of census-farm operator households associated with "viable" farms has occurred in each type of region (Figure 8 and Table 2). A slightly higher share of census-farm operator households are associated with "viable" farms in small city metro regions. Second, among households associated with "viable" farms, there is no difference across regions in terms of the share of household earnings generated from agricultural earnings (Figure 9 and Table 2).

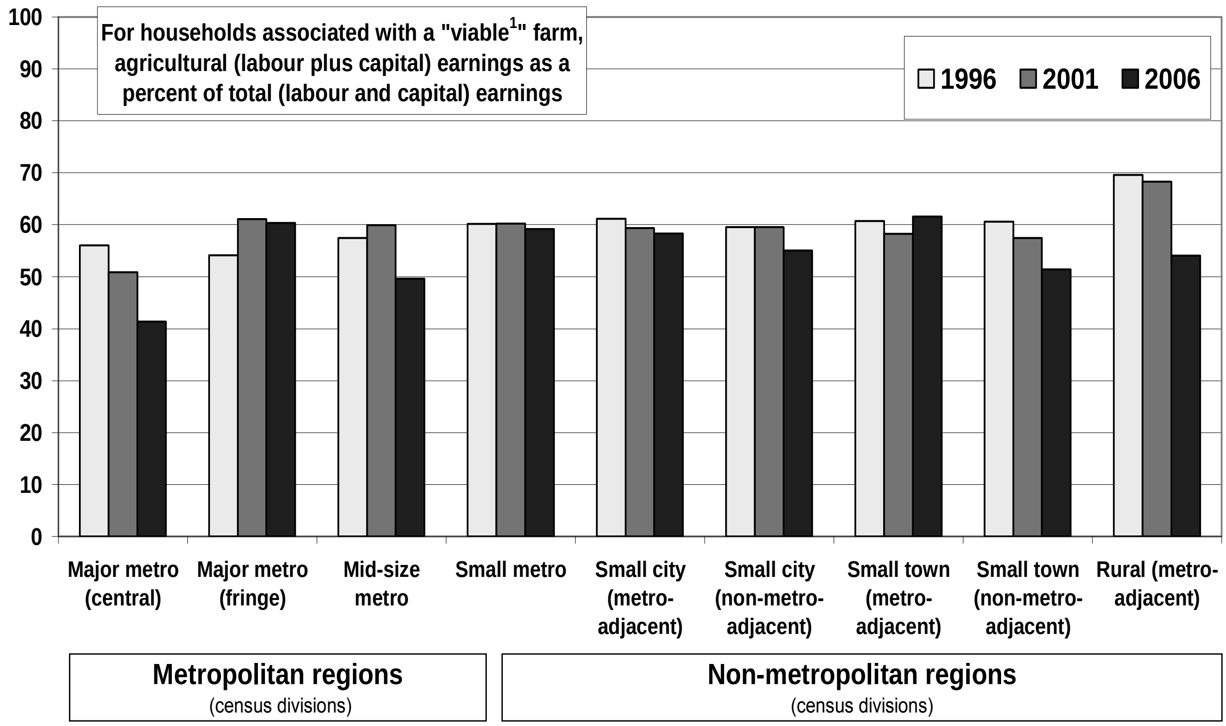
Figure 8 - A slightly higher share of farm households are associated with a "viable[1]" census-farm in non-metro small city regions, Canada



1. "Viable" census-farms, in this chart, refer to census-farms anticipated to generate a net farm income to meet the low income cut-off for a rural famiy of four.
Includes operators of proprietorship, partnership and family corporation census-farms.
Source: Statistics Canada. Agriculture-Population Linkage, 1996, 2001 and 2006.

[24] The urban-to-rural gradient is implemented by using the USDA "Beale codes" as applied to Canada by Ehrensaft and Beeman (1992).

Figure 9 -"If" the household is associated with a "viable[1]" farm, the share of household earnings from agriculture does not appear to be associated with the type of region, Canada



1. "Viable" census-farms, in this chart, refer to census-farms anticipated to generate a net farm income to meet the low income cut-off for a rural famiy of four.
Includes operators of proprietorship, partnership and family corporation census-farms.
Source: Statistics Canada. Agriculture-Population Linkage, 1996, 2001 and 2006.

Table 2

Number of census-farm operator households associated with a "viable[1]" census-farm and the share of earnings generated from agriculture for these households, Canada, 1996 to 2006

Type of region in which the household is located		number of households with a census-farm operator present			number of households associated with a "viable[1]" census-farm			percent of census-farm operator households associated with a "viable[1]" census-farm			for households associated with a "viable[1]" census-farm, average (labour and capital) agricultural earnings (current dollars)			for households associated with a "viable[1]" census-farm, average (labour and capital) non-agricultural earnings (cuurent dollars)			for households associated with a "viable[1]" census-farm, agricultural earnings as a percent of total earnings		
		1996	2001	2006	1996	2001	2006	1996	2001	2006	1996	2001	2006	1996	2001	2006	1996	2001	2006
Metro	Major metro (central)	5,660	4,990	4,685	1,155	940	800	20	19	17	44,492	41,063	77,123	34,908	39,671	109,328	56	51	41
	Major metro (fringe)	12,960	11,305	10,935	2,985	2,425	2,430	23	21	22	32,447	49,557	49,029	27,501	31,581	32,230	54	61	60
	Mid-size metro	26,770	23,855	23,425	5,430	4,510	4,000	20	19	17	37,955	46,459	46,782	28,067	31,083	47,468	57	60	50
Non-metro	Small metro	42,200	37,465	35,900	9,830	7,585	6,645	23	20	19	33,968	41,817	39,204	22,503	27,622	27,000	60	60	59
	Small city (metro-adjacent)	38,110	33,155	31,110	10,280	8,090	7,175	27	24	23	33,341	39,505	38,718	21,210	27,023	27,635	61	59	58
	Small city (non-metro-adjacent)	29,490	27,425	26,560	5,350	4,080	3,970	18	15	15	33,940	40,258	40,942	23,070	27,355	33,480	60	60	55
	Small town (metro-adjacent)	45,475	40,140	37,800	11,015	8,720	7,840	24	22	21	31,610	35,719	38,834	20,442	25,620	24,267	61	58	62
	Small town (non-metro-adjacent)	66,240	59,905	55,255	13,540	10,275	9,405	20	17	17	32,781	34,465	33,726	21,310	25,506	31,864	61	57	51
	Rural (metro-adjacent)	4,350	3,800	3,435	895	695	670	21	18	20	35,843	42,089	39,736	15,675	19,538	33,795	70	68	54
	Rural (non-metro-adjacent)	12,520	11,065	9,895	2,660	1,960	1,725	21	18	17	x	x	x	x	x	x	x	x	x
	Northern	1,760	1,640	1,430	140	85	100	8	5	7	x	x	x	x	x	x	x	x	x
Subtotal: Metro		87,590	77,615	74,945	19,400	15,460	13,875	22	20	19	35,478	44,338	45,296	25,570	29,988	38,567	58	60	54
Subtotal: Non-metro		197,945	177,130	165,485	43,880	33,905	30,885	22	19	19	32,813	36,591	37,201	20,860	25,710	28,689	61	59	56
All types of regions		285,535	254,745	240,430	63,280	49,365	44,760	22	19	19	33,630	39,018	39,711	22,304	27,050	31,752	60	59	56

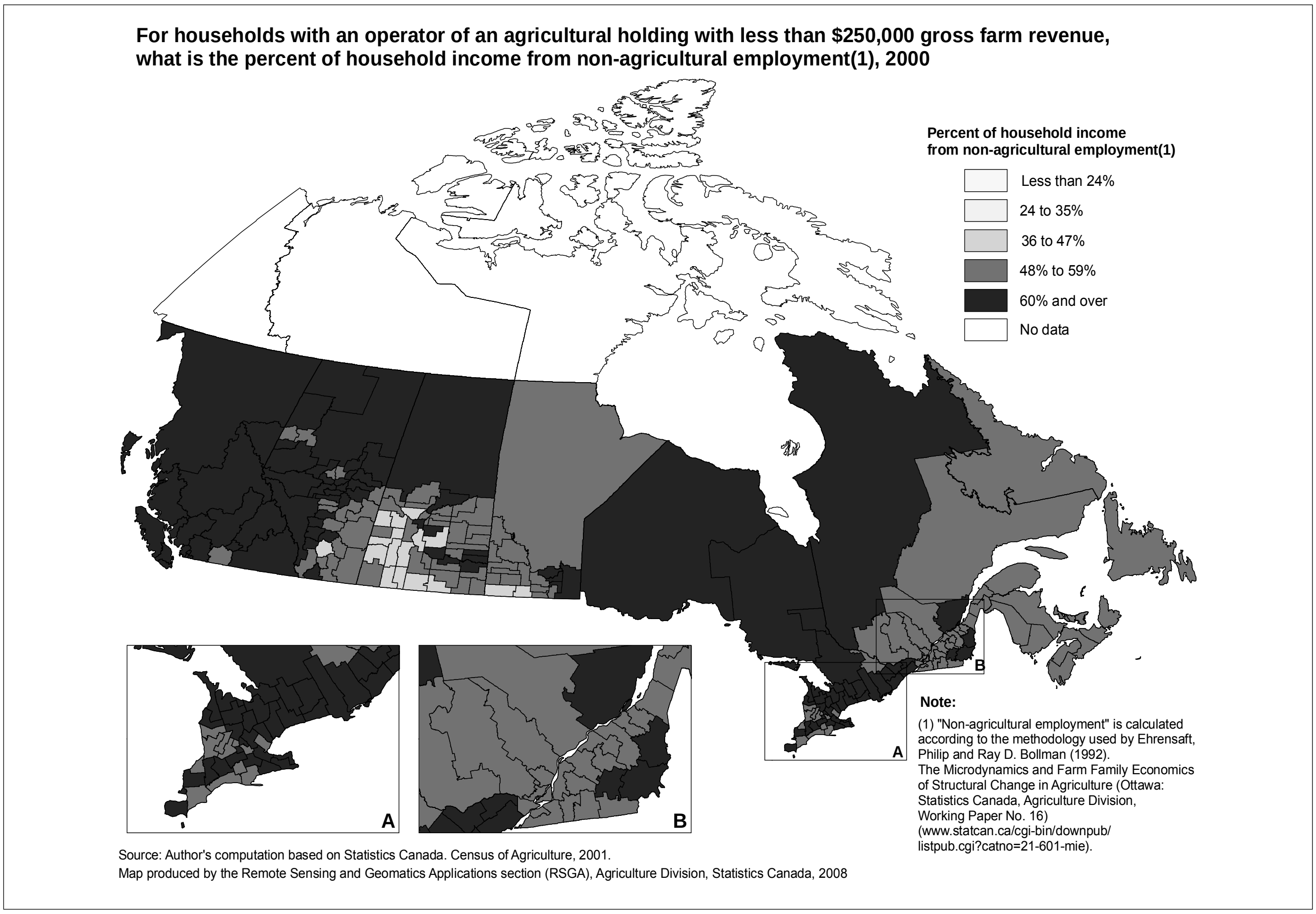
1. "Viable" and "non-viable" census-farms are defined according to the definition provided by Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture) . Specifically, a holding able to generate adquate income for a family of four.

Source: Statistics Canada. Agriculture-Population Linkage, 1996, 2001 and 2006.

A comparison of 2 maps may be instructive.

Map 1 refers to households associated with a census-farm in 2001 with gross revenue less than $250,000[25]. We show "non-agricultural (labour and capital) earnings" (labelled as "income from non-agricultural employment") as a percent of total household income. For all census-farm operator households in 2001, this represents 26 percent of total household income (Figure 2). Map 1 shows that in marginal agricultural areas (essentially areas on the agricultural<>forestry interface), "if" one is enumerated to be operating a "non-viable" census-farm, then non-farm employment is key. After acquiring non-farm employment, then some residents operate a census-farm with gross revenue less than $250,000. In addition, if one is operating a census-farm with gross revenue less than $250,000 in the vicinity of Ottawa, Toronto, Edmonton or Vancouver, again non-farm employment provides, on average, more than 60 percent of total household income.

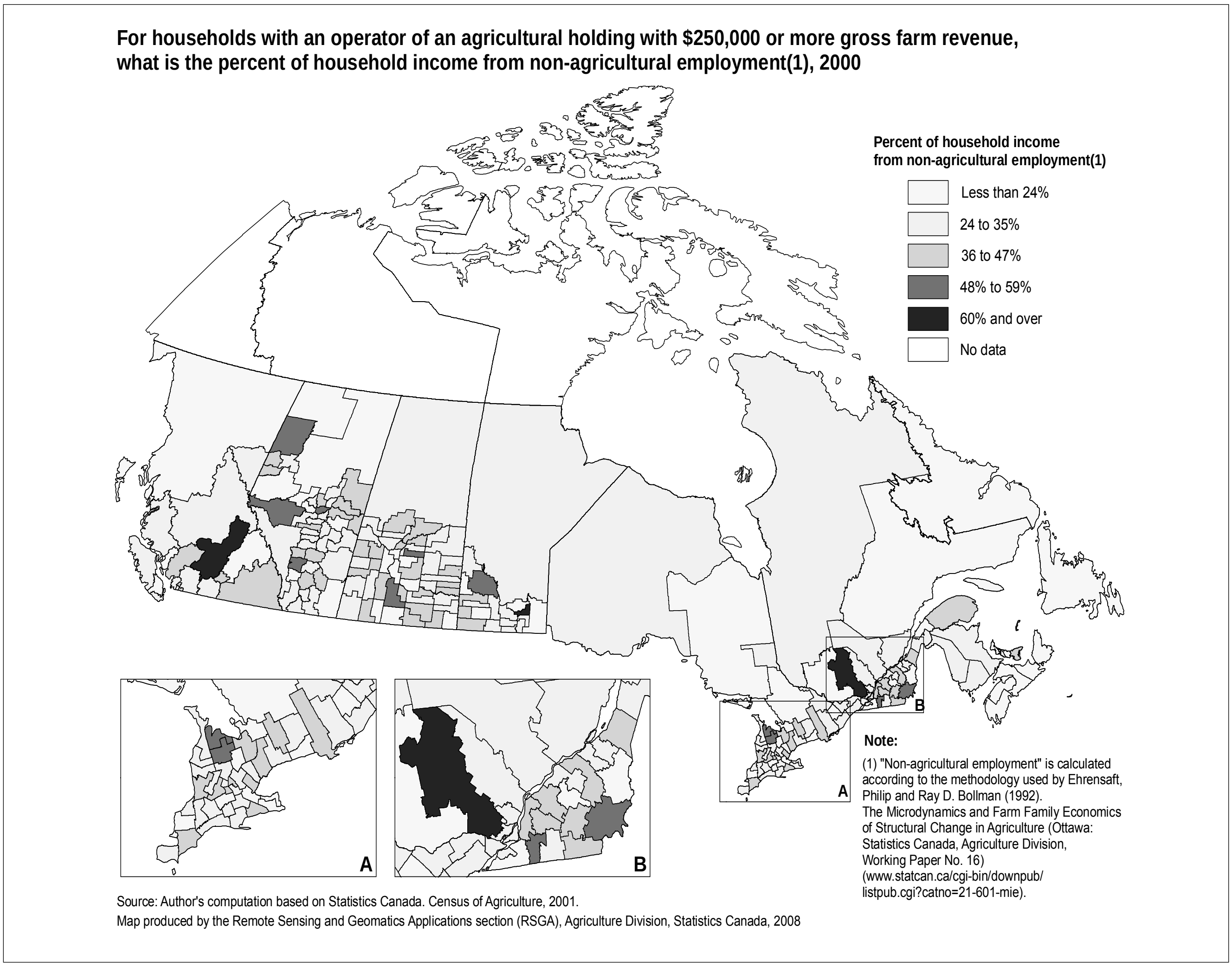
Map 1



Map 2 refers to households on "viable" census-farms. In almost all regions, if the census-farm generates gross revenue of $250,000 or more, then "non-agricultural employment" income is less than 47 percent (and typically less than 35 percent) of total household income.

[25] Essentially, these are "non-viable" farms (Canada, 1969) as our calculation for the gross farm revenue threshold for a "viable" farm in 2001 was $217,414.

Map 2



5. Topic #2: Typology of farmers versus a typology of farms

Colleagues in Statistics Canada have followed the lead of our colleagues in Agriculture and Agri-Food Canada and our colleagues in the Economics Research Service of the United States Department of Agriculture by mixing farm characteristics and operator (and family characteristics) in a so-called typology of “farms” (Statistics Canada, 2008b). The interesting feature of this typology is the personification of farms. Farms are labelled as being senior and are classified as “pension” farms. Farms are enjoying life and are classified as “lifestyle” farms. Farms are “in poverty” and are classified as “low-income” farms.

However,

- first, of course, farms do not receive pensions and farms do not have a lifestyle and farms cannot be living in “straitened circumstances.” Only individuals or families can get a pension or enjoy a lifestyle or live in “straitened circumstances”; and
- second, the individuals / families with these characteristics may be expected to be associated with any size of agricultural holding.

Thus, it would appear useful to develop a typology of agricultural holdings and, independently, to develop a typology of individuals / families associated with agricultural holdings. Then, it would appear useful to cross-tabulate the typology of agricultural holdings and the typology of individuals / families in order to understand:

a) the structure of agricultural holdings associated with the characteristics of individuals / families; and, to understand
b) the structure of individuals / families associated with the characteristics of agricultural holdings.

One framework might simply be a classification of whether the agricultural holding is a farm ("yes" versus "no") by a classification of whether the individual is a farmer (or whether the family is a farming family) ("yes" versus "no") (Table 3).

As noted in the footnotes to the simple classification in Table 3, there are various ways:

a) to classify agricultural holdings as "farms" or "non-farms" (and the choice will depend upon the analytic objective being pursued); and, there are various ways
b) to classify an individual as a "farmer" or as a "non-farmer" (or a family as a "farming family" or a "non-farming" family) (and again the choice will depend upon the analytic objective being pursued).

If the objective is to understand the on-farm versus off-farm labour allocation of individuals and families associated with an agricultural holding, then we might suggest:

a) agricultural holdings might be classified according to their expected capacity to generate an income to meet the minimum income requirements of a farming individual or a farming faming. Operators or operator families associated with a farm business smaller than this threshold may be expected to face a "demand" to search for non-agricultural earnings to bolster family income;
b) Individuals / families might be classified by their actual supply of labour to farming versus non-farm occupations.

Table 3

Proposed Typology of "Real" Farmers vs. "Real" Farms

		Is this business a farm?	
		No	**Yes**
Is this person a farmer?	**No**	**"Unreal" farmer on an "Unreal" farm**	**"Unreal" farmer on a "Real" farm**
	Yes	**"Real" farmer on an "Unreal" farm**	**"Real" farmer on a "Real" farm**

Is this person a farmer?

One option: Does the person classify him/herself on the Census or Labour Force Survey as having "farming" as the major occupation?

Another option: Does this person have net farm income as the major source of income (i.e., where the absolute value of net farm income is greater than the absolute value of total income from all sources)? This is problematic as revenue of incorporated farms does not flow to individuals as net farm income and thus does not appear as net farm income on the Census or on the Survey of Labour and Income Dynamics.

Is this business a farm?

One option: Picking up on the anecdote that "my last husband was a golfer", one might define a business as a farm if the level of expenditures were greater than the annual golf fees at a nearby golf course. If the level of expenditures exceeds this level, then the person would be expected to manage the enterprise as a business so that the loses would be restricted to the level of golf fees of the previous husband.

Another option: Would an enterprise of this size be expected to generate a level of net farm income that would meet the low income cut-off for a family of four (because the 1969 Task Force on Agriculture (Canada, 1969) defined a "viable" farm as an enterprise that can meet the living expenses of the farming family)?

As noted in the footnotes to the simple classification in Table 3, there are various ways:

c) to classify agricultural holdings as “farms” or “non-farms” (and the choice will depend upon the analytic objective being pursued); and, there are various ways
d) to classify an individual as a “farmer” or as a “non-farmer” (or a family as a “farming family” or a “non-farming” family) (and again the choice will depend upon the analytic objective being pursued).

If the objective is to understand the on-farm versus off-farm labour allocation of individuals and families associated with an agricultural holding, then we might suggest:

a) agricultural holdings might be classified according to their expected capacity to generate an income to meet the minimum income requirements of a farming individual or a farming faming. Operators or operator families associated with a farm business smaller than this threshold may be expected to face a “demand” to search for non-agricultural earnings to bolster family income;
b) Individuals / families might be classified by their actual supply of labour to farming versus non-farm occupations.

For this classification, we have chosen to classify operators, rather than families. Thus, the threshold of gross farm revenue to be “viable” is the level anticipated to generate a net farm income (plus cash wages received from the farm) to meet the low income cut-off for a single rural individual.

Using these criteria, the average structure for the 1971 to 2006 period is that 33 percent of Canadian census-farm operators may be classified as “real” farmers on “real” farms (Table 4). Specifically, these are operators associated with a census-farm with gross farm revenue over the “viability” threshold and the operator reports farming as the major occupation.

Table 4

Distribution of census-farm operators by main occupation and by association with "viable[1]" or "non-viable[1]" census-farms, Canada, average over the 1971 to 2006 census periods.

Main occupation of the operator[2] of a census-farm	**"Non-viable[1]"** census-farms (below the threshold for a single rural individual)	**"Viable[1]"** census-farms (equal to or above the threshold for a single rural individual)	**All census-farms**	**"Non-viable[1]"** census-farms (below the threshold for a single rural individual)	**"Viable[1]"** census-farms (equal to or above the threshold for a single rural individual)	**All census-farms**	**"Non-viable[1]"** census-farms (below the threshold for a single rural individual)	**"Viable[1]"** census-farms (equal to or above the threshold for a single rural individual)	**All census-farms**	**"Non-viable[1]"** census-farms (below the threshold for a single rural individual)	**"Viable[1]"** census-farms (equal to or above the threshold for a single rural individual)	**All census-farms**
	number of operators (average over the 1971 to 2006 census years)			as a percent of the operators in each year (row percent)			as a percent of the operators in each farm size class (column percent)			as a percent of all operators (average over the 1971 to 2006 census years)		
Operators[2] with a non-farming occupation	90,802	14,054	104,856	87	13	100	49	13	35	30	5	35
Operators[2] with a farming occupation	96,005	97,411	193,416	50	50	100	51	87	65	32	33	65
All operators[2]	186,807	111,465	298,272	63	37	100	100	100	100	63	37	100

1. A "viable" farm in this table is a census-farm with gross revenue anticipated to generate a net farm income above the low income cut-off for one rural individual. This follows the recommendation in Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture)

2. Operators in this table refer only to operators with a major occupation stated, with some hours of work "last week" and with some weeks worked "last year." Operators of non-family incorporated census-farms and "other" census-farms (such as institutional farms, co-operative farms, Hutterite Colonies, etc.) are excluded.

* Since 1991, each census-farm may report more than one operator.

Source: Statistics Canada. Agriculture-Population Linkage database. 1971 to 2006.

Importantly, this structure has essentially been the same since 1971 (Table 5). The decline in the share of operators with "viable" farms in 2006 (and 2001) may be attributable, in part, to:

1. our assumption that one-half of farm wages may be assigned as income received by the operator (if we assumed a higher share, the net/gross ratio would be higher and we would calculate a lower anticipated gross revenue to generate a net farm income above the low income cut-off which would generate more "viable" farms); and
2. high variability in net farm income in the last 10 years and although we used a 5-year average of net farm income and gross farm revenue to calculate our net/gross ratios, even the 5-year averages vary considerably depending upon which 5-year period is chosen and we chose the 5-year period up to and including the year prior to the census (which is the reference period for census revenue and expense data). Thus,
3. the decline in the share of farms that are "viable" in 2001 and 2006 (Table 5) may be more due to the methodology than is the case for earlier years.
4. Readers will note that the 1981 situation appears as an outlier in the opposite direction – compared with all other census periods, the 1981 period shows a significantly higher share of operators classified as associated with "viable" agricultural holdings (Table 5) (and for operator households, see Figure 4).

Table 5

Distribution of census-farm operators by main occupation and by association with "viable[1]" or "non-viable[1]" census-farms, Canada, 1971 to 2006

Main occupation of the operator[2] of a census-farm		"Non-viable[1]" census-farms (below the threshold for a single rural individual)	"Viable[1]" census-farms (equal to or above the threshold for a single rural individual)	All census-farms	"Non-viable[1]" census-farms (below the threshold for a single rural individual)	"Viable[1]" census-farms (equal to or above the threshold for a single rural individual)	All census-farms	"Non-viable[1]" census-farms (below the threshold for a single rural individual)	"Viable[1]" census-farms (equal to or above the threshold for a single rural individual)	All census-farms	"Non-viable[1]" census-farms (below the threshold for a single rural individual)	"Viable[1]" census-farms (equal to or above the threshold for a single rural individual)	All census-farms
		number of operators			as a percent of the operators in each year (row percent)			as a percent of the operators in each farm size class (column percent)			as a percent of all operators in each census year		
Operators[2] with a non-farming occupation	1971	72,120	12,205	84,325	86	14	100	42	9	28	24	4	28
	1981	68,810	15,085	83,895	82	18	100	56	10	31	25	6	31
	1986	68,315	8,415	76,730	89	11	100	44	8	29	26	3	29
	1991*	99,810	19,980	119,790	83	17	100	49	15	35	29	6	35
	1996*	111,820	19,470	131,290	85	15	100	52	17	40	34	6	40
	2001*	101,575	11,695	113,270	90	10	100	47	14	38	34	4	38
	2006*	113,165	11,525	124,690	91	9	100	52	18	44	40	4	44
Operators[2] with a farming occupation	1971	101,575	118,205	219,780	46	54	100	58	91	72	33	39	72
	1981	54,385	131,695	186,080	29	71	100	44	90	69	20	49	69
	1986	88,715	96,630	185,345	48	52	100	56	92	71	34	37	71
	1991*	104,455	116,590	221,045	47	53	100	51	85	65	31	34	65
	1996*	102,485	94,480	196,965	52	48	100	48	83	60	31	29	60
	2001*	115,320	71,460	186,780	62	38	100	53	86	62	38	24	62
	2006*	105,100	52,820	157,920	67	33	100	48	82	56	37	19	56
All operators[2]	1971	173,695	130,410	304,105	57	43	100	100	100	100	57	43	100
	1981	123,195	146,780	269,975	46	54	100	100	100	100	46	54	100
	1986	157,030	105,045	262,075	60	40	100	100	100	100	60	40	100
	1991*	204,265	136,570	340,835	60	40	100	100	100	100	60	40	100
	1996*	214,305	113,950	328,255	65	35	100	100	100	100	65	35	100
	2001*	216,895	83,155	300,050	72	28	100	100	100	100	72	28	100
	2006*	218,265	64,345	282,610	77	23	100	100	100	100	77	23	100

1. A "viable" farm in this table is a census-farm with gross revenue anticipated to generate a net farm income above the low income cut-off for one rural individual. This follows the recommendation in Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture).

2. Operators in this table refer only to operators with a major occupation stated, with some hours of work "last week" and with some weeks worked "last year." Operators of non-family incorporated census-farms and "other" census-farms (such as institutional farms, co-operative farms, Hutterite Colonies, etc.) are excluded.

* Since 1991, each census-farm may report more than one operator.

Source: Statistics Canada. Agriculture-Population Linkage database. 1971 to 2006.

Given this calculation, the major, perhaps obvious, point is that there is not a one-to-one mapping of the whether the individual is a “farmer” and whether the operation is a “farm”.

Among operators who are “farmers” (i.e. operators who claim “farming” is their major occupation), 50 percent operate “viable” farms (which, in this table, would be anticipated to generate the minimum standard of living for a single rural individual) and 50 percent are operating “non-viable” farms (Table 4). In the period from 1971 to 2006, the share ranged close to 50 percent in 4 periods – with 1981 being higher and 2001 and 2006 being lower (Table 5).

Among “viable” farms, two-thirds of the operators are “farmers” (i.e. with farming as their major occupation) and one-third of the operators of “viable” farms do not report “farming” as their major occupation. Only a small part of this finding may be attributable to the change in 1991 to allow each census-farm to report more than one operator. Before 1991, this share was less than 33 percent (ranging from 28 to 31 percent) and since 1991, the share was more than 33 percent (ranging from 35 to 44 percent). However, the conclusion remains – a significant share of operators of “viable” farms do not report “farming” as their major occupation.

The main point is that “real farmers” operate both “unreal farms” and “real farms.” Also, “real farms” farms are operated by “real farmers” and “unreal farmers.” There is not a large overlap of “real farmers” and “real farms.”

Thus, to understand farms, it would appear better to design a typology of farms. To understand farmers (or farming families), it would appear better to design a typology of farmers. Only then would it seem profitable to cross-tabulate the two typologies to see the inter-relationship between the typology of operators of agricultural holdings and the typology of agricultural holdings.

To emphasize, the major point is that being a “farmer” is not a one-to-one match with the agricultural holding being a “farm”. Consequently, analysts dealing with issues relating to the agricultural holding (stability of farming income, rates of returns to farming resources, etc.) should focus on the agricultural holding – and perhaps the focus is only on holdings that are “farms”.

Similarly, analysts dealing with issues relating to individuals operating the holding (human capital attributes of the individual, whether the individual lives in a household with total income below a low income cut-off) should focus on the individual – and perhaps the analyst would prefer to focus only on individuals that are “farmers”.

6. Topic #3: Labour supply generated by census-farm operator households

Following the algorithm used by Bollman and Smith (1986), we see that in 2006, members of census-farm operator households supplied an estimated 1 billion hours of labour to farm and non-farm occupations (Table 6).

Table 6

Estimated aggregate hours of work by members of census-farm operator households (includes only household members with a stated occupation, with some hours worked "last week" and with some weeks worked "last year"), Canada, 2006

Main occupation of member of census-farm operator household	Is the household member an operator or not an operator of a census-farm?	Gender of household member	"Non-viable[1]" census-farms			"Viable[1]" census-farms			All census-farms
			Gross revenue is less than 50% of the threshold (for a single rural individual)	Gross revenue is 50 to 99% of the threshold (for a single rural individual)	Subtotal, all "non-viable[1]" census-farms	Gross revenue is 100 to 199% of the threshold (for a single rural individual)	Gross revenue is 200% or more of the threshold (for a single rural individual)	Subtotal, all "viable[1]" census-farms	
			estimated aggregate annual hours of work[2] by members of census-farm operator households with a stated occupation, with some hours worked "last week" and with some weeks worked "last year"						
"Farming" is the major occupation	Operators	Males	148,347,384	87,596,573	235,943,957	85,807,565	70,846,718	156,654,283	392,598,240
		Females	32,062,613	15,101,617	47,164,230	14,518,230	9,103,834	23,622,064	70,786,294
		Both genders	180,409,997	102,698,190	283,108,187	100,325,795	79,950,552	180,276,347	463,384,534
	Non-operators	Males	8,302,951	4,789,045	13,091,996	6,461,078	6,738,150	13,199,228	26,291,224
		Females	13,907,710	8,055,189	21,962,899	9,417,842	7,529,472	16,947,314	38,910,213
		Both genders	22,210,661	12,844,233	35,054,895	15,878,920	14,267,622	30,146,543	65,201,437
	Operators and non-operators	Males	156,650,335	92,385,617	249,035,953	92,268,643	77,584,868	169,853,511	418,889,464
		Females	45,970,323	23,156,806	69,127,129	23,936,072	16,633,306	40,569,378	109,696,507
		Both genders	202,620,658	115,542,423	318,163,082	116,204,715	94,218,174	210,422,890	528,585,971
"Non-farming" is the major occupation	Operators	Males	174,019,826	18,402,605	192,422,432	10,194,352	7,024,272	17,218,623	209,641,055
		Females	59,033,597	8,806,900	67,840,498	6,632,249	4,685,780	11,318,029	79,158,527
		Both genders	233,053,424	27,209,506	260,262,929	16,826,601	11,710,052	28,536,652	288,799,582
	Non-operators	Males	38,934,007	7,182,172	46,116,179	5,612,917	4,115,449	9,728,366	55,844,545
		Females	86,397,777	21,173,691	107,571,468	18,231,232	15,817,561	34,048,793	141,620,260
		Both genders	125,331,784	28,355,863	153,687,646	23,844,149	19,933,010	43,777,159	197,464,805
	Operators and non-operators	Males	212,953,833	25,584,777	238,538,610	15,807,269	11,139,721	26,946,990	265,485,600
		Females	145,431,375	29,980,591	175,411,966	24,863,481	20,503,341	45,366,822	220,778,787
		Both genders	358,385,208	55,565,368	413,950,576	40,670,750	31,643,062	72,313,811	486,264,387
All occupations	Operators	Males	322,367,211	105,999,178	428,366,389	96,001,917	77,870,989	173,872,906	602,239,294
		Females	91,096,211	23,908,518	115,004,728	21,150,479	13,789,615	34,940,093	149,944,821
		Both genders	413,463,421	129,907,695	543,371,117	117,152,396	91,660,604	208,812,999	752,184,116
	Non-operators	Males	47,236,958	11,971,217	59,208,174	12,073,995	10,853,599	22,927,595	82,135,769
		Females	100,305,487	29,228,879	129,534,367	27,649,074	23,347,033	50,996,107	180,530,473
		Both genders	147,542,445	41,200,096	188,742,541	39,723,069	34,200,632	73,923,701	262,666,242
	Operators and non-operators	Males	369,604,168	117,970,394	487,574,563	108,075,912	88,724,589	196,800,501	684,375,063
		Females	191,401,698	53,137,397	244,539,095	48,799,553	37,136,647	85,936,200	330,475,295
		Both genders	561,005,866	171,107,791	732,113,657	156,875,465	125,861,236	282,736,701	1,014,850,358

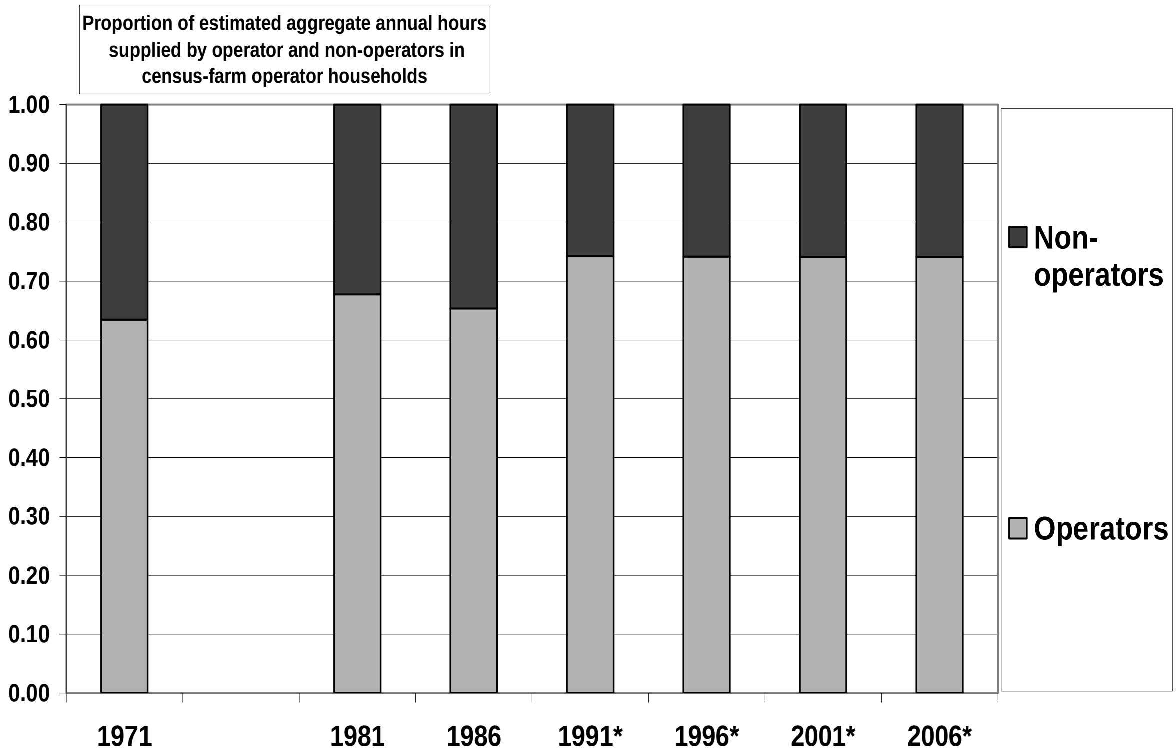
1. "Viable" and "non-viable" census-farms are defined according the definition provided in Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture). In this table, a "viable" census-farm is anticipated to generate a net farm income greater than the low income cut-off for a single rural individual.

2. Estimated annual hours of work is calculated as "hours worked last week" (i.e. in the week prior to the census (May 16, 2006)) multiplied by "hours worked last year" and thus this table only includes individuals with some "hours worked last week" and "some weeks worked last year."

Source: Statistics Canada. Agriculture-Population Linkage, 2006.

Since 1991, 74 percent of the labour supplied by census-farm operator households has been provided by an operator (Figure 10). These operators may be male or female and they may have "farming" or "non-farming" as their major occupation. Nevertheless, the share of household labour generated by individuals listed as an operator of a census-farm has been 74 percent of total household labour since 1991.

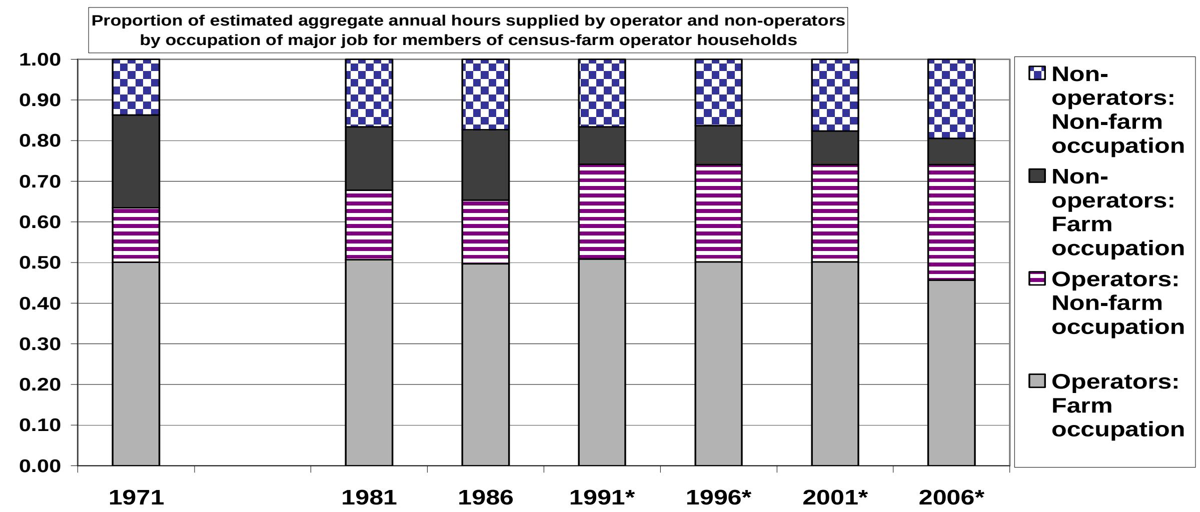
Figure 10 - Since 1991*, 74% of household labour has been contributed by operators, Canada



* Starting in 1991, more than one operator could be identified for each census-farm. Typically, the operators live in the same household.
Estimated annual hours of work is calculated as "hours worked last week" (i.e. in the week prior to the census (May 16, 2006)) multiplied by "hours worked last year" and thus this chart only includes individuals with some "hours worked last week" and "some weeks worked last year".
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

The share of household labour that was supplied by operators and allocated to a "farming" occupation was 50 percent from 1971 to 2001 (and fell to 46 percent in 2006) (Figure 11). Operator labour allocated to non-farm occupations increased from 13 percent in 1971 to 28 percent in 2006. Part was due to a 7 percentage point jump in 1991 when more than one operator could be listed for each census-farm. The share of household labour supplied by non-operators to non-farm occupations has been essentially constant (varying between 16 percent and 19 percent between 1981 and 2006). The 8 percentage point decline in the allocation of labour by non-operators to a farming occupation in 1991 is due to the change in the classification to allow more than one operator be identified for each census-farm.

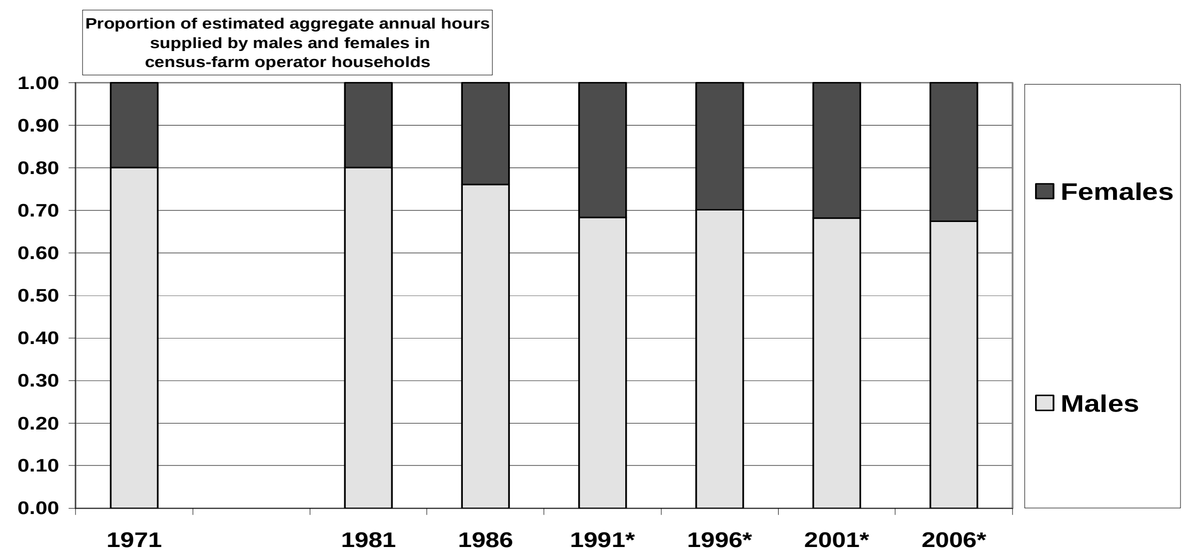
Figure 11 - Labour supplied by operators to a non-farm occupation has increased from 13% in 1971 to 28% in 2006 *(in part due to more than one operator being identified per census farm in 1991)*, **Canada**



* Starting in 1991, more than one operator could be identified for each census-farm. Typically, the operators live in the same household.
Estimated annual hours of work is calculated as "hours worked last week" (i.e. in the week prior to the census (May 16, 2006)) multiplied by "hours worked last year" and thus this chart only includes individuals with some "hours worked last week" and "some weeks worked last year".
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

Since 1971, the share of labour supplied by females in census-farm operator households has increased from 20 percent to 33 percent in 2006 (Figure 12). Since 1991, the share has been relatively constant in the ranged of 30 percent to 33 percent.

Figure 12 - Since 1991*, 67 to 70% of household labour has been contributed by males, Canada

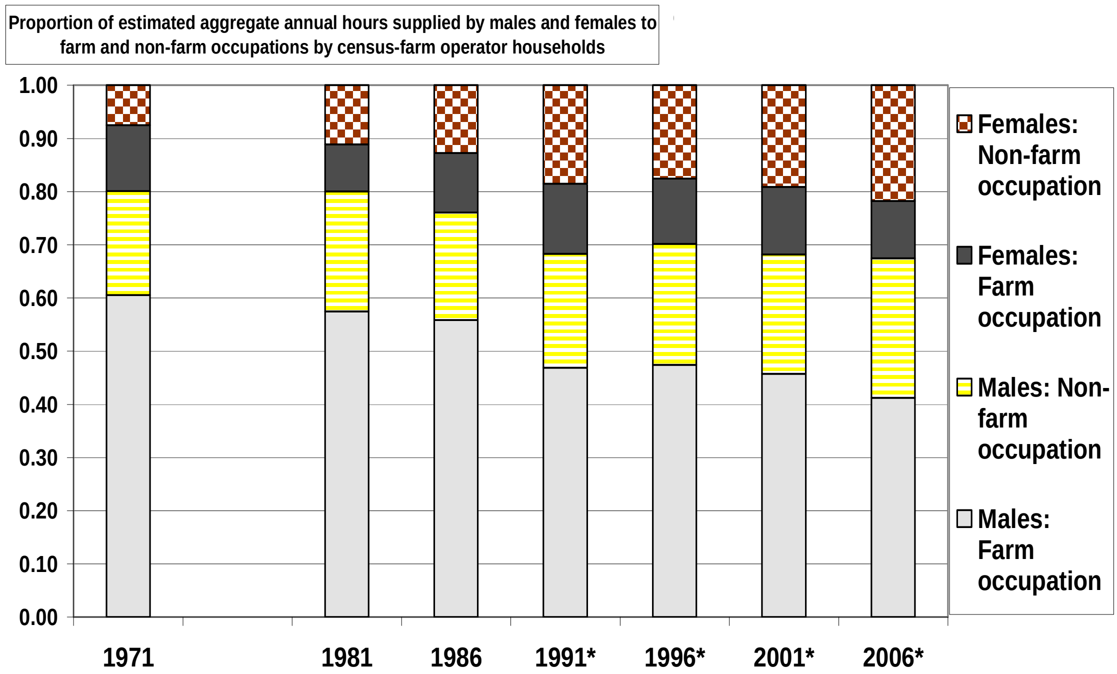


* Starting in 1991, more than one operator could be identified for each census-farm. Typically, the operators live in the same household.
Estimated annual hours of work is calculated as "hours worked last week" (i.e. in the week prior to the census (May 16, 2006)) multiplied by "hours worked last year" and thus this chart only includes individuals with some "hours worked last week" and "some weeks worked last year".
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

Although the allocation of household labour to non-farm jobs by both females and males has increased, the greatest increase has been by females. In 1971, 8 percent of household labour was a female working in a non-farm job (Figure 13). By 2006, females working in non-farm jobs represented 22 percent of household labour. The increase by males has not been as great. In 1971, males working in a non-farm job represented 20 percent of household labour – and this increased to 26 percent of household labour in 2006.

The declining share of household labour allocated to a farming occupation is entirely due to the declining share supplied by males – down from 61 percent of household total labour in 1971 to 41 percent in 2006. The female allocation of labour to a farming occupation has not changed – fluctuating between 9 percent and 13 percent of total household labour over this period.

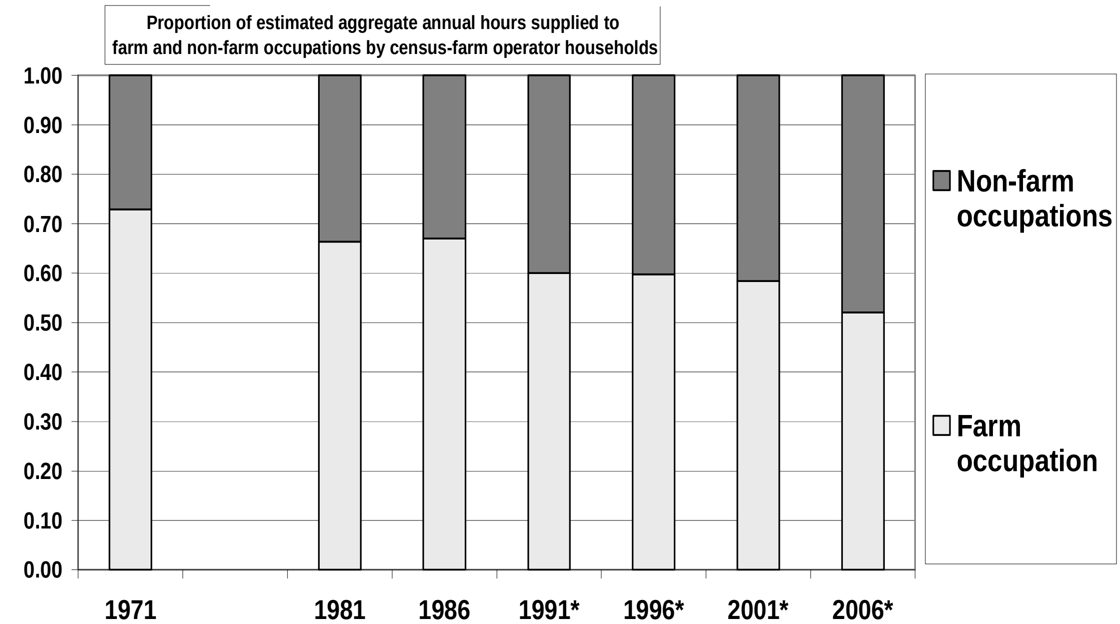
Figure 13 - As a share of household labour supplied: male hours to non-farm – up from 20% in 1971 to 26% in 2006; female hours to non-farm - up from 8% in 1971 to 22% in 2006, Canada



* Starting in 1991, more than one operator could be identified for each census-farm. Typically, the operators live in the same household.
Estimated annual hours of work is calculated as "hours worked last week" (i.e. in the week prior to the census (May 16, 2006)) multiplied by "hours worked last year" and thus this chart only includes individuals with some "hours worked last week" and "some weeks worked last year".
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

By re-arranging the above results and consistent with the on-going change in the structure of earnings when all census-farm operators are considered, we see a decline in the share of census-farm operator household labour allocated to a farming occupation. In 1971, 73 percent of household labour was allocated to a farming occupation and this has declined to 52 percent in 2006 (Figure 14).

Figure 14 - Labour supplied to farm occupations has declined from 73 to 52% of labour supplied by census-farm operator households, Canada



* Starting in 1991, more than one operator could be identified for each census-farm. Typically, the operators live in the same household.
Estimated annual hours of work is calculated as "hours worked last week" (i.e. in the week prior to the census (May 16, 2006)) multiplied by "hours worked last year" and thus this chart only includes individuals with some "hours worked last week" and "some weeks worked last year".
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

Above, we noted that females were increasing their share of household earnings – and this was associated with in increase in non-farm earnings within census-farm operator households. Here, again, the increase in labour supplied by household members is, largely, by females with non-farming occupations.

7. Topic #4: Typology of households by farm<>non-farm work patterns

Above, we were classifying individuals according to their major occupation. Here, we offer a typology of households according to:

a) whether the main occupation of the "husband" is farming or non-farming; and according to
b) whether the main occupation of the "wife" is farming or non-farming.
c) A not insignificant share of households are classified as "other." These are cases where there is no husband-wife couple in the household or where there is more than one husband-wife couple in the household. Also, cases where the "husband" has no stated occupation (includes retired "husbands") are also classified as "other" households.

In 2006, the three largest groups were:

- 64,285 census-farm operator households (27 percent) reported both the "husband" and the "wife" to have a non-farm occupation (Figure 15). There has been little change since 1991;

- 56,780 census-farm operator households (24 percent) reported the "husband" with a farming occupation and the "wife" with a non-farm occupation. There has been little change since 1986;
- 44,455 census-farm operator households (18 percent) were classified as "other" households. Again, there has been little change since 1986.

In 1971, the largest group was:

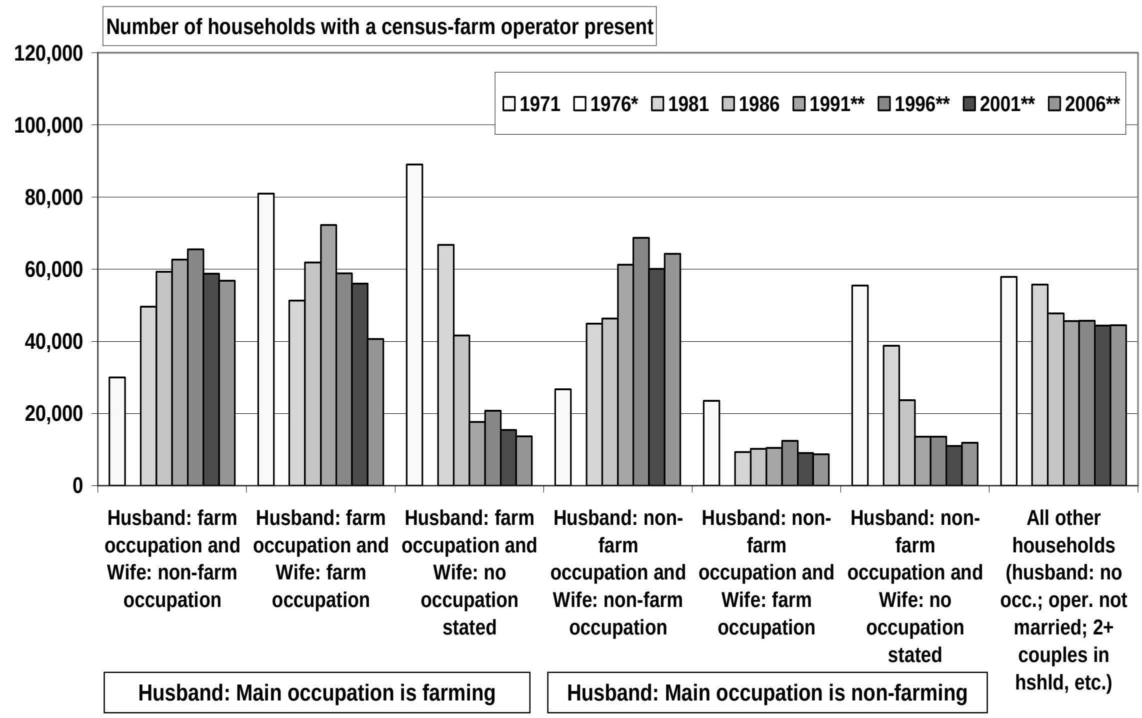
- 89,080 census-farm operator households (25 percent) were classified as "husband" with a farming occupation and "wife" with no occupation stated. This group declined to 13,640 (6 percent) in 2006.

In 1991, the largest group was:

- 72,315 census-farm operator households (25 percent) were classified with both the "husband" and the "wife" reporting farming as the major occupation. This group declined to 40,690 households (17 percent) in 2006.

Since 1981, the number of census-farm operator households with the "husband" with a non-farm occupation and the "wife" with a farming occupation has been relatively small (varying between 6,350 and 9,200 households) (about 4 percent of all census-farm operator households).

Figure 15 - In 2006, 41 thousand census-farm operator households reported both the husband and the wife with a "farm" occupation, Canada



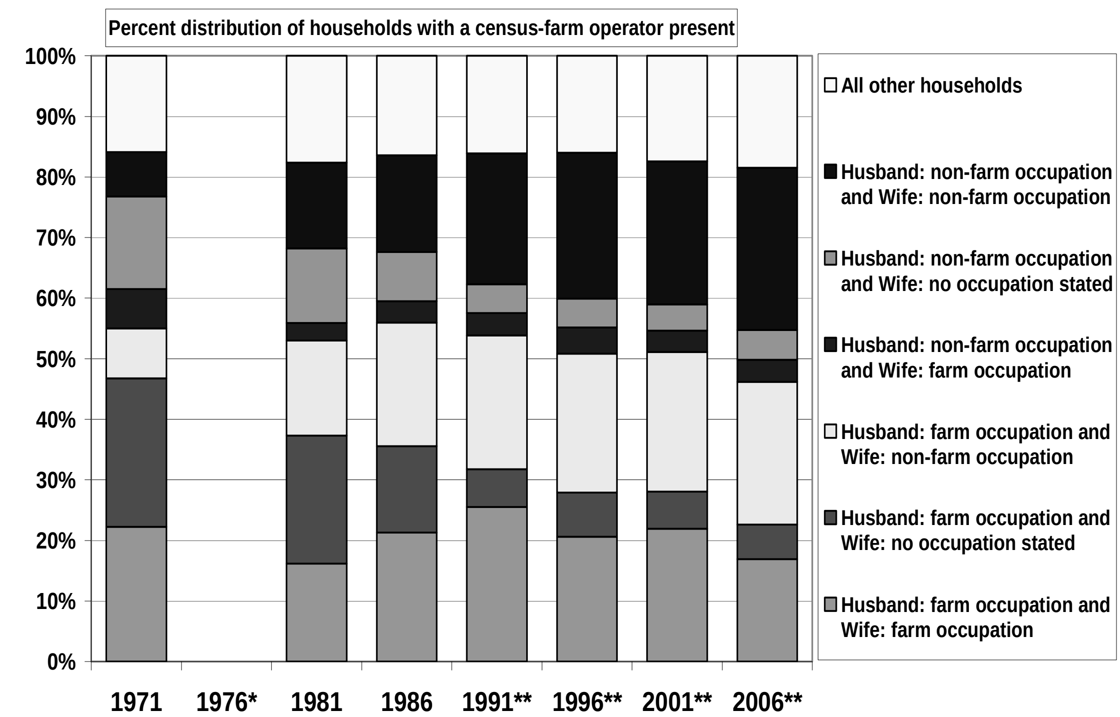
* There was no Agriculture-Population Linkage in 1976.
** Starting in 1991, up to three operators could be identified for each census-farm. If the operators lived in different households, we will have more than one household per census-farm.
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

The share of "husbands" with farming as their major occupation as remained relatively constant for the entire 1971 to 2006 period (the lower three groups in Figure 16). The share declined from 55 percent in 1971 to 46 percent in 2006.

Among these households with the "husband" with a farming occupation, the share of households with the wife also with a farming occupation varied between 16 percent and 25 percent -- recording 17 percent of all census-farm operator households in 2006. The share with the "wife" with no stated occupation declined and the share with the wife with a non-farming occupation increased steadily over this period.

The other side of this coin is that the share of "husbands" with a non-farm occupation was also relatively stable – increasing from 29 percent in 1971 to 35 percent in 2006.

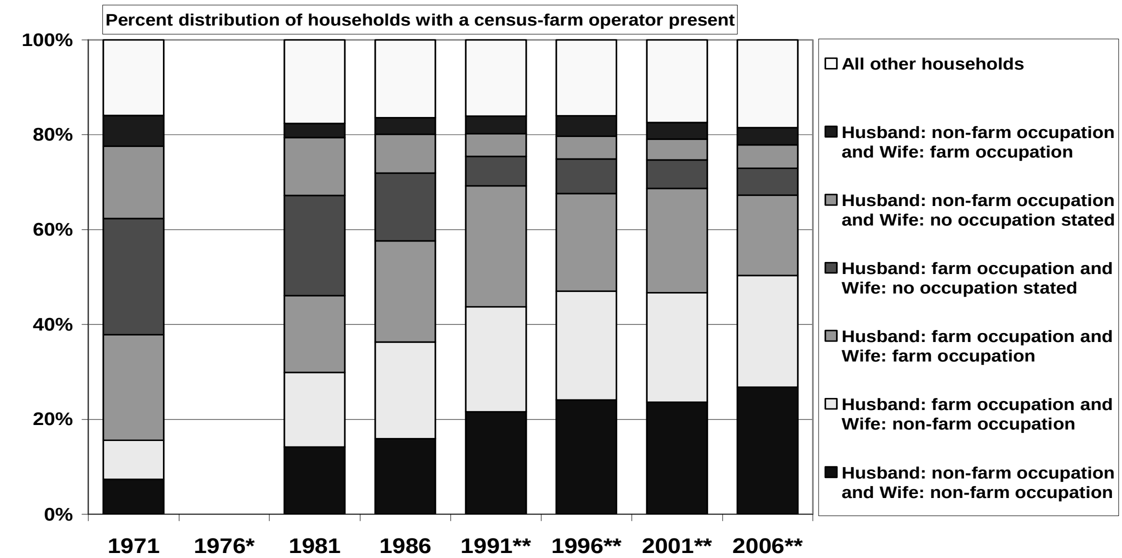
Figure 16 - In 2006, 46% of census-farm operator households reported the "husband" with a farm occupation *(down from 55% in 1971)*, **Canada**



* There was no Agriculture-Population Linkage in 1976.
** Starting in 1991, up to three operators could be identified for each census-farm. If the operators lived in different households, we will have more than one household per census-farm.
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

If we re-arrange the groups in Figure 16 to group the occupational classification of the "wife" in the lower three groups in the chart, Figure 17 shows (more clearly) the increase in the share of households with the "wife" with a non-farm occupation (the lower 2 groups in Figure 17) – from 15 percent in 1971 to 51 percent in 2006.

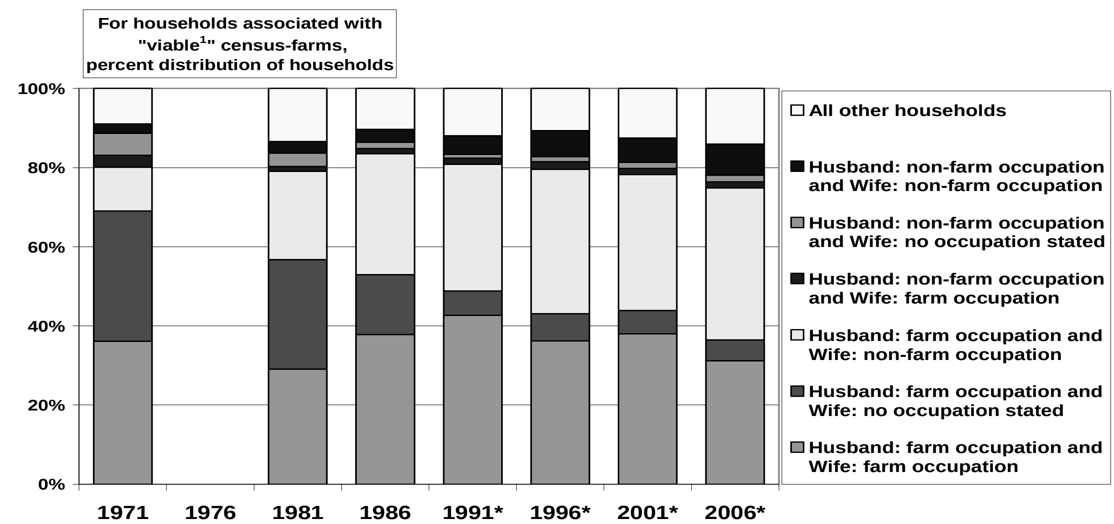
Figure 17 - In 2006, 51% of census-farm operator households reported the "wife" with a non-farm occupation ***(up from 15% in 1971)*****, Canada**



* There was no Agriculture-Population Linkage in 1976.
** Starting in 1991, up to three operators could be identified for each census-farm. If the operators lived in different households, we will have more than one household per census-farm.
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

Finally, we replicate Figure 16 for only households associated with a "viable" farm. Not surprisingly, a very small share of census-farm operator husband-wife households show a "husband" with the major occupation to be non-farming (Figure 18) (varying between a low of 6 percent in 1986 and a high of 11 percent in 2006). (This should not be confused with the classification of individuals presented in Table 4.). In 2006, 75 percent of the households associated with a "viable" farm reported a "husband" with a farming occupation.

Figure 18 - Within households associated with a "viable[1]" census-farm, the share of husbands with a farm occupation declined from 80% in 1971 to 75% in 2006, Canada

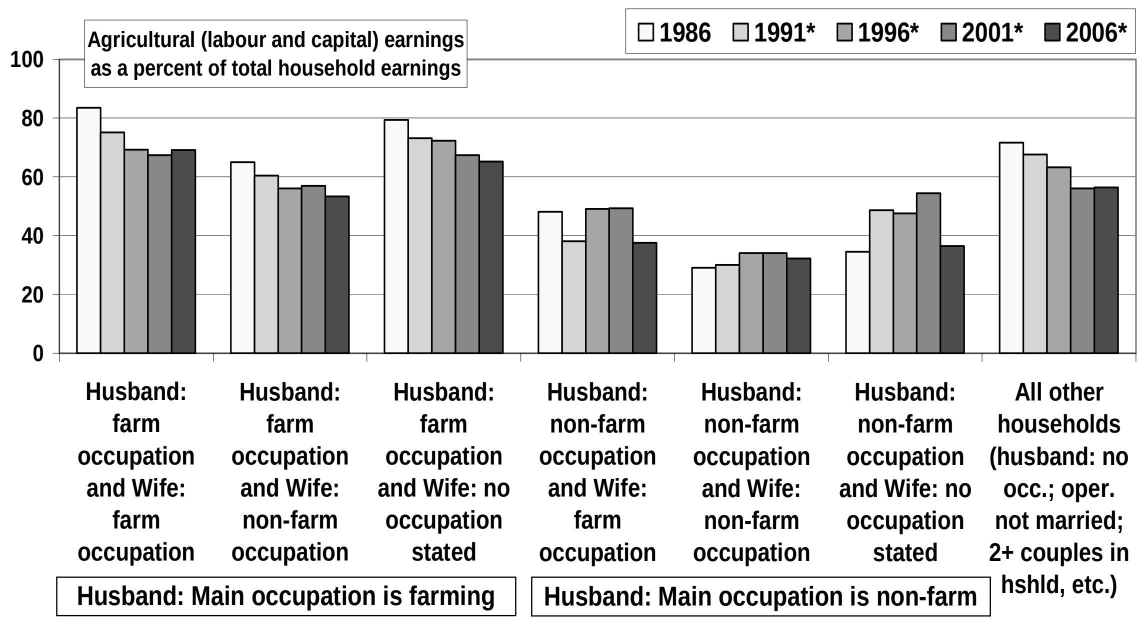


1. "Viable" and "non-viable" census-farms are defined according to the definition provided by Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture) . Specifically, a holding able to generate adquate income for a family of four.
** Starting in 1991, up to three operators could be identified for each census-farm. If the operators lived in different households, we will have more than one household per census-farm.
Source: Statistics Canada. Agriculture-Population Linkage, 1971 to 2006.

We continuing with the focus on households associated with “viable” farms. For these households, if the “husband” reports farming as the major occupation, then we see that agricultural (labour and capital) earnings represent over 50 percent of total household earnings (Figure 19).

The share contributed by agricultural earnings has declined somewhat over time. However, for households associated with “viable” farms and for households with the major occupation of the “husband” being “non-farming”, agricultural earnings are a lower share of household earnings (generally less than 50 percent) and there is no discernable trend over time.

Figure 19 - For households associated with “viable[1]” farms, in households with the “husband” with a farm occupation, there is a decline in agricultural earnings as a percent of total earnings, Canada, 1986 to 2006



1. "Viable" and "non-viable" census-farms are defined according to the definition provided by Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture) . Specifically, a holding able to generate adquate income for a family of four.
** Starting in 1991, up to three operators could be identified for each census-farm. If the operators lived in different households, we will have more than one household per census-farm.
Source: Statistics Canada. Agriculture-Population Linkage, 1986 to 2006.

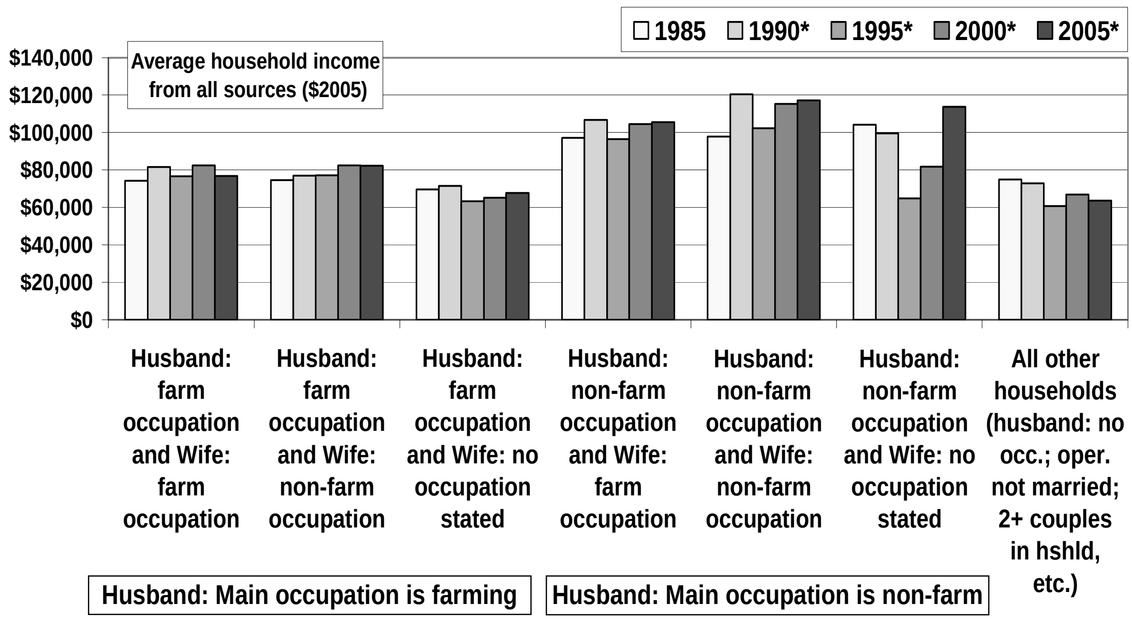
Interestingly, among households associated with “viable” farms, for households with the “husband” with a farming occupation, the average household income (in constant $2005) from all sources ranged over the 1986 to 2006 period between $60,000 and $80,000 (Figure 20). The range was between $80,000 and $120,000 for households with the “husband” with a non-farming occupation. In these households, there is a “viable” farm generating earnings and a “husband” working in a non-farming occupation. For reference, the average Canadian household income from all sources was $69,548.

To wrap up:

- by 2006, there was a relatively small share of census-farm operator households where the “wife” did not report an occupation;

- by 2006, most of the increase labour by “wives” was allocated to a non-farm occupation;
- the share of households with a “wife” with a farming occupation changed little over this period.

Figure 20 - For households associated with “viable[1]”farms, in households with the “husband” with a farm occupation, there is a decline in agricultural earnings as a percent of total earnings, Canada, 1986 to 2006



1. "Viable" and "non-viable" census-farms are defined according to the definition provided by Canada. (1969) **Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture** (Ottawa: Canada Department of Agriculture) . Specifically, a holding able to generate adquate income for a family of four.
** Starting in 1991, up to three operators could be identified for each census-farm. If the operators lived in different households, we will have more than one household per census-farm.
Source: Statistics Canada. Agriculture-Population Linkage, 1986 to 2006.

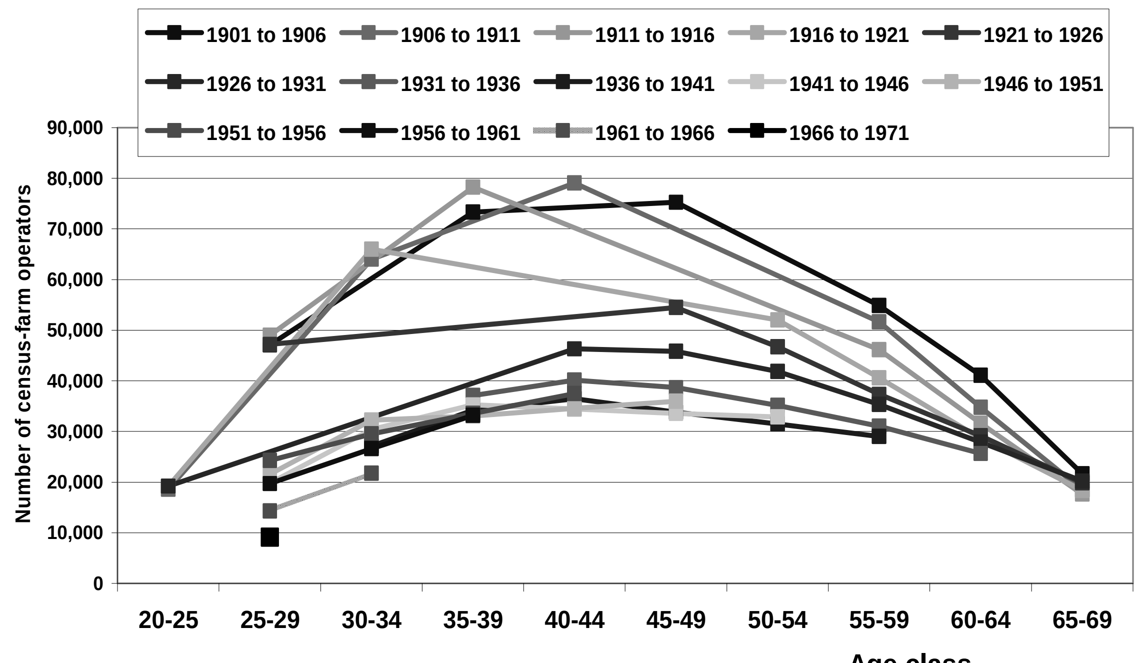
8. Topic #5: Do young(er) operators have an agricultural-related post-secondary education?

Farm production technology is continuously becoming more complex. An analysis of Agriculture-Population Linkage data has shown that the level of educational attainment of the operator is associated with more productive farms (Furtan et al.*,*1979).

Here we assess the share of younger operators who have completed some agriculture-related post-secondary education.[26] We designate “under 45 years of age” to be “younger” as, on a net basis, there is an increase in the number of census-farm operators up to age 45 (Figure 21). In the older age groups, more operators leave than enter the sector.

[26] “Agriculture-related fields of study include the following groups in the Classification of Instructional Programs (Statistics Canada, 2007x): 01-- Agriculture, agricultural operations and related sciences (including all "sub" categories); 13.1301 -- Agricultural teacher education; 14.0301 -- Agricultural / biological engineering and bioengineering; 26.03 -- Botany / plant biology (including all "sub" categories); 26.07 -- Zoology / animal biology (including all "sub" categories); 26.08 -- Genetics (including all "sub" categories); 47.06 -- Vehicle maintenance and repair technologies (including all "sub" categories); and 51.25 -- Veterinary biomedical and clinical sciences (including all "sub" categories).

Figure 21 - Number of census-farm operators by age cohort, Canada

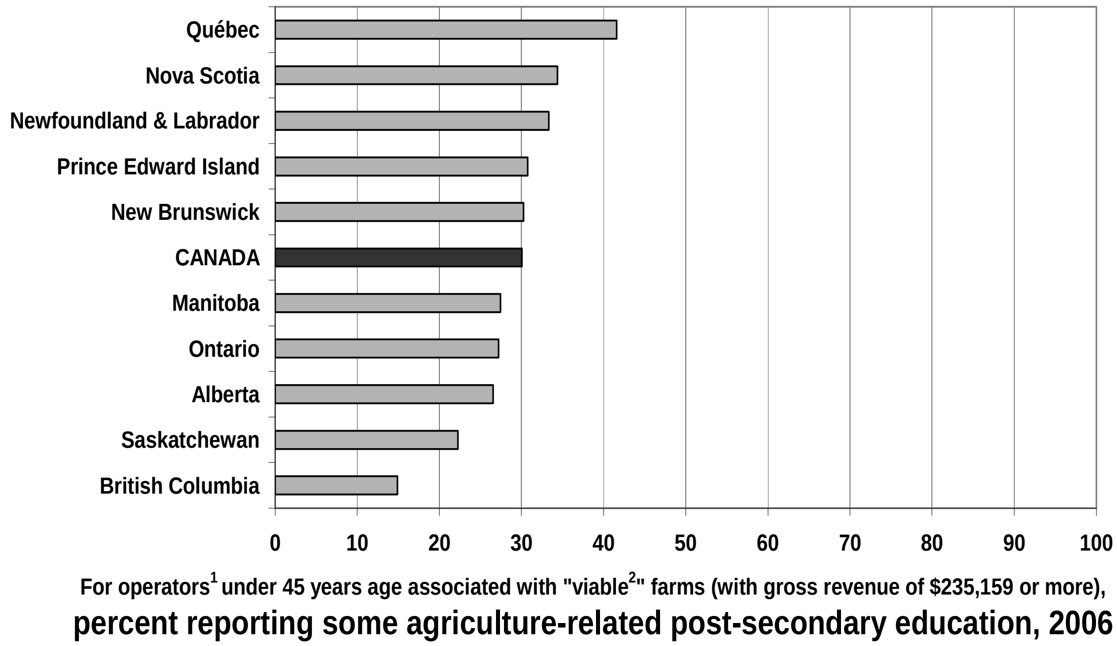


Source: Statistics Canada. Census of Agriculture. "First-listed" operator in 1991 and 1996.

Among younger operators, the share of operators associated with “viable” farms who report some “agricultural-related” post-secondary education ranges from a high of 42 percent in the province of Quebec to a low of 15 percent in the province of British Columbia (Figure 22). These data are displayed by province because, in Canada, education is a provincial jurisdiction. Thus, one way to interpret these data is that the post-secondary institutions providing “agricultural-related” post-secondary education have double the market share of younger operators in some provinces compared to other provinces.[27]

[27] These inter-provincial differences persist over time. A time series is not presented here as the coding for “major field of study” changed in 2006 and a concordance is not possible with the earlier coding. However, using the coding available in earlier Agriculture-Population Linkage databases does generate similar findings.

Figure 22 - 42% of younger operators[1] of "viable[2]" farms in Quebec reported some "agricultural-related" post-secondary education, 2006



1. Includes operators of proprietorship, partnership and family corporation census-farms.
2. "Viable" census-farms, in this chart, refer to census-farms anticipated to generate a net farm income to meet the low income cut-off for a single rural individual.
Source: Statistics Canada. Agriculture-Population Linkage, 2006.

9. Summary

Farming families and family farms remain a policy focus in Canada.

The Canadian Agriculture-Population Linkage database is a unique database that assembles the characteristics of the agricultural holding (from the Census of Agriculture questionnaire) and the characteristics of each member of the household of each operator of an agricultural holding (from the Census of Population questionnaire).

In this paper, we have pursued selected topics to illustrate the utility of this database.

During the 1990s, 20 percent of the earnings of all households with a census-farm operator present were received as unincorporated net farm income. However, household members receive agricultural earnings in other ways than as unincorporated net farm income. Household members may receive agricultural earnings as wages. Certainly, individuals associated with incorporated farms would receive earnings from the holding in the form of wages and / or as dividends. An estimated "agriculture labour and capital earnings" shows that, during the 1990s, agricultural earnings were about 30 percent of total household earnings.

A recognition of this difference is most important for households associated with larger agricultural holdings. Households associated with these holdings are more likely to receive wages from the agricultural holding and these holdings are more likely to be incorporated.

The distribution of agricultural holdings, according to the capacity to provide a net farm income above the Canadian low income cut-off, has not changed over time. Thus, there does not appear to be a change in the demand for census-farm operator households to find alternative sources of earnings.

Estimated agricultural labour and capital earnings, as a percent of total household earnings, has declined for households associated with agricultural holdings in each size class of farm business.

One major on-going feature during the study period was the increase in the number of females in the "measured" labour force. Within census-farm operator households, more women were being "measured" in the labour force and most of these women were working in non-farm occupations.

Males in census-farm operator households have shown some shift in labour supply from a farm occupation to non-farm occupations – but most of the shift in the labour supplied by census-farm operator households has been by women.

Thus, for census-farm operator households, most of the increase in earnings from non-farm sources is due to the increased participation of women in non-agricultural jobs.

A typology of "farmers" cross-tabulated with a typology of "farms" indicates that there is not a one-to-one mapping of whether the operator is a "farmer" (with farming being the major occupation) and whether the agricultural holding is a "farm" (with gross revenue above the threshold anticipated to generate a net farm income above the Canadian low income cut-off). To understand farm issues such as the variability of farm income or the rate of return to resources invested in farming, it would seem preferable to use farm variables to build a typology. To understand farmer issues such as the human capital of farmers or whether the farmer lives in a household with income below the low income cut-off, it would seem preferable to use farmer variables to build a typology.

Finally, the institutions providing agricultural-related post-secondary education have reached 15 percent to 42 percent (depending upon the province) of the younger operators of "viable" farms. Thus, there is potential for these institutions to increase their penetration among younger operators of "viable" farms.

Perhaps obviously, this paper has focussed on only a few selected topics that might be addressed with Canada's Agriculture-Population Linkage database. Analysts are encourage to pursue other relevant topics.

References

Alessandro Alasia, Alfons Weersink, Ray D. Bollman, John Cranfield. (2008). "Off-farm labour decision of Canadian farm operators: Urbanization effects and rural labour market linkages." *Journal of Rural Studies* 25, pp. 12-24. (http://dx.doi.org/10.1016/j.jrurstud.2008.04.002)

Bollman, Ray D. (1979) *Off-farm Work by Farmers* (Ottawa: Census Analytic Study, Statistics Canada, Catalogue no. 99-756).

Bollman, Ray D. and Pamela Smith. (1986) "Integration of Canadian Farm and Off-farm Markets and the Off-farm Work of Farm Women, Men, and Children.", Chapter 15 in G. S. Basran and David A. Hay (1988), *The Political Economy of Agriculture in Western Canada* (Toronto: Garamond Press), pp. 185-202.

Canada. (1969) *Canadian agriculture in the seventies: Report of the Federal Task Force on Agriculture* (Ottawa: Canada Department of Agriculture)

Ehrensaft, Philip and Ray D. Bollman. (1992) *The Microdynamics and Farm Family Economics of Structural Change in Agriculture* (Ottawa: Statistics Canada, Agriculture Division, Working Paper No. 16) (www.statcan.gc.ca/cgi-bin/downpub/listpub.cgi?catno=21-601-mie).

Ehrensaft, Philip and Jennifer Beeman. (1992) "Distance and diversity in nonmetropolitan economies." Chapter 9 in Ray D. Bollman (ed.) *Rural and Small Town Canada* (Toronto: Thompson Educational Publishing), pp. 193-224.

Fuller, A. M. (Tony) and Ray D. Bollman. (1992) "Farm Family Linkages to the Non-farm Sector: The Role of Off-Farm Income of Farm Families." Chapter 11 in Ray D. Bollman (ed.). *Rural and Small Town Canada* (Toronto: Thompson Educational Publishing).

Furtan. W. H. and Ray D. Bollman. (1979), "Returns to Operator Education in Saskatchewan", *American Journal of Agricultural Economics*, Vol. 61, Number 2 (May), pp. 318-321.

Keita, Naman. (2004) *Improving Cost-Effectiveness and Relevance of Agricultural Censuses in Africa: Linking Population and Agricultural Censuses (Ghana:* FAO Regional Office for Africa, Working Paper No. 30).

Shaw, Paul. (1979) *Canada's Farm Population: Analysis of Income and Related Characteristics* (Ottawa: Statistics Canada, Census Analytic Study, Catalogue no. 99-750).

Statistics Canada. (1975a) *Basic Socio-economic Characteristics of Farm Operators: Canada and Provinces* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 4 (Bulletin 4.4 – 1), Catalogue no. 96-712)

Statistics Canada. (1975b) *Cross-classified Socio-economic Characteristics of Farm Operators* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 4 (Bulletin 4.4 – 2), Catalogue no. 96-713).

Statistics Canada. (1975c) *Cross-classified Socio-economic Characteristics of Farm Operators with Off-farm Employment and Income: Canada, the Provinces and the Regions* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 4 (Bulletin 4.4 – 3), Catalogue no. 96-714).

Statistics Canada. (1975d) *Cross-classified Socio-economic Characteristics of Farm Operators' Families: Canada and Provinces* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 5 (Bulletin 4.5 – 1), Catalogue no. 96-715).

Statistics Canada. (1976a) *Cross-classified Socio-economic Characteristics of Farm Operators' Households: Canada and Provinces* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 5 (Bulletin 4.5 – 2), Catalogue no. 96-716).

Statistics Canada. (1976b) *Cross-classified Socio-economic Characteristics of Farm Operators' Dwelling Facilities: Canada* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 5 (Bulletin 4.5 – 3), Catalogue no. 96-717).

Statistics Canada. (1976c) *Farm Operators by Economic Class showing such characteristics as Sex, Age, Income, Schooling and Off-farm Employment* (Ottawa: Statistics Canada, 1971 Census of Canada, Catalogue no. 96-734).

Statistics Canada. (2003) *Agriculture-Population Linkage Data for the 2001 Census* (Ottawa: Statistics Canada, Catalogue no. 95F0303). (http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=95F0303XIE&lang=eng).

Statistics Canada. (2007) *2006 Census Dictionary* (Ottawa: Statistics Canada, Catalogue no. 92-566) (http://www12.statcan.gc.ca/english/census06/reference/dictionary/index.cfm)

Statistics Canada. (2008a) *Low Income Cut-offs for 2006 and Low Income Measures for 2005* (Ottawa: Statistics Canada, Income Research Paper Series No. 004, Catalogue no. 75F0002MIE).

Statistics Canada. (2008b) *Statistics on Income of Farm Families: 2005* (Ottawa: Statistics Canada, Catalogue no. 21-207) http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=21-207-X&chropg=1&lang=eng

Statistics Canada. (2008c) *Agriculture-Population Linkage Data for the 2006 Census* (Ottawa: Statistics Canada, Catalogue No. 95-633) http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=95-633-X&lang=eng

Statistics Canada. (2008d) *Break in the Agriculture-Population Linkage net farm income data series* (Ottawa: Statistics Canada, Catalogue no. 95-633) (http://www.statcan.gc.ca/pub/95-633-x/2007000/6500081-eng.htm).

Statistics Canada. (annual) *Net Farm Income: Agriculture Economic Statistics* (Ottawa: Statistics Canada, Catalogue no. 21-010) www.statcan.gc.ca/bsolc/english/bsolc?catno=21-010-XIE

United Nations. (1947) *United Nations Studies of Census Methods. Collation of Results of Population and Agricultural Census, No. 1* (New York: United Nations).

Appendix A

The Agriculture-Population Linkage: An Overview of the Methodology

Shaw (1979) notes that the idea of linking the Census of Agriculture questionnaire and the Census of Population questionnaire was anticipated by the United Nations (1947). He documents a number of feasibility studies.

> *For example, a project was undertaken in Canada by the Central Research and Development Staff of the Dominion Bureau of Statistics {the forerunner of Statistics Canada}, using approximately 50,000 records from the 1961 Censuses of Agriculture and Population. In the United States, projects were undertaken co-operatively by the Bureau of the Census and the Economic Research Service of the United States Department of Agriculture both in 1950 and 1960. In 1950, approximately 11,000 records were matched. In 1960, approximately 7,400 records were matched manually from the 1959 Census of Agriculture and the 1960 Census of Population and Housing. In both the Canadian and United States projects, linkage applications were on a small scale (sample) basis and in only one case have results been published (United States, 1953). Possibly Canada's 1971 Ag-Pop data base, representing a 100 percent linkage of agriculture and population census records, is without historical precedent* (Shaw, 1979, 225).

The first Canadian Agriculture-Population Linkage database was constructed for the 1971 census. The key feature of the Canadian census program is that the Census of Population and the Census of Agriculture are both enumerated on the same day by the same enumerator.

As outlined by Freeman (1976)

> *The program consists of a computerized record linkage of the 1971 Census of Agriculture and the 1971 Census of Population. The resulting linkage data base enables the cross-classification of agricultural characteristics of farming operations with socio-economic characteristics of farm operators and their households* (Freeman, 1976, p. 9).
>
> *The foundation of the program was relatively simple. The operator, or some member of the household of each census farm, completed two census questionnaires in 1971, the Agriculture and the Population questionnaire. . . The Agriculture questionnaire for each census farm was matched by the computer to its corresponding Population questionnaire. The existence of unique identifying criteria (province, electoral district, enumeration area and household number) for each farm operator household made this match possible. These criteria had been transcribed (during field collection and manual processing operations) to both questionnaires. The initial computer run successfully matched 358,872 census farms (98 percent). Subsequent matches substituted the operator's age (which appeared on both questionnaires) for the household number. A further 7,187 census farms were thus matched to their households. Finally, an imputation scheme matched the remaining 69 census farms* (Freeman, 1976, p. 10).

Freeman (1976) continues with an explanation of how the operator was identified on the Census of Population questionnaire and a re-weighting procedure to replicate control totals generated from the 100 percent databases. Specifically, in 1971, one-third of the households completed a "longer" questionnaire with the variables of interest (for each individual in the household, the Census of Population enumerated the occupation and industry of the main job, educational attainment, income by source, etc.). Thus, the 1971 Agriculture-Population Linkage was based on this one-third sample, However, the Census of Agriculture is a complete enumeration of all census-farms and the Census of Population has a "shorter" questionnaire (covering age, marital status, etc.) that provides 100 percent coverage of the entire population. A "raking ratio estimation procedure" was employed to adjust the 3:1 weights so that the Agriculture-Population Linkage would more closely replicate the control totals from the Census of Agriculture and the Census of Population.

Of course, the details are much more detailed. For example, see "Details on the Ag-Pop Linkage System", Appendix A in Shaw (1979). Perhaps not surprisingly, "The most significant problem . . . resulted from inadequate enumerator recording of key geographic codes which were required to identify record pairs." (Shaw, 1979, p. 227). Although "a failure-to-link ratio of approximately 5 percent - 9 percent was anticipated at the outset" (Shaw, 1979, p. 230), the decision to invest in "additional processing time at the Regional and Head Offices permitted a manual (i.e., pre-automated) collation of all non-resident farm operator agriculture and population schedules" (Shaw, 1979, p. 233) resulted in a failure-to-link ratio for Canada at just under 2 percent. This manual intervention was important because the location of the census-farm and the location of the household of the census-farm operator were different for 11 percent of census-farms in 1971. In these cases, one enumerator would enumerate the Census of Agriculture questionnaire in her "enumerator's area" and another enumerator would enumerate the Census of Population questionnaire in her "enumerator's area." Manual intervention ensured that the two appropriate questionnaires were linked. Specifically, during this step, the household number on the Census of Population questionnaire was transcribed to the Census of Agriculture questionnaire for census-farm operators who did not reside on their agricultural holding (Shaw, 1979, p. 234).

> *A matched record pair, containing the identification criteria for the household, now existed for each census-farm. The next step was the identity of the operator from among other persons in each household. A computer search, utilizing coding on the Population Questionnaire and the answers to specific questions from both questionnaires, identified each operator.*
> *The matched record pair, containing only the identification criteria for the household and operator, for each census-farm was "linked" into one record. Those linked records were used to produce index files on which the remaining stages of the programme were dependent. All characteristics from both questionnaires were now accessible from the separate Agriculture and Population data bases by using these index files in conjunction with a retrieval programme* (Statistics Canada, 1975a, 1975b, 1975c, 1975d, 1976a, 1976b 1976c).

In 1971,

> *there were 7,468 households in Canada with two or more operators. . . . Thus, two or more census-farms were matched to each multi-operator household – one farm for each operator – and each of these matches produced a separate linked record. Also, as there is only one operator per household, there cannot be more than one operator per family on the Agriculture-Population Linkage database. As a consequence, this methodology over-estimates some counts such as total households, total families and total persons* (Statistics Canada, 1975a, 1975b, 1975c, 1975d, 1976a, 1976b, 1976c).

The 7,468 multi-operator households are in the context of 366 thousand operators (and thus 366 thousand census-farms). Among the 7,468 multi-operator households in 1971, most (6,982 households) were 2 operator households (i.e. given that only one operator was identified for each census-farm, each operator in the household was operating a different census-farm). An additional 448 households had 3 operators and 38 households had 4 or more operators (i.e. the members in the household were operating 4 or more census-farms). The over-estimation of households, families and persons note above arose because the "census-farm" was chosen as the basic unit in the database and thus, if the operators of 2 (or more) census-farms resided in the same holding, the data for this household was replicated for each census-farm within the database.

The 1971 Agriculture-Population Linkage provided one of the first estimates of:

- the income from each source for the operator and for other members of the operator's household;
- the educational attainment of the operator and of other members of the operator's household;
- the major occupation stated by the operator and by other members of the operator's household.

Detailed tabulations were published in 7 bulletins (Statistics Canada, 1975a, 1975b, 1975c, 1975d, 1976a, 1976b, 1976c).

Shaw's 1979 monograph (Shaw, 1979) provided a detailed analysis of the family structure, mobility characteristics, educational characteristics, a classification of the occupation and main industry for the operator's "main" job plus details chapters on each of farm family income, a typology of low versus high income operators and determinants of farm performance.

Bollman's 1979 monograph (Bollman, 1979) estimated the inter-relationship between the off-farm work of the operator and various characteristics of the agricultural holding and the operator and the household.

Freeman (1976) presented some highlights of the main results arising from the 1971 Agriculture-Population Linkage database. These results were, essentially, the first data on these topics available to Canadian policy analysts.

One important contribution was the observation that operators on smaller holdings did not receive lower income from all sources (Appendix Table A1). The income from all sources for operators on the smallest agricultural holdings was larger than the income from all sources on the next two larger gross farm revenue groups.

Appendix Table A1

SIZE CLASS OF GROSS FARM REVENUE OF THE CENSUS-FARM	Average total income [1] of operators	Average net farm income of operators	Average total income of operators' families	Percent of operator income from net farm income	Percent of family income contributed by the operator
	1970 dollars			%	%
Under $2,500	4,628	298	6,977	6	66
$2,500 to 4,999	3,874	1,002	5,924	26	65
$5,000 to 9,999	4,187	1,772	5,958	42	70
$10,000 to 24,999	5,416	2,852	7,150	53	76
$25,000 to 34,999	7,428	4,171	9,411	56	79
$35,000 to 49,999	7,868	4,321	9,931	55	79
$50,000 and over	9,248	4,597	11,603	50	80
All census-farms	4,893	1,683	6,928	34	71

1. Total income refers to aggregate income received in 1970 from wages and salaries, net non-farm or farm self-employment, family and youth allowances, government old age pensions, other government payments, retirement pensions from previous employment, bond and deposit interest and dividends, other investment sources and other sources.

Source: Statistics Canada. Agriculture-Population Linkage database, 1971. Quoted in Freeman (1976).

Similarly, operators on smaller holdings when classified by the size of farm capital did not receive lower incomes from all sources (Appendix Table A2).

Appendix Table A2

Income of census-farm operators by size class of value of farm capital, Canada, 1970

TOTAL VALUE OF FARM CAPITAL (LAND AND BUILDINGS, MACHINERY AND LIVESTOCK)	Average total income [1] of operators	Average net farm income of operators	Percent of operator income from net farm income
	1970 dollars		%
Under $2,950	3,625	387	11
$2,950 to 7,449	3,672	467	13
$7,450 to 19,949	3,928	703	18
$19,950 to 74,949	4,602	1,464	32
$74,950 to 149,949	5,513	2,527	46
$149,950 and over	7,856	3,460	44
All census-farms	4,893	1,683	34

1. Total income refers to aggregate income received in 1970 from wages and salaries, net non-farm or farm self-employment, family and youth allowances, government old age pensions, other government payments, retirement pensions from previous employment, bond and deposit interest and dividends, other investment sources and other sources.

Source: Statistics Canada. Agriculture-Population Linkage database, 1971. Quoted in Freeman (1976)

Similarly, to reinforce the major point, operators associated with holdings with smaller land areas do not receive lower income from all sources (Appendix Table A3).

Appendix Table A3

Income of census-farm operators by size class of total area operated, Canada, 1970

SIZE CLASS OF TOTAL AREA OPERATED (ACRES)	Size class of total area operated (hectares)	Average total income [1] of operators	Average net farm income of operators	Percent of operator income from net farm income
		1970 dollars		%
1 to 9	Under 4.1	5,927	614	10
10 to 69	4.1 to 27	5,998	896	15
70 to 399	28 to 161	4,841	1,625	34
400 to 759	162 to 307	4,189	1,781	43
760 to 1,599	308 to 671	4,461	2,269	51
1,600 and over	672 and over	6,211	3,246	52
All census-farms	All census-farms	4,893	1,683	34

1. Total income refers to aggregate income received in 1970 from wages and salaries, net non-farm or farm self-employment, family and youth allowances, government old age pensions, other government payments, retirement pensions from previous employment, bond and deposit interest and dividends, other investment sources and other sources.

Source: Statistics Canada. Agriculture-Population Linkage database, 1971. Quoted in Freeman (1976).

Among operators with a university degree, total income is about double the average, but this is all due to non-farm income (from all sources) as net farm income is essentially zero (Appendix Table A4).

Appendix Table A4

Income of census-farm operators by level of of educational attainment of the operator, Canada, 1970

HIGHEST LEVEL OF EDUCATIONAL ATTAINMENT OF THE OPERATOR	Average total income [1] of operators	Average net farm income of operators	Percent of operator income from net farm income
	1970 dollars		%
Less than Grade 5	3,628	1,390	38
Grades 5 to 8	4,617	1,835	40
Grades 9 to 11	5,098	1,718	34
Grades 12 and 13	5,726	1,404	25
Some university	5,768	1,204	21
University degree	11,245	-100	-1
All census-farms	4,893	1,683	34

1. Total income refers to aggregate income received in 1970 from wages and salaries, net non-farm or farm self-employment, family and youth allowances, government old age pensions, other government payments, retirement pensions from previous employment, bond and deposit interest and dividends, other investment sources and other sources.

Source: Statistics Canada. Agriculture-Population Linkage database, 1971. Quoted in Freeman (1976).

Among operators with an occupation stated, 71 percent stated farming as their major occupation (Appendix Table A5). This varied from 41 percent in Newfoundland to 83 percent in Saskatchewan. Note that 336 thousand operators stated an occupation, out of 366 thousand operators. Some of the other 30 thousand operators would be retired.

Appendix Table A5

Number of operators of census-farms by major occupation, Canada and Provinces, 1971

PROVINCES	Major occupation of the farm operator [1]		Percent of operators with "farming" as the major occupation
	Farmer or farm manager	Other occupations	
	number of operators		%
Newfoundland	325	475	41
Prince Edward Island	2,740	1,280	68
Nova Scotia	2,755	2,535	52
New Brunswick	2,600	2,220	54
Quebec	36,890	15,560	70
Ontario	54,290	32,380	63
Manitoba	25,695	7,470	77
Saskatchewan	60,935	12,725	83
Alberta	44,485	14,935	75
British Columbia	7,175	8,650	45
Canada	237,890	98,230	71

1. An operator is the person responsible for the day-to-day decisions made in running a census farm, whether as an owner, tenant or hired manager. As only one person was listed for each farm holding, the number of operators is the same as the number of census farms. Where the holding was operated by more than one person, as in the case of partnerhips, only one of them was regarded as the operator.

Source: Statistics Canada. Agriculture-Population Linkage database, 1971. Quoted in Freeman (1976).

A smaller share of operators on smaller agricultural holdings reported farming as their major occupation (Appendix Table A6).

Appendix Table A6

Number of operators of census-farms by major occupation by size class of gross farm revenue, Canada, 1971

SIZE CLASS OF GROSS FARM REVENUE	Major occupation of the farm operator[1]		Percent of operators with "farming" as the major occupation
	Farmer or farm manager	Other occupations	
	number of operators		%
Under $2,500	37,260	55,215	40
$2,500 to 4,999	39,260	18,100	68
$5,000 to 9,999	63,725	13,895	82
$10,000 and over	97,645	11,025	90
Canada	237,890	98,235	71

1. An operator is the person responsible for the day-to-day decisions made in running a census farm, whether as an owner, tenant or hired manager. As only one person was listed for each farm holding, the number of operators is the same as the number of census farms. Where the holding was operated by more than one person, as in the case of partnerhips, only one of them was regarded as the operator.

Source: Statistics Canada. Agriculture-Population Linkage database, 1971. Quoted in Freeman (1976).

Operators with a higher level of educational attainment were less likely to report farming as their major occupation (Appendix Table A7).

Appendix Table A7

Number of operators of census-farms by major occupation by highest level of educational attainment, Canada, 1971

HIGHEST LEVEL OF EDUCATIONAL ATTAINMENT OF THE OPERATOR	Major occupation of the farm operator [1]		Percent of operators with "farming" as the major occupation
	Farmer or farm manager	Other occupations	
	number of operators		%
Less than Grade 5	18,990	6,135	76
Grades 5 to 8	123,365	44,665	73
Grades 9 to 11	68,725	29,790	70
Grades 12 and 13	18,960	11,230	63
Some university	6,140	3,275	65
University degree	1,720	3,130	35
Canada	237,900	98,225	71

1. An operator is the person responsible for the day-to-day decisions made in running a census farm, whether as an owner, tenant or hired manager. As only one person was listed for each farm holding, the number of operators is the same as the number of census farms. Where the holding was operated by more than one person, as in the case of partnerhips, only one of them was regarded as the operator.

Source: Statistics Canada. Agriculture-Population Linkage database, 1971. Quoted in Freeman (1976).

The methodology for the 2006 Agriculture-Population Linkage was essentially the same. The following is from the “notes” to the 2006 Agriculture-Population Linkage at http://www.statcan.gc.ca/pub/95-633-x/2007000/6500075-eng.htm (Statistics Canada, 2008c).

Automated matching process

The fundamentals of the Agriculture–Population automated matching process are simple. A farm operator completes a Census of Agriculture questionnaire as well as either a short or long Census of Population questionnaire, distributed to 80 percent and 20 percent of all households respectively. A unique household identifier is assigned to both the agriculture and population questionnaires when they are dropped off, and this identifier becomes the key for the match. Data from all successfully matched Census of Agriculture and long Census of Population questionnaires are linked to form the Agriculture–Population Linkage database. The 1991 to 2006 Censuses of Agriculture allowed respondents to report up to three operators per farm, and all farm operators were included in the matching process. With this additional information, the relationship between family members living in the same household and operating the same farm can be analyzed. As well, operators in different households operating the same farm can be included in the analysis (Statistics Canada, 2008c).

Sampling and weighting

As all questions on the short Census of Population questionnaire were also included on the long questionnaire, Census of Population data were collected either from 100 percent of the population or on a sample basis (i.e., from a random sample of one in five households). With the exception of data pertaining to very large agricultural operations and their operators, the data on the Agriculture–Population Linkage database must also be weighted up to compensate for sampling. The data associated with these very large agricultural operations and their operators were included on this database but excluded from the weighting procedure. If these operators of very large agricultural operations only received a short Census of Population questionnaire, their data for all supplementary questions contained on the long questionnaire were imputed using the responses of similar operators included in the 20 percent sample of households.

A method, known as the Generalized Least Squares Estimation Procedure, was used to calculate the weights. The weights were calculated independently in each of 206 geographic regions across Canada, defined as "weighting areas". Each weighting area represents between 1,700 and 8,000 persons from the farm population, and respects, as much as possible, the boundaries of census agricultural regions, census divisions and census consolidated subdivisions. As well, efforts were made to ensure the comparability of weighting areas between 1996, 2001 and 2006, while respecting these geographic boundaries. Characteristics referred to as "constraints" were also identified. These were agricultural and population characteristics of primary importance to data users for which data were already available on a 100 percent basis. In each weighting area, the Generalized Least Squares Estimation Procedure ensured that sample estimates of most of these constraints would be very close to the known population counts. The level of agreement depended on the scarcity of the constraints. Constraints common to many units had high agreement. Rare constraints had lower agreement. At the Canada level, half of the constraints had discrepancies between sample estimates and population counts less than 0.3 percent of the population count, 90 percent of the constraints had discrepancies less than 2.1 percent, and all constraints had discrepancies less than 5 percent. None of the largest constraints had discrepancies higher than 0.1 percent.

The Agriculture–Population database contains agricultural data (farm operations and farm operators) and population data (person, household, census family and economic family). For each of these components, weights have been calculated at the person level, household level, census family level and economic family level.

For any given geographic area, the weighted population, household, family or farm totals or subtotals may differ from that shown in previous releases containing Census of Agriculture data collected on a 100 percent basis. Such variation will be due to sampling. The discrepancies for variables used to define the constraints used in determining the generalized least squares weights were described above. The discrepancies for any variables highly correlated with at least one of the variables used to define a constraint will be similar to the discrepancy of that constraint. For other variables, discrepancies will depend on the relationship with the variable used to define a constraint, and could be large if no relationship exists (Statistics Canada, 2008c).

Matching errors

During the creation of the Agriculture–Population Linkage database, missing, incomplete, or incorrect operator identification information from either census has the potential to introduce errors into the matching process. As examples of false matches, the same operator on two different operations could be erroneously matched to two different persons, or two separate operators may be incorrectly linked to the same person on the Census of Population database. It may also occur that errors in operator identification could prevent some true matches from being made. The effects of these non-match situations are minimized through the use of imputation or weighting (Statistics Canada, 2008c).

Sampling errors

Sampling errors apply to all data relating to those questions on the long Census of Population questionnaires which were asked of only a one-fifth sample of households. These errors arise from the fact that the data for these questions, when weighted up to represent the entire population, inevitably differ somewhat from the results that would have been obtained if all households had been asked these questions. When variables relating to 100 percent of the population (either Census of Agriculture of Census or Population) are presented within the same table as variables relating to a 20 percent sample, all figures in this table will necessarily be sample estimates and therefore subject to sampling error.

The potential error introduced by sampling will vary according to the relative scarcity of the characteristic in the population. For large values, the potential error due to sampling, as a proportion of the total value will be relatively small. For small values, this potential error will be relatively large. The potential error due to sampling is usually expressed by the "standard error". Every population has an associated standard deviation, which is given as the square root of the average squared deviation of all population values about their mean. The standard error is an estimate of the population standard deviation corrected for the size of the sample relative to the size of the population.

Appendix Table A8 provides approximate measures of the standard error due to sampling based on the size of the data table cell values. They are intended as a general guide only. Note that these measures should not be used directly for estimates associated with averages of population, family or farm data (e.g., average size of census family).

Appendix Table A8 - Approximate standard error due to sampling for 2006 Agriculture–Population linkage data

50 or less	15
100	20
200	30
500	45
1,000	60
2,000	85
5,000	130
10,000	180
20,000	255
50,000	400
100,000	555
200,000	775
500,000	1,205
1,000,000	1,685

Users wishing to determine the approximate error due to sampling, based upon the Agriculture-Population Linkage, should choose the standard error corresponding to the value that is closest to that given in a particular Agriculture-Population Linkage table. With 95 percent certainty (i.e., 19 times out of 20), an interval constructed from the tabulated value plus or minus two times its standard error will contain the true value for the enumerated population (discounting all forms of error other than sampling). As an example using the approximate standard errors above, the user can be reasonably certain that for a value of 1,000, the range of 1,000 ± (2 x 60) or 1,000 ± 120, will include the true value of the characteristic being tabulated.

The effect of the particular sample design and weighting procedure used in the 2006 Census will vary, however, from one characteristic to another and from one geographic area to another. Therefore, the standard error values in the table may understate or overstate the error due to sampling (Statistics Canada, 2008c) (See also Statistics Canada, 2003).

Appendix B

Selected studies based, in whole or in part, on the Agriculture-Population Linkage database

Forthcoming

Levasseur, Sandrine (forthcoming). "Industry and occupation: the nature of the linkages between the farming households and the non-farm sector in Canada". *Rural and Small Town Canada Analysis Bulletin* (Ottawa: Statistics Canada, Catalogue no. 21-006-XIE). (www.statcan.gc.ca/bsolc/english/bsolc?catno=21-006-X&CHROPG=1).

2009

Alasia, Alessandro and Ray D. Bollman. (2009). "Off-Farm Work by Farmers: The Importance of Rural Labour Markets." Rural and Small Town Canada Analysis Bulletin Vol. 8, No. 1 (Ottawa: Statistics Canada, Catalogue no. 21-006-XIE). (http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=21-006-X&CHROPG=1&lang=eng)

2008

Alessandro Alasia, Alfons Weersink, Ray D. Bollman, John Cranfield (2008). "Off-farm labour decision of Canadian farm operators: Urbanization effects and rural labour market linkages." *Journal of Rural Studies* 25, pp. 12-24. (http://dx.doi.org/10.1016/j.jrurstud.2008.04.002)

Bollman, Ray D. (2008) *Where is Agriculture Important to Canada's Rural Economy?* Presentation to the symposium on "Growing Canada's Rural Economies: Toward an economic renaissance in agri-food and other sectors" organized by the Canadian Agri-Food Policy Institute, Winnipeg, February 28.

2007

Alasia, Alessandro, Ray D. Bollman, Alfons Weersink and John Cranfield. (2007) *Off-farm Labour Decisions of Canadian Farm Operators in 2001: The Role of Operator, Farm, Community and Regional Determinants.* (Ottawa: Statistics Canada, Agriculture and Rural Working Paper No. 85, Catalogue no. 21-601-MIE) (www.statcan.gc.ca/cgi-bin/downpub/listpub.cgi?catno=21-601-MIE).

Bollman, Ray D. (2007) *Manitoba's Agriculture Sector and its Rural Context.* Presentation to the Manitoba Chapter of the Canadian Agri-Marketing Association, Winnipeg, September 18.

Bollman, Ray D. (2007) *Key Features of Saskatchewan Agriculture*. Presentation prepared for Saskatchewan Agriculture and Food, Regina, October 23.

2006

Bollman, Ray D. and Sylvie Michaud. (2006) *Portraying Rural Canada*: Presentation to the Senate Standing Committee on Agriculture and Forestry (October 5). Webcast can be viewed at

2005

Bollman, Ray D. (2005) *Key Features of Prince Edward Island Agriculture*. Presentation to the Prince Edward Island Federation of Agriculture, Charlottetown, January 27.

2004

Bollman, Ray D. (2004). *The Aging Farmer: Opportunities and Consequences*. Presentation to the Alberta Young Farmer Forum 2004 Seminar, Red Deer, January 7.

Normand, Frédéric G. (2004)) "They're here to farm." *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-328).

2003

Statistics Canada. (2003) *Farm population: bucking the trend in a country shaped by immigrants* (Ottawa: Statistics Canada, Highlights of the 2001 Agriculture-Population Linkage). (www.statcan.gc.ca/english/agcensus2001/first/socio/immigration.htm)

2001
Silver, Cynthia. (2001) "From sun-up to sundown: Work patterns of farming couples." *Canadian Social Trends* (Ottawa: Statistics Canada, Catalogue no. 11-008, Summer), pp. 12-15.

2000
Statistics Canada. (2000) *Farming Facts: 1999* (Ottawa: Statistics Canada, Catalogue no. 21-522) (http://dsp-psd.tpsgc.gc.ca/Collection/Statcan/21-522-X/21-522-XIE1999001.pdf)

1999
Lonmo, Charlene. (1999) "Farming is going Dutch." *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-325), pp. 297-302.
Statistics Canada. (1999). *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-325).

1998
Boyd, Stephen. (1998) *Hobby Farming – For Pleasure or Profit?* (Ottawa: Statistics Canada, Agriculture Division, Working Paper No. 33) (www.statcan.gc.ca/cgi-bin/downpub/listpub.cgi?catno=21-601-mie).

1995
Harrison, Rick and Sylvain Cloutier. (1995) *People in Canadian Agriculture* (Ottawa: Statistics Canada, Catalogue no. 21-523).

1994
Cloutier, Sylvain. (1994) "Who Operates Canadian Farms?" In *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-301), pp. 32-34.
Couillard, Anne. (1994) "Census Recognizes Female Farm Operators?" In *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-301), pp. 40-43.
Harrison, Rick. (1994) "Farmers in the Nineties – A Comparison of Primary and Secondary Farmers." In *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-301), pp. 21-25.
Harrison, Rick. (1994) "Hardworking Farmers – Do the Numbers Agree?" In *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-301), pp. 29-31.
Kemp, Lynda. (1994) "The Canadian Farm Family – More Like the Family Next Door!" In *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-301), pp. 62-65.
Perrault, Estelle. (1994) "Farm Women and the Census – Everyone Counts!" In *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-301), pp. 58-61.
Statistics Canada. (1994) *Canadian Agriculture at a Glance* (Ottawa: Statistics Canada, Catalogue no. 96-301).
Wilson, Norm. (1994) "The Ethnic Composition of Canadian Farm Operators." In **Canadian Agriculture at a Glance** (Ottawa: Statistics Canada, Catalogue no. 96-301), pp. 54-57.

1992

Ehrensaft, Philip and Ray D. Bollman. (1992) *The Microdynamics and Farm Family Economics of Structural Change in Agriculture* (Ottawa: Statistics Canada, Agriculture Division, Working Paper No. 16) (www.statcan.gc.ca/cgi-bin/downpub/listpub.cgi?catno=21-601-mie).
Fuller, A. M. (Tony) and Ray D. Bollman. (1992) "Farm Family Linkages to the Non-farm Sector: The Role of Off-Farm Income of Farm Families." Chapter 11 in Ray D. Bollman (ed.). *Rural and Small Town Canada* (Toronto: Thompson Educational Publishing).

1991
Bollman, Ray D. (1991). "Efficiency Aspects of Part-time Farming." In M. C. Hallberg, Jill L. Findeis and Daniel A. Lass (ed.). *Multiple Jobholding among Farm Families* (Ames: Iowa State University Press), pp. 112-139.

1990

Beyrouti, M, and Marcelle Dion. (1990) *Canada's Farm Population* (Ottawa: Statistics Canada, Catalogue no. 98-133)

Bollman, Ray D. and Philip Ehrensaft. (1990) "The Microdynamics and Farm Family Economics of Structural Change in Agriculture." *1990 Annual Research Conference*: *Proceedings* (Washington, D.C.: U.S. Department of Commerce, Bureau of the Census, August, 1990), pp. 85 - 126.
Also published as *The Microdynamics and Farm Family Economics of Structural Change in Agriculture* (Ottawa: Statistics Canada, Agriculture Division, Working Paper No. 16, 1992).

1989

Beyrouti, M., M. Dion and S. Welsh. (1989) *Socio-economic Characteristics of the Farm Population.* (Ottawa: Statistics Canada, 1986 Census of Canada, Catalogue no. 96-114).

Bollman, Ray D. (1989), "Who Receives Farm Government Payments?" *Canadian Journal of Agricultural Economics*, Vol. 37, No. 3 (November), pp. 351-378.

1988

Bollman, Ray D., Pamela Smith and Monica Tomiak (1988), "Farm Financial Stress and the Ability of a Farm to Sustain a Family," Paper presented to the VII World Congress for Rural Sociology, Bologna, Italy, June.

Ehrensaft, Philip and Ray D Bollman (1988), "The Diversity of Farm Income Patterns in a Changing World System," in Peter Finkle and Duncan Cameron (ed.), *Decoupling: The Concept and Its Future in Canada* (Ottawa: Canadian Institute of Resources Law for Agriculture Canada), pp. 19-44.

1987

Smith, Pamela (1987) "What Lies Within and Behind the Statistics? Trying to Measure Women's Contribution to Canadian Agriculture." In *Growing Strong: Women in Agriculture* (Ottawa: Canadian Advisory Council on the Status of Women, November), pp. 123-208.

1986

Bollman, Ray D. and Pamela Smith (1986), "Integration of Canadian Farm and Off-farm Markets and the Off-farm Work of Farm Women, Men, and Children", Paper presented to the 1986 Meetings of the European Society for Rural Sociology, Braga, Portugal.
Published as Research Paper No. 16, Analytic Studies Branch, Statistics Canada, 1988).
Published as Chapter 15 in G. S. Basran and David A. Hay (1988), *The Political Economy of Agriculture in Western Canada* (Toronto: Garamond Press), pp. 185-202.

1985

Clemenson, Heather A. and Ray D. Bollman (1985), "A Profile of Managers of Agricultural Resources", Paper presented to the International Conference `Management of Rural Resources: Problems and Policies', University of Guelph, July 14-20.
Published as "Les agriculteurs canadiens des annees 1980", *Cahiers de recherche sociologique*, Vol. 5, No. 1 (Printemps, 1987), pp. 79-102.

1984

Ehrensaft, Philip, Pierre LaRamee, Ray D. Bollman and Frederick H. Buttel (1984), "The Microdynamics of Farm Structural Change in North America: The Canadian Experience and Canada-USA Comparisons", *American Journal of Agricultural* **Economics**, Vol. 66, No. 5 (December) pp. 823-828.
See also Ehrensaft, Philip, Pierre LaRamee, Ray D. Bollman and Frederick H. Buttel (1985), *The Microdynamics of Farm Structural Change in North America: The Canadian Experience and Canada-USA Comparisons* (Ithaca, New York: Cornell University, Department of Rural Sociology, Bulletin No. 142, March).

Steeves, Allan D. (1980) "The Dissociation of Occupation and Residence: a Study of Multiple Job-Holding Among Canadian Farm Operators." *Canadian Review of Sociology and Anthropology* Vol. 17.

1979

Bollman, Ray D. (1979), *Off-farm Work by Farmers* (Ottawa: Census Analytic Study, Statistics Canada, Catalogue No. 99-756).

Furtan. W. H. and Ray D. Bollman (1979), "Returns to Operator Education in Saskatchewan", *American Journal of Agricultural Economics*, Vol. 61, Number 2 (May), pp. 318-321.

Shaw, Paul (1979) *Canada's Farm Population: Analysis of Income and Related Characteristics* (Ottawa: Statistics Canada, Census Analytic Study, Catalogue no. 99-750).

1978

Bollman, Ray D. (1978), *Off-farm Work by Farmers: A Study with a Kinked Demand for Labour Curve*, Unpublished PhD. thesis, University of Toronto.

1976

Freeman, Wilson. (1976) "An Introduction to the Agriculture-Population Linkage Program." *Canadian Farm Economics* Vol. 11, No. 1 (Ottawa: Agriculture Canada), pp. 9 – 16.

Statistics Canada. (1976) *Cross-classified Socio-economic Characteristics of Farm Operators' Households: Canada and Provinces* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 5 (Bulletin 4.5 – 2), Catalogue no. 96-716).

Statistics Canada. (1976) *Cross-classified Socio-economic Characteristics of Farm Operators' Dwelling Facilities: Canada* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 5 (Bulletin 4.5 – 3), Catalogue no. 96-717).

Statistics Canada. (197?) *Farm Operators by Economic Class showing such characteristics as Sex, Age, Income, Schooling and Off-farm Employment* (Ottawa: Statistics Canada, 1971 Census of Canada, Catalogue no. 96-734).

1975

Shaw, R.P. (1975) "A Performance Note on Canada's 1971 Ag-Pop Linkage." *Socio-Economic Planning Sciences* Vol. 9, pp. 96-98.

Statistics Canada. (1975) *Basic Socio-economic Characteristics of Farm Operators: Canada and Provinces* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 4 (Bulletin 4.4 – 1), Catalogue no. 96-712)

Statistics Canada. (1975) *Cross-classified Socio-economic Characteristics of Farm* **Operators** (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 4 (Bulletin 4.4 – 2), Catalogue no. 96-713).

Statistics Canada. (1975) *Cross-classified Socio-economic Characteristics of Farm Operators with Off-farm Employment and Income: Canada, the Provinces and the Regions* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 4 (Bulletin 4.4 – 3), Catalogue no. 96-714).

Statistics Canada. (1975) *Cross-classified Socio-economic Characteristics of Farm Operators' Families: Canada and Provinces* (Ottawa: Statistics Canada, 1971 Census of Canada, Vol IV – Part 5 (Bulletin 4.5 – 1), Catalogue no. 96-715).

1973

Scott, J.F. (1973). "Providing for the Linkage of the 1971 Censuses of Agriculture and Population of Canada." *Socio-Economic Planning Sciences* Vol. 7, pp. 523-531.

1971

Shaw, R. P. (1971) "A Record Linkage System as a Means to Extensive Socio-Economic Farm Population Data: 1971 Census of Canada." *Socio-Economic Planning Sciences* Vol. 5, pp. 221 – 230.

Measuring Socially and Economically Sustainable Rural Communities - a Policy based Approach

Pippa Gibson
Defra, York,
pippa.gibson@defra.gsi.gov.uk

***Abstract**: England's Department for Environment, Food and Rural Affairs has taken a place-based – rather than land use based – approach to rural policy since it published its Rural Strategy in 2004. This approach is captured in its indicator set measuring Defra's objective to support 'socially and economically sustainable rural communities'. The objective has two components: one on mainstream policy areas and one on economic performance. The first reflects a wide range of policy areas from other government departments, ranging from education and health to poverty and housing affordability. The second focuses on productivity, supported by a range of indicators from earnings and employment to investment and enterprise. The indicators are updated twice yearly, and measure the relative position of rural areas to the national (English) average.*
This paper will first review Defra's population based approach to defining rural areas and its new methodology for classifying the rurality of different administrative areas. It will then summarise the indicators chosen to evaluate its objective for sustainable rural communities and discuss the reasons for their selection and criteria for measuring success.

Keywords: rural definition, rural policy, indicators

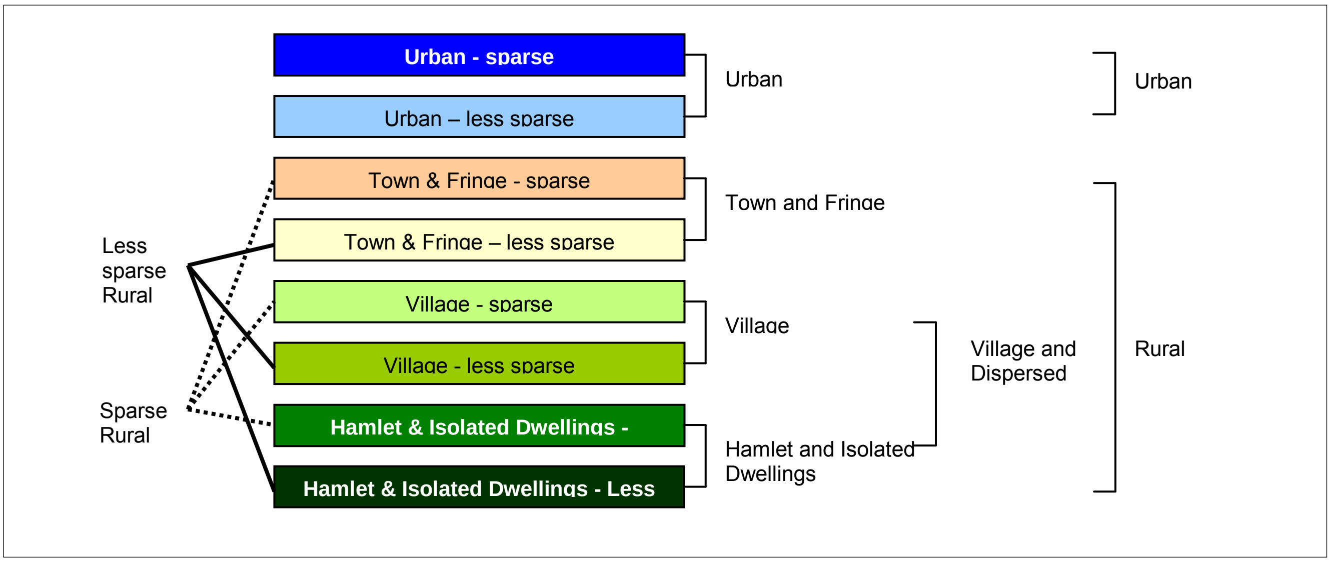
1. Introduction

England's Department for Environment, Food and Rural Affairs (Defra) aims, as one of its key strategic objectives, to support *Socially and Economically Sustainable Rural Communities*. Measuring such an objective not only demands a robust and fit-for-purpose system of classifying rural and urban areas, but also a set of indicators which are successful in encapsulating 'sustainable rural communities'. This paper will first outline Defra's approach to defining rural areas, and then summarise the indicator set chosen to evaluate the objective alongside the reasons for their selection. Finally, I will discuss how Defra measures the success of this rural objective.

2. Defining rural and urban areas

Defra takes a place-based – rather than land use based – approach to rural policy. Rural areas are identified using the Rural-Urban definition, based on hectare grid squares and postcode information from data from Census 2001. Both the morphology of a settlement and its context are taken into account in this definition. On morphology, settlements are defined as being urban if their populations are over 10,000 at Census 2001. If the population is less than 10,000, the settlement is defined as rural. These rural settlements are then separated into three settlement types: town and fringe; villages; and hamlets and isolated dwellings. The context of settlements is dependent on whether the wider area is defined as being 'sparsely' populated or not. The advantage of this eight-way definition is that it can be aggregated differently according to policy need – for example, by grouping all sparse rural areas and all less sparse rural areas – and according to analytical need, such as if there are not enough data points on which to base estimates at the very lowest level. Figure 1 illustrates the structure of the Definition.

Figure 1 - Structure of the Rural-Urban Definition

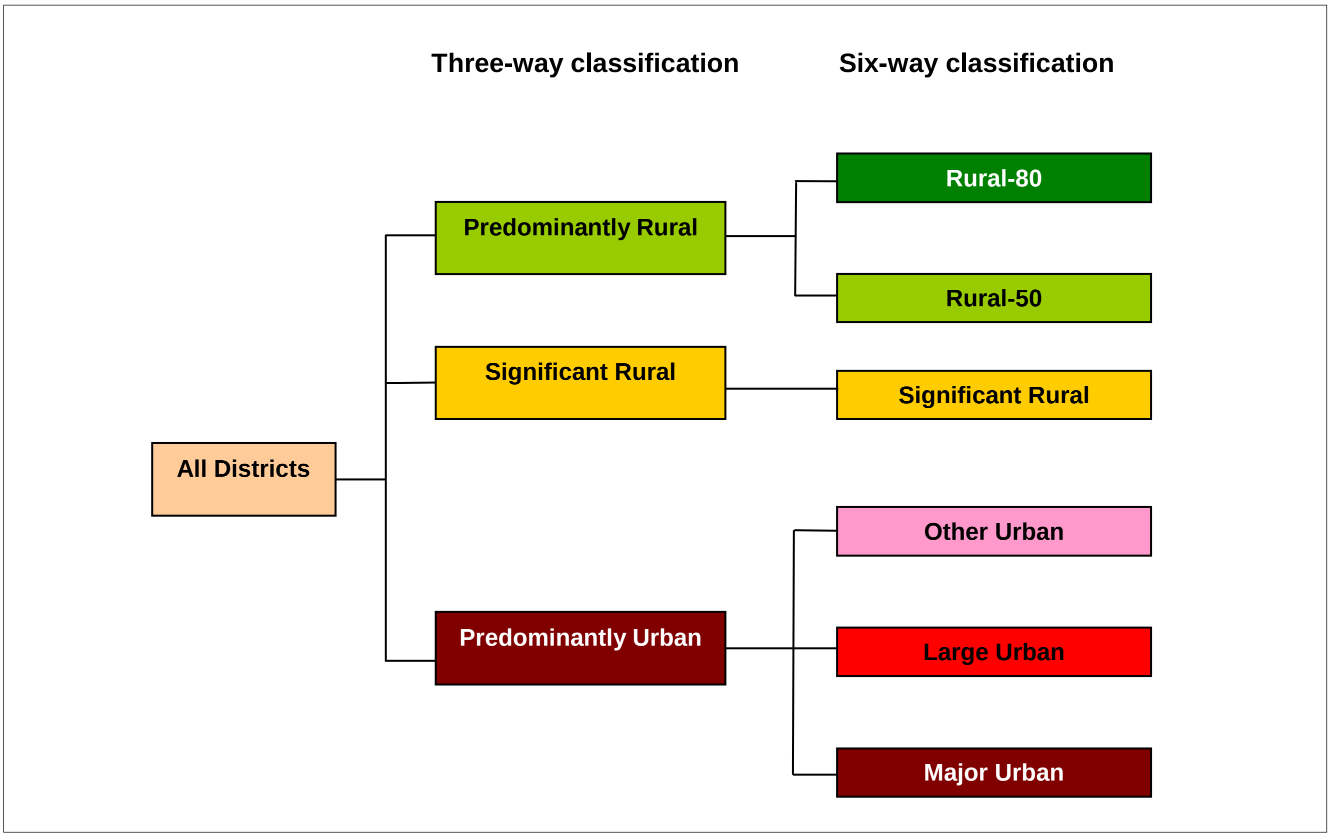


When data is not available at this very low level, Defra has developed a rural-urban classification based on the Rural-Urban Definition that can be applied to local authorities, which are equivalent in geography to NUTS4 statistical regions. This methodology is based on the rural-urban definition, and categorises areas on a six-point scale urban to rural based on the number of people living in large urban conurbations and the proportion of people living in rural areas:

- Major urban (MU) – districts with either 100,000 people or 50 per cent of their population living in urban areas with a population of more than 750,000.
- Large urban (LU) – districts with either 50,000 people or 50 per cent of their population living in one of 17 urban areas with a population between 250,000 and 750,000.
- Other urban (OU) – districts with less than 26 per cent of their population living in rural settlements and larger market towns.
- Significant rural (SR) – districts with more than 26 per cent of their population living in rural settlements and larger market towns.
- Rural-50 (R50) – districts with at least 50 per cent but less than 80 per cent of their population living in rural settlements and larger market towns.
- Rural-80 (R80) – districts with at least 80 per cent of their population living in rural settlements and larger market towns.

Figure 2 shows how the Rural-Urban Classification can be aggregated. More information on England's approach for defining rural areas can be found at http://www.defra.gov.uk/rural/ruralstats/rural-definition.htm.

Figure 2 - Structure of the local authority classification



These classifications mean that local-level data published by other government departments can almost always be subject to a rural-urban breakdown. Furthermore, the methodology underpinning this classification can also be applied to other geographies for which population data exists. This is useful when data are only available for certain geographies – for example, administrative areas for National Health Services, or NUTS3 statistical areas.

3. Measuring 'socially and economically sustainable rural communities'

In assessing the strategic objective for *Socially and Economically Sustainable Rural Communities*, Defra is required to report on both 'mainstream' and economic policy outcomes. The former, 'The evidenced needs of rural people and communities are addressed through mainstream public policy and delivery', relates to whether policy from across Government is reaching people in both rural and urban areas. The social and economic outcomes sought by Government apply equally to all areas, whether they are urban or rural. 'Mainstreaming' rural policy means ensuring that the policies and processes developed to deliver Government's desired outcomes are designed effectively to meet the needs of people living throughout the country. We can assess the performance of Government policies in rural areas by comparing outcomes and trends in rural areas to the national picture. This objective underlines that the responsibility for meeting the needs of rural people and places falls not to Defra but to all Government departments; for example, rural transport is fundamentally the responsibility of the Department for Transport. The latter, 'Economic growth is supported in rural areas with the lowest levels of performance', relates to the relative economic performance of rural areas. This objective also reflects the 'mainstreaming' agenda as the responsibility for economic growth falls to the Department for Business, Innovation and Skills (BIS).

Both sets of indicators have been selected to broadly reflect Government policy. However, as discussed above, in order to measure any indicator on a rural-urban basis, data must be available at a reasonably low spatial level, ideally allowing the application of the very fine-grained Rural-Urban Definition. Usually this means that data must come with detailed geographical information (for example postcode information or similar for surveys) and have a sufficient sample size for the smaller rural categories. Alternatively categories of the Definition can be merged as per Figure 1 above; for example, data can be aggregated to urban, sparse rural and less sparse rural, avoiding some of the problems associated with small sample sizes from survey data such as lack of robustness or confidentiality issues. If this is not a possibility, the higher level geographic information for districts (NUTS4) can be used to apply the classification. Defra does not collect its own rural (non-agricultural) statistics, instead re-analysing and applying rural definitions to data from other Government departments.

In previous years the indicators selected to measure Defra's targets were established from the top down, meaning that the policy areas to monitor were selected before consideration was made of the sources of data to populate them. As a result many of the previous set of indicators for the period 2004-2008 remained unpopulated with data throughout the reporting period. For the current set of indicators, therefore, a combined top-down and bottom-up approach was taken. First, we identified broad policy areas to monitor, based on priority areas relating to social exclusion challenges and a national long-list of indicators for all local authorities in England. Within these policy areas the individual indicators were established based on what it was possible to measure at a rural-urban level.

3.1 Mainstreaming objective

The broad policy areas included in the 'mainstreaming' objective are education, health, housing affordability, poverty and unemployment, crime and social capital/quality of life. Using these as a starting point data sources reflecting the broad themes of these areas were identified, and incorporated into an indicator set. For example, the education indicators are based on targets for the Department for Children, Schools and Families (DCSF). The objective for "all young people to reach age 19 ready for skilled employment or higher education" relates to building a skilled workforce to improve national wealth and reducing poverty and deprivation. There are a wide range of indicators that could be used to measure this objective – for example, educational attainment, the proportion of children from low-income families staying in education to aged 18, or the number of over-16s not in education, employment or training. However of these, data are available at a rural-urban level to support two broad areas: educational attainment at school-leaving age (16) and the number of 18-20 year olds entering full-time higher education. These two indicators do not give a complete picture of everything the DCSF target aims to measure – and indeed, an indicator set that did reflect all of the Department's policy objectives would be unwieldy – but rather provide an indication of how rural outcomes differ (or otherwise) to the national (English) average.

3.2 Economic growth objective

For the economic objective, a headline indicator of Gross Value added (GVA) per job is supported by a range of economic indicators. In addition to employment rates and earnings data, these attempt to broadly reflect HM Treasury's five drivers of productivity: skills, investment, innovation, competition and enterprise. Unlike with the majority of the mainstreaming indicators, Defra has specifically developed the headline indicator alongside the Office for National Statistics. The data to support this is not publicly available at the district level but it was important to Defra that the indicator accurately reflected the official methodology of measuring sub-national productivity. It is less easy to measure this objective because of the fluid nature of local economies, and for the supporting indicators, the innovation and competition indicators are yet to be populated.

3.3 Measuring success

Success on the indicators supporting the *Socially and Economically Sustainable Rural Communities* objective is measured by comparing rural areas to the national average. However, the aim is not for rural areas to achieve better outcomes than urban areas or the national average – just for rural areas not to perform below the national average. Therefore, if the predominantly rural categories are performing equally to or above the national average, this is measured as a success. When assessing each indicator's success we look at the rural average against the norm both for the current year (or latest year available) and against the trajectory for England and for rural areas over the previous years. Each indicator is measured using a traffic light system of green, amber-green, amber-red and red. The underlying principles are summarised in Annex 1.

Defra has no direct levers over the mainstream policy areas that the DSO monitors. Government aims to achieve positive outcomes for these indicators regardless of location, be it rural or urban. As a result of this, as well as lessons learnt from previous experience measuring indicators which set targets that were unrealistic for Defra as a department to achieve, the current suite of indicators set no specific targets for Defra to achieve in rural areas.

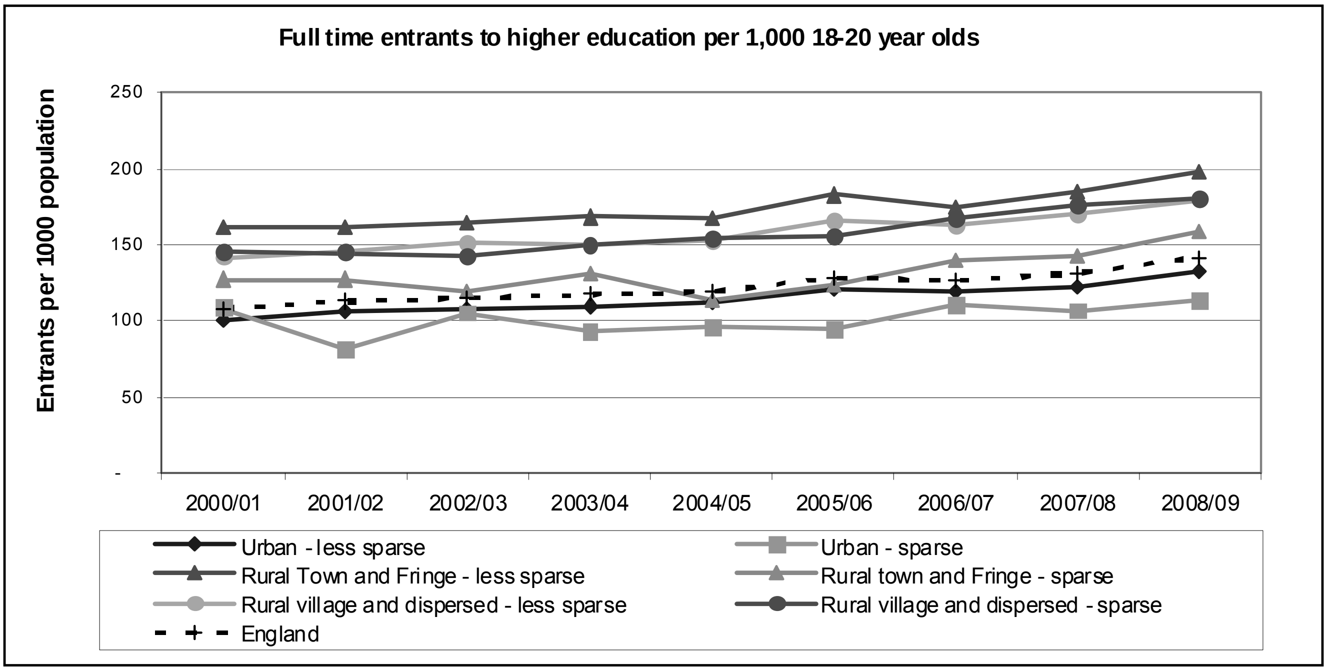
4. Results

This section summarises results from three of the indicators: for the mainstreaming objective, an indicator supporting the education sub-theme and one supporting the affordable housing sub-theme, and for the economic growth objective the headline indicator for productivity.

4.1 Education

For education, data are available at a low enough spatial level to use the Rural-Urban definition. Statistics on the number of full-time entrants to higher education are obtained by ward (roughly equivalent to NUTS5) and aggregated to the Definition, merging the two smallest settlement types (village and hamlet/isolated dwellings). The data show that generally, a higher proportion of 18-20 year olds in rural areas go into higher education than the England average and urban areas (Figure 3).

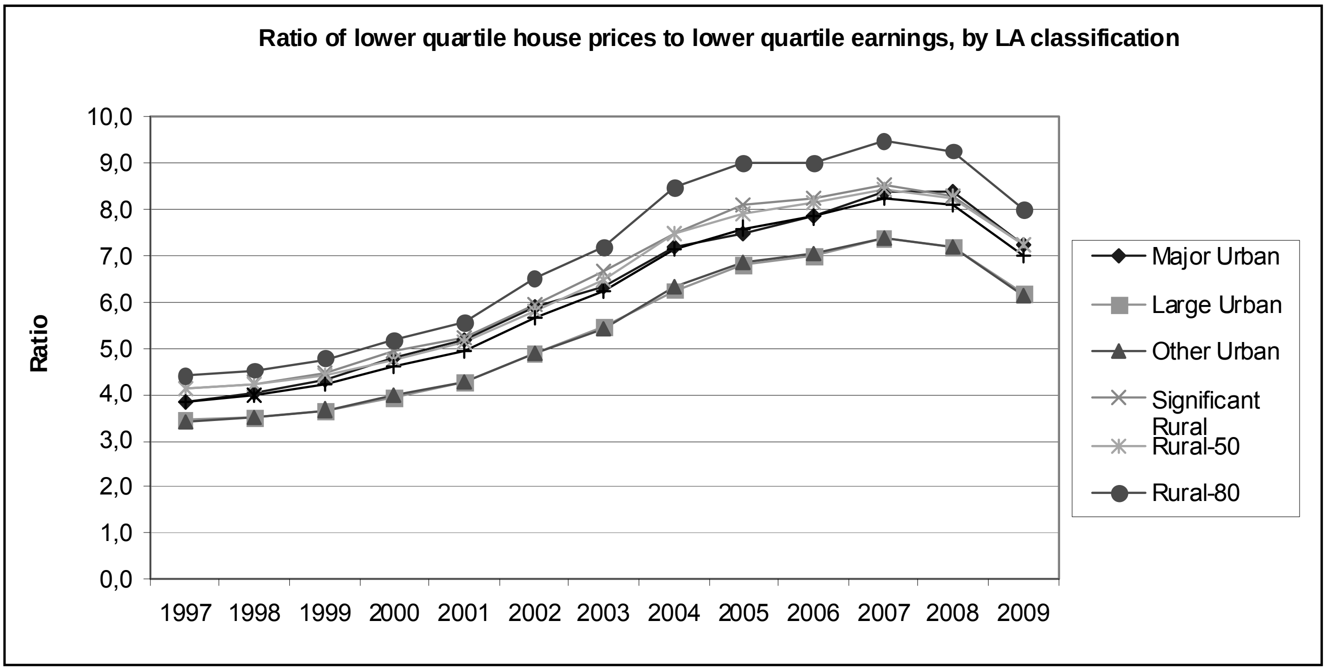
Figure 3 - Full-time entrants to higher education, by Rural-Urban Definition



4.2 Housing affordability

The data to support the indicator on housing affordability obtained from the Department for Communities and Local Government and aggregated to the local authority classification. This data shows the ratio of lower quartile earnings to lower quartile house prices, by local authority, and is an established methodology of assessing the affordability of houses by area. The data are then aggregated to the local authority classification. We then present the six categories of the classification and the England average on a graph (Figure 4). This shows that housing is less affordable in rural areas than in England overall. The average lower quartile house price in Rural-80 areas is around eight times the average lower-quartile earnings, whereas in England overall the ratio is around seven.

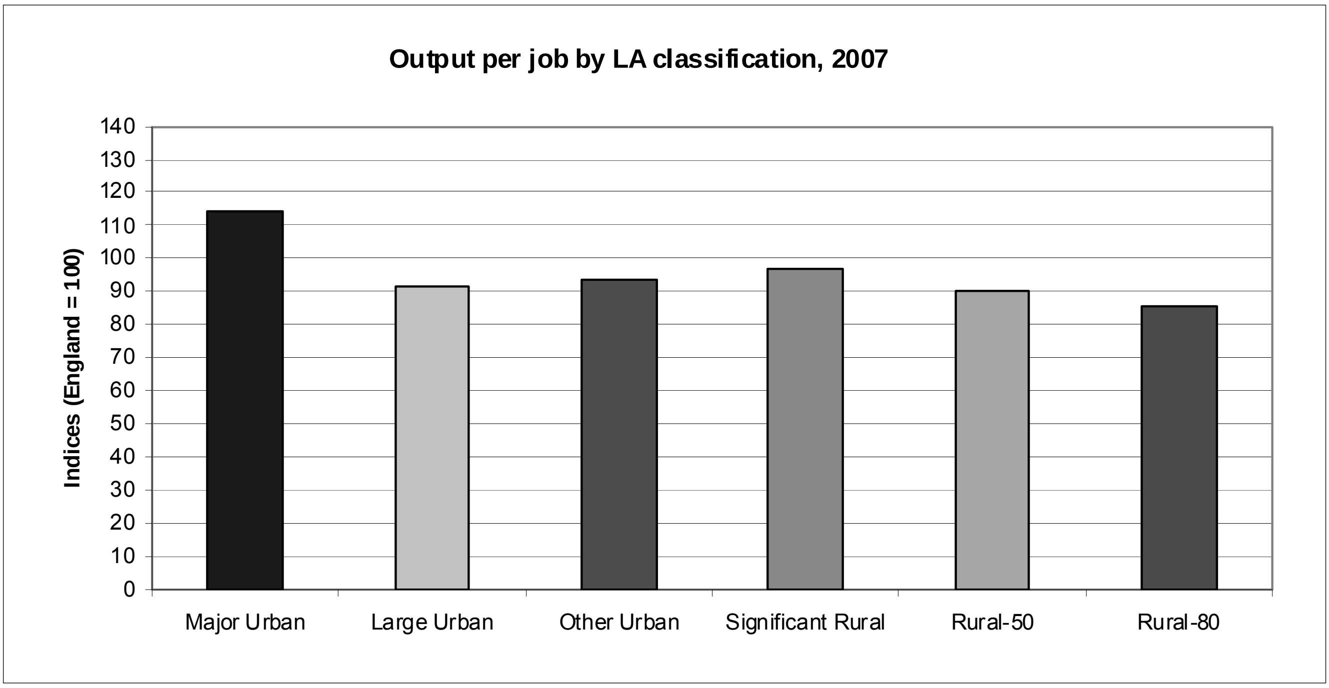
Figure 4 - Housing affordability by rural-urban classification



4.3 Productivity

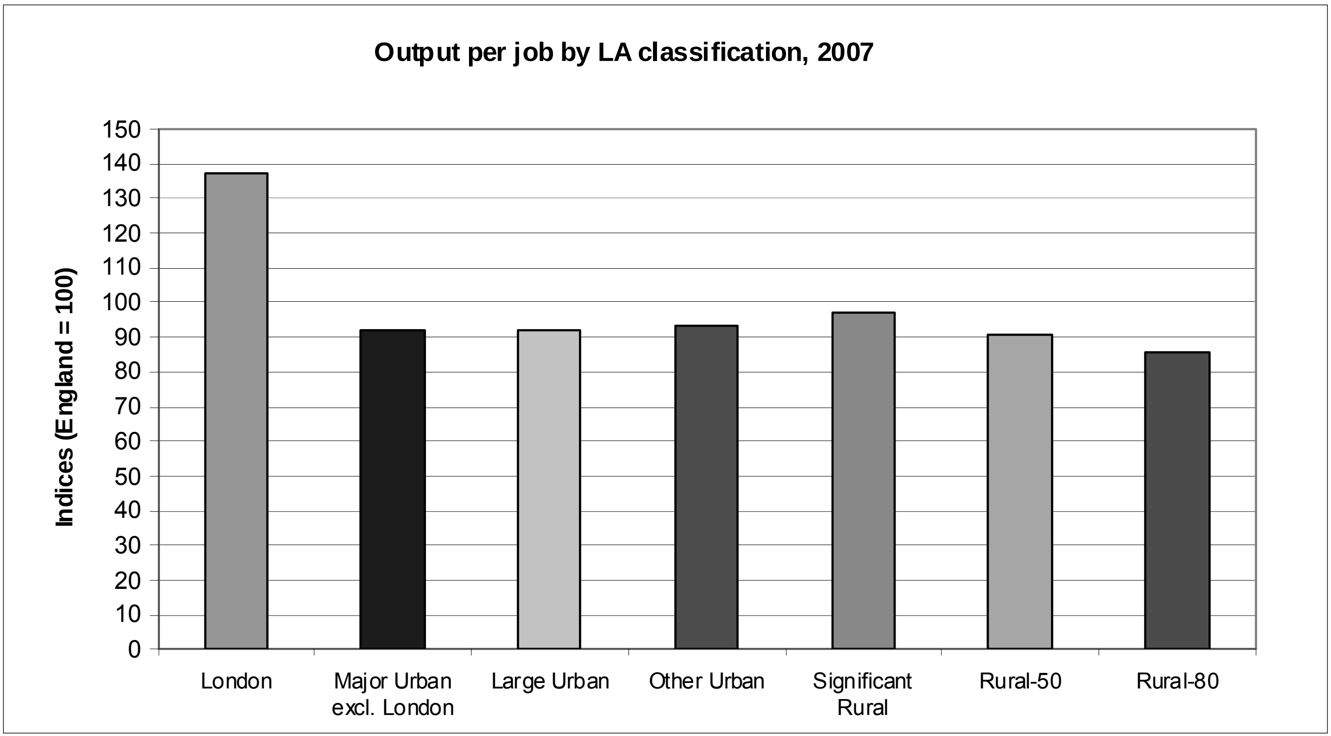
To measure productivity, data for Gross Value Added (the output measure) and the total number of workforce jobs (the input measure) are obtained by local authority district, and aggregated to the rural-urban classification for England. Output per job is then calculated for each category of the classification and indexed so that England=100. Results show that Major Urban areas have higher productivity than the other categories, with Rural-80 areas the least productive (Figure 5).

Figure 5 - Productivity by rural-urban classification



However a more sophisticated analysis, separating London from the other Major Urban districts, shows that it is more of a 'London effect' that influences the disparity in productivity than a rural-urban divide (Figure 6).

Figure 6 - Productivity by rural-urban classification, London extracted from Major Urban category



More information on the full range of indicators can be obtained via http://www.defra.gov.uk/rural/dso/index.htm.

5. Measuring success

Although Defra does not have any policy levers over the outcomes of these areas directly, the evidence helps us to prioritise our activity to ensure that we are focused on those issues where there is greatest evidence of need. It will also provide the basis for a further programme of analysis and investigation; looking beneath the high-level information captured by the DSO exploring evidence gaps and outstanding questions and testing our assumptions.

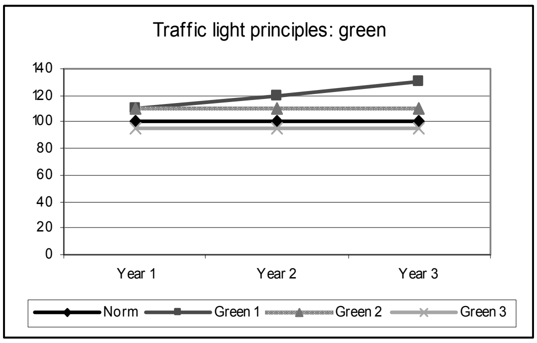
Where there are clearly differences between rural areas and the national average which put rural areas at a disadvantage (such as for affordable housing), Defra's role is in influencing the relevant Department to engage with the issue at hand and to ensure that the impacts of their policy are distributed equitably in all areas, be they rural or urban. Where the aggregated averages for rural areas are suspected to mask localised disadvantage (for example if they contradict other evidence), proactive research can be carried out. In the case of housing affordability, for example, a current research project is investigating what the economic drivers behind higher rural house prices are, and what impact this has on the people living (or hoping to live) there. Again, the outcomes of these research projects are shared with the lead department for the policy area in question.

6. Conclusion

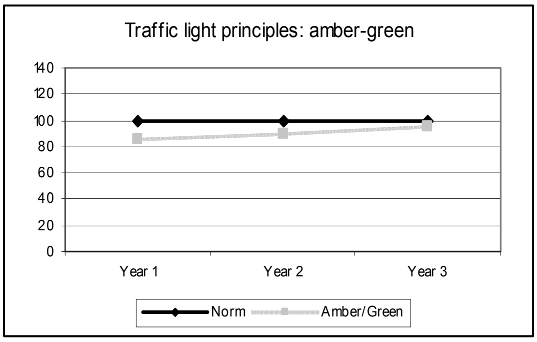
There is no single indicator to evaluate *Socially and Economically Sustainable Rural Communities* and nor is there a set of measures that accounts for every aspect of rural life. However it is possible to monitor a set of national policies to ensure that the outcomes are distributed equitably in all areas, be they urban or rural. The advantage of using a place-based definition of rurality, rather than one based on land use, is that the impacts of a wide range of Government policies in rural and urban places can be assessed with no underlying assumptions about the economic or social structure of the area. The result of this is a sound evidence base that allows Defra to focus its activity on those issues where there is greatest indication of need.

Annex 1 - Measuring success using traffic light principles

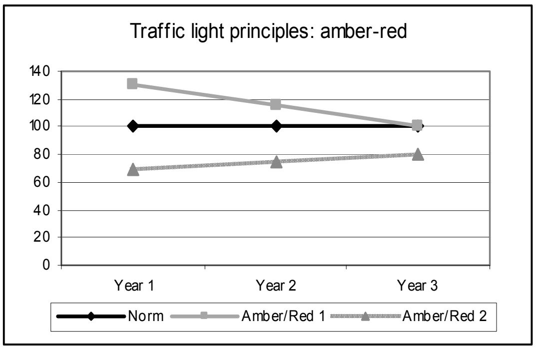
The graphs below demonstrate the methodology behind each type of traffic light. The norm represents the England average and is, for the purpose of illustrating the principles, set at 100.



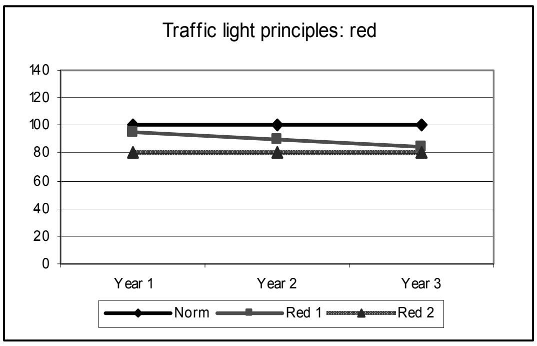
Green 1 and 2: An indicator where rural areas perform above or equal to the norm, with a trajectory suggesting that it will remain so.
Green 3: An indicator that is below, but within an acceptable range of the norm with a trajectory that remains within an acceptable range.



Amber/Green: An indicator where rural areas perform below an acceptable range of the norm, but with a converging trajectory that will converge within an acceptable time frame.



Amber/Red 1: Rural areas performing equally to the norm, but trajectory will clearly take rural below the norm.
Amber/Red 2: Indicator where rural performs below the norm with a converging trajectory that will converge outside an acceptable time-frame.



Red 1 and 2: An indicator where rural areas perform below an acceptable range of the norm with either a parallel or diverging trajectory.

SESSION 1

Parallel session 1.b

Developing Improved Rural and Farm Survey Methodologies

Chairman: *Krijn Poppe, WUR*

Report on Parallel Session 1b: Developing Improved Rural and Farm Survey Methodologies

Chairman: Krijn Poppe

Overview: *This parallel session discussed two issues related to the collection and interpretation of statistics on rural development and household income. The first paper reported on the International Financial Reporting Standards (IFRS), a set of standards that prescribes methodologies for income measurement at the business level. The second paper reported the experiences in China to set up an integrated agriculture and rural statistical system. There was no direct relation between the two papers, but both provided very valuable material to update the handbook.*

Experience on the Use of International Financial Reporting Standards for the Calculations of Agricultural Income
J.A. (Koen) Boone, LEI Wageningen UR, the Netherlands

International Financial Reporting Standards (IFRS) are developed in the accounting profession to correctly measure income and assets in companies. Over 100 countries have adopted these standards, including the EU and many developing countries. There is a convergence process with the USA's accounting standards. International Accounting Standard 41 deals with some specific agricultural issues like the valuation of biological assets. It introduced several breakthroughs in accounting standards, like the concept of 'fair value' for biological assets.

This paper reviews the implantation of IFRS standards in the Dutch FADN since 2001. It shows that the use of IFRS is feasible but that two issues have recently become the topic of a debate. One is the inclusion of changes in the value of breeding livestock in the income indicators (as prescribed under the fair value concept). This implies that income increases at the moment the prices of breeding livestock increase. The other issue is the depreciation of milk quota: the abolition of milk quota would lead to much lower income levels as the quotas have to be depreciated in the income statement.

The discussion revealed that the IFRS are a useful tool to guide discussion on the measurement of income and wealth, also in statistics. The standards are potentially a very useful way to standardize income calculations within agriculture but also between agriculture and other sectors. It was recognized however that in many data collection schemes the measurement of income and wealth is based on tax-related income concepts or the methodology for recognizing income is not made explicit at all.

Promoting and Integrated Agriculture and Rural Statistical System in China,
Yu Xinhua and Yan Fang, National Bureau of Statistics, China

China is a large agricultural country with 930 million people (70 percent of the population) living in rural areas. China is changing fast and the development of the rural area and agriculture is of strategic importance for the sustainable development of the country. China's statistical system includes a full set of statistical indicators to reflect the situation and development of agriculture, rural areas and the rural population. It has three main components: agricultural statistics, rural statistic and rural household statistics. The paper describes several efforts to improve the statistics system, especially on integrating rural and urban household surveying, improve agricultural production surveys with up-to-date technology, improved economic accounts and price data, improved coordination in the system and new tools for quality management.

Conclusions of the chair

There seems to be agreement in the session that the papers could provide the basis for extending and developing the Handbook. The IFRS paper could be reworked in a section at the beginning of part II to discuss measurement of income and wealth in more detail. The China paper would be a good basis for a box on best innovation practices in a large and fast developing country in part I.

Experiences on the Use of International Financial Reporting Standards for Calculations of Agricultural Income: Ultimate harmonization Tool or not relevant for Agricultural Statistics?

J.A. (Koen) Boone
Alexanderveld 5
2585 DB The Hague
The Netherlands
Koen.Boone@wur.nl

***Abstract**: The accounting standards used in the calculation of agricultural income differ heavily between databases and countries. This makes both the interpretation of absolute values of income as the comparison between farms and countries very complicated. After years of discussion, the IASB (International Accounting Standard Board) issued in 2001 IAS 41 on agriculture. From 2005 on, the use of IFRS (International Financial Reporting Standards) is obliged for stock listed companies in the EU and the standards are used in more than 100 countries. The IFRS standards are potentially a very useful way to standardize income calculations within agriculture but also between agriculture and other sectors.*
IAS 41 was implemented in the Dutch FADN in 2001. In this paper, the experiences with the implementation of this standard during the last 8 years are discussed. IAS 41 introduced several breakthroughs in accounting standards. The paper focuses on some of these like the valuation of biological assets and the inclusion of changes in the value of biological assets in income. Next to this, the valuation and depreciation of intangible assets like production rights (e.g. milk quota) and entitlements for payment under single payment scheme. Methodological discussions are illustrated with empirical data of the Dutch FADN.

Keywords: Accounting standards, IFRS, agriculture

1. Introduction

The accounting standards used in the calculation of agricultural income differ heavily between farms within a country and between countries. This makes both the interpretation of absolute values of economic indicators as the comparison between farms and countries, very complicated. After years of discussion, the IASB (International Accounting Standard Board at that time still named IASC) issued in 2000 IAS 41 on agriculture. From 2005 on, the use of IFRS (International Financial Reporting Standards) are obliged for stock listed companies in the EU and the standards are used in more than 100 countries. The only other important international accounting standard (the US based FASB, Financial Accounting Standard Board) has decided to harmonize with IFRS in the coming years. The IFRS are potentially a very useful way to standardize income calculations within agriculture but also between agriculture and other sectors. Harmonization of agricultural statistics with statistics in other domains has been identified as a priority by nearly all main agricultural statistical institutes and research organizations (for example /Worldbank/FAO/USDA-ERS, 2009). The adoption of the IFRS by the EU made Eurostat start a large project to investigate the effects of the adoption of the IFRS for Economic Indicators. (http://circa.europa.eu/irc/dsis/accstat/info/data/en/index.htm)

In the next section the relevant IFRS are described, concentrating on IAS 41 on Agriculture. IFRS were implemented in the Dutch FADN in 2001. In the fourth section of this paper the experiences with the implementation of this standard during the last 8 years are discussed. IAS 41 introduced several breakthroughs in accounting standards. The paper focuses on some of these like the valuation of biological assets and the inclusion of changes in the value of biological assets in income. Next to this, the valuation and depreciation of intangible assets like production rights (e.g. milk quota) is discussed. Methodological discussions are illustrated with empirical data of the Dutch FADN. The paper concludes with some remarks on the usefulness of IFRS for the harmonization of economic indicators in agricultural statistics.

2. IFRS standards

The International Financial Reporting Standards are issued to try to reach international harmonisation in accounting standards. Originally every country had its own accounting standards that made comparison very difficult and led to huge extra costs for multinational companies. The EU has used the IFRS to reach harmonisation of accounting standards in the European Union. After adopting some parts of the IFRS for European regulation, from 2005 on, the use of all IFRS is obliged for stock listed companies in the EU. The use of IFRS by other companies is strongly advised. IASB has issued a large number of standards. IAS 2 deals for example with inventories and IAS 38 with intangible assets. In 2001 the IFRS issued a standard on agriculture IAS 41. This paragraph deals mainly with this standard but some other IFRS that are relevant for agricultural enterprises will also be discussed shortly. It will not present a complete overview however.

2.1 Fair value for biological assets

The most important statement of IAS 41 is that all biological assets should be measured at fair value. Biological assets are defined as "living animals and plants that are controlled by an enterprise as result of a past event". Agriculture produce that has been harvested, is no longer part of the biological assets. Though the origin of the agricultural produce is a living animal or plant, it is no longer alive after harvest. Harvested products should be treated the same as other products where (part of the product) has a living origin. Therefore, harvested produce should be treated as all other inventories at the balance sheet. IAS 2 that discusses the valuation of inventories has a special paragraph on agricultural inventories. IAS 2.3 states that agricultural and forest products, agricultural produce after harvest, and minerals and mineral products may be measured at net realisable value (above or below cost) in accordance with well-established practices in those industries. This means that agricultural inventories can also be valued at the fair value of the balance sheet date.

IAS 41 considers the fair value at the point of harvest as the historical costs of the product from that point of time. This means the fair value of harvested produce should be determined at the point of harvest when inventories are valued at costs. At the balance sheet date, the price at the date of harvesting determines the price of the product. Farms can however decide to value their agricultural inventories at net realisable value. In this case the product should be valued at the net realisable value at balance sheet date.

2.2 Market price and alternatives

IAS 41 dictates how fair value can be determined when there is no market price available (table 1). When there's no market price at the current location of the product, the market price in another location less transportation costs, identification costs etc., should be used. When there's no market price for the balance sheet date, the most recent price should be used. When there's no market price at all, the price of similar or related assets or sector benchmarks should be used.

When the product is not marketable in its current state because it is immature, there is no current market price for the product. In these cases, fair value can only be based on estimations of future market prices. The future market prices of the product itself and/or future market prices of the products that are produced by the biological asset, could be used. In these cases Net Present Value should be used. When all above mentioned approaches are not possible, 'fair value' should be estimated by costs. This last method can only be used when estimations of future cash flows are very insecure and relatively little biological transformation has taken place since initial cost incurrence. In practice this means that the product is not valued at fair value anymore but at 'historical cost of production'.

1.	Market price at the reporting date in its location
2.	Market price at the reporting date in another location less costs to place the asset on the market
3.	Most recent market price for similar or related assets
4.	Sector benchmarks
5.	Net present value of expected cash flows
6.	Costs (little biological transformation or impact biological transformation is not material)

Table 1 Determining fair value

2.3 Profit and loss account

The most revolutionary statement of IAS 41 is that the change in fair value of biological assets should be recognised in the net profit or loss as part of operating activities. For agricultural inventories IAS 2.3 states that

When such [agricultural] inventories are measured at net realisable value, changes in that value are recognised in profit or loss in the period of the change

A farm should disclose the change in value for each group of biological assets separately (in the Income statement or in the notes of the income statement). IAS 41 encourages the separate disclosure of the physical change and the price change. When at the opening Balance Sheet, the value of a product is P0 * Q0 and at the closing Balance Sheet, the value is P1 * Q1, the division is made as following:

Physical change: (Q1-Q0)*P1

Price change: (P1 –P0)*Q0

2.4 Intangible assets

IAS 41 does not state anything in particular for agricultural intangible assets. IAS 38 states that intangible assets can be valued if they are identifiable, verifiable and lead to economic profits in the future. Valuation could be both at costs or at fair value. Valuation at fair values is only possible when an active market exist. IAS 38 presents as one of the examples for which it is clear that an active market exist, the market for milk quota. In the Netherlands every farmer can sell his quota at every moment in time and quotations are published on a daily or weekly base. For the valuation of quota it is irrelevant if the quota was bought by the farmer or distributed by the government for free at the moment of introduction of the quota.

2.5 Land

There are no new accounting standards for agricultural land. IAS 16 allows agricultural land to be carried at cost or fair value.

3. Dutch agriculture and Dutch FADN

3.1 Dutch agriculture

Dutch farms are relatively large in comparison with farms in other EU-member countries. Dairy farming is the most popular farm type in the Netherlands. Horticulture is also relatively important in the Netherlands. Because for some farm types scale effects can only be completely realised at a very large size, it might be expected that farms will become more and more industrial like. At the moment however, nearly all farms are still family farms where most of the work is done by the members of the family. Because of the intensity and the high degree of specialisation of Dutch agriculture, many inputs (feed, piglets e.d) are not produced on the farm but are bought on the market.

Market information about prices of most agricultural products has always been available in the Netherlands. Prices are published in agricultural magazines, newspapers and available on the Internet. For different reasons, market prices may cease be available in the future. First of all, products are more and more differentiated so 'the price' of a product does not exist anymore. The assembling of prices for niche products (for example biological products or special types of tulip bulbs) will be a lot more complex and expensive.

Furthermore some products are not publicly traded anymore. Where in the past products were traded at auctions that published the prices, products are now sold to one or a few large partners who have no interest in making their price publicly available. This lower market transparency can make it complex to find fair values for some products.

Because most Dutch farms are still family farms, they are not obliged to publicize their financial results. For tax purposes however, they are obliged to deliver a Balance Sheet and Profit and Loss Account based on fiscal principles. Each year, (fiscal) standards are developed for the valuation of most biological assets. These standards are mostly based on the costs of the biological assets. All accounting offices give farmers the possibility to receive a farm report based on business economic principles. Only a limited number of farms do get these reports. For large investment decisions calculations based on business economic principles are made by applying correction factors on the fiscal numbers.

3.2 Dutch FADN

In the FADN of the Agricultural Economics Research Institute (LEI) financial and technical results of 1500 Dutch farms are assembled. The data are assembled by the LEI employees using the original financial documents (invoices etc.). This makes it possible for the LEI to use its own accounting standards for the determination of balance sheets and results. Using fiscal numbers from accounting offices would distort economic analysis. Some environmental friendly assets could for example be depreciated in one year to stimulate adoption by farmers. Their useful economic life might be more than 10 years however[28].

The data of the Dutch FADN are part of an EU-27 database with data of about 80.000 individual farms. The EC gives a detailed prescription of the definitions and the accounting standard that should be used. Argiles (2001) and Zeddies et al. (2005) studied the differences between EU-FADN and IAS 41.

4. Implementation of IFRS in Dutch FADN

In the year 2001 a complete renewal of the Dutch FADN was realized. This gave the LEI the possibility to renew its accounting principles. It was soon decided that the LEI would try to make their accounting principles as much as possible in line with IFRS. Both international harmonization and harmonization with other sectors were important criteria for selecting the accounting principles.

4.1 Biological assets

The valuation of nearly all assets in Dutch FADN has always been at replacement value (in a method of current cost accounting). For economic decision making, this is the only relevant value. Next to this, comparison of economic performance of farms should not be influenced by the moment an asset is bought, as is the case when valuation is based on the purchase price. For practical reasons, the use of market values has also the advantage that original purchase price has not be reconstructed. While the FADN is a partly rotating panel, the purchase price is not always known.

For biological assets a combination of average costs of production based on current price level and market prices were used in the Dutch FADN depending on the kind of asset. The move to valuation at fair value for all biological assets was not heavily debated in general. For assets where markets prices were not readily available, cost of production could after all still be used. This was for example the case for strongly differentiated products like flower bulbs and flowers. Herbohn (2006) states that wine producers criticized the use of fair value while it was really hard to give a market value to their differentiated product.

[28] The most important reason however to do the assembling by the own employees is that data are assembled on a much more detailed way than available at accounting offices.

IAS 41 was heavily criticized for the fact that the setting of the fair value is very subjective and therefore might distort the comparison over time and between farms. While in FADN the same fair value is used for all farms, the same method is used over time and statisticians do not have an interest in manipulating income, this is not as important as for individual farms.

For which products reliable market prices were available led to long discussions. Specialist knowledge about the product, its markets and availability of prices is all necessary and this makes it difficult to realise consistent results over all products. It might be difficult for managers to judge between resistance to change on the one hand and on the other hand the lack of reliable market prices.

The EU-FADN also prescribes the use of market values for most biological assets. How these market values are set might differ between countries and also within a country. Institutes responsible for national FADN might buy their data from accounting offices and use the value that accounting offices deliver. These methods might differ between accounting offices.

4.2 Change in value of Biological assets

In the past changes in value of biological assets were not included in the income in Dutch FADN although changes in value of agricultural stocks (not living anymore) were. Quite some opposition resulted from the proposal to follow IAS 41 and thus to include change in value of all biological assets in the income. Theoretical arguments were used like the prudence principle that states that changes in valued should not to be included in profit before they are realised (product is sold). A more practical arguments used was that stakeholders (for example farmers) would not understand this while hardly anybody used this kind of profit calculation. Most users are used to fiscal accounting that do not include change in value in profit. Others stated that market prices have always some unreliability and volatility and it would not improve the insight in the performance of the farm to include the change in the unreliable estimations into profits. Some stated that it would only lead to extra volatility in income calculations that disturbed the insight in the real farm performance (see also Elad, 2004). Prices are so unpredictable that the effect of prices changes on the value of the assets has no relation with the real performance of the farmers although it is included in income. Elad (2004) states that the application of IAS 41 might be especially difficult in developing countries while price market prices are not so easily available for most products.

The EU FADN makes a calculation based on basic data delivered by member states that tries to exclude price changes from volume changes for breeding animals (EC, 2007). Price changes are not included in income but volume changes are. The method is subjective however and leads only to rough estimations of the real volume change. Changes in value of crops on the field (for example apple tree) are only taken into account as long as they are not yet mature and do not deliver harvest yet (EC, 2008). For crops that do already deliver harvest, increase in value (volume or price) are not taken into account but depreciation is possible.

The most severe opposition for the proposal to include difference in valuations of biological assets into income in Dutch FADN, was on the change in value of production factors, like dairy cows, apple trees and sows. Dairy cows are generally not sold by the farmer during their lactation period. They are sold after their production life for slaughtering. The price of a dairy cow that is still in production depends on the prices of milk and the costs. The price of a cow after its productive period just depends on the prices of meat. Opponents stated that change in prices of dairy cows are never realised because the cow is only sold in a different state. Because the price of a cow depends on the expected costs and output of milk it might however be realised by the sales of milk instead of the sale of the cow itself.

In spite of the opposition, IAS 41 was completely realised in Dutch FADN. Some compromises were made by valuing some biological assets at cost of production instead of market price. Cost of production was not updated anymore or only very smoothly so that change in cost of production was not included in profit. The discussion restarted in 2008 however. In 2007 the price of milk was extremely high and the price of dairy cows followed. The change in value of dairy cows between 1st of January and 31st of December added 22.000 Euro to the income for dairy farms in 2007. In 2008 prices fell very sharply that led to a negative change in value of dairy cows of 13.000. The combined effect of the change in value of dairy cows on the difference in income between 2007 and 2008 was thus 35.000 Euro. The discussion resulted in the decision not to include the change in value of production factors into the profit anymore from 2009 on.

4.3 Intangible assets

In 1983 production quota were introduced for dairy production. Each farm got a quota that was based on the production in some reference years. Shortly after the introduction the trade in quota was allowed and prices increased to levels of 2 euro per kg milk. The quota of an average farm in the Netherlands thus had a value of about 800.000 Euro and a large part of the quota was traded. Fiscal authorities decided that only quota that was bought, should be valued on the balance sheet and depreciation was allowed in 8 years. In Dutch FADN this procedure was followed but depreciation period was extended to 14 years.

Around 2000 however quota prices were still at top levels. Farmers that bought the quota 10 years before had nearly completely depreciated it while in practice the value was much higher than the purchase price. Following IAS 38 and value all quota at fair value and not depreciate anymore was therefore not intensively debated. Some argued however that when the quota was sold at a high price while the fiscal value was close to zero, a large part of the profit should be paid as income tax. Therefore a deferred tax provision was introduced with a value of 30 percent of the value of the quota. These changes led to an increase in value of the quota of about 700.000 Euro and an increase in average income of about 10.000 euro while the depreciation of quota was stopped.

At the end of 2008 it was decided that the quota system will be abolished in 2015. This means that the quota has no value anymore in 2015. At closing balance sheet date however, the average value of milk quota was about 600.000 Euro with a deferred tax provision of about 180.000 Euro. Depreciation over the remaining life of the asset would lead to costs of about 70.000 Euro per farm while the average income of the last years was about 50.000 Euro.

The increase in value of the quota that was distributed for free was however never included in profit so some argue that it was not fair to include the complete decrease in value into income. This does however only hold for quota that were not traded since the introduction of the quota system. Much more than 50 percent of all quota was traded however and thus it led to a cash outflow.

It is expected that part of the money that is now invested in quota will be invested in land in the coming years. Because of the tight environmental regulations in the Netherlands farmers can only increase production by buying more land. This means that quota prices will drop but land prices will increase (Luyt (forthcoming)). The change in value of land will however not be included in income while the decrease in value of quota will.

The current proposal will be to depreciate 50 percent of the total value of the quota. The rest of the quota is assumed not to be purchased and thus did not led to a cash outflow in the past. Another argument for this compromise is that it is assumed that about 50 percent of the decrease in value of quota will end up in a increase in the value of land so that in the end only 50 percent of the value of quota is lost.

5. Conclusions

The IFRS are potentially very useful for harmonization of agricultural income calculations. IFRS are already applied in more than 100 countries and the only competing standard (FASB) started a process to harmonize with IFRS. In the near future IFRS will probably be close to a worldwide standard. IFRS is already applied by stock listed companies with agricultural activities in the EU and by the Dutch FADN so the proof of the principle is there.

The IFRS has large methodological advantages for statistical and research purposes in comparison with fiscal accounting standards in most countries and also with most national accounting methods for business economic calculations that are more oriented to valuation based on cost of production.

There are however also some drawbacks. Most farms do not produce financial results based on business economic principles but only on fiscal principles. This means that most farmers (and other stakeholders like banks/advisors) are not used to work with business economic principles and therefore might misinterpret statistical economic indicators. IFRS have in general more differences with fiscal accounting than national accounting standards.

In some countries FADN data is based on financial reports produced by accounting offices. These reports of accountants are most of the time based on fiscal principles. It is not always easy to recalculate fiscal results into results that fulfill the IFRS.

National stakeholders might consider these drawbacks so serious that they will not accept the full implementation of the IFRS. For the Dutch FADN this will probably lead to the situation were the change in value of biological production factors will not be included in income anymore. This part of the IFRS might also be unacceptable in other countries. If IAS 41 would be adapted on this point, this would however not have to prevent the adoption of the IFRS as an international standard for economic agricultural statistics.

References

Argiles, J.M. en E.J. Slof (2001). New opportunities for farm accounting; The European Accounting Review 10:2 261-383.

Australian Accounting Standard Board (1998). Self generating and regenerating assets; Victoria.

Boone J.A. en K.J.H.M van Bommel (2000). Fair value in agriculture-first implementation of IASC E65, LEI. Paper presented at the 8th Pacioli meeting Rackeve (Hungary).

Boone J.A. (2002). Valuation based on Net Present Value in agriculture - implementation of IAS 41. Paper presented at the 9th Pacioli Meeting, Braunschweig, Germany, 2001 and published in: G. Beers and K.J. Poppe; *Pacioli 9*; Den Haag, LEI.

Elad, Charles(2004). Fair value accounting in the agricultural sector: some implications for international accounting harmonization, European Accounting Review,13:4, 621 - 641.

EC (2007). Definitions of variables used in FADN Standard Results. RI/CC 882 rev 8.1 Brussels.

EC (2008). Farm Return Data Definitions. RI/CC 1256 rev. 5. Brussels.

Eurostat, Worldbank, FAO,USDA-ERS (2009). Report on global initiative to improve agricultural and rural statistics. 40th meeting of Statistical Commission UN, New York.

IASC (2001). IAS 41: Agriculture, London.

Herbohn, K. (2006). International Accounting Standard (IAS) 41: What Are the Implications for Reporting Forest Assets? In: Small-scale Forest Economics, Management and Policy, 5(2):175-189.

Luyt, J., C. de Bont en J. Helming (forthcoming). Grondprijzen en toeslagen, LEI, Den Haag 2009/026.

Waasdorp, D. en J.A. Boone (2003). Waardering en verwerking van fruitopstanden en melkvee, Lei, Den Haag.

Zeddies, J. M. Köhne, E. Bahrs, B. Zimmermann, C. Janze and W. Gamer (2005). Comparison of the accounting standards used in FADN with the International Accounting Standards (IAS); Brussels.

Promoting an Integrated Agriculture and Rural Statistical System in China

Yu Xinhua, Yan Fang
National Bureau of Statistics, China

***Abstract**: China is a large agricultural country with large number of farmers in rural areas. There are still 930 millions people living in rural area, which is about 70 percentage of total population. In the recent years, with the rapid socio-economic development, the labors of rural area migrate massively into urban area, seasonally or permanently. Even though the contribution of agriculture and allied sectors to GDP becomes gradually less, the volume of the agricultural products and its stable provision is vital for the massive population of this country. Along with these changes, the rural area is still the main residential place of large portion of population and important part of market economy. The development of rural area and agriculture is of strategic importance to the sustainable development of this country.*

Keywords: integration, agriculture, rural, statistical system

1. Introduction

China's agriculture and rural statistical system includes a full set of statistical indicators to reflect the situation and development of agriculture, rural areas and rural people in China. Data are collected by using census, sampling surveys and statistical administrative reporting methods. Along with the economic growth and social development, the rural development strategy has shifted to the development of urban and rural areas as a whole and the construction of new rural area has become a major strategic task of China. It aims to make rural areas economically, socially, culturally and environmentally developed. However, some aspects of the rural statistical system are not very flexible to the very demanding requirements of changing policy analysis. To meet the data needs of monitoring agricultural and rural development, the rural statistical system should be reformed and innovated. Given the changing circumstances, the best reform proposition of the agriculture and rural area statistic should be in the short and the long run? This paper describes the proposed reform plans in the main aspect of the current system. In Section 2 the current situation of the agriculture and rural statistics at National Bureau of Statistics of China (NBS) is described briefly. Section 3 goes into the five aspects of changes of our system. Finally, in Sector 4 some remarks are made on work in progress.

2. An overview of China's agriculture and rural statistics system

The construction of China's agriculture and rural statistics system and methodology is based on thorough understanding of local conditions. When depicting the contents of the system, we can say its indicators possess 3D statistical characteristics which are agriculture, rural areas and farmers. The system has been providing foundation for the scientific and effective policy – making regarding agriculture and rural issues.

Agricultural statistics indicator system consists of indicator about agricultural resources, factor inputs, outputs, value-added, reflecting the operation results of agricultural economy. Core indicators are the output of major agricultural products, corresponding to the policy direction of effective supply of grain, cotton, oil plants, meat and other major agricultural products.

Rural statistical indicator system consists of indicators about rural investment, the flow of labour, poverty, regional economy and ecological environment, reflecting the all-round socio-economic changes in rural areas.

The investment and regional development are core indicators, corresponding to the orientation of the economic policies of structural adjustment and urbanization.

Rural household statistical indicator system includes farmer's production and livelihood, income and expenditure, consumption and accumulation among many other indicators. The income and expenditures are core indicators, corresponding to the policy direction to increase the income of the farmers and to stimulate the rural market.

2.1 Agricultural statistics system

Agricultural statistics system includes the statistics of agricultural elements, productions, prices and economic accounts, which supporting with each other.

2.1.1 Statistics of the basic conditions of agriculture production

The statistics of main agriculture elements are labors, use of arable land, machinery and equipment, water conservancy facilities and other agricultural production inputs.

2.1.2 The agriculture production statistics

The major commodities of agriculture to implement sampling survey are major farming products. The statistics of other minor farming products are mainly obtained from administrative reporting system. The major farming production surveys such as wheat, rice, corn, cotton, hog, cattle, sheep and poultry, are sampling surveys. The crop production is estimated as a product of area under crop and the average yield per unit area of the crops. The average yield of the specific crop is estimated through actual cutting and measuring survey. For the acreage, before 2004, the estimates of the area under crop are obtained through complete enumeration. Due to the lack of village-level statistical base, the quality of area data is poor. In order to improve the accuracy of data on the acreage, beginning in 2004, the crop production survey program are expanded. 60 thousand households of two-stage sampling were selected to estimate the crop area for major crops. For the cotton production, the sampling survey is implemented in 2000, but in major producing provinces only. The statistics of animal husbandry production before 2000 are also from the administrative reporting system and reformed in 2004 to sampling survey. The reformed statistics are better performed than before. The statistics of forestry and aquaculture are mainly from administrative reporting system which is implemented by Ministry of Agriculture and called "departmental statistics".

2.1.3 Surveys on prices of agricultural products

The price is an important signal to reflect the market information. The agricultural product price survey system includes producers' price, rural bazaars prices, and wholesale price of agricultural products.

In 1997, in order to objectively reflect the information of the rural market price, the rural bazaars' price survey was performed on five major food crops of both unprocessed and processed. In 2003, the survey was expanded to cover 18 varieties, implemented in 200 counties of 31 provinces.

In 2000, the pilot survey of survey on producers' price for agricultural products was proceeding in 12 provinces. In 2002, survey on producers' price of agricultural products was roll-out nationally. Survey on producers' price for agricultural products involves more than 280 varieties of the agricultural categories. The survey on producers' price in the first quarter of 2004 was brought into the economic statistics information released system of NBS, and periodically released survey data to the public.

The pilot survey of wholesale markets' price of agricultural products was launched in September of 2003. The survey was carried on 50 large-scale wholesale markets nationally for agricultural products at wholesale prices. The network of survey includes 30 large-scale comprehensive wholesale markets and 20 national professional wholesale markets. In 2004, the network of survey of agricultural products wholesale market outlets was expanded to a hundred, and the contents of the survey involving grain, cotton, vegetables, fruits, flowers, meat, poultry and eggs, aquatic products and timber totaled 8 categories of 159 varieties.

2.1.4 The agricultural economic accounts

Accounting of agricultural economic, is an important component part of the system of national account. It is the macroeconomic and information system of agricultural economy. The process of accounting and its results provides a full description for the agricultural economy.

2.2 Rural statistics

As China at the initial stage of socialism, the urban-rural economic structure of the prominent characteristics of various administrative, socio-economic development policies need to develop the rural area as relatively independent of the overall consideration, therefore, the rural socio-economic operation has also implemented independent monitoring and statistics. The conventional rural survey project established a fixed assets investment in rural areas, poverty survey, regional statistics, community environment, and ecological benefits.

2.2.1 The sub-provincial statistics

Administrative divisions as the basic unit for statistical work, research different parts of the development and changes in the development of summing up the experience and regularities, extremely important for guide the socio-economic development, and formulate development strategies.

County (city) socio-economic statistics. There has been 20 years of history that the NBS was constituted the county (city) statement of rural socio-economic system, mainly for collection, collate the national sub-county (city) socio-economic statistics, such as GDP, fiscal revenue and expenditure, investment in fixed asset, and etc.

Township survey. This survey was brought into the Basic Conditions of the Rural Community Survey System issued by NBS in 1990s. The survey was conducted every three years for all of the townships basic condition. The content includes rural township of basic production conditions, economic, financial and monetary situation, rural community environmental conditions.

2.2.2 Rural poverty monitoring

Poverty eradication is an important task during the social development process. As to fully reflect the evaluation on China's rural poverty situation, and evaluation on anti-poverty work, NBS, in cooperation with the relevant departments, began to conduct poverty monitoring survey in 592 key counties since 1990s. The results released annually by briefing poverty monitoring survey, and jointly published the China Rural Poverty Monitoring Report, released the findings to the public. The current system of indicators includes poverty monitoring indicators and poverty measurement indicators.

2.3 The rural household income and consumption survey

Rural Household Survey is carried out annually. The survey is well designed and implemented to minimize both sampling and non-sampling errors. A combination of simple random, stratified, systematic, multi-phase, and multi-stage sampling method is adopted to select 68,000 households distributed in 31 provinces, 857 sampled counties, and 7,100 sampled villages. Data are representative at provincial and national levels. Sampled households keep diaries on production, sales, incomes, purchases and consumptions. Assistant enumerators in each village are engaged to check and sort up the dairy books periodically as well as to help the illiterate to keep dairies. County interviewers visit villages twice a month supervising the diary-keeping and at the end of each year to collect community information, individual information and other household information which are not covered by diary-keeping through one-time survey. The sample of Rural Household Survey is rotated on a 5-year basis (with very small proportion of rotation in each year to ensure sample representativeness) and the latest two rotations were in 2000 and 2005.

3. Efforts to improve agriculture and rural statistics system

3.1 Pilot survey of an integrated rural-urban household survey

The current rural and urban household surveys are two separate survey programs which are designed, organized and implemented by two parallel departments inside the NBS. The households in the rural area differ fairly significantly from those in the urban area in terms of working and living behavior, means and environment and therefore there are distinct ways to set up and define indicators for rural household surveys, which are also different from the generally accepted international standard. With the development of the society's economy, there is a need to reform its statistic system in order to facilitate international communication and comparison. Most importantly, there exists a problem of insufficient coverage in the survey area of conventional survey -- some households in the urban-rural fringe are not included in both household surveys, which need to be addressed. The reforming target is to establish an integrated rural-urban household survey system which will adopt a uniform sampling frame and sampling method for both urban and rural areas, so that the problem of insufficient coverage will be better addressed. The principal development activities of the integrated rural-urban household survey system that will be undertaken are:

- Concept and data development
  - identification of data inadequacies, particularly to address the data needs for the estimation of the Gross Domestic Product, the Consumer Price Index and social indicators;
  - harmonization of core concepts between urban and rural surveys, respecting international standards to the extent possible;
  - review of household membership concepts and definitions to minimize coverage errors;

- Frame development and sampling strategies
  - assessment of different options for the frame (area frames, dwelling or other lists), with special attention to the coverage of the floating population;
  - review of sample rotation methodologies to reduce respondent burden and improve the quality of estimates;

- Collection, processing, estimation, analysis and dissemination
  - development of key indicators at pre-defined geographical levels, and, when possible, disaggregated by gender and other family characteristics for dissemination and analysis purposes;
  - design of questionnaires that take into account the ability of respondents to report the data and minimize respondent burden;
  - development of integrated (rural and urban) household survey processing procedures, including the rigorous application of editing and data correction methods;
  - assessment of the use of demographic totals for weight adjustment;
  - development of a strategy to create an integrated micro-data file for internal use;

- Evaluation
  - assessment of data quality, using data from censuses and other sources, including the comparison of results between old and new surveys;
  - development of survey collection indicators, including costs, in order to evaluate ongoing collection operations;

3.2 The development of an integrated agricultural production surveys

3.2.1 The development of the area-based crop surveys

The reformed crops survey will base on GIS and area sampling method. The remote sensing technology will be used to verify the results. The main development activities to be undertaken are as following:

• Use of GIS and remote sensing for sampling design

GIS is a powerful tool for storing, retrieving, analyzing and integrating both spatial geographical data and non-spatial data. It attaches geographic identifiers to non-spatial data, allowing them to be mapped. This visualizes not only the data in geographic form, but also facilitates the use of spatial statistical techniques and remote sensing.

A GIS designed to assist agricultural surveys with the help of remote sensing data will be developed recently. The sampling units in crop surveys are based on area frame obtained with the help of satellite image or geographical areas such as villages, cities, regions, etc. Census data, survey data and satellite image of geographical area are all integrated into GIS.

The major changes of crop surveys sampling design is the area frame construction, stratification and spatial sampling techniques. Recently, land use data had been collected from the 2nd land survey, organized by the Ministry of Land and Resources of China in 2007. This survey collected all farmland vector data and latest years' SPOT5 imagery. Besides, the attributes of land use were also collected. The data provides a good basis for area frame construction and some useful data for stratification. The farmland vector data is used to determine the boundaries of area frame strata and also the boundaries of segments. The current remote sensing data such as satellite images can not only provide updated information on area frame stratification boundaries and segment boundaries, but also provide ancillary information for optimizing the sample design when taking into account the positive spatial autocorrelation of characters under study.

• Use of GIS and remote sensing for estimation

Remote sensing data are generally used as auxiliary variables in regression estimation. The use of remote sensing data can reduce the amount of ground data to be collected. The procedure of the precision of estimates improvement is achieved by the linear regression correction by using the auxiliary variables determined by classification of satellite images. With the help of GIS, the information on the location of crops and other land uses is also meaningful for the exploration of new opportunities of available data.

3.2.2 The development of livestock surveys

The reformed livestock survey will use more suitable methods such as multiple frame sampling. The sample of crops survey and livestock survey will be referred to that of rural household survey for data consistency if possible.

3.3 Agricultural commodities prices, intermediate consumption survey and agricultural economic accounts

In order to match to the new system of national account, the agricultural added-value accounting was established in 1992 and the agricultural intermediate consumption survey was established in 2002.

The Accounting of gross output value of farming, forestry, animal husbandry and fishery reflects the total scale and results of agricultural production during a given period. It is a basic index of observation of forestry, animal husbandry and fishery production levels, and agricultural output value calculation. Since 2005, according to the national classification standard, the extent of gross output value of crop, forestry, animal husbandry and fishery industries accounting was expanded, The scope of the gross output value of agricultural accounting is the total value of crop, forestry, animal husbandry, fishery products and supporting services of forestry, animal husbandry and fishery production activities, was implemented every calendar year.

According to the calculation formulae of the gross output value of agriculture, forestry, animal husbandry and fishery product is: the determination of the prices of agricultural products was an important issue for calculating gross output value of agriculture, forestry, animal husbandry and fishery product.

Generally, there were two kinds of price adopted in the history: the current and constant prices. The *Current prices* of agricultural products, i.e. producers' first-hand prices of selling the agricultural products, root in the survey of agricultural products' price. The minority agricultural products in the survey which does not covered, which can be used the market price information fairs. The crops without the market prices are replaced by the production cost. Current price of agricultural products does not include profit-sharing, subsidies and production support fees. The output value at current prices mainly reflects the total scale and level of production. The Constant price is the National Generic Fixed Prices of agricultural products of the year. Measuring the output of forestry, animal husbandry and fishery output in constant prices is to observe the development of agriculture speed, eliminating the annual change in prices between different regions of the price differential, making the agricultural, forestry, animal husbandry and fishery product to posses the comparability. China has drawn up over 1952, 1957, 1970, 1980, 1990 constant prices of agricultural products. But it has a lot of problems unsolvable. Thus from 2004, in implementing the reduction of price index to calculate agricultural development speed, constant price has been revoked.

The scope of value-added accounting of agriculture is the same of the gross output value of agriculture. But there were two accounting methods. The crop, forestry, animal husbandry, fishery use the "production" accounting. The value-added of crop, forestry, animal husbandry and fishery services mainly taken distribution method or methods of value-added ratio for calculation, which is the most suitable approach since the intermediated consumption is difficult to acquire.

The intermediate consumption survey of major agricultural products was launched in 2000. It reflects the status of the intermediate consumption comprehensively. Related information could be used to research on the changes of intermediate consumption among the agricultural production and farmers' incomes. It provides the information for value-added accounting of agriculture. The scope of survey was the entire agricultural production units, including farmers and non-farmers. The sample of this survey includes a total of 9,000 agricultural production units. The agricultural producers' prices survey, launched in 2000 too, collecting data from the same sub-samples of rural household survey and agricultural production surveys. These two surveys will together provide a basis for the agricultural economy accounts.

3.4 Survey themes and indicators will be more coordinated within the new system

There are many advantages of survey integration although some sacrifice of flexibility may occur. The main advantages are:

- The micro-level survey data linkage for analytical purposes can be applied due to common respondent identifiers.
- The common statistics, concepts, definitions and methods will be used. The data consistency will be guaranteed and since the information can be summarized in the same way and fairly quickly, the aggregated data will be easier to share.
- The corporate planning and coordination among the integrated surveys will be improved.
- Data collection, processing and management will be shared among the survey themes. So the survey cost will be reduced.

3.5 New tools will be applied to ensure the quality of data

The last decades witnessed revolutionary changes in the approaches related to spatial problems with the introduction of modern Geographic Information System (GIS). It is a powerful tool for storing, retrieving, analyzing and integrating spatial and non-spatial geographical data apart from drawing any kind of maps. The development of spatial statistical techniques has been accelerated parallel to this rapid growth of GIS technologies and there is a need to integrate the GIS, and spatial statistical techniques and remote sensing to improve the data production.

3.5.1 Improve data management and statistical services

The traditional data from census and surveys were disseminated with text or graphic forms. But if the data are visualized in geographic form, it would provide information on how agricultural production varying with environmental measures. It also provides a powerful tool, as ecological data combined with demographic, economic, and social data.

The estimates from traditional statistics and remote sensing will be cross-validated to assure the reliability of data dissemination. The new system combining traditional ground survey, GIS and remote sensing will make the provision of the current crop estimates for small administrative area possible. And because of its objectivity and timeliness, the forecast of crop production based on remote sensing will improve the ability of official data providing greatly.

3.5.2 Small area estimation such as poverty mapping application can be developed with the help of GIS and remote sensing

Through the geographic congruence analysis, the GIS will be used to create more useful data for the rural development policy maker. The small area estimation along with geo-coded data and GIS provides another view of the poverty distribution in sub-county level. Traditionally, the small area estimation is to impute a measure from survey data into census for small administrative area. If the agro-climatic or other environmental characteristics are induced into the prediction models, not only the statistical precision can be improved, but also the visual nature of the maps may highlight unexpected relationships that would escape notice in a standard regression analysis.

4. Final remarks

In this paper, we have provided a brief introduction of the agricultural and rural statistical system implemented in National Bureau of Statistics of China. We have introduced some of our efforts to improve the surveys. Due to time, resource and technical constraints, the integration of surveys will be challenged. We also mentioned some attempts to introduce new technologies and methodologies. More pilot work is needed to see whether these new suggestions will go well or not.

References

Zhang Shuying (2007). Characteristics and Perplexities on China’s Agricultural and Rural Statistics and Its Reform Ideas. Proceedings of Fourth International Conference on Agriculture Statistics.

Elbers, C., Lanjouw, J.O., Lanjouw, P., (2002). Micro-level estimation of welfare. Policy Research Working Papers, vol. 2911. Development Research Group, the World Bank, Washington, DC.

Randhir Singh, Prachi Misra Sahoo and Anil Rai (2003). Use of Remote Sensing and GIS Technology in Agricultural Surveys. Proceedings of Map India Conference 2003.

SESSION 2

Plenary Session

Innovation, New Tools and Results in Rural Statistics

Chairman: *Pippa Gibson, DEFRA*

Report on Plenary Session 2: Innovation, New Tools and Results for Rural Data

Chairman: Pippa Gibson, DEFRA

Overview: *This session discussed new technologies for rural and agricultural data. The papers fell into two categories: dissemination and collection. Papers looking at using new technologies to disseminate data were presented in George et al's and Barcaroli et al's paper. Papers examining the use of new technology for data collection, such as the use of remote sensing, were discussed in Smith et al's paper and GPS technology in Doumbia et al's paper.*

Agro-MAPS: Mapping sub National Agricultural Land Use Statistics on a Global scale, *Hubert George, Isabelle Verbeke, Sandra Corsi, FAO*

Agro-MAPS is an interactive web-based information system on land use which was created specifically to support several key global applications requiring sub national statistical data on crop production, area harvested, and yields. The system allows users to query and browse interactively the geo-referenced statistical data in the form of maps and subsequently to download data and maps for a selected country or region of interest. The data can also be processed interactively on the Agro-MAPS web site in order to display maps of locally and regionally important crops. Land use applications relevant to rural development span a range of nationally to globally important issues, including food security and poverty, sustainable land management, climate change, as well as policy formulation and planning. The presentation also described the potential use of Agro-MAPS data for the development of selected land use indicators and in the characterization of national and global land use (farming) system maps.

During the discussion the strength of the data was questioned, as imputed data gives different accuracy to directly observed data. However all data used in the project was already published and taken directly from each individual country as FAOSTAT data are not collected at sub-national level. The maps would be updated every six to twelve months.

Use of Remote Sensing in Combination with Statistical Survey Methods in the Production of Agricultural, Land Use and other Statistics: Current Applications and Future Possibilities, *Jeffrey Smith, Frédéric Bédard, Richard Dobbins, Statistics Canada*

The benefits of remote sensing versus sample surveys were discussed, and whether the remote sensing system was operational enough to remove the need for surveys for core variables. Questions regarding the cost of remote sensing were also raised, and while remote sensing removed the administrative burden on farmers there would be software costs. The groundtruthing element of the methodology could improve accuracy and reduce the need for individual surveys.

An Assessment of the Adoption and Impact of Improved Rice Varieties in Smallholder Rice Production System in Côte d'Ivoire,

Sékou Doumbia, Assémien Aman, Koko Louis, CNRA, Côte d'Ivoire

The issue of improving yields by using irrigation, herbicides and fertilizer was raised. Then relating to Smith's paper, the potential of using remote sensing to identify mixed cropping was discussed. It was suggested that if the fields were reasonably sized, the system could be used, though some crops with distinctive flowers/leaves would be more easily identified, and perhaps different rice varieties would be more difficult to distinguish. The question about the benefit of surveys over GPS to engage and involve farmers was also raised.

An Open Source Approach to Disseminate Statistical Data on the Web,

Giulio Barcaroli, Stefania Bergamasco, Stefano De Francisci, Leonardo Tininini, ISTAT

The discussion began with a discussion of the users of the technology; as well as ISTAT, countries such as Kosovo and Bosnia subscribed to the system. There was also discussion of the disclosure control needed for such a system, and whether users themselves should have access to the full dataset and apply their own disclosure rules or whether the system would control for disclosure issues before dissemination. Tininini confirmed that in the case of the ISTAT system, the latter methodology was adopted.

Agro-MAPS: Mapping sub National Agricultural Land use Statistics on a Global Scale

Hubert George
Land and Water Division, FAO, Viale delle Terme di Caracalla, Rome, Italy,
hubert.george@fao.org

Isabelle Verbeke,
Land and Water Division, FAO, Viale delle Terme di Caracalla, Rome, Italy,
isabelle.verbeke @fao.org

Sandra Corsi
Land and Water Division, FAO, Viale delle Terme di Caracalla, Rome, Italy,
sandra.corsi@fao.org

Abstract: *Agro-MAPS is an interactive web-based information system on land use which was created specifically to support several key global applications requiring sub national statistical data on crop production, area harvested, and yields. These selected statistics represent a limited, yet important component of agricultural land use. In response to user needs, data are provided in both vector and raster formats. The system allows users to query and browse interactively the geo-referenced statistical data in the form of maps and subsequently to download data and maps for a selected country or region of interest. The data can also be processed interactively on the Agro-MAPS web site in order to display maps of locally and regionally important crops. A broad range of land use applications relevant to rural development is supported by Agro-MAPS data. These applications span a range of nationally to globally important issues, including food security and poverty, sustainable land management, climate change, as well as policy formulation and planning. This paper describes the potential use of Agro-MAPS data for the development of selected land use indicators which are relevant to these issues, as well as a recent application in the characterization of national and global land use (farming) system maps. Such maps are also of value as spatial planning and policy frameworks in support of rural development using a 'territorial' approach.*

Keywords: sub national, land use, statistics, farming systems, land use systems, land use planning, indicators.

1. Introduction

1.1 Land issues of relevance to rural development

For many developing countries, policy issues on land resources within the context of rural development can broadly be linked to Millennium Development Goals 1 (*Eradicate extreme poverty and hunger*) and 7 (*Ensure environmental sustainability*) (Millennium Ecosystem Assessment, 2005). Some major recurrent and emerging land use (LU) issues which influence progress by countries toward these goals are briefly described below.

Goal 1

- Where and what LU changes are needed in order to enhance food security and poverty? This is a recurring issue made more urgent in view of recently reported slow progress toward the 1996 World Food Summit goal to reduce by half, between 1990–92 and 2015, the number of undernourished people[29] (FAO, 2008a).
- How to minimize the risk of poorer farmers in insecure tenure conditions being driven to increasingly marginal lands as a consequence of high demand for bio energy production.
- How to cope with land scarcity due to low national endowment in suitable cropland relative to needs? This issue has been exacerbated by recent trends of large- scale sovereign-backed acquisition of croplands for irrigated crop production. Such acquisitions, which often occur with little to no involvement of local stakeholders, increase competition for water resources and may lead to water scarcity.
- What are the likely impacts of climate change on land suitability and land use? There is a need to encourage appropriate adaptation of existing land use (production) systems to expected changes in rainfall and temperature patterns.
- Increasing global urbanization tendency. The proportion of world population in urban areas is expected to grow from 47 percent in 2000 to 60 percent in 2030 (UNHABITAT, 2009). This highlights differences in peri-urban vs. rural needs, in terms of use of land and water resources, and the need for adequate information on land use along with appropriate means for deciding on land use options.
- Highly variable food prices. What investments and land use changes are needed to maximize opportunities to the vulnerable poor who spend a large % of household income on food and would be adversely affected by high prices?
- What are the expected impacts on rural development in the major centers of present-day crop production as a result of adoption of new agricultural technologies?

Goal 7

- Land degradation. What LU options should be promoted and where in order to reduce the social and economic impacts of land degradation?
- Sustainability of current agro-ecosystems. What LU changes are needed to ensure that levels of social, economic and environmental benefits concurrently fall within limits considered acceptable by stakeholders, on a long-term basis?
- Food versus environmental trade-offs. Biodiversity may be negatively affected by changes in LU – e.g. (i) replacement of forests by cropland in order to meet food production needs. (ii) The production of bio energy crops in order to mitigate climate change may reduce food crop production and lead to higher food prices.

A key element in objective decision making on these land-related issues is access to appropriate information, including statistics – at policy relevant scales on the endowment in natural resources of a given country or region as well as on how these resources are used within the given socio-economic setting i.e. the land use. Here, land use refers not only to the socio-economic purpose of activities undertaken in order to obtain desired benefits from the land (e.g. crop or livestock production), but also to information on the land management (e.g. rain fed vs. irrigated, use of fertilizers, mechanization, etc.) which is applied in order to obtain such benefits.

There is relatively little treatment of land-related issues in Chapter II (National and international rural development policies) of the current handbook on Rural households' livelihood and well being (Wye City Group, 2009). A main objective of this paper is therefore to show how existing statistical data available within the Agro-MAPS land use information system – when analyzed in combination with other relevant datasets - could be useful for meeting the information needs of decision making on some of the critical issues outlined above. In particular, the paper shows how these data could be used to develop several useful indicators at sub national scale as well as their application in the mapping of major land use systems at policy-relevant scales

[29] The Millennium Development Goal 1, target 3 is to halve, between 1990 and 2015, the proportion of people who suffer from hunger.

(sub national to regional) in support of land degradation assessment and remediation. The LU system maps serve as spatial ‘livelihood-based’ frameworks in support of targeted policy interventions. This framework is consistent with the gradual shift from a ‘sectoral’ to a ‘territorial-based’ approach to rural development policy formulation in developing countries described in Chapter II.3 of the handbook (Wye City Group, 2009).

2. Agro-MAPS

2.1 Origins and key database characteristics

Agro-MAPS is an interactive web-based information system on land use which contains statistics on primary food crops, aggregated by sub-national administrative districts, on crop production, area harvested and crop yields (Agro-MAPS, 2009). The database was originally developed as a joint initiative by FAO, IFPRI (the International Food Policy Institute), SAGE (The Center for Sustainability and the Global Environment) and CIAT (The International Center for Tropical Agriculture) to support a variety of applications being developed separately by the three institutions. Agriculture is a major source of employment and use of land in many developing countries. The raw statistics and directly derived information available through Agro-MAPS therefore represent a limited, yet very important component of land use.

Agro-MAPS permits regional to global overviews of crop production statistics and their spatial variation with a sub national level of detail. Agro-MAPS data are obtained mainly from published reports on national agricultural censuses, usually carried out every 5 to 10 years, or from annual estimates reported in published sources. The data are subject to minor pre processed in order to ensure overall consistency and enhance accuracy of the final integrated database. This includes (i) replacement of non-standard crop names and statistic descriptions with standardized FAO unique identifier codes[30] (ii) conversion when necessary, of data on ‘production’, ‘area harvested’ and ‘yield’ to standardized reporting units (i.e. metric tons, hectare and metric tons per hectare, respectively). Where possible, differentiation is made between ‘not reported’ and true ‘zero’ values. Basic meta-data, including citation of original sources, are included.

Agro-MAPS contains data aggregated at the first and second levels of administrative subdivision below the national level. The statistical tables include unique identifier codes (NUTS[31] for European countries, and SALB[32] for most other countries) for the administrative districts in each country. The codification schemes allow ready visualization of the tabular data as maps. Emphasis has been placed on compiling recent data; however, data covering multiple years are also available for many countries. Data for a total of 134 countries (130 countries at admin1 level and 59 countries at admin2 level), from six geographic regions (Africa, Asia, Near East in Asia, Latin America and the Caribbean, North America and Oceania) and representing approximately 92 percent of the world’s land surface, are currently available in Agro-MAPS. It is planned to improve further Agro-MAPS contents and coverage through distributed updating of site contents by partner institutions.

Access to the latest Agro-MAPS data is facilitated through an Interactive web site. Users can interactively browse the database and download statistical data in a variety of output formats (csv, dbf, xml) as well as the related shapefiles. Users can also create, for a selected country or region, thematic maps showing the spatial distribution of crop production, area harvested and yields, by year (or for the latest year for which data are available). Data distributions can be examined and display legends subsequently modified dynamically. The system can also generate interactively maps showing locally

important crops or user-definable crop groupings, based on relative contributions of individual crops or crop groups to the total harvested area for a given administrative unit (see below).

[30] FAOSTAT http://faostat.fao.org/site/567/default.aspx#cible
[31] NUTS http://ec.europa.eu/comm/eurostat/ramon/nuts/splash_regions.html
[32] Second Administrative Level Boundaries project http://www3.who.int/whosis/gis/salb/salb_home.htm

2.2 *Adding value*

The Agro-MAPS database is essentially a compilation of existing publicly available statistical data. However, it contains information of added value in the following key aspects that are of interest to a wide range of applications at sub national to global scales (see Annex).

- The database is a standardized global compilation of sub national data – in contrast to national aggregates available in FAOSTAT. Agro-MAPS thus facilitates regional to global analyses and perspective studies with a sub national level of detail which allows for better geographic targeting of interventions within countries.
- Data are geo-referenced and available in both vector and raster formats so as to facilitate ready integration with multiple user applications.
- The basic statistics are used to compute derived information, notably (i) the identification of locally important crop (or FAO crop groups). This information is a required input for the characterization of land use systems as described in the section which follows (ii) Agro-MAPS data are combined with other data in order to produce land use indicators of relevance to a variety of rural development issues.

The application of Agro-MAPS data to the characterization of land use systems and the development of indicators of relevance to MDG goals 1 and 7 is outlined in the following section.

3. Selected applications of Agro-MAPS data

3.1 *Mapping and the characterization of major land use systems*

Land use systems are areas representing significantly distinct geographic assemblages of three major land use characteristics: (i) the natural resources base, (ii) current land use and management, and (iii) the socio-economic setting, which influence the choice of land use and management options (George and Petri, 2006). These three classes of criteria inform on, among others, the inherent potentials and constraints of the resources base under prevailing socio-economic conditions. A LU system map therefore provides a useful spatial basis of 'stratification' for the purposes of tailoring planned interventions according to geographic zones sharing broadly similar characteristics of relevance to rural development. LU system maps therefore support an integrated 'livelihoods' (as opposed to a focused sector-based) approach to rural development planning. They facilitate analyses not only of problems but also of opportunities for appropriate interventions.

In practice, maps of LU systems are created by spatial integration of relevant data corresponding to each of the 3 major land use characteristics with the aid of geographic information systems as well as with input of expert local knowledge (George and Petri, 2006) (CSE, 2007). Expert knowledge is often a key requirement for mapping at national to sub national scales in order to overcome limitations in accurately delimiting small, yet locally significant LU systems, during the integration of spatial datasets which may vary widely in spatial resolution.

During the creation of the LU system maps, data from Agro-MAPS are used to identify sets of locally-important (dominant) crops which are associated with areas in which cropping is considered significant as interpreted from land-cover information derived from remote sensing imagery. Locally-important crops for each administrative unit are identified by noting which set of crop(s) having the highest relative percentages of total harvested area together just exceed a predetermined threshold percentage (75 percent) of the total harvested area for the administrative unit in question. A range of attributes (biophysical, socio-economic) could be linked to each land use system map in order to broaden its eventual usefulness for various applications. Dominant crop groups[33] (e.g. root crops, cereals, tree crops...) distinguish cropping activity within various agro-ecological zones. Such groupings were also a key element used by Dixon et al (2001) in characterizing land into broad

[33] Selected major FAO crop groups: (i) Cereals – e.g. wheat, rice, barley, maize, oats, millet, sorghum, fonio; (ii) Roots and Tubers – e.g. potatoes, cassava, yams; (iii) Pulses – e.g. beans, peas, lentils; (iv) Oil bearing crops – e.g. soybeans, groundnuts, oil palm, olives, sunflower seed, sesame seed, cotton seed; (v) Vegetables; (vi) Fruits.

farming systems using a predominantly expert-based approach in which on-site as well as off-site characteristics considered important in defining livelihoods (e.g. off-site income) were used in determining system boundaries. The farming systems were used to identify specific agricultural and rural development needs and opportunities, including priority areas for investment to counter food insecurity and poverty. Off-site characteristics are not considered in LU system mapping owing to the general unavailability of relevant spatial data.

A map of major land use systems at a global scale was recently created using GIS analyses only for the LADA project (Nachtergaele and Petri, 2008) (LADA, 2009). At national level, LU systems are used in the LADA project to guide assessment of the type and severity of land degradation as well as plan appropriate remedial measures, including policy formulation for rural development. Selected results for Senegal are presented in Figures 1 and 2.

Figure 1 - Map of locally important crops at departmental level in Senegal, reproduced from data generated interactively on the Agro-MAPS website.

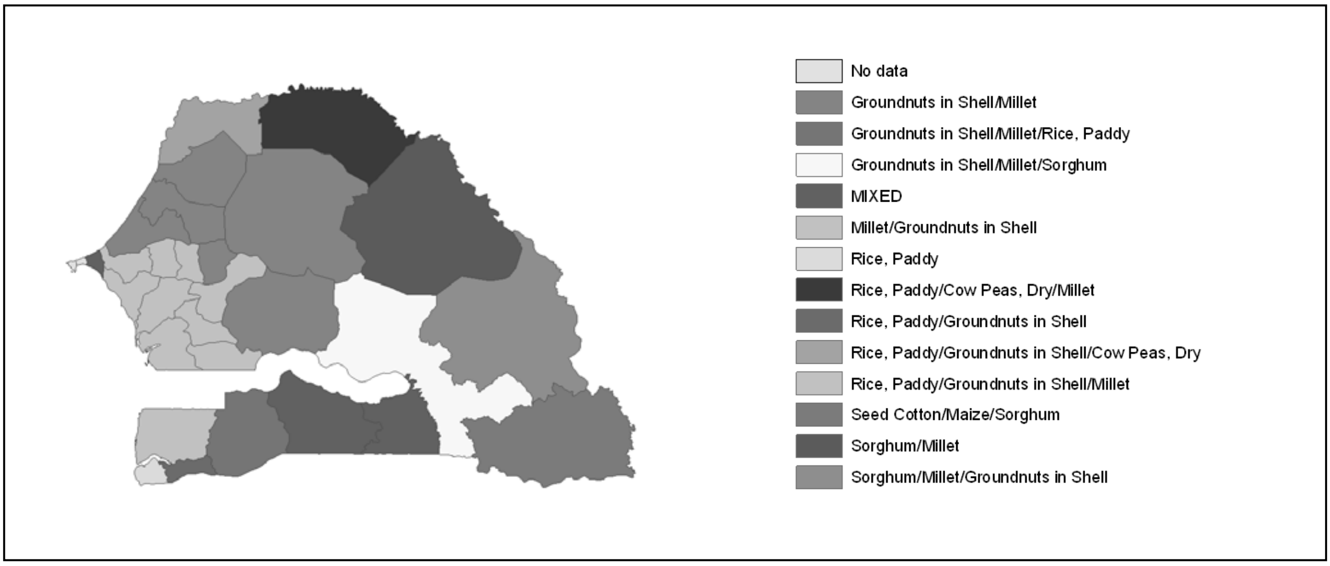
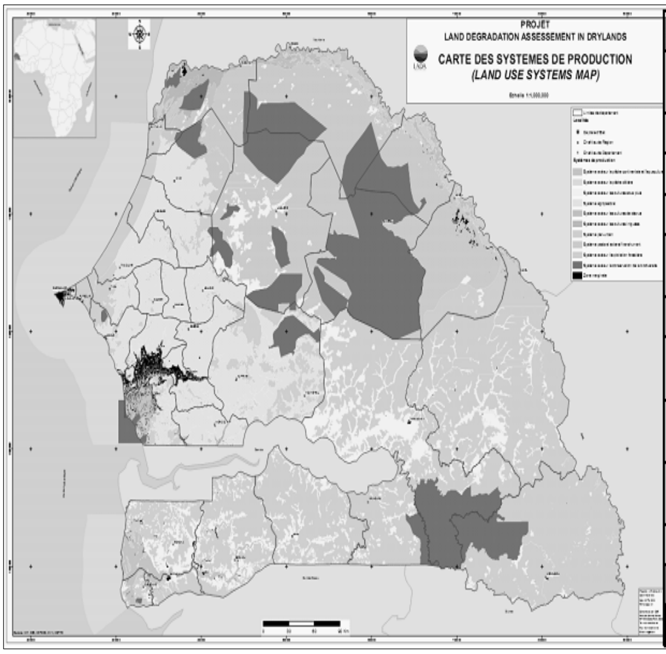


Figure 2 - Map of the major land use systems of Senegal overlain with administrative boundaries (Centre de Suivi Ecologique, 2007). Observations on land-management practices and land degradation within each land use system are aggregated to each administrative unit



Legend	Attributes
Inland fishing and aquaculture	Mangrove and aquatic vegetation; regularly flooded zone
Offshore fishing	Artisanal fishing; national industrial fisheries
Rainfed cropping	Significant presence of croplands; few cattle
Agro pastoral	Many cattle; significant presence of cropland; 400-700mm rainfall
Flood recessional cropping	Significant presence of cropland; flood-prone zone
Irrigated cropping	Significant presence of cropland; significant irrigation infrastructure; intensive inputs
Peri-urban agriculture	Mixed activities (animal husbandry; horticulture; fishing); Littoral North hydro geologic unit; close to urban centres; intensive inputs
Extensive Pastoral - transhumance	Large numbers of cattle; low population density; insignificant cropland
Extensive Pastoral - sedentary	Intermediate numbers of cattle; significant cropland;
Forest based	Woodlands and forests outside of protected areas
Protected areas	Protected zones (national parks, reserves)
	Tannes ; rock outcrops ; hardpans ; bare soils ; artificial zones

3.2 Facilitating a 'territorial' approach to addressing land issues

Preliminary insights on livelihoods which could be of priority concern in achieving progress towards MDG1 may be obtained by more in- depth analyses of LU system maps.

Specific analyses could target, for instance, the identification of 'hotspot' areas requiring priority attention for remedial actions by mapping areas which are (i) characterized simultaneously by high poverty, high population density and high levels of land degradation (ii) subject to highest relative pressures on the sustainability of agro-ecosystems as determined from spatial analysis of globally available data on several key environmental and socio-economic factors (George et al, 2009). The outcomes of these analyses support decision making in rural development in that they are indicative of pressures influencing changes in land use, migration rates, and rural employment opportunities.

4. LU indicators

Agro-MAPS data, either alone or in combination with other data on the natural resource base or socio-economic setting are useful for developing indicators relevant to most of the land issues presented earlier under 'Introduction". Indicators which inform specifically on land degradation and land scarcity include the following:

- Percent changes in (i) crop production, (ii) area harvested or (iii) yields (however, changes may be affected by fluctuations due to land management and rainfall)
- Percent changes in (i) per capita crop production or (ii) per capita area harvested
- Proportion of harvested area to total suitable land (Note: this differs from 'ratio of arable land to total land area' cited in FAO, 2008b)

- Cropping intensity (i.e. harvested area/cropland area). This indicator could be calculated for cases where crop data are comprehensive and the extent of cropland is known. It is useful for estimating future food production under given conditions of the availability of land suitable for cropping and population growth.
- Yield gap. Difference between potential yields and actual yields available from Agro-MAPS. Potential yields can be predicted from agro-ecological modeling or through field trials which examine crop response to plant nutrients. The FERTIBASE information system contains data from field-trials on yields within selected agro-ecological zones for the main crops of a country (FERTIBASE, 2009). Mapping of yield gaps allow geographic targeting of regions where productivity gains having predictable positive impacts on crop production and eventually rural employment and increased food security, are possible.

5. Concluding remarks

The Agro-MAPS land use information system facilitates access to sub national aggregated statistics on area harvested, production and yields, on a global basis. These data, especially when combined with other widely available information, are useful for a range of user applications, including the mapping of land use systems at various scales. Such systems facilitate the adoption of more effective 'territorial', rather than sectoral-based, approaches to planning and policy formulation for rural development.

The data are also useful in developing a range of indicators at a sub national level on recurrent and emerging issues related to land resources and MDG goals 1 and 7.

References

Agro-MAPS (2009). Available at http://www.fao.org/landandwater/agll/agromaps/interactive/page.jspx

Centre de Suivi Ecologique (2007). Préparation du guide pour la stratification – Projet LADA. Rapport intérimaire 2. 22p.

Dixon J., Gulliver A., Gibbon D. (2001). *Farming systems and poverty: Improving farmers'livelihoods in a changing world. FAO and World Bank*, 412 p, in: http://www.fao.org/farmingsystems/

FAO (2008a). *The state of food insecurity in the world*, in: http://www.fao.org/docrep/011/i0291e/i0291e00.htm

FAO (2008b). *Tracking results in agriculture and rural development in less-than-ideal conditions. A sourcebook of indicators for monitoring and evaluation*, in: http://www.fao.org/docrep/011/i0380e/i0380e00.htm

FERTIBASE (2009). in: http://www.fao.org/ag/agl/agll/nrdb/index.jsp?lang=en

George H., Todd K., Peiser L. (2009). *Areas of agricultural ecosystems under sustainable management: building on LADA achievements*; in Proceedings of LADA workshop, Bangkok, April 2009 (in press)

George H. & Petri M. (2006). f-CAM – *The rapid characterization and mapping of agricultural land use: A methodological framework approach for the LADA project.* Unpublished report, FAO. 26p, in: http://www.fao.org/nr/lada/index.php?/Technical-Reports-and-manuals/View-category.html

LADA (2009). *Land degradation in drylands*, in: http://lprlada.fao.org/lada/

Millennium Ecosystem Assessment (2005) Ecosystems *and human well being. A framework for Assessment*, in: http://www.millenniumassessment.org/en/Framework.aspx

Nachtergaele, F. and M. Petri (2008). *Mapping land use systems at global and regional scales for land degradation assessment analysis*, 13p, in: ftp://ext-ftp.fao.org/SD/Data/Upload/LADA/Land_Use_Systems/TR08-G-LUS_Guidelines_new.doc

UNHABITAT (2003). *World urbanization prospects: The 2003 revision*, in: http://www.un.org/esa/population/publications/wup2003/WUP2003Report.pdf

Wye City Group (2009). *Rural households' livelihood and well being*, in: http://www.fao.org/statistics/rural/

Annex - Selected applications in which Agro-MAPS data are used
(Extracts from an Agro-MAPS user survey conducted in April 2009)

Climate change
- GIS-based cropland GHG inventory for Burkina Faso and Tanzania
- Carbon sequestration calculation
- MSc research project aiming to upscale the emissions of the ozone depleting gas methyl bromide
- research on carbon sequestration in croplands

Land use (policies; assessment; planning)
- Land use assessment in calculating arid and semi arid land area in Kenya
- Plantation planning
- Comparing yields between SSA and LA
- Biofuels policies impact on land use
- For presentation of sugarcane production areas under cultivation and yield in India
- For research Purpose- Land-livestock planning on country scale
- Data Preparedness for response to emergency
- Preparation of seminar on food security

Investment and marketing
- Investment research
- Preparing analyses for sales department
- Size markets in Argentina and Brazil
- Soybean production in Madhya Pradesh research
- Researching oil palm industry in DRC
- Gain understanding of African agricultural imports/exports
- Food production and consumption in Asia

Environment analyses and management
- Geospatial analysis for evaluating North American and European Union ecological areas for pesticide dissipation studies project
- Ecological Region analysis North America and EU
- Establish GIS database for environment management

Academic and scientific
- Modeling exercise on water use
- Research on Crop Growth Modeling
- Bio-fuels research
- Change in indigenous land practices since 1950

Use of Remote Sensing in Combination with Statistical Survey Methods in the Production of Agricultural, Land Use and other Statistics: Current Applications and Future Possibilities

Jeffrey Smith
Statistics Canada, Jean Talon Building, Floor 12 C-8, 170 Tunney's Pasture Driveway
Ottawa, Ontario, CANADA K1A OT6
Jeffrey.Smith@statcan.gc.ca

Frédéric Bédard
Statistics Canada, Jean Talon Building, Floor 12 D-2, 170 Tunney's Pasture Driveway
Ottawa, Ontario, CANADA K1A OT6
Frederic.Bedard@statcan.gc.ca

Richard Dobbins
Statistics Canada, Jean Talon Building, Floor 12 D-2, 170 Tunney's Pasture Driveway
Ottawa, Ontario, CANADA K1A OT6
Richard.Dobbins@statcan.gc.ca

***Abstract**: This paper describes the Prince Edward Island potato area estimation and land cover classification study conducted by Statistics Canada from 2006 to 2008. The method involves several phases: a stratified statistical sample design to select a relatively small number of geographic sampling units ("cells") across the province; acquisition of multi-date satellite imagery covering the entire island; aerial and ground level observations for visual identification of selected cells (ground truthing); and the combination of data using statistical techniques (e.g., regression) to produce land cover and selected crop area estimates and associated measures of precision. The paper reviews the methodology used and presents results from the three year study period, examining both the individual years as well as the changes in land cover and land use observed during the period. A discussion of additional applications of this approach will also be included.*

Keywords: Remote sensing, land cover, land use, stratified sampling

1. Introduction

1.1 General Overview

Timely and accurate information on the area and location of crops, and more generally land cover/land use, is an important input to agricultural, rural and environmental decision making and policy development. For example, such information can inform debates concerning crop rotation, conversion of forested land to farmland, loss of farmland to urban development, environmental issues related to rural and urban areas, and so on. Traditional techniques involve direct collection of information from land owners or users, which not only involves respondent burden but may also introduce delays due to the combined length of the collection, processing and analysis periods. The availability and declining cost of higher resolution sensors has opened up the possibility of using satellite remote sensing data in conjunction with ground observation data and statistical methods to produce timely and precise land cover estimates with no burden on respondents.

The Agriculture Division of Statistics Canada was engaged by the Prince Edward Island (PEI) Department of Agriculture in the spring of 2006 to conduct a study on the improvement of potato area estimation and land cover classification. This paper describes the PEI Potato/Agricultural Land Area Estimate and Classification Study (known as PACS) conducted by Statistics Canada from 2006 to 2008. The method involves several phases: a stratified statistical sample design to select a relatively small number of geographic sampling units ("cells") across the province; acquisition of multi-date satellite imagery covering the entire Island; aerial and ground level observations for visual identification of selected cells (ground truthing); and the combination of data using statistical techniques (e.g., regression) to produce land cover and selected crop area estimates and associated measures of precision. The paper reviews the methodology used and presents results from the three-year study period, examining both the individual years as well as the changes in land cover and land use observed during the period. A discussion of additional applications of this approach is also included. Before getting into the details of the project and results, an overview of the area where the study was conducted is provided.

1.2 Brief Introduction to Prince Edward Island

The Canadian confederation was born in 1867 when the British North American colonies of New Brunswick, Nova Scotia and Canada (the latter being the result of the union of Lower Canada and Upper Canada, essentially Québec and Ontario, respectively, in 1841), united under the name Dominion of Canada. Relatively soon after, Manitoba (1870), the Northwest Territory (1870) and British Columbia (1871) joined. Prince Edward Island, after some reluctance, joined the confederation in 1873. Thereafter followed a period of inactivity until the Yukon made its entry in 1898, followed by Alberta and Saskatchewan, both in 1905. Another long interval followed until Newfoundland joined in 1949 (the province name changed to Newfoundland and Labrador in 2001). The latest change was the creation of Nunavut in 1999, creating the present day configuration of 10 provinces and 3 territories.

Prince Edward Island (PEI) is Canada's smallest province. The Island is located in the Gulf of St. Lawrence and is separated from the mainland by the Northumberland Strait (a tidal water body), which ranges from 4 to 17 kilometres in width and has depths ranging from 68 metres to less than 20 metres. The Island itself is about 224 kilometres in length and between 6 and 64 kilometres in width, with a land area of approximately 5,662 square kilometres (566,171 ha, or 1.4 million acres). The 12.9 kilometre Confederation Bridge, linking PEI to the mainland, was opened in 1997. The Island is formed from sedimentary bedrock of soft, red sandstone which contributes to the richness of the soil and imparts the characteristic red colour. The population of the Island was enumerated at 135,851 or about 24 persons per square kilometre at the time of 2006 Census (conducted in May that year). The January 1, 2009 intercensal population estimate puts the population at 140,402 (making the density a bit under 25 persons per square kilometre).

Continuing with the 2006 Census results, nearly 75,000 people (55 percent) were found living in one of the two census agglomerations[34] (CA) in the province, Charlottetown (population 58,625; density 80.5 persons per km^2) and Summerside (population: 16,153; density 175.9 persons per km^2). The land area of these two CAs is about 820 km^2 (728 km^2 and 92 km^2, respectively), representing about 14.5 percent of the total land area of the province. Within the CA of Charlottetown is the city of Charlottetown, which is the capital city of PEI and which recorded a population of 32,174 in 2006 with an area of about 44 km^2 (density of 725.8 persons per km^2). The city of Summerside, within the CA of the same name, had a 2006 census population of 14,500 and an area of about 28 km^2 (density 511.3 persons per km^2). The urban/rural character of the province will be revisited later.

The major industries in the province are agriculture, tourism, fishing and manufacturing. Within the agriculture sector, potatoes are a very important crop.

[34] A census metropolitan area (CMA) or a census agglomeration (CA) is formed by one or more adjacent municipalities centred on a large urban area (known as the urban core). A CMA must have a total population of at least 100,000 of which 50,000 or more must live in the urban core. A CA must have an urban core population of at least 10,000. To be included in the CMA or CA, other adjacent municipalities must have a high degree of integration with the central urban area, as measured by commuting flows derived from census place of work data.

2. The Potato/Agricultural Land Area Estimate and Classification Study

2.1 Background

In the spring of 2006, the Remote Sensing and Geospatial Analysis (RSGA) Section of the Agriculture Division of Statistics Canada was engaged by the Prince Edward Island (PEI) Department of Agriculture to conduct a study on the improvement of potato area estimation and land cover classification. This project was also supported by the Prince Edward Island Potato Board. Potato area is of particular interest to PEI since farm cash receipts from potatoes represent over 80 percent of the total crop receipts in the province and since PEI accounts for nearly a quarter of total Canadian potato production (2008 figures). The project, formally known as the Potato/Agricultural Land Area Estimate and Classification System (PACS) study, was conducted for each of the 2006, 2007 and 2008 growing seasons. Prior to undertaking this project, the RSGA Section had successfully completed the six-year PEI Land Cover Classification Project (PLCCP) which provided annual forest and agricultural land cover classification for the years 1995 through 2000.

2.2 "Traditional" Statistics

Before presenting the details of the PACS project, some other more traditional means of producing crop area and land use statistics are briefly described.

Every five years, Statistics Canada conducts the Census of Agriculture. This data gathering exercise collects a variety of information from the approximately 230,000 agricultural operations (the 2006 count was 229,373) in Canada. The Census of Agriculture defines an agricultural operation as one that "produces at least one of the following products (a list is given on the questionnaire[35]) intended for sale." Among its various sections, the Census asks operators to report on area generally (total or workable and non-workable land) as well as areas[36] for: field crops and hay (27 specific, plus "other"), vegetables (24 specific, plus "other"); fruits, berries and nuts (13 specific, plus "other"), sod and nursery products, Christmas trees, fallow and pasture land, greenhouse flowers, vegetables and other products, and mushrooms. Since the Census is conducted in mid-May, the areas to be reported are "to be harvested", "seeded or to be seeded", "planted or to be planted", etc. As noted, these data are collected at five year intervals and rely on the operators to report the areas for 2006 and, since the collection period begins in mid-May, to base these reports on their best estimates. The quality of the estimates will depend to some extent on the type of area being estimated – for things like tree fruit orchards, greenhouse areas and crops that are already fully planted by Census day, the areas will be known, while areas which have not been seeded (or fully seeded) at the time the operator completes the questionnaire may be less accurate.

The 2006 Census of Agriculture counted 1,700 farms in PEI, with an average size of about 148 hectares. Of the 1,700 farms, 1,524 reported having some land in crops, on average about 113 hectares. However, a reasonably large number of those farms also reported keeping livestock. For example, of the 1,700 farms, 923 reported cattle and calves (average of 94 head per farm reporting), 288 farms reported horses and ponies (average of 7 per farm reporting), 152 reported hens and chickens (average of 2,941 birds), 149 farms reported pigs (average of 827 animals per farm), and 69 farms reported sheep and lambs (average of 57 head per farm). Obviously, many farms are engaged in a combination of crop and livestock production. Classified according to

[35] Crops: hay, field crops, tree fruits or nuts, berries or grapes, vegetables seed; Livestock: cattle, pigs, sheep, horses, game animals, other livestock; Poultry: hens, chickens, turkeys, chicks, game birds, other poultry; Animal products: milk or cream, eggs, wool, furs, meat; Other agricultural products: Christmas trees, sod, greenhouse or nursery products, mushrooms, honey or bees, maple syrup products.

[36] Areas are asked for crops to be harvested in 2006, even if planted in an earlier year, including those to be seeded even if not yet seeded.

the North American Industry Classification system (NAICS[37]), the 1,700 farms counted in the 2006 Census of Agriculture were distributed as follows:

Table 1 - 2006 Census of Agriculture PEI Farm Counts by Industry Group

INDUSTRY GROUP (NAICS code)	Number of Farms	% of total
Oilseed and Grain Farming (1111)	75	4.4
Vegetable and Melon Farming (1112)	384	22.6
Fruit and Tree-nut Farming (1113)	153	9.0
Greenhouse, Nursery and Floriculture production (1114)	34	2.0
Other Crop Farming (1119)	164	9.6
Subtotal crop production	**810**	**47.6**
Cattle Ranching and Farming (1121)	602	35.4
Hog and Pig Farming (1122)	71	4.2
Poultry and Egg Production (1123)	29	1.7
Sheep and Goat Farming (1124)	17	1.0
Other Animal Production (1129)	171	10.1
Subtotal animal subtotal	**890**	**52.4**
TOTAL	**1,700**	**100.0**

Source: Selected Historical Data from the Census of Agriculture, Statistics Canada catalogue no. 95-632-XWE

The 2006 Census of Agriculture estimates of crop areas for PEI are shown in Table 2. Given the relative balance between crop and animal production, it should not be surprising to see that hay, pasture and barley are among the significant land uses on the Island.

[37] The North American Industry Classification System (NAICS) is an industry classification system developed by the statistical agencies of Canada, Mexico and the United States. Created against the background of the North American Free Trade Agreement, it is designed to provide common definitions of the industrial structure of the three countries and a common statistical framework to facilitate the analysis of the three economies. NAICS is based on supply-side or production-oriented principles, to ensure that industrial data, classified to NAICS, are suitable for the analysis of production-related issues such as industrial performance. NAICS is principally a classification system for establishments and for the compilation of production statistics. An establishment is classified to an industry when its principal activity meets the definition for that industry. In most cases, when an establishment is engaged in more than one activity, the activities are treated as independent. The activity with the largest value-added (value of outputs minus cost of inputs) is identified as the establishment's principal activity, and the establishment is classified to the industry corresponding to that activity. For the 2006 Census of Agriculture, farms were classified using NAICS 2002. The current version of the NAICS is the 2007 edition.

Table 2 - PEI Crop Areas from the 2006 Census of Agriculture

CROP OR OTHER CLASSIFICATION	Land area (hectares)
Total area *	**566,171**
Total area of farms **	**250,859**
Land in crops ***	**171,296**
*Tame hay **	*63,699*
*Potatoes **	*39,512*
*Barley **	*32,071*
*Spring wheat (excl. durum) **	*9,267*
*Durum wheat **	*0*
*Winter wheat **	*5,079*
*Soybeans **	*4,580*
*Berries and grapes **	*4,135*
*Mixed grains **	*4,096*
*Corn for silage **	*1,773*
*Corn for grain **	*818*
*Fall rye **	*1,741*
Spring rye	*464*
*Vegetables (excl. greenhouse) **	*1,741*
*Buckwheat **	*187*
*Flaxseed **	*102*
*Canola **	*64*
*Tree fruits **	*59*
*Dry field beans **	*29*
*Sunflowers **	*8*
*Greenhouse area **	*5*
Other crops **	*492*
Tame or seeded pasture	**10,847**
Summerfallow land *	**231**
*All other farmland***	*68,230*
Non farm land	***315,312***

* Total area - total area of farms
** Total area of farms - land in crops - tame or seeded pasture – summerfallow land
*** Land in crops - sum of the named crops
Source: Selected Historical Data from the Census of Agriculture, Statistics Canada catalogue no. 95-632-XWE

Another source of traditional estimates (that is, collected by survey directly from farmers) is the Field Crop Reporting Series. This series consists of six survey occasions during each calendar year to collect information on grains and oilseeds, principal field crops and major special crops. From these six survey occasions, eight reports are produced covering stocks of grain at several points in the year (March 31, July 31 and December 31), area planted (March intentions, June preliminary estimates) and production (July, September and November estimates). This survey series draws its samples from the list frame established by the Census of Agriculture, and the sample size varies according to the survey occasion, ranging from about 11,800 farms (used to produce the December 31 stocks) to about 26,000 farms for the preliminary areas estimates produced in June, and about 30,000 farms in the sample used for the November production estimates. The other survey occasions have sample sizes in the 15,000 to 16,000 range. Selected area estimates for PEI, these from the November estimate of production, released on December 4, 2008, are given below.

Table 3 - Selected PEI Crop Area Estimates from the Field Crop Reporting Series

CROP	Land area (hectares)	
	Seeded	Harvested
Winter wheat[1]	2,000	2,000
Spring wheat	15,000	14,200
Oats	4,900	4,900
Barley	31,200	30,400
Mixed grains	3,200	3,200
Soybeans	7,300	7,300
Fodder corn	2,800	2,800
Tame hay	58,700	54,600

[1] Seeded area remaining in June after winterkill
Source: Field Crop Reporting Series, November Estimate of Production (2008), catalogue no. 22-002-X

Statistics Canada also conducts a Fruit and Vegetable Survey, for which the target population is all farms in the ten provinces of Canada that grow fruit and/or vegetables for sale. The survey frame excludes farms producing only mushrooms (there is a separate mushroom growers survey), farms producing only greenhouse vegetables, and farms producing only potatoes (greenhouses and potatoes are also surveyed separately), as well as farms that are on Indian reserves, community pastures and Hutterite colonies. Small farms with total fruit area or total vegetable area less than 1 acre are also excluded from coverage. The Fruit and Vegetable survey collects data to provide estimates of the total cultivated area, harvested area, total production, marketed production and farm net value of selected fruits and vegetables grown in Canada. There are two survey occasions; the spring survey collects data in April and May for the May-June reference period (with a sample size of about 12,500) and the fall survey collects data in November and December for the May to October reference period (with a sample size of about 9,200).

The following table illustrates some of the area data from the 2008 spring survey, released July 14, 2008.

Table 4 - Selected PEI Fruit and Vegetable. Areas from the Spring 2008 Fruit and Vegetable Survey

CROP	Land area (hectares)	
Fruit	Cultivated	Bearing
Blueberries[1]	3,845	1,659
Strawberries	91	73
Raspberries	12	10
Grapes[2]	8	8
Plums and prunes	2	2
Vegetables	Planted	Harvested
Carrots[3]	320	320
Rutabagas and turnips	223	223
Cabbage[4]	89	89
Pumpkins	32	32
Sweet corn	28	28
Beets	20	20
Broccoli	20	20
Lettuce[5]	14	14
Parsnips	14	14
Beans, green or wax	12	12
Cucumbers	8	8
Squash and zucchinis	4	4
Asparagus	2	2
Spinach	2	2
Tomatoes	2	2

[1] Includes low bush and high bush.
[2] Includes table and wine grapes.
[3] Includes baby carrots and regular carrots.
[4] Includes chinese cabbage and regular cabbage.
[5] Includes leaf and head lettuce.
Source: Fruit and Vegetable Production, June 2008, Statistics Canada, catalogue no. 22-003-X

The Potato Area and Yield Survey, as the name suggests, is a survey that is conducted to gather information particularly about potatoes. The target population includes all potato farms in Newfoundland and Labrador, Nova Scotia, Prince Edward Island, New Brunswick, Manitoba, Saskatchewan, and British Columbia except those on Indian Reserves and institutional farms. The Census of Agriculture provides a list of farms and their potato area. This list is updated annually from various available sources. The list frame is stratified on the basis of Census potato area and provincial geography. For 2008, 120 potato farms in Prince Edward Island were included in the sample. The survey is conducted twice per year. In June, data is collected for seeded area. The yield portion of the survey is conducted in October to confirm area planted and to ask for area harvested and production. Operations that had reported no potatoes in June are not contacted on the second occasion.

Table 5 - Recent PEI Seeded Area Estimates from the Potato. Area and Yield Survey

YEAR	Seeded area (hectares)	Coefficient of variation (%)
2006	38,315	4.01
2007	33,746	3.62
2008	35,438	4.56

Source: Potato Area and Yield Survey

Information from the Potato Area and Yield Survey, the Farm Product Prices Survey, the Survey of Fruits and Vegetables is used in conjunction with information from surveys conducted by certain provinces themselves (Québec, Ontario, Alberta), as well as administrative information, to publish the Canadian Potato Production bulletin three times per year (July, November, January). The first issue in each volume provides preliminary information on the new crop year, and subsequent issues may revise the estimates based on additional information. The table below shows PEI potato areas for selected years:

Table 6 - Estimates of Canadian Potato Production

	PEI Potato Land area (hectares)					
YEAR	Vol.4, no.1 (Jul 2006)		Vol.4, no.2 (Nov 2006)		Vol.4, no.3 (Jan 2007)	
	Seeded	Harvested	Seeded	Harvested	Seeded	Harvested
2006	39,256	..	39,256	38,366	39,256	38,527
YEAR	Vol.5, no.1 (Jul 2007)		Vol.5, no.2 (Nov 2007)		Vol.5, no.3 (Jan 2008)	
	Seeded	Harvested	Seeded	Harvested	Seeded	Harvested
2006	39,256	38,527	39,499	38,77	39,499	38,77
2007	39,054	..	38,851	38,851	38,851	38,851
YEAR	Vol.6, no.1 (Jul 2008)		Vol.6, no.2 (Nov 2008)		Vol.6, no.3 (Jan 2009)	
	Seeded	Harvested	Seeded	Harvested	Seeded	Harvested
2006	39,499	38,77	39,499	38,77	39,499	38,77
2007	38,851	38,851	38,851	38,851	38,851	38,851
2008	37,637	..	37,435	36,018	37,435	36,018

.. Data not available for specific reference period
Source: Canadian Potato Production, Statistics Canada, catalogue no. 22-008-X

The examples of crop and land area estimates that come from the sources mentioned above share some properties. For the most part, the data is collected by census or survey directly from the farm operator (in some cases, a portion of the input data is derived from administrative sources). This has a number of consequences. Aside from the sampling error (except in the case of the Census of Agriculture), there may be reporting error. In addition, there is the burden placed on the sampled farms to respond to the surveys, often at times of the year when they are quite busy. This somewhat "goes with the territory" as surveys of this nature are usually timed to collect the information when the data being requested, whether about planting intentions, areas seeded, amount harvested, etc., are "at hand", that is, the event being asked about is taking place, nearing completing or has just ended. Even in the case of just-ended events, though, farmers are typically engaged in the next activity, so there is never really a good time (i.e., when they are not quite busy) to survey them during the growing season. This brings up another point related to reporting, namely, timeliness. The in-season surveys typically have quite short collection periods and attempt to be in the field at a certain time. The goal is to get the data and produce the estimates while they are still timely and relevant. Given the weather dependence of crop production, the planned field dates may be too early or too late given the conditions in a particular part of the country, and there is only a little scope to advance or delay field collection dates since interviewers are tightly scheduled. There will normally be only a few days "play" to accommodate anomalies.

Also, on the topic of reporting and the desire for timeliness, some of the surveys are scheduled to get an "early look." One example is the planting intentions survey conducted in March. By definition, the data collected here are somewhat subjective since farmers may not have firmly made up their minds on exactly what they will plant or how much. Even on the later surveys, when the crop is "in the ground", there may be some subjectivity as farmers may offer a conservative estimate of the eventual harvest on the mid-season report, and this tendency may persist even at the last report if the harvest is not quite done. Also, there is anecdotal evidence to suggest that some farmers are of the opinion that revealing their true planting intentions or the true size of their harvest will work against them by having the market react with lower prices for the commodity they have decided to raise if the numbers indicate that the supply will be plentiful. This opinion seems to persist despite studies in the US and Canada showing that the reaction of markets to the release of crop report data from statistical agencies is random, with prices rising as often as they fall.

The PACS project showed that objective, high precision, timely, cost-effective estimates of crop area and land cover can be produced with no burden on farmers.

2.3 PACS Overview

The main goal of the project was to successfully develop a Potato/Agricultural land area estimate and classification system to be delivered to management of the PEI Department of Agriculture, for each of the crop seasons 2006, 2007 and 2008. Specific project deliverables included the following:

- Generate area and precision estimates of **potatoes** in Prince Edward Island for each crop season using agricultural field data collected from a statistical sample;
- Generate area and precision estimates of **total agricultural land** in Prince Edward Island for each crop season using agricultural field data collected from a statistical sample;
- Generate a **province-wide land-cover/crop classification map** for potatoes, cereal grains, forages, other crops and other non agriculture land cover, based on the analysis of multi-date, medium resolution satellite data acquired for each crop season;
- Using potato data derived from analysis of satellite imagery and potato data collected on a sample basis from aerial and fieldwork, generate area and precision estimates of potatoes in Prince Edward Island using a regression estimator;
- Generate omission/commission tables (i.e., confusion matrices) of the land-cover/crop classification for principal agriculture classes;
- Prepare a report providing an outline of the general methodology, results and recommendations.

The approach taken by the project was to combine a statistical sample design, aerial observation and photography, ground-based observation and satellite imaging observation. The fieldwork was conducted starting around the end of July and continued into the early part of August. Given the interest in the potato crop in PEI, this is an ideal time since most potato fields on the Island are in flower, making identification easier and more accurate. Satellite images were acquired at several points during this same time period. The output of the combination of these techniques is a complete classification of the land area.

2.4 PACS Sampling Methodology

The sample design involved having the province delineated into Universal Transverse Mercator[38] (UTM) rectangular cells and a sample of these cells was selected using stratified one-stage sampling. For the 2006 growing season, the cells were 2 km x 3 km in size. In 2006, the stratification variable was the percentage of agricultural land within the cell in 2000, and the population of 1,217 cells covering the province were divided into 6 strata. A total of 147 cells were selected to be in the sample. Thus, the sample covered approximately 882 km^2 or approximately 15.6 percent of the total land area of PEI (5,661.71 km^2). In the 2006 design, the sample was distributed so that approximately equal numbers of cells were selected into the sample from each stratum. This produced variable sampling fractions since the stratum sizes varied.

In 2007, the sampling design was changed, primarily in an attempt to reduce field collection costs without jeopardizing the precision of the estimates. Several options were considered for the cell size (1 km x 1 km, 1 km x 3 km and 2 x 3 km), and the 1 km x 1 km cell size was selected for use, with 6,546 being needed to cover the province. The stratification variable was also changed for 2007 – the average area of potatoes in 2000 and 2006 within the cell was used to create 5 strata. The 360 cells included in the sample meant that the sampled cells covered about 360 km^2, or about 6.4 percent of the land area. In the 2007 design, the sample size per stratum was not constrained to be equal, rather an optimal allocation was used (stratum sample size proportional to variance of the potato area within the stratum). The choice of a smaller size for the cells and selecting fewer of them, as noted above, was intended to reduce field collection work and avoid some problems encountered in previous years. This change in design also led to workload reductions in preparation for the fieldwork, data capture and in the quality assurance activities.

For 2008, the design was again changed slightly, to employ 1 km x 2 km cells, with a population of 3,387 cells being required to cover the province. The stratification variable was again changed, this time reflecting the average percentage of the cell area that was agricultural land in 2006 and 2007. Again, as in 2007, five strata were created and a sample of 202 cells was selected, so that approximately 404 km^2 or about 7.1 percent of the total land area of the province was covered by the selected cells. Also like 2007, the allocation of the sample to the strata was done proportionally to the variance (of the stratification variable) within the stratum, but in 2008, the sampling weight was constrained to be no greater than 30 in any stratum. Thus, in the most homogenous stratum for example, the calculated (unconstrained) sample size would have been four in 2008, producing a sampling weight of about 142, but this was adjusted to a sample size of 19, with associated weight of 29.95. In contrast, in the 2007 design, sampling units in three of the five strata had sampling weights in excess of 30 (the three largest weights were 31.56, 52.55 and 206.50). The 2008 design was basically a compromise design based on the lessons learned in 2006 and 2007, which attempted to combine the benefits of larger cell size (more fields per cell resulting in efficient collection and reduced travelling time) but avoid the drawbacks of "too large" cells (excess heterogeneity with a cell and having to pass over the cell many times which is not efficient or pleasant for the aerial team or citizens on the ground). The ability to view the fields within a cell was not affected by the cell size since generally speaking, the larger the cell, the more public roads it included, so that in all three years, about 70 percent of the fields could be adequately seen from the roadside.

The sample design of the ground truth data collection for each of the three years of the PACS project is shown below in Table 7.

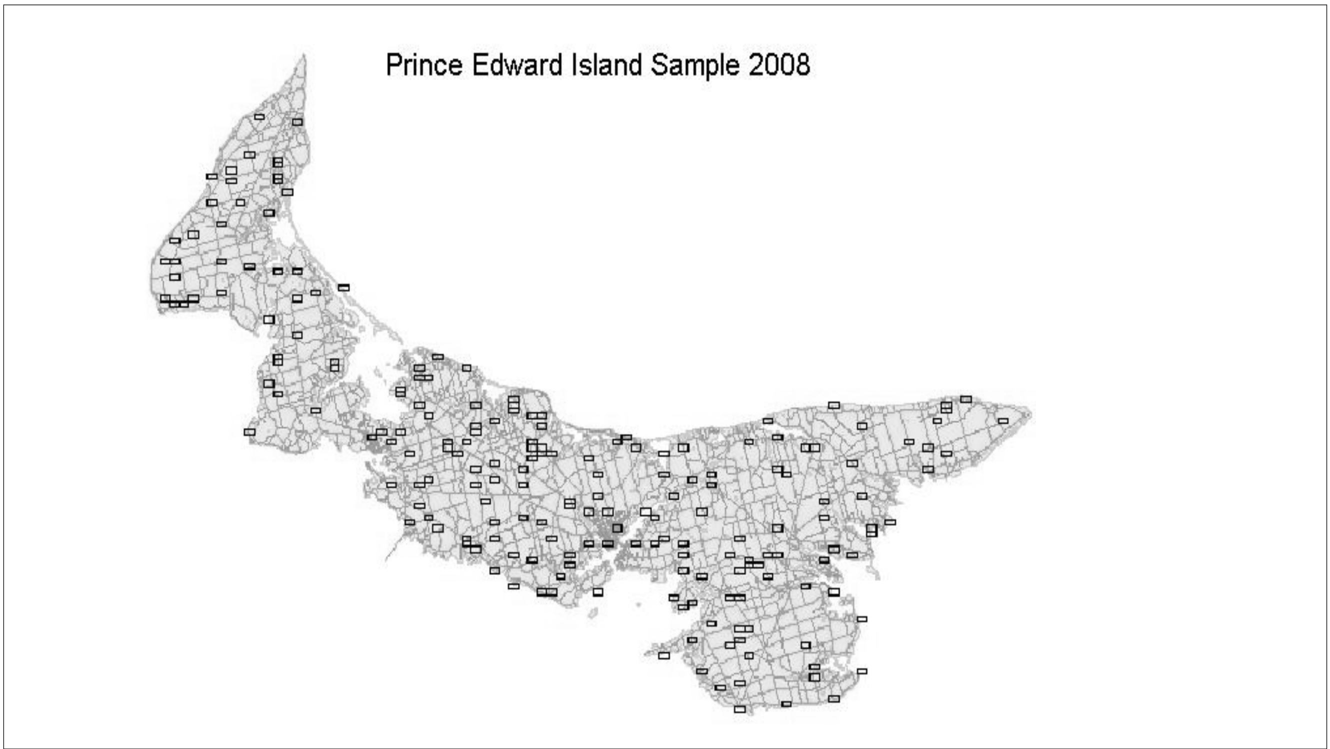
[38] Prince Edward Island falls into UTM Zone 20.

Table 7 - Summary of PACS Sample Designs for Ground Truth Data

DESIGN ASPECT	Year		
	2006	2007	2008
Sample unit (cell) size	2 km x 3 km	1 km x 1 km	1 km x 2 km
Number of cells to cover province	1,217	6,546	3,387
Sample size (number of cells)	147	360	202
Total area in sample (km^2)	882	360	404
Number of fields in sample cells	4,700	5,230	4,273
Portion of province in sample (%)	15.6	6.4	7.1
Number of strata	6	5	5
Stratification variable(s)	Total area in potatoes, grain, hay and pasture in 2000	Average % of area in potatoes in 2000 and 2006	Average % of area in agriculture in 2006 and 2007
Allocation of sample to strata	equal	proportional to variance	proportional to variance
Largest sampling weight	29.4	206.5	29.95

The evolution of the design over the three years reveals the efforts made to home in on an efficient design. Figure 1 indicates the location of the selected cells in 2008. This gives an idea of the coverage achieved with the sampled cells, including the fact that some cells are selected in the urban areas of the province.

Figure 1 - The Cells Selected in the 2008 Sample



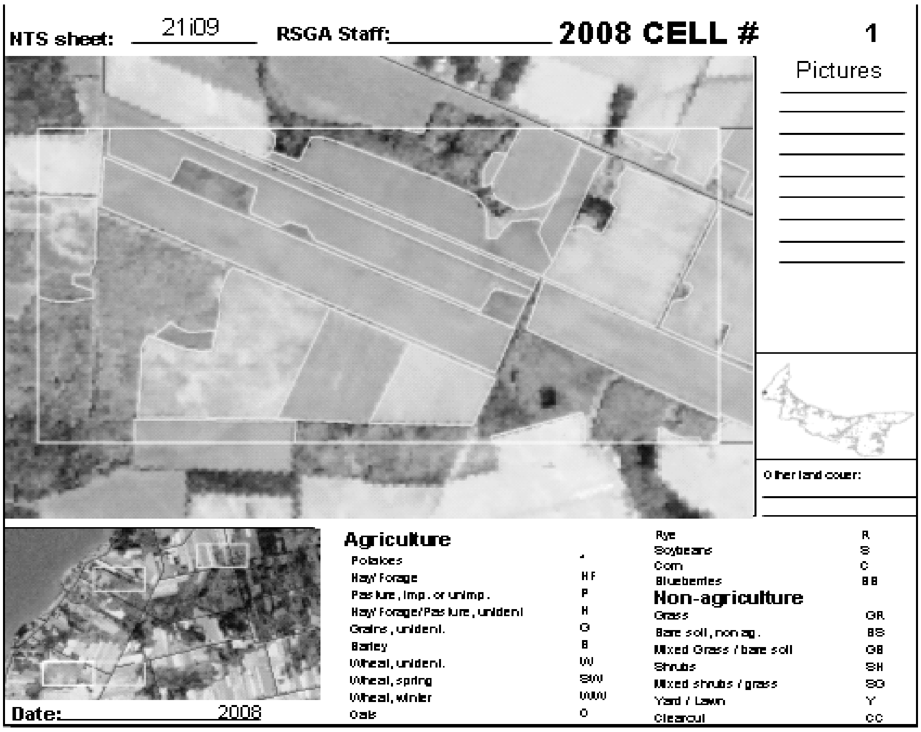
2.5 Field Data Collection

All agricultural fields and land-cover had to be identified and located correctly within each of the selected sample cells. The field data were collected using a combination of aerial and ground surveillance and the collection was conducted during the last week of July through early August. It is during this time in the summer that identification of most crop types by airplane or from the roadside is easiest. This is because most potato fields in PEI have reached the flowering stage, cereal grains are approaching the ripening stage, and many of the hay fields have undergone a first cutting, all of which leave unique or distinguishable markings and field characteristics.

For the 2006 project, the ground data was collected almost exclusively by aircraft. In contrast, however, for 2007 and 2008, the strategy was to collect as much field data as possible from the roadside first. Missing fields which were inaccessible by roadside were covered by aerial surveillance. Any fields not identified with certainty by aircraft were also re-visited by roadside. As a time-saving measure in 2008, a strategy was developed whereby it was decided in advance which cells would be visited first by car, using the road network and number of fields as criteria. Specifically, cells were not pre-selected for roadside collection if the cell was not well served by roads (meaning that observation would be difficult or of poor quality) or if there were a very small (e.g., only 3 or 4) number of agricultural fields in the cell (meaning that it would be much more efficient to make a pass over the cell by air). These low field count cells occurred when a sampled cell fell in a forested area or straddled the shoreline. This strategy resulted in about 85 percent of the total number of sampled cells being identified in this way. Within most of these cells approximately 70 percent of the fields were usually visible from the roadside, so that only 30 percent of them required enumeration by aerial surveillance.

In preparation for the 2008 ground data collection, paper prints of all sampled cells (SU's) were prepared using spring/summer 2007 or spring 2008 multi-spectral SPOT 5 10-metre resolution satellite imagery. Using GIS, field boundaries that were generated by the PEI Department of Agriculture for the 2001 agriculture layer project were updated with new field boundaries. These new boundaries were visible from the summer 2007 and/or spring 2008 satellite imagery. In 2008, a total of 202 hard-copy images were prepared, one for each of the 202 1 km x 2 km cells in the sample, and the respective boundaries of all fields were drawn. Roads from the National Road Network (available at no cost in digital format at www.geobase.ca) were also added. These satellite image products also included a land-cover/crop type identification key, which was used to record the land-cover or crop. An overview smaller scale image showing the surrounding region was also included with each image product. This overview image was useful to help locate the target SU from the roadside.

Figure 2 - Example of the Documentation Used in the Fieldwork



2.6 Aerial Surveillance

A small aircraft (Cessna 172 High-Wing Float Plane) was used to observe the fields contained within the selected cells. Typical flying elevation during the aerial observation was approximately 200 to 300 metres. Surveillance was primarily done on a visual basis, and results recorded during the flights, in real time. Photographs were also taken from the air, using a hand-held digital camera.[39] The photographs were used to check and confirm the results during preparation of the estimates. This was especially useful in 2006 when the proportion of data collected by air was higher. As noted earlier, aerial data were collected in the period covering the end of July to early August, when stage of growth and other conditions present the best opportunity for positive identification of the fields. In 2008, the aerial work was completed between July 28 and August 3, took 14.8 flying hours and was carried out by one RSGA staff member. This figure represents a reduction from the 2006 and 2007 required flying times, which amounted to 30 hours in 2006 and 20 hours in 2007. The paper documentation described above was used on board the aircraft to record the field information observed during the flights. The information was digitized shortly thereafter.

2.7 Ground Surveillance

Fields within the selected cells were also observed from the ground, using vehicles that kept to established public roads. In this way, no burden was placed on the agricultural operators. The roadside data collection took place in 2008 during the period from July 23rd to July 29th. In 2008, RSGA used two (2) GIS-based global positioning system (GPS) software and hardware devices during the field campaign. These tablet PCs with the ESRI ArcPAD system were used by both field crews for the aerial and the ground work. Essentially the ArcPAD system was used to assist ground crews to precisely locate the cells selected in the sample. From the

[39] The camera used was a Sony Cybershot "SuperSteadyShot" DSC-H7, with 8 mega-pixel resolution.

ground, the ArcPADs were also used to directly collect the field data in numeric format, and, using the GPS device, to ensure that the information was collected for the correct field. The time required for the roadside ground surveillance in 2008 was about 50 person-hours, and was carried out by two RSGA staff members.

Since the ArcPad system can be rather cumbersome to manipulate in the airplane, field data information was captured on the paper documents as in previous years and converted to digital format shortly after.

In 2008, for a small number of fields, no data was collected either from the aerial surveillance or the roadside observation. For these few missing fields (approximately 100, or just over 2 percent of all fields in 2008), crop type information was imputed by interpreting the information in summer 2008 satellite data. In 2007, data were acquired for all fields, although 70 of the 360 sampled cells that year were observed only by air. In 2006, all fields within all 147 sampled cells were enumerated by aerial surveillance and following that, those fields which were identified with less than 100 percent confidence from the aircraft were verified by roadside observation.

2.8 Preliminary Estimates

In all three years, once the ground and aerial data were collected, the digitization of field boundaries, which was done in preparation for the ground and air data collection, was completed for each of the cells in the sample (202 in 2008, 360 in 2007, and 147 in 2006). Current season satellite imagery was used in each year as a backdrop to assist in the boundary determinations. The total area for each crop within each field was then computed for each cell. Using the areas computed for each cell in the sample, weighted-up estimates of the total potato area and the total agricultural land area were prepared for the province as a whole, including estimates of precision (coefficients of variation). These estimates were available just a few days after the completion of the ground and aerial data collection – in 2008, this meant early August.

Table 8 - PACS Preliminary (weighted) Estimates of Potato and Total Agricultural Area

YEAR	Potato Area (hectares)	Coefficient of Variation (CV)	Total Agricultural Area (hectares)	Coefficient of Variation (CV)
2006	38,350	6.1%	182,462	2.7%
2007	35,666	9.1%	187,371	5.4%
2008	33,144	7.7%	193,986	2.3%

These weighted estimates based on the ground and aerial data collection were available in August in each of the project years. The estimates for total agricultural area have quite good precision (low CV) and the 2006 PACS estimate is quite close to the 2006 Census of Agriculture estimate of 182,374 hectares (the sum of land in crops, tame or seeded pasture, fallow shown in Table 2, above). On the other hand, while the CVs associated with the potato estimates are reasonable, given the importance of this crop in the province, it was desired to improve on this level of precision. This is discussed later in the paper.

2.9 Province-wide Land-cover/crop Classification

In addition to the very timely estimates of potato area and total agricultural land area, the other main component of the PACS project each year was to produce a complete land cover and crop classification for the entire province. In order accomplish this, additional satellite imagery analysis was combined with the ground and aerial data, using statistical techniques. An additional benefit is the refinement of the potato area estimate, resulting in a much more precise value.

Given the different vegetation occurring in PEI, in order to maximise the reliability of land cover and crop type identification using satellite data, it is preferable to acquire multispectral imagery (visible and infrared channels) and it is desirable to have images from two periods: end of spring (i.e., late May to early June), and middle of summer (i.e., end of July to mid-August). The early season imagery is used to separate perennial forage (hay/alfalfa), pasture and grassland fields from later season cultivated (seeded) annual crops (such as potatoes, cereals, soybeans, and vegetables, etc.). Because of the nature of the image spectral data, and the likelihood of spectral data overlap between some of the cropland classes, the aim was to acquire these data at the "peak" or "heading" crop development stage. In a normal PEI crop season this would occur in late July or early August. During this time, the majority of potato fields will have already reached the flowering stage and also have a complete vegetative canopy cover. This crop structure and crop canopy pattern gives the potato crop a unique "spectral signature" which helps to separate potatoes from other crops. Of course, another highly desirable characteristic is that the image data be cloud and haze free.

From an operational crop classification perspective, and in terms of imaging sensor characteristics (i.e., spectral range, spatial resolution and spatial coverage), satellite data acquired from the SPOT and/or Landsat satellite series are considered the most attractive.

In each of the three years of the project, a total of nine images were acquired and processed. For the 2008 work, the images consisted of three Landsat 5 TM (30m spatial resolution) scenes, two SPOT 4 (20m) scenes and four SPOT 5 (10m) acquired during the 2008 crop growing season between May 15, 2008 and August 18, 2008. Figures 3.a and 3.b shows the different satellite images which were acquired in 2008 with their geographic coverage and the image acquisition dates. The same three sources were used in 2006 and 2007 although the number of scenes from each source, and the acquisition dates, varied.

Each of the image scenes provide different and unique properties (i.e., spectral, spatial, radiometric, multi-temporal and geographic) which must be accounted for during the land-cover image classification process. Extensive and chronic cloud cover over the eastern portion of PEI throughout the summer of 2008 resulted in the purchase of several images in this region of the province (see Figure 3.b). In fact, as it turned out, none of the summer scenes in the eastern part of the Island were cloud free. Consequently, the quality of the image classification in these clouded regions was affected. Table 9 summarizes the timing and quality of the images used in 2008.

Figure 3A - Spring 2008 Satellite Imagery Acquired

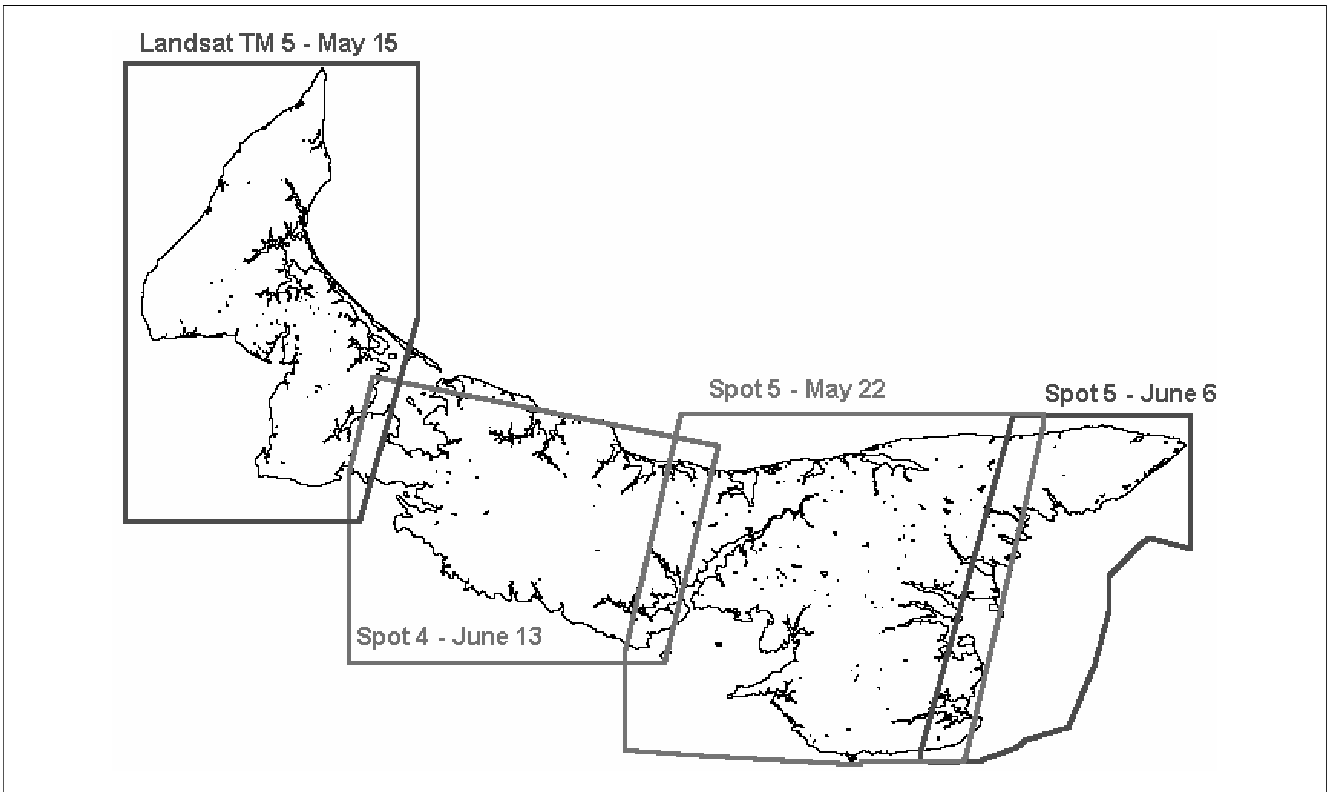


Figure 3B - Summer 2008 Satellite Imagery Acquired

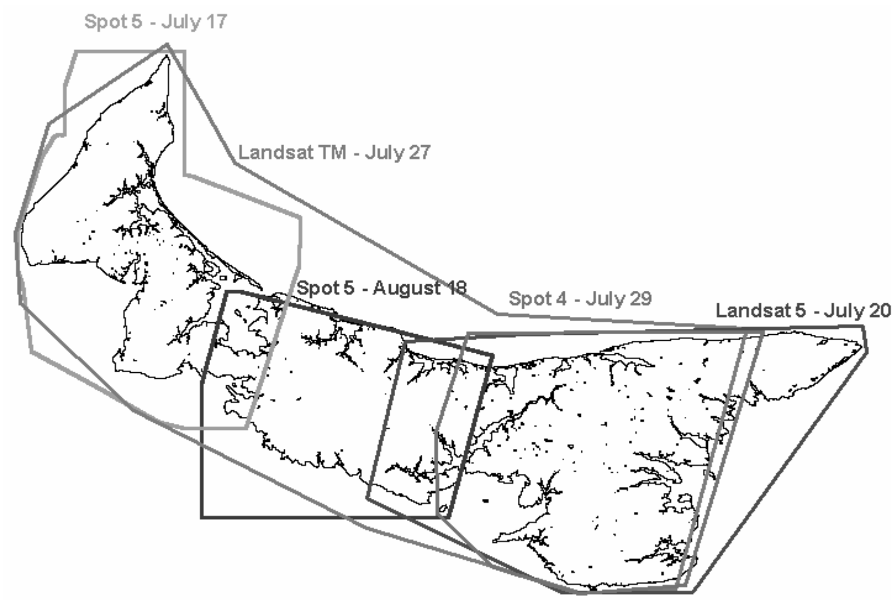


Table 9 - Summary of PACS Image Acquisition and Quality

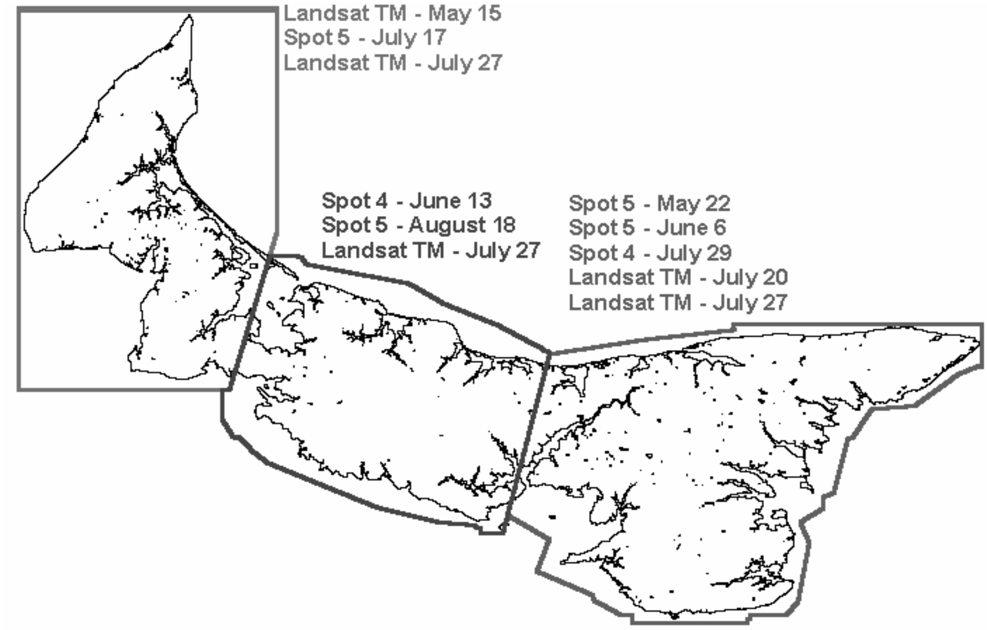
YEAR	SEASON	Source			Acquisition date range	Quality
		Landsat 5	Spot 4	Spot 5		
2006	Spring	1	0	2	May 09 – May 30	Some haze in west
	Summer	1	3	2	Jul 11 – Aug 17	Some haze in central; cloudy in east
2007	Spring	0	0	4	May 9 – Jun 03	Some cloud in east
	Summer	2	0	3	Jul 15 – Aug 10	Some cloud in east, west; some haze in central
2008	Spring	1	1	2	May 15 – Jun 13	Some cloud & haze in east
	Summer	2	1	2	Jul 17 – Aug 18	Cloudy in east

Upon receipt of the satellite imagery, after creating the project database(s), each satellite image underwent a quality check. This analysis included a verification of each scene for geographic coverage and checking image channel overlays, bad data lines, and scene radiometry. All images were then ortho-rectified to a common geographic map projection (UTM zone 20). This was completed using PCI Geomatica Orthoengine software using ground control points acquired from a Digital Elevation Model (DEM) and a national road network file acquired from the Geobase website (source: http://www.geobase.ca). Areas of cloud, cloud shadow and significant haze were then delineated (automatically or manually) to ensure that the classification algorithms did not use these areas for classification.

Cloud-free spring and summer SPOT and Landsat 5 image channels were used to maximize the spectral content of the imagery which ultimately helps the classification algorithm distinguish different land-cover/crop types. Both Landsat 5 and the SPOT 4 images were resampled to 10m spatial resolution to match the spatial resolution of SPOT 5 image data.

Image classifications were performed on a scene by scene basis, rather than processing a province-wide mosaic consisting of several merged images. Figure 4 shows the three land-cover classification regions for 2008 and corresponding images which were processed separately.

Figure 4 - Regions Created in 2008



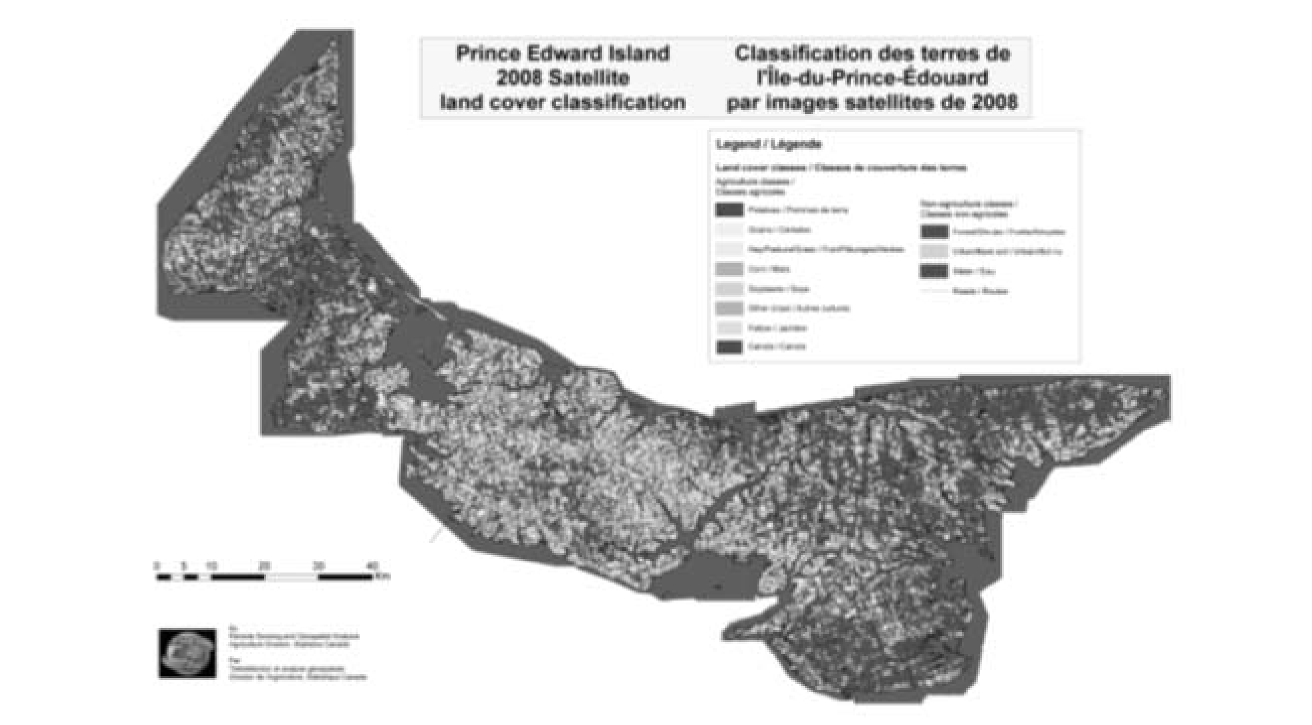
Once the land-cover/crop data within each of these regions were quality checked and finalized, the data was merged across the province. In 2007, four regions were created for the classification exercise and in 2006, six were used.

For each crop type, training sites were randomly selected from 50 percent of the individual study fields, that is, the fields for which "ground truth" data were collected by roadside and aerial collection in the first part of the study. Testing sites were selected from the remainder of the study fields (i.e., training and testing areas were not located in the same fields). There was also no overlap between the training and testing pixels. The image pixels used for training were usually chosen from the interior of a field without using pixels along field boundaries. This was done to reduce contamination from mixed pixels (e.g., a pixel that contains a mixture of land cover). In 2008, 2,137 fields where ground truth data had been collected were used for training the classification algorithm and the remaining 2,136 were reserved for testing. In 2007, the corresponding figures were 2,650 fields each for training and testing and in 2006, there were 2,350 fields each for training and testing,

A standard per-pixel classification was performed using a Decision Tree (DT) approach. Decision boundaries for multivariate DTs are defined by combinations of features and a set of linear discriminate functions are applied at each test node. Decision boundaries and coefficients for the linear discriminate function are estimated empirically from the training data. DT methodologies permit the integration of disparate geospatial data and, unlike maximum likelihood classifiers, the DT approach does not make any assumptions regarding the statistical distribution of these data.

Once the land-cover data was generated, an image was segmented into object polygons using Definiens (formerly eCognition) software. A majority (or mode) filter was then applied to the polygon classification to remove extraneous misclassified pixels, fill holes and "clean" the output classification file. The classifications were visually assessed against the PACS verification data, which were acquired during the field data collection (roadside and aerial data gathering). A further step in the post-processing work involves computing classification error-matrices to determine inter- and intra-class errors.

Figure 5 - Final Land Cover Classification Map Produced in 2008



The "cleaning" mentioned earlier refers to the step taken in cases were there was a very small area within a field that was correctly classified but was clearly an anomaly within that field, such as a small patch of weeds or a puddle of water. In order to improve the presentation of the map, these very small areas were classified to match the classification of the field.

2.10 Accuracy of the land cover classification

Once the land-cover classifications were accepted as final, a representative set of known pixels, or class "evaluation" sites were used to compute classification accuracy. These evaluation sites were used to generate confusion matrices. The number of correctly classified pixels, expressed as a percentage, was computed for each class.

As a standard practice of remote sensing land-cover studies, for 2008 PACS, 50 percent of the total number of ground "truth" fields (e.g., 2,137 fields in 2008) were used for "training" the classification algorithm, while the remaining 50 percent (2,136 in 2008) were used for assessing the classification results. The 50 percent selection process was made randomly. During the classification process, which is an iterative process that generally took about three steps in this project, additional training pixels were added in areas where misclassification was higher. This was not always possible in the less common classes.

Generally, the proportion of "correct" classification was quite high, between 90 percent and 99 percent for most agricultural land classified in each of the three years. Some classes were more problematic, such as the "other crops" class and the "fallow" class. Also, as previously mentioned, in 2008 the eastern part of the province was relatively cloudy and this reduced the accuracy rate in that region, which in turn had a downward effect on the overall classification accuracy rate at the province level. Table 10 shows the final overall classification confusion matrix from 2008.

Table 10 - Classification Accuracy in 2008

AGRICULTURE CLASS	% of areas in Class classified to:								
	Potatoes	Grain	H/P/F/G[1]	Corn	Soybeans	Other crops	Fallow	Canola	Other[2]
Potatoes	87.0	2.9	7.4	0.3	1.9	0.1	0.0	0.0	0.3
Grain	0.4	88.0	10.0	0.1	0.5	0.1	0.0	0.0	0.9
H/P/F/G[1]	2.0	3.8	93.5	0.1	0.2	0.0	0.0	0.0	0.4
Corn	0.8	7.8	8.3	82.3	0.6	0.0	0.0	0.0	0.1
Soybeans	6.6	1.4	8.3	0.7	82.6	0.3	0.0	0.0	0.2
Other crops	6.0	4.8	25.5	0.1	0.7	60.4	1.6	0.0	0.8
Fallow	4.2	0.3	21.4	0.0	0.0	0.0	74.1	0.0	0.0
Canola	1.9	4.4	0.8	0.3	8.4	0.1	0.0	84.2	0.0

[1] Hay/Pasture/Forage/Grass
[2] Other non-agriculture classes

2.11 Improving the Potato Area Estimates

The potato area estimates were of great interest to the sponsors of the PACS project, so additional efforts were made to achieve a high degree of precision. To combine the strengths of the ground truth data (the data collected by roadside and aerial observation) which was collected for only a portion of the province (e.g., about 7.1 percent in 2008; see Table 7) and the satellite image data which was collected for the entire province, a regression estimator was used.

This method involves the use of auxiliary information to adjust a weighted estimate. Collecting field data is a costly procedure, and to collect field data across the entire province would have been prohibitively expensive. As such, the field data for PACS was collected on a sample basis as described earlier. Satellite image-derived crop classification data, on the other hand, is relatively inexpensive to acquire – as it can be generated across the province covering all units of the statistical population. Since it is expect that these two sources of information would be highly correlated, a regression estimator is an appropriate statistical estimation approach for PACS.

The auxiliary data source is the number of potato pixels classified from analysis of the satellite imagery. Strictly as a preliminary “early indication” of potato area, the total number of classified potato pixels across the province are totalled and converted into area estimates. However, this direct conversion approach does not take into account any inconsistencies in classification performance within and between satellite images, resulting in a bias.

Instead, 50 percent of the selected sample (i.e., 101 cells in 2008) was used to “train” the classification algorithm, which was then used to interpret and process the satellite imagery – leading to a land-cover/crop classification which covered all units of the population. The other 50 percent of the sample is used to build a weighted estimate. The technique used the same general approach that was used to produce the initial weighted estimate, but the quality of this initial estimate was expected to be lower since only 50 percent of the sample was used. However, the auxiliary information (i.e., classification data) can then be used to refine the estimate, and greatly improve its precision. In 2008, 13 of the 101 cells were cloud covered and so were omitted, leaving the remaining 88 for use in the regression calculations. It should be noted that for these calculations, the data used did not include adjustment due to the “cleaning” step mentioned earlier, since for potatoes, a high degree of precision was desired and since the very small anomalous areas (such as a small weed patch) would likely reduce the potato harvested area, these small areas were not treated as potato area. Figure 6 shows the regression fitted for the potato area in 2008.

Figure 6 - Illustration of correlation between ground truth and satellite classification

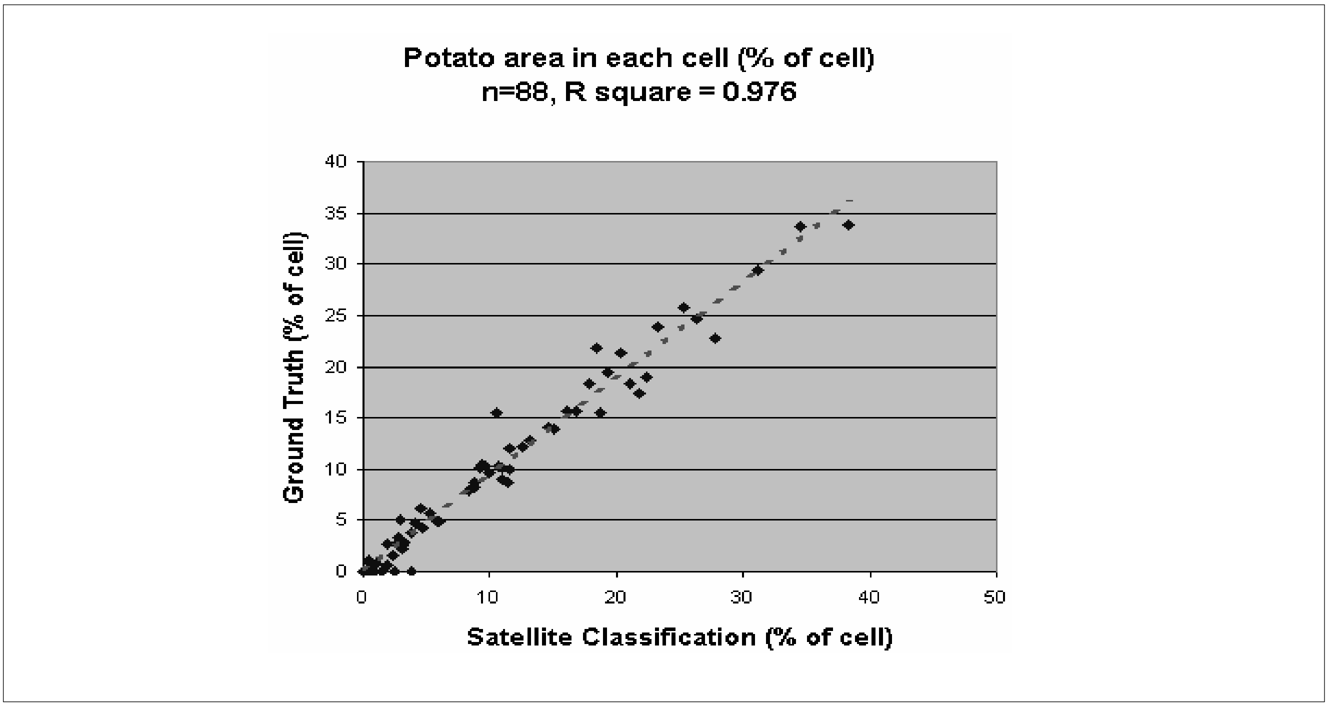


Table 11 shows the final land area classification for each of the years of the PACS project. The coefficients of variation for the potato area estimates were: 2006: 1.6 percent; 2007: 3.4 percent; and 2008: 1.9 percent. It can be seen that these CV values are quite a bit better (lower) than those associated with the preliminary estimates (see Table 8).

Table 11 - PACS Land Area Classification

CLASSIFICATION CATEGORY	2006	2007	2008
	hectares	hectares	hectares
Potatoes	38,700	40,200	37,500
Grains	59,700	67,000	53,100
Hay/Pasture/Forage/Grass	168,900	156,400	175,800
Corn	1,700	2,200	3,700
Soybeans	2,700	4,300	6,300
Canola	na	na	600
Fallow	1,700	800	200
Other Crops	1,600	4,000	1,500
Forest	277,700	276,700	273,100
Urban/bare soil	13,500	14,600	14,400
Total (CEAG)	**566,200**	**566,200**	**566,200**

3. Discussion of the PACS Project and Results

The weighted estimates of area can be produced only a few days following the field data collection. In each of the years of the project, the potato area estimate produced this way had a relatively high CV, while the total agricultural area estimate was more accurate. In 2008, using agricultural land as the stratification variable – particularly an average over two consecutive years – appears to have generated a much more robust design.

Since the other aspect of the project was to produce a land cover classification of the entire province using satellite data, the data extracted from the images could be combined with the ground truth data to produce much more precise area estimates. Given the economy of the Island, this was especially important for potatoes.

Table 12 - Comparison of several PEI Potato Area Estimates

ESTIMATE	Estimates of PEI Potato Area *(hectares)*					
	2006		2007		2008	
	Seeded	Harvested	Seeded	Harvested	Seeded	Harvested
PACS[1]	38,700		40,200		37,460	
Census of Agriculture[2]	39,512					
22-008-X[3]	39,499	38,770	38,851	38,851	37,435	36,018

[1] Potato/Agricultural Land Area Estimate and Classification System study, released in September each year.
[2] Released May 16, 2007.
[2] Released May 16, 2007.

As shown in Table 12, the PACS estimates of potato area were similar to the other sources, but were available sooner. The PACS estimates also had very good precision (low CV) and had the advantages of providing objective estimates with no reporting burden placed on farmers.

While producing a land-cover classification using cloud-free imagery is accurate and relatively straight-forward, it becomes more difficult and time consuming to use cloud-covered images. This was the case for the eastern portion of the Island in 2008. Five images had to be used to be able to map this portion of the province (versus two or three in the other years), and results were still considerably inferior compared to what was expected based on 2006 and 2007 results. The accuracy for the potato class was at only 73 percent in the east in 2008, while it is generally between 95 percent and 97 percent under optimal conditions. In the west and central portions of the province accuracy rates of 95 percent and 96 percent, respectively, were achieved in 2008. In 2006 and 2007, accuracy rates around the mid 90 percent range were obtained in the east.

The 2008 land cover map was therefore expected to contain more errors east of Charlottetown. It was the mid-summer image that revealed most of the information for the classification, and some of the land only had spring imagery for use in the determination of the land cover of each field. Classification accuracy is also reduced if haze is present, as was also the case for some large portions of the images in 2008. Even though crop growth in many regions of the province was lagging a few days behind normal in 2008, the first two weeks of August was found to be ideal for the mid-summer image acquisition. This timing was been substantiated each year of PACS.

During the project, multispectral SPOT 5 at 10 metre spatial resolution was found to be the best option for the land cover/crop classification work; especially in regions where fields are relatively small (average of 4 hectares per field in PEI). Although this image product is relatively expensive, only the cloud free portions of the imagery over land are charged. SPOT 4 at 20 metre spatial resolution is an interesting substitute, but field boundaries are not clearly defined. The main advantage with Landsat TM imagery is the large geographic coverage per image compared to SPOT (i.e., 185 x170 km, compared with 60 x 60 km for SPOT). Landsat acquires imagery continuously but has a repeat cycle of 16 days, while the SPOT satellites, with sensor steering capability and variable viewing angle, can acquire imagery much more frequently. Unlike Landsat, SPOT has an advantage in that the image data is made available by programming the satellite. This programming is done by the satellite image provider on behalf of the client. However, conflicts between other priorities and conflicting programming requests made by other users often reduce the number of image acquisitions within the desired acquisition windows.

The 2008 sample design gave very satisfactory results. The assumptions made at the beginning of the year about the size of the sampling units, the stratification variable to use, the size of the sample and the sample allocation per stratum produced excellent results as expected. The improvements made from the 2006 and 2007 strategies resulted in a reduced amount of field work and data processing effort, which resulted in lower probability of errors and sped up the production of the estimates. If a similar project is planned in the future, the 2008 sample design strategy would be recommended, at least as point of departure.

4. Other Applications of a PACS-type Approach

The methodology of the PACS project could easily be applied in other jurisdictions, for example other Canadian provinces, other countries, etc. to produce a timely and accurate land cover classification and area estimates for crops that are of special interest to that jurisdiction (like potatoes are to PEI). Some issues would need to be considered, however. In a much larger jurisdiction, the larger land would require more careful planning of the field data collection (roadside and aerial data gathering) and perhaps some compromises made on the quality (e.g., smaller relative sample). Even then, costs for this portion of the project would be higher, perhaps much higher, if only due to increased travel cost and staff time. The costs to acquire the satellite imaging would not likely be affected as much. However, with a very large area to cover, the probability of image quality problems would increase (the likelihood of clouds *somewhere* could be quite high) and the time period needed to collect all the images needed could be longer, which could also contribute to increased costs. A very large area, unless quite "narrow" in terms of the agriculture and other land use, could also mean a greater diversity of land and crop cover, perhaps necessitating a greater number of classes to meaningfully portray the jurisdiction. This could lead to greater difficulty, or at the least extra effort and work, in the classification process and possibly lead to higher costs and perhaps affect the quality of the results (perhaps more misclassification if there are many plausible choices during the interpretation of the images). A greater diversity of agriculture could also necessitate using more and longer collections periods for both parts of the collection (ground data and image acquisition), since more and varied crop types may require stretching the periods in order to catch the crop at its optimal time when its "signatures" from the roadside, from the air and from space are most distinctive, allowing more confident identification.

The feasibility of covering a larger area using a combination of ground truth and satellite data is well illustrated by the US Department of Agriculture National Agricultural Statistics Service's (USDA/NASS) successful Cropland Data Layer product. This work uses the USDA's Farm Service Agency (FSA) Common Land Unit data as ground truth and Resourcesat-1 AWiFS satellite data as the source for the remote sensing data. The FSA administers and manages farm commodity, credit, conservation, disaster and loan programs (as laid out by the U.S. Congress) through its very large network of federal, state and county offices. Thus, the FSA administrative dataset is large and has comprehensive coverage of crops covered by programs. The labour saved by using this data is balanced by the fact that it is not a true probability based sample. The dataset is split into two separate halves, with one being used to train the classifier and the other used for testing, assessment and validation. The AWiFS sensor (Advanced Wide Field Sensor) resolution is 56 metres and has a 740 kilometre swath width, providing the coverage necessary to image large Midwestern states in a single pass. Segment boundary and summary data are obtained from the June Agricultural Survey (JAS), a large (approximately 41,000 farms) probability survey gathering information on area planted or intended to be planted and the area expected to be harvested. The JAS data are used in building the regression model estimate. Other ancillary data, such as the National Land Cover Data set are used to improve classification accuracy. The Cropland Data Layer shows that the general methodology used by PACS can be used to cover large areas.

The results generated from the PACS project have other applications as well as simply producing accurate area estimates and land cover classifications. In the case of PEI, there is legislation, the Agricultural Crop Rotation Act, and its associated regulations, which has as its purpose to: a) maintain and improve surface water quality by reducing run-off and soil erosion; b) maintain and improve groundwater quality; c) maintain and improve soil quality; and d) preserve soil productivity. The basic requirements are that a "regulated crop[40]" can

[40] The Act defines *regulated crop* as "potatoes and other crops which are planted and harvested within one calendar year, excluding cereals and forages." The excluded cereal are listed in the schedule to the regulations associated with the Act: PEI Reg. ED166/02). Source: Agricultural Crop Rotation Act, RSPEI 1988, c.A-8.01.

be grown in a field no more frequently than one year in three and that regulated crops may not be grown on land with a slope greater than 9 percent unless grown under an approved Management Plan. With data such as produced by the PACS project, it is possible to calculate, for example, the percentage of potato fields in a given year that were not planted in potatoes in either of the previous two years, in other words, statistics that would help to illuminate the degree of compliance with the Act. As an illustration, using data from two years of the PACS project, it is estimated that about 6 percent of the area planted in potatoes in PEI in 2007 were again found to be in potatoes in 2008.

While not the primary purpose of the PACS project, the type of methodology used in the project could contribute to the refinement of the rural and urban areas of a jurisdiction. As can be noted from the material presented above, the PACS project classified about 14,000 hectares of the province of PEI as "urban/bare soil". Using one approach to "urban", this compares to the land area of the province contained within Census Metropolitan Area/Census Agglomeration (CMA/CA) boundaries (PEI only has CAs and there are just two of them), which in 2006 was about 82,000 hectares or nearly 6 times the PACS estimate. As large as this ratio is, it is not as high as it could be since the PACS estimate includes some area classified to "urban" outside of the two CAs. Taking only the area within the Census boundaries of the cities of Charlottetown and Summerside, the land area according to the Census was about 7,200 hectares, again showing that the CMA/CA areas contain a lot of territory that many would not call "urban." According to the 2006 Census, there were seven "urban areas" (population of at least 1,000 and a population density of at least 400 persons per km^2) in PEI, covering a land area of about 10,155 hectares. This and the PACS "urban" value of about 14,000 hectares seem reasonably coherent since PACS would have found urban pixels in areas other than the seven "urban areas" in PEI identified by the 2006 census, and conversely, the census UAs, even though they are a "tighter" concept of urban, will still contain some farmland.

Statistics Canada's Environmental Accounts and Statistics Division (EASD) has initiated a project known as the "Settlements Project", which includes partners within Statistics Canada, such as Statistics Canada's Geography Division, as well as external departments such as Environment Canada. Initial seed money was provided from the Canadian Space Agency's Government Related Initiatives Program. Recently, the project received more substantial funding from the Policy Research Data Group (PRDG), with Infrastructure Canada as the lead policy department. The overall objective of this PRDG project is to develop improved information on the nature of urban growth in Canada in order to fill important horizontal policy needs. The key outputs will be new spatial data with more precise delineations of "settlement areas" and improved indicators related to urban growth. Recognizing that Census Metropolitan Area (CMA)/Census Agglomeration (CA) boundaries and even the Urban Area (UA) boundaries defined by the Census are too generalized and overstate the extent of the "built-up" areas (by including within their boundaries a significant portion of non-settled land, especially agricultural land), this project is using Census dissemination block-level data combined with satellite imagery to come up with boundaries that will more accurately delineate the settled part of the country.

5. Some Thoughts on the Application of the PAC Methodology in Developing Countries

The methodology employed in the PACS project appears to be suitable, for a number of reasons, for application in countries where the traditional survey-taking infrastructure is perhaps less developed and/or sources of administrative data may be scarce, of unknown quality or difficult to access.

Although actual data collection is involved in the PACS approach, it is accomplished using a simple stratified design on an area frame. Also, since it is observational data collection, rather than direct collection from respondents, there is no need for elaborate questionnaire instrument design/testing and the usual infrastructure needed to distribute questionnaires, gather them up, follow-up for non-response, and so on. Since the data are gathered by a small number of staff members by their own observation of the land from the ground and the air, and by interpreting satellite images, data collection is quick, accurate and manageable. And, it need not be overly costly.

In the PACS project, some value was attached to the fact that the data were collected without placing response burden on farmers. This stems from PEI's small size in terms of population, number of households, number of businesses, number of farms, etc., and the fact that many statistical programs are designed to produce national and provincial estimates. The result is that the people and businesses of PEI are relatively heavily surveyed, so a methodology for producing estimates without respondent burden is attractive. On the other hand, in some developing countries, interaction with farmers during the course of survey work may be considered desirable as it affords the opportunity to exchange information on farming methods, to identify specific issues, to build relationships and so on. Personal visits during the collection of the ground truth data could easily be incorporated into the methodology described for the PACS project. The time and cost to collect the ground data would likely increase, but in addition to the positive interactions with farmers, the quality of the ground truth data might be improved.

The availability of information on approximate agriculture areas and geographic locations would be useful in performing the stratification and will lead to more accurate results. Current information is naturally more valuable, but as the 2006 PACS showed, using data that is several years old can still contribute to reasonable results.

Naturally, the better is the road network, the more convenient, efficient and accurate will be the collection of the ground-based observations. Similarly, access to reliable small aircraft service may facilitate the gathering of the ground-based data where the terrain is amenable. However, the two sources can complement each other and, as shown in the PACS project, one can approach this phase of the work by emphasizing the roadside portion and using the aerial portion "as needed", or make the aerial collection primary and gather roadside data where necessary, or various intermediate combinations.

The acquisition of satellite images at a reasonable cost does not appear to a limiting factor, although for some sensor types, weather difficulties during collection windows can lead to higher costs when multiple images need to be acquired to obtain sufficient image coverage with reasonable quality. This is an area where the technology is improving, with more and more sensors available, and costs generally going down[41], so that this may become less of a concern going forward. The more challenging issues may be the processing and interpretation of the image data, although even here, these may not be factors that would greatly limit the application of the PACS approach since software costs should not be prohibitive. Also, the cost to contract out for the expertise to operate the software and interpret the images and produce the estimates should not be a barrier to adopting this type of approach.

6. RADARSAT-2

Recently, a new sensor became operational which holds a great deal of promise for agricultural applications. On December 14, 2007, the Canadian satellite RADARSAT-2 was launched on a Soyuz II vehicle (provided by Starsem of France) from Russia's Baikonur Cosmodrome in Kazakhstan. The first images from the satellite were taken on December 18, 2007 and the Commissioning Complete Review was held on April 24, 2008 and the system was declared ready for operation. This satellite has been designed with advancements that include high-resolution imaging, flexibility in selection of polarization, left and right-looking imaging options, superior data storage and more precise measurements of spacecraft position and attitude. The satellite has a minimum design life of seven years although, like RADARSAT-1, it is expected to function longer.

Some of the specific benefits of RADARSAT-2 that make it well-suited to crop type, crop condition, crop yield and land use studies are:

- near-polar, sun-synchronous orbit at altitude of 798 km;
- 14 orbits per day (100.7 minute period) with repeat cycle of 24 days and 28 minutes of imaging capacity per orbit;

[41] For example, on April 21, 2008, the US Geological Survey announced plans to provide all archived Landsat scenes to the public at no charge.

- spatial resolution capability from 3m to 100m and nominal swath widths from 20 km to 500 km combine to offer numerous beam modes;
- left and right looking imaging capability and single, dual and quad-polarization choices;
- on-board recording and storage guarantees image acquisition anywhere in the world for subsequent downlinking;
- synthetic aperture radar (SAR) sensor, operating with C-band (5.405 GHz) frequency, which is not hindered by atmospheric effects and is able to "see through" clouds and rain;

RADARSAT-2 is a collaboration between the federal government – the Canadian Space Agency (CSA) – and industry – MacDonald Detweiller and Associates (MDA). MDA is responsible for the operations of the satellite and the ground segment, while CSA contributed funds for the construction and launch of the satellite. CSA will recover its financial investment through the supply of RADARSAT-2 data to Canadian government agencies during the lifetime of the mission. Agriculture and Agri-Food Canada and Statistics Canada are participating departments and have already begun to receive RADARSAT-2 data for evaluation.

While more research is needed, preliminary results from investigations at Agriculture and Agri-Food Canada have shown promising results from using a combination of various radar sensors (C. X and L bands) using multipolarization modes. At this time, challenges to be overcome are the difficulty and expense to cover large areas in operational mode.

7. Conclusion

The PACS project has demonstrated the use of remote sensing to estimate crop area and classify land cover and use is enhanced by the combination of statistically-based ground truth data for the improvement of the precision of the estimates and increasing the accuracy of the classification. Aside from producing results for a given year in a timely manner, generally as soon or sooner than traditional survey-based estimates, other uses can be envisioned such as monitoring adherence to crop rotation schemes, monitoring changes in land use and crop area over time, and as input to the refinement of the definition of what is "urban" land.

A PACS-type methodology, combining ground and aerial data collected by observation with satellite imagery, may be especially attractive for developing countries to consider due to its low cost, the fact that it does not rely on the existence of an elaborate survey-taking infrastructure, and its ability to produce results in a short period of time with a small complement of human resources.

References

Bédard, F., Dobbins, R., Pantel, M. (2008). *Development of a Potato/Agricultural Land Area Estimate and Classification System for Prince Edward Island using Remote Sensing, GIS and Statistical Survey Methodologies.* Project Methodology Report, Remote Sensing and Geospatial Analysis, Agriculture Division, Statistics Canada, Ottawa, Ontario, Canada.

Bédard, F., Dobbins, R., Pantel, M. (2007). *Development of a Potato/Agricultural Land Area Estimate and Classification System for Prince Edward Island using Remote Sensing, GIS and Statistical Survey Methodologies.* Project Methodology Report, Remote Sensing and Geospatial Analysis, Agriculture Division, Statistics Canada, Ottawa, Ontario, Canada.

Dobbins, R., Reichert, G., Bédard, F. (2006). *Development of a Potato/Agricultural Land Area Estimate and Classification System for Prince Edward Island using Remote Sensing, GIS and Statistical Survey Methodologies.* Project Methodology Report, Remote Sensing and Geospatial Analysis, Agriculture Division, Statistics Canada, Ottawa, Ontario, Canada.

Dobbins, R., Reichert, G., Lanciault, P. and Bédard, F. (2000). *Report for the 2000 Prince Edward Island Land-Cover Classification Project (PLCCP).* Project Methodology Report, Spatial Analysis and Geomatics Applications (SAGA), Agriculture Division, Statistics Canada, Ottawa, Ontario, Canada.

Dobbins, R., Reichert, G., and Lanciault, P. (1999). *Methodology Report for the 1999 Prince Edward Island Land-Cover Classification Project (PLCCP).* Project Methodology Report, Spatial Analysis and Geomatics Applications, Agriculture Division, Statistics Canada, Ottawa, Ontario, Canada.

Fisette, T., Chenier, R., Maloley, M., Gasser, P.Y., Huffman, T., White, L., Ogston, R. and Elgarawany, A. (2006). *Methodology for a Canadian Agricultural Land Cover Classification.* Proceedings of the 1st International Conference on Object-based Image Analysis, July 2006, Salzburg University, Austria.

McNairn, H., Shang, J., Champagne, C., Huffman, E., Smith, A. and Fisette T. (2005). *A Multi-Sensor Approach to Inventorying Agricultural Land Use.* Proceedings of the 31st International Symposium on Remote Sensing of the Environment, Petersburg, Russia.

US Department of Agriculture, National Agricultural Statistics Service, *Cropland Data Layer – Examples;* www.nass.usda.gov/research/Cropland/sarsexample3.html accessed May, 2009.

An Assessment of the Adoption and Impact of Improved Rice Varieties in Smallholder Rice Production System in Côte d'Ivoire

Sékou Doumbia
CNRA, Adiopodoumé, Km 17 Rte de Dabou ; 01 B.P. 1740 Abidjan 01
moulouck2001@yahoo.fr

Assémien Aman
CNRA, Adiopodoumé, Km 17 Rte de Dabou ; 01 B.P. 1740 Abidjan 01
sylvestre.aman@cnra.ci

Koko L. K.
CNRA/Divo, Programme cacao; BP 808 Divo, Côte d'Ivoire
jkokolouis@yahoo.fr

Abstract: *CNRA, the Ivorian national research institute is responsible for the bulk of technological research related to agricultural sector. The impact assessment unit of this institute has carried out a two year adoption and impact study of improved rice varieties, including two NERICA varieties, in the central western region of the country.*

A formal questionnaire was used for the survey and the global positioning system (GPS) was utilized to measure individual rice plot and landholdings.

In addition to describing the rainfed rice commodity system, this paper examines and assesses the adoption rate and the socioeconomic impact of improved rice varieties. The results showed that rice production is traditional, based on low-input and the production is nearly wholly subsistence-oriented. The results also indicated that food crop production, particularly rice production is generally the lone responsibility of women farmers in the region. But these women gained access to land only when married. Individual rice plots generally average 0.1 ha, but can reach as small as 0.02 ha; average landholdings are 0.5 ha per woman farmer.

The results also showed the cultivated area size distribution by rice type (traditional/improved) and by rice varieties. In 2007, the adoption rate of improved varieties was 45 percent. Because marketed as seed at a price well above the paddy price, the improved varieties are popular among the women farmers. Those of them who adopted the improved varieties derived the bulk of their income from this activity.

But the seed market is a narrow one and for the system to be sustainable there is a need to help these women farmers get access to credit and other agricultural input to boost paddy production for consumption and marketing.

Keywords: rice, adoption, impact, Nerica, income

1. Introduction

En Côte d'Ivoire, comme dans de nombreux pays de la sous région ouest africaine, l'équation alimentaire en ce qui concerne le riz est relativement simple. En effet, la question fondamentale qui se pose est de savoir comment produire suffisamment de riz afin de réduire les importations tout en améliorant la disponibilité en riz des ménages, notamment urbains, à des prix relativement bas.

Par rapport à cette situation, la recherche agronomique a entrepris depuis la fin des années 60, un effort constant de création et de sélection de variétés de riz. L'objectif visé étant de mettre à la disposition des utilisateurs, des variétés performantes afin de couvrir les besoins nationaux, et d'exporter éventuellement le surplus de production. Cependant, force est de constater que ces objectifs sont loin d'être atteints. En effet, les besoins des consommateurs ne sont couverts qu'à 50 percent par la production nationale, et il est fait recours aux importations pour combler la différence. Or, la recherche dispose de plusieurs variétés de riz adaptées aux différentes écologies (pluviale, irriguée et de bas fonds) mises au point sur une base régionalisée. Les résultats des premières évaluations conduites auprès des producteurs indiquent que ceux-ci reconnaissent aux variétés améliorées de réelles qualités telles que la précocité, la productivité et la résistance à la sécheresse. Il devient de ce fait urgent pour la recherche d'évaluer (1) les contraintes à la diffusion des variétés de riz mises au point par la recherche ; (2) leur taux d'adoption ainsi que leur impact sur les producteurs.

2. Methodologie

2.1 Objectifs de l'étude

L'objectif général de l'étude est d'évaluer le taux d'adoption des nouvelles variétés de riz pluvial issues de la recherche et leur impact au niveau des producteurs.

De manière spécifique, l'étude vise à (1) identifier les facteurs expliquant les faibles taux d'adoption des variétés modernes de riz pluvial ; (2) formuler des recommandations à la recherche et à la vulgarisation en vue d'une part d'améliorer les méthodes de sélection variétale, et d'autre part d'améliorer les méthodes de diffusion des nouvelles technologies agricoles, et enfin (3) formuler des mesures de politiques agricoles afin d'améliorer le taux d'adoption et l'impact des nouvelles variétés de riz au niveau des producteurs.

2.2 Zone d'étude et methode d'investigation

L'enquête a été conduite en Côte d'Ivoire dans le département de Daloa dans la région du Haut Sassandra. Elle a concerné sept (7) villages tous situés dans un rayon de moins de vingt kilomètres autour de la ville de Daloa.

3. L'échantillonnage

Les résultats de cette étude reposent sur quatre enquêtes, la taille de l'échantillon de base est de deux cents cinquante ménages rizicoles. Des sous échantillons de taille variable d'une enquête à l'autre ont été tirés en fonction des moyens et des objectifs de chaque enquête. (1) L'enquête sur les caractéristiques socio-économiques des producteurs a concerné un échantillon aléatoire stratifié de (196) cent quatre vingt seize riziculteurs ; les 7 villages ayant constitué les strates. Après dépouillement et élimination des fiches mal remplies notre échantillon définitif a été de cent soixante dix riziculteurs répartis entre des ménages ayant cultivé au moins une fois une des deux variétés de riz Nerica (adopteurs) et les ménages n'ayant jamais cultivé aucune des deux variétés de Nerica (non adopteurs) ; (2) l'enquête sur l'estimation des superficies a porté sur trois cents treize parcelles de riz regroupées au sein de soixante onze (71) rizières ; (3) l'enquête sur l'estimation des rendements a été réalisée au niveau de soixante deux rizières (62), trois répétitions sous forme de placettes de 1m x 1m ayant été installées dans chacune des rizières ; enfin (4) l'enquête portant sur le revenu des producteurs a concernée deux cents cinquante (250) ménages producteurs de riz.

4. La Cartographie des nouvelles varietes de riz, l'estimation des superficies et des rendements

4.1 La cartographie des nouvelles variétés de riz

La cartographie des nouvelles variétés de riz a été réalisée grâce au logiciel ARCVIEW 3.2 qui a permis la numérisation et la visualisation des données.

4.2 Méthodologie de mesure des superficies avec GPSMAP 76S

Le tracé et le calcul des superficies des parcelles paysannes ont été effectués à l'aide d'un GPS (Global Positioning System) portatif de type Garmin (GPSMAP 76S). Cet outil a permis un enregistrement automatique d'environ 10 tracés de parcelles par jour.

La mesure de la superficie d'une parcelle débute lorsque la réception satellitaire devient correcte (5 ou 6 satellites minimum pour calculer et actualiser une position). Une fois bien positionné, l'opérateur valide la saisie du premier sommet (première borne). L'opérateur se déplace sur la seconde borne (deuxième sommet) e t valide à nouveau sa saisie, et ainsi de suite jusqu'à la dernière borne. Au fur et à mesure du déplacement d'une borne à l'autre, la parcelle se dessine sur l'écran du GPSMAP 76S. L'échelle de l'affichage est automatique quelque soit la taille de la parcelle. Le dessin est systématiquement orienté vers le Nord. Une fois le dernier sommet saisi, la parcelle est automatiquement fermée (trait entre le dernier sommet saisi et le premier enregistré au départ). Un fichier est enregistré et la surface est affichée.

Les rendements ont été estimés à la récolte à partir d'un carré de rendement de 1 mètre de côté (1m x 1 m) en trois répétitions par rizière. Cet exercice a été répété pour chaque variété en autant de rizières que possible.

4.3 Les variables mesurées

4.3.1 L'enquête socio-économique

Les variables mesurées au cours de cette enquête sont :

10. l'identité, l'âge et le statut matrimonial de la personne enquêtée
11. le niveau maximum d'éducation atteint
12. son appartenance à un groupe associatif
13. sa situation par rapport à l'adoption (adopteur/ ou non adopteur)
14. ses moyens de productions et ses sources de revenus autres qu'agricoles
15. ses contacts avec les services de vulgarisation

4.3.2 L'enquête portant sur l'estimation des superficies

La superficie parcellaire a été la variable primaire mesurée. Ces superficies ont été agrégées à différents niveaux pour obtenir la superficie totale par rizière, par variété, par type de variété, par niveau d'adoption et éventuellement par village.

4.3.3 L'enquête portant sur l'estimation des rendements

La production par placette de 1m x 1m a été la variable primaire mesurée en trois répétitions. Ensuite un rendement moyen a été calculé pour les trois placettes, et cette quantité a été agrégée à différents niveaux pour obtenir le rendement par rizière, par variété, par type de variété, par niveau d'adoption et éventuellement par village

4.3.4 L'enquête portant sur l'estimation du revenu

La variable mesurée ici correspond au revenu brut issu de la commercialisation par ménage des différentes formes sous laquelle le riz est commercialisé. Il s'agit du riz paddy, du riz décortiqué et de la production de riz sous forme de semence.

5. Résultats

5.1 Quelques caractéristiques socio-économiques des populations enquêtées. Le contexte de la production du riz en zone forestière de Côte d'Ivoire.

La zone forestière se caractérise depuis l'indépendance du pays par un flux migratoire important dû à un potentiel agro-écologique élevé. Ce fait a créé une menace permanente sur les ressources forestières et les équilibres écologiques et s'est traduit par la quasi-disparition de la forêt primaire et une perturbation importante du régime pluviométrique (Léonard et Oswald, 1996). En effet, l'analyse de la pluviosité de 1941 à 2000 indique une tendance décroissante. La moyenne stabilisée y est de 1500 mm pour la période 1941-1970 et de 1350 mm pour la période 1971-2000, soit une baisse de 150 mm (Koné, 2003).

Au niveau de la riziculture pluviale, le capital d'exploitation n'est jamais important, et se limite à quelques outils dont la machette et la daba. Le travail essentiellement d'origine familiale et limité représente le principal facteur de production avec la terre. On dénombre en moyenne deux à trois actifs agricoles par exploitation. Le niveau des techniques culturales est rudimentaire. Le travail du sol est superficiel, le semis en ligne est exceptionnel. Il est au contraire pratiqué le semis en poquets non alignés, qui se traduit par une faible densité à la levée. L'utilisation des intrants agricoles est rare, sauf lorsque ceux ci sont subventionnés dans le cadre de projets de développement.

5.2 Quelques caractéristiques socio-économiques des producteurs

Tableau 1 - Caractéristiques de l'âge des riziculteurs de la région de Daloa en 2007 en fonction du niveau d'adoption

NIVEAU D'ADOPTION	Effectif	Moyenne	Médiane	Min	Max
Non adopteur	64	39,25	38	18	74
Adopteur	106	47,61	46	20	74
Total	**170**	**44,46**	**43**	**18**	**74**

D'après les résultats du tableau 1, en moyenne les rizicultrices ayant adopté les nouvelles variétés de riz sont plus âgées que celles n'ayant pas adopté les nouvelles variétés de riz.

Tableau 2 - Niveau de formation des riziculteurs en fonction du niveau d'adoption

NIVEAU D'EDUCATION	Non adopteur	Adopteur	Total
	11	**18**	**29**
Illettré (e)	37,93%	62,07%	100,00%
	17,19%	16,98%	17,06%
	27	**60**	**87**
Niveau primaire	31,03%	68,97%	100,00%
	42,19%	56,60%	51,18%
	12	**16**	**28**
Niveau secondaire	42,86%	57,14%	100,00%
	18,75%	15,09%	16,47%
	14	**12**	**26**
Formation sur le tas	53,85%	46,15%	100,00%
	21,88%	11,32%	15,29%
	64	**106**	**170**
TOTAL	37,65%	62,35%	100,00%
	100,00%	100,00%	100,00%

Pearson CHI2(3) = 4,8518 , Pr = 0,183

Quant on considère le niveau de formation atteint par les riziculteurs de notre échantillon au tableau 2 , rien ne distingue un adopteur d'un non adopteur, le test de CHI2 étant non significatif au seuil de 5 percent. On note que le niveau de formation d'une majorité de non adopteurs (42,86 percent) et d'adopteurs (56,60 percent) correspond au niveau du cycle primaire de l'enseignement général en Côte d'Ivoire.

5.3 Le modèle de diffusion des nouvelles variétés de riz

5.3.1 L'introduction des nouvelles variétés de riz

Les variétés améliorées issues de la recherche ont été introduites au cours de deux grandes vagues. La première vague d'introduction a eu lieu au cours des années 1970 et est caractérisée par l'introduction de variétés essentiellement irriguées IR8, Bouaké 189 et Morobérékan. La seconde vague a démarré en 1997, et se poursuit encore actuellement.

Pendant cette phase plusieurs variétés ont été introduites dans la région. Elles proviennent principalement de deux sources que sont le CNRA et l'ADRAO (Figure 1)

5.3.2 Les aires de diffusion des nouvelles variétés de riz

La figure 2 permet de visualiser l'aire de diffusion des nouvelles variétés de riz dans la région de Daloa au cours des dix dernières années. Il ressort de cette figure que le village de Zaguiguia a constitué à partir de 1997 le premier foyer de diffusion. La diffusion s'est poursuivie par la suite le long de l'axe routier Daloa-Duékoué en touchant les villages de Digbapiai et Bateguedia.

Dans une seconde phase allant de 2000 à 2003 la diffusion a progressé le long de l'axe Daloa-Vavoua, en touchant les villages de Gueya, Tapéguhé, Zakaria et Brizeboua. A l'ouest, la diffusion a touché les villages de Kéibla et Zibraguhe le long de l'axe Daloa-Duékoué ; de même que le village de Zaibo situé plus au nord, ainsi qu'une poche au sud autour de Békiprea.

Dans une troisième phase allant de 2003 à 2006 la diffusion a davantage touché la zone sud en direction de la ville d'Issia avec des villages comme Zakoua et Tahiraguhé.

La figure 2 indique également la répartition spatiale actuelle des nouvelles variétés de riz autour de la ville de Daloa. On note distinctement que les variétés NERICA 1 et NERICA 2 sont les plus répandues, suivies des variétés WAB. Les variétés WITTA, Bouaké 189 et IDSA85 occupent majoritairement des niches autour respectivement des villages de Sibraguhé Korea1 et Bateguedia sur l'axe Daloa-Duékoué, et Lobia dans la banlieue de la ville de Daloa. Il existe au sud du village de Zaibo, une large bande de terre peu peuplée pour laquelle aucune donnée n'existe. L'existence d'une forêt classée au Nord de cette zone constitue un premier élément d'explication à cette situation.

Figura 1 - Principales vagues d'introduction depuis 1997

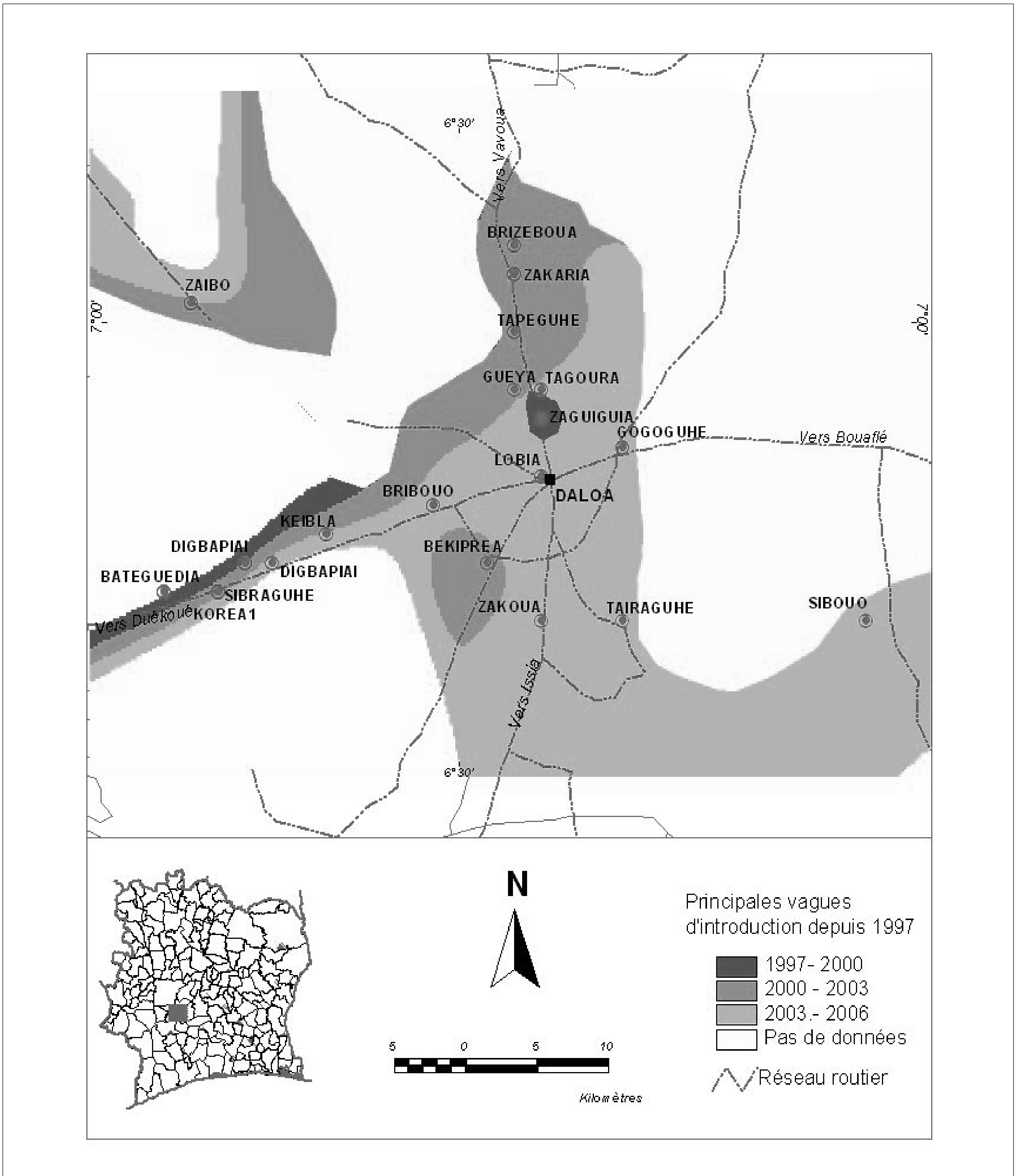
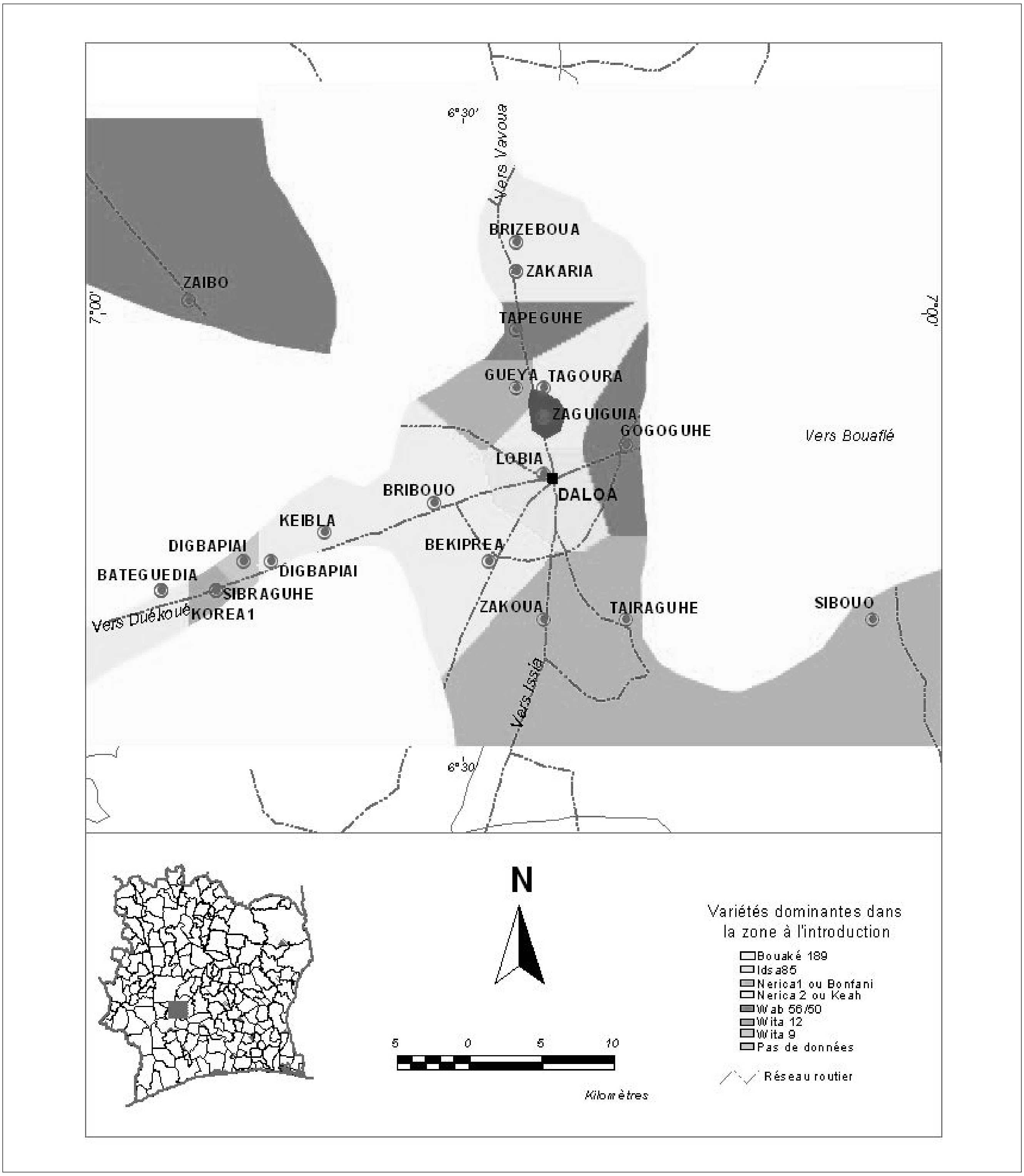


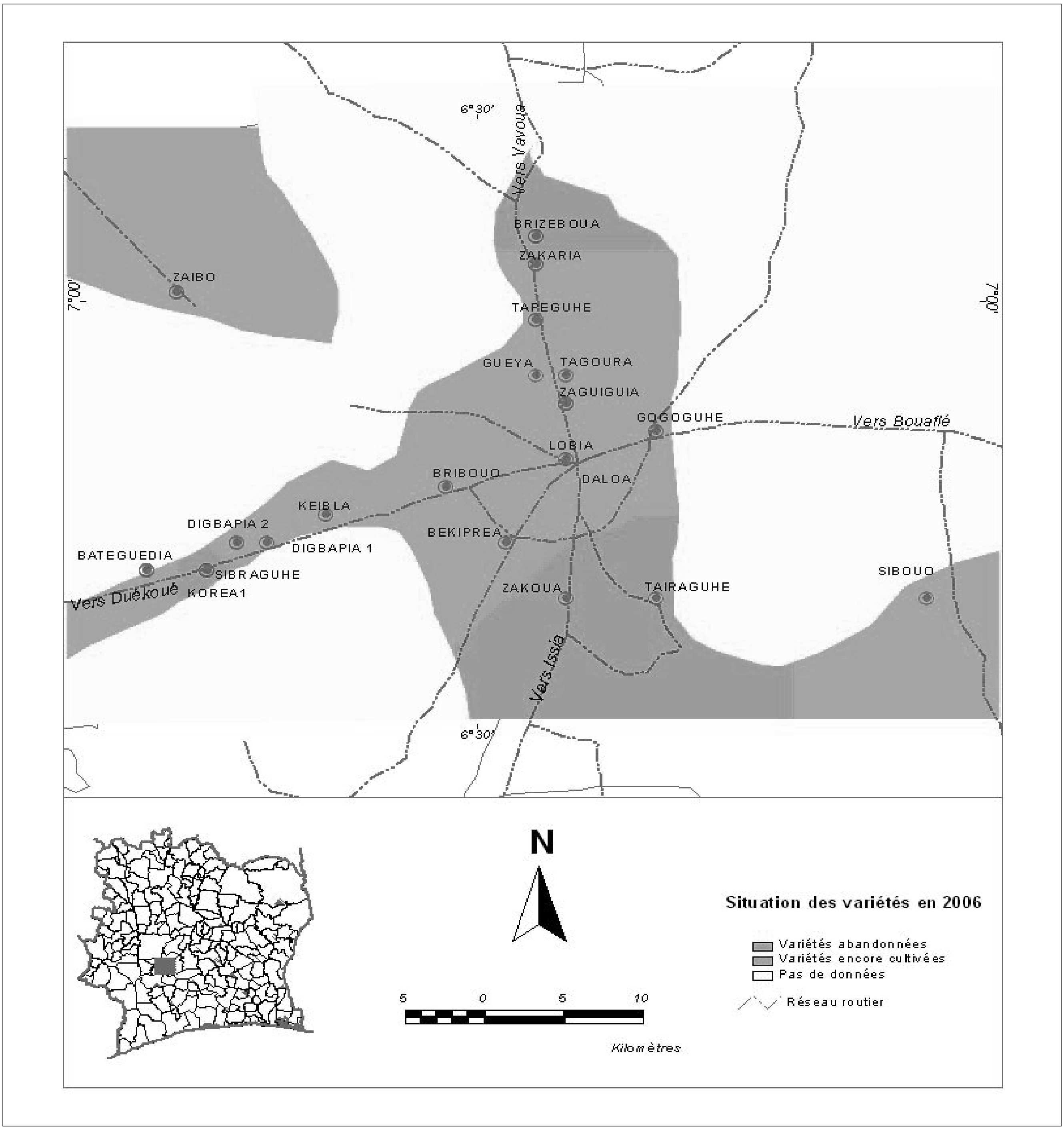
Figura 2 - Répartition spatiale des variétés améliorées



5.3.3 Les nouvelles variétés de riz encore cultivées dans la région de Daloa en 2006

Une évaluation en 2006 de la présence ou de l'absence des nouvelles variétés introduites dans la région a permis de constater que certaines d'entre elles se maintiennent, tandis que d'autres au contraire connaissent pour différentes raisons un reflux plus ou moins important. La figure 3 schématise l'état de cette évolution.

Figura 3 - Variétés présentés dans la région en 2006



Par rapprochement des figures 2 et 3, parmi les variétés dont la diffusion se développe ou à défaut se maintient, on peut citer WITTA9, WAB56-50, IDSA85, 13 IAC165, NERICA 1 et NERICA 2. A l'opposé on note une régression notable des variétés suivantes WITTA3, WITTA4, WITTA12 et IDSA78.

On constate un reflux des nouvelles variétés de riz sur l'axe Daloa-Duékoué dans les villages de Sibraguhé et Korea 1. Il s'agit là essentiellement de variétés de riz de type WITTA. On note une seconde zone de reflux des nouvelles variétés de riz au Nord de la ville de Daloa en direction de Vavoua avec pour village centre Brizeboua. Ce reflux concerne majoritairement la variété de riz NERICA 2. Enfin, plus au sud en direction d'Issia, on constate en 2006 une nouvelle zone de reflux des variétés de riz. Il s'agit principalement de NERICA 1.

5.3.4 Les canaux de diffusion utilisés pour informés les rizicultrices de l'existence des nouvelles variétés

Parmi les riziculteurs de notre échantillon, les résultats du tableau 3 indiquent que l'information relative aux nouvelles technologies rizicoles est surtout véhiculée par les groupements ou coopératives de production et de commercialisation du riz. En effet, dans plus de trois fois sur quatre (78,82 percent) ces structures associatives constituent le principal véhicule de l'information. La vulgarisation, ici essentiellement l'Anader contribue à la circulation de l'information dans moins de un cas sur cinq (18,82 percent), tandis que les ONGs et la Recherche contribuent de manière marginale (moins de 2 percent des cas) à la circulation de l'information.

Tableau 3 - Canaux par lesquels les rizicultrices sont informées de l'existence des nouvelles variétés de riz

SOURCE DE L'INFORMATION	Effectif des rizicultrices Informées par cette source	Pourcentage
Groupement / Association / villageoise	134	78.82
Vulgarisation	32	18.82
ONG	2	1.18
Recherche	2	1.18

5.3.5 Le taux d'adoption des nouvelles variétés de riz et le modèle de diffusion utilisé

Tableau 4 - Ventilation des superficies (ha) du riz pluvial au niveau de l'échantillon en fonction du type de variété *(campagne 2006-2007)*

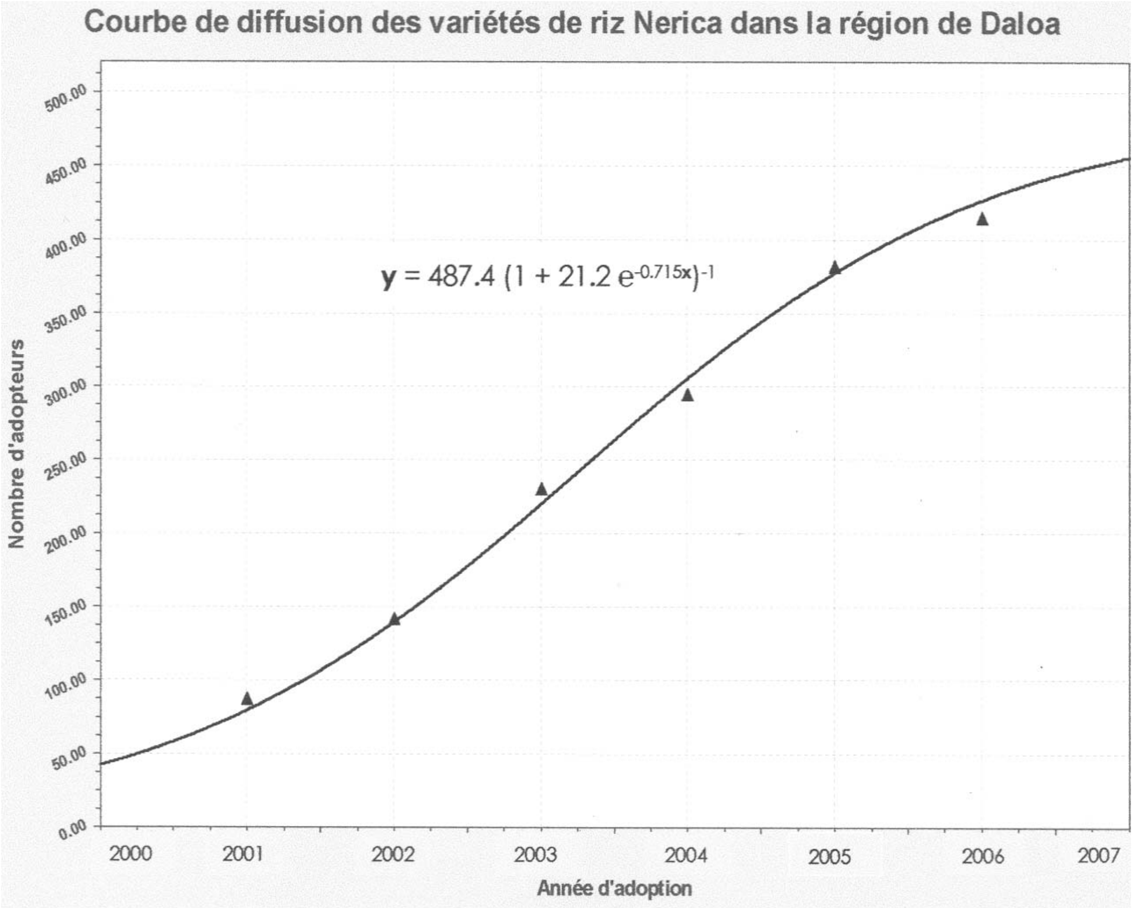
TYPE DE VARIETE'	Effectif des parcelles	Superficie totale	Moyenne	Médiane	Écart-type
Variété traditionnelle	199	19,32194	0,097	0,064	0,101
Variété améliorée	114	15,79958	0,138	0,067	0,154
TOTAL	**313**	**35,12152**	**0,112**	**0,066**	**0,124**

Les résultats du tableau 4 indiquent que dans notre échantillon de 313 parcelles, 114 soit 36,42 percent sont emblavées en variétés améliorées, correspondant à une superficie totale d'environ 16 (15,79958) hectares, soit un taux d'adoption de presque 45 percent (44,9854 percent) en variétés améliorées dans la région.

5.3.6 Le modèle de diffusion utilisé

Dans la littérature, plusieurs modèles sont utilisés pour expliquer le processus de diffusion des nouvelles technologies agricoles. (Griliches, 1957 ; Feder et al, 1982). Le modèle logistique dont les caractéristiques sont bien connues, demeure un des plus usités. Nos données s'ajustent parfaitement à ce modèle, comme l'indique la figure 4 ci-dessus.

Figure 4 - Courbe de diffusion des variétés de riz Nerica



5.3.7 L'estimation des superficies cultivées en riz

Le tableau 5 indique la répartition des parcelles élémentaires de riz par classe de superficie.

Tableau 5 - Répartition des superficies parcellaires (ha) en riz par classe de superficie *(campagne 2006-2007)*

CLASSE DE SUPERFICIE	Fréquence	Pourcentage	Pourcentage cumulé
de 0 à un quart d'hectare	277	88.50	88.50
de un quart d'hectare à moins d'un demi hectare	30	9.58	98.08
Plus d'un demi-hectare	6	1.92	100.00
TOTAL	**313**	**100.00**	

Ces résultats indiquent un morcellement très élevé des parcelles de riz. En effet, environ 90 percent des parcelles élémentaires ont une superficie égale à au plus un quart d'hectare, environ 10 percent des parcelles élémentaires ont une superficie située entre un quart d'hectare et un demi hectare, et moins de 2 percent des parcelles élémentaires ont une superficie supérieure à un demi hectare.

Tableau 6 - Ventilation des superficies (ha) au niveau des parcelles de l'échantillon par variétés les plus cultivées *(campagne 2006-2007)*

RANG	Variété	Fréquence	superficie totale	médiane	moyenne
1	Nerica1	43	10,764	0,239	0,250
2	Lokple	21	3,101	0,123	0,147
3	Azico	22	2,795	0,078	0,127
4	Nerica2	15	2,003	0,118	0,133
5	Dogore	23	1,877	0,058	0,081
6	NONNONNON	13	1,503	0,094	0,115
7	Digbeugbassou	10	1,171	0,072	0,117
8	Goklia	11	1,153	0,077	0,104
9	IDSA85	17	1,049	0,031	0,061
10	Kimisere	16	0,997	0,055	0,062

Les résultats du tableau 6 ci-dessus indiquent que parmi les dix variétés les plus cultivées dans notre échantillon en 2007 dans la région de Daloa, trois sont des variétés améliorées dont deux du groupe Nerica introduit dans la région il ya moins de dix ans. La variété Nerica 1 est largement adoptée et les superficies parcellaires moyennes sont significativement supérieures à celles de toutes les autres variétés y compris la variété Nerica 2. Il est à noter que la variété IDSA85, a été introduite dans la région depuis plus de quinze ans et qu'elle est encore cultivée.

Au niveau des variétés locales, *Lokple* et *Azico* constituent les variétés de tête.

5.3.8 L'estimation des rendements

Les variétés qui sont indiquées au tableau 7 sont celles pour lesquelles le nombre de répétition est supérieur ou égal à trois (3). Au niveau des variétés locales, Lokple et Maloba sont les plus productives, avec des rendements médians supérieurs à deux tonnes à l'hectare à 14 percent d'humidité.

Tableau 7 - Distribution des rendements de riz à 14% d'humidité par variété

Variété	N	Moyenne	Médiane	Ecart type
Dogore	7	1.887	1.767	0.525
Kimisere	3	0.992	1.022	0.142
Lokple	6	2.232	2.558	0.771
Maloba	4	2.279	2.511	0.534
Nerica1	20	1.679	1.674	0.438
Nerica2	6	1.534	1.348	0.450
Wab56-50	4	1.465	1.209	0.641

En ce qui concerne les variétés améliorées, Nerica 1 est la plus productive, suivent dans l'ordre les variétés Nerica 2 et Wab56-50. Hormis la variété Kimisere, les autres variétés indiquent une variabilité du rendement relativement élevée.

Tableau 8 - Distribution des rendements de riz à 14% d'humidité par type de variété

TYPE DE VARIETE'	N	Moyenne	Médiane	Ecart type
Variété traditionnelle	30	1.950	1.674	0.694
Variété améliorée	31	1.623	1.581	0.451
TOTAL	**61**	**1.784**	**1.581**	**0.602**

Le tableau 8 ci-dessus indique la distribution des rendements par type de variété. Quand on considère les conditions de cultures paysannes, c'est-à-dire sans utilisation d'intrants, on peut affirmer que les rendements des deux types de riz sont du même ordre de grandeur. Le rendement des variétés améliorées semble légèrement plus stable que celui des variétés traditionnelles.

Tableau 9 - Distribution des rendements de riz à 14% d'humidité par village

VILLAGE	N	Moyenne	Médiane	Ecart type
Doboua	6	1.720	1.488	0.845
Gaboua	16	1.67	1.488	0.708
Tapéguhé	9	1.560	1.395	0.576
Zaguiguia	19	1.968	2.04	0.452
Zakaria	9	1.829	1.581	0.532
Zakoua	2	1.162	1.162	0.328

Le tableau 9 indique les rendements moyens du riz pluvial par village à 14 percent d'humidité. Le rendement médian dans le village de Zaguiguia est légèrement supérieur à deux tonnes à l'hectare. On note des écarts type des rendements moyens relativement élevés dans tous les villages.

5.3.9 L'impact socio-économique des nouvelles variétés de riz

L'adoption des nouvelles variétés s'est accompagnée de quelques changement tant au plan agronomique qu'au plan socio-économique. En effet, au niveau agronomique les femmes ont opéré sur des parcelles plus grandes que lorsqu'elles cultivent des variétés locales. On a également noté, étant donné la précocité des nouvelles variétés améliorées, une souplesse dans le calendrier cultural, une réduction du temps de travail par la réduction du nombre de sarclage. De plus, il est désormais possible de pratiquer deux cycles de cultures par an (premier semis en avril et second semis en juillet).

On a également constaté un début d'utilisation d'intrants (engrais et herbicide), et une diminution de la quantité de semence utilisée à l'hectare.

Au plan socio-économique, la production et la commercialisation de semence de riz a amélioré le revenu agricole des femmes, ce qui s'est traduit par:

- une plus grande prise en charge des femmes par elles mêmes ;
- une capacité accrue de contribution aux charges du ménage (frais de scolarité des enfants, soins médicaux ; investissement au niveau agricole, achat de bien d'équipements, amélioration de l'habitat etc.)
- une plus grande participation aux décisions qui engagent le couple

Avec pour conséquence une amélioration de la stabilité du foyer, une plus grande valorisation du statut de la femme, et un renforcement des relations sociales.

Au plan matériel, la production et la commercialisation des semences (en particulier des variétés NERICA), ont par ailleurs amélioré la condition de vie des femmes, voire des ménages au point où des hommes s'intéressent désormais à la culture du riz pluvial.

6. L'estimation du revenu agricole

La commercialisation concerne la semence et le surplus de production mis en marché. L'estimation du revenu agricole repose donc sur l'estimation des ventes de ces deux quantités.

6.1 Rizicultrice ayant adopté les nouvelles variétés de riz

Tableau 10 - Forme sous laquelle production est commercialisée et pourcentage de femmes impliquées dans chaque forme

FORME SOUS LAQUELLE LE RIZ EST COMMERCIALISE'	Pourcentage de rizicultrices
Paddy	11.66
Riz blanchi	4.16
Semence	75.83

Le tableau 10 ci-dessus indique qu'au niveau des femmes ayant adopté les nouvelles variétés de riz, seules environ 12 percent dégagent un surplus commercialisable sous forme e paddy, 5 percent un surplus commercialisable sous forme de riz blanchi, et environ 76 percent commercialisent effectivement de la semence.

Tableau 11 - Répartition des rizicultrices en fonction des classes de revenu

CLASSE DE REVENU (FCFA)	Fréquence	Pourcentage	Pourcentage cumulé
de 0 à 10 000	26	21.67	21.67
de 10 001 à 50 000	54	45	66.67
de 50 001 à 100 000	30	25	91.67
de 100 001 à 200 000	9	7.50	99.17
300 000 et plus	1	0.83	100.00
TOTAL	**120**	**100**	

Le tableau 11 ci-dessus indique les classes de revenu. On note qu'environ les deux tiers des femmes ayant adopté les nouvelles variétés de riz ont un revenu compris entre 0 et 50 000 FCFA, le dernier tiers des adopteurs pouvant se vanter d'avoir un revenu supérieur à 50 000 FCFA ; 8 percent d'entre elles dispose d'un revenu excédant 100. 000 FCFA.

6.2 Les productrices n'ayant pas adopté les nouvelles variétés de riz

Le tableau 11 ci-dessus indique qu'au niveau des femmes n'ayant pas adopté les nouvelles variétés de riz, seules environ 15 percent dégagent un surplus commercialisable sous forme de paddy, 5 percent un surplus commercialisable sous forme de riz blanchi, et naturellement aucune femme de cette catégorie ne commercialise de la semence, étant donné que seules les variétés améliorées de riz sont commercialisées sous forme de semence.

Tableau 12 - Forme sous laquelle production est commercialisée et pourcentage de femmes impliquées dans chaque forme

FORME DE COMMERCIALISATION DU RIZ	Pourcentage
Paddy	14.78
Riz blanchi	5.21

Le tableau 12 ci-dessous indique qu'environ 90 percent des rizicultrices n'ayant pas adopté les nouvelles variétés de riz ont un revenu compris entre 0 et 10 000FCFA, seulement 10 percent de ces femmes ont un revenu compris entre 10 000 FCFA et 50 000 FCFA. Aucune femme de cette catégorie ne dispose d'un revenu supérieur à 50000 FCFA.

Tableau 13 - Répartition des rizicultrices en fonction des classes de revenu

CLASSE DE REVENU (FCFA)	Fréquence	Pourcentage	Pourcentage cumulé
de 0 à 10 000	104	90.43	90.43
de 10 001 à 50 000	11	9.57	100.00
TOTAL	**115**	**100.00**	

7. Discussion et conclusion

Les parcelles paysannes ont rarement des formes géométriques précises comparativement aux parcelles des stations de recherche. La mesure des surfaces des parcelles en milieu réel présente donc des difficultés pratiques qui sont facilement levés avec l'utilisation du GPSMAP 76S. En effet, il est possible de créer et d'utiliser jusqu'à 500 points de cheminements, permettant d'affiner les limites d'une parcelle paysanne. Par ailleurs le taux d'erreur demeure de l'ordre de 2 percent, même pour des parcelles dont les superficies sont inférieures à un demi hectare, d'où la fiabilité et l'intérêt du GPS en milieu rural africain.

Par ailleurs, l'utilisation du logiciel ARCVIEW a permis une cartographie d'où une bonne représentation de la répartition spatiale de ces variétés.

Nos résultats d'introduction et de diffusion des variétés indiquent que rarement les variétés sont adoptées définitivement ; le phénomène connait des flux et des reflux. Sur une dizaine de variétés introduites sur la période, seules trois ou quatre sont encore cultivées à une échelle significative par les rizicultrices. Les variétés Nerica d'introduction récente sont remarquables de ce point de vue, d'où leur taux important d'adoption. La courbe de diffusion des variétés Nerica s'ajuste bien à la courbe logistique.

Nos résultats indiquent également un morcellement des parcelles caractérisées par la faiblesse des superficies des parcelles individuelles et leur nombre relativement élevé par rizière, trois à quatre parcelles en moyenne.

Les performances de la riziculture pluviale sont faibles dans la région, ce qui se traduit par la faiblesse du volume de surplus commercialisé. Le riz est essentiellement mis en marché sous forme de paddy et rarement sous forme de riz décortiqué faute d'équipement adéquat dans les villages. La principale forme de commercialisation concerne les semences de variétés améliorées, ce qui est à la portée des seules femmes qui ont adopté ces nouvelles variétés. La conséquence de cette situation est que le revenu agricole des adopteurs est significativement plus élevé que celui des non adopteurs. Toutefois, le marché des semences est relativement étroit et peut connaître assez rapidement la saturation.

8. Perspectives

La riziculture pluviale est la plus importante en Côte d'Ivoire, et cette forme de riziculture demeure une cible privilégiée si l'on veut obtenir des augmentations significatives de la production de riz. Comme elle est pratiquée à plus de 90 percent par les femmes, celles doivent donc être au centre de tout projet visant à l'amélioration de la production de riz en Côte d'Ivoire. L'amélioration des conditions de travail des ricicultures, la facilitation de leur accès à la terre et aux intrants, de même que la fourniture d'équipement adéquat constituent autant de préalables à tout projet de développement durable de la riziculture en Côte d'Ivoire. De plus les Pouvoirs publics devront donner la priorité à la production locale de riz en réduisant les importations et en soutenant la production locale.

Bibliographie

Feder, G., Just, R.E. and Zilberman, D. (1982). *Adoption of agricultural Innovations in developing countries*. A survey. World Bank Staff Workings, No 542, Washington D.C.

Griliches, Z.(1957). Hybrid corn: *An exploration in the economics of technological change*.
Econometrica 25:501-522.

Koné D. (2003). "Caractérisation du risqué climatique de la culture de maïs en zone centre de Côte d'Ivoire". In *Soil Water balance in the Sudano-sahelian Zone*. IAHS Publ No 199 pp 515-521.

Léonard E. et Oswald M. (1996). *Une agriculture forestière sans forêt. Transformation de l'environnement et mise en place de système stables en Côte d'Ivoire forestière*. Nature Science et Société, 1996 (4) 3.

An Open Source Approach to Disseminate Statistical Data on the Web

Giulio Barcaroli, Stefania Bergamasco,
Stefano De Francisci, Leonardo Tininini
ISTAT – via Cesare Balbo, 16 – 00184 – Roma (Italy)

***Abstract**: The Italian Institute of statistics has been working for several years on the development of generalised software, i.e. reusable in its numerous statistical production lines. The recent adoption of free/open source software has further fostered the reusability strategy, by making the technological platforms more independent from the usage context. Particularly, open source and reusable solutions were chosen in the dissemination context, by developing the Integrated Output Management System, aimed to support the integration of the several transformation phases in the statistical data life cycle, up to the various output products made available to final users. In this paper the main characteristics of this system are described, along with the numerous opportunities this kind of system can offer in the context of international cooperation.*

Keywords: open source software, statistical dissemination

1. Introduction

The statistical production activities of the Italian Institute of Statistics (ISTAT) are supported by a distributed organization. Each area of statistical production operates through its own subsystems that, as often as not, cover the full statistical data life cycle, from data collection up to dissemination. For this reason, the Institute is long since involved in the development of generalized software to harmonize and integrate the production processes and the common statistical contents of its own production areas. Lately, the adoption of open source software solutions has further enhanced the actions of generalization and integration, enabling ISTAT to carry out software packages reusable in external contexts too.

Also in the phase of statistical data dissemination, ISTAT has focused its own strategies on the development of standard and reusable software. In particular, generalised packages to manage the processes for statistics Web dissemination were developed. Such solutions are available to be used directly by the statistical production areas to deploy their specific instances of statistical data warehouses. Also in this case, the gradual adoption of free/open source software has promoted a large reuse of the dissemination systems in the field of international cooperation.

This paper presents the most important results achieved in ISTAT in the development of solution based on open source software. In particular, after a brief overview on the tools developed to support the main relevant phases of the statistical survey (Section 2), the Integrated Output Management System (ISTAR) will be illustrated in detail. The general strategy of the system is presented in Section 3, while the architectural framework and a brief history of the project is illustrated in Section 4. Section 5 describes a particular ISTAR module, namely the data warehouse module to disseminate statistical aggregate data on the Web, while Section 6 concludes the paper.

2. ISTAT open source tools for statistical cooperation

ISTAT involvement in statistical cooperation projects has very often regarded support in methodological issues and also in related software, i.e. software implementing most advanced methods and techniques for any relevant phase of a typical statistical survey.

From a very general standpoint, the issue of the use of statistical software has an impact not only on the way each phase of the statistical production process is performed, but it has to do with the very sustainability of the statistical system that is supported and fostered through technical cooperation.

Donors often dedicate limited time and resources to cooperation activities, and once methodologies are transferred and acquired, the required objectives and results are obtained by supplying beneficiary institutions with the software applications used by the relevant partner: this is often either a commercial software, whose costly licenses expire, or software developed *ad hoc* by the partner institution, whose reusability is low or even null; training is also frequently provided, rendering that specific intervention acceptable, but limited, and with no given relation with the overall IT framework of the beneficiary institution. In these institutions, the situation is worsened by the high human resources turnover, especially of those expert in software development. The rapidly changing IT environment and knowledge creates an additional pressure for these institution to optimise their approach.

As a result, the managers of a statistical institution in development have to urgently face the issue with a comprehensive strategy, as it touches aspects like scientific independence, sustainability of development processes and human and financial resource management.

ISTAT has attempted to support the institutions involved in its cooperation programmes by fostering the use of generalised tools, based on open source software wherever possible, because this particular choice overcomes the drawbacks characterising *ad hoc* solutions. In fact, generalised software can be reused by definition, with limited or no need to write new code: so, applications developed under the support of the donor can be replicated by the beneficiary institution even when the project has ended, once an adequate training has been provided.

Moreover, if a given generalised system has been developed by using open technologies, one relevant benefit is the fact that it is portable on every platform with no cost for the user. And this is a very important feature in terms of the sustainability of the cooperation projects.

In achieving that, ISTAT has been facilitated by the internal policy it had adopted since long, consisting in *internally* developing a number of important generalised systems and tools, namely for editing and imputation, for dealing with sampling issues (design and estimation) and for disseminating statistical information: as a consequence, the choice regarding underlying technologies has always been an open option.

So, when at the beginning of the new millennium, the strategy of privileging open source technologies instead of proprietary ones was adopted, it was an almost straightforward task to migrate generalised software.

In particular, we refer to the three most important set of tools used inside ISTAT, namely:

- CONCORD (*CONtrollo e CORrezione dei Dati*) for edit and imputation of data (Riccini, 2004);
- MAUSS (*Multivariate Allocation of Units in Sampling Surveys*) and GENESEES (*GENEralised Sampling Estimates and Errors in Surveys*) (2005a and 2005b) respectively for sampling design and estimation;
- ISTAR for statistical data warehousing.

The first to be migrated was CONCORD, whose first version was based on SAS. The occasion was given by a cooperation project (2004 Household Budget Survey, “HBS”, in Bosnia): to let the beneficiary autonomously use CONCORD without having to pay for SAS, a different version (Linux based) was developed and, from that one, was derived the current version, that is a Java one, running on all platforms (Linux and Windows).

Immediately after, a R version of MAUSS was developed, substituting the SAS one; at the same time, a new R package, “EVER” (Zardetto, 2008) was produced, enabling users to perform the functions (calibration and sampling variance estimation) till then ensured by GENESEES, based on, and requiring, SAS. Also in this case, Bosnia was the first to adopt the new tools, for the past 2007 HBS (EVER) and for the next 2010 HBS (MAUSS-R).

First versions of ISTAR made a prevalent use of open technologies (namely Apache, Tomcat, JSP), but data management was entirely based on ORACLE system. The cooperation project for the preparation of the next Kosovo Population Census was the occasion to migrate towards an open solution, where PL/SQL procedures have been substituted by JAVA ones, and the user can choose the dbms he/she wants (for instance, MySql). Once again, Bosnia is going to be the first test-stand for the new version, as the web data warehouse containing 2007 HBS will be developed by using the new ISTAR toolkit.

So far, we have mentioned the tools ISTAT developed on its own, tools that are best suitable for cooperation projects in that they are generalised and based on open technologies. But many other software tools are available, so to cover all the phases of a statistical survey. We cite here:

- the R package "sampling" (Tillè and Matei, 2007) for optimal sampling units selection;
- for data collection: CsPro and LimeSurvey, respectively for CAPI and web surveys;
- the R packages "yaImpute" and "mice" for (single and multiple) imputation of missing values;
- R, Adamsoft, Weka, Rattle, Knime, RapidMiner for data analysis and data mining;
- ARGUS of disclosure control while disseminating data at different levels of aggregation (micro and macro).

Even if they are not all "pure" open source software tools (as their source code is not available, as in the case of CsPro), they are all free software, commonly downloadable from the Internet.

3. The Integrated Output Management System of ISTAT

The INTEGRATED OUTPUT MANAGEMENT SYSTEM (ISTAR) of ISTAT is an information system oriented towards the integration of part of the statistical data life cycle, particularly, all the steps required to produce purposeful statistical outputs for end users. In particular, ISTAR has been developed to maintain, integrate and manage the data and metadata supplied by the statistical production areas of ISTAT after the validation processes.

The track ISTAT is following to integrate its own information systems is mostly based on the exploitation of new technologies and on a new way to organize and manage the knowledge. The experiences already completed have shown, on one hand, the chance of integrating and sharing knowledge existing in differently structured information (from legacy data base or data warehouse to textual documents, volumes, etc.) and on the other hand paying more and more attention to the information needs of the users. For this reason, ISTAR is based on a complex scenario of integration which includes not only data warehouses and metadata information systems, but also descriptive and textual information and diverse models of classification of reality. It combines the approaches for browsing dimensional data, typical, for example, of statistical data warehouses on the Web, with new models for the management and representation of knowledge and the information architecture.

The technical solutions developed take advantage of the construction of specific metadata layers and their strict associations to the objects managed in the database. At the same time, the system preserves all the features of the search engine relating to optimization of search, in order to improve the performances of the scanning operations.

ISTAR is based on two general principles: workflow and toolkit.[42] The system supports the statistical data transformation workflow, by adopting ETL (Extract, Transform and Load) methodologies and technologies, enabling the automated and integrated transformation of input data into statistical output data for dissemination. These data are then loaded into a generalised database, independently of the statistical domain. This type of process organisation improves the timeliness and coherence of the dissemination process, both minimising the delay between data checks and publication – i.e. the moment that data are returned to the community in a usable form – and, thanks to the high degree of automation, reducing the probability of human error during calculation and storage of aggregate data in the dissemination database.

From the point of view of the typology of data handled, the structure of ISTAR is based on several levels and kinds of statistical data and metadata. With respect to the data layers, ISTAR is able to manage both elementary and aggregated data. The system offers a set of packages to extract data from statistical sources, transform them into manifold formats, load the data into statistical data warehouses or data banks and make the information available to many different users, by means of different types of dissemination channels and technologies. The

[42] The term *toolkit* is commonly used in the computer programming domain to denote a collection of generalised tools and components, which can be used to implement a unified system, customized according to the user's specific needs and requirements. Toolkits are usually made available as libraries or application frameworks.

metadata layers cover not only the description, the design and the reference of the contents, but are also oriented towards the management of the navigation, the finding, the interchange and the semantics of the data. In detail, the main typologies of ISTAR metadata are:

- Statistical metadata: they are centred on the description and management of meaning and role of the statistical data in the system. Through the use of generalized packages and databases, statistical metadata accompany the data along the statistical surveys life cycle, from the validated elementary data environment to the dissemination on the Web;
- Reference metadata: this component is handled by a specific module for the integration of documentation metadata. They are stored in the Surveys Documentation Information System (Sidi) and in the Quality System (SIQual), strictly integrated with Istar;
- Controlled vocabularies and glossaries: these components are managed by a semantic thesaurus and a specialized glossary of statistical terms directly associated to the statistical information contents of Istar;
- Metadata for searching: this layer enables the retrieval of collections of information available in several formats and digital supports (electronic publications, press releases, spreadsheets, databases, and so on) through a specialized search engine.

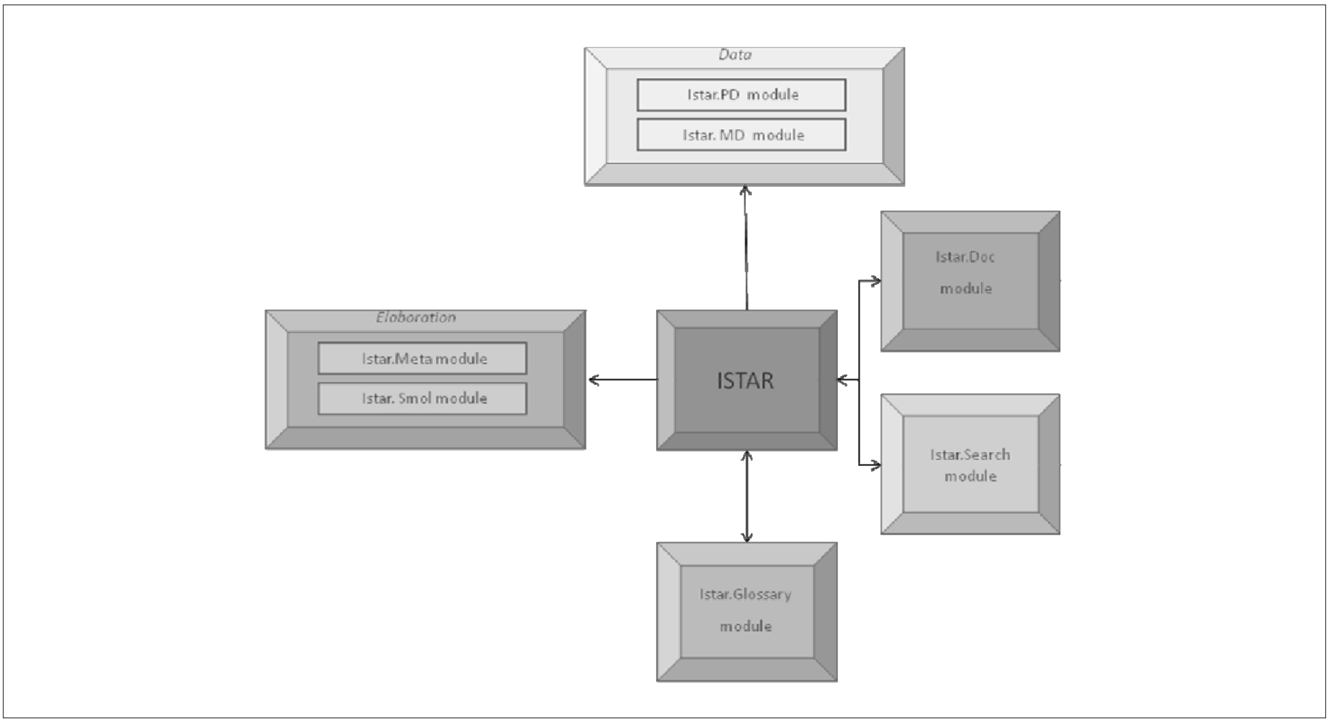
In order to manage all these kinds of data and metadata, a collection of tools strictly integrated has been developed. As mentioned above, the toolkits are specifically designed to support the statisticians in all the phases required to disseminate statistical aggregate data on the Web. From the functional point of view, the collection of toolkits is structured in two different kinds of packages: modelling tools and analysis and reporting tools. Modelling tools allow the user to design the semantic layers of the system, through the mapping of the structures of data sources (not easily understandable by the end users) into statistical outputs specifically oriented to describe the subject matter domains closer to the user language. From the application point of view, the modelling tools include both tools for managing on line interaction with designers and batch procedures for running ETL functionalities. Analysis and reporting tools provide navigation tools, in-house or publication on the Web of the data warehouse contents. In the next section we will present in detail the architectural framework of ISTAR.

4. The Istar framework

The project ISTAR was born in the year 2004 with the intent to deploy a whole software package allowing the statistic production sectors to elaborate and to spread the data on the Web, starting from the validated microdata.

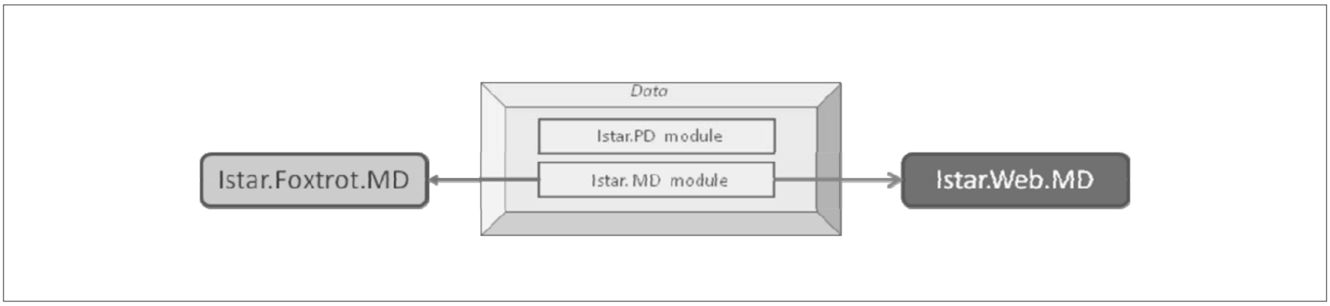
ISTAR, as represented in figure 1, is composed of seven modules: modules to elaborate the data (Elaboration - *Istar.Meta* e *Istar.Smol*); data module to publish the tables on the web (Data module - *Istar.PD*); data warehouse module (Data module - *Istar.MD*); glossary module (*Istar.Glossary module*); documentation module (*Istar.Doc module*); search engine module (*Istar.Search module*).

Figure 1 - Istar framework



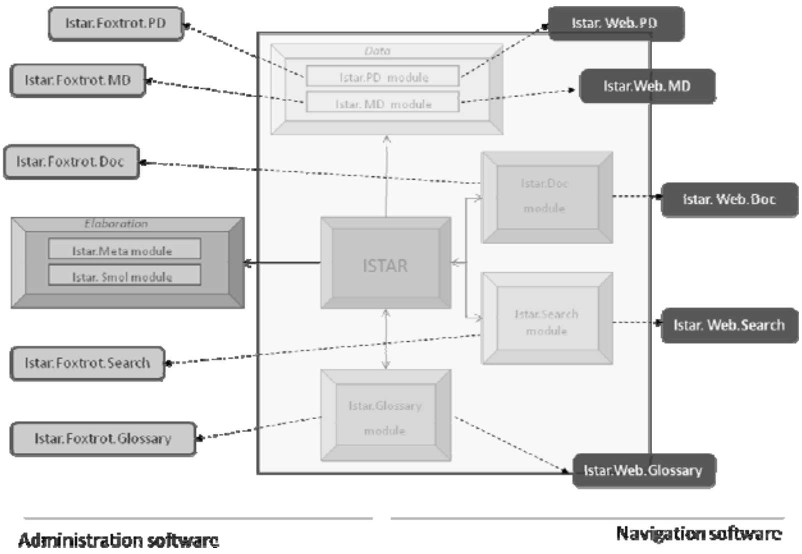
Every module, except the first one that is meant for exclusive use of the ISTAT production sectors, is composed of two software components: the administration component, named with *foxtrot*, to create the web site, and the software, denominated with the prefix *web,* to surf among the data or metadata or documentation. Accordingly, *Istar.MD* has, for instance, two components: *Istar.Foxtrot.MD* to design and feed a data warehouse and *Istar.Web.MD* to navigate its data on the Web (Figure 2).

Figure 2 - Istar.MD



The set of *Istar.Foxtrot* components represents the dashboard with which it is possible to create a complex web site, while, the set of *Istar.Web* components represents the different ways of navigation and retrieval the information publish on a web site. The ISTAR modular structure allows to choose which components to use and which on line services to offer to the external users. For instance if we want to create a data warehouse system, we have to use the *Istar.MD* module and its two software components (*Istar.Foxtrot.MD* and *Istar.Web.MD*). If we want to also equip such system with the glossary we have to use the *Istar.Glossary* component with the administration and consultation tools.

Figure 3 - Istar framework detail



In the following a brief description of the different components is given:

Istar.Meta = it allows to pass from a sequential structure of a microdata file to a Data Mart organization. Such component is linked with the Centralized system of validated microdata;

Istar.Smol = it allows the elaboration of the data and the creation of tables (tables for the press, excel tables, html files, xml files);

Istar.PD = it allows to publish statistical tables (also in excel downloadable format) making them navigable according to their topics, years and territories;

Istar.MD = it allows the realization of a Web data warehouse environment;

Istar.Glossario = it allows the deployment of a glossary of the terms used on the Web site;

Istar.Ricerca = it allows to equip our own system with a search engine. Such component has been implemented through the use of Google Search Appliance (GSA) and, therefore, not completely free;

Istar.Doc = it allows to equip the system with a series of information related to the documents and to the surveys to which the data refer. Such software is the connection to the central documentation system of the ISTAT surveys (SIQUAL).

The ISTAR project originated from some previously developed software applications, which were evolved and integrated also with other ones. Such software applications are *Dawinci.MD and Web.PD*, respectively the first versions of *Istar.Web.MD* and *Istar.Web.PD* components. Such components were developed to publish the 2001 census data on the Web.

Starting from 2004, various systems were implemented by the Italian Institute of Statistics within the ISTAR framework. During this experience several different ISTAR versions were released but the adjustment of the systems already realized to the last consolidated version and the realization of new was planned for 2009 and 2010. In the following a brief synthesis will be given of the deployed systems, available on Internet, and of in progress systems, currently on the Web.

Beginning from the experience of the 2001 Census the first realized system, in 2005, was an international collaboration with Bosnia-Herzegovina. The National Institute of Statistic, in fact, collaborated for the realization of the data warehouse related to household budget survey realized in Bosnia-Herzegovina during 2004. This system is available on the Web at the address http://hbsdw.istat.it. Such experience is, today, in phase of consolidation through a new step of collaboration. We are releasing the whole *Istar.MD* module to the national institute of Bosnia-Herzegovina, in order to allow the statistic users to realize their own data warehouse environment related to 2007 household budget survey.

During 2005 the ISTAT has respectively realized the systems related to the data on the law I.S. and Water Census I.S. The year 2006 saw the release of the systems about graduate employability (http://dip.istat.it, http://lau.istat.it). During this year the National Institute of Statistics began to experiment the realization of thematic multi source systems. These are systems into which various surveys publish altogether their own data about a topic. Particularly, in collaboration with the Ministry of the Social Politics, the INCIPIT system was carried out (http://incipit.istat.it). The aim of this system is to offer a series of local information to support the local politics. The realization of such system required the evolution of the *Istar.MD* component, passing from the original system based on a single year and territorial aggregation type to a new one enabling multi-year and multiple territorial aggregation type management.

The positive experience of the multi-source system, as well as the external requirement for thematic systems, has brought the institute to reiterate it during the years 2007 and 2008 building further thematic environments. Particularly, it is now available on the internet the system related to the agriculture and zootechnical data (http://agri.istat.it) while further systems on the job market and on foreigners and immigrants are in the validation phase.

The modular organization of the ISTAR framework enables every project to use the software components which are more appropriate for its own context in terms of objectives to reach, time, resources as well as typology of data. More and more projects, however, are envisioned to use the framework in its entirety with the objective of creating a Web system that has contextually the table navigation component, the data warehouse, the glossary, the documentation, as well as the search engine. The above mentioned systems on the job market and on foreigners and immigrants have been carried out in this perspective.

Finally, the demand of software reusability in different linguistic contexts and for different DBMSs led the institute to an operation of maintenance of ISTAR modules. Accordingly, the *Istar.MD* module is currently available on both Oracle and MySql databases, as illustrated in the following section.

5. Istar.MD

Istar.MD is a collection of tools specifically designed to support the statisticians in the several phases required to disseminate statistical aggregate data on the Web starting from a collection of validated data. In the following we illustrate *Istar.MD'*s main characteristics, as well as the motivations underlying its development, based on open source technologies.

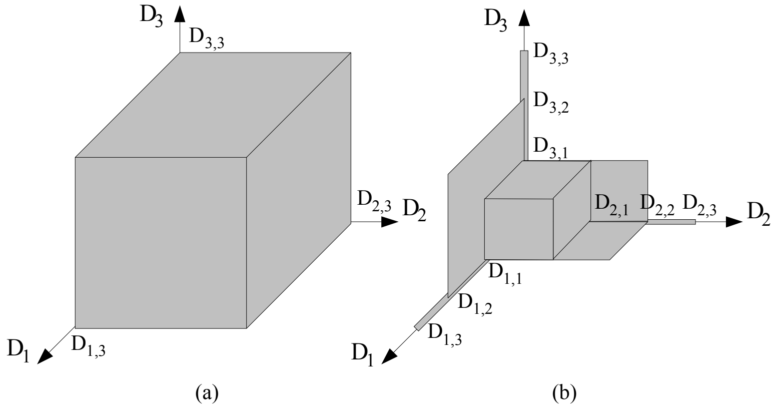
5.1 Istar.MD modelling basic concepts

The strict correspondence between statistical dissemination systems (SDSs, sometimes called also statistical databases), and data warehouses (DWHs), also known as On-Line Analytical Processing (OLAP) systems, was pointed out a few years ago by Shoshani (1997). Consequently, as DWHs have well-established methodologies and techniques, as well as powerful and user-friendly tools supporting the design, storage and multidimensional navigation of data, one may think to straightforwardly extend their use to the interactive dissemination of statistical data, in particualar by modelling microdata using *star schemas* (Kimball, 1996) and by navigating the corresponding aggregates (*data cubes*) and classifications (*dimensions*) using commercial DWHs.

However, despite the evident similarities, SDSs have several peculiarities that require conventional DWH techniques to be extended with more specific models and structures (Sindoni and Tininini, 2008). These are mainly related to sample surveys, issues of privacy disclosure (Malvestuto and Moscarini, 2003), microdata unavailability, filter questions and heterogeneous classification hierarchies (Lehner, 1998).

The differences between multidimensional navigation in a conventional DWH and an SDS are depicted in Figure 4, where the dimension levels are represented with an increasing level of detail on the dimension axes (e.g., if D2 is an area dimension, D2,1, D2,2 and D2,3 may correspond to the national, regional and municipality level) and the grey areas represent the dimension level combinations which can be accessed by users.

Figure 4 - Accessible dimension combinations in (a) a conventional data warehouse and (b) a Statistical Dissemination System



In conventional DWHs (a) the user is free to drill-down and roll-up along any dimensional hierarchy of the *data cube* (Gray et al., 1996), independently of the detail level of the other dimensions. In contrast, drill-down on a dimension in an SDS (b) can only be performed starting from certain combinations of the other dimensions and conversely, rolling-up on a dimension increases the number of possible explorations (drill-down) on other dimensions. This has obvious severe consequences on the conventional multidimensional navigation paradigm. In other words, a trade-off is required between the characteristic freedom and flexibility of DWH multidimensional navigation and the constraints arising in the statistical dissemination context. This trade-off was achieved in *Istar.MD* by modelling aggregates in terms of object-classification(s) combinations (*basic-tables*) and *spatio-temporal instantiations* of these basic tables, as well as by precisely defining which instantiations have to be made accessible to the users (and conversely which should not):

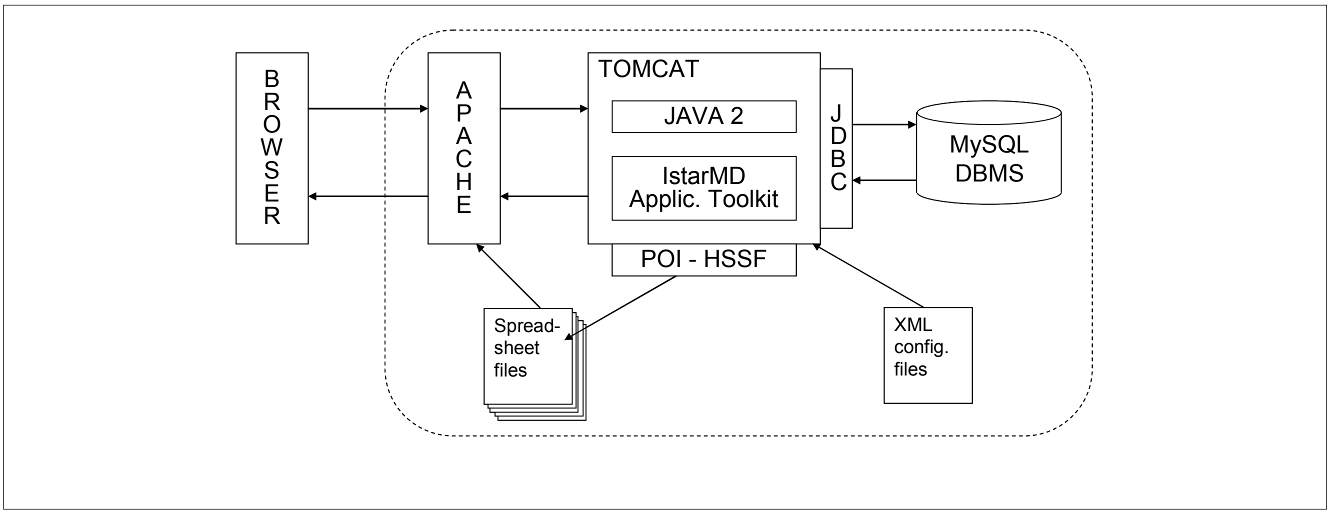
- *Istar.MD objects* basically correspond to measures in a conventional data warehouse, although there are some subtle differences, mainly related to the fact that an object may also incorporate some slicing operations on the data cube. For example in a conventional data warehouse "Resident population" and "Resident population aged 6 and over" refer to the same measure, whilst in *Istar.MD* they may be modelled by two distinct objects if they are related to different classifications, arising from filter questions in the questionnaire.
- *Istar.MD classifications* basically correspond to dimension levels in data cubes, although the structure of a classification can be more complex and articulated with respect to usual flat dimension levels. Examples of classifications of the object "Resident population" may be "sex", "civil status", "age by single year", etc.
- A *basic table* (b-table for short) is nothing but the combination of an object with a (possibly empty) list of classifications. For example the combinations ("Resident population"; "sex", "civil status"), ("Resident population"; "age by single year") but also ("Resident population") are examples of b-tables.
- *Spatio-temporal instantiations*. In fact, specifying a b-table is not sufficient to precisely identify a collection of aggregate values, as two further components need to be specified: the territory and time to which the data refer to, e.g. European Union and year 2009. Hence we say that a single b-table can have many different *spatio-temporal instantiations* and only the combination of a b-table with a specific pair (territory, time) actually identifies a precise collection of aggregate values. For example, given the b-table BT=("Resident population"; "sex"), its spatio-temporal instantiation (BT, European Union, 2008) identifies 2 aggregate values corresponding to the female and male resident population in the European Union in 2008.

All data that have to be disseminated by *Istar.MD* are expressed in terms of the above mentioned concepts. In particular the dissemination administrator can define the allowed combinations depicted in Fig. 4(b) in terms of a certain number of *maximum detail b-tables*, namely those representing the corners of the gray zone in the figure. In practice a maximum detail b-table is defined by the combination of a b-table with a certain year and a (maximum) territorial detail. Consequently, the same b-table may be disseminated with different maximum territorial details in different years, e.g. up to the regional territorial detail in 2008 and up to the municipality detail in 2009.

5.2 Open source software architecture

Both the navigation and administration component of *Istar.MD* are based on the same multi-tier (open source) software architecture, depicted in Figure 5.

Figure 5 - Istar.MD software architecture



The *presentation tier* is the part of the application responsible of the interaction with the user and is based on a conventional Web browser (e.g. Internet Explorer, Firefox, etc.) and HTML. The browser interacts with the application (business logic) tier through a series of usual Web pages, producing HTTP requests and responses, i.e. the normal interaction between browsers and Web servers.

The *data tier* is where the application data and metadata are permanently stored, updated and retrieved. In the system's original deployment this was constituted by the Oracle proprietary DBMS. *Istar.MD* current deployment can support either Oracle or MySQL open source DBMS, interchangeably. The possibility of adopting other open source DBMSs (e.g. PostgreSQL or a light-weight and very portable DBMS like SQLite) is currently under study.

The *application tier* is where the application's functionality is implemented and is constituted by several modular/layered components:

- The *Java software platform* can be considered as the "glue" of all application components and is constituted by a number of software products (the Java programming language, libraries, compiler, run-time environment, etc.), enabling the user to develop application software and deploy it in a cross-platform environment. Java has always been free to be used, but was not originally open source. Its transition to truly open source software started in 2006 and was basically completed in 2008 thanks to the third-party project, IcedTea.
- The top-most component (i.e. closest to the presentation tier) is the *Apache HTTP Web Server*, released under an open source license and available for a wide variety of operating systems. Its fundamental task is to reply to requests received from browsers on the Web according to the HTTP protocol. In some

cases the reply is simply constituted by (static) HTML pages (or more generally files), already available on the server, but in most cases the request involves *Istar.MD* dynamically generated HTML pages and is forwarded to the Tomcat servlet container (see below).

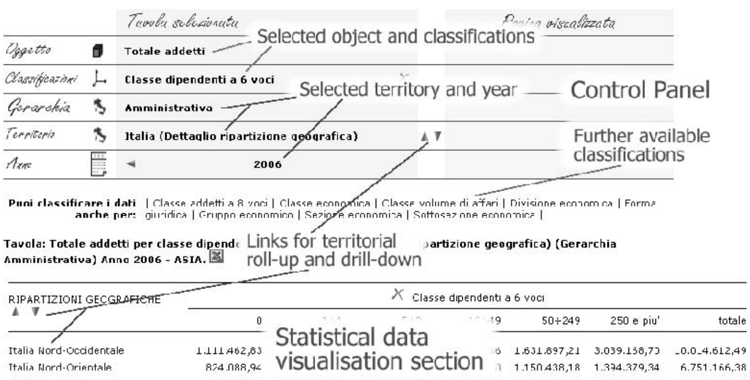
- *Apache Tomcat* is a JSP/servlet container, i.e. a server which is able to handle Java Server Pages and Java Servlets. These are particular forms of Java applications, which are able to reply to HTTP requests, by producing dynamically generated HTML pages in response.
- The *Istar.MD Application Toolkit* is a collection of software packages, developed in Java and based on Java Server Pages and Java Servlets technologies. This is obviously the core of the whole software architecture, where all functionalities of multi-dimensional navigation and statistical data administration are implemented.
- Two main *Java libraries* (provided by third-parties) are used by *Istar.MD*: (i) *JDBC*, enabling a Java program to interact with a generic DBMS (e.g. Oracle and MySQL) by a standard programming interface, and (ii) *POI-HSSF*, enabling a Java program to read and write files in Microsoft Excel (.xls) format. In *Istar.MD* POI-HSSF is used to produce the spreadsheet file corresponding to a certain statistical table (and displayed as an HTML table). The spreadsheet file can then be downloaded by the user on her/his local disk for further manipulations.

5.3 The WebMD navigation component

WebMD is the *Istar.MD* component for multidimensional navigation and dissemination on the Web. WebMD originates from the DaWinciMD dissemination system (Sindoni and Tininini, 2006), initially developed to disseminate aggregate data from the 2001 Italian Population and Housing Census.[43]

WebMD navigation is based on the maximum detail b-tables, defined by the dissemination administrator (see Section 5.2), enabling the user to browse only permitted combinations of object, classifications, year and territory (i.e. to navigate only inside the gray zones in Figure 4). When visualising the data corresponding to a certain combination of measure (*object*) and dimension levels (*classifications*) the user can navigate to other tables through roll-up and drill-down operations, without ever violating the dissemination constraints. It is the system itself that proposes, on each visualisation page, all and only the dimension levels compatible with the measure and dimension levels already selected, thereby always leading the user to a permitted dimensional combination.

Figure 6 - WebMD statistical table visualisation page

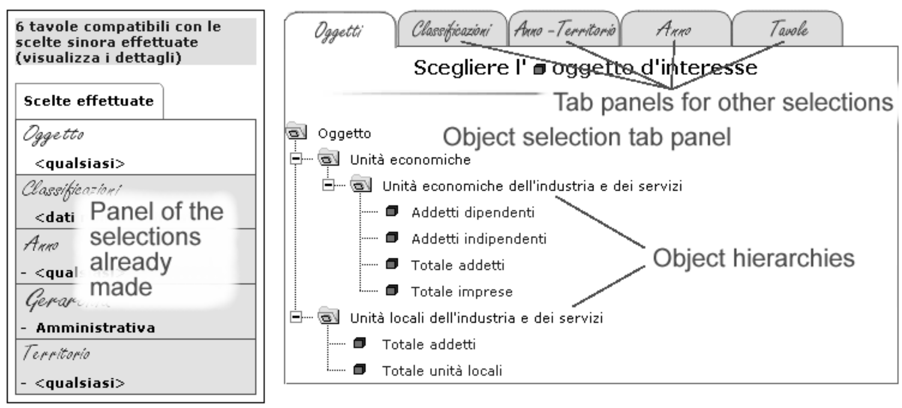


43 http://dawinci.istat.it/MD

Figure 6 shows the table visualisation page of WebMD with its two main sections: the *control panel* in the upper part of the page that contains the access mechanisms to all navigation functions; and the *statistical data visualisation section* in the lower part that contains the table with statistical data, or one of the pages that compose the table if the number of classifications is too large to be displayed in a single page.

The initial selection of the table to be visualised can be performed by using the table selection page shown in Figure 7. This page enables the user to express the required table by selecting (without a predefined order and possibly only in part) the single components of the corresponding b-table instantiation, i.e. the object, classifications, territory and year of interest. In order to guide the user in selecting the required table, objects and classifications are organized into hierarchies, mainly based on generalization relationships, and the user can choose "generic" concepts, i.e. those located in the higher levels of the hierarchy. The system is able to combine the generic user choices and map them to the actual object-classification combinations specified by the metadata.

Figure 7 - WebMD statistical table selection page



5.4 The Foxtrot.MD administration component

Foxtrot.MD is *Istar.MD* administration component, specifically designed for metadata management and aggregate data computation. By *Foxtrot.MD* the dissemination administrator can:

- manage the *objects* and *the classifications* of interest for the statistical tables to be disseminated, in particular their descriptions in the two languages chosen for publication, the corresponding modalities in both languages, the related statistical tables (i.e. tables defined using a given object or tables defined using a given combination of classifications). As mentioned above, objects and classifications can indeed be arranged into a hierarchical structure based on generalization.
- manage the *statistical tables* to be disseminated, defined by the combination of an object with a certain number of classifications. Each table will have its own multi-language descriptions, object and classification components and possibly multiple spatio-temporal instantiations, i.e. combinations of territories and years for which data are available (and have to be disseminated). *Foxtrot.MD* also enables the dissemination administrator to define the rules to extract and aggregate the data to be disseminated, starting from one or more tables of (validated) microdata.
- compute and store the aggregate data to be disseminated. By using the specified rules, the ETL component of *Foxtrot.MD* can aggregate the data and store them in the aggregate data table used during statistical table visualisation by *Web.MD*. The aggregation process is automatically performed at all levels of the territorial partitioning hierarchy specified by the administrator.

Figure 8 - Foxtrot.MD user interface for ETL procedure management

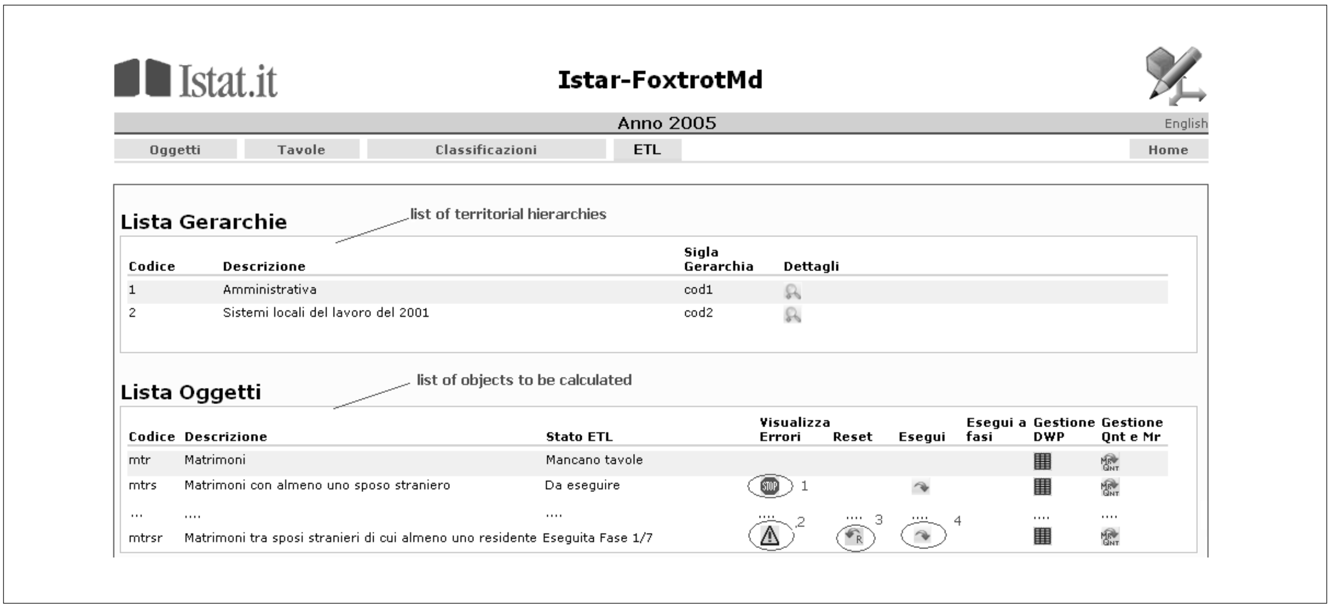


Figure 8 shows the user interface of the *Foxtrot.MD* for ETL procedure management. The system allows the user to manage the entire workflow, by driving (and partially constraining) his/her activities in a series of consecutive and interdependent steps. For example, only objects that are not currently related to statistical tables can be modified and the data can not be modified after a statistical table has been published (unless the whole process is restarted from scratch).

The process of aggregate computation is organised in several phases aiming at verifying the compliance of microdata structure and contents to what specified in the metadata. Alerts and blocking errors can be issued during the various phases. In the former case the user can check *(Figure* 8 – *point 2*) if the warnings actually correspond to what expected and possibly reset the process execution *(Figure* 8 – *point 3*) or enable its prosecution *(Figure* 8 – *point 4*). In the latter case *(Figure* 8 – *point 1*) some errors in the data or metadata prevent the system to complete the process, a correction activity is required and the process will have to be restarted from the first phase.

In more detail, the ETL component functionalities are divided into seven phases, each of which has a specific purpose described below.

Phase 1 and Phase 2: in these phases the system verifies if the microdata territorial granularity (e.g. municipal, provincial, national, etc.) has been specified in the metadata and the microdata table structure. In particular the system checks the presence of two columns containing the year of reference and the territorial codes, the absence of "null" values in these columns, the existence of at least one record for the year of interest, the correct correspondence between the territorial codes in the microdata table and the ones extracted from the reference territorial database.

Phase 3: In this phase the data checked in the previous phase are partially reorganised and stored in auxiliary tables to speed up the following phases, especially that of aggregation

Phase 4: In this phase the contents of the single columns identified in phase 2 are checked, also by exploiting the reorganised data stored in auxiliary tables during phase 3. The checks strictly depends on the type (quantitative vs. qualitative) of each classification in the specific microdata table. If the classification is qualitative the modality codes in the microdata table column(s) must correspond to those stored in the metadata repository. In particular, if a classification corresponds to a multiresponse variable in the microdata, the microdata table will have as many columns as the number of classification modalities and a specific check will be performed on each column. The values found in the microdata columns are compared with those expected, according to what stored in both the metadata repository and the auxiliary tables, generated in the previous phase.

Depending on the analysis results, a simple alert may be provided to the user or a blocking error be issued, prompting the user to fix the inconsistencies found.

Phase 5: In this phase the data in the microdata table are aggregated, by applying the rules specified in the metadata and exploiting the auxiliary tables generated in phase 3. The obtained data are stored in the aggregate data repository. For many reasons, some of the possible modality combinations may not have a correspondence in the computed data (e.g. there may be no individual corresponding to a certain combination of professional activity and level of education modalities, say 'lawyer' with 'secondary school'). These missing combinations will be inserted in the following phase.

Phase 6: In this phase the aggregate data repository is completed with values corresponding to the missing combinations determined by the aggregation process of the previous phase. This completion is required to increase the system's performances during multidimensional navigation.

Phase 7: In this phase some supporting files are generated, which are mainly used to increase the system's performances in case of massive download operations.

Conclusion

The Integrated Output Management System can be considered as the core of a global integration architecture of ISTAT, aiming at providing a seamless cooperation among: (i) local production systems, (ii) the set of reference and documentation metadata systems, (iii) the centralised repository of validated microdata and (iv) the environments for analysing and disseminating statistical data on the Web.

The recent adoption of open source software for managing the entire life cycle of dissemination, from the elementary data level to the aggregated data to be published on the Web, has encouraged the reuse of the implemented solutions also in the context of international cooperation. The current experiences in this direction have already shown that ISTAR is a valid alternative to commercial solutions in terms of architectural deployment. At the same time, it ensures a full control of all the steps needed to generate meaningful statistical output, providing a fundamental support from the methodological point of view.

References

AA.VV. (2005a). GENESEES v3.0 Funzione Riponderazione - ISTAT Tecniche e strumenti n. 2 - 2005.

AA.VV. (2005b). GENESEES v3.0 Funzione Stime ed Errori - ISTAT Tecniche e strumenti n. 3 - 2005.

Bergamasco S., Colasanti C., De Francisci S., Giacché P., Giacomi P. (2009) - An integrated approach to turn statistics into knowledge combining data warehouse, controlled vocabularies and advanced search engine. - NTTS Conference (New Techniques and Technologies for Statistics), Bruxelles 2009.

Gray, J., Bosworth, A., Layman, A., Pirahesh, H. (1996). Data Cube: A Relational Aggregation Operator Generalizing Group-By, Cross-Tab, and Sub-Total. In *Proceedings of the International Conference on Data Engineering (ICDE'96)*. (pp. 152-159).

Kimball, R. (1996). *The Data Warehouse Toolkit*. John Wiley & Sons.

Lehner, W. (1998). Modelling Large Scale OLAP Scenarios. In *International Conference on Extending Database Technology (EDBT'98)*. (pp. 153-167).

Malvestuto, F. M., Moscarini, M. (2003). Privacy in Multidimensional Databases. *Multidimensional Databases*, M. Rafanelli (editor). Idea Group Publishing. (pp. 310-360).

Riccini E (2004). – CONCORD v1.0 Controllo e correzione dei dati - ISTAT Tecniche e strumenti n. 1 - 2004.

Shoshani, A. (1997). OLAP and Statistical Databases: Similarities and Differences. In *Proceedings of the ACM Symposium on Principles of Database Systems (PODS 97)*, (pp. 185-196).

Sindoni, G., Tininini, L. (2006). Statistical warehousing on the Web: navigating troubled waters. In *Proceedings of the International Conference on Internet and Web Applications and Services (ICIW'06)*, IEEE Press, 2006.

Sindoni, G., Tininini, L. (2008). Statistical Dissemination Systems and the Web. *Handbook of Research on Public Information Technology*, G.D. Garson and M. Khosrow-Pour (editors). Information Science Reference, (pp. 578-591).
Tillé Y, Matei A. (2007). sampling: Survey Sampling. R package version 0.8.
Zardetto D. (2008). "EVER: Estimation of Variance by Efficient Replication". R package version 1.0, ISTAT, Italy.

SESSION 2

Parallel Session 2.a

Data Collection

Chairman: *Koen Boone, WUR*

Report on Parallel Session 2a: Data Collection

Chairman: Koen Boone

Statistical Data and Objectives: a Suitable Methodology for Data Collection - *Massimiliano Gallina*

In this paper, a protocol was developed for selecting the best source for producing statistics in less than ideal situations. The idea behind this is that in most cases no money is available for a complete new survey and therefore the statistics should be based on the best available (administrative) sources. A prioritisation of sources was presented ranging from official sources used by the government to very partial data or no valid statistical data. During the discussion it was argued that official sources of the government also sometimes lack reliability and thus are not always preferred. A very crucial part of the protocol is a team of local experts that has to make the evaluation of the available sources. They should have local knowledge, a good understanding of agriculture and agricultural incomes and preferably background information about potential sources.

The Changing Nature of Family Farms in the U.S. and Europe: Implications for Data Collection *- Mary Ahearn et al.*

Ahearn's paper discussed the changing structure of farms. In the past most farms were family farms with one operator that was also the owner. Now farms have diversified organisational structures, multiple operators that might own part of the farm or not and multiple owners. Next to that contract farming increases in importance. These developments have large consequences for the indicators used within a country. They are especially important when comparing countries while next to the issues discussed, large differences in structure of the agricultural farms might exist. This is illustrated by a comparison of Dutch, Italian and American data on number of farms, farm size and pluriactivity. The authors advise the editors of the handbook to develop an integrated conceptual framework for the two parts on rural areas and agricultural income that is able to take into account the changing structure of farms and households. This framework should be the base of future work on indicators. The editors agreed with the authors that an integrated framework would be welcome but very difficult to develop. They stated that originally they even wanted to develop two separate handbooks.

Les données statistiques: Méthodologie pour la création d'un "Protocole d'établissement de données statistiques utilisables"

Gallina Massimiliano
Statisticien, ex-ISTAT, 00137 Rome, Via Ugo Ojetti 408, Italie
massimilianoga@gmail.com

***Résumé**: Un rapport destiné à présenter des hypothèses de décisions opérationnelles a besoin d'informations statistiques fiables.*
Ce travail veut proposer un schéma méthodologique pour l'utilisation de données statistiques choisies pour un but spécifique. L'hypothèse de départ est d'avoir à disposition des informations statistiques de différentes sources et typologie sans réaliser une enquête spécifique.
La phase basique de ce schéma est d'identifier les informations spécifiques nécessaires et ensuite créer une équipe d'experts. Ces personnes feront un recensement des données statistiques disponibles avec une série d'indications qui doivent aider au travail d'analyse.
Les informations examinées devront être mises dans le classement proposé qui spécifie les différentes catégories des données.

1. Introduction

Un rapport destiné à présenter des hypothèses de décisions opérationnelles a besoin d'informations statistiques fiables. Deux **solutions sont possibles:**

- mettre en place une enquête statistique spécifique (recensement ou échantillonnage) pour obtenir les informations nécessaires. Cette solution est idéale, mais très couteuse et, en outre, nécessite un temps de réalisation long.
- l'utilisation des informations statistiques déjà disponibles (couts limités et disponibilité immédiate)

Tout le monde souhaite pouvoir **choisir la seconde solution.**

Le travail proposé, est de réaliser un « schéma méthodologique » qui puisse mettre en condition tout le monde d'utiliser les informations les plus fiables pour l'élaboration d'un document final le plus proche possible des réalités des phénomènes étudiés. L'auteur a la possibilité d'utiliser une longue expérience de statisticien dans le secteur de l'agriculture auprès de l'ISTAT, durant les périodes passées au Cap Vert comme « expert résident » pour la création d'un « Système stable de statistiques agricoles » et l'assistance technique à un certain nombre de pays (Romanie, Bulgarie, Kazakhstan, Azerbaïdjan,….).

Pour la **première solution**, à la fin on fera des suggestions, mises au point durant ces expériences de travail.

2. Recueil des informations statistiques

En premier lieu il est important de rappeler que les données statistiques peuvent être recueillies grâce à:

- des statistiques administratives
- des enquêtes exhaustives/recensements où sont observés tous les éléments de l'ensemble de la population que l'on veut étudier,
- des enquêtes par sondage où est interrogée une partie de l'ensemble de l'univers que l'on veut étudier.

Dans la réalité la plupart des données se réfèrent à des enquêtes par sondage (coûts plus accessibles par rapport à un recensement), mais on doit se rappeler que ces données sont sujettes à des erreurs qui proviennent de l'échantillon. Sur ce thème il est important de rappeler que, d'un point de vue opérationnel, existent deux méthodes de base : le choix raisonné (choix de caractéristiques) et le choix aléatoire (le hasard intervient) qui permettent de construire un échantillon représentatif de la population étudiée. Les sources d'erreur dans les enquêtes (dues en particulier aux biais d'échantillonnage) peuvent être améliorées par l'utilisation des méthodes de redressement, afin de tenir compte des non réponses. D'autres erreurs peuvent être dues à des erreurs d'observation, à l'incompréhension du questionnaire, etc.

Des précautions sont donc à prendre lors des procédures situées en amont et en aval du traitement des données **mais, dans tous les cas, on n'a pas la possibilité de réduire à zéro les erreurs (qui peuvent être plus ou moins élevées) dans la phase de report à l'univers des données.**

Le thème spécifique en discussion est le « Développement rural et revenu global » et, par exemple, on peut examiner la manière de déterminer la « Disponibilité économique des ménages ou le revenu global ».

Logiquement, ce «schéma méthodologique» peut être généralisé à toutes les analyses qui ont besoin d'utiliser des données statistiques.

Le travail préliminaire à faire est:

- connaitre le territoire ou les différents territoires pour lesquels on veut déterminer le revenu global,
- repérer une série d'informations au niveau macro économique,
- connaitre toutes les caractéristiques et particularités de l'agriculture de l'univers considéré.

Pour la création du groupe d'experts il faut repérer « les meilleurs » aussi bien dans l'environnement des gouvernements centraux ou périphériques que dans les autres secteurs opérationnels ou non, qui ont des compétences particulières dans le domaine du revenu des familles agricoles.

Dans ce deuxième groupe sont compris les chefs d'entreprises liées au secteur agricole (semences, engrais, alimentation animale,…) qui pour leur travail sont en contact permanent avec les exploitations agricoles, sont également compris des professeurs universitaires ou d'écoles professionnelles du secteur agricole.

Pour mémoire, les sources à prendre en considération pour arriver à la « Disponibilité économique des ménages ou le revenu global » sont les suivantes :

- Revenu primaire:
  - de l'agriculture et pêche
    - Autoconsommation
    - Productions vendues (agricole, bétail, pêche)
    - Vente de produits transformés
  - d'autres sources
    - Travaux salariés
    - Autres
- Remises (import de revenus de l'extérieur du territoire considéré)
  - Internes
  - d'autres pays

Dans l'équipe d'experts, chacun pour son secteur, doit récupérer toutes les informations statistiques disponibles qui comprennent celles utilisées dans leur travail spécifique mais également d'autres non utilisées. Pour chaque type d'information il sera nécessaire d'ajouter une note spécifique avec les indications suivantes:

- période a laquelle se réfèrent les données statistique,
- méthodologie d'enquête (recensement, échantillonnage, données administratives, élaborations spécifiques),

- pour les échantillonnages il est très important d'indiquer les « estimations de l'erreur de l'échantillonnage » pour la série de phénomènes enquêtés,
- pour les données administratives, décrire la typologie (origine, méthode de recueil, période ou périodes de référence).

Lorsque tous les experts auront à disposition toutes les informations statistiques avec les indications complémentaires il sera possible de passer à la phase suivante.

3. Analyse des informations

Cette phase de travail est la partie nodale parce qu'à la fin de l'analyse on devra établir une subdivision des données disponibles selon un **classement** qui, dans le schéma, doit être le suivant:

1. données utilisées à niveau gouvernemental (Institut de statistique, Ministère de l'Economie),
2. données liées directement aux thèmes traités à l'intérieur de l'analyse en cours, mais qui ne sont pas utilisées à niveau gouvernemental,
3. données qui peuvent aider à obtenir une image plus claire des phénomènes étudiés,
4. données statistiques insuffisantes pour réaliser une étude fiable,
5. données très partielles,
6. aucune information statistique valable.

Logiquement les données statistiques du point 1 sont **à priori** utilisables parce qu'elles ont déjà obtenu une validation à travers une utilisation officielle de la part de la structure gouvernementale, mais il y a la possibilité qu'elles soient insuffisantes.

Toutes les données statistiques des points 2, 3, 4 et 5 **ont obtenu une validation** par «l'équipe des experts».

C'est ce travail de validation qui constitue la partie névralgique de l'analyse ; les experts devront analyser de manière distincte les **données administratives** et celles obtenues **par échantillonnages.**

En tout cas la structure de l'analyse est la même pour les deux différentes typologies des données avec des différences qui seront mises en évidence dans le document. L'équipe d'experts doit réaliser l'analyse avec deux approches méthodologiques : une « **macro** » et une « **micro** »,

La phase macro doit examiner pour chaque source d'information:

- origine et finalité de l'enquête,
- enquête occasionnelle ou régulière (avec une cadence fixe),
- typologie du recueil des données (exhaustive, partiel),
- phénomènes étudiés,
- modalité d'acquisition des données (pour chaque unité statistique ou pour l'ensemble des unités statistiques agrégées),
- typologie des contrôles réalisés.

La phase micro doit examiner, toujours pour chaque source d'information:

- définition de l'unité statistique,
- définitions des phénomènes étudiés.

En premier lieu il est nécessaire d'examiner la « phase micro » parce que dans le cas ou l'équipe trouve que les deux typologies de définitions sont différentes par rapport à celles utilisées pour l'élaboration du revenu global des ménages agricoles, elle devra décider si exclure ces informations ou les mettre en « stand by » dans l'hypothèse de les utiliser seulement pour des possibles contrôles de cohérence.

Lorsque les définitions sont comparables, on passera à l'examen de la «phase macro » ; l'équipe trouve que:

- si la finalité de l'enquête a beaucoup points comparables ou est parfaitement compatible, on pourra continuer à examiner les autres points. Dans le cas contraire l'équipe devra affirmer que ces données **ne sont pas utilisables,**
- si la période où l'enquête a été faite est voisine de celle pour laquelle le rapport est fait et qu'il n'ya pas de modifications importantes (économique, structurel,..) on pourra continuer à examiner les autre points. Dans le cas contraire l'équipe devra affirmer que ce type des données n'est pas utilisable,
- si la typologie de recueil est exhaustive, il n'ya pas aucun problème, mais dans le cas d'un enquête partielle on peut se trouver dans le cas:

   a. d'une enquête réalisée sans aucun dessein statistique, alors **ce type de données n'est pas utilisable**
   b. d'une enquête réalise avec échantillonnage alors **on devra accepter les estimations des données avec des « erreurs minimales » et rejeter les autres,**
- si les phénomènes étudiés ont beaucoup de points communs ou sont parfaitement compatibles, on pourra continue à examiner les autre points. Dans le cas contraire ce type des données **n'est pas utilisable,**
- si la modalité d'acquisition des données, selon l'équipe des experts, n'a une aucune répercussion sur leur validité et leur utilisation, on pourra continuer à examiner les autre points. Dans le cas contraire l'équipe devra **approfondir la question avant de décider si les données sont utilisables ou non,**
- si la typologie des contrôles réalisés ne conduit pas à une acceptation ou un refus des données mais ce type les données peut donner seulement plus de force à la décision finale quelle qu'elle soit.

La phase suivante est: le classement des données selon leurs caractéristiques aux points 2 ou 3 ou 4 ou 5.

Pour les données recueillies par échantillonnage, à la différence de celles exhaustives d'origine administrative, on devra ajouter une analyse approfondie sur les erreurs d'échantillonnage. Il est très important de **connaitre l'erreur de chaque estimation qui devra être utilisée** car il existe une grande variabilité entre les erreurs, liées à la fréquence de chaque phénomène pris en considération dans l'enquête.

Dans le cas où sont disponibles des données avec des erreurs élevées il sera nécessaire d'exclure ces estimations ; au contraire les estimations validées par les experts seront insérées aux points 2 ou 3 ou 4 ou 5.

4. Phase finale

L'équipe d'experts, à la fin du travail de validation, aura à disposition le **classement rempli plus ou moins avec les différentes types données statistiques validées.**

Dans le cas idéal où l'on trouve des données statistiques classées au point 1 qui peuvent satisfaire totalement, ou de manière partielle, la possibilité d'arriver à définir la « Disponibilité économique des ménages ou le revenu global » les informations statistiques ont été déjà examinées et validées ; il est possible, donc, d'affirmer que l'étude n'a pas de grandes difficultés à être réalisée parce que l'on dispose de toutes les données nécessaires ou d'un « noyau dur » solide auquel on peut intégrer d' autres données.

Dans le cas ou il n'y a pas des données statistiques au point 1 mais aux points 2, 3, 4 et 5 l'équipe des experts doit évaluer si l'utilisation de toutes les données disponibles sera possible pour prépare une étude valable ou s'il est nécessaire de rechercher d'autres données.

Pour les **données administratives** l'évaluation numérique des éventuelles erreurs n'est pas disponible et l'équipe d'experts devra réaliser l'analyse avec une méthodologie « macro » et une autre « micro ».

Dans le cas où toutes les informations ont été mises au point 6 les solutions possibles sont:

- mettre en place une enquête exhaustive seulement si les données à recueillir sont peu nombreuses et l'univers réduit
- programmer un échantillon.

Dans ce dernier cas je vous rappelle qu'en considération du fait que les estimations des données devront être utilisées pour des **décisions très importantes pour le monde rural**, l'échantillon devra être très bien étudié.

L'unique suggestion que je vous propose c'est de choisir comme univers à étudier des « espace de territoire » le plus possible homogène pour réduire les « variables de stratification ».

The Family Farm in a Flat World: Implications for Farm Household Data Collection

Mary Ahearn
Economic Research Service, USDA, 1800 M St., N.W. Washington, D.C., USA, mahearn@ers.usda.gov

Krijn Poppe
LEI, P.O. Box 29703, 2502 LS The Hague, Netherlands,
Krijn.poppe@wrl.nl

Cristina Salvioni
University of Pescara, Italy
cristina.salvioni@fastwebnet.it

Koen Boone
LEI, P.O. Box 29703, 2502 LS The Hague, Netherlands,
koen.boone@wur.nl

Aide Roest
LEI, P.O. Box 29703, 2502 LS The Hague, Netherlands,
aide.roest@wur.nl

Abstract: *The purpose of this paper is to consider how four current household strategies are shaping the nature of family farms in developed countries. In particular, farm families are making choices with regard to growth in farm production, product and marketing diversification, pluriactivity, and multi-functionality activities.*
The paper will document the extent of these practices in three countries: Italy, the Netherlands, and the USA. A contribution of this paper will be consistency in the definitions and measurement of concepts across country analysis. Next, the paper will discuss the structural effects and likely policy implications of these farmer choices, including highlighting the differences in policies and emerging issues among the three countries. For example, this will include across country differences in the extent to which family farming dominates a country's agricultural sector and the likely impacts of the current economic downturn on family farming. The paper will culminate in a discussion of the implications of the evolving household strategies for data collection efforts.

Keywords: farm household, farm structure, farm size, hectares, pluriactivity, off-farm income.

1. Introduction

The 2007 Handbook on Rural Households' Livelihood and Well-Being (United Nations, 2007, and hereafter referred to as the Handbook) emphasizes (1) that there are many meaningful systems for classifying rural areas and agriculture is but one of many important themes in rural indicator development and (2) that an important unit of analysis for agricultural indicators is the farm household. The first 7 chapters of the Handbook are devoted to rural indicators and the next 8 chapters are focused on indicators for agricultural households. The objective of the continuation of the Wye City group includes the consideration of challenges to consistency of adoption of comparable methods of data collection across countries. In particular, the focus of this meeting is to examine the emerging issues related to the adoption of comparable methods across countries.

In the spirit of recommending improvements to the handbook, in this paper we hope to make a contribution by (1) recommending that an important enhancement to the Handbook would include the development of an integration of its two separate parts on rural indicators and agricultural household indicators, (2) emphasizing the importance of farm structure in the context of a cross-country comparison of farm household well-being indicators, and (3) discussing emerging issues for future information priorities.

2. Framework Integration for Rural Territory and Farm Household

The Handbook could have easily been presented as two separate handbooks, one on rural indicators and one on farm household well-being indicators. This is because the Handbook lacks a full conceptual treatment of the integration of these two realms. Chapter III offers the reader a conceptual framework for the rural indicators and Chapter IX provides a conceptual framework for the agricultural household indicators. Most of the material in the current conceptual framework chapters explores current institutional approaches to the indicator issues and presentation of empirical analysis of alternative indicators for the two foci, rural territories and agricultural households.

A future improvement in the Handbook would be to provide an underlying conceptual framework to the process of territorial development that includes the performance of industries and the well-being of people, such as agricultural households. Firms and households are the basic units economists use to model and understand behaviors. It is these behaviors that government policies attempt to influence and, collectively, eventually result in development outcomes, such as population migration, income distribution, business investment and location choices, productivity, and quality of life variables including environmental quality. In a flat world of outsourcing, insourcing, open sourcing, supply chains, etc., internal and external forces are quick to ripple through agriculture, rural areas, and other parts of the economy. Furthermore, a more comprehensive framework should be viewed separately from, and as the basis for, the development of a conceptual framework for development of indicators. Currently in the Handbook, the foci of the conceptual frameworks provided are limited to indicator frameworks.

The provision of a general regional development framework is essential given the diversity across countries and within territories in terms of standard of living, inequality, natural resource endowments, share of the population engaged in agriculture, and population densities, to name but a few variables. For example, using a unified definition of rural, the Handbook reports a wide range of national shares of population who are considered to be rural, from under 10 percent in the Netherlands and Belgium to about 60 percent in Finland, Norway and Turkey, as well as considerable variation in areas of territories classified as rural (from about 35 to nearly 100 percent). The proposed, more cohesive, framework we envision will encourage innovations in knowledge generation about indicator development and policy design.

Given the multitude of interrelationships that are relevant, it is no simple feat--and we make no attempt to provide in this paper--a description of an integrated framework. The two conceptual frameworks and the Introduction currently in the Handbook provide clues as to the most productive interrelationships that must be incorporated into an integrated framework. Regional development frameworks, in general, should provide a useful starting point for the proposed conceptual framework material that could be provided in future enhancements of the Handbook. One empirical outcome from this framework, for example, would be development of the aggregate relationships captured by the System of National Accounts from the bottom-up and lead to disaggregated accounts for relevant policy units, such as subpopulations of households and firms and for relevant territorial units.

3. Farm Household Indicators Begin with Structure

The most basic indicators to describe the structure of any industry are the number and size distribution of units, or in our case, farms. Describing the structure in basic, nonmonetary terms, is helpful in developing an understanding of how to develop a meaningful stratification within the industry for monetary indicators. This is useful to understand the dynamics in the industry over time and to understand to what extent income problems are linked to management and strategy of firms or to the structure of the industry.

Agriculture as an industry is unique, as has been commonly understood, including in the Handbook and elsewhere. In particular, agriculture continues to be dominated by many, oftentimes small, family farms. Allen and Lueck (1998) argue that the factors that contribute to this situation result from the dependence of the farm production function on nature, which is seasonal and random. There is also evidence that farmers are willing to trade-off cash returns for nonpecuniary benefits by continuing to operate small family farms (e.g., Fall and Magnuc, 2004, Key, 2005). Often times ignored in the empirical literature, perhaps because it is widely acknowledged, is that family farms usually provide the family a place of residence, with intergenerational links, and a variety of nonmarket social and natural amenities.

The highly skewed size distribution of farms worldwide limits the usefulness of indicators of the average well-being of farms and farm households. In order to be useful, cross-country comparisons of well-being indicators should be complemented by consistent indicators of farm structure. An indicator framework should also recognize the value of flexible and broad definitions of farms and family farms. We provide four recommendations regarding the development of indicators for agriculture:

- First, in order to enhance their usefulness, cross-country comparisons of well-being indicators should be complemented by basic and general indicators of farm structure that are relevant to all levels of country development.
- Secondly, allow for comparability and inclusiveness in defining the farm population across countries. The countries which have farm definitions that incorporate a requirement that farms be commercial in nature will limit the cross-country comparability of indicators. If the scope of the farm population is limited to commercial production, the indicators will very quickly become irrelevant for many of the most important policy issues. While many farms are small in terms of their production of agricultural commodities, they may be producing other goods and services that will garner public support in the form of subsidies or gain in value in the marketplace, such as landscape amenities, carbon sequestration potential, or locally-produced food. Furthermore, to the extent that an integrated rural and farm data system is desirable, the small farm households will be within the scope of the population of interest. This approach of being inclusive of all farms is similar to the recommendation provided in the rural indicator part of the Handbook which argued that the most useful classification system of territories is one which classifies all territories in a nation. On the other hand, we believe this is controversial and should be the subject of debate for a very pragmatic reason: the data collection costs of identifying and collecting information from very small farms. If the primary goal is information on agricultural production, the data collection costs may not warrant the outlay in terms of agricultural coverage. Furthermore, if indicators only reflect the means of the population, the inclusion of the small farms distorts the position of the group of farms fully engaged in agricultural production. Statistical approaches to containing the data collection costs associated with inclusion of small farms include adjusting sample weights for undercounted small farms or by modeling the small farm sector.
- Thirdly, do not limit the population of farms which are the focus of indicator development to family farms (however defined). Just as the appropriate definitions of rural territories may vary depending on the context and the issue at hand, the definition of a family farm will always be variable, making comparisons problematic. Limiting indicators to family farms, the group for which household indicators are meaningful, may prevent indicators from capturing important structural change in agriculture.
- Fourthly, in defining the population of farms and family farms and developing well-being indicators, the accounting must allow for complexity in the dynamic nature of key business relationships and agricultural technologies. In a flat world, successful businesses and households are constantly adjusting to take advantage of the potential productivity gains that are offered by new ways of doing business and producing agricultural goods and services. For example, in the US, 11 percent of farms report that

individuals not related to the farm operator share in the asset ownership of the farm (excluding landlords and lenders); 35 percent of farms report renting in some of the land they operate; 42 percent of farms have two operators (usually the spouse of the principal operator) and 7 percent of farms have at least three operators; 10 percent of farms have marketing or production contracts (USDA, NASS, 2009; table 4). Each of these structural characteristics – shared ownership and management – are much more common for large farms and, hence, much more of the total US commodities are produced under these shared arrangements than are reflected by the incidence of the practice. A comprehensive set of indicators, structural in nature, should include measures that capture these types of business and family relationships. A source of complexity in business relationships that will vary significantly by country arises from evolving and variable farm inheritance and estate tax traditions and policies.

3.1 US Examples of Effects of Structural Change on Agricultural Indicators

While indicators will always lag changes, developers of data collection systems are constantly evaluating whether the current system is capable of accurately collecting and accounting for the costs, returns, and various forms of capital involved. It is best to have flexible frameworks that allow for changes in business or production system to be accounted for, although this is not always foreseen. In that case, it is best to make enhancements to the empirical frameworks to match structural changes, as earlier as possible. Perhaps one indicator of how well indicator developers are accomplishing their goal is whether or not an indicator system was able to account for an innovation, or once recognized and accounted for, how significant was the revision in the indicator. We provide three examples from the US experience; they vary based on the magnitude of the revised indicator and the understanding about the interpretation of the indicator. First, the concepts that multiple households share in the returns and ownership portfolio associated with a single farm business unit and that some of the farm labour expenses are paid to farm household members have been incorporated into US farm household indicators for more than two decades. This enhancement resulted in a significant change in our understanding about the well-being of US farm operator households (Ahearn 1986; Ahearn, Perry, and El-Osta 1993). The change was significant because the US went from a system based on constructing estimates using aggregate accounts with many gross assumptions to a system using farm household level data.

Another example for the US was the evolution of the understanding of production and marketing contracts in agriculture. While commodity experts were aware of the incidence of contracting for some commodities, e.g., poultry, and the Census of Agriculture collected qualitative information on its incidence as early as 1960, an understanding of the terms of contracts for income accounting purposes was only documented in the late 1980s (Farm Income Estimation Team, 1988). Unlike the previous example, which led to significantly revised estimates of farm household income indicators, the understanding on contracting provided a fresh perspective on the meaning of the aggregate indicators, namely, it identified that the residual claimants of the aggregate net farm income included contractors as well as farms. Improved quantitative data were not collected with the intention of improving the accounting and understanding the distribution of costs and returns of contracting until this period and later (e.g., Farm Business Economics Branch, 1996 and MacDonald, et al., 2004). Because contractual arrangements varied significantly by commodity and region of the country, there has been a rather long learning period to develop a satisfactory data collection process.

More recently, the US began collecting information on the corporate dividends that incorporated family farms pay to members of operator households to improve the development of income indicators for this small group of farm households and updated its definition of a family farm. Unlike the first two examples, this enhancement did not significantly alter the magnitude or understanding of the indicators, but it allowed the framework to be better equipped for accounting for structural changes as they occur. The ability to capture the effects of structural changes on indicators with a minimal lag is largely due to the development and availability of the Farm Costs and Returns Survey (now called the Agriculture Resource Management Survey, ARMS) farm level data base (Johnson and Baum, 1986).

To support our view about the importance of structure in comprehending indicators of well-being for farming, we next provide a cross-country comparison of (1) the size distribution of farms, (2) the change in the size distribution of farms between 1997 and 2007, and (3) the extent of pluriactivity for the U.S. and Europe.

3.2 Number and size of farms/holdings in 2007, US and EU

We provide farm (holdings) distributions by two underlying size measures: an input measure, hectare classes, and an output measure, Standard Gross Margin classes. Furthermore, to emphasize the diversity within, we present measures of these indicators for two EU countries: The Netherlands and Italy. The size distribution varies considerably by geographic region of the U.S., just as it does among the member countries of the EU.

Both the European and the US definitions of farms are not without controversy. For an EU perspective, Poppe et al (2006) discuss the issues with the farm definition and, for the U.S., the definitional issues are discussed in O'Donoghue, et al. (2009).

For the EU, a holding is a technical-economic unit under single management engaged in agricultural production. According to Eurostat (2000), p. 10:

"The field of observation of the Community farm structure surveys extends to the following survey units: Agricultural holdings with a utilised agricultural area of 1 ha or more; agricultural holdings with an utilised agricultural area of less than 1 ha if they produce on a certain scale for sale or if their production unit exceeds certain natural thresholds. Member countries may introduce thresholds if certain conditions are not met."[44]

In the US, a farm is defined (by the National Agricultural Statistics Service) as any place from which $US 1,000 or more of agricultural product was produced and sold, or normally would have been sold, during the year (USDA, NASS, 2009). Hence, it is a very inclusive definition and includes farms operated by households that are retired or attracted to farming for reasons not primarily related to production, such as the rural lifestyle or investment opportunities. In addition, since the definition is dollar-based, it becomes more liberal with each passing year as price levels change. Although it is regularly discussed, an inclusive definition of a farm is very popular with many for a variety of reasons (O'Donoghue). For example, some Federal program dollars are distributed to states in part based on the farm population in a state, e.g., extension funds.

Tables 1a. and 1b. compare the size distribution for the territories using land area classes (hectares) and tables 2a. and 2b. compare the size distributions using an output based measure of size, the Economic Size Unit (ESU).[45] In recognition of any biases that could be interjected by the lack of comparability in farm definitions across the countries, we report the distributions in two ways. First, we consider all farms/holdings in calculating the share of farms in each class. We also report the share of hectares in each of the size classes. For the EU, the data are from the Farm Structure Survey (FSS, Eurostat, various years) . For the US, the population would be farms as represented in USDA's ARMS data. Both data sets exclude farms of less than 1 hectare (ha) with negative standard gross margins (SGM). Since the cross-country definitional inconsistencies affect the populations at the small end of the distribution, we also report the distributional statistics after eliminating the small tail of the distribution. In this second way, for farm size measured in hectares, we eliminate farms of less than 5 hectares. For farm size measured in ESUs, we eliminate farms of less than 4 ESUs.

In 2007, there were 2 ½ times more farms/holdings in the EU than in the US (approximately, 5.6 compared to 2.2 million), but the US has nearly three times the land area in farms. US farms are significantly more likely

[44] Different thresholds are, in fact, used by some member countries. The countries that likely have higher thresholds than 1 ha include: Belgium, Denmark, the Netherlands, Sweden, and the UK. These thresholds are defined by either larger hectare sizes, standard gross margins, or major occupation of the farmer. While the UK defines both main and minor holdings, the Eurostat statistics only include the larger "main" holdings for this country. Belgium's definition is perhaps the most conservative, and includes only those whose major occupation is farming or who produce on a "commercial" basis. Denmark uses 5 ha, the Netherlands uses 4,200 ECU (in 1997), and Sweden uses 2 ha, as alternative thresholds. The Netherlands notes that the definition covers 99 percent of total agricultural production.

[45] The disadvantage of using the land area size measure is the great variability in the productivity of the land. In the U.S., for example, there are approximately 1 billion acres classified as agricultural land, excluding forests, but less than half of that is cropland. The majority of US agricultural land is used for pasture and range. On the other hand, measurement issues are facilitated when size classes are defined by land area.

to be 100 ha or more, than are EU holdings (26 percent compared to 5 percent in 2007). Conversely, US farms are also less likely to be less than 5 ha than are EU holdings (12 percent compared to 54 percent in 2007). About 90 percent of EU farms are less than 50 ha, compared to about 58 percent of US farms. Of course, the distribution of the land area by farm size is even more skewed than the distribution of the number of farms/holdings. The farms/holdings of 100 ha or more control 12 percent of the land in the EU and 87 percent of the land in the US. It seems accurate to say that, in general, US farms are larger than EU holdings when size is measured in land area. We reach the same conclusions when we eliminate the holdings of less than 5 ha from the distributions, although the differences between farm sizes in the US and the EU are not as large.

The size distribution of farms for Italy and the Netherlands shows the diversity within the EU. Italy has a smaller farm structure than the EU at large, while the Netherlands has a larger farm structure. For example, in Italy for 2007, 85 percent of the farms, comprising 34 percent of the land, are in farms of less than 20 ha. In the Netherlands, in contrast, only 42 percent of the farms, comprising 5 percent of the land, are in farms of less than 20 ha.--and these include a significant number of glasshouse holdings that are big in sales but not in land use.

The conclusion about comparative size distributions is less extreme when the economic measure of size, the ESU, is employed. The ESU measure of size allows us to capture the differences in the intensity of production on the land area. One reason for differences in the intensity of agriculture might be the result of differences in climate and the quality of the natural resource base. For example, large areas of the US, especially in the West, have low land quality. It is in these areas of the US that we see a large share of the largest farms in terms of land area.

Based on ESUs, it is still true that a greater percent of farms are classified as large in the US than in the EU, but the differences are not as great as in the case of size measured by land area. There were 10 percent of US farms of 100 ESUs or more, compared to 5 percent of the EU holdings in 2007. Roughly one-quarter of the farms/holdings in the two territories are greater than 16 ESUs (27 percent in the EU and 26 percent in the US). However, using the ESU size measure, the US has a greater share of small farms of less than 2 ESUs than does the EU, 55 percent compared to 28 percent. In fact, comparing the US to member countries, the US' share of small farms is even larger than Italy's share of small holdings <2 ESU of 34 percent.

When we eliminate the smallest farms (of under 4 ESUs), in the interest of consistency in definition, we reach the same qualitative conclusions regarding the larger farm structure of US farms. However, the Netherlands has a larger proportion of its holdings in the largest size class of 100 ESUs or more than the US, indicating the diversity within the EU.

3.3 Changes in the Size Distribution

By comparing the 1997 size distributions for the two size measures, hectare classes and ESU, in tables 1a. and 2a. to those for 2007 in tables 1b. and 2b., we get a sense of the different dynamics in the territories. For the EU territories as a group, the number of holdings in the decade between 1997 and 2007 in the small hectare size classes (<20 ha) declined, while the share of farms in the larger size classes increased. This shift represents an increase in the concentration of production in the EU. This is consistent with the results reported by Poppe, et al. (2006). Obstensibly, during this same period, the US experienced another dynamic. The share of small farms increased, and the share of the largest farms (50 ha. and over) declined. However, the decline in the share of large farms is also reflecting an increased concentration in production: although the number and share of large farms decreased, as a group these large farms still operated the same share of farmland and still produced the same share of production in 2007 as they did a decade before. Had the size cut off for large farms been greater, for the US, there would have been both an increase in the number of farms and the share of farms that are large. The US result of a decline in the share of large farms (>100 ha), in contrast to the EU's increase in the share of large farms illustrates that this fact alone cannot be used as evidence of the concentration in production, since both territories experienced an increase in concentration. For the US, there has also been a relatively rapid increase in the number of small farms; this increase has a significant effect on the share of farms in any particular size class. A popular measure in industrial organization is to report market shares for the 4 largest firms in an industry, i.e., CR4 ratios. This low number of farms, four, may present some confidentiality concerns for agriculture, although Bunte has done so for the NL (OECD, 2006). A common way that concentration is reported in the US for agriculture, is to report the number and share of farms that account for a certain share of the sales or production (75, 50, 25, and 10 percent). For example, in 2007, 1.5 percent or 32,886 farms accounted for half of all products sold, compared to 2.4 percent or 46,068 in 1997, and 3.6 percent or 75,682 in 1987 (USDA, NASS, 2007 and earlier censuses).

When size is measured by the ESU class, the same dynamics are observed as when size is measured by hectare class, but there are less dramatic shifts over time. For example, the share of holdings in the EU declined in the smallest class and increased in the largest class. For the US, the most notable dynamic was the larger share of small farms in 2007 compared to 1997 and, while the share of farms in the largest size class change little during the decade, the share of land operated by these farms increased from 36 percent of all hectares operated to 45 percent.

The comparison above regarding shifts in the size distributions between two time periods for aggregated size groups does not provide information about the underlying dynamics of farm entries and exits as well as the growth and size reduction for those farms that continue over time. In the US, the Census of Agriculture data have been linked to show that many farm businesses go out of business and many new farms come into business (Ahearn, Korb, Yee, 2009). Considering the 5 censuses and 4 time periods between 1978-97, the rate of entry and exit varies somewhat—for two periods the entry rate exceeded the exit rate and for two periods the opposite was true--but entry rates overall were relatively stable, showing no strong upward or downward trend. Both the annualized entry and exit rates during the four subperiods ranged from 8 to 11 percent.[46] In farming, businesses enter at all sizes. Entry rates among small farm businesses, however, are significantly greater than for other farm sizes. Entry rates decline steadily as farm size grows, until farms reach a US mid-size range of 100 hectares or more. In addition, to the rates of exit and entry, it is interesting to consider the tendency of farms who stay in business, i.e., the survivors, to either expand or contract. The majority of surviving farms stay in the same size class from one census period to another. The smallest farms (under 20 hectares) have one of the highest shares of farms remaining in their size class. This size-tenure dynamic is not generally found in manufacturing industries, where the pattern is for smaller firms to increase in size over time. The small size class of farms, however, is likely dominated by those in operation largely to provide its operators with a farm residence, rather than serve as a viable commercial operation. Since family farms dominate agriculture across countries, the dynamic of farm size growth and survival will be commonly affected by the life-cycle of the farm family. However, it will likely vary considerably over countries due to variation in inheritance laws.

3.4 Pluriactivity or Off-farm Work

There are clearly large difference in the off-farm work of farm households between the US and member countries of EU. Table 3. reports participation for three time periods, 1987, 1997, and 2007. For the US, we report the share of principal operators that worked any days off the farm and the share of principal operators that had a nonfarm occupation as his or her major occupation. For the EU, for 1987 and 1997 "old", data are the share of operators that worked any days off the farm and for 1997 "new" and 2007, data are for the share of operators that had a nonfarm activity as the major or subsidiary occupation.

Farm operators in the US are more likely to work off the farm than farmers in the EU-15, with the exception of Sweden. Pluriactivity is not a new phenomenon in the US. Questions regarding off-farm work were included in the Census of Agriculture as early as 1929, where about 30 percent of farm operators reported being engaged in pluriactivity (Jenkins and Robison, 1937). As today, the extent varied significantly over farm size and space. Two states (Maine and Vermont) had nearly half (49 percent) of its operators report that they worked off the farm part-time in 1929. The high level of off-farm work participation for US farmers increased as recently as the last two Census for 2002 and 2007 (USDA, NASS). This increase was consistent with the increase in the share of small farms accounted for by the 2007 Census. Pluriactivity in EU member countries

[46] Entry and exit of farming businesses differs from changes in the use of land for agricultural purposes. Since 1978, the acres of land used in agriculture have declined. The 442 million acres of land used for cropland in 2002 was the lowest level since land use estimates were made for 1945.

combined was 31 percent in 2007, compared to 65 percent in the U.S. However, there is a great deal of variation in pluriactivity across EU countries, ranging from 16 percent in Belgium to Sweden's 71 percent. Different member countries have also experienced higher rates of growth in the past decade, such as Denmark, Ireland, Sweden, and the UK.[47]

The high rate of off-farm work among farm operators in the US should not be surprising when we consider that more than half of all farms lose money farming in a typical year (e.g., 54 percent in 2007 according the ARMS). Perhaps, another factor explaining the US' greater off-farm work participation is the result of the lower government payments US farmers receive compared to EU farmers. In the US, only about 40 percent of farms receive any government payments. The OECD provides various estimates of support, by commodity and country, using Producer Subsidy Equivalents (PSEs) (OECD, 2001a).[48] A comparison of the PSEs for the US and EU indicates that the EU's agricultural sector has consistently received a greater share of its returns from government support than in the US (Normile and Leetmaa, 2004). In the US, studies of off-farm work have shown that government payments are negatively related to off-farm work participation (El-Osta and Ahearn, 1996; Mishra and Goodwin, 1997). A study by Weersink, Nicholson, and Weerhewa (1998) points to the importance of differing policies, both farm and social, in explaining off-farm work between the US and Canada. They studied the off-farm work of dairy farm families in Ontario, Canada which is geographically similar to New York in the US. They concluded that the more generous and stable Ontario dairy policies and the government-provided medical care of Ontario were the major factors in explaining the differences in the observed lower rates of off-farm work of Ontario farm families.

4. Implications for Future Information Needs

It is recognized in the Handbook and elsewhere, that agricultural subsidies are facing a new era of public accountability. The implications of this new era are that conditions in--and connected to--agriculture must be made more transparent through enhanced indicators. Provision of improved indicators regarding the well-being of farm households is one obvious example. But, future public policy issues will be greatly informed by an indicator system that goes well beyond that single dimension.

The greater demand for accountability requires that information systems include a wide variety of indicators of the public returns from agriculture and rural development. It is for this reason, that we began this paper by arguing for an integrated and improved conceptual framework for the Handbook that accounts for all regions. Consider the most important issues that have recently and/or continue to face those concerned with agriculture and rural development:

- escalating food prices and economic insecurity of households and nations,
- the role of bioenergy production in fuel prices, energy independence and environmental externalities,
- the role of trade agreements and illegal immigration and rapid community change,
- the role of agriculture and forestry land uses in mitigating climate change impacts through carbon sequestration.

All of these examples are pressing international and national issues that are central to agriculture and rural territories, but not contained within any sphere that could be defined solely as agriculture or rural areas. It is also clear from this short list that scientific uncertainty pervades these issues, greatly challenging the development of useful indicators.

We turn now to the more narrow and tractable issue of implications for future information regarding agriculture, and family farms, in particular. The forthcoming Standard Output (SO) measurements, destined to replace the EU's Standard Gross Margin (SGM) measures will facilitate cross-country comparisons between the EU and other countries. This is because of the greater simplicity of SO measures and because output mix and

[47] Some of the variation may be due to variation in the farm definition.
[48] The PSEs accounts for 66 percent of the value of agricultural production in the US and 63 percent of the value of production in the EU.

production technologies vary across countries. The classes of inputs that are considered in the measurement of SGM are not intuitive and inclusive for a wide variety of production technologies. For example, labour, while a variable input, is not included. Nor is energy included as a variable input. Both of these inputs vary significantly by commodity mix. However, the accounting treatment for various types of government subsidies to be included in SO measures, and size measurement based on output in other countries, is still in need of justification before a harmonized approach can be adopted.

Also the "standardisation" in SO needs to be internationally standardized.

A further advancement in understanding the structure of farming would come from a longitudinal analysis of the entry, exit, and survival-growth dynamics. Such an analysis is only possible in countries that have panel data sets, such as Canada. A cross-country comparison for that subset of countries may prove insightful, if compared in light of the variation in domestic agricultural policies and inheritance laws.

As mentioned above, a mature information system should produce indicators that are capable of accounting for changing technology and family and business arrangements in agricultural production. The general public commonly considers farming to be a traditional activity, but we know the bulk of agricultural production (in contrast to the number of farms producing) is not produced under traditional technologies. Indicators that account for relatively new innovations in production, such as shared ownership or contracting, need to complement basic indicators. Of course, it must also be recognized that statistical agencies are increasingly challenged by the need to collect information from very large farms. A 2007 Invited Paper panel at the AAEA meetings provided a set of innovative approaches to data collection for economic research purposes in an increasingly concentrated sector, but these ideas are not easily transferable to indicator development (Fernandez-Cornejo, J. and R. Just, 2007; Hueth, B., E. Ligon, and C. Dimitri, 2007; Perloff, J. and M. Denbaly, 2007).

One important area for farm indicator development that is newly developing relates to the engagement of farms in the production of multifunctionality and nontraditional goods and services and has much in common with concepts of sustainability. These growth strategies include the production of nonmarket goods and services, such as environmental services. Governments are currently compensating farms for environmental and conservation services, including farmland preservation. Other activities associated with multifunctionality include community-oriented production aimed at local markets, such as Community Supported Agriculture and agritourism. Organic production and value-added production (such as jams from berries) are both marketed locally and distributed widely through traditional markets. Also included in the multifunctionality category of activities are energy-related production activities, such as wind energy and bioenergy sources. These activities are small, but growing, components of the agricultural activities in many countries and the focus of another paper at this meeting. Most of these activities are more commonly found on large farms, rather than small farms in the US (table 4). The exception to this generalization is for the large and growing area of direct sales. About 7 percent of farms with an ESU of less than 100 are engaged in direct sales, compared to 6 percent for the larger farms.

5. Conclusions

The most useful set of indicators regarding agriculture and family farms will place them in their larger contexts, within territories and within industries, in a flat world. For this reason, an integrated conceptual framework for indicator development could be highly productive. There are distinct forces driving the evolving structure and well-being of farms which expand the scope for indicator development: Innovations in technologies and business and family ownership and management arrangements are changing the way agricultural goods and services are produced and distributed in the supply chain. Pressure to further concentrate production will result from efforts to minimize costs and consumer prices. On the other hand, some of the market and nonmarket attributes of goods and services demanded by consumers may be linked to small farm production. In the future, governments may look to agriculture for solutions to nontraditional issues, such as climate change. Farm households that operate smaller farms and dominate the farm sector in numbers, though not in farm output, will continue to require access to income from off-farm sources if they choose to stay small;

access to nonfarm opportunities in remote areas will be key to their survival. A key to developing relevant indicators for agriculture in a flat world is to understand in real time, or even better, to anticipate the forthcoming changes.

References

Ahearn, M. (1986). "Financial Well-Being of Farm Operators and their Households." USDA, ERS, AER NO. 563, Sept. 1986.

Ahearn, M., H. El-Osta, and J. Perry (1993). "Economic Well-Being of Farm Operator Households, 1988-90." USDA, ERS, AER No. 666, Jan. 1993.

Ahearn, Mary Clare, Penni Korb, and Jet Yee (2009). "Producer Dynamics in Agriculture: Empirical Evidence," Producer Dynamics: New Evidence from Micro Data, Timothy Dunne, J. Bradford Jensen, and Mark J. Roberts (eds.), Chicago: University of Chicago Press and National Bureau of Economic Research, chapter 10.

Allen, D.W. and D. Lueck (1998). The nature of the farm in: Journal of Law and Economics, 41 pp. 343-386.

El-Osta, Hisham and Mary Ahearn (1996). "Estimating the Opportunity Cost of Unpaid Farm Labour for US Farm Operators." USDA, ERS, Techn. Bull. 1848, March.

Eurostat. "Farm Structure" 1987, 1997, 2007 Surveys (various years). Office of Official Publications of the European Communities, Luxembourg.

Fall, M. and T. Magnac (2004). "How Valuable is On-Farm Work to Farmers?" AJAE, Vol. 86, No. 1, Feb., pp. 267-81.

Fernandez-Cornejo, J. and R. Just (2007). "Researchability of Modern Agricultural Input Markets and Growing Concentration," Amer. J. of Agric. Econ., Vol. 89, No. 5, pp. 1269-1275.

Hueth, B., E. Ligon, and C. Dimitri (2007). "Agricultural Contracts: Data and Research Needs," Amer. J. of Agric. Econ., Vol. 89, No. 5, pp. 1276-1281.

Jenkins, W. and H. Robison (1937). "Part-Time Farming in the United States." 1935 Census of Agriculture, Special Study, Bureau of the Census, U.S. Dept. of Commerce. Wash., DC: pp. 5-33.

Johnson, J. and K. Baum (1986). Whole farm survey data for economic indicators and performance measures. Agricultural Economics Research. USDA, Econ. Res. Serv. AER, Vol. 38. No. 3, Summer.

Key, N. (2005). "How much do farmers value their independence?" Agricultural Economics, 33,1 (July): pp. 117-126.

James MacDonald, Janet Perry, Mary Ahearn, David Banker, William Chambers, Carolyn Dimitri, Nigel Key, Kenneth Nelson, and Leland Southard (2004), "Contracts, Markets, and Prices: Organizing the Production and Use of Agricultural Commodities", Nov. http://www.ers.usda.gov/publications/aer837/.

Mishra A. and B. Goodwin (1997). "Farm Income Variability and the Supply of Off-farm Labour," Amer. J. Agric. Econ. 79: pp. 880-887.

Normile, Mary Ann and Susan Leetmaa (coordinators) (2004). "US-EU Food and Agriculture Comparisons." MTED, ERS, USDA, ATR, WRS-04-04, March.

O'Donoghue, E., R. Hoppe, D. Banker, and P. Korb (2009). "Explaining Alternative Farm Definitions." U.S. Dept. of Agric., Economic Research Service, EIB No. 49, March.

Organization for Economic Cooperation and Development. (OECD) (2001a). Agricultural Policies in OECD Countries: Monitoring and Evaluation, 2001 (Highlights). Paris: OECD.

Organization for Economic Cooperation and Development (OECD) (2001b). "Agricultural Policy Reform and Farm Employment. Paris: OECD, 44 pp. (AGR/CA/APR(2001)10/FINAL).

Organization for Economic Cooperation and Development (OECD) (2006). "Changes in Retail Buying Behaviour and the Impact on Structure and Returns in Agriculture." Paris, May.

Perloff, J. and M. Denbaly (2007). "Data Needs for Consumer and Retail Firm Studies," Amer. J. of Agric. Econ., Vol. 89, No. 5, pp. 1282-1287.

Poppe, K., H. Vrolijk, K. van Bommel, and H. van der Veen (2006). "Observations on Farm Structure in Europe." Paper presented at the Intl. Assoc. of Agric. Econ. Meeting, Brisbane, Australia, August.

United Nations (2007). "Handbook on Rural Households' Livelihood and Well-Being: Statistics on Rural Development and Agriculture Household Income," New York and Geneva, www.fao.org/statistics/rural/

U.S. Department of Agriculture, Economic Research Service (1996). "Farmers' Use of Marketing and Production Contracts," Farm Business Economics Branch, AER No. 747, November.
U.S. Department of Agriculture, Economic Research Service (1988). "The Farm Income Handbook," Vol. 9, Major Statistical Series of the USDA, The Farm Income Estimation Section, November.
U.S. Department of Agriculture, National Agricultural Statistics Service (2009). 2007 Census of Agriculture, United States, Summary and State Data, Vol. 1, Geographic Area Series, part 51, February.
Weersink, Alfons, C. Nicholson, and J. Weerhewa (1998). "Multiple Job Holdings among Dairy Farm Families in New York and Ontario." Agric. Econ. Vol. 18, No. 2, March, pp. 127-43.

Table 1A - Comparison of farm/holding size distribution measured in hectares, EU-15, NL, Italie, and the U.S., 1997

DESCRIPTION	Holdings (1000)			Land area (1000 hectares)		
	No.	% of all	%, exc. Small	No.	% of all	%, exc. Small
European Union						
Under 5 ha	3.902	56		7.008	5	
5-20 ha	1.687	24	55	17.229	13	14
20-50 ha	802	11	26	25.459	20	21
50 to 100 ha	372	5	12	25.784	20	21
100 ha and over	226	3	7	53.211	41	44
Total	6.989	100	100	128.691	100	100
NL						
Under 5 ha	35	32		72	4	
5-20 ha	37	34	50	403	20	21
20-50 ha	29	27	40	919	46	47
50 to 100 ha	7	6	9	429	21	22
100 ha and over	1	1	1	187	9	10
Total	108	100	100	2.011	100	100
Italie						
Under 5 ha	1.754	76		2.818	19	
5-20 ha	424	18	76	3.970	27	33
20-50 ha	96	4	17	2.903	20	24
50 to 100 ha	27	1	5	1.868	13	16
100 ha and over	14	1	3	3.274	22	27
Total	2.315	100	100	14.833	100	100
U.S.						
Under 5 ha	205	10		600	0	
5-20 ha	365	18	20	4,187	1	1
20-50 ha	423	21	23	14,095	4	4
50 to 100 ha	355	17	19	25,913	7	7
100 ha and over	696	34	38	332,870	88	88
TOTAL	**2,044**	**100**	**100**	**377,664**	**100**	**100**

For U.S., includes all except 5,155 holdings with less than 1 hectare and with negative SGM.
Sources: For EU, Farm Structure Surveys. For US, USDA, NASS and ERS, ARMS.

Table 1B - Comparison of farm/holding size distribution measured in hectares, EU-15, NL, Italie, and the U.S., 2007

DESCRIPTION	Holdings (1000)			Land area (1000 hectares)		
	No.	% of all	%, exc. Small	No.	% of all	%, exc. Small
European Union						
Under 5 ha	3.033	54		5.515	4	
5-20	729	13	28	13.598	11	11
20-50 ha	1.230	22	48	20.400	16	17
50 to 100 ha	353	6	14	24.808	20	21
100 ha and over	264	5	10	60.225	48	51
Total	5.608	100	100	124.546	100	100
NL						
Under 5 ha	21	28		46	2	
5-20	11	14	20	255	13	14
20-50 ha	33	43	60	702	37	38
50 to 100 ha	9	12	17	611	32	33
100 ha and over	2	3	4	301	16	16
Total	77	100	100	1.914	100	100
Italie						
Under 5 ha	1.230	73		2.021	16	
5-20	203	12	45	3.109	24	29
20-50 ha	206	12	46	2.599	20	24
50 to 100 ha	27	2	6	1.839	14	17
100 ha and over	13	1	3	3.177	25	30
Total	1.679	100	100	12.744	100	100
U.S.						
Under 5 ha	251	12		752	<1	
5-20	525	24	27	6,140	2	2
20-50 ha	485	22	25	16,097	5	5
50 to 100 ha	341	16	18	24,158	7	7
100 ha and over	576	26	30	308,602	87	87
TOTALE	**2,179**	**100**	**100**	**355,750**	**100**	**100**

For U.S., includes all except 17,946 holdings with less than 1 hectare and with negative SGM.
Sources: For EU, Farm Structure Surveys. For US, USDA, NASS and ERS, ARMS.

Table 2A - Comparison of farm/holding size distribution measured in ESU, EU-15, NL, Italie, and the U.S., 1997

DESCRIPTION	Holdings (1000)			Land area (1000 hectares)		
	No.	% of all	%, exc. Small	No.	% of all	%, exc. Small
European Union						
0 to <2	2.357	34		7.422	6	
2 to<4	1.174	17		5.448	4	
4 to <8	1.039	15	30	8.719	7	8
8 to <16	840	12	24	13.067	10	11
16 to <40	843	12	24	27.429	21	24
40 to <100	536	8	15	35.432	28	31
100 or more	201	3	6	31.196	24	27
total	6.991	100	100	128.712	100	100
NL						
0 to <2	0	0		0	0	
2 to<4	1	1		3	0	
4 to <8	10	9	9	36	2	2
8 to <16	13	12	12	78	4	4
16 to <40	19	17	17	189	9	9
40 to <100	33	30	31	624	31	31
100 or more	33	30	31	1.080	54	54
Total	108	100	100	2.011	100	100
Italie						
0 to <2	1.072	46		1.371	9	
2 to<4	451	19		1.328	9	
4 to <8	336	14	42	1.959	13	16
8 to <16	215	9	27	2.297	15	19
16 to <40	162	7	20	3.105	21	26
40 to <100	59	3	7	2.315	16	19
100 or more	21	1	3	2.458	17	20
Total	2.315	100	100	14.833	100	100
U.S.						
< 0	556	27		35,652	9	
0 to <2	389	19		24,389	6	
2 to<4	158	8		10,555	3	
4 to <8	161	8	17	15,874	4	5
8 to <16	143	7	15	19,911	5	6
16 to <40	226	11	24	52,220	14	17
40 to <100	221	11	23	81,733	22	27
100 or more	190	9	20	137,328	36	45
TOTALE	2,044	100	100	377,662	100	100

For U.S., includes all except 5,155 holdings with less than 1 hectare and with negative SGM.
Sources: For EU, Farm Structure Surveys. For US, USDA, NASS and ERS, ARMS.

Table 2B - Comparison of farm/holding size distribution measured in ESU, EU-15, NL, Italie, and the U.S., 2007

DESCRIPTION	Holdings (1000)			Land area (1000 hectares)		
	No.	% of all	%, exc. Small	No.	% of all	%, exc. Small
European Union						
0 to <2	1.565	28		6.932	6	
2 to<4	928	17		4.282	3	
4 to <8	887	16	28	7.073	6	6
8 to <16	704	13	23	10.404	8	9
16 to <40	720	13	23	22.476	18	20
40 to <100	514	9	16	33.159	27	29
100 or more	291	5	9	40.220	32	35
Total	5.608	100	100	124.546	100	100
NL						
0 to <2	0	0		0	0	
2 to<4	1	1		3	0	
4 to <8	8	10	10	30	2	2
8 to <16	9	12	12	64	3	3
16 to <40	13	17	17	171	9	9
40 to <100	19	25	26	481	25	25
100 or more	27	35	36	1.165	61	61
Total	77	100	100	1.914	100	100
Italie						
0 to <2	568	34		688	5	
2 to<4	350	21		826	6	
4 to <8	293	17	39	1.298	10	12
8 to <16	188	11	25	1.544	12	14
16 to <40	160	10	21	2.635	21	23
40 to <100	80	5	10	2.474	19	22
100 or more	40	2	5	3.279	26	29
Total	1.679	100	100	12.744	100	100
U.S.						
< 0	668	31		36,138	10	
0 to <2	515	24		24,664	7	
2 to<4	159	7		9,213	3	
4 to <8	160	7	19	11,885	3	4
8 to <16	123	6	15	14,682	4	5
16 to <40	187	9	22	40,488	11	14
40 to <100	147	7	18	57,134	16	20
100 or more	219	10	26	161,545	45	57
TOTALE	**2,179**	**100**	**100**	**335,750**	**100**	**100**

For U.S., includes all except 17,946 holdings with less than 1 hectare and with negative SGM.
Sources: For EU, Farm Structure Surveys. For US, USDA, NASS and ERS, ARMS.

Table 3 - Percent of farm operators/holders with any off-farm work

AREA	1987	1997	1997	2007
	OLD		NEW	
		Percent		
U.S., any days	57	58	58	65
U.S., non farm major occupation	46	50	50	55
EUR, 12	30			
EUR, 15		37	29	31
Belgium	33	19	17	16
Denmark	33	36	35	48
Germany	43	49	45	48
Greece	33	31	27	23
Spain	28	44	28	32
France	36	29	25	25
Ireland	36	34	33	47
Italy	24	31	24	28
Luxembourg	18	33	17	19
Netherlands	23	25	22	28
Austria		51	39	38
Portugal	39	39	33	25
Finland		52	49	43
Sweden		62	59	71
United Kingdom	24	39	30	42

For EU, New is other gainful activity as the major or subsidiary occupation. In 2007, number of holdings and, in 1997, number of persons. For U.S., source is Census of Agriculture for the principal operator. For EU, source is Farm Structure Surveys.

Table 4 - Structural and multifunctionality characteristics of U.S. farms by ESU, 2007

ITEM	< 100 ESU	100 or more ESU	All
Number of farms	1,958,351	219,023	2,177,374
Percent of farms	89.09.00	10.01	100.00.00
Number of family farms*	1,918,008	205,985	2,123,993
Percent of family farms*	90.03.00	9.07	100.00.00
Average number of hectares	99	738	163
Percent of hectares	54.06.00	45.04.00	100.00.00
Average value of production, Euro	20,726	803,391	99,455
Share of value of production	18.07	81.03.00	100.00.00
Average government commodity payments, Euro	796	14,962	2,221
Share of government commodity payments	32.02.00	67.08.00	100.00.00
Average government conservation payments, Euro	646	1,792	761
Share of government conservation payments	76.03.00	23.07	100.00.00
STRUCTURAL CHARACTERISTICS		Percent of farms	
Marketing or Production Contracting	6	48	10
Own all acres operated	70	23	65
Use of hired manager	<1	3	1
Use of hired labour	26	79	31
Ownership shared outside household	10	27	11
Use of borrowed capital			
Non-real estate debt	11	41	14
Real estate debt	19	48	22
Farm business debt-asset ratio >=0.10	16	48	19
Commodity specialization	54	92	58
MULTIFUNCTIONALITY ACTIVITIES		Percent of farms	
Agritourism	2	2	2
Government landscape conservation program	15	24	16
Government conservation practices program	1	4	1
Fallow and cover crop	18	25	19
Conserving tillage practices	19	61	23
Intensive management grazing	20	24	21
Organic production	1	2	1
Energy production (wind, solar)	1	2	1
Community-oriented marketing:	7	6	7
Community sponsored ag	<1	1	0
Value added ag	2	3	2
Direct sales	6	4	6

Source: 2007 USDA Agricultural Resource Management Survey. Alaska, Hawaii, and US territories are excluded from the surveys.
Excludes farms of < 1 ha. with a farm loss.
*Farms where 50 percent or more of assets are owned by related individuals

SESSION 2

Parallel session 2.b

Technologies for Rural Data

Chairman: *Edoardo Pizzoli, ISTAT*

Report on Parallel Session 2b: Technologies for Rural Data

Chairman: Edoardo Pizzoli, ISTAT

Overview: *This session discussed the growing complexity of the relationship between agricultural endeavour and well being in both OECD and non-OECD countries. All of the papers by and large drew upon international comparisons to address issues related to changes in governance structure; the changing nature of traditional agricultural activity; and the changing allocation of labour across this traditional notion of agriculture and "non-agricultural" activities. A common theme was the need to reconsider the kinds of data needed to understand and monitor these trends both for research and policy implementation.*

Micro Versus Macro Approach on Agricultural Income Measurements for Rural Households in Italian Official Statistics: an Application for Albania
Domenico Ciaccia, Andrea Morreale, Edoardo Pizzoli

The paper focuses on available data, from micro and macro sources, concerning agricultural households' incomes in Italy and Albania. After a brief history of these statistics in EU, the Italian approach on income measurement was presented. It was shown that the same approach can be applied in countries, such as Albania, where there is limited availability of statistical data.

Is the Italian Organic Farming Model inside Rural development? A Farm Structure Survey Data analysis
Giampaola Bellini

Analysis performed on Farm structure survey data revealed good performances for organic farming (OF) in year 2005 in environmental and socio-economic area. In fact, they not only adopt more environmentally friendly agricultural practices – as the ones suggested by law – but they also seem to have positive effects on the socio-economic dimension, thus enhancing rural development as a whole.

From the statistical point of view, farm structure survey revealed to be a suitable data source of standardised environment and socio-economic variables, all linked to a single holdings, so that they are suitable for analysis with a multidimensional approach.

Measuring Cultivation Parcels with GPS: a Statistical Evidence
Gabriele Palmegiani

The aim of the paper was to study the statistical relevance of measuring cultivation parcels with Global Positioning System (GPS), respect to the traditional method using compass and meter. The procedures used for the study reached the following two main findings: The first is the Unconditional Inference Result. On the statistical equivalency hand, only Garmin60 is found statistically equivalent to the traditional method. On the parcel estimates hand, the traditional method tends to produce larger parcels estimates respect to all GPS's measurements methods.

The first finding is the Conditional Inference Result. On the statistical equivalency hand, empirical p-values produce the same conclusion of the theoretical ones: only cultivation parcel estimates using Garmin60 are found statistically equivalent to the traditional method.

On the parcel estimates hand, nothing can be state about the largeness of the cultivation parcels using the conditional approach, and then the unconditional inference result remains valid.

The paper finally concludes that because the GPSs methods are globally cheaper than traditional method using compass and meter, it’s strongly recommended the use of GPS60 to reduce the costs of the agricultural surveys.

Micro Versus Macro Approach on Agricultural Income Measurements for Rural Households in Italian Official Statistics: an Application for Albania

Domenico Ciaccia, Andrea Morreale, Edoardo Pizzoli

National Institute of Statistics (ISTAT), V. Cesare Balbo 16,
ciaccia@istat.it, morreale@istat.it, pizzoli@istat.it

***Abstract**: At aggregated level, the agricultural component of income is a basic part in total income of households living in rural areas. The measurement of this component entails considerable technical difficulties for statisticians due to the particularity of agricultural production, its institutional organization and the distribution of products for consumption. Self-consumption of agricultural product, for instance, is relevant in agricultural household's income but its value is not immediately available and have to be calculated. The double approach adopted in Italy, at micro-level with REA survey and at macro-level with European Economic Accounts for Agriculture (EAA), deserves a particular attention for its results and future applications in other countries.*
Italian statistics on agricultural income will be presented with an application to Albania to verify the exportability of the methods in a statistical system limited in data availability.

Keywords: economic accounts for agricultural, agricultural households, total households' income

1. Introduction

The Wye City Group meeting in Rome, jointly organized by FAO and ISTAT, is an opportunity to focus on available data, from micro and macro sources, concerning agricultural households' incomes in Italy. After a brief history of these statistics in EU, in the first part of the paper the Italian approach on income measurement will be presented. In the second part, will be shown the applicability of the same approach in countries, as Albania in this work, where there's limited availability of statistical data.

2. History and developments in agricultural households' income statistics of EU

Early EU studies and related statistics on agricultural households' income began in 1985 under Eurostat initiative, through the project approved by the Committee of agricultural statistics of European Commission, directed by Berkeley Hill (Eurostat, 1988a). ISTAT contributed to the project from the beginning, including the initial planning of activities and the methodology dissemination to calculate total income of agricultural households indices.

A further systematization to the approach adopted on this issues by ISTAT, comes back to 1998. The analysis of Income of Agricultural Household Sector (IAHS) statistics for Italy, at that time, clarity indicated the priority of a policy shift: from a policy mainly targeted on prices sustain, to another aimed to income sustain, that is an objective closely linked to rural and socio-environmental development.

Recently, in 2004, ISTAT was financed by Eurostat, through the Action Tapas 2002, to reconstruct Italian time series from 1984 to 2001. Data from the new REA Survey (1998 – 2000 time series) allowed, for the first time in Italy, to use a micro approach side by side to the macro one.

3. The state of the art at European and international level

As already said in the previous paragraph, several studies were carried out across Europe from the eighties. Results are available in reports published by Eurostat over the years (Eurostat, 1988 – 2000). A larger international dissemination of these experiences was done trough the international seminar of Eurostat, in January 1996 in Luxembourg.

The beginning of 2000 was characterized by an OECD commitment on this issue, followed by Unece, World Bank and Fao research studies and publications. In 2003, a resolution of EU Court of Auditors expressed criticism on the information collected by Eurostat in the framework of IAHS statistics. In the Court point view, there was a lack of comparability of data and time series available in EU member countries.

The update of IAHS series, from both micro and macro sources, has been suspended and it depends from Eurostat decision. The project "Feasibility study on the achievement of the European Statistics on Income of agricultural households", realized for Eurostat by B. Hill and B. Dylon, highlighted the state of these statistics in different member states and indicated how to continue their production. New technologies could be used to simplify measurements, comparable in all member states.

Furthermore, in addition to consumption and total income, other indicators of well-being, not directly related to agriculture, could be added.

The preconditions for a successful development of these statistics seem promising. The study project has been completed; the results from the questionnaire submitted to all member countries have been examined; now it is up to Eurostat decision-makers the revival of this family of statistics.

4. Agricultural households' income in Italian national accounts by ISTAT: summary of results

Until early 2004, the Central Directorate of National Accounts in ISTAT, has regularly sent to Eurostat agricultural households' income statistics (years 1984 – 2001). Complete estimates are available for the so-called type A and type B, narrow and broad definition of agricultural households, together with the total households. Further estimates are available by socio-economic groups (Eurostat-ISTAT, 2004).

The number of households of type A and type B is constantly evolving over time, in both macro and micro measurement's approach.

As highlighted in Table 1, the contribution of family type A is decreasing.

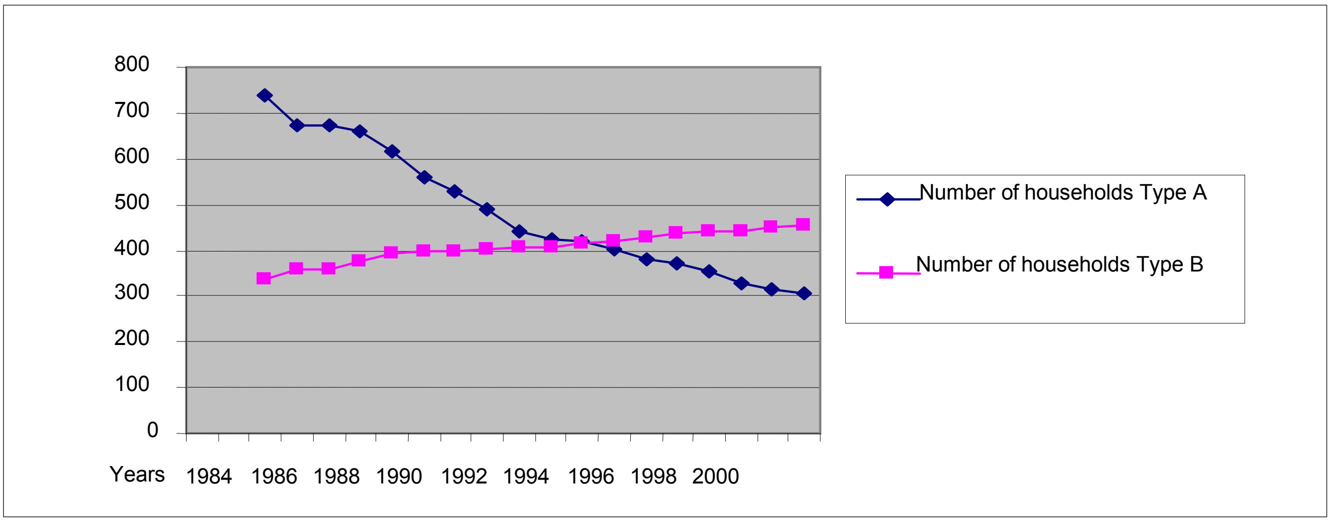
Table 1 - Number of independent head-of-family occupied in agriculture *(thousands)*

YEARS	Type of households		
	Type A*	Type B**	Type A + B
1984	738,0	338,4	1.076,4
1990	529,0	398,7	927,7
1995	401,4	420,3	821,7
1996	381,8	427,9	809,7
2000	313,9	449,7	763,5
2001	306,2	454,7	760,9

* Agricultural household in "narrow" definition.
** Agricultural household in "broad" definition.

It is evident a movement of households from the type A to B over the years. This trend can be seen in Figure 1. Households of type A are steadily declining, while those of type B are growing.

Figure 1 - Evolution of type A and type B households in macro approach (1984 – 2001)



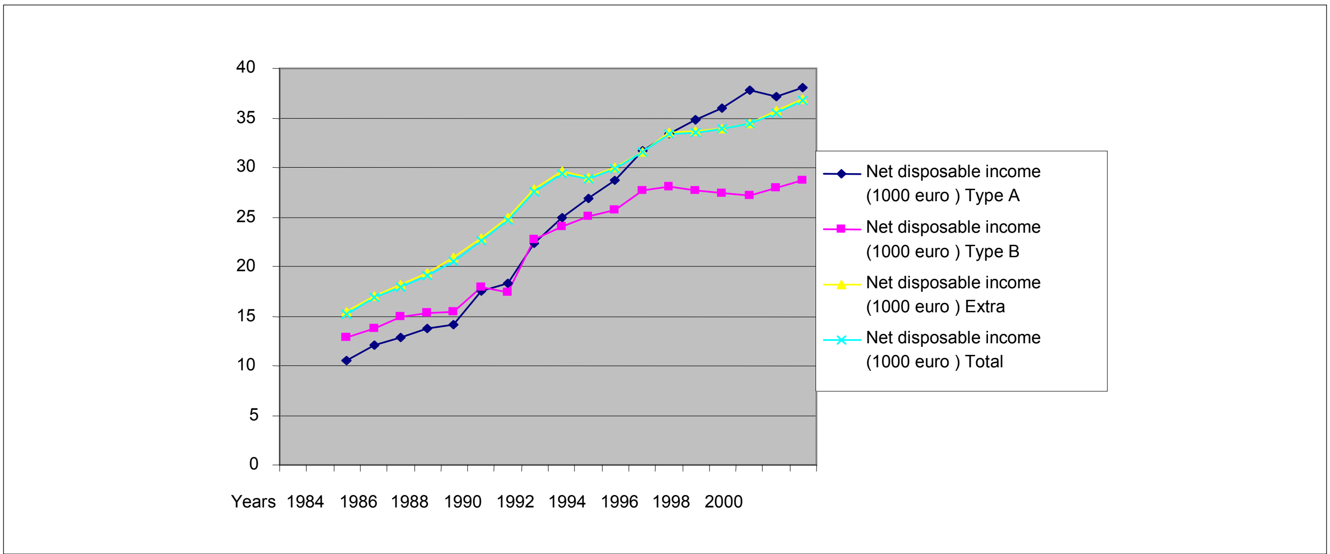
Comparing micro and macro approach, on an experimental basis and limited to only the three years (1998, 1999, 2000) with Rea data available, the number of households results very similar. The number of households, estimated with both approaches, does not exceed 800 thousand units (Table 2).

Table 2 - Number of agricultural households in micro and macro approach

DESCRIPTION	1998	1999	2000
N° households type "A " *(thousands)*			
Micro approach	391	297	294
Macro approach	352	330	314
N° households type "B"_*(in thousands*)			
Micro approach	679	511	528
Macro approach	440	441	450

The macro-side approach to estimate net income level is shown in Figure 2:

Figure 2 - Net disposable income by type of households (macro approach 1984 – 2001)



The level of disposable income for different types of households (macro approach 1984-2001) is growing. For type A households, by 1992 (Mac Sharry reform), income is in evident recovery. Between 1998 and 2001, income of agricultural households exceeded all other households.

Households of type B, throughout all the period, presented a level of net income always lower than the others. This result suggests a particular attention to this group of households, perhaps them the most vulnerable and at risk, and indicates to the need for an appropriate policy of support.

In short, the macro approach applied to type B households, gives us a two-speed agriculture: a first type, in a "narrow" sense, focused on its agricultural activities and the other, in a "large" sense, that seeks the path of income with multiple activities even outside agriculture.

The levels of income of these households in particular, should be supported, in our view, in order to guarantee and ensure their presence in the territory to protect the management and protecting the environment, land, typicity, of disadvantaged rural areas, hilly and mountainous.

Table 3 - Income of agricultural households by direct management: micro approach (Rea data) – year 2000 *(%)*

N° DAYS WORKED BY THE HEAD OF THE FARM	N° farms	%	Income from agricultural activity	Other incomes (outside farm activity)				Income of agricultural households
			Gross operating surplus	From independent activity	From dependent activity	Social benefits	Property income and others	Total
>280 (1)	294.057	12,0	80,5	3,8	7,4	7,7	0,6	100,0
>180 (2)	527.729	22,0	71,7	4,9	9,5	13,3	0,6	100,0
>140 (3)	658.670	28,0	66,5	6,1	11,0	15,7	0,7	100,0
>70 (4)	1.002.432	42,0	53,3	7,3	18,9	19,9	0,6	100,0
<70	1.375.805	58,0	17,4	13,5	33,8	34,1	1,1	100,0
Total farms in direct management	2.378.237	100,0	36,2	10,2	26,0	26,7	0,9	100,0
Other management	216.588	8,3	60,2	8,5	11,9	16,8	2,6	100,0
Total farms	**2.594.825**	**100,0**	**39,6**	**10,0**	**24,0**	**25,3**	**1,1**	**100,0**

Main results in terms of percentage composition of agricultural households' income are reported and summarized in Table 3, with respect to days-worked by the head of the farm (TAPAS Action for further details).

5. The future of the two approaches: macro and micro-economic

Surveys that could be able to supply adequate basic data to change the estimates from net to disposable income, will be Eu/Silc, on households' standards of living, and Bank of Italy/households' budgets.

The sample of households is in both cases not sufficient and in the near future should be recalibrated to provide valuable information at micro level also for agricultural and rural groups.

A different approach must be followed by Rica-Rea survey, that is done to study the evolution of agricultural income and, only in part, to follow the evolution of the income of agricultural households. Information on other sources of income, inside and outside the farm, of the household' components have to be collected: wages and salaries from employments in non-agricultural activities, property incomes, social benefits and public support of agriculture.

The micro approach must be calibrated better in the future to highlight the differences in incomes of different types of households.

6. The Italian experience in Albania

In the period 2003 to 2005, as part of the Twinning project "Albanian Statistics towards the EU", ISTAT has tested EU methodology in national accounts and developed a structural analysis on the changes in Albania's economy. With respect to agriculture and agricultural households, important changes have been done to the calculation procedure for agricultural income's accounts.

Under the project coordinated by ISTAT, several statisticians from the agriculture department in INSTAT were trained to design and to construct agricultural accounts.

In addition to the census conducted in 2000, the annual survey on surfaces land (Area Frame Survey), conducted by the Albanian Ministry of Agriculture (MAF), has produced some major inputs to the pull of experts that introduced new questions in 2004 surveys. The purpose was to broaden the range of useful information to estimate national accounts.

For the first time, a country-table of resources & uses, in values and in quantities, has been produced to facilitate and to improve the calculation of production account.

The availability of price information for products in the agricultural sector and of quantities produced, was sufficient to draw up accounts at current prices and at constant prices (prices of previous year). Also the two components of volume and price were separated. The calculation of value added has become easier and in line with EU standards by Eurostat.

7. Evolution of agricultural sector in Albania from 2003 to 2005

The table below highlights some of the Albanian data of agriculture that covers 22.5 percent of GDP and represents 55.0 percent of the rural population.

Table 4 - **Summary of Albanian agriculture** *(Year 2004)*

ITEMS	
Agricultural GDP	22,5%
Farms	377.000
Rural population	55,0%
Agricultural households	51,0%
Rate of growth in agriculture	+6,1%
Agricultural prices	-4,1%
Own-account consumption	20,0%
Intra-unit consumption	37,1%

In Albania there is an agriculture that, despite the growth, shows an up&down of prices and production that is almost exclusively supplied to the domestic market (net of intra consumption and self-consumption). The weight on GDP is declining but it still high (22.5 percent). It is the growth of rest of the economic, construction and services in particular, that reduce the weight of agriculture. In the tables below, it is shown the evolution of agricultural in the period 2002 – 2004. As for neighbouring countries, in Albanian countryside is undergoing a process of depopulation, combined with a process of structural adjustment.

Table 5 - Economic accounts for agriculture in Albania *(2002 – 2004).* **Indices** (%)

DESCRIPTION	Indexes of quantity		Indexes of price		Indexes of value	
	2003/2002	2004/2003	2003/2002	2004/2003	2003/2002	2004/2003
AGRICULTURE						
PRODUCTS						
Vegetable production	101,2	106,1	113,2	92,2	114,5	97,8
Animals	105,0	104,5	101,7	101,7	106,8	106,2
Agricultural services	101,7	104,9	102,5	100,4	104,3	105,3
Secondary activities	99,6	101,3	102,2	100,9	101,7	102,2
Total production	**102,9**	**105,1**	**106,9**	**97,0**	**110,0**	**102,0**
INTERMEDIATE CONSUMPTION						
Seeds and planting stocks	94,8	99,8	119,8	89,9	113,5	89,6
Feedeingstuffs (intra-unit)	102,9	102,3	104,5	102,3	107,6	104,7
Total	101,7	102,6	105,7	100,4	107,5	103,0
Value added	103,4	106,1	107,5	95,7	111,1	101,6
FORESTRY						
Production	102,7	102,8	102,2	100,3	105,0	103,2
Intermediate consumption	99,1	102,0	106,0	101,4	105,1	103,4
Value added	104,7	103,3	100,3	99,8	105,0	103,0
FISHING						
Production	115,8	104,3	99,5	101,5	115,3	105,9
Intermediate consumption	113,5	101,5	97,8	100,8	111,1	102,3
Value added	117,7	106,5	100,9	102,1	118,7	108,7
AGRICULTURE, FORESTRY AND FISHING						
Production	103,1	105,1	106,7	97,2	110,0	102,1
Intermediate consumption	101,9	102,6	105,5	100,4	107,5	103,0
Value added	103,6	106,1	107,2	95,9	111,1	101,7

Table 6 - Economic accounts for agriculture *(2002 – 2004)*. **Composition** *(%)*

DESCRIPTION	% value		
	2002	2003	2004
PRODUCTS			
Plants	45,7	47,6	45,6
Animals	47,5	46,1	48,0
Agricultural services	2,1	2,0	2,1
Secondary activities	4,7	4,3	4,3
Total production	**100,0**	**100,0**	**100,0**
INTERMEDIATE CONSUMPTION			
Seeds and planting stocks	2,9	3,1	2,7
feedeingstuffs (intra-unit)	61,3	61,4	62,4
Other	35,8	35,5	34,9
Total	**100,0**	**100,0**	**100,0**

At the end, as highlighted in Table 7, agricultural income of household is a very large component in total income (80 percent), together with the migrant remittances which covers 15 percent of the total.

Table 7 - Total agricultural households income estimates – Albania *(Year 2004)*. **Composition** *(%)*

ITEMS	2004
	% value
Income from agricultural activity	80,0
Other income (salaries, social benefits etc.)	5,0
Remittances from emigrants	15,0
Total	**100,0**

(*) Elaborations on Instat data

8. Conclusions

In the near future, it is necessary to extend agricultural households' income indicators at regional (NUTS2) and provincial (NUTS3) levels, by means of new data available and improved estimation techniques. This further step will allow politicians to optimize territorial interventions targeted to the support of households' incomes, also through solidarity policies, and with a particular attention to the needs of rural population.

There should be also more attention to type "B" of agricultural households, that is a vulnerable group in constant growth. It is important to guide policies at territorial level, providing statistical information on available services, opportunities to find out additional incomes from inside and outside the farm activity, encourage their members in working age on being integrated with the territory, to develop concrete steps able to reach a satisfactory integrated income.

The future evolution of the issues related to rural development statistics and extension of field observation on more socio-professional groups in rural areas, should allow to further refine the basic surveys, linking rural development and the impact that rural development policies will have on agricultural households and rural areas, present in the territory.

The future is strongly linked to the priority given to statistics on agricultural households income: an obstacle not small to this aim, is the resources and the priority that the Eurostat and the member states through their policy intend to give to this kind of statistics, with the purpose to guide the choices and redraw on the territory a number of interventions in support of those subjects (households) that should be protected and encouraged with supports to integrate with the territory.

Different is the situation of new member states in the process of harmonization, as is the case of Albania.

What emerges from the evolution of poor households, is that the poorest population is rural, although the gap with the urban population is steadily declining.

In short, the experience described, is a good example of application and export of the statistic methodology in other realities even with a limited availability of data.

References

Barberis, C. (1981). Povertà e distribuzione dei redditi nelle campagne italiane. In Barberis *et al.* La povertà del mondo rurale in Italia. Franco Angeli.

Ciaccia, D. (1996). "Il nuovo SEC e il settore Agricoltura*",* paragraph 4.3, Annali di statistica, *Verso il nuovo sistema di contabilità nazionale*, ISTAT.

EURISPES (2003). *La povertà in agricoltura. Una mappa del rischio e del disagio rurale in Italia*.

EUROSTAT (1988a). *Revenu global des mènages agricoles*, thème 5, Sèrie D, B. Hill.

EUROSTAT (1988b). *Revenu agricole 1987: analyse de l'indice du revenu sectoriel,* thème 5 sèrie D, Chapitre V (Revenu global disponible des mènages agricoles).

EUROSTAT (1989). *Manuel sur les comptes èconomiques pour l'agriculture et la sylviculture*, thème 5, Sèrie E.

EUROSTAT (1995a). *Systѐme Europèen des Comptes: SEC 1995*.

EUROSTAT (1995b). Manuel du revenu global des menages agricoles (Rev.1), 10 Theme 5, agricolture Sèrie E metodes.

EUROSTAT (2000), *Incomes of Agricultural Sector Households,* Luxembourg.

ISTAT (1990-2008). *Valore aggiunto dell'agricoltura per regione,* Collana d'informazione, n. 15.
ISTAT (1985). *I consumi delle famiglie. Anno 1984* - Supplemento Bollettino mensile di statistica, n. 16.
ISTAT (1995). *Occupazione e redditi da lavoro dipendente*. *Anni 1980-1994,* Collana d'informazione, n. 19.
ISTAT (1998). *Il reddito delle famiglie agricole*, Argomenti, n. 11.
ISTAT-EUROSTAT (2004). Azione TAPAS 2002, by Ciaccia et al.
Militello, A. (1987). *Un confronto tra redditi dichiarati al fisco e redditi stimati dalla Contabilità Nazionale per gli anni 1981 e 1982*, in Quaderni di discussione, n. 87, ISTAT.

Is the Italian Organic Farming Model inside Rural Development? A Farm Structure Survey Data Analysis

Giampaola Bellini,[49] *Simona Ramberti* [50]
ISTAT, via Adolfo Ravà 150 Roma.
bellini@istat.it; ramberti@istat.it

Abstract *The aim of the present paper is to depict agro-environmental and socio-economic performances of Italian organic farms. Data analysis provided will enforce the idea that organic farming not only adopts a more environmentally oriented behaviour but also peculiar strategies towards economic assets and is characterised by specific social profiles. Thus, it can be concluded that organic farming can represent a model of farming where rural development is taking place in several forms.*
Results of farm structure survey run by ISTAT were thoroughly analysed, through calculation of suitable indicators for each dimension, as the environmental and the socio-economic one. A multiple correspondence analysis was also performed.

Keywords: organic farming, rural development, agri-environmental indicators.

1. Introduction

Rural development issue at European level represents an essential part of the Common agriculture policy and organic farming is - within rural development - one of the priority targeted areas to be promoted. In terms of public economic support based on committed area, organic farming was first supported as an agri-environment measure, among others, with the adoption of the Council Regulation (Eec) No 2078/92, and afterwards it was fully integrated in the rural development policy in the second pillar of the Cap, still under the agri-environmental measures. As such it continued to be supported under Council Regulation (Eec) No 1257/99 *on support for rural development from the European Agricultural Guidance and Guarantee Fund (Eaggf) and amending and repealing certain Regulations* for the period between 2000-2006, and at present is ruled by the Council Regulation (Ec) No 1698/2005 *on support for rural development by the European Agricultural Fund for Rural Development (Eafrd)* for the period 2007-2013.

Specific measures for organic farming are included under Axis 2 *Improving the environment and the countryside by supporting land management* of Article 4 of the Council Regulation (Ec) No 1698/2005, that defines the objectives to be achieved through the support for rural development.

2. What is organic farming?

In the common believes organic farming is considered the agricultural activity without use of synthetic plant protection products and fertilisers. In fact such agricultural activity includes more relevant differences with conventional farming based on a holistic natural resources management. For several years these principles were put in practice by farmers and only in year 1991 an official definition has been introduced by the first European related legislative act, when the Council Regulation (Eec) No 2092/91 *on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs* entered into force. This Regulation didn't refer to livestock breeding that was later ruled by Council Regulation (Ec) No 1804/1999

[49] Bellini G. authored §§ 1, 2, 3.1 and 4.
[50] Ramberti S. authored § 3.2.

supplementing Regulation (Eec) No 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs to include livestock production.

Several amendments were adopted since then and the two laws - taking into account all the amendments adopted – have been recently overcome by a unique legislative act entered into force this year last January, precisely the Council Regulation (Ec) No 834/2007 *on organic production and labelling of organic products and repealing Regulation (Eec) No 2092/91* including - referring specifically to farming activity - terms of reference for crop production and livestock.

As stated by the Regulation, the area cultivated with organic production methods can be either certified or under conversion. The Regulation establishes that the entire agricultural holding shall be managed in compliance with the requirements applicable to organic production, but in case the holding is split up into clearly separated units these can be not all managed under organic production. In the case of animals, adoption of organic and non organic growing conditions can be possible only if different species are involved.

In detail, according to the mentioned act "organic production is an overall system of farm management and food production that combines best environmental practices, a high level of biodiversity, the preservation of natural resources, the application of high animal welfare standards and a production method in line with the preference of certain consumers for products produced using natural substances and processes".

As organic production refers to farming and food production (including preparation and distribution) in the following we'll only refer to organic farming. Thus "organic farming should primarily rely on renewable resources within locally organised agricultural systems. In order to minimise the use of non-renewable resources, wastes and by-products of plant and animal origin should be recycled to return nutrients to the land".

In terms of sustainability organic farming contributes to the sustainability of the whole system by "maintaining and enhancing soil fertility as well as to preventing soil erosion". The mentioned objective can be reached by an appropriate "soil fertility management, choice of species and varieties, multi-annual crop rotation, recycling organic materials and cultivation techniques".

The easiest way to maintain soil fertility and to minimise the use of non-renewable resources is to use livestock production by-products (meaning manure) on land. Thus crop and livestock production should be closely related, so that nutrient lifecycle can be closed within the same holding. On the other side "as organic stock farming is a land-related activity, animals should have, whenever possible, access to open air or grazing areas", or should be fed "with organic-farming crop products produced on the holding itself or on neighbouring organic holdings".

Of course beyond general guidelines, organic farming is defined by the adoption of specific production rules described in the mentioned Regulation.

Particularly article 12 refers to plant production rules and article 14 to livestock production rules. It has to be underlined that in the aim of the legislation there are not quantitative targets for specific agricultural practices to be adopted in organic farming, but in some cases it gives mainly guidelines or best practice to follow.

Article 12 does refer to the maintaining or increasing of soil fertility, through use of *appropriate tillage and cultivation practices*, and the *adoption of multi-annual crop rotation including legumes and other green manure crops* by the *application of livestock manure or organic material*, both preferably composted, from organic production. Seed and material for propagation shall be cultivated according to the methods described in the same Regulation.

Furthermore it is stated that mineral nitrogen fertiliser cannot be used and that only fertiliser and plant protection products authorised for organic farming shall be used, as reported under article 16. Any technical or agronomic solution shall be applied to avoid pest, diseases and weeds control, as prevention is anyway preferable to be used instead of plant protection products.

Article 14 refers to livestock production rules. Those rules refer to origin and growing conditions of animals, to husbandry and housing conditions, in order to take into account of developmental, physiological and ethological needs of the animals. In fact livestock shall have access to open air areas and pasture, and referring to environment rules stocking densities shall be kept under a certain level to "minimise overgrazing and poaching of soil, erosion, or pollution caused by animals or by the spreading of their manure". Other rules refer to welfare, to be considered for example during transportation and to avoid mutilation. With regard to breeding, natural reproduction methods are preferable. Regarding feeding conditions, feed shall be organic and preferably grown in the same holding. This can help in reducing pollution as a short chain is promoted (less transportation with reduction in burned fuel).

Referring to animal health, disease prevention is preferred and promoted, being based on breed and strain selection, good management practices, quality of feed, exercise and good housing and hygienic conditions. Kind of products to be used in animal disease treatment are also defined.

Other prohibitions refer to use of:

- genetically modified organisms and products at any stage of the farm production and food and feed processing;
- ionising radiation for the treatment of organic food or feed, or of raw materials used in organic food or feed.

3. Organic farming role in general rural development context

As our Country – according to available data – is one of the main organic products producers on world market and the sector is growing rapidly, great attention is being given to it by the specific operators.

Thus data exploitation is essential to better understand the specific sector role and potentiality, both in terms of production and in terms of contribution to the general rural development.

Statistical data available are the ones collected through Farm structure survey (Fss) run by ISTAT. Last available data set refers to year 2005.

Referring to absolute values and relative incidence of the sector with respect to general agriculture, figures show that organic holdings in 2005 are 43,721 representing 2.5 percent of total holdings. In terms of Uaa, both completely converted and under conversion, 666,151 hectares are involved in 2005, representing 5.2 percent out of total Uaa (Table 1).

Southern regions are the ones where organic farming is more practiced; in fact some 55 percent out of all organic Uaa is located there. Among livestock, ovine animals are the ones most raised organically as in year 2005 the share of them out of total ovine and goats reaches 7.3 percent (Table 1).

Table 1 - Holdings with organic farming by geographical region - Year 2005

GEGRAPHICAL REGIONS	Holdings		Uaa		% out of total livestock heads	
	a.v.	% out of all holdings	a.v.	% out of total Uaa	Bovine and buffalo	Ovine and goats
North	8.092	1,8	122.910,86	2,7	1,2	3,2
Centre	6.659	2,4	174.781,91	7,5	4,3	12,5
South	28.971	2,9	368.458,49	6,4	6,1	6,2
ITALY	**43.721**	**2,5**	**666.151,26**	**5,2**	**2,6**	**7,3**

Source: ISTAT, Farm structure survey 2005

Organic area is available by crop type including completely converted and under conversion areas. Beside the category "other crops" that accounts for 27.0 percent out of all organic area, the larger group is represented by cereals whose area equals 24.5 percent out of the organic one, followed by pasture and meadow with 22.7 percent. Among tree plantations, olive plantations are the ones with the highest share reaching 13.0 percent out of total organic area (Table 2).

Table 2 - Organic (a) **Utilised agricultural area (Uaa) by crop category and geographical region - Year 2005** *(percentages out of total)*

GEOGRAPHICALREGIONS	Cereals	Fresh vegetables	Vineyards	Olive plantations	Citrus plantations	Fruit plantations	Pasture and meadows	Other crops	Total
North	20.0	2.4	4.7	0.3	-	9.2	25.9	37.5	100.0
Centre	23.0	0.5	5.3	8.6	-	2.2	22.8	37.7	100.0
South	26.9	0.9	4.7	19.8	4.7	3.9	21.5	17.6	100.0
Italy	**24.5**	**1.0**	**4.9**	**13.0**	**2.5**	**4.5**	**22.7**	**27.0**	**100.0**

Source: ISTAT, Farm structure survey 2005
(a) Including Uaa under conversion and completely converted.

3.1. Organic versus conventional farming: a multi-dimensional indicators analysis

Data released through Fss survey have been analysed in order to explore the features of the Italian farming activity with the intent of highlighting possible differences between holdings adopting the organic production method and the ones adopting the conventional one. Particularly, indicators have been calculated referring to the environmental and the socio-economic dimension, according to priority issues identified at international or considered relevant at national level. Existing indicators list implemented under different framework have been taken into account, as the agri-environmental and sustainability ones. All the dimensions – environment and socio-economic ones – have been explored in order to assess performances of the sector in each specific field. Among environmental variables, several agricultural practices adopted at farm level are monitored as they can improve environmental farm performances.

A list of the variables available in year 2005 and analysed for research purpose is given in the following.

Prospect 1 - List of analysed variables

BASIC/STRUCTURE VARIABLES	SOCIO-ECONOMIC VARIABLES
Holdings number	Manager gender, age, training level
Utilised agricultural area (Uaa),	Labour force (by typology of labour)
Farmland area	Working days
Livestock unit (Lsu) by specie	Labour force intensity related to capital factors (Uaa, Lsu, Esu)
European size unit (Esu)	Other gainful activities by kind of activity
	Holder's family self-consumption
ENVIRONMENTAL VARIABLES	
Irrigable and irrigated area	Crops succession
Irrigation system (type and area)	Land withdrawn from food production
Soil cover practices	Land erosion evidence by kind of erosion
Tillage practices (type and depth)	Livestock unit by Uaa
Treatment of grape processing residues	

Going to results obtained and referring to the farm dimension, organic holdings showed to be much larger than conventional ones (Table 3).

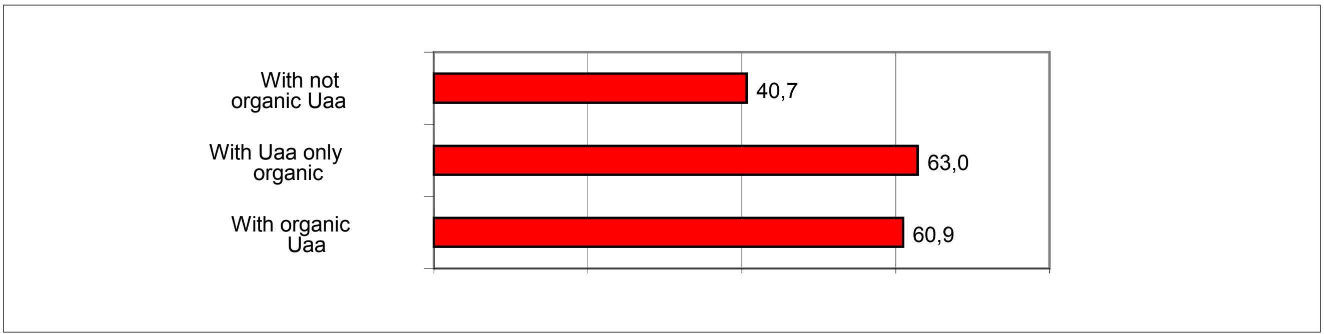
Table 3 - Utilised agricultural area (Uaa), total farm area, Livestock unit (Lsu) and European size unit (Esu) by holding and production method - Year 2005 *(area in hectares)*

PRODUCTION METHODS	Uaa	Total farm area	Lsu	Esu
With organic Uaa and/or livestock	22,1	29,7	13,7	30,5
With non organic Uaa and/or livestock	7,0	9,8	5,6	12,3

Source: ISTAT, Farm structure survey - Year 2005

Beside farm structure, referring to the environmental dimension, organic farms differ from the overall farms population for agricultural practices adopted at farm level for crop and water management. In terms of to crop management on arable land, holdings - with partial or total Utilised agricultural area conducted under organic method rules -show a higher share of crop rotation compared to all holdings (Graph 1).

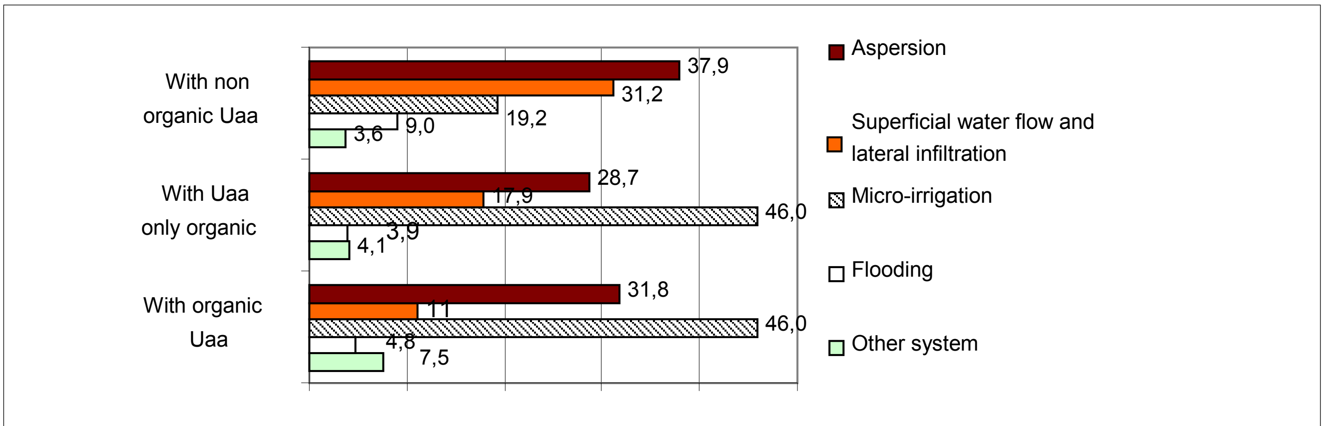
Graph 1 - Crop rotation area - Year 2005 *(% over arable land)*



Source: ISTAT, Farm structure survey - Year 2005

Referring to irrigation, organic farming shows a positive pattern as all the less efficient irrigation methods (superficial flowing water and lateral infiltration, flood, and aspersion) are the least spread (Graph 2).

Graph 2 - Irrigated area by irrigation system - Year 2005 *(% over total irrigated area)*



Source: ISTAT, Farm structure survey - Year 2005

The socio-economic dimension was also analysed and in terms of age, organic producers are younger and are better trained than all managers (Tables 4, 5).

Table 4 - Holdings by managers' age band and production method - Year 2005 *(percentages out of total)*

PRODUCTION METHODS	Managers' age bands			Total
	< 45	45-64	>= 65	
With organic Uaa and/or livestock	23,0	35,9	41,1	100,0
With not organic Uaa and/or livestock	14,5	44,0	41,5	100,0

Source: ISTAT, Farm structure survey - Year 2005

Table 5 - Holdings by manager training level and production method - Year 2005 *(percentages out of total)*

PRODUCTION METHODS	Degree	Diploma	Primary/Lower secondary school	No education (a)	Total
With organic Uaa and/or livestock	8,2	27,5	62,3	1,9	100,0
With non organic Uaa and/or livestock	3,8	16,5	72,6	7,2	100,0

Source: ISTAT, Farm structure survey - Year 2005
(a) Only practical agricultural experience

Referring to characteristics of labour force, Annual work unit[51] (Awu) per organic holding is larger than for all holdings, as are working days per worker (Table 6).

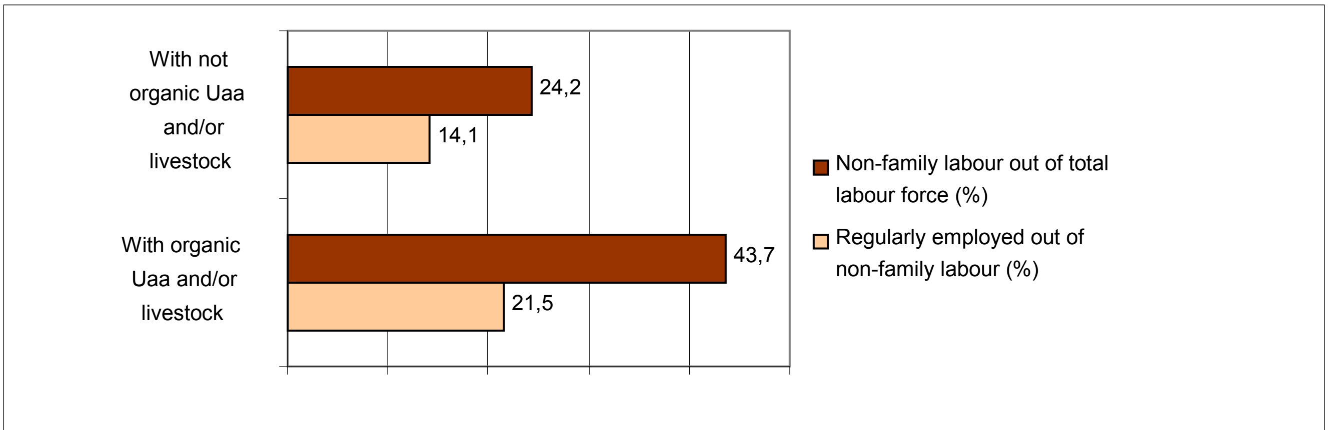
Table 6 - Holdings and related labour force, working days and annual work unit (Awu) by production method - Year 2005

PRODUCTION METHODS	Labour force (a) by holding	Working days		Awu
		By holding	By worker	By holding
With organic Uaa and/or livestock	3,4	384	113	1,3
With non organic Uaa and/or livestock	2,4	151	63	0,6

Source: ISTAT, Farm structure survey - Year 2005
(a) Holder's family and relatives, and non-family workers are included.

Regarding labour force composition, the share of family workers over total number in organic holdings is lower than in all holdings. The higher number of working days per worker in an organic farm is confirmed by the more common employment of regularly employed[52] workers in organic holdings that is two-threefold the one registered in all holdings (Graph 3).

Graph 3 - Labour force composition -Year 2005



Source: ISTAT, Farm structure survey - Year 2005

[51] The full-time equivalent employment, i.e. the total hours worked divided by the average annual hours worked in full time jobs in the country. Full-time means the minimum hours required by the national provisions governing contracts of employment. The working time of the non-regular labour force is converted into full-time working days, even if the hiring contract states that the working days are longer or shorter than for regular workers.
[52] Regularly employed labour force refers to persons who carried out farm work every week during the 12 months ending on the reference day of the survey, irrespective of length of the working week.

Lastly, organic holdings seem go towards the so-called multi-functionality in order to raise their revenues. Figures show that the "other gainful activities of the holding" (comprising any non-agricultural activity, e.g. the processing of agricultural products on the holding) are more common in organic holdings than in all holdings (Table 7).

Table 7 - Holdings with other gainful activities by kind of activity - Year 2005 *(percentages out of total holdings)*

PRODUCTION METHODS	Total	Other gainful activities			
		Agri-tourism	Plat products processing	Animal products processing	Other activities
With organic Uaa and/or livestock	13,5	5,1	6,7	3,0	2,4
With non organic Uaa and/or livestock	5,9	0,6	4,2	0,9	0,5

Source: ISTAT, Farm structure survey - Year 2005

3.2 Organic and conventional farming: a Multiple correspondence analysis

A wider set of indicators has been calculated and analysed in a multidimensional approach through the application of the Multiple correspondence analysis (Mca). Indicators synthesized the available information through application of weights defined according to explore, moreover, pressures generated on the environment.

In order to perform the Mca analysis, active and supplementary variables have been therefore chosen, after having explored different combinations of variables that were coherent with the objectives of the research and with the underlying theoretical choices and that better summarized the information available in the starting data matrix; in some cases it has been necessary to synthesize the information contained in crucial questions, otherwise unusable, in indicators. These variables are: *Irrigation indicator; Crops succession indicator; Erosion indicator; Percentage of regularly employed workers out of total other workers*[53]; *Managers' age band*; *Other gainful activities related to agriculture*; *Self-consumption of more than fifty percent of production*.

These variables have been chosen as they are associated to environmental, social and economic dimensions. In particular, *irrigation, crops succession* and *erosion* refer to the environmental component, whereas the *percentage of regularly employed workers out of total other workers* and *managers' age band* to the social one and the last two, *gainful activities related to agriculture* and *self-consumption of more than fifty percent of production* to the economic one.

The interpretation of factorial axes produced by the statistical method applied enables the identification of the structural components through which explain a possible segmentation of the population surveyed. Axes interpretation is carried out starting from categories with bigger absolute contributions.

The output analysis shows that the negative side of the first factor (x-axis) is characterized by holdings with elderly manager (at least 65 years), familiar labour (no other workers), in which the self-consumption of at least the 50 percent of their products is typical and other gainful activities related to agriculture are not present. The positive side gives the reverse pattern, in fact here the higher contributions derive from holdings with young manager (up to 44 years), who have other workers (regularly or not regularly employed workers), don't consume at least the 50 percent of their production and are engaged in activities related to agriculture.

The second factor (y-axis) is characterised, in the negative side, by high levels of eco-friendly indicators related to the irrigation system, crops succession and to the sorts of land degradation; while in the positive side higher contributions are from holdings that make low eco-friendly choices.

The space identified by the first two factors crosses socio-economic characteristics, that we'll define market orientation and environmental eco-friendly approach of holdings. Three clusters become visible among all the farms in the sample. The *Eco-friendly market oriented holdings*, or young farms (in relation to holding managers age), market-oriented and environmental sustainable are located in the fourth quadrant. *Traditional holdings*, family-run farms, with old manager and generally eco-friendly are found in the second and the third quadrant. This cluster is really good represented on the first axis. *Intensive holdings*, or larger farms with many employees, mindful of the market dynamics but little virtuous in the environmental sense is in the first quadrant.

[53] Regularly and non regularly employed workers.

Moving in the central area of the graph we see that it has the highest concentration of the categories concerned; being located closer to the centre of gravity, this band has a greater counterparty within the population, since in fact it is characterized by higher frequencies.

To characterize better these clusters, significant supplementary categories will be analysed. The interpretation of results is facilitated observing graphics (Figures 4.1 - 4.4). On each graph all active variables categories have been plotted jointly with the supplementary categories defining each thematic area. This solution has been adopted for a major clarity in the reading of charts. Of course, graphs relating to the same factors could be laid upon to assess the closeness or distance between variables categories belonging to different areas.

The variable *organic* has been plotted on each graph. It is possible to note that the mode "no_organic" of the supplementary variable "Organic" is positioned about in the origin of the axes, a confirmation of the fact that most Italian holdings don't practise organic agriculture.

The *Eco-friendly market oriented holdings* are large holdings (that is with Uaa larger then ten hectare, including the ones with 100 hectare and over), run by young managers (up to 44 years) with a high educational qualifications (degree or diploma, often in agriculture science), which have important economic interests and therefore have diversified offering with activities related to agriculture, the sale of more than 50 percent of their products and, most of the others, agri-tourism. They are for the most part organic holdings and generally virtuous in the environmental sense: it can be easily seen observing the position on the chart of the categories "organic_yes" and "medium-high_eco-friendly" of environmental indicators. Although in Italy the number of female managers is already rather low (in fact, category sex=M is almost coinciding with the origin of the axes), *Eco-friendly market oriented holdings* are even less run by a female manager. In these farms family labour is less present in spite of what happens in non-organic holdings, where the family is very often the only professional resource used. Moreover, among the other gainful activities related to agriculture, the production of renewable energy, although generally little spread, is practised more than in the other holdings. Even in case that these holdings engage in breeding, the choices made are, on average, more virtuous compared to non-organic holdings. This is indicated by low levels of the indicator "Lsu per hectare of Uaa" (up to four Lsu per hectare of Uaa) and by the contemporaneous presence of forage crops and livestock, either dairy cows, bovine and ovine animals. Similarly, arrangements for treatment of grapes residues are more eco-friendly. The geographical location of these virtuous holdings is mainly on the plains of Northern Italy. These holdings have benefited, in great measure, of aids for investments or for rural development purpose and that, probably with the already mentioned propensity to market, participate most to professional associations or associations of producers using, in particular, among various services, the exploitation and the marketing of products.

Traditional holdings are generally small size (less than five ha), led by elderly managers, with low educational qualifications (no education, primary or lower secondary), in which the self-consumption of at least the 50 percent of their products is typical, so they aren't active in selling, neither they run agri-tourism and, in general, other activities related to agriculture. It's likely that this cluster of holdings is then formed by family-run holdings that serve to support the unique needs of the family. So small businesses, where land degradation is low and where the degree of environmental sustainability of agricultural practices is good since forms of irrigation and crops succession are mostly non-existent. It's easy to find this type of holdings in the regions of Southern and Central Italy. These farms generally do not adopt the organic production method.

The *Intensive holdings* are holdings overall present in Northern Italy, of large dimensions (at least 50 hectares of Uaa) and high incidence of regularly employed workers. Managers are generally middle-aged men (35-54 years). These holdings are market-oriented and take generally part of professional associations. Regarding the level of eco-sustainability, we remind that crops succession and irrigation systems have, for the most, medium-low levels of sustainability, while the erosion forms of the farm land in the last three years are, on average, less serious than in other farms; this one could be the result of different reasons as the realisation of solutions (often expensive) to solve problems of degradation, or the different location of the holding – possibly in plain land – or the physical nature of the farmland – less prone to erosive factors. If breeding is present in the farm, the indicator "Lsu per hectare of Uaa" presents values rather high (at least five Lsu per hectare, up to 50 Lsu). Breeding is therefore very intensive and therefore not much sustainable.

The characterization of intensive holdings is less defined than other holdings types. This becomes evident analysing the printouts and the graphs, in which points appears less dense. This is probably due to the limited number of these occurrences and from the various personalities that they possess, so that it's more difficult to outline a mean profile.

Figure 4.1 - Active and supplementary categories - Area: “Social and structural characteristics”

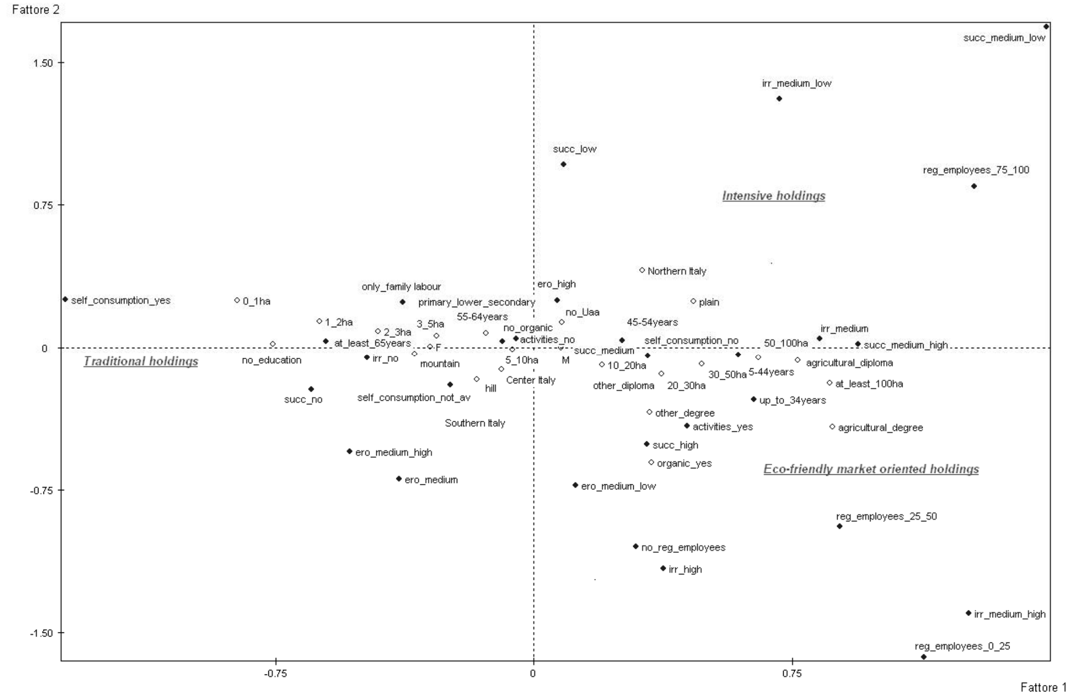


Figure 4.2 - Active and supplementary categories - Area: “Breeding”

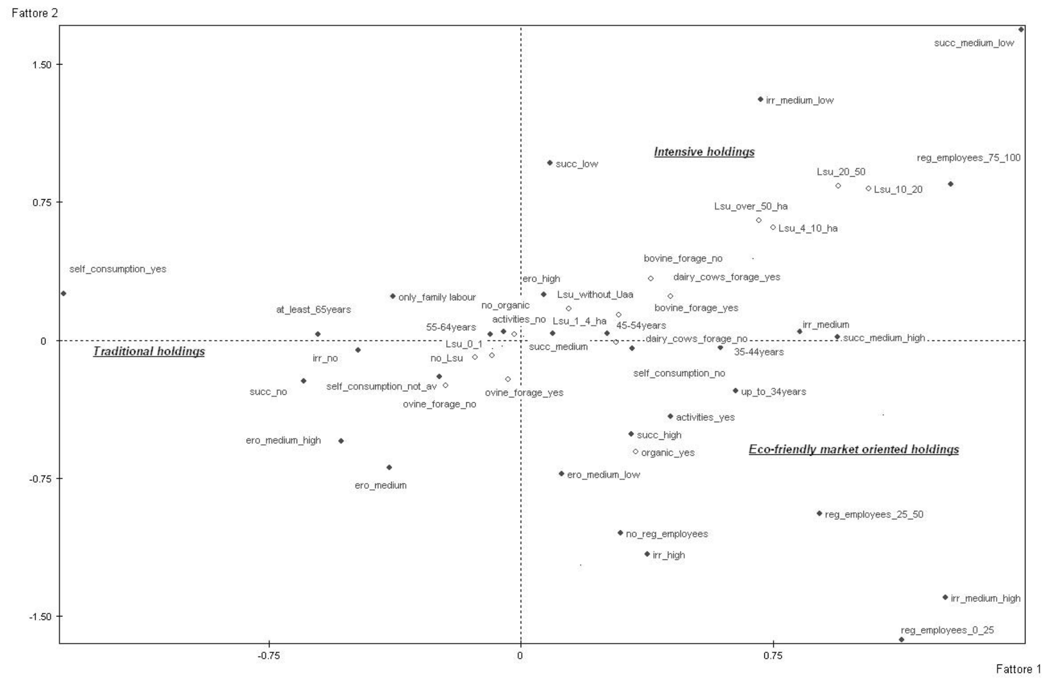


Figure 4.3 - Active and supplementary categories - Area: “Market participation”

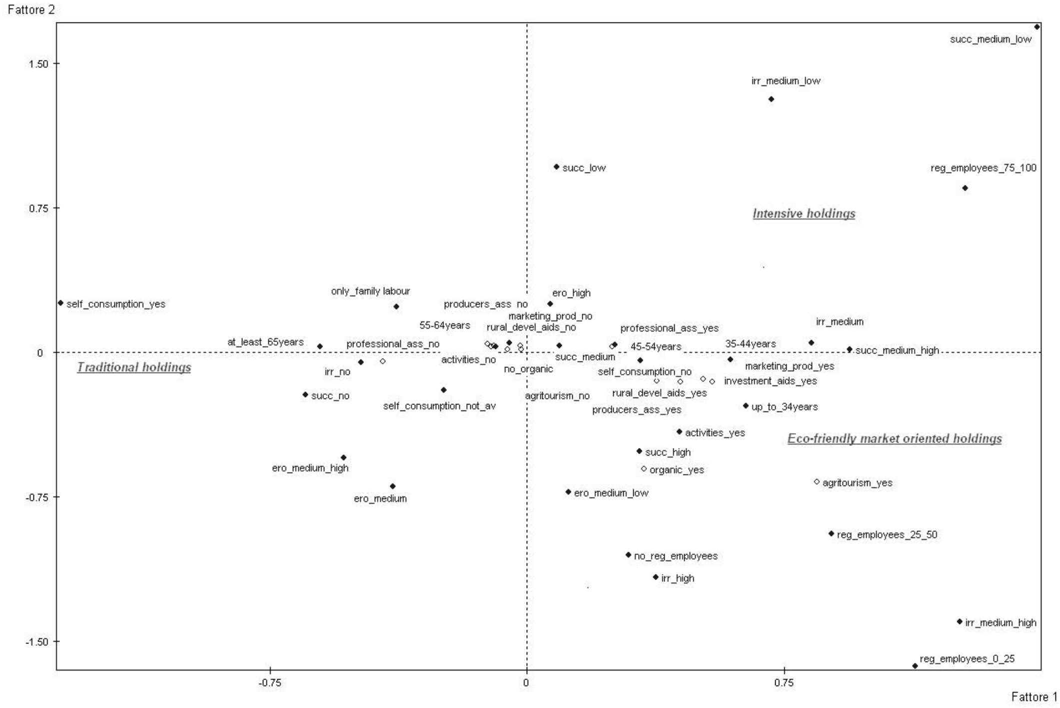
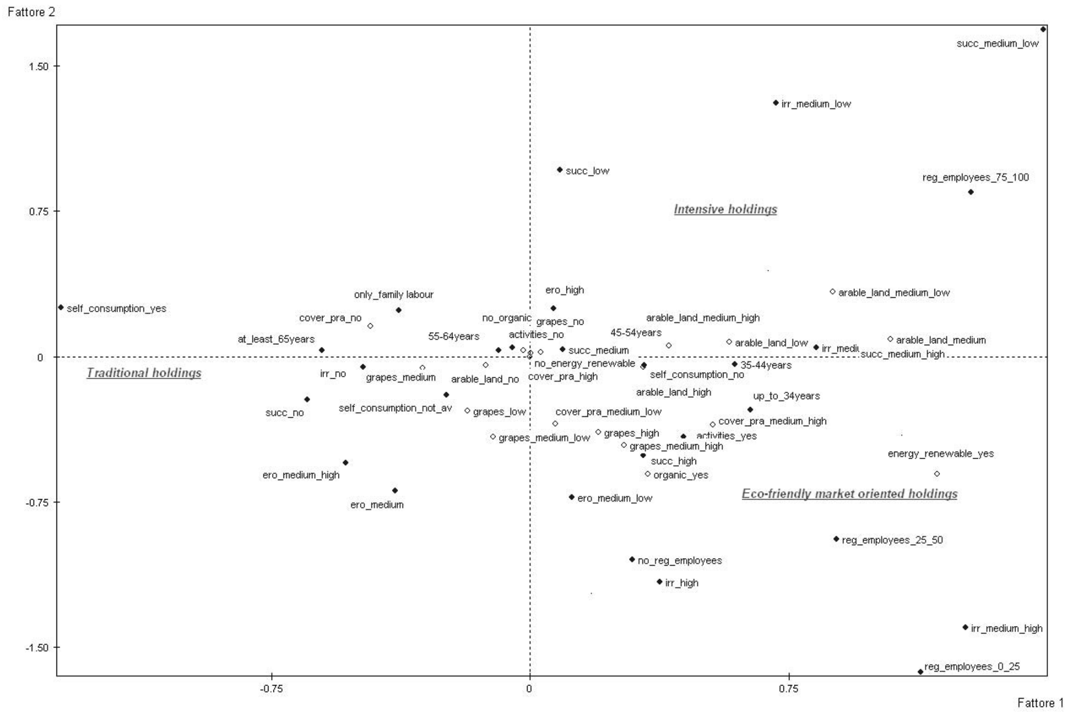


Figure 4.4 - Active and supplementary categories - Area: “Agricultural practices”



4. Conclusions

Farm structure survey data are standardised and different environment and socio-economic characteristics are surveyed referring to the same farm so that they are suitable for analysis with a multidimensional approach. Referring to data exploitation, good performances have been recorded for organic farming in year 2005, as they not only adopt more environmentally friendly agricultural practices as the ones suggested by law, but they also seem to have positive behaviour in the socio-economic dimension, thus enhancing rural development as a whole. Further analysis should be performed in order to assess whether the same pattern is confirmed in the following years.

Particularly, study results show that organic holdings are generally larger than others - in terms of Uaa and livestock heads - and main crop production is related to livestock feeding as other arable land crops - including rotational forage -, and pastures and meadows are the first two categories organically grown in terms of share of organic utilised agricultural area, followed by cereals.

Generally they adopt environmentally oriented agricultural practices, such as irrigation with high efficiency rate, soil cover practice, tillage at low depth – particularly for holdings with only organic Uaa -, and, according to law, in holdings with livestock, Lsu per hectare is lower than other holdings type. Referring to the socio-economic dimension, organic holdings are managed by a better educated and younger person; labour force is composed by a higher share of regularly employed workers, with a lower holder' family percentage; their recourse to other gainful activities is higher, whereas is lower to farm products for self-consumption purpose.

Also a suitable statistical tool - the multiple correspondence analysis - has been applied to deepen the study. The space identified by the first two factors crosses socio-economic characteristics that have been defined market orientation and environmental eco-friendly approach of holdings. Holdings are thus grouped according to their features and three clusters become visible among all the farms in the sample: the *Eco-friendly market oriented holdings*, or young farms (in relation to holding managers age), market-oriented and environmental sustainable, adopting organic method for crops and animals production; the *Traditional holdings*, family-run farms, with old manager and generally eco-friendly; and the *Intensive holdings*, or larger farms with many employees, mindful of the market dynamics but little virtuous in the environmental sense.

References

Bellini, Giampaola. *Agri-environmental indicators: methodologies, data needs and availability*. Roma: ISTAT, 2006. (Essays, n. 16).

Bellini, Giampaola. "Water resources for the agriculture sector". In *Water Resources Assessment and Water Use in Agriculture in Italy: Methods and Data Sources*. Roma: ISTAT, 2006. (Essays, n. 18).

Benzécri, Jean-Paul. *L'analyse des données. Tome 1. La taxinomie. Tome II. L'analyse des corrispondences*. Parigi: Dunod, 1973.

Bolasco, Sergio. *Analisi multidimensionale dei dati. Metodi, strategie e criteri d'interpretazione.* Roma. Carocci, 1999.

Cicchitelli, Giuseppe. *Il campionamento statistico*. Bologna: Il Mulino, 1997.

Commission of the European communities. *Communication from the Commission to the Council and the European parliament COM (2006) 508. Development of agri-environmental indicators for monitoring the integration of environmental concerns into the common agricultural policy*.

Commission Staff Working Paper [SEC (2001) 266]. *A Framework for Indicators for the Economic and Social Dimensions of Sustainable Agriculture and Rural Development*.

Commission Staff Working Document [SEC (2007) 1416] *accompanying the Communication from the Commission to the Council and the Parliament Progress report on the Eu Sustainable Development Strategy 2007*.

Corbetta, Pier Giorgio. *Metodi di analisi multivariata per le scienze sociali*. Bologna. Il Mulino, 1999.

De Lillo, Antonio et al. *Analisi multivariata per le scienze sociali*. Pearson Education, 2008

Di Franco, Giovanni. *EDS: Esplorare, descrivere e sintetizzare i dati*. Milano: Franco Angeli, 2001.

Di Prinzio, Alessia. *Studio di un indice per la valutazione dell'eco-compatibilità delle aziende agricole*. Tesi di laurea in Scienze Statistiche e Tecnologiche dell'Informazione - Facoltà di Scienze statistiche, Università di Roma la Sapienza. Anno Accademico 2005-2006. Relatore: Prof.ssa Giovanna Jona Lasinio. Relatore esterno: Giampaola Bellini.

Ismea. AA.VV. *Agricoltura e ruralità. L'indagine socioeconomica sull'agricoltura italiana*. Milano: Franco Angeli, 2005.

ISTAT. AA.VV. *Istruzioni per la rilevazione dei dati. Indagine sulla struttura e produzioni delle aziende agricole*. Roma: ISTAT, 2005.

ISTAT. (Autori Bellini G., Ramberti S.). *Relazioni tra agricoltura e ambiente: dalle statistiche agli indicatori - Anno 2005*. Roma: ISTAT, 2008. (Statistica in breve - ambiente e territorio, 28 gennaio 2008).

Leti, Giuseppe. *Statistica descrittiva.* Bologna. Il Mulino, 1983.

Measuring Cultivation Parcels with GPS: a Statistical Evidence[54]

Gabriele Palmegiani
Affiliation: LUISS University of Rome
gabriele.palmegiani@gmail.com

Abstract: *This paper uses African survey data (2005-2006), to study the statistical relevance of measuring surfaces of cultivation parcels using Global Positioning System (GPS) respect to the traditional method using compass and meter. Cultivation parcel selection was not random. Cameroon, Niger, Madagascar and Senegal were involved. More types of GPSs were used. Before supposing that selection was random, the unconditional inference approach is provided for both parametric and non-parametric level. The paired t-test and the Wilcoxon sign rank test are applied on measurement differences.*
After assuming that selection was not random, the conditional inference approach for means based on resampling methods is applied. The permutation distribution function of the paired t-statistic and the empirical p-values associated are worked out for differences. Two main conclusions are found: first, the conditional inference fully supports the unconditional one, only parcel estimates using GPS60 are statistically equivalent to parcel estimates using traditional method and the lose of accuracy when random sampling is assumed is on the order of 2/1000. Second, parcel estimates using compass tend to be larger than parcel estimates using GPSs. In conclusion, because the GPSs methods are globally cheaper than compass method, is strongly recommended the use of GPS60 to reduce the costs of the agricultural surveys.

Keywords: Random Sampling, Conditional Inference, Independence, Normality, Variance Homogeneity,t-tests, Wilcoxon tests, Resampling methods, Permutations tests.

1. Introduction: statistical inference and random sampling for GPS measurements

Statistical inference cannot have nothing to do with the *sampling.* The sampling is that part of statistics concerned with the selection of observations intended to describe some features about the population of interest (target population). Typically, only samples from a given target population are available. Most of the inferential methods require the assumption that the samples have been generated by a random mechanism. It insures that, samples are *random variables*, indeed, a set of values drawn independently from a larger population or *uniform random variables* when all members of the target population have an equal chance of being drawn. Common statistical tests, as *t*-tests assume also that the target population is normaly distributed. Often, observations are not a random sample

from a well-defined target population. For example, the one sample extraction without replacement of m balls from an urn containing M balls, with $m<M$, is a different experimental design respect to the individuals recruited to be FAO volunteers. In the first case, the balls are extracted randomly from the urn and each of them is drawn independently from the others. Researchers can make inference on the all sample space variability of the target population, then the statistical inference is called *unconditional* or *simple inference*. Common tests, such as *t*-tests may be used. In the second case, FAO's volunteers are hardly ever a random sample from a set of all possible candidates having at least a degree, but are a strict selection of resourceful and successful students who have a specific educational background. Besides, for a given division, often volunteers are taken with different skills, then probably they are not independently chosen. Intentional selection exists and some bias must appear. Now, inference can be done only on a restricted part of the sample space associated with the

[54] I wish to express my most sincere gratitude to Mr. Hiek Som (FAO, ESSS) and Mr. Naman Keita (FAO, ESSS) for their availability and supervision in writing this paper. I do warmly appreciate their contributes and comments. For questions or suggestions concerning this paper fell free to contact me.

conditioning event of interest, then the statistical inference is called *conditional inference*. In this case, *t*-tests cannot work well and *resampling methods* for inference and parameters estimation are strongly recommended (Pesarin (2001)).

In practice, researchers may take the random sampling assumption when the selection mechanism does not guarantee randomness. Inferences from data that are chosen according to a given intentional selection are inevitably less secure than where we have random samples. The lose of accuracy may become greater when the samples are smaller. We shall make inference assuming that cultivation parcels are both random and non-random sampled.

The aim of the paper is to verify whether estimation of surfaces of cultivation parcels using traditional method and using types of GPSs gives different results. Then, because the GPS methods are globally cheaper than traditional method, the equivalent GPS measurement, if found, will be strongly recommended to reduce the costs of agricultural surveys.

Given different types of measurements, the *statistical equivalency* between two methods, might be evaluated respect to the surfaces obtained, the time requested, the costs undertaken and the weather conditions presented. Obviously, the equivalence depends on both the size of the parcels considered and the staff ability. It means that *error measurements* might be treated as a linear or nonlinear function of both the parcel extension and the number of training staff hours.

In this paper, the statistical equivalency will be studied only in the results or surfaces obtained. Immediately after this preparatory section, we shall describe the data-set *(Section 2)*, then the statistical inference is runned assuming both random parcel selection *(Section 3)* and non-random parcel selection *(Section 4)*. For the random sampling case, starting from a simple statistical inference framework *(Subsection 3.1)* we shall select parametric and non-parametric suitable tests. We shall provide both their theory *(Subsection 3.1 & Subsection 3.2)* and their practical application *(Subsection 3.3)*. After, relaxing the random selection assumption, a conditional inference approach based on resampling methods is applied. The permutation distribution of the paired *t*statistic will be estimated from the statistical units surveyed and unconditional and conditional inference for means will be faced toward *(Section 4)*. Final conclusions will be summarized in *(Section 5)* and further developments will be explained in *(Section 6)*.

2. The data-set

The GPS survey is entirely built and collected by FAO's Statistical Division in the framework of the project GCP/INT/903/FRA. Cameroon, Niger, Madagascar and Senegal were involved. Measurements on surfaces, perimeters, weather conditions and time requested were taken for different methods of measurements and for each of the 207 cultivation parcels. Since many of these samples are missing for Madagascar, we have chosen to drop out its observations. The total number of observations is reduced to

157. Deleted the possible outliers the applied analysis will be conducted on 126 observations. The covariates of interests (all expressed in squared meters) are the following:

S_1 = Compass and meter cultivation parcel surface.
S_21_1 = Garmin60 (GPS60) cultivation parcel surface.
S_22_1 = Garmin72 (GPS72) cultivation parcel surface.
S_24_1 = Magellan400 (MAG400) cultivation parcel surface.

These variables take into account of both bigger and smaller parcels together and only first passages measurements. From these covariates, we shall interested in the following differences:

c_g60diff = the difference between compass and meter cultivation parcel surface and Garmin60 cultivation parcel surface.

c_g72diff = the difference between compass and meter cultivation parcel surface and Garmin72 cultivation parcel surface.

c_m400diff = the difference between compass and meter cultivation parcel surface and Garmin72 cultivation parcel surface.

Which will be studied using both the unconditional and the conditional inference approach.

3. Unconditional inference

This section makes statistical inference assuming that cultivation parcel selection was random. It implies that samples are random variables drawn independently from a larger population. We can assume or not normality of the differences. When normality is supposed we shall use tests on means, when normality is not assumed tests on *pseudomedians* (indeed, medians worked out starting from the ranks of the original samples) will be carried out. Described the general unconditional statistical inference framework *(Subsection 3.1)* two methods will be compared: a parametric level *(Subsection 3.2)* and a non-parametric one *(Subsection 3.3)*. In the former, normality is supposed and the *t*tests may work well. In the latter, normality is relaxed and the *Wilcoxon sing rank test* is runned. The practical application of these tests is contained in *(Subsection 3.4)*.

3.1 How can we make simple inference?

Supposing that covariates are random variables, the unconditional statistical inference can be done according to the (*Table 1*)[55]. As we can see, statistical inference depends on both the aim and the nature of the data that we are facing. On the data hand, choosing the right test to compare measurements implies a selection between two families of tests: *parametric tests* and *non-parametric test*.

Table 1 - Unconditional statistical inference: the aim and the data nature

Statistical aim	Data-set features			
	Continous Data		Non-Continous Data	
	Measurements from a Gaussian distribution	Measurements, Ranks or Scores, from a non-Gaussian distribution	Binominal Data (two possible outcomes)	Survival Data
Describe one sample	Mean Standard deviation	Median Interquartile range	Proportion test	Kaplan Meier Survival Curve
Compare one sample to a hypothetical value	One sample t-test	One sample Wilcoxon test	Chi-square test Binominal test	
Compare two unpaired samples	Unpaired t-test	Unpaired Wilcoxon test (Wilcoxon Rank Sum test)	Fisher's test (chi-square test for large samples)	Log-rank test
Compare two paired samples	Paired t-test	Paired Wilcoxon test (Wilcoxon Sign Rank test)	McNemar's	Hazards regression
Compare three or more unmatched samples	One-way ANOVA	Kruskal-Wallis test	Chi-square test	Cox-regression
Compare three or more matched samples	Repeated-measures ANOVA	Friedman test	Cochrane Q	Hazards regression
Quantify association between two variables	Pearson correlation	Sperman correlation	Contingency coefficients	
Predict value from another measured variable	Linear regression Non-linear regression	Non-parametric regression	Logistic regression	Cox-regression
Predict value from several measured or binominal variables	Multiple linear regr Multiple non-linear regression		Multiple logistic regression	Cox-regression

[55] When the same test is pointed out, it means the application of the same test under different assumptions.

Parametric tests are based upon the assumption that the samples are drawn from a well defined probability distribution. Often, the Gaussian distribution is assumed. Commonly used parametric tests are listed in the first column of the *(Table 1)*. Because normality is a strong assumption, as starting point it is fundamental verify if normality works well using *histograms of frequencies distributions* or *normal quantile probability plots*. All commonly used non-parametric tests rank the outcome variable from low to high and then analyze the ranks. These tests are listed in the second column of the *(Table 1)* and include the paired and unpaired Wilcoxon test.

Choosing between parametric and nonparametric tests is sometimes easy. We should definitely choose a parametric test if they are sure that our samples are drawn from a population that follows a Gaussian distribution (at least approximately). Instead, when the samples are not normally distributed or the outcome is a rank or some outliers remain is strongly recommended the use of a non-parametric framework. Anyway, cause the *central limit theorem* (CLT), parametric tests work well with large samples even if the population is not Gaussian[56] [3]. Data may be also non-continuous. Inference on binominal data (two possible outcomes) or survival data (time to event data) requires the tests listed in the third and fourth column of the *(Table 1)*. We do not deal with these latter tests.

On the other hand, the statistical inference depends also by the goal of the analysis. Given only one sample, for describing, the mean or the standard deviation might be useful. Instead, to make simple inference on the mean, one sample *t*-test should be appropriate. When samples are two, we need to decide whether to use a *paired test*. To compare three or more samples, the term paired is not adapt and the term repeated samples is used instead. Paired observations are found when two measurements are made on the same statistical unit. In this case, we might expect a correlation between two measurements, either because they were made on the same individual or were taken from the same location. Pairing is effective only when the sample correlations are not weak. When it works, two samples from a given data-set must be handled as paired, then the differences should be taken for inference. The pairing reduces the degrees of freedom of the test statistic. The conclusions may be different, then it would be seriously inappropriate to analyze samples without taking the pairing into account when it is effective (Greene 2008). When samples are more than two, they may be grouped or matched. In this case, the ANalysis Of VAriance (ANOVA) and repeated ANOVA methods can be used to compare unmatched and matched samples respectively.

Finally, the association between two variables can be studied through correlation measures, instead simple linear regression (SLR) or multiple linear regression (MLR) can be applied for forecasting.

Given that inference framework, to assess the relevance of measuring cultivation parcels using GPS we need to choose the right test. On the data hand, the data-set is constituted by *continuous* and *independent samples*. Independence assumption is satisfied, because the parcel measuring using a method cannot influence the same measuring using another method. Obviously, samples are continuous, because values observations varies in a continuous way. Then, the choice is reduced at the first two column of *(Table 1)*. On the statistical aim hand, we are interested in comparing couples of measurements. Basically, the comparison may be done in a parametric framework using sample means or in a non-parametric framework using sample medians. Besides, we might work on unpaired or paired samples. Let's see now, how that works.

At parametric level when pairing is not effective, assuming that two samples are drawn from two normal distribution functions with $N(\mu_1; \sigma_1^2)$ and $N(\mu_2; \sigma_2^2)$, the system of the hypothesis is the following:

$$H_0; \mu_1 = \mu_2 \qquad (1)$$

$$H_A; \mu_1 \neq \mu_2$$

Where μ_1 and μ_2 are the unknown theoretical or population means, estimated using the samples counterparts. This hypothesis can be tested using the so called *unpaired two sample t-test* which can be reduced to only one

[56] In most situation, a vaste number of possible samples could have been taken from a particular population. Each sample may have a different value for its mean. The distribution of these possible samples means is called the *sampling distribution of the mean*. The CLT states that, for a population with finite mean μ and finite standard deviation σ , the sampling distribution of the mean can often be well approximated by a normal distribution whose mean is μ and whose standard deviation is σ / n. This result depends strongly on both that the n observations in the sample have been selected independently of each other and on the size of n. When, for one sample $n \geq 30$ or for two samples $n_1 + n_2 \geq 30$, in practice, we do not need to worry too much about the normality assumption. To avoid distribution mistakes, it is often suggested a safer threshold; $n \geq 50$ for one sample and $n_1 + n_2 \geq 50$ for two samples.

sample unpaired *t*-test on the differences. When pairing is effective the two populations problem is reduced to only one population problem. Given *i*-th observation and two samples measurements X_{1i} and X_{2i}, the variable of interest becomes the paired differences $d_i = X_{1i} - X_{2i}$. Assuming that differences are normally distributed N(μ ; σ2), the system of the hypothesis becomes:

$$H_0; \mu = 0 \qquad (2)$$
$$H_A; \mu \neq 0$$

Where μ is the unknown theoretical or population mean, estimated using its sample counterpart. This hypothesis can be tested using the so called *paired t-test*.

At non-parametric level, means are substituted by cumulative distribution functions. When pairing is not effective, the system of hypothesis is the following:

$$H_0; F_{X1} = F_{X2} \qquad (3)$$
$$H_A; F_{X1} \neq F_{X2}$$

Where Fx_1 and Fx_2 are two unknown population distribution functions, which can be estimated by their empirical distribution counterparts. When pairing is effective, the system of hypothesis becomes:

$$H_0; F = 0 \qquad (4)$$
$$H_A; F \neq 0$$

is the unspecified population distribution function, which can be estimated by its empirical distribution counterpart. We shall use two kind of non-parametric test: the *Wilcoxon sign rank test* and the *permutation paired t-test*. In the first case, a pseudomoment of these distributions is taken[57]. In the second case, the location of the empirical counterpart of the distribution *F* will be studied.

The paring has a significant impact on inference. First, since only a measure of variability is present, tests on variances have not any sense to exist. Second, given the significance level, since the pairing reduces the number of degrees of freedom, the test statistic tends to be higher and the p-value associated smaller, then we are boosted to reject the null hypothesis that measurements methods are, on average, statistically equivalent when it is true.

There are two simple tests for comparing two samples:

Student's *t*-tests: Can be used when samples are independent, their variances are similar and finite and their distribution is normal or near normal.

Wilcoxon tests: Can be used when samples are independent, the variances are similar and finite, but their distribution is not normal or not near normal distributed.

These tests can be applied to one and two samples problems as well as to paired and to non-paired data. For unpaired problems, the *t*-test is known as *two sample t-test* and the Wilcoxon test is known as *Wilcoxon rank sum test*. For paired problems, the *t*-test is known as *paired t-test* and the Wilcoxon test is known as *Wilcoxon sign rank test*. The tests underlined in *(Table 1)* will be used to make simple inference.

3.2 The Student's t-tests

Student was the pseudonym of W.S. Gosset who published his famous paper in Biometrica in 1908. He was prevented from publishing under his own name, cause an employment law in place at the time, which allowed his employer to prevent him publishing his ideas as independent work. His distribution, the t-distribution, will be perfected by R.A Fisher, who called the distribution Student's distribution, has revolutionized the study of small sample statistics.

[57] The moment used by the Wilcoxon sign rank test will be pseudo-medians, that is, medians calculated starting from the ranks of the samples.

Given two random samples, X_1 and X_2, to test the null hypothesis *(Equation 1)* we can use the so called the *two sample t-statistic*:

$$t = \frac{\textit{difference between two means}}{\textit{s.e of the mean difference}} = \frac{\overline{X}_1 - \overline{X}_2}{SE_{(\overline{X}_1 - \overline{X}_2)}}$$

$$= \frac{\overline{X}_1 - \overline{X}_2}{S / \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \xrightarrow{d} t_{n_1 + n_2 - 2} \qquad (5)$$

Where $\xrightarrow{d}$ means "distributed in law", X_1 and X_2 are the samples means[58], S is the sample standard deviation[59], n_1 and n_2 are instead the samples size. This formula counts the number of standard errors of the mean difference $SE_{(\overline{X}_1 - \overline{X}_2)}$ by which the two sample means are separated. Under the null hypothesis *(Equation 1)*, the *t*-statistic has a Student's *t* distribution with $n_1 + n_2 - 2$ degrees of freedom. But if samples are sufficiently larger[60], the CLT can be applied:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{SE_{(\overline{X}_1 - \overline{X}_2)}} \xrightarrow{a} N(0;1) \qquad (6)$$

Where $\xrightarrow{d}$ means "asymptotically distributed". This happens because the *t* distribution depends on the number of degrees of freedom associated with the denominator $SE_{(\overline{X}_1 - \overline{X}_2)}$. Because $n_1 + n_2 - 2$ degrees of freedom have been used to calculate the standard deviation *S*, the *t*-statistic has a *t*-distribution with $n_1 + n_2 - 2$ degrees of freedom.

When the samples size increases, also the degrees of freedom increases then the samples standards deviations gives an increasingly good approximation to the populations standards deviations; thus the *t*-statistic becomes more and more like a standard normal random variable.

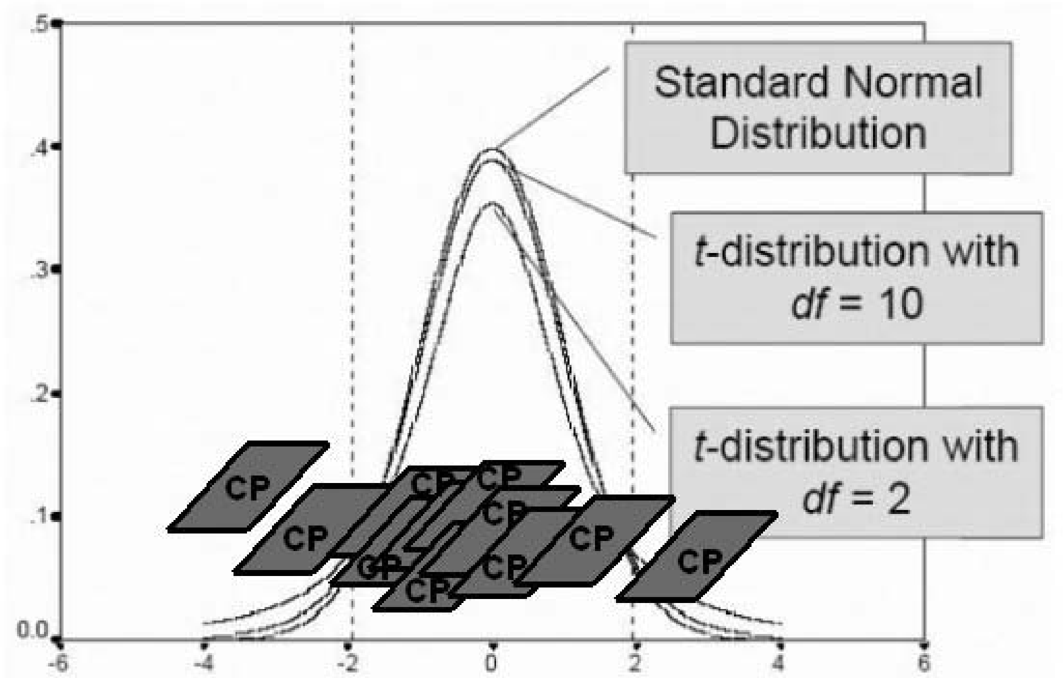
---

[58] The sample mean for the k-th sample is defined as: $\overline{X}_k = n_k^{-1} \sum_{i=1}^{n_k} X_{2k}$; for $k = 1;2$ Where X_{2k} are the values of *k*-th sample.

[59] The sample standard deviation for the *k*-th sample is defined as: $S_k = \sqrt{\frac{\sum_{i=1}^{n_k} (X_{ki} - \overline{X}_k)}{n_k - 1}}$; for $k = 1;2$

[60] We said $n_1 + n_2 \geq 50$ is safer.

Figure 1 - Standard normal distribution and Student-t distribution



The main difference between a standard normal variable and a Student-*t* distribution is on the *tails (Figure 1)*. The Student-*t* distribution is less concentrated around the mean than is the normal distribution and more spread out in the tails, with the difference greatest when the number of degrees of freedom is small than almost ten. Assuming that differences of cultivation parcel estimates are distributed like a normal distribution, means that, these observations (represented using the brown rectangles) are more concentrated around a common mean and less concentrated on the tails.

The total variability of the *t*-distribution has two sources: the sampling variability of the mean difference and the sampling variability of $SE_{(\bar{x}_1 - \bar{x}_2)}$. Since the denominator involves the variability of the samples captured by their standard deviations, it is fundamental for inference. Let's see now, how these work.

When samples have the same variance is reasonable to estimate the standard error of the mean difference treating the variability of the samples together:

$$S = S_p = \sqrt{\frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}} = \sqrt{\frac{\sum_{i=1}^{n_1}(x_{1i} - \bar{x}_1)^2 + \sum_{i=1}^{n_2}(x_{2i} - \bar{x}_2)^2}{n_1 + n_2 - 2}} \quad (7)$$

Where S_p is the so called *pooled standard deviation* estimate, S_1 and S_2 are the samples standards deviations. Substituting this formula in *(Equation 5)* and calculating the samples means, we can obtain the value of the statistic.

A $100(1\text{-}\alpha)\%$ confidence interval for the mean difference is constructed as:

$$\overline{X}_1 - \overline{X}_2 \pm t_{\alpha\,;\,n_1+n_2-2}\ S_p\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}$$

Where α is the significance level of the test. It implies that $t_\alpha;\ n_1 + n_2 - 2$ is the percentage point of the t-distribution such that the cumulative distribution function $P_r(t \le t_{\alpha\,;\,n_1+n_2-2})$ equals $1\text{-}\alpha/2$.

When two samples have different variances we have *heterogeneity in variance*, instead. In this case, to estimate the standard error of the mean difference is better treating the variability of the samples in a separated way. A modified form of t-statistic, known as the Welch test (1949), may be used:

$$t = \frac{\overline{X}_1 - \overline{X}_2}{SE_{(\overline{X}_1 - \overline{X}_2)}} = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{S_1^2}{n_1}+\frac{S_2^2}{n_2}}} \xrightarrow{d} t_g \qquad (8)$$

Where it has been substituted the pooled standard deviation with the samples standards deviations. Under the null hypothesis *(Equation 1)* this statistic can be well approximated by a Student t-distribution with g degrees of freedom, where:

$$g = \left[\frac{c}{n_1 - 1} + \frac{(1-c)^2}{n_2 - 1}\right]^{-1}$$

With:

$$c = \frac{S_1^2 / n_1}{S_1^2 / n_1 + S_2^2 / n_2} \in \Re$$

a scalar (it belongs to real space of dimension one).

When pairing is effective, we said that the two sample test is reduced to only one sample test on the paired differences $d_i = X_{1i} - X_{2i}$. In this situation, test on variances have not any sense to exist, because only a measure of variability is present; the standard deviation of paired differences.

To test the null hypothesis *(Equation 2)* we can use the so called *paired t-statistic*:

$$t_{paired} = \frac{\overline{X}_{1i} - \overline{X}_{2i}}{SE_{(\overline{X}_{1i} - \overline{X}_{2i})}} = \frac{\overline{d}}{SE_{\overline{d}}} = \frac{\overline{d}}{S_{\overline{d}} / \sqrt{n}} \xrightarrow{d} t_{n-1} \qquad (8)$$

With:

$$\overline{d} = n^{-1}\sum_{i=1}^{n} d_i \qquad ; \qquad S_{\overline{d}} = \sqrt{\frac{\sum_{i=1}^{n}(d_i - \overline{d})^2}{n-1}}$$

Where d_i is the i-th pair difference, $\overline{d}$ is the mean of the paired differences, $S_{\overline{d}}$ is the standard deviation of the paired differences and n is the number of pairs. Under the null hypothesis *(Equation 2)*, the paired t-statistic follows a t-distribution with only $n\text{-}1$ degrees of freedom.

A *100(1-α)%* confidence interval for μ can be constructed by:

$$\bar{d} = t_{\alpha;n-1} S/\sqrt{n}$$

Where $\bar{d} = t_{\alpha;n-1} S/\sqrt{n}$ is the percentage point of the *t*-distribution such that the cumulative distribution function $P_r(t \leq t_{\alpha;n-1})$ equals $1-\alpha/2$. Since:

$$n - 1 < n_1 + n_2 - 2$$

the number of degrees of freedom is reduced respect to the two samples case.

3.3 The Wilcoxon tests

The *t*-tests are based on the main assumption that samples are independent random variables drawn from a larger normal population. We might prefer a non-parametric test if we doubt about the normal assumption of the differences. These tests were proposed by Wilcoxon(1945) for paired and unpaired independent samples. Conversely to the *t*-test case, here we shall comparing ordered statistics and not samples values.

When the samples are unpaired, the non-parametric alternative to the two sample *t*-test, is the so called, Wilcoxon rank sum test. Rank-based approaches proceed by transforming the raw data-set into ordered statistics or ranks, one for the smallest value up to the sample size for the largest. To see how the rank sum approach works, consider

$$\text{Raw data} = \begin{pmatrix} 10 & M \\ 20 & M \\ 15 & M \\ 12 & M \\ 9 & F \\ 11 & F \\ 8 & F \end{pmatrix} \quad ; \quad \text{Ranks} = \begin{pmatrix} 3 & M \\ 7 & M \\ 6 & M \\ 5 & M \\ 2 & F \\ 4 & F \\ 1 & F \end{pmatrix}$$

Where the male sample size is greater than the female sample size. The males have ranks of 3, 7, 6, 5 while the females have ranks of 1, 2, 4. On the sum of these ranks the test statistic is built. It implies that, the proper values of the samples do not enter in the analysis. We are discounting unusually original values (the largest and the smallest values) keeping its path.

Given two samples with sizes n_1 and n_2, with $n_1 > n_2$, the *Wilcoxon rank sum test statistic* is computed as:

$$\begin{aligned} WRS_2 &= n_1 n_2 + \frac{n_2(n_2+1)}{2} - \sum_{i=1}^{n_2} R_i \\ &= n_1 n_2 + \frac{n_2(n_2+1)}{2} - G_{n_2} \end{aligned} \qquad (10)$$

Where R_i is the rank of the *i*-th point observation and G_{n_2} is the sum of all ranks for the smaller sample. The meaning of the test statistic is the following:

$$WRS_2 = \overbrace{n_1 n_2 + \frac{n_2(n_2+1)}{2}}^{\text{the maximum value of } G_{n_2}} - \underbrace{G_{n_2}}_{\text{the sum of ranks for the smaller sample}}$$

It measures the distance between the sum of all ranks for the smaller sample and its maximum. Since the distribution of ranks under the null hypothesis *(Equation 3)* has been tabulated we can extract exact p-values also when the samples are relatively small. When the sample sizes increase, a standard normal approximation is possible:

$$\frac{WRS - \mu_{WRS}}{\sigma_{WRS}} \xrightarrow{a} N(0;1) \qquad \text{as} \qquad n_1 \cup n_2 \rightarrow \infty$$

Where:

$$\mu_{WRS} = \frac{n_1 n_2}{2} \qquad ; \qquad \sigma_{WRS} = \sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}$$

It works for very small values of the sample sizes. If n_1 and n_2 are both equal to or greater than five this approximation works well. This approximation is better when n_1 and n_2 are both equal to or greater than ten. It becomes very powerful when n_1 and n_2 are both equal to or greater than twenty-five.

When the samples are paired, the non-parametric alternative to the paired *t*-test, is the so called, *Wilcoxon sign rank test* known also as Wilcoxon matched pairs test. The step ahead of rank-based sign approaches respect to the rank-based sum approaches is to take care about the sign of the rank differences *(Table 2)*. To test the null hypothesis *(Equation 4)* we can use the *Wilcoxon signed rank statistic*:

$$WSR^+ = \sum_{i=1}^{n} 1\{d_i > 0\}R_i \qquad (11)$$

Where *n* is the number of pairs and *1{ ·}* is the *indicator function*:

$$1\{\cdot\} = \begin{cases} 1 & ; \quad \text{if} \quad d_i > 0 \\ 0 & ; \quad \text{if} \quad d_i < 0 \end{cases}$$

which permits only the summation of all positive ranks of the differences. When the number of pairs *n* increases, a standard normal approximation works. For $n < 20$, exact probabilities can be calculated, for $n > 20$ the standard normal approximation is used. Due to the fact that the Wilcoxon tests are non-parametric tests, no confidence intervals are allowed.

The advantages of non-parametric tests versus parametric tests are a contentious issue. If the assumptions of the parametric test are fulfilled, then it will be somewhat more efficient, on the order of 5% in large samples, although the difference can be larger in small samples. Anyway, samples independence must be reached. The main disadvantage of the Wilcoxon tests are the problems of *ties*. When several observations share the same value, the average of the tied ranks is used. For example, observations five and six in *(Table 2)* share the same value of the differences and their rank assigned is a average value. This is not a problem for the large sample normal approximations, but the exact small sample distributions becomes much more difficult to calculate.

Table 2 - The rank sign approach: the signed rank differences

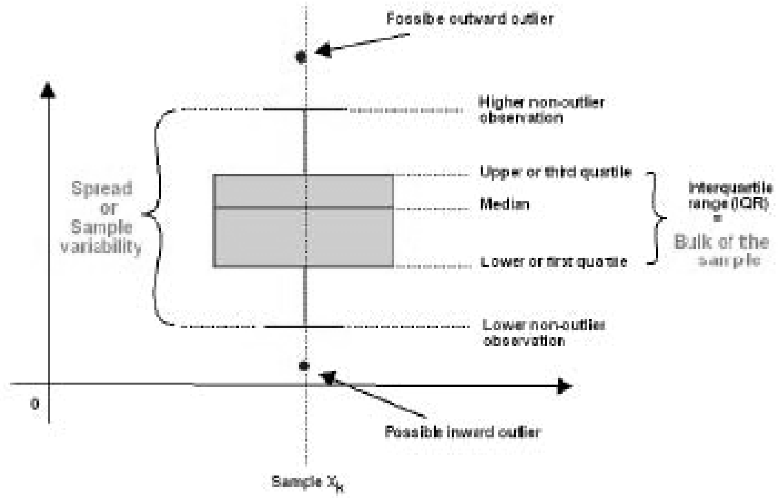
i-th obs.	X_{1i}	X_{2i}	$d_i = X_{1i} - X_{2i}$	$\lvert d_i \rvert = \lvert X_{1i} - X_{2i} \rvert$	rank of $\lvert d_i \rvert$	signed rank d_i
1	78	78	0	0	-	-
2	24	24	0	0	-	-
3	64	62	2	2	1	+1
4	45	48	-3	3	2	-2
5	64	68	-4	4	3.5	-3.5
6	52	56	-4	4	3.5	-3.5
7	30	25	5	5	5	+5
8	50	44	6	6	6	+6
9	64	56	8	8	7	+7
10	50	40	10	10	8.5	+8.5
11	78	68	10	10	8.5	+8.5
12	22	36	-14	14	10	-10
13	84	68	16	16	11	+11
14	40	20	20	20	12	+12
14	40	20	20	20	12	+12
14	40	20	20	20	12	+12
15	90	58	32	32	13	+13
16	72	32	40	40	14	+14
						$WSR^+ - 67$ $n = 14$

3.4 The statistical analysis

Working on differences, as a preliminary work we have checked both the existence of *outliers* and the satisfaction of all assumptions for applying correctly a *t*-test. To check outliers, scatter plots matrix and a box plots are provided. The scatter plot matrix is the multivariate innovation of a scatter plot. A scatter plot visualizes a relation between two covariates, where point observations are represented as pairs in a two dimensional space. The scatter plot matrix arranges scatter plots in a matrix format. The box plot *(Figure 2*) is a graph capable of displaying five characteristics of a given

sample (labelled by X_k , where k denotes the k-th sample) in the same picture: the largest non-outlier observation, the upper or third quartile, the median, the lower or first quartile and the smallest non-outlier observation. Outliers are points observations which appear to be inconsistent with the remainder of the data. These point observations having a negative impact on the statistical inference accuracy, must be deleted before the applied analysis. The box plot is a useful tool to inspect these points. Are considered outliers points observations which belong above the largest non-outlier observation or below the smallest non-outlier observation. These abnormal points are labelled by a point.

Figure 2 - The box plot: the meaning



Apart possible outliers, this graph is able to explain other sample characteristics. The distance between the upper and the lower non-outlier observation gives information on both the *spread* or *variability* of the sample and its *tail length*. The distance between the third and the first quartiles[61], the so called *interquartile range*:

$$IQR = Q_3 - Q_1$$

provides information on the *location* of the sample bulk. The median, shown by an horizontal line, is a number, which provides information on both the location of 50% of the data and the sample *skewness*.

As we were expecting, the scatter plot matrix *(Figure 3)* shows that differences are concentrated around the zero, but some pairs are too far from the bulks of the samples. These points may be outliers or measurements errors. This evidence is confirmed by the box plot *(Figure 4)* where the bulks are crushed by some influential values represented by the isolated points. Dropping these inconsistent values, the size of the samples is reduced and both the scatter plot matrix *(Figure 5)* and the box plot *(Figure 6)* enhance their exploratory power. As we were expecting, the sample differences produces similar graphs, but some departures can be inspected. The scatter plot matrix *(Figure 5)* shows that the point concentration is more diluted when Magellan400 is involved.

Table 3 - Sample differences: summary statistics

Sample Differences	Observations	Mean	Standard dev.	Minimum	Maximum
c_g60diff	88	17.6208	227.6341	-529	577
c_g72diff	126	102.1954	293.5093	-742	884
c_m400diff	126	144.014	277.6434	-436	1156.34

[61] Quartiles divides the sorted samples into quarters. For example, the first quartile, Q_1, is a number, it is greater than 25% of the sample cases, and lower than the remaining 75%.

Figure 3 - Outliers check of the differences: the scatter plot matrix

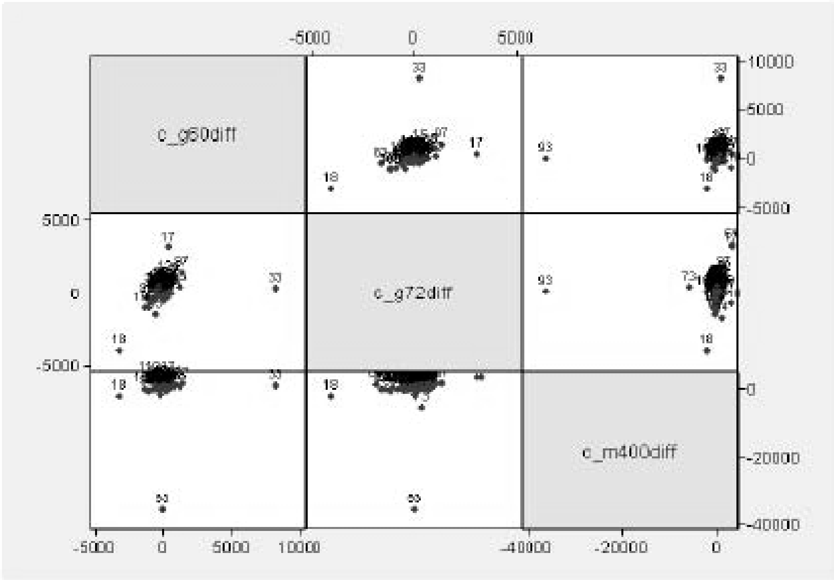
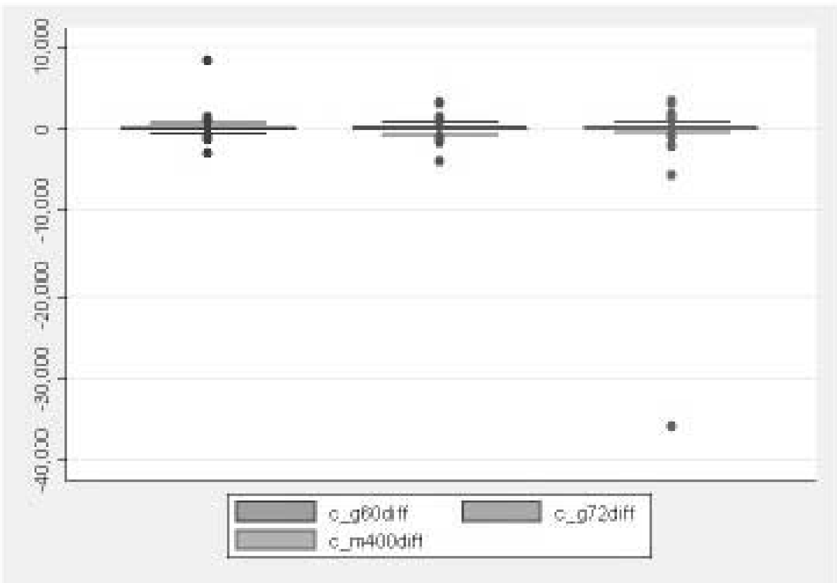


Figure 4 - Outliers check of the differences: the box plot



The box plot *(Figure 6)* shows that sample differences do not seem to differ much in their: spread, location, *skewness* and tails length. It is confirmed by inspecting their summary statistics *(Table 3)*. Anyway, the better results are reached for the surface difference between the traditional method and Garmin60 method. Its median near to zero is located in the middle of the sample bulk. Then, since the distance between the upper non-outlier and the lower non-outlier observation is the smallest, the variability should be the shortest. For all samples, remains the problem of possible outliers in the differences. We would have to drop other point observations, but we risky to losing significant sample variability. The permanence of outliers suggests the use of nonparametric tests.

Figure 5 - Outliers check of the differences: the scatter plot matrix of filtered samples

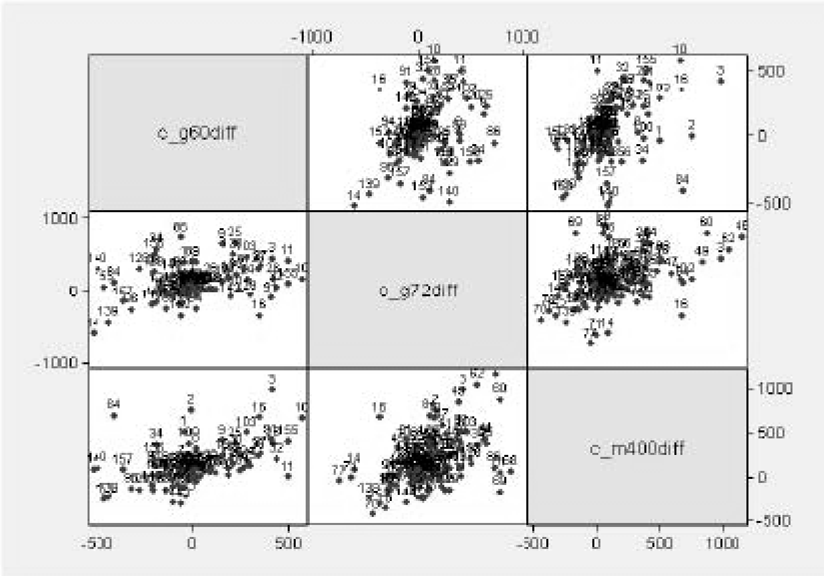
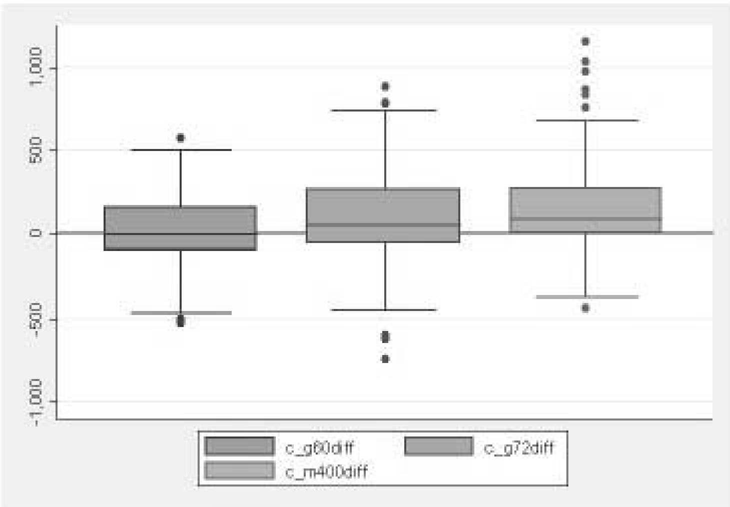


Figure 6 - Outliers check of the covariates: the box plot of filtered differences



Dropped the outliers we have verified for differences if the assumptions for applying correctly a *t*-test are satisfied.

First, we have tested if normality works well. To check normality, histogram plots of the frequency distribution *(Figure 7)* and normal quantile probability plots on defined residuals *(Figure 8)* have been used. If the normality assumption is satisfied, the frequency distributions should be distributed like a normal and the quantiles of the residuals should be linearly related to the quantiles of the normal distribution. These figures suggest that both Garmin60 and Garmin72 difference may be considered near normally distributed, but for

Magellan400 difference the normality is further. This departure from normality, although tempered from the CLT, suggests the use of nonparametric tests.

Second, samples must be independent. Here independence is guaranteed, because is reasonable to assume that measurements cannot influence each other. It means that, for example the measurement using compass cannot influence the measurement using Garmin72. It implies that the variance of the mean difference between two methods equals the sum of two sample variances.

Third, samples variances should not differ significantly. But since the samples must be considered as paired, tests on variances have not any sense to exist, only a measure of variability is present. Otherwise, when the samples are unpaired, each of them has a measure of variability and tests on variances based on *F* test are strictly necessary to decide between a *t*-test based on the pooled standard deviation or a modified *t*-test based on the Welch approximation *(Equation 7)*.

Figure 7 - Normality check of the differences: histogram plots of frequency distribution

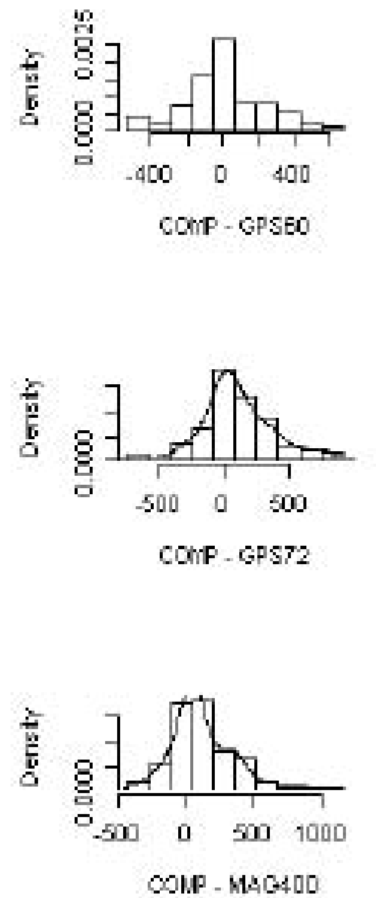
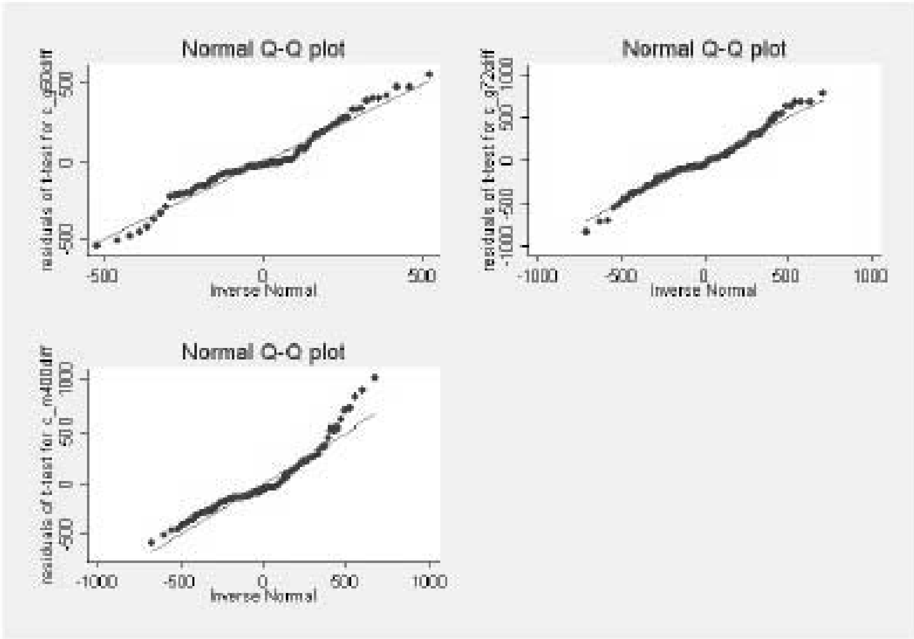


Figure 8 - Normality check of the differences: normal quartile probability plots



The statistical inference must be performed according to these difference features summarized in *(Table 4)*. Usually tests, as *t*-tests, can work well only when all of these assumptions (at the right of *Table 4*) are satisfied. The permanence of outliers and the departure from normality, suggests the use of non-parametric methods. We shall provide conclusions for both parametric and non-parametric methods. All tests are conducted at 5% significance level.

At parametric level differences are assumed normaly distributed, although some departure from normality appears. To assess the statistical equivalency for unconditional means, the paired t-test *(Equation 8)* on samples differences is applied *(Table 5)*.

Table 4 - T-test assumptions and features found

t-test assumptions	Features found
1) Normality (measurements must be normal or near normal distributed)	1a) c_g60diff can be considered near normal. 1b) c_g72diff can be considered near normal. 1c) c_m400diff cannot be considered normal.
2) Independence (measurements cannot be influence each other)	2a) It is satisfied, because measurements cannot influence each other.
3) Random Sampling (measurements must be random variables) (random selection avoids conscious or unconscious bias)	We may assume that the selection was: 3a) Random → *t*-tests work well 3b) Not random → *t*-tests do not work well → use permutation tests
4) Variance Homogeneity (measurements must have the same variance)	We must assume that samples are paired: — tests on variances have not any sense — the standard deviation of paired differences $S_{\bar{d}}$ is assumed as the only measure of variability
5) No Outliers (all possible outliers must be deleted before the applied analysis)	5a) Some evidence of cutliers remains.

In Panel A, traditional method and Garmin60 method are compared. Since the p-value is greater than the significance level (0.4697 > 0.05), we cannot reject the null hypothesis *(Equation 2)* that the true difference in means is equal to zero, then we can conclude stating that parcel estimates using Garmin60 ***are not statistically different*** from parcel estimates using traditional method.

In Panel B, traditional method and Garmin72 method are faced toward. Since the p value is now smaller than the significance level (0.0001514 < 0.05), we can reject the null hypothesis and we can conclude stating that parcel estimates using Garmin72 are statistically different from parcel estimates using traditional method.

In Panel C, traditional method and Magellan400 method are compared. As was happening for Garmin72, the p-value is smaller than the significance level (4.601e-08 < 0.05), we can reject the null hypothesis and we can conclude stating that parcel estimates using Magellan400 are statistically different from parcel estimates using traditional method.

The p-value of the test communicates the different being, but nothing about the level and the sign of the parcel estimates departure. Then, to move from statistical equivalency towards the relatively size of the parcels, we need to take care of the sign of mean of the differences.

When the measurement methods are statistically different (it means, the p-value is not significative), this value and its sign is exploratory. Otherwise, for equivalent measurements this value and its sign loses its explicative power, because the parameters estimates are in their confidence intervals. In other words, when statistical equivalency works nothing can be stated on the relatively size of the parcels, they must be considered identical.

Table 5 - Paired t-test on sample differences: the parametric result

Paired t-test

Panel: A

data: S.1 and S.21.1

$t_{paired} = 1.738$; $df = 87$; p-value = **0.4697**

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

-30.61026 65.85185

mean of the differences :

17.62080

Panel: B

data: S.1 and S.22.1

$t_{paired} = 3.9084$; $df = 125$; p-value = **0.0001514**

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

50.44549 153.94531

mean of the differences :

102.1954

Panel: C

data: S.1 and S.24.1

$t_{paired} = 5.8224$; $df = 125$; p-value = **4.601e-08**

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

95.06151 192.96658

mean of the differences:

144.0140

As we can see *(Table 5)*, for all cases, the mean of the differences is positive. It implies that traditional method produces, on average, larger estimates respect to the GPSs methods. These estimates are: larger respect to the Garmin72 (the mean of the differences is +102.1954) and broadly larger respect to the Magellan400 (the mean of the differences is +144.014).

Due to both the permanence of outliers and the departure from normality appears, the use of non-parametric methods are suggested. Sample means are substituted by sample medians and the Wilcoxon sign rank test *(Equation 11)* on samples differences is applied *(Table 6)*. In Panel AW, traditional method and Garmin60 are face toward. Since the p-value is greater than the significance level (0.7977 > 0.05), we cannot reject the null hypothesis *(Equation 4)* that the true difference in medians is equal to zero, then we can conclude stating that parcel estimates using Garmin60 are not statistically different from parcel estimates using traditional method.

In Panel BW and CW since the p-value is smaller than the significance level, we can reject the null hypothesis concluding that both Garmin72 and Magellan400 parcel estimates should be considered statistically different from parcel estimates using the traditional method. Let's inspect now, the relatively sizes of the parcels using the value and the sign of pseudo-medians of the differences. In Panel BW and CW, the pseudo-median of the differences is positive. Then, parcel estimates using traditional method are *slightly larger* respect to the Garmin72 (the pseudo-median of the differences is +91), and *larger* respect to the Magellan400 (the pseudo-median of the differences is +109.565). The pseudo-median departure pointed out in Panel AW, has not exploratory power.

Table 6 - Wilcoxon sign rank test: the non-parametric result

Wilcoxon Sign Rank test

Panel: AW

data: S.1 and S.21.1

W^+ = 1886.5; p-value = **0.796**

alternative hypothesis: true location shift is not equal to 0

pseudo-median of the differences:

5.99996

Panel: BW

data: S.1 and S.22.1

W^+ = 5428; p-value = **0.0001076**

alternative hypothesis: true location shift is not equal to 0

pseudo-median of the differences:

91

Panel: CW

data: S.1 and S.24.1

W^+ = 6276; p-value = **3.018e-08**

alternative hypothesis: true location shift is not equal to 0

pseudo-median of the differences:

109.565

The non-parametric approach based on the Wilcoxon sign rank test, supports broadly the parametric conclusions *(Table 7)*.

Table 7 - The paired t-test and the Wilcoxon sing rank test *(random sampling is assumed)*

Paired *t*-test: the results
1) Statistical equivalency:
* traditional method is *statistically equivalent* to the Garmin60 method.
* traditional method is *statistically different* to the Garmin72 method.
* traditional method is *statistically different* to the Magellan400 method.
2) Parcel estimates:
* using traditional method are *larger* than parcel estimates using Garmin72 method.
* using traditional method are *brandly larger* than parcel estimates using Magellan400 method.

Wilcoxon Sign Rank test: the results
1) Statistical equivalency:
* traditional method is *statistically equivalent* to the Garmin60 method.
* traditional method is *statistically different* to the Garmin72 method.
* traditional method is *statistically different* to the Magellan400 method.
2) Parcel estimates:
* using traditional method are *slightly larger* than parcel estimates using Garmin72 method.
* using traditional method are *larger* than parcel estimates using Magellan400 method.

On the statistical equivalency hand, traditional method is found, statistically equivalent to the Garmin60 method. Instead Garmin72 and Magellan400 are discovered, statistically different from traditional method. On the parcel estimates hand, the traditional method tends to produce larger parcels estimates respect to all GPSs measurements methods.

4. Conditional inference

In this section, the data will be reanalysed using conditional test procedures, indeed, statistical tests where the distribution of the test statistic under the null hypothesis is determined *conditionally* on the data at hand.

When the samples are not generated by a random mechanism, covariates are not longer random variables and parametric statistical tables (such as *t* or *F* tables) are not valid because their are based on *theoretical distributions* which assume random sampling. Fisher(1935) was the first to understand that, classical parametric tests comparing observed statistics to theoretical distributions were inappropriate. The sample space variability is intentionally reduced and *empirical distributions* of the test statistics, indeed, distributions of the test statistics calculated directly from the statistical units surveyed, should be used instead. The resampling is the tool to depart from theoretical distributions to empirical distributions.

These concepts together with the resampling issue are briefly explained in (*Subsection 4.1)*. After that, the paired permutation *t*-test is theoretically described in *(Subsection 4.2)* and applied in *(Subsection 4.3)*. Final conclusions are gather in *(Section 5)* and further developments are suggested in *(Section 6)*.

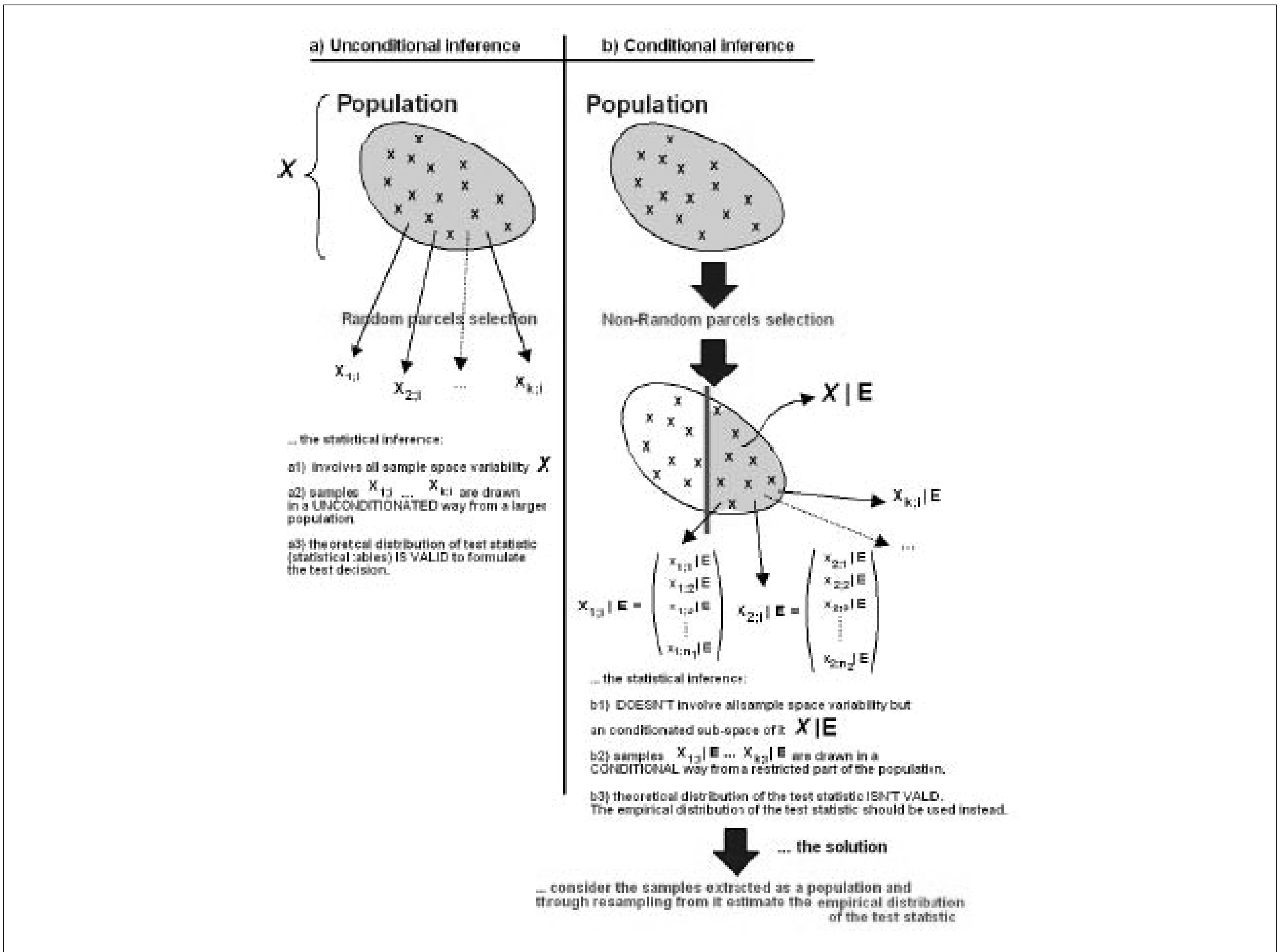
4.1 How can we make conditional inference

Up to now, the keeping of random sampling assumption has had a great influence. Samples were random variables and the test statistic was itself a random variable with a defined theoretical distribution associated with it. For example, under the null hypothesis, the t_{paired} test statistic was as a random variable distributed as a Student-*t* distribution with *n-1* degree of freedom. The observed value of the test statistic was found from the samples and its critical value from the statistical tables. Finally, comparing the observed and the critical value of the test statistic we have formulated our test decision.

When random sampling assumption is not satisfied this procedure fails and resampling methods are necessary for statistical inference. About that, Edginton (1987) has written:
... in the absence of random sampling the statistical inferences are restricted to the subjects actually used in the experiment, and generalization to other subjects must be justified by a nonstatistical argument. Two issues are raised. First, intentional selection implies a conditional restriction of the sample space variability. Second, population statistical remarks cannot be directly inferred from the statistical units surveyed without any artificial transformation applied of the samples extracted.

Let's see now, the resampling role for these two issues *(Figure 9)*. Supposing that there is a target population whose individuals are elements of a sample space denoted by $\mathcal{X}$ and assuming that we are interested in studying the variable of interest *X*. It is supposed observable on each element of $\mathcal{X}$ and that associated with $(\mathrm{X},\mathcal{X})$ there exists a possibly unknown population distribution indicated with P_r. The notation $\Theta = (\mathrm{X},\mathcal{X},\ P_r)$ summarizes the statistical model associated with the unconditional problem. When intentional selection appears: first, the reference space is obtained by considering the restriction of $\mathcal{X}$ to the sub-space associated with the conditioning event of interest[62], which is pointed out by $\mathcal{X}|\mathrm{E}$.

Figure 9 - Unconditional and conditional inference



[62] The event of interest **E** represents any conscius or unconscius selection bias introduced in the experiment. For example, for GPS cultivation parcel selection, **E** could be local government's bonds, FAO's staff instructions or natural environment impediments.

The statistical model becomes: $\Theta|\mathrm{E} = (\mathrm{X},\mathcal{X}|\mathrm{E},\ P_r|\mathrm{E})$, where $P_r|\mathrm{E}$ is the unknown conditional probability distribution of the population. Second, because we are observing realizations of $\mathcal{X}|\mathrm{E}$ with probability law $P_r|\mathrm{E}$ and not realization of $\mathcal{X}$ with probability law P_r. Moreover, we are also interested in *generalizing* our inference to the entire target population and, due lack of assumptions, we are not allowed to use unconditional methods based on all $\mathcal{X}$. It means that, test statistical tables are not useful and empirical distributions of the test statistic must be used instead. Resampling is the tool used for generalizing to other statistical units the conditional statistic remarks.

There are at least three major types of resampling. Each of them, was developed by different people at different periods for different purposes:

Randomization tests: Was developed by Fisher (1935-1960). They are also known as *permutation tests* because the inference foresees the shufflement of the samples elements as a cards deck. In his later years, Fisher lost interest in the permutation method because there were no computers in his days to implement such time consuming and laborious calculus. The aim is to make inference estimating the empirical distribution of the test statistic, called the *permutation distribution*.

Jackknife: Was invented by Quenouille (1949) and later developed by Tukey (1958). The aim is to estimate the distribution of a population by *deleting* one observation at time. This distribution can be used, for estimating the bias and the standard error of a given estimator.

Bootstrap: Was introduced by Efron (1979, 1981, 1982) and further developed by Efron & Tibshirani (1993). The aim is to estimate the distribution of a population by resampling *with replacement* for estimating the standard error and the bias of a given estimator.

Because we are interested in inference and not in estimators' reliability, we shall have to dealing with permutation tests. More specifically, we shall consider the permutation test procedure associated to the paired *t*-test, which is called the *permutation paired t-test*.

4.2 Permutation tests

In non-random hypothesis testing, permutation tests are often applied as a nonparametric test based on resampling, but unlike to the ordinary bootstrap sample replicates are repetitively drawn *without replacement* from the samples observed.

Permutation tests exist for any type of test statistic. Under the null hypothesis *(Equation 3)* or *(Equation 4)*, estimating the permutation distribution of the test statistic, we can compute exact p-values as a proportion of test statistic replicates that are, in absolute value, at least large as the observed test statistic calculated for the original samples.

The main assumption of these tests is that the sample observations are *exchangeable* under the null hypothesis, that is, the joint distribution of the samples remains unchanged under rearrangements of their elements positions when the null hypothesis is true. This implies two consequence: first, observations viewed individually must be identically distributed, second, to compare the location of sample distributions equal variance assumption is required (Good (2000)).

The test statistic chosen, may take into account to one and or two sample as well as to paired and to un-paired data. We shall consider the permutation distribution associated to the paired *t*-statistic.

When pairing is not effective, to test the null hypothesis *(Equation 3)*, we may use the resampling counterpart to the unpaired *t*-test, known as *unpaired permutation t-test*. Suppose that, two independent samples $X_{1;n_1} = (x_{1;1};\ldots;x_{1;n_1})'$ and $X_{2;n_2} = (x_{2;1};\ldots;x_{2;n_2})'$ with $n_1 \neq n_2$ are observed from the unknown distributions F_{X_1} and F_{X_2}. To carry out the permutation test, first of all, we need to work out the unpaired *t*-test statistic for all sample replicates. To do that, we need to create a set capable of interchanging the values attached to each statistical unit. Cause independence, we can consider the ordered pooled sample:

$$Z = X_{1;n_1} \cup X_{2;n_2} = (x_{1;1};\ldots;x_{1;n_1};x_{2;1};\ldots;x_{2;n_2})'$$

indexed by:

$$\upsilon = \{1;2;\ldots;n_1;n_1+1;\ldots;n_1+n_2\} = \{1;2;\ldots;N\}$$

It implies that:

$$Z_i = \begin{cases} X_{1;i} & ; \text{ if } \quad 1 \le i \le n_1 \\ X_{2;i-n_1} & ; \text{ if } \quad n_1+1 \le i \le n_1+n_2 \end{cases} \qquad (12)$$

indeed, Z sample gathers sample elements in a defined order. Now, any partition of Z, let's say, $Z^* = \{X_1^*; X_2^*\}$ corresponds to a permutation γ of the integers υ, where $Z_i^* = Z_{\gamma(i)}$.

In this unbalanced situation, we can generate:

$$P_{N;n_1;n_2} = \binom{n_1+n_2}{n_1} = \frac{(n_1+n_2)!}{n_1!n_2!} = \frac{N!}{n_1!n_2!}$$

permutations. According to the Permutation Lemma, Efron (1993 pag.84), is reasonable assuming that all permutations are equally likely. It implies that, under the null hypothesis *(Equation 3)* a partition of Z has probability:

$$P_r(Z^* = z^* \mid H_0) = \left[\frac{N!}{n_1!n_2!}\right]^{-1}$$

of having been drawn. Where z^* is a particular realization of the Z^* partition. If $\hat{\theta}$ is our test statistic calculated for the original samples, it can be viewed as a function of them, indeed, $\hat{\theta}(X_{1;n_1}; X_{2;n_2})$. Using the index vector υ we can rewrite it as a function of the ordered sample and the index vector, that is, $\hat{\theta}(X_{1;n_1}; X_{2;n_2}) = \hat{\theta}(Z;\upsilon)$. It follows that, the *permutation distribution* of our test statistic is the distribution of the test statistic replicates:

$$\{\hat{\theta}^*\} = \left\{\hat{\theta}(Z;\gamma_j(\upsilon)) \quad ; \quad j = 1,2,\ldots,\frac{N!}{n_1!n_2!}\right\}$$
$$= \quad \{\hat{\theta}^{(j)} \mid \gamma_j(\upsilon)\} \qquad (13)$$

Where $\hat{\theta}^{(j)}$ is the j-th replicates of the test statistic and $\{\hat{\theta}^*\}$ a set of test statistic values which can be displayed using a histogram plot.

Thus, the cumulative distribution function of the permutation distribution is an equally weighed function which cumulates the values of the j-th test statistic replicates:

$$F_{\hat{\theta}^*}(t) = P_r(\hat{\theta}^* \le t \mid H_0) = \left[\frac{N!}{n_1!n_2!}\right]^{-1} \sum_{j=1}^{N} 1\{\hat{\theta}^{(j)} \le t\} \tag{14}$$

Besides, the achieved significance level or p-value of our test statistic $\hat{\theta}$ is the probability that the observed statistic is not greater than the test statistic replicates:

$$P_r(t) = P_r(\hat{\theta}^* \ge \hat{\theta} \mid H_0) = \left[\frac{N!}{n_1!n_2!}\right]^{-1} \sum_{j=1}^{N} 1\{\hat{\theta}^{(j)} \ge \hat{\theta}\} \tag{15}$$

where, the observed test statistic $\hat{\theta}$ is a function of Z and υ , indeed, $\hat{\theta} = \hat{\theta}(Z; \upsilon)$. The achieved significance level for the lower tail or for the two tails test based on the observed statistic $\hat{\theta}$, can be calculated in similar way. Only when $P(\hat{\theta}^* \ge \hat{\theta} \mid H_0) \le \alpha$, we shall boosted to reject the null hypothesis, stating that, parcel estimates are conditionally statistical different.

When pairing is effective, the permutation procedure does not change too much. The main effect is the reduction of the total number of the permutations. In fact, being the test statistic calculated for the number of pairs n, we have only n paired differences to interchange and not longer $n_1 + n_2 = N$. Because each paired differences can be interchanged two times, taking the positive or the negative sign of it, we can generate 2^n permutations. Then, a paired two sample experiment with n pairs has only 2^n possible permutations:

$$\overbrace{P_{n;2} = 2^n}^{\text{total number of paired permutations}} < \overbrace{\frac{N!}{n_1!\, n_2!}}^{\text{total number of unpaired permutations}} = P_{N;n_1,n_2} \tag{16}$$

it implies that the inverse of the total number of permutations, indeed, the probability of each permutation is greater for the paired case:

$$P_r(Z_p^* = z_p^* \mid H_0) = 2^{-n} > \left[\frac{N!}{n_1!n_2!}\right]^{-1} = P_r(Z^* = z^* \mid H_0) \tag{17}$$

These changes affect partially the permutation procedure. The pooled sample is worked out as:

$$Z = X_{1;n} \cup X_{2;n} = (x_{1;1};\ldots;x_{1;n};x_{2;1};\ldots;x_{2;n})'$$

indexed by:

$$\upsilon = \{1;2;\ldots;n;n+1;\ldots;2n\}$$

and structured as:

$$Z_i = \begin{cases} X_{1;i} & ;\ \text{if} \quad 1 \le i \le n \\ X_{2;i-n} & ;\ \text{if} \quad n+1 \le i \le 2n \end{cases} \tag{18}$$

In this situation, only 2^n partitions may be formulated from the pooled ordered sample Z, then, if $\hat{\theta}_p(Z; \upsilon)$ is our paired test statistic, the *paired permutation distribution* of $\hat{\theta}_p^*$ is the distribution of the paired replicates:

$$\{\hat{\theta}_p^*\} = \left\{\hat{\theta}(Z; \gamma_j(\upsilon)) \quad ; \quad j = 1,2,3,\ldots,2^n\right\}$$
$$= \quad \{\hat{\theta}_p^{(j)} \mid \gamma_j(\upsilon)\} \qquad (19)$$

Then, the cumulative distribution function of the paired permutation distribution:

$$F_{\hat{\theta}_p^*}(t) = P_r(\hat{\theta}_p^* \leq t \mid H_0) = 2^{-n}\sum_{j=1}^{2n} 1\{\hat{\theta}_p^{(j)} \leq t\} \qquad (20)$$

As was happening before, the achieved significance level or p-value of our paired test statistic $\hat{\theta}_p$ is the probability that the observed statistic is not greater than the test statistic replicates:

$$P_r(t) = P_r(\hat{\theta}_p^* \geq \hat{\theta}_p \mid H_0) = 2^{-n}\sum_{j=1}^{N} 1\{\hat{\theta}_p^{(j)} \geq \hat{\theta}_p\}$$

The achieved significance level for the lower tail or for the two tails test based on the observed statistic $\hat{\theta}_p$, can be found in similar way. Only when $P_r(\hat{\theta}_p^* \geq \hat{\theta}_p \mid H_0) \leq \alpha$, we will reject the null hypothesis, stating that, parcel estimates are conditionally statistical different.

In practice, unless that the sample size is very small, is not feasible work out the test statistic for all possible unpaired or paired permutations. An approximate permutation test can be effectively implemented by randomly drawing a large number of samples without replacement but not all possible permutations. At least 99 and at most 999 random permutations should be sufficient (Davison & Hinkley (1997)). We shall consider 999 randomly replications. Finally notice that, cause resampling, both the permutation distributions and the empirical p-value associated are random variables, since their values change each time that the simulation is implemented.

4.3 The conditional inference analysis: the permutation distribution of paired t-statistic

This section contains the practical implementation of the paired permutation test described previously. Because, replications of the paired *t*-statistic will be used, we shall compare unconditional and conditional inference for means.

The logical sequence that explains the paired permutation *t*-test is summarized by *(Figure 10)*, while its result is displayed in *(Figure 11)*.

As we can see *(Figure 10)*, the test goes through four main steps. First, the ordered sample *Z* capable of gathering sample elements in a specific order must be created. This set of values could be a pooled ordered matrix whether the samples were picked up in a more than two dimensions.

Second, we need to work out the test statistic for the original samples. We have already done that in *(Table 5)*. These values (indicated by t_{paired}) will be used as p-values' cutoff points.

Third, is necessary estimating the test statistic for the sample replicates. When *h* pairs are interchanged,

$$\binom{n}{h}$$

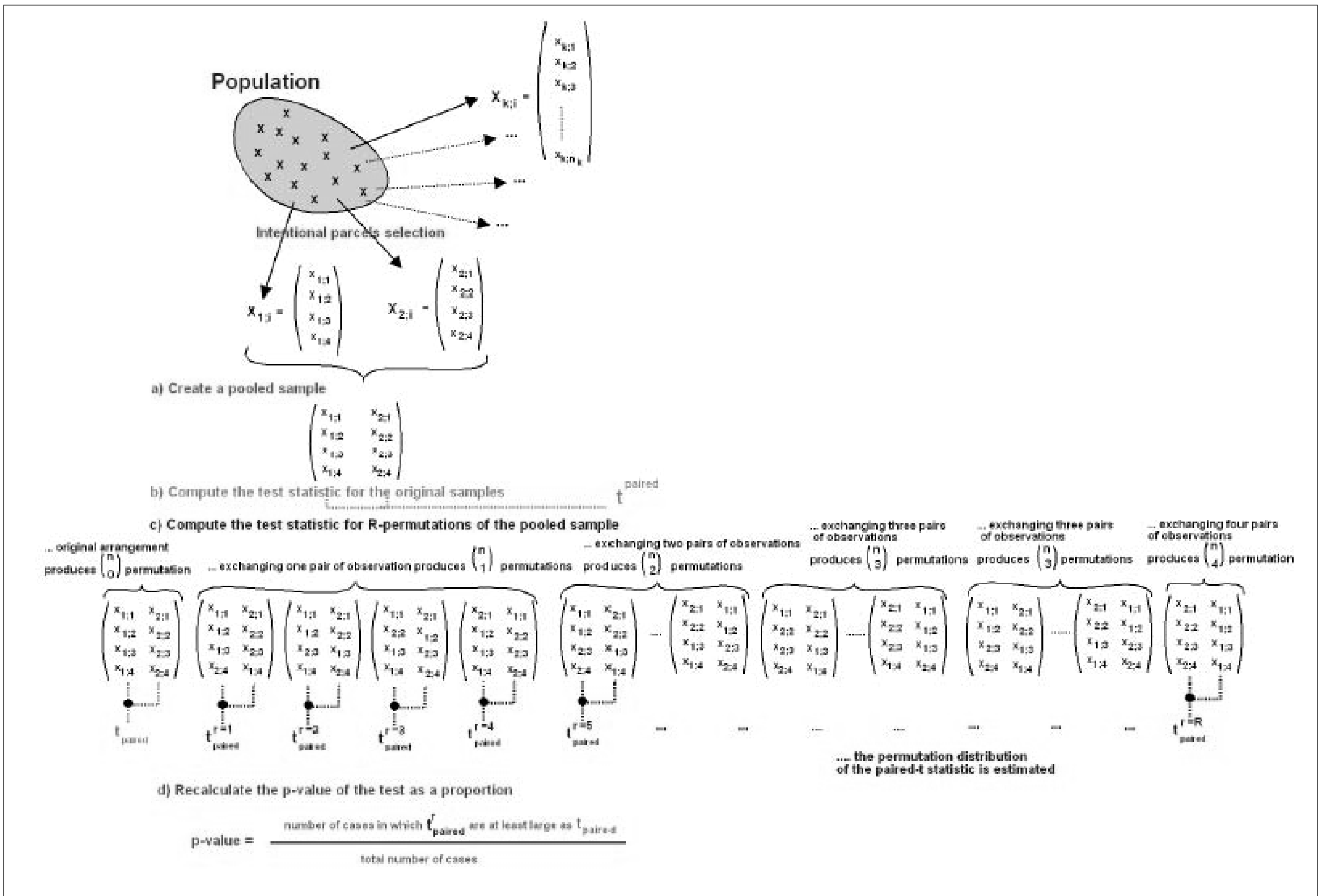
permutations are generated. Obviously, if any pair or all pairs are interchanged only one permutation is created, otherwise more than one permutation is produced. Summing up all of these combination terms, we can obtain the total number of paired permutations:

$$\sum_{h=0}^{n} \binom{n}{h} = \binom{n}{0} + \binom{n}{1} + \ldots + \binom{n}{n-1} + \binom{n}{n} = 2^n \qquad (22)$$

where n is the number of pairs. The paired t-statistic is worked out only a large number of these total permutations. The paired t-test may have a different value for each permutation. The distribution of these test statistic replicates is the permutation distribution of the paired t-test, it represents the empirical counterpart of the paired Student-t distribution.

Fourth, the p-value of the test is recalculated as a proportion of the cases in which the paired t-statistic replicates are, in absolute value, at least large as the observed paired t-statistic.

Figure 10 - The logical sequence of the paired permutation t-test



This sequence of steps produces the permutation distributions displayed in *(Figure 11)*, from these, the empirical p-values are gathered in *(Table 8)*.

These histogram estimates *(Figure 11)* are the empirical distribution functions of paired t-test statistic worked out *conditionally* to the data at hand. Under the null hypothesis *(Equation 4)*, the empirical p-value of the test will be given by the area of the histogram estimate outside the absolute value interval of the observed statistic (this area is emphasised in gold brown).

In Panel AR, the empirical p-value is worked out for the differences between traditional method and Garmin60 method. Since it is greater than the significance level (0.472 > 0.05) we cannot reject the null hypothesis *(Equation 4)* and then we can conclude stating that the parcel estimate using Garmin60 are not conditionally statistical different from parcel estimates using traditional method.

In Panel BR and CR, the same procedure is applied for the differences between Garmin72 method and Magellan400 method. Here, the empirical p-value is smaller than the significance level (0.001 < 0.05), then we can reject the null hypothesis, stating that parcel estimate using Garmin72 or Magellan400 are conditionally statistical different from parcel estimates using traditional method.

The unconditional and conditional inference on means tend to move in the same direction *(Table 9)*.

The empirical p-values bear us to the same final conclusion of theoretical ones: only the Garmin60 cultivation parcel surfaces *are statistically equivalent* to the cultivation parcel surfaces measured using the traditional method. For the largeness of the cultivation parcels nothing can be state using the conditional approach, then the unconditional results remain valid.

Figure 11 - The approximated permutation distributions of paired t-test

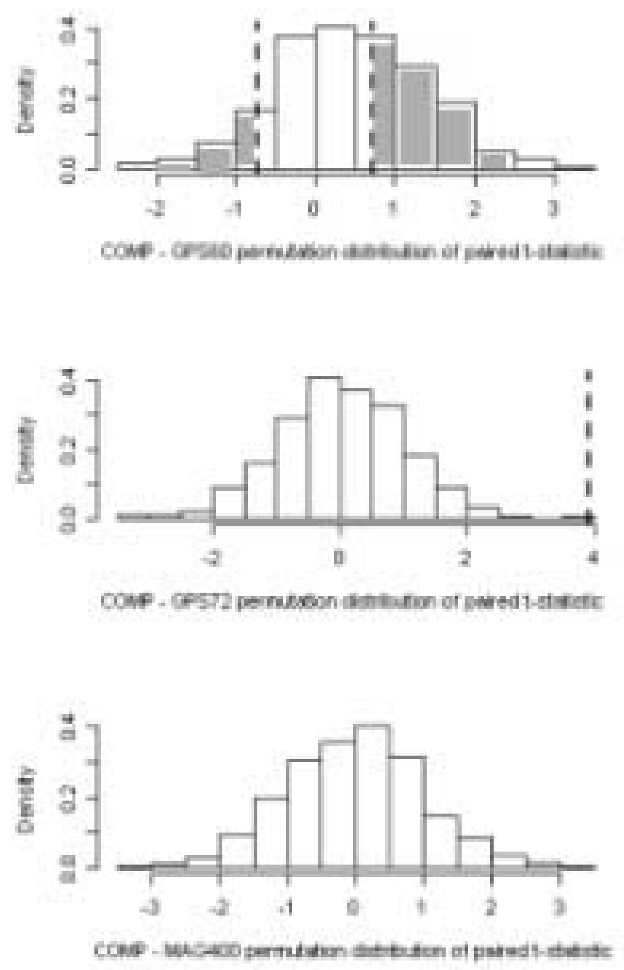


Table 8 - Permutation paired t-test: the conditional inference result

Permutation paired t-test
Panel: AR
data: S.1 and S.21.1
Observed test statistic: $\hat{\theta} = 0.7262$; Empirical p-value $=$ **0.472**
alternative hypothesis; $H_A: \ F \neq 0$
Panel: BR
data: S.1 and S.22.1
Observed test statistic: $\hat{\theta} = 3.9084$; Empirical p-value $=$ **0.001**
alternative hypothesis; $H_A: \ F \neq 0$
Panel: CR
data: S.1 and S.24.1
Observed test statistic $\hat{\theta} = 5.8224$; Empirical p-value $=$ **0.001**
alternative hypothesis; $H_A: \ F \neq 0$

Paired t-test	Permutation paired t-test
Panel: A	
data: S.1 and S.21.1	
$t_{paired} = 0.7262$; $df = 87$; p-value $= 0.4697$	$\hat{\theta} = 0.7262$; Empirical p-value $=$ **0.472**
$H_A: \ \mu \neq 0$	$H_A: \ F \neq 0$
95 percent confidence interval:	
-30.61026 65.85185	
mean of the differences:	
17.62080	
Panel: B	
data: S.1 and S.22.1	
$t_{paired} = 3.9084$; $df = 125$; p-value $= 0.0001514$	$\hat{\theta} = 3.9084$; Empirical p-value: **0.001**
$H_A: \ \mu \neq 0$	$H_A: \ F \neq 0$
95 percent confidence interval:	
50.44549 153.94531	
mean of the differences :	
102.1954	
Panel: C	
data: S.1 and S.24.1	
$t_{paired} = 5.8224$; $df = 125$; p-value $= 4.601e{-}08$	$\hat{\theta} = 5.8224$; Empirical p-value: **0.001**
$H_A: \ \mu \neq 0$	$H_A: \ F \neq 0$
95 percent confidence interval:	
95.06151 192.96658	
mean of the differences:	
144.0140	

5. Conclusions

The unconditional and conditional statistical inference done on the available survey dataset for Cameroon, Niger and Senegal, allows drawing some concluding remarks:

- Statistical inference is *strictly necessary* to assess the relevance of GPSs measurements. It cannot have nothing to do with the sampling. Unconditional or simple statistical inference can be formulated only when parcel selection is supposed random. Both parametric and non-parametric approaches are possible. Instead, when parcel selection is assumed non-random, resampling methods for parameter estimation and inference should be preferred;
- The measurement of cultivation parcels using GPS may be *significant* to reduce the costs of agricultural surveys. The significancy works when methods measurements are found statistically equivalent. It implies that, the more expensive traditional method may be substituted by the cheaper equivalent GPS method;
- On the statistically equivalence hand, using both unconditional and conditional inference procedures, traditional method is found *statistically equivalent* to the Garmin60 method. Garmin72 and Magellan400 methods are discovered statistically different instead. The lose of accuracy when we accept the null hypothesis using the unconditional approach is on the order of 2/1000;
- On the parcel estimates hand, only the unconditional approach can be used. Both the parametric and non-parametric approaches applied suggest us that the traditional method tends to produce larger parcel estimates than GPSs methods.

In conclusion, because GPSs methods are globally cheaper than traditional method, is strongly recommended the use of Garmin60 to reduce the costs of agricultural surveys.

6. Future research

As basic hint for the upcoming papers, we suggest to take care about the random mechanism which has generated the samples. When the selection mechanism does not guarantee randomness, we recommend taking apart the classical statistical tests and move on to the permutation tests. Instead, if the selection mechanism guarantees randomness both classical tests and permutation tests may be applied.

Taking in mind that, the arguments presented in this paper can be developed in two broad directions: changing the statistical aim or changing the permutation procedure. On the one hand, changing the statistical aim keeping the permutation procedure unchanged represents the immediate extension of this work. We might be interested in:

- Study the **statistical equivalency** taking into account of **smaller and bigger parcels separately**. It may allow us, first, to verify how the size of the parcels affect the statistical equivalency, second, to find out the *surface threshold* apart which the equivalency is not satisfied;
- Study the **statistical equivalency** for the **time requested** to do the measurements. It may permit us, first, to verify how the time affect the statistical equivalency, second, to discover the *time threshold* apart which the equivalency is not satisfied.

On the other hand, we may change just the permutation procedure. Then to study the statistical relevance of different measurements we may consider:

- Permutation tests which take care of *any differences* of the two samples, not only in means. The permutation distribution of the **Kolmogorov-Smirnov test statistic** represents the optimal tool to measure this global departure;
- **Multivariate permutation tests** where more than two samples are jointly faced toward. These tests represent an open field for the research. The main type of multivariate permutation test is based on *nearest neighbors*. The nearest neighbour is an algorithm used in data mining, statistical pattern recognition, image processing to classify variables based on minimum distance from the query instance.

References

Agresti A. (2002): *Categorical Data Analysis*, John Wiley & Sons, 2nd edition.

Davison A. C. & Hinkley D.V. (1993): *Bootstrap Methods and their Application*, Cambridge University Press, Oxford, 1997.

Edgington E. S. (1987): *Randomization Tests*, Ney York, Macel Dekker.

Efron B. (1979): Bootstrap methods: Another look at the jackknife, *The Annals of Statistics*, 7, 1-26.

Efron B. (1981): Nonparametric estimates of standard error: The jackknife, the bootstrap and other methods, *Biometrika*, 63, 589-599.

Efron B. (1982): The jackknife, the bootstrap, and other resampling plans, *Society of Industrial and Applied Mathematics* CBMS-NSF Monographs, 38.

Efron B.& Tibshirani R.J. (1993): *An introduction to the bootstrap*, New York: Chapman \& Hall.

Fisher R. A. (1936): *The Design of Experiments*, Oliver and Boyd, Edinburgh.

Good P. (2000): *Permutation Tests: A Practical Guide to Resampling Methods for Testing Hypotheses*, New York, Springer-Verlag.

Green W. H. (2008): *Econometric Analysis*, Prentice Hall, 6th edition.

Gosset W. S. (1908): The probable error of the mean, *Biometrica*, 6, 1-25.

Kennedy P.E. (1995): Randomization tests in Econometrics, *Journal of Business and Business*, 7, 1-14.

Palmegiani, G., Pizzoli E.: (2007b): Rural Development Statistics (RDS) for Policy Monitoring: a Rural-Urban Territorial Classification and Farmers' Income Data, AFCAS, Alger. www.fao.org/statistics/meetings/afcas2007

Peracchi, F. (2000): *Econometrics*, Wiley.

Pesarin, F. (2001): *Multivariate Permutation Tests: with Applications to Biostatistics*, Wiley.

Quenouille M. (1949): Approximate tests of correlation in time series, *Journal of the Royal Statistical Society Series B*, 11, 18-84.

Tukey J.W. (1958): Bias and confidence in not quite large samples, *Annals of Mathematical Statistics*, 11, 18-84.

UNECE, FAO, OECD and World Bank (2005) *Rural Household's Livelihood and Well Being:Statistics on Rural Development and Agriculture Household Income*, Handbook, United Nations, www.fao.org/statistics/rural.

Wooldridge J. M. (2001): *Econometric Analysis of Cross Section and Panel Data*, MIT press.

Wilcoxon F. (1945): Individual comparisons by ranking methods, *Biometrics*, 1, 80-83.

SESSION 3

Plenary Session

Some Issues in Rural Development and Household Income Statistics for Countries at Different Levels of Development

Chairman: *Graham Eele, World Bank*

Report on Plenary Session 3: Some Issues in Rural Development and Household Income Statistics for Countries at Different Levels of Development

Chairman: Graham Eele, World Bank

Overview: *The main objective of this plenary session was to discuss issues related to the collection and interpretation of statistics on rural development and household income in countries at different levels of development. The level of development of a country has an impact on how these statistics can be collected and their analysis and use in three main ways. First, the size of the rural sector both in terms of the number of people involved and the contribution of agriculture and agricultural related activities to the national economy is crucial. Second, the level of technology employed and the extent to which production activities are determined by the location in which they take place and the environment they operate in. Third, the level of development has an important impact on how much countries have been able to invest in their statistical systems and hence in their capacity to collect, compile and use statistics on rural development and agricultural household income.*

Session 3 of the June Rome meeting of the Wye Group illustrated a number of different aspects of these three issues and demonstrated the kinds of challenge that an update of the Handbook, focusing on the needs of low income countries, will face. There were four papers, one describing the problem of measuring and understanding rural poverty in a developing country – India; one illustrating the use of administrative records and registers to analyze longitudinal changes in agricultural households in Canada, and two focusing on multi-country studies. The papers and the discussion they generated, however, helped to make clearer the ways in which the Handbook is already relevant to all countries and where it may need to be extended and developed further.

Estimation of Rural Poverty: a Discussion with Reference to India, *Dr. S. Chatterjee, NIRD, India*

This paper reviews national data on rural poverty in India with reference to the 2004/05 national sample survey. India has a long history of carrying out household surveys and the National Sample Survey Organization is one of the premier survey agencies worldwide. This history provides a long time series of poverty data for the different states and territories and the paper provides a summary of how rural poverty has changed over the past 30 years. While there has been substantial progress nationally, across states the picture is mixed, with some states making substantial progress, but others lagging behind. The paper describes a number of different poverty reduction programs and also provides a number of case studies to illustrate how these have had an impact. It also argues that a better understanding of rural poverty and its many characteristics requires both qualitative as well as quantitative data.

Accounting for the Diversity of Rural Income Sources in Developing Countries: The Experience of the RIGA Project, *Katia Covarrubias, Ana Paula de la O Campos and Alberto Zezza, FAO*

This paper addresses the issues and lessons learned by FAO's Rural Income Generating Activities Project (RIGA) in both the construction of income aggregates for cross-country comparison, and the results derived from this exercise. Major issues regarding the estimation of income covered the categorization of suitable approaches for dealing with costs, and the importance of reporting taxes and deductions in surveys collecting income data. In terms of survey questionnaire design, issues such as the appropriate use of reference periods, the need for equivalence scales, and the consistency in units and coding were discussed. Finally, lessons learned derived from RIGA's cross-country analysis highlighted the diversification of rural income and identified various definitions of the agricultural household, to which the results of income analyses may be sensitive.

Farm Families, Rural and Urban Non-Farm Families and the Incidence of Low Income in Canada,
David Culver, Cally Dhaliwal and Fay Abizadeh, Agriculture and Agrifood Canada

Canada has a rich source of family income data for farm, rural and urban families. Tax records provide both annual and longitudinal family income data for Canadian families. The taxation data is used to illustrate the complexities involved in comparing family income levels and measuring the incidence of low income. When the sample is restricted to only couple families, urban families had the highest median income. However, when all families and individual were analyzed the median income of farm families was significantly higher than non farm families. The frequency of low income can also change depending on the type of low income measure used. Longitudinal farm family income data provides significant benefits over annual data by tracking the same family for more than one year. Longitudinal data is particularly important when examining the income of those families operating large and very large farms.

Gathering Information on Total Household Income within an "Industry Oriented" Survey on Agriculture: Methodological Issues and Future Perspectives,
Benedetto Rocchi, University of Florence

This paper argues for the inclusion of questions on total household income within agricultural surveys that use the holding or the farm as the unit of enumeration. The paper also illustrates how the links between farming activities and the overall income strategy of the household may be represented in a Social Accounting Matrix (SAM) framework. This kind of model provides a means of classifying *production activities* according to technical criteria and *institutions* according to socio-economic criteria. The identification of the group of *agricultural households* then results from combining an *industry* with a *sector* classification. The paper then argues that the proper level to survey (and to represent in models) this structural linkage is the *production unit*, which in agriculture is the holding or the farm.

Discussion and conclusions

There was a wide ranging discussion on the papers. It was agreed that many of the issues that were raised should be addressed in future editions or versions of the Handbook, but that the basic conceptual framework is sound and applies to more or less all countries regardless of their level of development. The main concepts of income as determined by the Canberra Group seems to be both relevant and applicable in a wide range of different environments, what is required is a wider range of case studies and examples that illustrate how the concepts can be used and applied in different countries. There would also seem to be a need for more discussion of statistical methods and procedures, especially those that can be used effectively in less than ideal conditions.

There was also agreement that the papers could provide the basis for extending and developing the Handbook. Areas that could be covered include:

- The importance and use of longitudinal data for studying income and poverty dynamics
- Linking information from both quantitative and qualitative studies
- The need to develop an inventory of key concepts used in different countries, with examples where possible
- The question of whether to measure income or consumption as welfare indicators and the associated problems of dealing with concerns such as remittances, capital flows and changes in stocks.
- The role of frameworks such as the Social Accounting matrix as an integrating device for bringing together data from different sources and for identifying data inconsistencies and gaps
- How to deal with own consumption of production within the farm household and associated problems of valuation.

Estimation of Rural Poverty: a Discussion with Reference to India

Dr. Shankar Chatterjee
Assistant Professor, National Institute of Rural Development (NIRD), Rajendranagar, Hyderabad – 500 030, India.
shankarjagu@gmail.com & shankar_nird@yahoo.com

Keywords: Below Poverty Line (BPL), Poverty, Participatory Identification, Poorest of the poor, Poor, Rural.

1. Background about Poverty

Study of poverty is an important issue in the field of rural development. No development can be thought of if any household/person in any country lives Below the Poverty Line (BPL). As is known to all, calorie concept is the measuring rod of poverty. First Director General of FAO was the first person to propound the starvation line in 1945 which referred to the consumption of less than 2300 calories per person per day. This idea has been transformed in to poverty line. Planning Commission of India has defined poverty line on the basis of recommended nutritional requirements of 2400 calories per person per day for rural areas and 2100 calories per person per day for urban areas. Based on this, income criterion has been adopted in India to determine poverty line. The latest income criterion to determine poverty line in India is based on 2004-05 data where it is stated that all India level minimum income for rural and urban areas for a person per month should be Rs. 356.30 and Rs.538.60 respectively. Apart from all India average, state wise income has been worked out for rural and urban areas (Table 1).

Table 1 - State-Specific Poverty Lines in 2004-2005 *(Rs. per capita per month)*

Sl. No.	STATE/UNION TERRITORIES	Rural	Urban
1	Andhra Pradesh	292.95	542.89
2	Assam	387.64	378.84
3	Bihar	354.36	435.00
4	Chhattisgarh	322.41	560.00
5	Delhi	410.38	612.91
6	Goa	362.25	665.90
7	Gujarat	353.93	541.16
8	Haryana	414.76	504.49
9	Himachal Pradesh	394.28	504.49
10	Jammu & Kashmir	391.26	553.77
11	Jharkhand	366.56	451.24
12	Karnataka	324.17	599.66
13	Kerala	430.12	559.39
14	Madhya Pradesh	327.78	570.15
15	Maharashtra	362.25	665.90
16	Orissa	325.79	528.49
17	Punjab	410.38	466.16
18	Rajasthan	374.57	559.63
19	Tamil Nadu	351.86	547.42
20	Uttar Pradesh	365.84	483.26
21	Uttarakhand	478.02	637.67
22	West Bengal	382.82	449.32
23	Dadra & N. Haveli	362.25	665.90
	All-India	356.30	538.60

Source: Planning Commission, India

The research paper has been prepared for presentation in Wye City Group on "Statistics on Rural Development and Agriculture Household Income" for the Second Meeting to be held in Rome, Italy 11-12 June 2009

In a huge country like India, where food habit of rural persons differ from state to state, so state wise income has been worked out as well as poverty ratio in percentage and absolute number. Thus micro (state wise) and macro (all India) level incomes are available for determining BPL household in India. Latest poverty study was carried out in 2004-05. However, in July, 1962 the Government of India set up a study group to assess what should be the minimum consumer expenditure. The study group recommended that Rs. 20 should be per capita monthly consumer expenditure at 1960-61 prices was the bare minimum. However, Dandekar and Rath based on their study in 1960-61 of segregating rural (Rs. 180 per annum per capita) and urban (Rs. 270 per annum per capita) areas came to conclusion that about 40 percent of rural population and about 50 percent of urban population lived below the desired minimum level (Dandekar and Rath 1971).

Before 2004-05, poverty study was carried out in India mainly based on expenditure on food items, but UNDP in their 1990 Report specifically mentioned that lack of income for measuring “absolute poverty” is not sufficient reason, as minimum income does not lead to basic survival needs and for standard of living (UNDP, 1990). For the first time, Uniform Recall Period (URP) and Mixed Recall Period (MRP) (hence URP and MRP will be used) concepts have been used in 2004-05 to determine BPL population in India. The URP and MRP are based on consumer expenditure data both for food and non food items. This is the latest study on poverty in India, published by the Government of India. In case of URP, consumer expenditure data for all the items were collected from 30-day recall period. On the other hand, Mixed Recall Period (MRP data) study throws light on food and non-food items.

Table 2 - Number and percentage of population Below Poverty Line in different states of India - 2004-2005 *(Based on URP-Consumption) - (Number in Million)*

Sl. No.	STATES/ UNION TERRITORIES	Rural		Urban		India	
		Persons (%)	No. of Persons	Persons (%)	No. of Persons	Persons (%)	No. of Persons
1	Andhra Pradesh	11.2	6.47	28.0	6.14	15.8	12.61
2	Arunachal Pradesh	22.3	0.19	3.3	0.009	17.6	0.20
3	Assam	22.3	5.45	3.3	0.12	19.7	5.57
4	Bihar	42.1	33.67	34.6	3.24	41.4	36.91
5	Chhattisgarh	40.8	7.15	41.2	1.94	40.9	9.09
6	Delhi	6.9	0.06	15.2	2.23	14.7	2.29
7	Goa	5.4	0.036	21.3	0.16	13.8	0.20
8	Gujarat	19.1	6.34	13.0	2.71	16.8	9.06
9	Haryana	13.6	2.14	15.1	1.06	14.0	3.21
10	Himachal Pradesh	10.7	0.61	3.4	0.02	10.0	0.63
11	Jammu & Kashmir	4.6	0.36	7.9	0.21	5.4	0.58
12	Jharkhand	46.3	10.31	20.2	1.32	40.3	11.63
13	Karnataka	20.8	7.50	32.6	6.38	25.0	13.88
14	Kerala	13.2	3.24	20.2	1.71	15.0	4.96
15	Madhya Pradesh	36.9	17.56	42.1	7.40	38.3	24.96
16	Maharashtra	29.6	17.11	32.2	14.62	30.7	31.73
17	Manipur	22.3	0.37	3.3	0.02	17.3	0.39
18	Meghalaya	22.3	0.43	3.3	0.016	18.5	0.45
19	Mizoram	22.3	0.10	3.3	0.016	12.6	0.12
20	Nagaland	22.3	0.38	3.3	0.012	19.0	0.40
21	Orissa	46.8	15.17	44.3	2.67	46.4	17.85
22	Punjab	9.1	1.51	7.1	0.65	8.4	2.16
23	Rajasthan	18.7	8.73	32.9	4.75	22.1	13.48
24	Sikkim	22.3	.11	3.3	0.002	20.1	.11
25	Tamil Nadu	22.8	7.65	22.2	6.91	22.5	14.56
26	Tripura	22.3	.61	3.3	0.020	18.9	0.64
27	Uttar Pradesh	33.4	47.30	30.6	11.70	32.8	59.00
28	Uttarakhand	40.8	2.71	36.5	0.88	39.6	3.59
29	West Bengal	28.6	17.32	14.8	0.35	24.7	20.84
30	A & N Islands	22.9	0.06	22.2	0.032	22.6	0.09
31	Chandigarh	7.1	0.008	7.1	0.067	7.1	0.07
32	Dadra & N. Haveli	39.8	0.068	19.1	0.015	33.2	0.08
33	Daman & Diu	5.4	0.007	21.2	0.014	10.5	0.02
34	Lakshadweep	13.3	0.006	20.2	0.006	16.0	0.01
35	Pondicherry	22.9	0.078	22.2	0.159	22.4	0.02
	All-India	28.3	220.93	25.7	80.79	27.5	301.72

URP consumption = Uniform Recall Period consumption in which the consumer expenditure data for all the items are collected from 30-day recall period.
Source: Planning Commission, Government of India.

Table 3 - Number and percentage of population Below Poverty Line in different states of India in 2004-2005 *(Based on MRP-Consumption)* - *(Number in Million)*

Sl. No.	STATES/UNION TERRITORIES	Rural		Urban		India	
		Persons (%)	No. of Persons	Persons (%)	No. of Persons	Persons (%)	No. of Persons
1	Andhra Pradesh	7.5	4.32	20.7	4.55	11.1	8.87
2	Arunachal Pradesh	17.0	0.14	2.4	0.007	13.4	0.15
3	Assam	17.0	4.14	2.4	0.09	15.0	4.24
4	Bihar	32.9	26.29	28.9	2.71	32.5	29.00
5	Chhattisgarh	31.2	5.47	34.7	1.64	32.0	7.11
6	Delhi	0.1	.001	10.8	1.58	10.2	1.58
7	Goa	1.9	0.01	20.9	0.16	12.0	.17
8	Gujarat	13.9	4.62	10.1	2.11	12.5	6.74
9	Haryana	9.2	1.45	11.3	0.79	9.9	2.25
10	Himachal Pradesh	7.2	0.41	2.6	0.01	6.7	0.42
11	Jammu & Kashmir	2.7	0.22	8.5	0.23	4.2	0.45
12	Jharkhand	40.2	8.97	16.3	1.06	34.8	10.03
13	Karnataka	12.0	4.33	27.2	5.32	17.4	9.66
14	Kerala	9.6	2.36	16.4	1.39	11.4	3.75
15	Madhya Pradesh	29.8	14.20	39.3	6.90	32.4	21.09
16	Maharashtra	22.2	12.84	29.0	13.14	25.2	25.98
17	Manipur	17.0	0.28	2.4	0.01	13.2	0.30
18	Meghalaya	17.0	0.33	2.4	0.01	14.1	0.34
19	Mizoram	17.0	0.07	2.4	0.01	9.5	0.09
20	Nagaland	17.0	0.29	2.4	0.009	14.5	0.30
21	Orissa	39.8	12.93	40.3	2.43	39.9	15.36
22	Punjab	5.9	0.97	3.8	0.35	5.2	1.33
23	Rajasthan	14.3	6.67	28.1	4.05	17.5	10.71
24	Sikkim	17.0	0.08	2.4	0.002	15.2	0.08
25	Tamil Nadu	16.9	5.65	18.8	5.86	17.8	11.51
26	Tripura	17.0	0.47	2.4	0.001	14.4	0.48
27	Uttar Pradesh	25.3	35.76	26.3	1.04	25.5	45.81
28	Uttarakhand	31.7	2.11	32.0	0.77	31.8	2.88
29	West Bengal	24.2	14.66	11.2	2.66	20.6	17.32
30	A & N Islands	16.9	0.04	18.8	0.02	17.6	0.07
31	Chandigarh	3.8	0.004	3.8	0.03	3.8	0.04
32	Dadra & N. Haveli	36.0	0.06	19.2	0.02	30.6	0.07
33	Daman & Diu	1.9	0.003	20.8	0.01	8.0	0.01
34	Lakshadweep	9.6	0.004	16.4	0.005	12.3	0.009
35	Pondicherry	16.9	0.05	18.8	0.13	18.2	0.19
	All-India	21.8	170.30	21.7	68.20	21.8	238.50

MRP consumption = Mixed Recall Period consumption in which the consumer expenditure data for five non-food items, namely, clothing, footwear, durable goods, education and institutional medical expenses are collected from 365-day recall period and the consumption data for the remaining items are collected from 30-day recall period.
Source: Planning Commission, Government of India.

For MRP, consumer expenditure data for five non-food items namely, clothing, footwear, durable goods, education and institutional medical expenses are collected from 365-day recall period and the consumption data for the remaining items are collected from 30-day recall period. The URP and MRP data are available for each of the states of India, which may be seen in Tables 2 and 3.

Both URP and MRP data reveal that large number of persons in India is below the poverty line and in the states like Bihar, Jharkhand, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal, the number is so huge that many countries in the world are not having even the total population which below poverty line population of one state of India is having.

2. Rural Poverty in India from 1973-74

To get an idea about the level of rural poverty in India as well as in various states rural poverty in percentage terms from 1973-74 onwards are presented in Table 4.

Table 4 - State-wise percentage of population Below Poverty Line in Rural India

Sl. No.	STATEs	1973-74	1977-78	1983	1987-88	1993-94
1	Andhra Pradesh	48.44	38.11	26.53	20.92	15.92
2	Arunachal Pradesh	52.67	59.82	42.60	39.35	45.01
3	Assam	52.67	59.82	42.60	39.35	45.01
4	Bihar	62.99	63.25	64.37	52.63	58.21
5	Goa	46.85	37.64	14.81	17.64	5.34
6	Gujarat	46.35	41.76	29.80	28.67	22.18
7	Haryana	34.23	27.73	20.56	16.22	28.02
8	Himachal Pradesh	27.42	33.49	17.00	16.28	30.34
9	Jammu & Kashmir	45.51	42.86	26.04	25.70	30.34
10	Karnataka	55.14	48.18	36.33	32.82	29.88
11	Kerala	59.19	51.48	39.03	29.10	25.76
12	Madhya Pradesh	65.66	62.52	48.90	41.92	40.54
13	Maharashtra	57.71	63.97	45.23	40.78	37.93
14	Manipur	52.67	59.82	42.60	39.35	45.01
15	Meghalaya	52.67	59.82	42.60	39.35	45.01
16	Mizoram	52.67	59.82	42.60	39.35	45.01
17	Nagaland	52.67	59.82	42.60	39.35	45.01
18	Orissa	67.28	72.38	67.53	57.64	49.72
19	Punjab	28.21	16.37	13.20	12.60	11.95
20	Rajasthan	44.76	35.89	33.50	33.21	26.46
21	Sikkim	52.67	59.82	42.60	39.35	45.01
22	Tamil Nadu	57.43	57.68	53.99	45.80	32.48
23	Tripura80%	52.67	59.82	42.60	39.35	45.01
24	Uttar Pradesh	56.53	47.60	46.45	41.10	42.28
25	West Bengal	73.10	68.34	63.05	48.30	40.80
26	A & N Islands	57.43	57.68	53.99	1.29	32.48
27	Chandigarh	27.96	27.32	23.79	45.80	11.35
28	Dadra & Nagar Haveli	46.85	37.64	14.81	14.67	51.95
29	Daman & Diu	-	-	-	-	5.34
30	Delhi	24.44	30.19	7.66	67.11	1.90
31	Lakshadweep	59.19	51.48	39.03	29.10	25.76
32	Pondicherry	57.43	57.68	53.99	45.80	32.46
	All India	56.44	53.07	45.65	39.09	37.27

Source: India Rural Development Report, 1999, NIRD, Hyderabad

Thus a comparative picture for last thirty years is available for the country as a whole as well as for the different states.

Government of India is sincere to eradicate poverty from the country particularly from rural areas as rural poverty of India is massive and conspicuous due to landlessness, very small/uneconomic holding, lack of employment opportunities etc. In view of this presently in rural India two employment programmes are in operation sponsored by the Government of India. One is self employment programme for rural population who are below the poverty line. The programme has been functioning under the banner of Swarnajayanti Gram Swarojgar Yojana (SGSY) and other one is wage employment programme for rural households which have been implemented under the Act passed in the Parliament in September 2005. This is known as National Rural Employment Guarantee Act (NREGA) and as a programme known as National Rural Employment Guarantee

Scheme (NREGS). For the benefit of readers few important points about basic contents of SGSY and NREGS are mentioned.

3. Swarnajayanti Gram Swarojgar Yojana (SGSY)

This is a self-employment programme meant for the rural poor so that through income generating activities the rural poor can above the poverty line. In India the programme is popularly known as SGSY (henceforth SGSY will be used). Prior to SGSY, time to time different self-employment programmes were introduced for elimination of rural poverty in the country. Before SGSY, there were six self-employment programmes viz., Integrated Rural Development Programme (IRDP), Training of Rural Youth for Self-employment (TRYSEM), Development of Women and Children in Rural Areas (DWCRA), Supply of Improved Tool-kits for Rural Artisans (SITRA), Million Wells Scheme (MWS) and Ganga Kalyan Yojana (GKY). Some salient features are presented here (SGSY guidelines, 2007).

The beneficiaries of SGSY are known as Swarojgaris. SGSY lays emphasis on the group approach under which rural poor are organized into Self-help Groups. Although there is provision for individual Swarojgaris (not encouraged), but focus is on group approach.

Social Mobilization

A major focus of SGSY is its emphasis on the social mobilization of the poor. The programme focuses on organization of the poor at grassroots level through a process of social mobilization for poverty eradication. Social mobilization enables the poor to build their own self help groups in which they fully and directly participate and take decisions on all issues that will help them to come above the poverty line.

Number in a self-help group

A self-help group may consist of 10-20 persons belonging to below poverty line families and a person should not be a member of more than one group. In case of minor irrigation scheme and for disabled persons, this number may be a minimum of five (5). According to guidelines, 50 percent of self-help groups in each block (group of villages, a development unit) should be exclusively of women.

The members of self-help groups have to save regularly and convert their savings into a Common Fund known as Group Corpus. The fund is used among the members as internal lending. The Group Corpus is supplemented with Revolving Fund by the Government and Cash Credit Limit by the banks.

Activity Clusters – Planning and Selection

The SGSY emphasizes assistance to the Swarojgaris only for those activities, which have been identified and selected as key activity in terms of their economic viability in the area. The SGSY adopts a project approach for each key activity and project reports are to be prepared in respect of each identified key activity. The banks and other financial institutions are closely associated and involved in preparing these project reports.

Target Group

Families below the poverty line constitute the target group of SGSY. Within the target group, special safeguards have been provided to vulnerable sections, by way of reserving 50 percent benefits to Scheduled Castes/Scheduled Tribes, 40 percent for women, 15 percent for minorities and 3 percent for disabled persons.

Financial Assistance

Assistance under the SGSY to individual Swarojgaris or self-help groups is given in the form of subsidy by the government and credit by the banks.

For groups of Swarojgaris, the subsidy is 50 percent of the cost of the project, subject to a ceiling of Rs. 0 .125 Million. There is no monetary limit on subsidy for irrigation projects.

Achievement under SGSY

Under SGSY about 3.2 million self-help groups have been formed since inception i.e. from April 1999 to November 2008 (*Gram Vikas*, 2009). On an average each self-help group consists of 10 members from 10 different families so this indicates that roughly 32 million families are under the banner of self-help groups for pursuing economic activities for improving their economic condition.

4. National Rural Employment Guarantee Scheme (NREGS)

This is a wage employment programme implemented in the country under National Rural Employment Guarantee Act, notified on 7th September 2005. Before NREGS, time to time different wage employment programmes were introduced in the country. Some of these are Rural Manpower Programme (RMP), Crash Scheme for Rural Employment (CSRE), Pilot Intensive Rural Employment Programme (PIREP), and Food for Work Programme (FWP), National Rural Employment Programme (NREP), Rural Landless Employment Guarantee Programme (RLEGP), Jawahar Rozgar Yojana (JRY), Jawahar Gram Samridhi Yojana (JGSY), Employment Assurance Scheme (EAS) and Sampoorna Grameen Rozgar Yojana, (SGRY). Some of the salient features of NREGS are presented below.

- Employment is to be provided to every rural household whose adult member volunteer to unskilled manual work. Such household is to be provided work for 100 days in a financial year.
- This is a demand based Programme and demand emanating from the Village through the village assembly (in India called Gram Sabha).
- Every person who has done the work to be provided minimum wages. Disbursement of wages to be done on weekly basis but not beyond a fortnight.
- Work should ordinarily be provided within 5 kilometers radius of the village or else extra wages of 10 percent are payable.
- Each employment seeker to be registered by village level local self-government, called Gram Panchayat in India, after due verification and the household to be provided a Job Card.
- Village level local self-government (Gram Panchayat) is the authority for planning, registering, issuing job cards to the beneficiaries, allocating employment and monitoring of works.
- Wages have to be paid through bank/post office accounts.
- At-least one-third of the workers should be women.
- Contractors/machineries are not permitted.
- Mainly water conservation, droughts proofing including plantation and afforestation, flood protection, land development and minor irrigation works are permitted.
- Employment will have to be provided by the village panchayat (local self governing body) within 15 days of work application or else unemployment allowance has to be paid.

Since inception (2006-07) to 2008-09 (October 2009) 3508.7 million person days of employment were created with the total expenditure of 388321million rupees of which share of wages is 264899 million rupees. NREGS has good impact in many respects in rural India although it is baby stage. If proper care is taken care then undoubtedly rural persons will be greatly benefited.

One eminent effect of NREGS is that employment opportunities and wage rates have gone up as a sequel purchasing power of the people in rural areas have increased. Minimum wages for agricultural labourers have increased after implementation of NREGS. For example, a few of the states may be cited here: Maharashtra from Rs.47 to Rs.72, Uttar Pradesh from Rs.58 to Rs.100, Bihar from Rs.68 to Rs.85, Jammu & Kashmir from Rs.45 to Rs.70, and in Chattisgarh from Rs.58 to Rs.72. At all India level, the average wages paid under NREGS has gone up from Rs.75 in 2007-2008 to Rs.85 in 2008-09.

As a result of NREGS activities, water table in dry and grid regions has increased due to large number of water conservation and drought proofing (*Gram Vikas*, 2009).

5. Impact of Poverty Eradication Programme in India

It has to be admitted that poverty eradication measures for rural poor are not implemented in the same momentum in all the states of India. Some states have been doing well and some are lagging behind as is evident from the data incorporated in tables 2, 3 and 4. The state which has been performing well in this regard is Andhra Pradesh. It is located in southern part of India with 76 million population of which 55 million (72 percent) live in rural Andhra Pradesh as per 2001 census (Handbook, 2008). The total area of the state is 275,000 square kilometers. Many countries in the world are not having this much area and population.

The state had high poverty ratio once upon a time, which drastically has come down in recent years. Although in table 4, rural poverty ratio has been mentioned in percentage term for the years 1973-74 onwards but for the benefit of readers poverty statistics for Andhra Pradesh in 1973-74 is compared here with few states of India. As is evident from the table-4, the poverty in percentage term was 48.86 and 22.57 million in absolute number in Andhra Pradesh in 1973-74. Against this backdrop, rural and urban populations below poverty line were 48.41 percent (17.62 million) and 50.61 percent (4.75 million) respectively in the state during 1973-74. As mentioned already in tables 2 and 3, few million persons are now below poverty line in Andhra Pradesh (rural 6.5 million in 2004-05 based on URP and 4.32 million based on MRP) which is very low in percentage term also. For comparison purpose Andhra Pradesh and Uttar Pradesh are discussed. In Uttar Pradesh during 1973-74, number of below poverty line rural population was 45 million and based on URP data of 2004-05 number of below poverty line rural population is 47 million and 35.8 million based on MRP study. If we consider URP data in Uttar Pradesh then number of BPL persons is more in 1973-74 than 2004-05. Uttar Pradesh has been bifurcated few years back by creating another state namely, Uttrakhand, otherwise figure would have been much higher. Like Uttar Pradesh few more states are there, where below poverty persons are substantial in number.

Over a period of 30 years i.e. from 1973-74 to 2004-05 these states (Orissa, Bihar etc.,) could not do conspicuous result in reduction of BPL persons. However with regard to Andhra Pradesh it may be said that the days are not very far when there may not be any person living below the poverty line in the state. Hopefully, persons of next generation may see poverty (poor) in the ‘museum’. The state is not only successful in bring down poverty, but also ahead in many respects. In this context rural socio-economic development indicators developed by National Institute of Rural Development (a Training and Research organization on Rural Development of Government of India) for all the states including Andhra Pradesh may be referred. For the benefit of readers’ performance of Andhra Pradesh with respect to few important indicators are discussed here. Type of house is an indicator of development. As is known to all if income of poor persons increases after spending on food, house is developed. Referring type of rural houses, the data reveal that 47 percent of rural houses (2001) are made of processed materials which are known as “Pucca House” (durable house) against all India average of 41 percent. With regard to agricultural productivity, it is observed that yield of food grains in the state (Andhra Pradesh) is much higher than all India average. During 2005-06, yield rate of food grains was 2356 kilograms per hectare against all India average of 1708 kilograms/ hectare. Thus it is evident that with high yielding rate of food grains and good housing condition the state is marching towards development. Apart from these, it is evident from other development indicators that state is much ahead. Electrification of rural households may be cited as an example. Around 60 percent of rural households (2001) in Andhra Pradesh had electricity facilities than all India average of 43.5 percent. Same is the case of rural safe drinking water supply. Even malnourished children in percentage term are below than all India average.

Endeavour of officials, non-governmental organizations, political leaders and people of the state may be attributed for bringing down poverty ratio in the state as well as leading the states to development. One of the officers of Rural Development Department, Andhra Pradesh Government who deserves credit for successfully guiding in implementation of rural development programmes is K. Raju. He belongs to Indian Administrative Service, a senior dynamic and dedicated officer. Raju is in the rural development department (about a decade) in various capacities so he is well acquainted with problems of rural persons.

For successful implementation of poverty eradication programmes identification of genuine poor is sine qua non. In other words genuine poor should be identified first and among the poor, poorest of the poor should be endowed with income generating activities after imparting training and skill development for capacity building. For this the state (Andhra Pradesh) has adopted qualitative approach for identification of poor and poorest of the poor. The rural poor/poorest of the poor are identified under the banner of "Participatory Identification of the Poor (PIP)" which is transparent and accepted by all. The process is discussed below.

6. Qualitative Approach of Participatory Identification of Poor (PIP)

Robert Chambers highlighting the importance of PRA methods write, "Questionnaire surveys used to gain insights, especially for project formulation, select and simplify reality, often mislead, and reconfirm the realities of uppers, missing local complexity and diversity. In contrast, PRA methods usually engage the commitment and analysis of local people, enable the expression and sharing of their diverse and complex realities, give insights into their values, needs and priorities and can also lead on into participatory action" (Robert Chambers, 1999). Thus it is evident that local problems can be addressed through participatory approach. Qualitative approach is an important tool for successful planning, implementation, monitoring and evaluation of any programme/project. By sidelining, qualitative approach, no programme/project meant for marginalized persons can be successful. Qualitative approach is sine qua non for poverty related study. By going through at the chapter on "Income Levels Distribution and Poverty" of "Rural Households Livelihood and Well-being" of The Wye Group Handbook, it is observed that no reference has been made about the qualitative approach for identification of poor. In view of this, it is suggested that qualitative approach should be added in the next edition.

It is believed that qualitative approach guides to identify poorest of the poor. If qualitative approach is not considered then poorest of poor/poor may not be identified properly. The reason is obvious because while conducting Below Poverty Line (BPL) survey, poor are identified based on quantitative indicators such as income and expenditure. Sometimes selection of appropriate indicators also raises controversies. According to some scholars, Nolan and Whelan (1996) select appropriate indicators of poverty. However poverty study through indicators (quantitative method) does not take into account villagers' way of life, their needs, priorities, traditional skill, type of problems faced by their families - socially, economically etc. As a result many times the real poor and poorest of the poor do not find their names in the BPL list. On the other hand the persons not so poor also find their names in the BPL list, as a sequel BPL list generates controversy. In India cases are there where BPL list has been verified again in many states. But with the qualitative approach (like Participatory Identification of Poor), above mentioned problem(s) may be neutralized to a great extent. Quantitative approach may be supported by qualitative approach and vice versa, when the question of identification of poor, selection of projects for the poor etc., arise.

Qualitative approach under 'Participatory Identification of Poor (PIP)' is being implemented in Andhra Pradesh in all the *Mandals* (Mandal is the development unit consists of 15 to 20 villages). There are 1128 *Mandals* (Handbook, 2008) and 26,613 inhabited villages (2001 census of India) in Andhra Pradesh. It is implemented under the guidance of Society for Elimination of Rural Poverty (SERP) which is under Rural Development Department, Government of Andhra Pradesh. Under 'Participatory Identification of Poor' some general indicators are decided at the district (consists of *Mandals)* and *Mandal* level. Since in rural areas agricultural land is an important issue, so the indicators regarding the definition of poorest of the poor is decided first based on land holding. Then the question comes about well being of the families which generally is not at the same level for all villages. Since, village to village "Well Being" differs as a sequel based on workshop held at District /*Mandal* level, indicators are developed. This is followed by training of the *Mandal* Resource Persons (MRPs); generally 8-12 MRPs for each *Mandal* are given training. The MRPs, after being trained begin the programme of "identifying the poor through participatory method" which is later on approved by the elected representatives of the village.

The *Mandal* Resource Persons (MRPs) take up the programmes consecutively in three days, in the villages assigned to them, when identifying the poor through the participatory method. Participatory Identification of

Poor (PIP) is conducted at the villages with the help of 2 to 3 teams. Each team consists of 4 *Mandal* Resource Persons (MRPs) to conduct the programme, which continue for three days.

Tasks for three days in the village:

First Day

Mandal Resource Persons after going to the village meet personally village leaders, village elders, women organizations, youth organizations, *Anganwadi* workers (special post created in India under Government of India's programme for the development of poor children and women), teachers and cultural groups in the village and inform them the reasons for coming to the village and gather required information. Then the team hold meeting with them and give them an idea of the visit and explain to them the importance of their participation. Also in this process, *Mandal* Resource Persons discuss about holding a community meeting with all the villagers. Once the place and time are decided accordingly meetings are held. It is ensured that villagers of all categories and castes attend meeting as fixed by MRPs in consultation with village leaders and elders and others. At the outset after informal discussion with the villagers, Transact Walk with all the villagers takes place followed by Social Mapping. It covers various social facilities of the village and other issues such as population, houses, drinking water resources, economic resources, number of cattle, and other information related to the village. More importantly, it gives scope for all the villagers to participate in the process, thereby leading to some constructive discussions.

Further, the Social Mapping helps to get an idea about the following:

- the utilization of available local resources and facilities;
- who has the control of these resources;
- the villagers belonging to which class are able to make use of the resources;
- Which class/caste is living in which areas of the village;
- Apart from the above, social mapping helps to understand which caste is exposed to which kind of oppression/suppression. Specific indicators are used to indicate the information gathered through the Social Mapping.

Activities in the Second Day

Important work which is carried out in the second day in the village is Welling Being Analysis. It is done to get an idea about the economic condition of rural households. Based on this, houses of different families are categorized and thus it is possible to know the well being as well as variations in lifestyle of the villagers who belong to the different social, economic and other categories.

Process: First Stage

As a first stage, the economic conditions of the poor in the village and the different dimensions of poverty with the villagers are discussed. During the process following issues are discussed:

i) What is poverty and conditions of poverty?

ii) What are the problems that the poor face in that village?

iii) Do these problems affect all the poor in the same way?

iv) Do all the villagers live in these circumstances? Or are there any differences? If there are differences, how many classes can the villagers are divided into?

v) Based on which components, indicators or variations can the villagers be identified under different categories?

After the discussion based on economic class in that particular village, families are identified. Number of families that roughly falls into each category is worked out.

Second Stage

Social Mapping and the Well Being Analysis are placed in front of the villagers for everyone's knowledge. Thus finally families are selected based on four categories – i) poorest of the poor, ii) poor iii) middle class and iv) rich. The prepared list is presented in the *Gram Sabha* (village assembly means all eligible voters meet) and change/modification is finalized there.

Third day

On the third day, the list is ratified in the village assembly.

To understand entire process, a flow chart is presented below.

7. Participatory Identification of the Poor in the Village: Flow Chart

First Day

- Rapport building with the villagers

↓

- Organizing an Informal Meeting

↓

- Organizing a Community Meeting

↓

- Coming to an agreement with the villagers regarding the place and time for the Social Map and then Preparing materials required for the Social Map

↓

- Transact Walk with all sections of persons

↓

- Making the villagers draw the Social Map

↓

- Gathering the information and identifying it in the Social Map

↓

- Sharing the information gathered with the villagers

↓

- Preparing the report (drawing the Social Map on a chart, documentation of the discussions, method and other details of things observed)

Second Day

- Categorization according to the well being conditions

↓

- Discussion held about the living condition of the village

↓

- Explanation of the present exercise

↓

- Discussion regarding the well being conditions of the villagers

↓

- Categorization of the poor

↓

- Category wise identification of the families on the Social Map

↓

- Documentation

Third Day

- Organize Gram Sabha and get the ratification

↓

- Incorporation of corrections and getting the ratification of the Gram Panchayat

↓

- Giving thanks to persons present in the meeting

8. Process of Identification: A case at the village level

To clarify about the identification of i) poorest of the poor, ii) poor, iii) middle class and iv) rich, a case from *Balijaguda* village, *Hayatnagar Mandal* of *Ranga Reddy* district , Andhra Pradesh is discussed. This study was carried out in January, 2003 under the guidance of Society for Elimination of Rural Poverty (SERP). Entire process was carried out by the villagers.

Poorest of the poor (Indicators) 26 families

1) Small Hut
2) 2 or 3 children, no one going to school
3) No Agricultural land
4) Daily wage earners- Work – Earn - Eat
5) No sheep or goat or cow or buffalo
6) Serious illness approach to Government Hospitals
7) No approach to Bank

Poor (Indicators) 24 families

1) Thatched house
2) ½ acre – 1 acre agricultural land
3) Little income through land, cattle/ daily wage.
4) 1 or 2 cows or buffalo or cattle
5) Can spend little amount
6) Can approach – get small loans
7) Children study in Government school

Middle Class (Indicators) 12 families

1) 1-2 acres of land
2) Livelihood through cultivation of land
3) Some run small business
4) Some own cattle
5) Children are able to attend private school
6) Capacity to renovate their houses

Rich (Indicators) 5 families

1) Minimum 10 acres of land
2) Some are contractors
3) Some are having cars
4) Some are government employees
5) Treatment in private hospitals
6) Children study in convent or city school

9. Economic improvement of Poorest of the Poor

As an example two cases, from Kalva village and four cases from Nannoor village of Orvakal Mandal, Kurnool district of Andhra Pradesh, are presented. Out of six cases, two cases in depth and four cases in brief are presented. The village is located about 250 kilometers away from state capital of Andhra Pradesh i.e. Hyderabad. These cases reveal how through proper identification of poorest of the poor and subsequently through grounding of economic activities the poor families, who were totally in the category of 'have not', have not only crossed poverty line but now owner of land and building. These cases have been studied in April 2009.

Case-1

Mohammad Bee now about 55 years old illiterate Muslim woman was a very poor up to 1994. She was married at the age of 13 years and became mother at the age of 18 years. Her father due to poverty arranged her marriage with a poor person who was eking out his livelihood as daily labourer. Those days as assets, they had a hut and a small cot and four aluminum vessels. She had two *saris (Indian women wear)* to wear. In her words, after drying of one, another one she could wear. They were very poor so they were not invited by other villagers' in the functions/festivals. Even incidentally someone invited, she was avoiding because of dirty cloth.

She joined with her husband for working as labouerer to get two square meals a day. With the passing of time, they were blessed with 3 male children. When they were grown up, she admitted her in the school not for education but for getting two pairs of dresses which were provided at free of cost. As soon as the dresses were provided, children were withdrawn from the school and asked to earn. Her elder son joined as a worker in stone polishing and cutting unit at the age of 10 years in Hyderabad, 250 kilometers away from the village, capital of Andhra Pradesh. Later on other two sons also joined. Thus all of her three sons joined as workers under a contractor, resulting five members family were surviving through their hard labour. In the year 1995, she joined in a self-help group which was a part of UNDP's Poverty Alleviation Programme. The self-help group was formed with 12 women under the banner of *Chand* self-help group. Mohammad Bee was gratefully remembering Vijaya Bharathi, the lady who took initiative to form the self-help group under UNDP's Poverty Alleviation Programme. Vijaya Bharathi was dedicatedly working morning and evening to apprise women about the importance of self-help group. As a result *Chand* self-help group was formed in the village. At the time of study (April 2009), it was reported that after the death of one member, the group has been functioning with 11 women members. With the joining of self-help group, Mohammad Bee felt happy that at least she could share her woes with others. With the savings in the group, she took a loan of Rs. 1000 at the rate of 2 percent simple rate of interest per month with which she grew tomato on neighbour's land. She was identified poorest of the poor so she could get loan within 6 months of joining in the self-help group. The landowner asked to give 50 percent of total tomato production as a condition of providing land. She accepted the same as for a poorest person this term and condition is better in many respects.

After repaying of Rs. 1000 with an interest of 2 percent to the group and 50 percent tomato to the land owner, she earned an amount of Rs. 5000 within six months. According to her first time she could see so much money in her life, and with this amount, first the family members ate full meals with their preferred items. Striking feature is that she was inspired to take further loan and developed confidence to handle more loans. After approaching to the local bank, she was extended an amount of Rs. 20,000 as loan. Out of this amount, she spent Rs. 15,000 for having a plot of agricultural land on lease for 3 years. After repaying of loan, she took another loan and thus process continued for 24 times. In other words, she took loan 24 times starting initially with an amount of Rs. 1000. Already she has repaid Rs. 0.6 million amount of loan taken time to time and has taken recently fresh loan of Rs. 0.4 million, which she has been repaying regularly. She is now having a concrete house and 11 acres of agricultural land including 6.5 acres of mango garden. Her husband looks after this as he is no longer working as a labourer. Mohammad Bee apart from attending self-help group meetings, watches television and now-a-days in the village no functions/festivals are held without her. The *Chand* self-help group where is attached is having savings up to Rs. 0.2 million.

Case-2

Ramakka was also a very poor woman (belonged to marginalize social group) in the village before joining Menaka Gandhi self-help group in 1995. She never had gone to school. Eating two square meals, a day was dream for her. By chance she and her husband could get two square meals a day, they were thinking lucky enough for that day. Out of 5 children, 4 children died due to lack of care and poverty. Later on her husband also died. Once upon a time, for whole day of arduous work she was earning Rupee 1 (according to her a very low earning in those days). She was remembering once due to severe hunger she went to a neighbour's house where owner of the house asked her to pound 5 kilograms of red-chili (which is done manually, an arduous work). Ramakka agreed to do the same but requested some food first to eat. Neighbour declined, asked her first to complete the work. Like this, she had to tackle situations many a times.

After joining the self-help group, couple of months later she was sanctioned a sum of Rs. 5000 for undertaking business, as she was identified poorest of the poor. She first time saw such huge money in her life. With the amount she started selling eggs to the villagers as most of the villagers, were non- vegetarian. Mention may be made here that, in India many villagers/even many city dwellers eat vegetarian foods. However, with the selling of eggs, she could earn daily around Rs. 25. After repaying of loan, she was given another dose of loan for sheep rearing business. This way process continued for 14 times i.e. 14 times she took loan and refunded which amounts to Rs. 0.85 million. Now she owns 5 acres of agricultural land and 1.5 acres of mango garden, which are looked after by his married son. Now her self-help group is having savings of Rs. 0.15 million, she many a times hold important position in the self-help group.

Apart from above cases, four cases from *Yarab* self-help group of Nannoor village, *Orvakal Mandal* may be mentioned here. The self-help group was started in 1999 with 13 Muslim women, all were poor and some of them were very poor. Their economic condition has been greatly improved when the author visited (April, 2009). Four cases are presented here who were very poor before joining in the group.

NAME	Before joining self-help group (1999)	After joining self-help group (April 2009)
Chi. Shajaha	Widow with a daughter; Husband died of TB; No property; Illiterate; Beedi-making (a type of local cigarette);	House constructed; beedi making; Grocery shop;
Rahamath Bee	Husband blind; No house; No property;	Grocery shop; Bangle selling; Sweet selling by Husband;
Ch. Noorjaha	Widow at 23 years age with two children; No property; Beedi making; Government sanctioned house;	Husband Building Contractor; Beedi making
Pedda Shajaha	No land; Husband was working as mason; Self- beedi making; two children;	Self-beedi making; Husband Building Contractor ;

Before starting of self-help group, economic condition of the self-help group members was so miserable that eating two square meals with balanced diet a day was a matter of luck. But after joining of self-help group, and subsequently doing income generating activities, their economic condition has been greatly improved. Earlier they were dealing with few rupees now all of them have been individually dealing with thousands rupees as loan. It was observed that loan taken time to time crosses more than hundred thousand rupees individually.

10. Conclusion

It is evident from the above that qualitative study with participatory approach gives better picture to identify poorest of the poor. If poorest of the poor are injected proper income generating activities along with their skill up gradation and capacity building then every possibility for improvement in their economic condition as they know they are not having any alternative to survive. To get an actual picture about the economic status of the villagers' participatory approach is undoubtedly a better method. Robert Chambers from his book 'Whose Reality Counts' (1999) may be quoted in this regard, "Participation, empowerment, and mutual respect enable lowers, and poor people in general to express and analyze their individual and shared realities". Further he feels that, "the values and preferences of poor local people typically contrast with those of the better off, outsiders and professionals……..

Local people are themselves diverse, with sharp contrasts of preferences and priorities by age, gender, social and ethnic group, and wealth." In this study our experience in Andhra Pradesh shows the state through participatory approach both with quantitative and qualitative methods successfully could bring down the poverty ratio in the state. In view of this, it is suggested that qualitative approach should be adopted. Such type of reference is not found in the chapter of "Income levels, Distribution and Poverty" of Rural Households' Livelihood and Well-Being (The Wye Group Handbook).

It is also suggested that "Wye City Group Meeting" in their second meeting should develop the terminology like Rural, Agriculture Income, Agricultural Labourer, Landless Labourer, etc. which should be accepted through out the world like common words in the dictionary.

References

Chambers Robert (1999). *Whose Reality Counts? Putting the First last;* Intermediate Technology Publications, London.

Dandekar V.M. and Rath Nilakantha (1971). *Poverty in India;* Gokhale Institute of Politics and Economics.

Directorate of Economics & Statistics (2008). Government of Andhra Pradesh, *Hand book of Statistics*, Hyderabad, India, 1.
Government of India, Ministry of Rural Development, (2007). *Guidelines of SGSY*, New Delhi, India, 1-23.
Government of India, Ministry of Rural Development, *Annual Report 2007-08*, New Delhi, India 3-15.
Ministry of Rural Development, Government of India, (2009). *Gram Vikas: Programmes at a Glance*, New Delhi, 3-4, 11.
National Institute of Rural Development (NIRD) (1998). *Rural Development Statistics*, Hyderabad, India.
Nolan, B. and Whelan, C. (1996). *Measuring Poverty using Income and Deprivation Indicators: Alternative Approaches,* Journal of European Social Policy, Vol. 6 No. 3 225-40.

The author extends his grateful thanks to P. Purushotham, Professor & Head (CSERE), NIRD, Hyderabad India; C.P. Nagi Reddy, State Project Manager (Monitoring and Learning), Society for Elimination of Rural Poverty (SERP), Andhra Pradesh, India and K.P. Rao, State Project Adviser (Marketing), Society for Elimination of Rural Poverty (SERP), Andhra Pradesh, India for their cooperation in carrying out the study.

Accounting for the Diversity of Rural Income Sources in Developing Countries: the Experience of the Rural Income Generating Activities Project[65]

Katia Covarrubias[66]
Agriculture and Economic Development Division
Food and Agriculture Organization
Viale Terme di Caracalla
00153 Rome, Italy
katia.covarrubias@fao.org

Ana Paula de la O Campos
FAO-ESA

Alberto Zezza
FAO-ESA

Based on joint work with:
Gero Carletto (World Bank), Benjamin Davis (UNICEF)
and Paul Winters (American University, Washington, DC) - *May, 2009*

***Abstract**: The RIGA project of the Food and Agriculture Organization created a growing database of 33 household living standards surveys from which a set of income aggregates and other measures of well-being were constructed in a methodologically consistent manner. Through this elaborate task a host of definitional and methodological issues arose that confirmed the need to reflect on the different stages leading to the construction of income aggregates for developing countries. These issues relate to topics such as the defining agricultural households, identifying rural areas, defining reference periods and frequencies, among other topics. We summarize both the RIGA methodology for income aggregate construction and the obstacles faced in their construction and offer a consolidated list of methodological recommendations for the measurement of household income levels.*

JEL Keywords: C80, C81, C83, D13, J00, J30, Q10, R20.

1. Introduction

A number of efforts have been made in recent years to systematise the work on the collection of income data at the household level. Available sources have emphasised the importance of collecting and analyzing income data mainly as a measure of "the economic well-being of individuals and households" (ILO, 2003; Canberra Group, 2001), as well as a tool for looking at the distribution of income in society. The latter focus is, for instance, strongly reflected in most of the recommendations of the Canberra Group (2001). In the Wye City Group Handbook (2007), the basic motivation for looking at income at the household level also seems mostly related to measuring (farm) household well-being as well as distributional issues, including comparing low-income to other households (p. 17) and "farm households to (...) other socio-professional groups" (p. 15), as these income differentials are seen as key in driving the exit from agriculture, a major policy concern in relatively high income countries where farming still absorbs a sizeable share of the workforce.

[65] Paper prepared for presentation at the Wye City Group Meeting on Rural Development and Agricultural Household Income, 11-12 June, 2009, Rome, Italy.
[66] Corresponding author.

In developing countries, consumption expenditure is usually preferred to income as a measure of household well-being for a series of both practical as well as theoretical reasons (Lipton and Ravallion, 1995; Deaton, 1997; McKay, 2000). Even though measuring household well being is still considered one of the key reasons to collect income data, other purposes are often more important, such as utilizing income data as an input into the analysis of the determinants of welfare and poverty, to check the accuracy of consumption data, to estimate household savings, and to assess the relative importance of the various activities that contribute to total household income (McKay, 2000).

Much of the focus of welfare analysis in developing countries in the last twenty years or so has focused on the assessment of poverty and the monitoring of its trends. Since consumption expenditure is the preferred metric for poverty measurement, the collection of good consumption expenditure data has received considerably more attention than the collection of income data. In some countries (Integrated) Household Budget Surveys (I-HBS), Living Standard Measurement Study (LSMS) surveys and other similar surveys have collected very little, if any, income data. Practical guidelines have been developed to assist researchers and analysts computing broadly comparable and theoretically consistent consumption aggregates and poverty measures from household surveys (Deaton and Zeidi, 2002; Ravallion, 1998), but much less information is available *for low-income countries* in terms of looking at income data. The Luxembourg Income Study, the Canberra Group and the Wye Group Handbook, the three major efforts in systematising work on household income data, all share a bias towards working with high- and middle-income countries.

On the other hand, during the 1980s and 1990s development economists started devoting increasing attention to issues related to rural non-farm income and employment and the diversification of the rural economy (FAO, 1998; Haggblade et al., 2007). Serious concerns soon began to emerge concerning the comprehensiveness, comparability and coverage of the available data. Much of the literature was based on country case studies, lacking statistical representativeness at the national level. Those based on Census data were strong on coverage, but often collected limited information on employment (e.g. only the primary occupations) and in consequence very little, if any, information on income. Studies based on nationally representative household surveys often used data coming from very different survey instruments and lacking a comparable definition of income and its components, as well as a standardised way of treating the data. Lanjouw and Feder (2001) identified data comparability and coverage issues as major shortcomings of this strand of literature.

The Rural Income Generating Activities (RIGA) project started in 2005 as a collaboration between FAO, the World Bank and American University in Washington, DC[67] with the aim of overcoming some of these issues with income data comparability, furthering our understanding of the sources of income in rural areas, and generating lessons for improving the collection of rural income data. The project has since created a database of 34 household living standards surveys from which a set of income aggregates and other measures of well-being were constructed in a methodologically consistent manner.

Through this elaborate task a host of issues arose that confirmed the need to reflect on the different stages leading to the construction of indicators of well-being, namely the construction of income aggregates. This paper summarizes the RIGA methodology for income aggregate construction and the obstacles faced in their construction to ultimately generate a consolidated list of recommendations for the measurement of household income. These are viewed in the context of both some of the possible research and analytical needs of data users, as well as from the practical point of view of the people engaged in the collection and analysis of the primary data.

The paper is organized as follows. The next section discusses the definitions and components of the RIGA income aggregates in the context of the existing literature on measuring household income. Section 3 elaborates on the survey design and methodological considerations for income aggregate construction. Section 4 reports on some key results of the RIGA work, focusing on how differences in definitions can generate very different

[67] For more information on the RIGA project and access to the RIGA data see www.fao.org/es/esa/riga .

analytical results. Section 5 offers conclusions and recommendations. The Annexes included at the end of the paper also provide more detail regarding specific methodological issues faced in the development of the RIGA database that escape the scope of the main body of this paper, but still merit mention due to their linkages of the overall subject matter.

2. Riga Income Aggregate Methodology

2.1 Preliminary considerations

In explaining the RIGA approach to the measurement of household income it is important to frame the discussion in the context of the objectives of the project and the constraints in which it operated. Concerning the former, the project stated goals put a strong emphasis on international comparability of the income measures being computed as well as on the definitions of the different components of income across countries and surveys. The project also has a strong emphasis on comparative research and analysis, particularly concerning the composition of rural household incomes. Regarding the latter, the project did not engage in the collection of new data, but worked with existing, and mostly publicly available surveys.

These considerations clearly drove the choice of the surveys with which the project, as well as the emphasis in the data work that was undertaken by the project. First, the project chose to work with multitopic surveys, such as Living Standards Measurement Study (LSMS) surveys and other, similarly structured surveys. These surveys tend have the desirable quality (from a researcher's point of view) of collecting data on a number of individual, household, and community characteristics that are essential when the purpose is not only to characterise the level and composition of income but also to investigate its correlates and determinants.

From the pool of possible surveys, the choice of particular countries was guided by the desire to ensure geographic coverage across the four principal developing regions – Asia, Africa, Eastern Europe and Latin America – as well as adequate quality and sufficient comparability in codification and nomenclatures (see Table 1 for the full list of RIGA database surveys). Surveys that did not provide adequate detail on income, or where information on income was collected via very synthetic survey instruments, were not included in the RIGA database because of concerns with their quality and with ensuring a good degree of comparability within the RIGA database. Furthermore, an effort was made to include a number of International Development Association (IDA)countries as these represent developing countries with higher levels of poverty and are therefore of particular interest to the development and poverty reduction debate.

The urban/rural definition adopted in RIGA is an immediate consequence of the choice of surveys. Countries have their own unique mechanisms for defining what constitutes rural. Thus, government definitions tend not to be comparable across countries and this may play some part in explaining cross country differences in comparisons of rural incomes. On the other hand, it may make sense to use government definitions since presumably they reflect local information about what constitutes rural and are used to administer government programs. While recognizing the potential problem with using country-specific definitions of rural, the available survey data do not allow for a straightforward alternative definition and therefore the government definition of what constitutes rurality is used. One additional caveat regarding rurality is that with the information available RIGA identifies rurality via the domicile of the household, and not the location of the job. It is probable that a number of labour activities identified as rural in RIGA are in fact located in nearby urban areas.

A host of issues that are sometimes discussed in the statistical literature on income measurement, including in the Wye City Handbook, concern the differentiation between total and disposable income, the latter being income after certain deductions take place (taxes, social security payments). Often, and namely for wage employment, such deductions are not reported or collection due to the reality of tax collection in developing countries. Nonetheless, and as explained below, income in the RIGA data is defined as 'net income', which is deducting from gross income the cost of any inputs that went into the generation of specific sources of revenues.

2.2 General Principles for Estimating Income Aggregates

Issues related to the definition and classification of income and its components, of the concept of (agricultural and farm) household, and of what constitutes rural have been explored in considerable depth in previous reports (Canberra 2001; ILO, 2003; Wye Group Handbook, 2007). The RIGA definition of income closely follows the definition given by the International Labour Organization (ILO) (Box 1).[68] An income aggregate is a measure of household welfare that is based on the different sources of income – wage and non-wage, dependent and independent – that a given household can earn over a well-defined reference period. Set up as a monthly or annual indicator, the income aggregate is reported as an average net income figure.

As per the definition of household, the RIGA project applies the definition utilised by the corresponding survey. Generally, LSMS-type surveys define the household based on some variation of the concept that household members share a dwelling and the means of living (e.g. "eating from the same pot"). Each survey provides precise instructions as per which individuals should be considered household members (usually based on a minimum number of months they were present during the 12 months preceding the interview).

No systematic effort was made in RIGA to come up with a consistent definition of what constitutes an agricultural household, as in Chapter IX of the Wye Group Handbook. In some of the analytical papers produced by the RIGA project, agricultural households have been defined as those who had any agricultural production. Recently the RIGA database has been used in a comparative paper that looks at how different definitions can yield very different characterisation of what constitutes an agricultural household (Aksoy et al., 2009). We summarize some of the main results of that study in Section 4.

Box 1: *ILO Definition of Income*

The ILO *Resolution concerning household income and expenditure statistics* defines income as follows: "Household income consists of all receipts whether monetary or in kind (goods and services) that are received by the household or by individual members of the household at annual or more frequent intervals, but excludes windfall gains and other such irregular and typically onetime receipts. Household income receipts are available for current consumption and do not reduce the net worth of the household through a reduction of its cash, the disposal of its other financial or non-financial assets or an increase in its liabilities" (ILO 2003).

Based on the definition proposed by the ILO, we therefore consider as income receipts those that (i) recur regularly; (ii) contribute to current economic well-being; and (iii) do not arise from a reduction in net worth. These three criteria are embodied in each of the components of income; as such, irregular payments such as lottery earnings or inheritances; investments and savings and the value of durables are not included in our estimation of income.

In order to create income aggregates that are comparable across countries and over time, we apply the following criteria in the generation of our income measures:

1. All total income aggregates are estimated at the <u>*household level*</u>. Although income data is reported at individual, household, business and farm levels, depending on the survey module, to facilitate any analysis it is necessary to aggregate income to a common level. Since income strategies and consumption patterns are often jointly determined among household members, the household is an appropriate level of aggregation for the income aggregate.

2. All income and expenditures are <u>*annualized*</u>. Income is also reported for different time periods ranging from days to weeks, months and the full year since households may earn income from different activities and to different degrees over the course of the year. In order to generate a clear picture of household-

[68] Source: ILO, Resolution I "Resolution concerning household income and expenditure statistics" Available from: http://www.ilo.org/public/english/bureau/stat/download/res/hiestat.pdf

level income, it is therefore preferable to establish a broad enough time frame that captures the full extent of activities undertaken by the household. The straightforward approach to annualization involves multiplying the amount of income received (or expenditure incurred) by the number of times it was received (or spent) such that the total revenues and costs over the course of one year are captured, accounting for the frequency in which they were earned or spent. Often complete information on frequencies is not available in which case some assumptions are drawn to enable the annualization of income and expenditures. Specifically, *when data on frequencies is not available*, the RIGA project assumes 313 working days per year (6 days per week; applied to daily earnings or costs); 52 weeks per year (to annualize weekly data) and 12 months per year (when values are on a monthly basis).

3. All income components are *net of costs* in order to obtain an estimate of income which is readily available for household consumption, investment and/or savings. Arriving at a net income aggregate takes into consideration expenditures made by the household that are essential to its income activities but only if they are incurred on a regular basis. Two exceptions to this point are for rental income and transfer income, both of which are kept at a gross level. These exceptions are elaborated upon in the following section.

4. *Purchases and sales of durable goods, investments* and *windfall gains are excluded* from household income and expenditure calculations since these are not transactions undertaken regularly by rural households and can result in the significant over- or under-stating of permanent income.

5. All aggregates are reported in *local currency units* of the year in which the survey took place. Income shares are estimated in order to make cross-country and over-time comparisons. If the comparison of income levels is necessary, PPP US dollars are applied, using exchange rates obtained from the most recent version of the World Bank World Development Indicators.

6. Although the RIGA project focuses on rural households, income aggregates and household-level variables are constructed for all *rural and urban* households in the sample of each survey. As discussed earlier, defining rural and urban areas in a comparable manner is a difficult task since countries have their own methodologies by which they differentiate these areas.[69] Despite the limitations already described on this matter, the available survey data do not allow for a straightforward alternative definition of rural and urban as that would require data on population density from census data, geo-referencing of households, and information on the location of the employment, each of which is generally unavailable in most household surveys; therefore the survey-specific definitions are used.

2.3 Components of Aggregate Income

Although the construction of the income aggregates takes into consideration all sources of income reported by the household in the survey, the aggregation of the different sources is necessary and practical for analytical purposes. At the least disaggregated level, we can define two categories of income: wage and non-wage. Wage income includes all activities undertaken by persons in which the income received is in the form of a salary paid out by an employer; in other words, wage income includes earnings from dependent activities. Non-wage income is a broader category referring to (1) independent income, which includes crop and livestock production and self-employment (enterprise) earnings, and (2) non-labour income, containing transfer and other miscellaneous income sources. We therefore disaggregate our income measures into the following principal categories that follow standard practices and best reflect the analytical objectives of the RIGA study: (agricultural and non-agricultural) wages, self-employment, crop production, livestock production, transfers, and other income (see Box 2). In the remainder of this section, we expound further on each of these categories. The full classification is summarized in Table 2.[70]

[69] See de Ferranti et al (2005) for examples of and discussion on the variability of definitions of rural areas.

[70] Further country-specific disaggregation and classifications are fully described in the survey-specific methodology, available from the RIGA website: www.fao.org/es/esa/riga.

Box 2: *Components of Total Household Income*

$$TOTY_I = Agwage_i + Nonagwage_i + Crop_i + Livestock_i + Selfemp_i + Transfer_i + Other_i$$

2.3.1 Dependent Income Sources

Wage Income. Wage income consists of all income received in the form of employee compensation either in cash or in kind. Since it is common for household members to simultaneously hold more than one job or change jobs throughout the survey reference period, all income from primary, secondary and any additional jobs held in a 12-month period is considered. Since wage employment information is obtained from the "economic activities" module of the living standards surveys within which all individuals generally report all their dependent and independent activities, it is necessary to only keep reported income from individuals that are not employers, own-account workers, or unpaid workers to ensure that only dependent labour income is captured and to avoid double-counting income that is reported in other survey modules. Income from individuals that identify themselves as employers or own-account workers is considered self-employment income and is accounted for in that category. Individuals identifying themselves as unpaid workers do not report income and are therefore excluded from the wage income estimation.

Wage employment income is first disaggregated by industry. The classification is based on the United Nations International Standards Industrial Classification of All Economic Activities (ISIC). As the classification of industries changes over time, the most appropriate revision of the ISIC classification standards is chosen based on the year the survey was undertaken.[71] As presented in Table 2, industries are grouped into ten principal categories: (1) Agriculture, Forestry and Fishing; (2) Mining; (3) Manufacturing; (4) Utilities; (5) Construction; (6) Commerce; (7) Transportation, Communications and Storage; (8) Finance and Real Estate; (9) Services; and (10) Miscellaneous. Using this industrial classification, total wage employment income is separated into two aggregate categories: agricultural wages (industry 1) and non-agricultural wages (industries 2 through 10).

The wage component is further disaggregated into skilled and unskilled labour and when insufficient information is provided by the respondent in a specific survey, some observations are forcibly classified into an unknown skill level. The distinction among these three sub-categories is based on the ILO International Standard Classification of Occupations (ISCO-88)[72] and, sometimes also on country-specific documentation. Whereas the skilled labour classification is given by ISCO-88 major groups 1 through 4, unskilled labour corresponds to groups 5 through 9, and the unknown skill level is assigned for major group "0" and the observations for which this information is missing.

2.3.2 Independent Income Sources

Labour income that is not earned in wage activities is accounted for by household enterprise income which is either "on-farm" or "non-farm" in nature. On-farm enterprises are represented by crop and livestock activities, which are agricultural production activities taking place on the household's own, rented in, borrowed, or sharecropped land. Non-farm enterprises represent the household's business(es) that are not directly connected to the household's agricultural production, if it has any. All of these independent activities are accounted for in the income aggregate through the categories of crop, livestock and self-employment income.

Crop. The estimation of crop income accounts for the sale of crop production, crop by-product production, sharecropping, the consumption of household crop production, net of all expenditures incurred in realizing these activities, such as agricultural inputs (seeds, pesticides and fertilizers) and the hire of farm labour.

For the valuation of own crop consumption, two different estimates are generated depending on the availability and quality of the data in each country. In the first approach (the "*crop1"* component in RIGA total

[71] See: http://unstats.un.org/unsd/cr/family1.asp.
[72] See: http://www.ilo.org/public/english/bureau/stat/isco/isco88/major.htm.

income), own crop consumption is calculated based on the quantities consumed of own-produced crops as reported in the agricultural module of the household questionnaire. In cases where the quantities of own consumption are not specifically asked for in the questionnaire, this magnitude is estimated for each crop as a residual by subtracting the total amount sold, bartered, lost or used as an input (such as for seed or fodder) from the total amount harvested. The second approach (the *crop2* component) relies on the food expenditure section of the questionnaire to estimate the quantities of food consumed from own production.

In both approaches, to estimate the value of the reported quantities of own-consumption, the value of consumption is obtained using a set of imputed median prices (the specific procedure is described in greater detail below in Annex 3). For most surveys the second estimate was used in the total income calculation, among other reasons, to improve the comparability with consumption-base welfare measures; in a few cases, however, quantities from the production side were used as they were deemed more accurate or due to survey data limitations.[73]

Livestock. The livestock income category includes income from the sale and barter of livestock, livestock by-product production (i.e. milk, eggs, honey etc.), net of expenses related to livestock production (e.g. fodder, medicines) and livestock purchases, plus the value of household consumption of own livestock and livestock by-product production. The values of own consumption are estimated based on the food consumption/expenditure section of the questionnaire. In cases where this information is not available in that module, the consumption amount is obtained from the agricultural module. The approach for valuing own consumption is the same as for the valuation of crop own-consumption (see above and Annex 1).

Self-employment. Income earned from all non-farm household enterprises is captured in this category. In most surveys this income is reported in an autonomous module; however, in a few cases, it is identified as "independent income" in the "economic activities" module of the survey and is thus necessary to differentiate from wage employment jobs (see "Wage Income" above). Self employment income includes all in cash and in kind earnings and non-durable, recurrent expenditures for all non-farm businesses operated by any member of the household over a 12-month period. All expenditures for equipment and machinery purchases and other investment expenses are not included in the aggregate. It must be noted that the purchase of raw materials, although clearly not an investment, are often procured in bulk; consequently, in some instances, they had to be treated differently from other expenses. Annex 3 elaborates on the issues encountered with this expenditure category and the treatment applied for some surveys.

Income from household enterprises can also be decomposed into industries according to the ISIC nomenclature. It should be noted that the first industry category for self-employment represents agricultural processing activities, which is differentiated from agricultural production activities. Further, when the information is available, the total income is weighted by the share of the enterprise owned by the household since non-farm enterprises may be owned by more than one household.

2.3.3 Non-labour Income Sources

Transfers. This category refers to both private and public transfers received by the household, both in cash or in-kind. *Private transfers* primarily refer to remittance income, but they can also include benefits obtained from private organizations and/or associations as well as forms of gifts and contributions not associated with the performance of a job or the provision of a service. *Public transfers* are divided into state-funded pensions and social benefits, which include welfare support, maternity benefits, and educational transfers. Pensions and social benefits reported in this section do not include benefits received from employers, as those are included under the wage employment component. Further, transfer income is overall estimated as a gross, rather than net, figure; this is elaborated upon in Section 3.2.b.

Other Sources. All other non-labour income components that do not fall into the previous five categories are accounted for in this last grouping. Other income is separated into (1) gross income from farm land rental,

[73] These cases include Indonesia (both years), Vietnam (1992), Pakistan (2001), and Cambodia (2004).

(2) gross income from the rental of non-farm real estate and/or of owned assets, and (3) other miscellaneous non-labour sources not specified in the questionnaire. Some caution should be exercised when comparing this income category across countries because not all surveys contain all three categories and due to the ambiguous nature of the possible sources comprising the third category. Nonetheless, in the vast majority of cases, it only represents an insignificant portion of total income.

2.4 Higher Levels of Aggregation

As shown in Box 2, total income is the sum of the seven categories described above, and is calculated twice, using the two estimates of crop income described in section 2.3.b, above. Although these seven income categories form the basis of the RIGA analyses, they are also aggregated into higher groupings in several cases. For the first grouping, total *agricultural* activities are composed of crop, livestock and agricultural wage labour. Its complement, *non-agricultural* activities, is made up of non-agricultural wage labour, self employment, transfers and other income activities. *On-farm* income is the sum of crop and livestock production activities whereas *off-farm* activities include all activities performed off of the household's own land (agricultural and non-agricultural wage labour, self employment, transfers and other income activities). Finally, *non-farm* activity is comprised of non-agricultural wage labour and self employment.

2.5 Individual and Job Level Aggregates

Recently, the RIGA project started complementing household level with individual level sources of income data. In this case the focus is limited to agricultural and non-agricultural wage labour income sources, as independent and non-labour income sources are not easily attributed to any one household member in LSMS-type surveys. The focus of this analysis is on individuals of working age, defined as those between the ages of 15 and 60 for sixteen RIGA surveys. The dataset (referred to as RIGA-L) provides comparable data on the rural labour markets, such as individuals' participation in wage employment, income and number of jobs, as well as the frequency and duration of these jobs.

Labour market participants are defined as any individual in the household in the 15-60 age category that responded to labour time and earnings questions in the wage employment modules of the corresponding survey. Along with the data on labour market activities, individual-level and household-level variables are also available in these data sets. This allows for an investigation of how labour market participation and remuneration varies based on individual and household factors. The final dataset includes data on individual labour participation, time participation categories, daily wages, individual characteristics and household level characteristics (Winters et al., 2008).

It should be noted that wage income aggregates forming part of the RIGA-L component of the database are estimated at the *individual and job levels*. This subcomponent of the RIGA study focused on wage employment data and the pluriactivities of individuals within each household; therefore, these lower levels of aggregation were fundamental to the RIGA-L analysis.

Income is aggregated at the job level, providing information on the duration, frequency, participation in and income earned from each job held by each individual. As these are wage jobs, these variables are also disaggregated by industry and also re-aggregated, into agricultural and non-agricultural wages, though always at the job level.

At the individual and job levels in RIGA-L, wage employment is also disaggregated by labour time categories. All employment is categorized into one of the following four classifications: a) Full Year-Full Time (FYFT), b) Full Year-Part Time (FYPT), c) Part Year-Full Time (PYFT), and d) Part Year-Part Time (PYPT). These groups are intended to capture the labour time characteristics of individual employment and reflect the predominant types of jobs that exist. It can be assumed that the FYFT category represents full-time employment while the FYPT category represents part-time jobs. In addition, the PYFT category represents seasonal jobs and the PYPT category represents causal employment (see Table 3 for a synthesis of the methodology).

One major limitation of this individual level dataset from an analytical point of view is that of being limited to wage employment. To fully analyze important policy issues, such as the relation between demographic and human capital characteristics of individual workers and the transformation of the rural economy as well as to different pathways out of poverty, requires filling individual-level information gaps in future surveys. This is in part already happening where time-use modules are being integrated into living standard surveys. This is one of the avenues along which income data collection may progress in the near future.

3. Considerations for Income measurement and Aggregate Construction

Having defined the components of and the basic RIGA methodology for the income aggregate and the wage-labour market activities, we now elaborate on some key methodological points and on the main obstacles faced when creating income aggregates with household income and expenditure data. Following a review of the RIGA database surveys, we identify the principal issues that were characterized by similar, recurring problems across countries and years that must be considered in the construction of an income aggregate. We grouped these issues into those related to questionnaire design and survey implementation (which impact the quality of the raw data obtained) and those related to income aggregate construction and other data-use points, providing a list of survey-module-specific considerations based on the RIGA project experience in working with those surveys.[74] Each of the issues discussed represents a challenge in the creation of an accurate income aggregate. While these obstacles can be overcome with a proper understanding of the surveys and the data, it is necessary to take these issues into account in all stages of income aggregate creation especially the survey design stage.

3.1 Questionnaire Design and Survey Implementation[75]

The way in which the household survey collects information drives the reporting of income and expenditures in the survey. It is therefore critical to structure the questionnaire and implement the survey in a way that encourages reporting that accurately represents all sources of household income. The key issues surrounding questionnaire design relate to the way in which questions are asked, the scope of information asked for, the time frame to which the questions refer and the target respondents. Below we summarize the key points related to these issues.

3.1.1 Reference Periods and Frequencies

The choice of reference period has a large impact on the accuracy, reliability and quality of the data collected and thus should be chosen very carefully. A large body of literature exists debating the appropriate choice of reference period when conducting living standards surveys, specifically those of the LSMS project (see Saunders and Grootaert 1980; Deaton and Grosh 1998; Pettersson 2005; Scott, et al. 1980; Glewwe 2005). A reference period can span from a short reporting period (daily, weekly or biweekly) to a long (seasonal or annual) time frame. Trade-offs exist between selecting a short versus long reference period: proponents of shorter reference periods argue that annual reference periods lead to inaccurate reporting due to recall errors. The reference period that the respondent is asked to recall must not be too long, as this would increase the probability and magnitude of recall errors (Pettersson, 2005).

On the other hand, due to seasonal fluctuations, short-term income and expenditures may be too variable to present an accurate picture of annual income and expenditures such that the reference period should be kept at twelve months (Saunders and Grooteart 1980; Deaton and Grosh 1998). A full-year reference period can be regarded as essential for the survey as a whole – unless enough data is collected to show how a reasonably representative shorter period can be selected for future rounds (Scott, et al. 1980). One of the ways to address the problem of seasonal variability is to undertake multiple visits to the household throughout the year, but this solution is costly and may not be feasible due to difficulties in coordinating revisits with households, changes in household structure over time, as well as logistical issues such as the problem of reaching households in unfavourable periods, for example the rainy season. Ultimately, due to these numerous challenges and the

[74] Additional issues are covered in Annexes 1-3.

[75] For a much more comprehensive review of issues related to LSMS survey design and implementation the 3 volumes edited by Grosh and Glewwe (2000) are mandatory reading. This section only reviews a few specific issues that are particularly relevant for the RIGA work with income aggregates.

financial cost of following households throughout a year, the possibility of obtaining a sufficiently large sample would be greatly limited (Saunders and Grootaert 1980).

In the end, the reference period should coincide with respondent's ability to recall reported information as accurately as possible. The key consideration in dealing with reference periods and frequencies should be ensuring that the information provided from the questions answered in the survey is sufficient to create a reliable annual estimate of the income or expenditure. The income and expenditures of a household range from frequent (food expenses; monthly wages) to infrequent purchases or income receipts (i.e. durable goods purchases; annual interest from savings). As a result, the reference period should reflect the frequency of the incurred income and expenditures. As noted by Pettersson (2005), high-frequency items such as food usually have relatively short reference periods, at most a one-month period. The recall of expenditures on low-frequency items, such as household durables, must cover a relatively longer period since a short reference period could result in large variations in the final estimates. The length of a suitable reference period must consequently differ across item groups and income activities (Pettersson 2005).

In consequence, depending on the survey module at hand, the most appropriate reference period will vary. Even within sections it may differ, such as for wage employment, in which households can report income from current jobs and those undertaken over the previous year. Income that is earned infrequently is better off reported with a broader reference period (the previous 12 months) whereas consistent, regular or frequent sources of income are better off being reported on a shorter time frame. When reference periods are shorter, households must be probed for more information about the frequency with which the income is received (or the expenditure is incurred) to generate a picture of the annual importance of the income or expense. Under a broader reference period, fewer questions need to be asked regarding the frequency of income, but enough should be made to enable cross-checks of the reported values. It is inefficient for surveys to have many questions regarding the frequency of an income source when the value earned is a total reported for the previous twelve months.

The method by which information is collected is also relevant. For example, the use of a 14-day consumption diary, as in the case of the Albania LSMS, is one approach used to obtain a clear picture of daily consumption of food and non-food items among household members. For generating estimates of consumption, this could arguably be the best approach instead of asking households regarding their consumption patterns based on a pre-defined list of items; with a food diary, the scope of the data collected is created by the household, minimizing the possibility of not accounting for items a household may regularly consume. A similar approach could be applied for measuring income from household enterprises to obtain accurate estimates of regular income and expenses and minimize the recall error of the responses. Of course, the reference period for such an approach must be chosen carefully: it should be broad enough so that one can assume with confidence that household income and expenditures over the course of *N* days/weeks are representative of a longer time period, but not so great so that households fail to complete the booklet.[76] The time frame should also be chosen so to not include "abnormal" periods such as holidays in which consumption behaviour may deviate from the norm (though the questionnaire can also account for this kind of consumption separately).

Collecting complete and representative information on frequency and duration of work is fundamental also for wage employment data, specifically for calculating variables on full-time and part-time jobs; as well as full-year and part-year jobs. Data on frequency and duration should be available for all types of jobs (main, secondary, third, etc.), to improve the accuracy of the estimations of labour-time and ultimately income. One inherent challenge faced is the differing ways in which individual surveys ask labour time questions. For some surveys, labour time questions vary depending on whether the first, second, or third job is being referred to while in other cases all labour time queries are consistent. In addition, in some surveys the first job is designated as the primary or full-time job whereas the second job is considered a casual, other, or default employment, a problematic approach when, for example, a person has two full-time jobs over a 12 month period, or when a person has no full-time job but two or more part-time jobs. In such cases, designating one particular employment as the primary or secondary job is difficult and requires additional criteria on labour time

[76] de Mel, et al (2007) find that when household enterprises were requested to complete a booklet of income and expenditures over an extended period of time, accuracy dropped after one month as households were less regular in their accounting.

or earnings to be applied, which can introduce further complications when labour time or income questions are inconsistent throughout employment modules. In consequence, in addition to the importance of selecting adequate reference periods for reporting income and expenditures, when dealing with with-in module reporting of similar income sources, the consistency of the questions asked is also critical for accurately estimating income, notably when reference periods may mask the true nature or importance of a given employment.

The experience of the RIGA project allows for the conclusion to be drawn, for this matter, that certain reference periods are more appropriate for estimating income from each of the income survey modules and that linked to those recommended reference periods are other relevant considerations. Table 4 highlights what are identified as "recommended" reference periods for each component of income. It should be emphasized though that these are just guidelines, and therefore should be taken as such.

For crop income to be accurately estimated, it is most practical for questions regarding production to refer to production seasons, such as the previous season, the wet season and/or dry season. Collecting information in a way that follows the actual practices of the producer is logical and encourages better recall for the survey. The number of harvests or production seasons may vary across countries so these should be specified according to the local context. Information on frequency of sales, consumption, and other categories reported should also be collected with the goal of accurately annualizing each component of crop income.[77] Similarly, despite that inputs are used on a regular basis, the reference period for these expenditures should be annual since their purchase is not necessarily undertaken on a periodic basis (e.g. seed inputs are likely purchased only prior to the cropping season). Similarly, questions on livestock income and expenditures should also be framed around the previous 12 months as livestock sales and purchases are generally infrequent. Livestock products such as eggs, milk and milk products, however, could be structured on a monthly reference period since their production is more regular in nature. Conversely, by-products related to the slaughter of animals are probably infrequent and therefore should also adhere to the annual reference period.

Regarding reference periods for own consumption, since the objective is to obtain an accurate representation of the regular consumption patterns of the household that reduced recall error, a recommended reference period would be the previous 14 days complemented with information on the frequency of consumption. As emphasized above, it is of utmost importance in this case to undertake the survey in a period that best reflects regular consumption periods. That is to say, avoiding periods where consumption may substantially increase or drop such as the Tet holiday in Vietnam or during Ramadan in countries with a Muslim population.

Multiple reference periods should exist for wage employment activities in order to capture individuals' pluriactivities throughout the year. Whereas the overall reference period for any wage income reporting should be the previous year, it is preferable to have wages reported in terms of the frequency in which they are received; that is, the reference period should be specified by the respondent. Further, the questionnaire should ask questions regarding the duration of each job (in hours, days, weeks and/or months of the previous year), the wage received, the frequency the wage was received, the time worked to receive the wage, and the amount earned over the past year. In-cash or in-kind income from wage jobs obtained as benefits granted by the employer should be divided into those received monthly (e.g. transportation; food) and those received bi-annually or annually (e.g. uniforms). The frequency of their receipt should always be reported.

For self employment activities, RIGA work demonstrates that the preferred reference period would be the previous month. If a household owned an enterprise in the previous year but no longer operated it in the month preceding the survey, then the average monthly income from the enterprise should be reported. It is therefore essential for the survey to also ask about the number of months the enterprise operated in the previous year, as well as the share of household ownership in the enterprise (since businesses are often owned by more than one household). Business costs should be asked with respect to the previous month, the average month, and the frequency with which the household incurs such costs must be reported.

[77] For example, the Ghana 1998 Living Standards Survey asks about crop sales income in the previous two weeks but the survey does not contain information that allows the data user to know if those two weeks are representative of crop sales over the course of the year or if crop sales are irregularly distributed over the year.

The reference period for transfer income must also vary depending on the type of transfer. Public transfers such as pensions are generally received regularly therefore a monthly reference period is appropriate. Social transfers, such as educational scholarships, may have a lower frequency such that an annual reference period is preferable. For private transfers, households should be asked regarding their receipt during the previous year, the average amount received and the frequency with which that amount is received so to construct a more specific and accurate annual estimation of this sort of income.

Finally, other income sources are comprised of rental income and miscellaneous non-labour sources. Rental income is generally regularly received therefore a monthly reference period, accompanied with the frequency of the income is appropriate whereas the latter category is best reported with respect to the previous year given the unspecified and potentially irregular nature of the income.

An additional important note on reference periods is the way in which they are phrased. To ask an individual about the previous week's consumption is different than to ask about the consumption of the previous seven days. The former specifically refers to the previous Sunday through Saturday (or Monday through Sunday) period whereas the latter refers to the previous seven days, irrespective of the day of the week. The same concept holds for previous year versus the previous 12 months; the previous 14 days versus last 2 weeks; etc.

3.1.2 Units and Coding

The use of appropriate units and coding is an important factor determining the accuracy of constructed consumption and income aggregates. One of the key problems encountered in the generation of the RIGA income aggregates is inconsistency in units and coding across survey modules, across years for one country in different time periods, and across surveys for different countries. These issues engendered problems in the interpretation and processing of household data with the primary objective being the creation of interpretable values that are intra-module, intra-year or internationally comparable.

Although internationally recognized units for measurement exist, it is inevitable that different countries have local units by which measurements are recorded. For example, *cuadras* are common in some Latin American countries, whereas ropes and poles may only be found in Ghana. And though different countries may refer to a unit by the same name, the equivalence to internationally recognized units can vary across or even within countries: one *cuadra*, for example, is equal to 4.17 acres in Argentina, 3.89 acres in Chile and 1.85 acres in Paraguay and anywhere from 1.58 to 4.45 acres in Venezuela. When dealing with weight or mass quantities, some countries will account for units sold in kilos, whereas other countries, when referring to the same items, may report items in sacks, carts, or boxes, depending on the unit of the consumption or transaction. Further, household surveys generally include an "other unit" category which is often undefined, thus complicating the task of placing values in common units.

It is not to say that only standard units should be used in the survey design. As noted by Saunders and Grootaert (1980), the appropriate classifications of groups must be related to the local context. The accuracy of data collection is enhanced by reporting in units with which households are most familiar; nevertheless, it is clear that in all cases, regardless of the type of measurement at hand, equivalencies to international standard units are necessary to provide with each survey. Not doing so will lead to the persistence of the measurement inaccuracies prevalent in many surveys and impede accurate and meaningful cross-country comparisons, and can complicate the comprehensibility of analyses using unit-level data. These inaccuracies may also carry over to analyses which are often the basis for policy-making and program evaluations (Chander et al. 1980; Pettersson 2005).

Table 5 demonstrates the variability in unit reporting across a selection of the RIGA surveys. For some surveys, only one unit is reported, while for others, upwards of seventy are reported. Further, as an added difficulty for the analyst, equivalence scales for converting units often are not included in the surveys where many local or non-standard units are reported. In other cases, the reported unit is identified as "other" but without any additional information to inform the analyst as to what is represented by "other". This is particularly problematic in certain cases, such as in identifying land units in the surveys for Ghana and Nigeria, in which one of the four potential units in which land area can be reported is "other", and in which no extra information is given.

Also of great importance is internal consistency in the codification of items within a survey. This point is notable for living standards surveys containing agricultural production and food expenditure modules. From the perspective of the construction of an income aggregate which requires data from multiple survey modules to be utilized, it is both practical and logical to facilitate analytical work by codifying items from these modules consistently, as well as to ensure consistent lists of production and consumption items, particularly those which are consumed by the household. Within a survey module it is beneficial for the analysis if the unit in which a specific item is reported is always consistent. For example, if a respondent reports harvesting 100 kilos of rice for a given reference period, subsequent questions on the quantity of rice sold, consumed, paid out to labour, and stored, etc, would preferably be reported in the same unit (kilos, in this case). Doing so facilitates the valuation of items for which no real value can effectively be reported (e.g. the value of crops consumed or stored).

Another issue related to units and coding is the application of existing nomenclature in the collection and analysis of wage data. Some surveys do not collect data on the industrial classification of labour activities and only collect occupational sectors. It is important for surveys to collect data on both given that industrial and occupational classifications represent different concepts and are not substitutes for descriptive information about labour activities. Further, given the existence of ISIC and ISCO coding schemes, it is practical for surveys to adhere to such nomenclature rather than incorporating local industrial or occupational classifications in the survey. When a survey does adopt the existing ISIC or ISCO codes, it is also important to follow the current revision of such coding schemes, which are updated when necessary by their respective institutions. Although these updates may challenge consistency in codification schemes over time, it is also important to keep data collection and analysis in line with current definitions.

3.1.3 Data Validation

Structuring surveys in a consistent manner can alleviate many of the problems encountered by data users in creating estimates of income, expenditures and other indicators. Resolving issues of questionnaire design must also be complemented by granting attention to the process by which a survey is carried out. In order to establish confidence in the quality of the data collected by a survey, it is necessary to cross-check the answers provided by respondents.

Data validation can be undertaken through various approaches both during and after the survey. In the questionnaire, surveys can ask additional questions to cross-check the responses to other questions for ensuring accurate reporting. For example, the quantity of crop harvest can be validated by asking follow-up questions about the crop production such as the quantity sold, given away, stored, used as inputs, used to pay the landlord or labour, consumed and lost;[78] total harvest should equal the sum of these components. Another approach is to include, as with the agricultural module of the 1996 Nepal Living Standards Survey, an accounting table which can serve to cross-check and summarize reported income and expenditures. Finally, data entry ideally takes place concurrent to the survey fieldwork so that field validation can be undertaken, if necessary, to verify questionable responses by revisiting households to reconfirm answers.

[78] An aside related to this point is the importance for keeping the reporting of sales and own consumption separate in the agricultural production module; some surveys aggregate these in the question, placing obstacles to accurate price estimations and disaggregated agricultural income analyses. Ideally, households are asked about their total harvest, harvest sold, consumed, given away, used to pay labour, use to pay rent, stored, used as an agricultural input, and lost.

3.2 Dealing with Specific Income Estimation Issues[79]

3.2.1 Investments

The estimation of a net income aggregate is based on sources of regular and/or recurring income and expenditure receipts for a specified reference period that contribute to current economic wellbeing (ILO 2003). Such transactions occur on some recurring basis- daily, weekly, monthly, etc., and exclude anything that is beyond the scope of the previous year. The examples of non-regular income are few and generally fall into the category of lottery earnings and inheritances. These kinds of earnings would not be accounted for since generally they are not regular or recurrent earnings and since such earnings would be a source of income beyond the range of normal income for that household.[80] On the expenditure side, the cases that should be identified and dropped are numerous, since large expenditures can be recorded in multiple sections of the survey (namely, where income earned is from an independent activity: crop, livestock and self employment) which places the risk of under-estimating or driving negative household income if the cases are overlooked or misidentified.

The misclassification of expenditures into investments or durables is always a risk if a survey is not properly structured. Chander et al. (1980) emphasizes the importance of clearly grouping questions and sections in a logical structure to avoid such misclassifications. The result of not doing so can produce reduced estimates of net income in a given section, such as in the self employment module of the 1998 Vietnam Living Standards Survey in which, the distribution and magnitude of annualized raw material expenses appear to be more like investment expenditures than regular, non-investment expenditures undertaken by the households. For more detail on this issue, Annex 3 provides a broader discussion.

3.2.2 Gross versus Net (Disposable) Income

In the estimation of a net income aggregate, the identification of revenues and expenditures is highly important. The wage employment module of many questionnaires contain inconsistencies in the reporting of wage income: some surveys ask for net income, others for gross income and in those surveys with gross income reported, taxes and other deductions are not always consistently or clearly accounted for in the reporting of expenditures. The lack of detail on taxes and deductions is of course a reflection of the reality of the large scale of the informal sector in low income countries in which taxes are often not collected and deductions not applied. This "reality" generates the need to differentiate income estimation methodology for low-income countries from what is the standard for OECD countries and what is described in the Wye City Group Handbook.

Table 6 summarizes this tendency for a selection of the countries in the RIGA study and demonstrates that most surveys do not ask for net income in the reporting of wage income. Many surveys allow the respondents to specify whether their reported income is gross or net, a useful feature of those surveys since doing so allows analysts to structure their work accordingly. Further, this kind of reporting permits, to an extent, the consideration of the informal sector since adherence to tax laws in developing countries may not necessarily be common (Tanzi and Zee 2000). However, the flexibility in reporting of wages may complicate the estimation of wage income if appropriate follow-up questions are not asked in conjunction with the reporting of the earnings. In only one survey of those reviewed for this paper did the questionnaire follow up the question "were taxes deducted from the wage?" (2001 Bulgaria Integrated Household Survey) with a question on the value of taxes deducted. Most often in the surveys for which respondents can choose to report gross or net earnings, no question is included regarding the amount of taxes paid or if they were paid at all. Other surveys may include a question regarding the payment of taxes in wage employment; however it is not clear if these were subtracted from the reported wages. Two examples of these are the Guatemala 2000 *Encuesta de Condiciones de Vida* and the Nicaragua 2001 *Encuesta de Medición de Niveles de Vida*, which both include a question on payments to social security (such as "did you pay quota to social security for the work that you do as…?"), but do not state if the tax amount has been subtracted from the reported wages. Although this lack of information conveys the reality of tax collection in developing countries, it places an obstacle for the analyst who wishes to undertake

[79] For the RIGA protocol for dealing with outliers and impute missing values see the Annexes.

[80] It should be noted that if the payment is received as a lump-sum it should be unquestionably excluded but if such payment is spread over 30 years though, as could be the case for large lottery earnings, then the treatment of the income would be different. However, the occurrence of this is so rare; such income would be treated as an outlier, and be dropped or imputed.

livelihoods analyses, particularly comparative ones. If international comparisons of income strategies are to be realized, the over-arching principle is to establish a common set of standards and guidelines by which to measure and aggregate income sources This objective is undermined when some surveys report net earnings and others gross without the possibility of estimating taxes and other withholdings.

At the analytical level, the consideration of gross versus net earnings from certain activities is also a subject of debate. Whereas some income sources should clearly be estimated as net figures (agricultural income, self employment earnings and wages, whenever possible), others should be gross earnings. The two cases in which earnings are always estimated as gross figures in the RIGA data work are rental income and transfer income. Given that the purpose of discounting expenditures from revenues in the income aggregate is centred on accounting for regular current costs that contribute to the realization of the labour activities under consideration and, overall, available for current consumption, it is not appropriate to account for the cost of renting in property or sending out transfers.

In the case of transfer income, it is important to first note that expenditures can only be incurred on private transfers since the public and social transfers are generally received at no financial cost to the household. Private transfers, though, can be incoming and outgoing. The outgoing transfers are not accounted for since it is not possible in any of the surveys to differentiate between those that are permanent and those which will be repaid and therefore classified as loans. The RIGA income aggregate does not consider loans in its calculations since they represent a reduction in net worth (see Box 1). This reporting ambiguity obliges the exclusion of outgoing transfers and the necessary estimation of gross, rather than net, transfer income. Moreover, the payment of transfers to other individuals does not contribute to the household's current economic well-being (these instead contribute to other households' well-being) in the sense that making an outgoing transfer does not enable the household to earn income from a given activity; conversely, expenditures made for agricultural and non-agricultural businesses do contribute to the household's economic well-being since they allow the household to realize its income-generating potential. It follows from this last point that rental expenditures are also not considered in the income aggregate. They do not embody an incoming-outgoing transaction and are not necessarily associated with the generation of income through labour activities.

To summarize some of the main points in this section, for dependent labour employment, regardless of net or gross wages being reported, deductions and taxes should also be reported to enable the estimation of both values. Further, the inclusion or exclusion of in cash and in kind benefits received in the reporting of the wage must be specified. With respect to the agricultural production and non-farm enterprise modules, regular expenditures and durable expenditures should be clearly distinguished in different sections of the survey module so to avoid misinterpreting the kind of expenditures considered in the income aggregate. It thus follows that survey questionnaires should avoid grouping together expenditures for several different items into one code; if expenditures are to be disaggregated by item, they should be reported for each item, not groups of items. Finally, "other" expenditures should be identified or described to determine if they are investments or not.

4. An Overview of Key RIGA Results

4.1 Diversification of Rural Household Income in RIGA Countries[81]

Much of the literature on rural non-farm activities focuses on the diversification of income sources over the rural space, or over groups of households within the rural space. To examine that, the RIGA dataset is able to describe the share of income from, and household participation in, rural income generating activities. Some of this work is summarised in this section based on 16 country datasets from the RIGA database. These results also show how household level income data can be a useful starting point to look beyond the microeconomic level, to better describe and understand the structure of the rural economy.

[81] This section is based on Davis et al. (2009).

Overall, as would be expected, the share of rural non-agricultural income increases, with increasing levels of GDP per capita (Figure 1) and as such, its complement, agricultural income, declines with higher GDP levels. Off-farm sources of income account for 50 percent of total income in almost two-thirds of the countries of the dataset (Table 4). This is true of all of the countries from Eastern Europe and Latin America and for all but Vietnam among the Asian countries in the sample. On-farm sources of income tend to be more important for the African countries, where the shares range from 59 to 78 percent of total income. Joining together income from agricultural wage labour with crop and livestock production, around half (9 of 16) of the countries in this dataset had a majority of income from agricultural sources.

These results speak of a highly diversified rural economy and suggest that rural households employ a wide range of activities. The question remains, however, over whether households tend to specialize in activities with diversity in activities across households or, alternatively, whether households themselves tend to diversify their activities thereby obtaining income from a range of activities. To answer this question, we examine the degree of specialization and diversification by defining a household as specialized if it receives more than 75 percent of its income from a single source and diversified if no single source is greater than that amount.[82] This provides a sense of the degree of specialization and of the activities through which households specialize, though we are limited from delving into greater details about this specialization by the way in which household survey data are typically collected. The apparent diversification shown in the data may be due to aggregation across seasons (with households specializing seasonally) or across individuals, with specific household members specializing in different activities.

In any case, household diversification, not specialization, is the norm, as can be seen in the data presented in Table 8. Not only are most rural economies highly diversified, but rural households are as well. With the exception of the African countries where it is still most common to specialize in on-farm activities, the largest share of rural households is diversified. When households do specialize, in a majority of cases this specialization is in on-farm activities, although the shares decline with higher per capita GDP. At higher GDP levels specialization in non-agricultural wages becomes more important, whereas no distinct association between GDP levels and specialization in agricultural wage or self-employment is suggested by the data.

This is illustrated in Figure 2 with the average country shares of specialization and diversification identified by the country data points in the figure and the trend lines for the first, third and fifth expenditure quintile. The share of diversified rural households increases only at the higher levels of per capita GDP for low and high income households alike. Clearer patterns linked to the level of development emerge for specialization in farming (declining with GDP), and in non-agricultural wage labour (increasing with GDP for all but the poorest households in the first quintile). In the former case two countries appear to be significantly distant from the pattern set by the others: Nigeria (high share of farm specializers for its GDP level) and Bangladesh (low share). In the latter case, the only significant 'outlier' is Pakistan with a relatively high share of non-agricultural wage specializers for its GDP level.

4.2 Sensitivity of the Characterisation of Agricultural Households to the Criteria for Defining Such Households[83]

Given the diversity of income generating activities in which rural households tend to be involved, defining what constitutes an agricultural household becomes a difficult task. Policy interventions and price changes reallocate income from agricultural households to others and vice versa. Precisely defining the agricultural household is important, particularly when measuring the poverty impact of changes in policy and in the overall economic environment.

[82] Other definitions of diversification and specialization are possible. We also looked at using 100 percent and 50 percent of income from a single source as alternative thresholds to define specialization, in order to ascertain the robustness of our results. The extent of diversification is clearly affected by the choice of the threshold, which drops to around 10 percent or less in all cases when using the 50 percent definition and climbs to around 90 percent when using the 100 percent definition. The broad patterns by country and by level of welfare discussed in this section, however, do not change with the choice of the threshold. Similarly, alternative groupings of income categories are also possible, such as joining together agricultural and non agricultural wage labour, or non agricultural wage labour and non agricultural self employment, which would increase the share of household specializing.

[83] This section is based on Aksoy et al. (2009).

One definition widely used in the literature equates rural with agriculture, thus treating all rural households as agricultural or farming households. Although this may be an appropriate definition in some country contexts, it is subject to some limitations. Firstly, it discounts the fact that farming is often widely practiced in urban and peri-urban areas. Another important shortcoming is the inconsistent definition of rural and urban across countries, which this paper elaborates upon in Section 2.

A second definition uses sources of income to classify households as agricultural or non-agricultural. By this measure, households that earn any income from crop and livestock production are defined as farming households. This is similar to the broad definition that is used in the OECD country studies and also used in the Luxemburg Income Study (LIS) and can thus be used for comparative purposes. Although it is more specific than equating rural with agricultural, this definition also has the limitation of identifying as agriculturally-oriented households with only small shares of agricultural income, namely those that maintain some subsistence production, but are actually more fully employed in other sectors. In the sample of surveys used in Table 9 (which combines RIGA and non-RIGA data), almost 93 percent of households in Vietnam, and 97 percent in Bolivia have some positive agricultural income. Similarly 41 percent of all urban households have some income from agricultural activities. The results indicate that this appears to be too loose a definition to satisfactorily identify farm households in developing countries.

A variation of this definition uses a cut-off point of the level of income originating from agricultural activities. Households that earn more than a given level of income from agriculture are classified as agricultural households. Clearly, there are no "a priori" correct cut-off points. In Table 9, two thresholds are used: 10 and 30 percent. In other studies, thresholds of up to 50 percent are also used[84] and, as Table 9 demonstrates, results change according to the selection of the cut-off points.

Finally, a third approach consists in defining farming or agricultural households based solely on the occupation of the household head. As with the other definitions, caveats exist, the main one in this case is assuming that the household head's main activity is representative of that of all household members. This definition also ignores the tendency, as described in Section 4.1 for households to diversify their income sources.

Table 9 presents the share of households under the various definitions. The share of the rural population varies between 88 percent in Malawi, to 36 percent for Peru. Latin American countries have much lower share of rural populations. Countries in the Asia sample of surveys have the greatest share of rural households and the Africa surveys fall in between. With respect to the income cut-off point definitions, the table also shows that using a threshold of 10 percent of income from agriculture eliminates most of the marginal agricultural producers, and reduces the share of households classified as farmers from 72 percent of all households to 57 percent. Increasing the cut-off point to 30 percent reduces this share to only 46 percent suggesting that most of the marginal agricultural producers have agricultural incomes at levels below 10 percent. This change is more dramatic in urban areas where about 41 percent of urban households have some positive income and when the cut-off point is increased to 10 percent, the share drops to 21 percent.

With the 10 percent definition, almost 23 percent of rural households would not be classified as agricultural households, and 21 percent of urban households earn enough agricultural income to be classified as agricultural households. Even at 30 percent, 13 percent of urban households would be classified as agricultural households, and 37 percent of rural households would not be classified as agricultural households. Using the 30 percent cut-off point, two countries, Cambodia and Madagascar have much higher shares of urban households who can be classified as farmers. To a lesser extent, Malawi and Ghana also have high urban agricultural income shares. This might be due to a different rural-urban classification system for these countries, to more extensive urban and peri-urban agricultural production, or to a combination of these factors. Similarly the Bangladesh data

[84] These cut-off points for identifying agricultural households should not be confused with the thresholds for specialization in agriculture, described in the previous section.

report a much lower share of rural households earning more than 30 percent of their income from direct agricultural production.

Table 9 shows the share of households that earn more than 30 percent of their income from agricultural production and the share of households where the household head classifies its sector of operation as agriculture. For the 14 surveys for which this information was estimated, the share of agricultural households who classify their occupation as agriculture is about 46 percent. For the same countries, 46 percent of the households have income above that the 30 percent threshold. Of course the share of households classified as agricultural under the two definitions varies significantly for individual countries. In both urban and rural areas, the unweighted averages point to more households defining their sector of occupation as agriculture than the households earning more than 30 percent of their income from agriculture; but, this result is not robust across countries and thus no generalization should be made.

One more definitional measure is the share of households that classify their occupations as agriculture and also have agricultural incomes which constitute more than 30 percent of their total income. Only about 57 percent of rural households (32 percent of all households) meet each of the three definitions of being an agricultural household. That is, they are located in rural areas, the head of the household lists agriculture as his main occupation, and they earn more than 30 percent of total household income directly from agricultural activities. It is worthwhile to highlight the heterogeneity of the households under each definition. The physical and social characteristics, needs and capabilities of households vary depending on the definition applied; therefore, the interpretation of data about agricultural households should consider those differences.

Another important lesson from this data is the misleading nature of identifying rural with agricultural and urban with non agricultural activities. An important proportion of households with significant agricultural incomes reside in urban areas, as demonstrated for Madagascar, Cambodia, Malawi, Ghana, and Nepal. Overall, more than 12 percent of urban households identify agriculture as their main occupation. Similarly, a significant number of households in rural areas, ranging from 15 to 65 percent, do not earn more than 30 percent of their income from agriculture. While some share of these households might be agricultural labourers etc, the numbers are still large. On average, almost 30 percent of rural households do not list agriculture as their main occupation.

The main message of this discussion is that even if no universal definition of an agricultural household exists, analysts of data from low-income countries need to be especially aware of the sensitivity of their results to small changes in the definition of an agricultural household. Not only do the number and proportion of households defined as agricultural vary, but their profile and overall characteristics may also change in several important dimensions having far-reaching implications on an analysis if not adequately considered (see Aksoy et al. (2009) for a more comprehensive discussion).

5. Summary of Recommendations and Conclusions

In this paper we have tried to contribute an analyst and practitioner perspective to both the conceptual and analytical motivations, as well as the practical concerns related to measuring household level income in developing countries, focusing in particular on multi-topic household survey data. It is worth emphasising how from the perspective of the analyst there are several additional uses of household income information beyond those most widely cited in the statistical literature (income as a measure of well-being, and as a source of data on economic inequality). The income data from the RIGA database, for instance, are being used for a number of analytical application as diverse as looking at the importance of specific subsectors within the rural economy (e.g. the livestock sector, or the staple vs. commercial crop sector), the extent to which farm rural households are oriented towards commercialization rather than subsistence production, or the impact of economic shocks on household well-being (for instance in the case of the recent food price crisis). None of these analyses are possible at a reasonable level of accuracy if reliable information on income and its components is not available.

We have also tried to emphasise how in low-income countries the characterisation of the agricultural household is particularly sensitive to issues of definition. Not only do the number and proportion of households defined as agricultural/farm change, but their profile and overall characteristics change in several important dimensions as different criteria and thresholds are applied.

On a more specific level, this paper focused on the process of constructing income aggregates with the aim of addressing the most common obstacles encountered when undertaking this endeavour. Accurately estimated income aggregates serve as important indicators of household well-being and provide a wealth of information about income strategies, inequality and the structure of the overall economy that can complement welfare and poverty analyses which are conducted with consumption data. We identify several problems that analysts encounter in the process of creating income aggregates and provide recommendations for how to surmount those obstacles. However, it is important to note that the accuracy of the constructed income aggregates and analysts' ability to deal with these issues are largely dependent on data availability and data quality which ultimately depend on the proper design and implementation of household surveys. A well-designed household survey that aims to provide accurate data for both consumption and income aggregations enables analysts to create more precise income estimates with fewer assumptions tied to them, ultimately increasing the usability of the constructed indicator as a complementary measure of household welfare and improving the quality of livelihoods analyses based on survey data.

We identified several common categories of issues across various surveys that consistently hinder the estimation of precise income measures. Our main conclusions from these issues are summarized below.

Reference Periods and Frequencies. The key consideration in dealing with reference periods and frequencies should be to ensure that the information provided from the questions asked in the survey is sufficient to create reliable annual estimates and that the chosen reference period coincides with respondent's ability to report as accurate figures as possible. It is important that the chosen reference period is appropriate for the type of survey module such that reference periods will vary across survey modules. In general, infrequently earned income is better off reported with a broader reference period whereas consistent, frequent and regular sources of income should be reported on a shorter time frame. It is vital for surveys to include questions regarding frequency with which income is received in order to enable the annualization of income indicators.

Units and Coding. Inconsistency in units and coding across modules and questionnaires and the lack of appropriate conversion factors can result in problems with data processing. The usage of country-specific units, with which survey respondents are more familiar, allows survey respondents to more accurately report their earnings and expenditures and thus should not be eliminated for the sake of standardized ones. Nevertheless, it should be ensured that whatever kinds of units are chosen, that they are used consistently across modules to enable intra-module comparison. It is absolutely necessary that equivalence scales and/or tables for the conversion of local units to standard units be provided with the survey. With respect to coding, crop, occupational and other codes should be structured in a manner that enables intra-module, intra-year and international comparison.

Dealing with Costs. Income aggregates are based on sources of regular and/or recurring income and expenditures. Household surveys should be structured in a manner that clearly separate questions regarding investments and durables. The misclassification of expenditures can result in understated income figures and a bias the final income aggregate estimates. Clarification on whether income reported is net or gross should also be included followed up by the value of all possible withholdings.

The principal considerations presented in this paper are a valuable set of points that we recommend be reflected upon by future analysts as well as those involved in the design and drafting of household surveys. The resolution of these issues in future household surveys will not only benefit the generation of cross-survey comparable income estimates, but also the estimation of income for individual countries, particularly when an analysis spans more than one year. This paper is certainly not an exhaustive list of the issues for dealing with household surveys but it does establish a core set of "best practices" based on the first-hand experience of creating comparable and consistent income aggregates for 34 household surveys, which should serve as a set of useful considerations in the future design of household surveys and the analysis of data obtained from those surveys.

References

Aksoy, A., Beverinotti, J., Covarrubias, K. & Zezza, A. (2009). Household Income Structures in Low Income Countries, Forthcoming.

Canberra Group (2001). *Expert Group on Household Income Statistics: Final Report and Recommendations*. Ottowa.

Chander, R., Grootaert, C., & Pyatt, G. (1980). Living Standards Surveys in Developing Countries, The World Bank, Living Standards Measurement Study Working Paper No.1.

Coudouel, A., Hentschel, J.S., & Wodon, Q.T. (2002). Poverty Measurement and Analysis, in: *PRSP Sourcebook*, The World Bank, Washington D.C.

Davis, B., Winters, P., Carletto, G., Covarrubias, K., Quiñones, E.J., Zezza, A., Stamoulis, K., Azzarri, C., & DiGiuseppe, S. (2009). A Cross Country Comparison of Rural Income Generating Activities, *World Development*, Forthcoming.

Deaton, A. (1997). *The Analysis of Household Surveys: A Microeconometric Approach to Development Policy.* Johns Hopkins University Press.

Deaton, A. & Grosh, M. (Eds.) (1998). Consumption, in: *Designing Household Survey Questionnaires for Developing Countries: Lessons from Ten Years of LSMS Experience*, Grosh, Margaret & Paul Glewwe, eds., The World Bank.

Deaton, A. & Zaidi, S. (2002). Guidelines for Creating Consumption Aggregates for Welfare Analysis, The World Bank, Living Standards Measurement Study Working Paper 135.

de Ferranti, D., Perry, G.E., Foster, W., Lederman, D., & Valdés, A. (2005). *Beyond the City: The Rural Contribution to Development*. The World Bank: Washington, D.C.

De Mel, S., McKenzie, D.J., & Woodruff, C. (2007). Measuring Microenterprise Profits: Don't ask how the sausage is made, World Bank Policy Research Working Paper 4229.

FAO (1998). *The State of Food and Agriculture: Rural Non-Farm Income in Developing Countries*, Rome: Food and Agriculture Organization.

Glewwe, P. (2005). An overview of questionnaire design for household surveys in developing countries, in: *Household Sample Surveys in Developing and Transition Countries,* United Nations, Department of Social and Economic Affairs, Statistics Division, Studies in Methods, Series F, No. 96.

Gradín, C., Cantó, O., & del Río, C. (2004). Inequality, Poverty and Mobility: Choosing Income or Consumption as Welfare Indicators, Prepared for the 28th General Conference of The International Association for Research in Income and Wealth, Cork, Ireland, 22-28 August.

Grosh, M. & Glewwe, P. (2000). *Designing Household Survey Questionnaires for Developing Countries: Lessons from Fifteen Years of Living Standard Measurement Study*, The World Bank.

Grootaert, C. (1982). The Conceptual Basis of Measures of Household Welfare and their Implied Survey Data Requirements, The World Bank, Living Standards Measurement Study Working Paper No.19.

Haggblade, S., Hazell, P.B.R. & Reardon, T. (2007). *Transforming the Rural Nonfarm Economy: Opportunities and Threats in the Developing World*.

Hentschel, J., & Lanjouw, P. (1996). *Constructing and Indicator of Consumption for the Analysis of Poverty: Principles and Illustrations with Reference to Ecuador*, The World Bank, Living Standards Measurement Study Working Paper No.124.

ILO (2003). Report II: Household income and Expenditure Statistics, Prepared for the Seventeenth International Conference of Labour Statisticians, Geneva, 24 November.

Kamanou, G., Ward, M., & Havinga, I. (2005). Statistical Issues in Measuring Poverty from Non-Survey Sources, Chapter 5 of Draft Resolution.

Kozel, V. (1990). The Composition and Distribution of Income in Cote d'Ivoire, The World Bank, Living Standards Measurement Study Working Paper No.68.

Lanjouw, P. and Feder G. (2001). Rural Nonfarm Activities and Rural Development: From Experience towards Strategy, Rural Development Strategy Background Paper #4, The World Bank.

Lipton, M., & Ravallion, M. (1995). Poverty and policy, in: *Handbook of development economics, Vol. 3*, Behrman, J. & Srinivasan, T.N. (Eds). Amsterdam: North Holland.

Johnson, M., McKay, A.D. & Round, J.I. (1990). "Income and Expenditure in a System of Household Accounts: Concepts and Estimation" The World Bank, Social Dimensions of Adjustment in Sub-Saharan Africa Working Paper Series, No. 10.

McKay, A. (2000). Should the Survey Measure Total Household Income? in: *Designing Household Survey Questionnaires for Developing Countries: Lessons from Fifteen Years of Living Standard Measurement Study*, Grosh, M., & Glewwe, P. (Eds.), The World Bank, 83-104.

Mohadjer, L., & Choudhry, G.H. (2001). Adjusting for Missing Data in Low-Income Surveys, in: Citro, C., Moffitt, R., & Ver Ploeg, M. (Eds.) *Data Collection and Research Issues for Studies of Welfare Populations*. National Academy Press, Washington, DC.

Nestic, D. (2003). Inequality in Croatia in the Period from 1973 to 1998, Institute of Public Finance, Occasional Paper No. 17.

Pettersson, H. (2005). Survey design and sample design in household budget surveys, in: *Household Sample Surveys in Developing and Transition Countries,* United Nations, Department of Social and Economic Affairs, Statistics Division, Studies in Methods, Series F, No. 96.

Ravallion, M. (1992). Poverty Comparisons: A Guide to Concepts and Methods, The World Bank, Living Standards Measurement Study Working Paper No.88.

Richard R. (1994). Issues relating to the UN system of national accounts and developing countries, *Journal of Development Economics*, 44, 77-85.

Saunders, C. & Grootaert, C. (1980). Reflections on the LSMS Group Meeting, The World Bank, Living Standards Measurement Study Working Paper No.10.

Scott, C., de Andrew, P.T.A., & Chander, R. (1980). Conducting Surveys in Developing Countries: Practical Problems and Experience in Brazil, Malaysia, and the Philippines, The World Bank, Living Standards Measurement Study Working Paper No.5.

Tanzi, V. & Howell H. Zee (2000). Tax Policy for Emerging Markets: Developing Countries, *National Tax Journal.* 53(2): 299-322. June.

Wahab, M. & Wahab, A. (1980). Income and Expenditure Surveys in Developing Countries: Sample Design and Execution, The World Bank, Living Standards Measurement Study Working Paper No. 9.

Winters, P., De la O, A.P., Quiñones, E.J., Hertz, T., Davis B., Zezza, A., Covarrubias, K., & Stamoulis, K. (2008). Rural Wage Employment in Developing Countries, Under review at *Oxford Development Studies*. *The Wye City Group Handbook, Rural Households' Livelihood and Well-Being: Statistics on Rural Development and Agriculture Household Income*. (2007) United Nations: New York and Geneva.

Table 1 - RIGA Surveys

COUNTRY	Name of Survey	Year of Survey
Africa		
Ghana	Ghana Living Standards Survey- Round Two	1992
Ghana*	Ghana Living Standards Survey- Round Three	1998
Kenya	Kenya Integrated Household Budget Survey	2004-2005
Madagascar	Enquête Permanente Auprès des Ménages	1993-1994
Madagascar	Enquête Permanente Auprès des Ménages	2001
Malawi*	Integrated Household Survey-2	2004-2005
Nigeria*	Living Standards Survey	2004
Asia		
Cambodia	Socio-Economic Survey	2004
Bangladesh*	Household Income-Expenditure Survey	2000
Bangladesh	Household Income-Expenditure Survey	2005
Indonesia	Family Life Survey- Wave 1	1992
Indonesia*	Family Life Survey- Wave 3	2000
Nepal	Living Standards Survey I	1995-1996
Nepal*	Living Standards Survey I	2003
Pakistan	Integrated Household Survey	1991
Pakistan	Integrated Household Survey	2001
Vietnam	Living Standards Survey	1992-1993
Vietnam*	Living Standards Survey	1997-1998
Vietnam*	Living Standards Survey	2000
Eastern Europe		
Albania	Living Standards Measurement Survey	2002
Albania*	Living Standards Measurement Survey	2005
Bulgaria	Integrated Household Survey	1995
Bulgaria*	Integrated Household Survey	2001
Tajikistan*	Living Standards Survey	2003
Tajikistan	Living Standards Survey	2007
Latin America		
Bolivia	Encuesta de Hogares	2005
Ecuador*	Estudio de Condiciones de Vida	1995
Ecuador	Estudio de Condiciones de Vida	1998
Guatemala*	Encuesta de Condiciones de Vida	2000
Guatemala	Encuesta de Condiciones de Vida	2006
Nicaragua*	Encuesta de Medición de Niveles de Vida	1998
Nicaragua*	Encuesta de Medición de Niveles de Vida	2001
Panama	Encuesta de Condiciones de Vida	1997
Panama*	Encuesta de Condiciones de Vida	2003

* Denotes the surveys also forming part of the RIGA-L dataset.

Table 2 - RIGA Income Aggregate Components

WAGE EMPLOYMENT	Agricultural	Agriculture & fishing, Skilled
		Agriculture & fishing, Unskilled
		Agriculture & fishing, Unknown
	Non-agricultural	Mining- Skilled
		Mining- Unskilled
		Mining- Unknown
		Manufacturing- Skilled
		Manufacturing- Unskilled
		Manufacturing- Unknown
		Electricity & Utilities, Skilled
		Electricity & Utilities, Unskilled
		Electricity & Utilities, Unknown
		Construction, Skilled
		Construction, Unskilled
		Construction, Unknown
		Commerce, Skilled
		Commerce, Unskilled
		Commerce, Unknown
		Transport, Storage, Skilled
		Transport, Storage, Unskilled
		Transport, Storage, Unknown
		Finance, Insurance, Skilled
		Finance, Insurance, Unskilled
		Finance, Insurance, Unknown
		Services, Skilled
		Services, Unskilled
		Services, Unknown
		Other, Skilled
		Other, Unskilled
		Other, Unknown
Self Employment	Agricultural	Agricultural Processing
	Non-agricultural	Mining
		Manufacturing
		Electricity & Utilities
		Construction
		Commerce
		Transport, Storage and Communications
		Finance, Insurance and Real Estate
		Services
		Other
Crop Production	Crop income (1)	
	Crop income (2)	
Livestock Production	Livestock income	
Transfers	Private Transfers	
	Public Transfers	Pensions
		Social Transfers
Other Income Sources	Non farm Rental Income	
	Farm Rental Income	
Total Income	Other Total income	Wage + Self employment + Crop (*1 or 2*) + Livestock + Transfers + Other

Table 3 - Methods to Determine Duration and Frequency Classifications

	Methods
Duration	- Months: If the number of months is not available, the number of days per year is divided by days per month to estimate the number of months per year worked.
	- Weeks: In the absence of months per year, weeks per year are used to designate full year or part year employment. It is estimated that 44 weeks are equivalent to 10 months.
	- Another way to determine the number of weeks worked per year is multiplying weeks per month by the number of months worked.
Frequency	- Hours per week: If the number of hours per week is unavailable, we divide hours per month by 4.35 (the estimated number of weeks per month) to get hours per week.
	- Days per week: In the absence of hours per week, days per week are used. Five days or more per week are assumed to designate full time status and less than five days per week as part time status.
	- When days per week are not available but hours per day are available, hours per day are multiplied by the number of days worked in a week.[85]

Table 4 - Recommended Reference Periods

ACTIVITY	Recommended Reference Period
Food consumption	Weekly or fortnightly
Crop production	Seasonal (previous season; or previous wet season and previous dry season, depending on the number of harvests/production seasons per year in the given country)
Crop expenditures	Annual
Livestock production	Annual
Livestock expenditures	Monthly
Wage employment	Weekly/monthly earnings for current or most recent work; annual earnings for infrequent or past jobs.
Self employment	Monthly (with data on frequency, as well as seasonality of earnings)
Transfers	Monthly (with frequency of receipt) or Annual
Other income	Annual

[85] In general, the median days per week worked for job 1 is six in most RIGA countries/surveys (the means and modes also hover directly around six). As a result, when days per week are not available six days per week is relied on for the purpose of facilitating analysis.

Table 5 - Unit Reporting in Agricultural and Consumption Modules

SURVEY	Number of Units	Comments	Equivalence Incl.?
Albania 2002	3 (crop; livestock) 1 (land)	Only standard units (gram, kilo, ton, litre, etc)	N/A
Albania 2005	3 (crop; livestock) 1 (land)	Only standard units.	N/A
Bosnia 2001	9 (consumption; crop; livestock) 5 (land)	Only standard units.	Yes
Bulgaria 1995	3 (consumption; crop; livestock) 1 (land)	"Unit" is an unspecified unit.	N/A
Bulgaria 2001	3 (crop; livestock) 1 (land)	"Unit" is an unspecified unit.	N/A
Ecuador 1995	22 (consumption, crop)	Includes non-standard units.	No
Ecuador 1998	23 (consumption, crop)	Includes non-standard units.	Yes
Ghana 1992	25 (crop)	Includes non-standard units	No
Ghana 1998	25 (crop)	Includes non-standard units	
Guatemala 2000	66 (total possible units)	Includes non-standard units	No
Malawi 2004	20 (crop) 4 (land)	Consistent across sections. Includes non-standard units.	No
Nepal 1996	10 (crop) 4 (land)	Includes non-standard units.	Yes
Nicaragua 2001	57 (total possible units) 27 (crop) 3 (land)	Includes non-standard units.	Yes, but incomplete.
Panama 1997	77 (crop, consumption)	Includes non-standard units.	No
Panama 2003	45 (crop, consumption) 2 (land)	Includes non-standard units.	No
Vietnam 1998	4 (crop; consumption) 1 (land)	Only standard units.	N/A

Table 6 - Reporting of Gross vs. Net Wage Income

SURVEY	Gross or Net	Are Tax Expenditures & Other Deductions Reported?
Albania 2002	Net	No
Albania 2005	Net	No
Bulgaria 1995	Both	Yes
Bulgaria 2001	Both	Yes
Ecuador 1995	Gross	Yes: Reported in Annual Non-Food Expenditures Module
Ecuador 1998	Gross	Yes: Reported in Annual Non-Food Expenditures Module[86]
Ghana 1992	Unclear/Both	Yes
Ghana 1998	Unclear/Both	No
Guatemala 2000	Gross	No
Malawi 2004	Not Specified	No
Nepal 1996	Unclear/Both[87]	Yes: Reported in Non-Food Expenditures Module.
Nicaragua 2001	Net	Yes: Reported in Non-Food Expenditures Module.
Panama 1997	Net	Yes: Reported in Annual Other Household Income and Expenditures Module.
Panama 2003	Gross	Yes: Reported in Annual Other Household Income and Expenditures Module.
Vietnam 1998	Unclear[88]	Unclear: Reported in Annual Non-Food Expenditures Module

[86] Same as Ecuador 1995.

[87] Household can report gross or net income, but if it reports gross (distinguished by a question asking "are taxes already deducted?") it is not asked to report how much in taxes it will pay. Income taxes are accounted for in the Non-Food Expenditures module; but, it is unclear if households that report net pay in the employment module report taxes in the Expenditures module. To make a clear distinction in either case is impossible and it is likely that either (1) wages reported as gross would be over-stated if taxes from the Non-Food Expenditures module are not accounted for or (2) wages reported as net would be understated if taxes are reported in the Expenditures module.

[88] The questionnaire states that in the reporting of the wage, the respondent should "exclude contributions to pensions, health insurance, etc" yet this does not specify if taxes should also be excluded.

Table 7 - Share of rural income generating activities in total income

	Income-generating activity												
	Group I							Group II		Group III			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(1) + (2) + (3)	(4) + (5) + (6) + (7)	(1) + (2)	(4) + (5)	(6) + (7)	(3) + (4) + (5) + (6) + (7)
Country and year	Agriculture-Crops	Agriculture - Livestock	Agricultural wage employment	Non-farm wage employment	Non-farm self-employment	Transfers	Other	*Agricultural total*	*Non-Agricultural Total*	*On-Farm Total*	*Non-farm total*	*Transfers & Other*	*Off-farm Total*
Malawi 2004	56.1%	9.4%	11.4%	7.4%	8.7%	6.6%	0.3%	*77.0%*	*23.0%*	*65.5%*	*16.1%*	*7.0%*	*34.5%*
Madagascar 1993	57.3%	13.2%	6.5%	6.1%	8.5%	6.2%	2.2%	*77.0%*	*23.0%*	*70.5%*	*14.6%*	*8.4%*	*29.5%*
Bangladesh 2000	15.5%	1.2%	20.2%	19.9%	16.4%	13.4%	13.4%	*36.9%*	*63.1%*	*16.6%*	*36.4%*	*26.8%*	*83.4%*
Nepal 2003	20.3%	17.7%	12.6%	21.1%	9.2%	16.8%	2.4%	*50.6%*	*49.4%*	*38.0%*	*30.2%*	*19.2%*	*62.0%*
Ghana 1998	55.0%	4.4%	1.4%	9.6%	20.5%	8.5%	0.5%	*60.9%*	*39.1%*	*59.4%*	*30.1%*	*9.0%*	*40.6%*
Tajikistan 2003	37.3%	17.4%	16.9%	11.5%	1.1%	15.5%	0.3%	*71.6%*	*28.4%*	*54.7%*	*12.6%*	*15.7%*	*45.3%*
Vietnam 1998	41.5%	14.8%	5.9%	9.2%	21.2%	7.0%	0.3%	*62.2%*	*37.8%*	*56.3%*	*30.5%*	*7.3%*	*43.7%*
Nigeria 2004	73.5%	4.3%	2.0%	7.1%	10.8%	1.7%	0.6%	*79.8%*	*20.2%*	*77.8%*	*17.8%*	*2.4%*	*22.2%*
Pakistan 2001	21.2%	11.4%	8.9%	28.8%	10.7%	14.5%	4.6%	*41.4%*	*58.6%*	*32.6%*	*39.5%*	*19.1%*	*67.4%*
Nicaragua 2001	21.1%	14.3%	21.4%	21.3%	11.1%	6.1%	4.6%	*56.9%*	*43.1%*	*35.4%*	*32.5%*	*10.7%*	*64.6%*
Indonesia 2000	23.8%	2.1%	9.7%	20.3%	17.6%	22.9%	3.6%	*35.5%*	*64.5%*	*25.8%*	*37.9%*	*26.5%*	*74.2%*
Guatemala 2000	27.6%	2.6%	19.9%	20.2%	12.4%	16.9%	0.5%	*50.1%*	*49.9%*	*30.2%*	*32.6%*	*17.3%*	*69.8%*
Albania 2005	17.2%	23.3%	2.8%	18.1%	7.4%	28.0%	3.2%	*43.3%*	*56.7%*	*40.5%*	*25.5%*	*31.2%*	*59.5%*
Ecuador 1995	9.0%	3.4%	10.3%	39.1%	23.2%	8.9%	6.0%	*22.8%*	*77.2%*	*12.5%*	*62.3%*	*14.9%*	*87.5%*
Bulgaria 2001	3.9%	12.0%	4.6%	16.5%	1.3%	60.5%	1.2%	*20.5%*	*79.5%*	*15.9%*	*17.8%*	*61.7%*	*84.1%*
Panama 2003	15.8%	2.0%	16.7%	27.1%	22.6%	14.6%	1.2%	*34.6%*	*65.4%*	*17.8%*	*49.7%*	*15.7%*	*82.2%*

Table 8 - Percent of rural households with diversified and specialized income generating activities

	Diverse Income Portfolio	Principal Household Income Source (>= 75% of Total Income)					
		Ag Wage	Nonag wge	Self Emp	Transfers	Other	Farm
Malawi 2004	39.3%	5.5%	5.6%	5.0%	2.5%	0.0%	42.0%
Madagascar 1993	30.6%	1.3%	2.8%	4.0%	1.4%	0.4%	59.4%
Bangladesh 2000	52.4%	11.4%	12.2%	10.5%	5.5%	2.2%	5.9%
Nepal 2003	52.5%	4.3%	11.7%	4.9%	6.9%	0.3%	19.4%
Ghana 1998	24.0%	0.6%	6.2%	15.4%	3.4%	0.2%	50.1%
Tajikistan 2003	54.3%	4.5%	3.7%	0.6%	4.8%	0.0%	32.0%
Vietnam 1998	44.3%	2.1%	1.9%	12.8%	1.2%	0.1%	37.7%
Nigeria 2004	14.7%	1.0%	5.5%	7.8%	0.9%	0.2%	69.9%
Pakistan 2001	36.1%	5.4%	19.3%	6.6%	9.1%	1.6%	21.9%
Nicaragua 2001	43.8%	12.7%	14.1%	6.2%	0.7%	0.4%	22.1%
Indonesia 2000	41.5%	5.9%	14.0%	10.5%	11.5%	1.1%	15.6%
Guatemala 2000	54.6%	8.7%	12.8%	5.6%	5.0%	0.1%	13.2%
Albania 2005	54.8%	1.4%	9.1%	5.0%	9.8%	0.5%	19.4%
Ecuador 1995	45.5%	13.2%	11.7%	8.9%	2.3%	1.1%	17.4%
Bulgaria 2001	41.1%	1.8%	9.3%	1.4%	43.1%	0.1%	3.4%
Panama 2003	48.8%	9.6%	20.0%	10.0%	6.6%	0.1%	4.8%

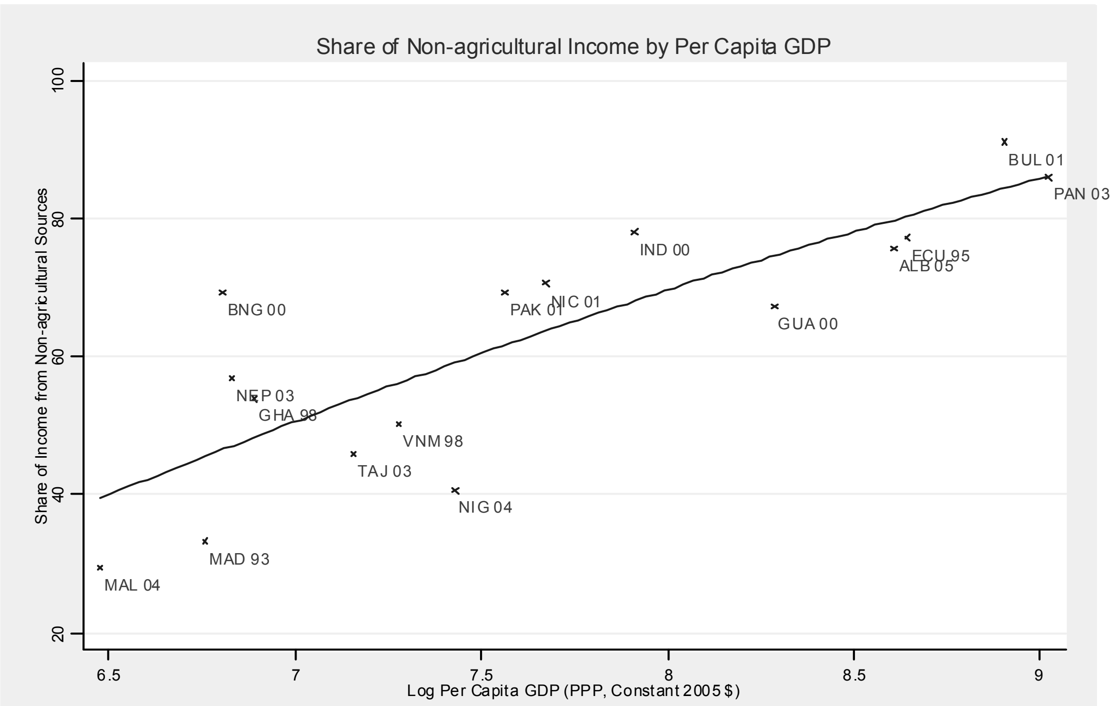
Outlined cells represented the greatest share of households for a given country dataset; shaded cells represent the highest among specializing households

Table 9 - Shares of Rural and Agricultural Income Households

COUNTRY AND YEAR	GNI per capita (PPP) 2005	Percent Rural	Shares of Households with Positive Agricultural Income			Shares of Households with Agricultural Income greater than 10%			Shares of Households with Agricultural Income Greater than 30%			Share of Agricultural Households by Occupation		
			Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Ethiopia 2000	630	50.7	13.7	91.4	71.3	11.0	84.5	65.4	7.9	76.1	58.4	6.7	89.4	67.9
Malawi 2004	640	88.1	39.0	95.8	89.0	31.9	92.5	85.2	21.5	85.1	77.5	21.8	72.3	66.3
Zambia 1998	1090	47.8	33.9	93.2	70.1	20.2	87.7	61.4	11.0	78.5	52.2	5.6	75.6	48.4
Nepal 2003	960	87.4	56.0	95.6	90.6	32.8	85.6	78.8	18.2	65.8	59.8	20.8	53.7	49.5
Ghana 1998	1140	63.3	32.1	84.9	65.5	28.2	77.9	59.7	22.7	69.4	52.3	22.7	67.2	49.7
Cambodia 1999	1380	60.0	49.1	92.6	86.1	42.2	87.3	80.6	35.4	78.1	71.7	n.a.	n.a.	n.a.
Bangladesh 2000	1120	79.7	19.1	71.9	61.3	8.3	51.7	43.0	4.3	32.3	26.7	10.5	57.6	48.2
Vietnam 1998	2100	71.2	74.5	98.5	92.7	20.8	90.8	73.9	10.9	78.8	62.3	11.2	76.8	60.8
Madagascar 2001	820	75.8	34.0	83.1	71.2	31.8	79.8	68.2	29.6	74.4	63.5	24.1	74.6	62.3
Nicaragua 2001	2250	43.9	72.8	92.7	80.5	25.6	74.2	44.4	12.2	54.9	28.7	11.2	59.2	29.8
Pakistan 2001	2280	71.0	18.8	71.1	55.9	9.9	59.3	44.9	6.3	49.9	37.3	4.4	42.5	31.5
Bolivia 2002	3610	42.0	95.7	96.5	96.0	18.4	79.5	41.3	4.2	64.3	26.7	5.7	78.6	33.0
Guatemala 2000	4030	56.7	43.3	90.8	70.2	18.1	69.1	47.0	9.0	48.4	31.4	12.3	58.9	38.7
Perù 2003	6030	35.9	14.0	89.8	37.5	8.0	76.3	29.2	4.2	55.9	20.3	14.6	84.9	36.4
Ecuador 1995	6390	37.4	21.8	80.7	43.9	9.8	64.1	30.1	4.6	45.5	19.9	6.4	80.0	26.4
Unweighted average	2295	60.72	41.19	88.57	72.12	21.14	77.36	56.87	13.49	63.83	45.92	12.7	69.4	46.4

Source: Aksoy, et al. (2009)

Figure 1 - Share of rural non-agricultural income by per capita GDP



Notes: 1. Non-agricultural income is comprised of income earned from non-agricultural wages, self employment, transfers and other income.
2. Fitted curve fits the quadratic prediction of the income shares on per capita GDP.

Figure 2 - Share of diversified, on-farm and non-agricultural wage specializing households, by per capita GDP

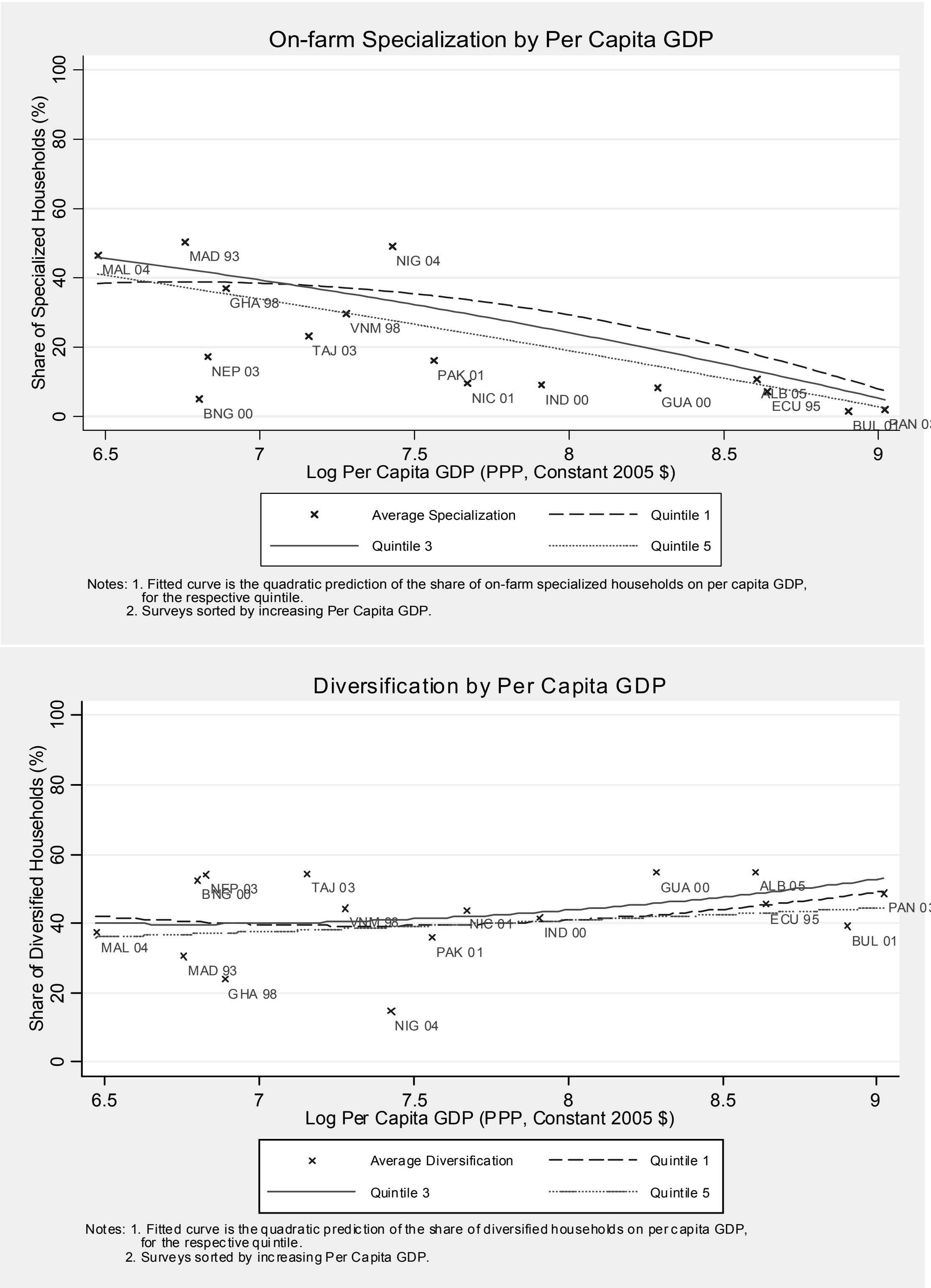
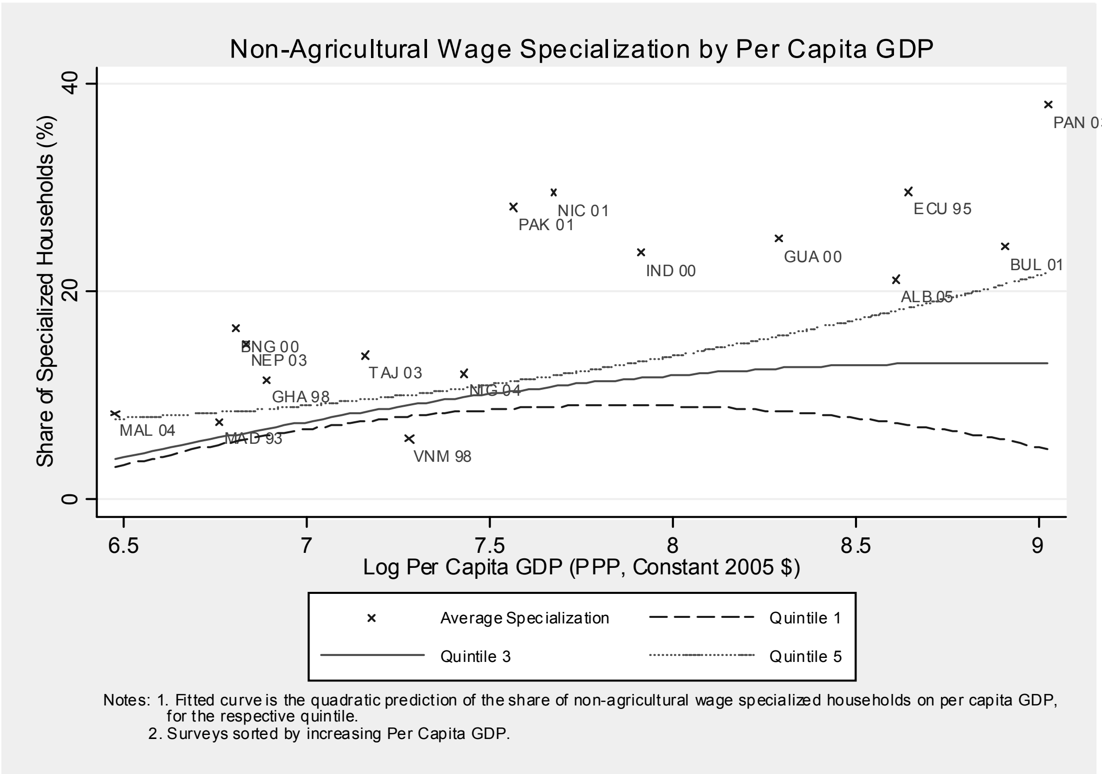


Figure 2 follows - **Share of diversified, on-farm and non-agricultural wage specializing households, by per capita GDP**



Annex 1 - Detailed issues concerning outlier checks and imputation procedures in RIGA

A major concern in the entire RIGA project has been that of avoiding that differences in definitions and data manipulation procedures could affect the results of the analysis. Standard protocols have therefore been developed to treat the data as consistently as possible across surveys. This Annex provides a discussion of the procedures adopted in dealing with outliers and data imputation procedures.

A.1. Outlier Checks

Raw data are assumed to have been already checked for consistency and erroneous values; therefore, in creating the RIGA income aggregate components, checks for outliers are performed only on constructed variables. Such transformations include, but are not limited to: annualizing the original variable; collapsing the data from individual to household level; and multiplying the price received by the quantity sold. In order to obtain comparable estimates of the income aggregate components, there must be consistency as well in the methodology for outlier checks. Different approaches exist by which extreme values can be identified and imputed; this section describes the RIGA approach for undertaking this task.

The outlier check is performed twice, following the same procedure each time. For a given variable, the values are divided by one to two relevant subgroups, for example, crop code for checking the values of crop sales, or industry sector and skill level for wage employment income. For variables without a logical sorting variable and for variables in which the logical sorting variable does not include a sufficient number of observations in the sorting category, an administrative unit variable, such as district or region, is used as the sorting variable. The choice of the sorting variable for the outlier check must be carefully undertaken so to avoid potential endogeneity when performing empirical analyses. Outliers are identified as values greater or less than three standard deviations from the median value of the variable for the specific sorting group. The outlier values are flagged and then replaced with the median value of the variable within the corresponding sorting category. This procedure is described in more detail, along with its corresponding Stata syntax, in Annex 2. After completing the first check for outliers, the data is summed at the household level (or transformed in some other way, if already at the household level) and final aggregate variables are computed. The outlier check is repeated on these variables using an administrative or geographic unit as the categorical sorting variable.

For all outlier checks, zeroes and missing values in the income and expenditure variables in question are excluded from the calculation of the median and standard deviation as well as from the identification of outlier values in order to achieve accurate imputations. Since some income activities may have a significant share of non-participants, a notable share of the values in income and expenditures may be zero or missing. The exclusion of these values ensures the estimation of the median and standard deviation is not skewed and that households with missing values are not erroneously assigned income or expenditures. Further, in order to avoid mis-identifying and mis-imputing outliers, the standard outlier check is performed on groups of minimum 50 observations whenever possible. Smaller groups have greater variance and as such increase the possibility of flagging values as outliers, even when none may be present.[89]

One final outlier check is imposed after the construction of the income aggregate to deal with extreme income shares that arise following the aggregation of all income components. After estimating the shares of the seven principal income categories (agricultural wages, non-agricultural wages, crop, livestock, self employment, transfers and other) in total income, observations whose share is greater than or less than 3 (indicating a percentage share of +/- 300%) are dropped from the aggregate, a procedure that leads to the loss of a small yet distortionary share of observations in each survey, usually representing less than 1 percent of the sample. The fact that such extreme shares exist are a product of two factors. The first is the estimation a net income figure: taking into consideration costs related to income generating activities reveals that some households incur net losses in certain activities. Most often, negative income is obtained in self-employment activities in which households incurred substantial costs (e.g. wholesale purchases or high labour costs) but did not report returns that offset those expenditures. However, since the nature of household pluriactivity is such that the losses in one activity can be offset by gains in another activity, in most cases, only a small share of households have negative total household income (see Table A2). Recognizing this possibility, the second factor driving extreme income shares is the persistence of problematic data. The magnitude of certain losses (or gains) are undoubtedly implausible and are attributed to erroneous values introduced either at the data collection stage (due to recall error, enumerator error, or flawed survey design) or at the data entry stage.

Two amendments for flagging outliers in the original procedure apply in the construction of the wage income aggregates in RIGA-L. First, outlier checks are weighted according to the weights provided by each survey. Secondly, outlier checks use the logged wages of monthly income variables instead of the “raw” wages. Although this approach is diverges from the one taken in the construction of the RIGA household level aggregates, the difference in the number of the cases affected is trivial (see Annex 2 for more detail on this procedure).

Here is it worthwhile to note that the approaches selected by RIGA for identifying and imputing outliers are one of multiple possibilities. Whereas other methodologies exist for dealing with outliers- such as regression imputations, the elimination of all negative values, nearest neighbour matching- the above-described methodology is one that is possible to replicate in a systematic manner across surveys applying limited assumptions and reducing the possibility of confounding empirical work with potential endogeneity.

[89] This criterion is adhered to in most cases; however, in some instances when there are few observations participating in labour employment, outlier check sub-groups may be slightly smaller.

A.2. Imputations

One major obstacle in working with survey data is the presence of missing and misreported values. Missing values can be identified in three categories:[90] under-coverage, unit non-response and item non-response. Of these three, it is item non-response which is of concern for the RIGA analysis since it is the failure of the respondent to respond accurately to a question posed by the interviewer or due to the interviewer's failure to ask or record a response to a question. Misreported/miscoded values arise either when the answer provided by the respondent does not logically correspond to the question, or in the data entry stage of the survey. In these instances, recoding and imputation procedures may be necessary.

A.2a Recoding

As it is always the case, some respondents choose not to answer or are unable to answer some questions in the questionnaire and as a result the answer is coded as missing. In other cases, the missing value is a natural result of the skip pattern in the questionnaire: for example, if a respondent answers "zero" when asked for the quantity of milk sold, a subsequent question regarding the price at which the milk was sold would be skipped and coded as missing. Missing values of this sort are preserved and not recoded. However, if the amount of milk sold is reported but the price is reported as missing, the price must be recoded to a logical, imputed value, a procedure described below. For the purpose of recoding, it is thus important to first distinguish between missing values resulting from intentional or unintentional omission and missing values caused by the skip pattern of the questionnaire

In the employment module, recoding time variables when these are either missing or erroneously reported is fundamental for calculating the duration of jobs (i.e. full-time jobs) and earnings at different time levels (i.e. daily wage or monthly income). When time variables are missing but income is reported, we procedure to replace those missing values with the median of the values reported. However, recoding also occurs when missing values are outside the range of possibility, i.e. when the number of reported months worked is 13 or when the reported of days worked in a week is 8. These instances exclusively refer to values that are too high, not those below a certain range. In these instances, values are recoded with the maximum possible value; as in the following example:

Box 3: *Recoding example*

Original (implausible) value	Maximum possible value	Recoded Value
Number of months worked = 13	12	12
Number of days per week worked = 8	7	7

Although the existing values are erroneous, it is more appropriate to replace them with their maximum possible value rather than the median, because it is assumed that the true value of these observations is at or closer to the maximum than to the median of the distribution. Table A3 is a list of maximums used, followed by a brief explanation wherever necessary.

Note that in order to calculate the maximum days of work in a year, 365.25 days are used instead of 365 days, to account for the extra day in the calendar every 4 years (leap year). Also, in the case of hours worked per day, 16 hours is a rather generous assumption, intended to minimize the number of observations that are changed and to allow for the instances when individuals work extraordinary numbers of hours in short periods. Both hours per day and hours per week assumptions (84 hours per week) allow so that no more than a handful of values are replaced.

[90] For more detailed explanation on these types of missing values, see: Mohadjer, L. & Choudry, G.H. (2001).

A.2b Imputation Procedures

Following the recoding procedure, imputations can be used (1) to correct values that are erroneously coded or reported; (2) to value a transaction that has a bearing on poverty or livelihoods but goes unreported or minimally reported in the survey; and (3) to appropriately assign values where they have been intentionally or unintentionally omitted. For the first case, outlier checks, as described above, are one form of imputations undertaken to deal with extreme values. Also corresponding to the first objective is the reassigning of miscoded values. For example, if the answer to a filter question (e.g. "Did you sell...?") is coded "No" yet all subsequent questions (which would correspond to quantity sold, price received, etc.) were answered, indicating the answer to the filter question should actually be "Yes", then the response to the filter question would be modified. Similarly, in the self employment module, if there is a missing value for a response to a question regarding the share of ownership in the household enterprise yet the response to another question states that the household is the sole owner of the enterprise, it would be necessary to recode the missing value to 100% so to be able to accurately weight self employment income by the share of ownership in the enterprise.

In the second case an imputation can be undertaken when it is necessary to capture the value of a transaction that is not adequately captured by data collection efforts. The most common example of this is the estimation of *imputed rent* in an income aggregate. This value of well-being is described by Deaton and Zaidi (2001) as "a measure in monetary terms of the flow of services that the household receives from occupying its dwelling." It is specifically used, in the consumption aggregate estimation in which current rent expenditure is considered, to assign a value to the use of the dwelling for households who own their dwelling so to avoid placing an upward bias on households that rent in their dwelling with respect to those who do not.

Whereas some methodologies include imputed rent in the income aggregate as a measure of household wealth that augments household disposable income,[91] viewing it as a productive asset from which households can derive consumption value (Johnson et al 1990), the RIGA project does not account for imputed rent in its aggregates. Also, a key principle followed in the RIGA project methodology is to not create income or costs where they are not explicitly reported. Assigning rental expenditures (or any other cost or income) to households that have not reported them in the survey counters the methodological approach of RIGA. Finally, even if the previous reasons were not concerns, a major caveat to the estimation and inclusion of imputed rent in the income aggregate computation when working with developing countries' household surveys is that the approach used is based on information for which there is usually limited data. Imputed rent is generated using a hedonic regression which uses reported data on actual rent paid out, along with other household characteristics, to obtain rental values for households that own their dwelling and therefore do not report rental income. As noted by Johnson et al (1990) housing rental markets for rural areas in developing countries are shallow since most households own their dwelling (see Table A1). Few households rent out an owned dwelling (since ownership is usually limited to one dwelling) and few rent-in their homes. Furthermore, many living standards surveys do not ask households to value the potential rental value of their owned dwelling, a fact that, when taken together with the limited data on actual dwelling rental income, implies that an imputation regression for this purpose would be based on a limited number of observations with little variability, and as such would likely generate poor estimates of dwelling rental values.

The third case in which imputations are used to replace missing values corresponds to estimating prices for variables that represent income or expenditures but are not given a monetary value or do not contain any information on price per unit. To value these income sources, we apply the price imputation approach proposed in Deaton and Zaidi (2002) using prices obtained from (1) sales data from the production modules of the survey; (2) the price questionnaire, if it exists; and finally (3) the consumption module of the survey.[92] Specifically, we use the data available in each of the three sources to obtain an overall unit price for each item. The median unit price is then estimated at different levels of the sample going from the narrowest level (item-unit prices in each cluster) to the broadest level (item-unit prices across the full sample). These imputed prices are then merged with the data on quantities (e.g. quantity consumed; quantity received as gift) and values are estimated

[91] For example, the Luxembourg Wealth Study and Chile's Encuesta de Caracterización Económica Nacional, CASEN.

[92] The consumption module prices are used only when imputing own consumption. Only in the rare cases when no price can be assigned to an own consumption quantity is the household-reported valuation used.

multiplying the quantities with the imputed sales prices, then with the imputed price questionnaire prices, and finally with the imputed prices from the consumption module, in each case applying the cluster-level prices first and following up with the sample-level item-unit prices. This procedure is demonstrated step-by-step in Annex 2 along with the Stata syntax used for the imputation.

The imputation of prices is also particularly relevant for obtaining estimates of household "own consumption," the consumption of crop and livestock items produced by the household. Surveys generally collect information on the quantity consumed but also ask households to place a value on their own consumption, an estimate that is not considered reliable since the household's estimate is unlikely to reflect the market price of the good. In this case it useful to impute, as described above, a set of market prices for valuing own consumption which is then incorporated in the estimation of total net agricultural income.

The RIGA income aggregates contain two estimates of crop income, "*crop1*" and "*crop2*". The former applies the own consumption estimated from the survey's agricultural production module whereas the latter uses own consumption estimated from the survey's food expenditure module.[93] The calculation of both figures leads to interesting findings. Firstly, the results demonstrate that the module from which own consumption is estimated matters greatly in terms of capturing the full extent of own consumption income. Participation rates for *crop2* are almost always greater than those for in *crop1* (see Table A4) indicating that there are a number of true subsistence producers (households that produce exclusively for consumption) that go unaccounted for in the *crop1* variable. This finding conveys the importance of using the reported own consumption from the food expenditure module, and therefore using *crop2*, to estimate total household income, whenever possible.

Taking this as given, it is then worthwhile to compare crop income levels and shares in total income across *crop1* and *crop2*, and thus to note how the contribution of crop income to total income varies significantly depending on the variable used. Although for both cases imputed prices are applied to estimate own consumption, in general more confidence can be placed on the results from *crop2*, since a broader range of items is considered (as *crop2* is generated from the expenditure module) and therefore a broader set of prices is applied[94] for the valuation of consumption. To summarize the differences in results, Table A4 reveals that in 21 of the 23 cases, participation in *crop2* is greater than for *crop1*. Meanwhile, in 12 of the 23 cases highlighted, the income level for *crop2* is greater than *crop1*; however, with respect to the share in total income, for 13 of the surveys is the share of *crop2* income greater than that of *crop1*. Although in theory one would anticipate *crop1* and *crop2* to produce comparable results, in practice, the two estimates are subject to great variability.

Many of the issues discussed in this paper are relevant in the generation of the imputed value of own consumption. Pulling own consumption data from different modules of the survey questionnaire to generate two versions of the same variable highlights the importance of reference periods, recall error, frequencies, and units and coding. By not adequately treating these issues in a given survey, it is likely that inconsistencies like those displayed in Table A4 will likely to reappear in other analyses.

One particular point of concern is how differences in the reporting of units and consistency may influence the gap between *crop1* and *crop2* estimates. Assigning prices from the *community price questionnaire* to the quantities reported in the *food expenditure module* in order to obtain the household consumption of own production for the *crop module* raises the issue of comparability of values because the units in which items are reported in each section are not necessarily consistent and obtaining a common unit for all items in each section is often impossible. This problem is most complicated when households are given the flexibility of reporting their crop production in the crop module in any unit. In the case of the Guatemala 2000 ENCOVI survey, households report crop sales and consumption in nearly 66 different units for which conversions are not readily available; not surprisingly, the difference between *crop1* and *crop2* in Table A4 is notable for this survey.

[93] In a small number of surveys, only one of the two crop variables was generated due to the non-existence of a food expenditure module, or the non-separability of own consumption as an independent variable in the expenditure module, or, rarely, since the agricultural module did not ask households to report their own consumption of production. The surveys affected include Indonesia 1993, Indonesia 2000, Tajikistan 2003, and Cambodia 2004.

[94] Although both *crop1* and *crop2* are generated using imputed prices, *crop1* only uses agricultural module prices which essentially represent farm-gate prices. Market prices would be inappropriate for valuing agricultural production.

Of course, the disparity in unit-reporting is for the obvious and unavoidable reason that in practice, households do not necessarily consume their food items in the same unit in which they produce. For example, a household may harvest 10 kilos of rice but instead records consumption of rice on in terms of grams or cups (i.e. *n* cups of rice are consumed for one meal on day *X*). Further, in the price questionnaire (when it exists for a given survey), items are reported on a per-unit basis, the unit corresponding to that which is most commonly found in the market: for apples it may be per kilo whereas for potatoes it may be per sack and for milk it may be per carton or per litre. Nonetheless, as discussed above, if survey data and/or documentation do not include equivalence factors or tables, finding an accurate unit price to assign to the quantity of household own consumption becomes complex and the estimation of the value of consumption will remain a rough rather than precise one. The estimation of precise values also can be further assisted by structuring questionnaires in a way to make the units comparable across sections.

The principal recommendations stemming from the process of price imputations reflect the same ideas summarized in the previous sections. The process of price imputations underscores the importance of dealing with the obstacles emphasized and the need to address these issues in all stages of income aggregate creation.

A.2c Additional considerations

Some methodologies for the estimation of aggregate income consider further adjustments and corrections to the data than those described within the RIGA methodology. Two cases worth highlighting are those of the rescaling of self employment income and that of accounting for price variability in the income estimation.

Several analyses of the quality of household income data have demonstrated that misreporting of self employment income is common and that survey instruments should be designed to minimize this misreporting (De Mel et al 2007). Misreporting may be unintentional due to recall error and the lack of accounting systems in the business, but it may be deliberately understated due to household concerns with taxation or also to convey an image of greater poverty in hopes of receiving social benefits that respondents perceive may be linked to the household survey. Attaining reliable self employment income data can be approached through proper questionnaire design (see De Mel et al 2007 for details on various methods), through the coordination and/or integration of different survey instruments, as well as through alternative or indirect estimation methods such as Germany's summation of consumption expenditure and savings to yield an estimate of income (Wye City Group Handbook 2007). Despite these possibilities, to date the RIGA methodology for calculating self employment income does not present new innovations for addressing underreporting. Household survey data will inevitably be subject to various kinds of errors and therefore income aggregates should be recognized as providing estimates rather than precise measures of household income levels and shares, a point that should be taken into consideration in the interpretation of any analyses and statistics produced from survey data.

Accounting for price variability is another relevant issue that is not always possible to address. Seasonal price fluctuations are not easily controlled for given that data collection for household surveys often is undertaken in a limited period of the year, on which is normally constrained to the months in which households are most accessible (usually outside the rainy season). Although this does not present an issue for the valuation of income and expenditures for which reference periods are the previous twelve months, some bias may be introduced for income sources with a shorter reference period and those for which imputed prices are applied in order to value income, specifically the valuation of own consumption. In this case, prices will be based upon the reference period of sold production and purchased food items. Overcoming this limitation in a clean and straightforward manner would require data collection to be spread throughout the year so that the household survey would naturally account for changes in prices, or perhaps for a price questionnaire to be administered at the community level several times per year in order to be able to track the evolution of market prices over a longer time frame.

Alternatively, though less accurately, questions could be incorporated into survey instruments that ask households about how the price received for their sold production (or on the price paid for purchased food consumption) compares at the time of the survey to different points in time in the twelve months preceding the survey interview. This approach is likely to be more practical with a low marginal cost, but it is subject to recall error and does not effectively collect price data, but a subjective perception of price changes, which could introduce other biases.

Taking these factors into consideration, the RIGA income aggregate estimation does not introduce adjustments for seasonal price variability. Without the adequate data, making such adjustments would require placing many assumptions for each survey's data construction which would possibly be idiosyncratic across surveys and thus limit the methodological consistency of each RIGA income aggregate. The RIGA project does account for regional price differences through its price imputation approach (described in A.2.b. above) in which prices are imputed and assigned at different administrative levels. Other, more conventional adjustments for regional price differences (e.g. regional price deflator) are not applied in the data construction process. They are relevant and recommended for analyses of income levels. To date, however, RIGA income analyses focus on income shares and participation rates and as such have not applied these sorts of additional adjustments.

Table A1 - Share of households owning dwelling *(full sample, select surveys [95])*

COUNTRY	Survey Year	Share Owning Home
Ecuador	1995	65.3%
Ghana	1992	37.0%
Ghana	1998	41.4%
Guatemala	2000	57.4%
Indonesia	2000	82.7%
Malawi	2004	80.6%
Nepal	1996	93.8%
Nicaragua	2001	77.6%
Nicaragua	1998	78.7%
Nigeria	2004	71.5%
Panama	1997	78.9%
Vietnam	1992	93.6%
Vietnam	1998	94.7%
Mean		*73.3%*

[95] Table reports means for surveys for which this variable was constructed. No other discretion was applied in the selection of surveys for this table.

Table A2 - Dropped households and negative income

COUNTRY	Year of Survey	Share of Households Dropped, Final Outlier Check	Share Households with Negative Income	
			Totincome1	Totincome2
Africa				
Ghana	1992	1.1%	12.9%	6.8%
Ghana	1998	1.8%	11.2%	7.6%
Madagascar	1993-1994	0.8%	2.2%	1.7%
Madagascar	2001	0.6%	0.9%	1.0%
Malawi	2004-2005	0.5%	3.4%	0.6%
Nigeria	2004	2.7%	4.6%	4.1%
Asia				
Bangladesh	2000	0.3%	0.5%	0.6%
Indonesia	1992	0.7%	1.9%	n/a
Indonesia	2000	0.3%	1.1%	n/a
Nepal	1995-1996	1.5%	0.6%	0.7%
Nepal	2003	1.1%	0.4%	0.7%
Pakistan	1991	3.3%	11.9%	11.2%
Pakistan	2001	0.9%	1.3%	5.5%
Vietnam	1992-1993	2.6%	2.1%	2.5%
Vietnam	1997-1998	0.6%	0.7%	0.9%
Vietnam	2002	1.3%	5.9%	6.1%
Eastern Europe				
Albania	2002	1.1%	2.6%	2.3%
Albania	2005	0.1%	0.3%	0.3%
Bulgaria	1995	0.1%	0.8%	0.7%
Bulgaria	2001	0.3%	1.4%	1.3%
Tajikistan	2003	0.3%	0.7%	n/a
Latin America				
Ecuador	1995	1.3%	3.4%	3.3%
Ecuador	1998	1.2%	4.2%	3.8%
Guatemala	2000	0.1%	0.3%	0.1%
Guatemala	2006	0.0%	0.1%	0.1%
Nicaragua	1998	1.2%	3.5%	3.2%
Nicaragua	2001	0.8%	2.3%	2.4%
Panama	1997	0.2%	0.3%	0.1%
Panama	2003	0.2%	0.3%	0.2%

Table A3 - RIGA-L Recoding Guidelines

TIME REFERENCE VARIABLE	Recoded Value
Months per year	12 (the maximum per year).
Weeks per year	52 (the maximum per year).
Weeks per month	4.35 (365.25 days per year divided by 12 months, all of which is divided by 7 days per week – ((365/12)/7) – which rounds to 4.35).
Days per year	365 days per year (the maximum per year) or 312 working days per year (52 weeks multiplied by 6 working days per week. This is used if it is more appropriate for a select survey).
Days per month	31 (the maximum per longest month).
Days per week	7 (the maximum per week or 6 working days per week, if more appropriate for a specific survey).
Hours per day	16 (assuming that an individual can work a maximum of 16 hours in a single day).
Hours per week	84 (assuming that an individual can work a maximum of 12 hours per day for 7 days or 14 hours per days for 6 days, etc.). Note: this implies that it is not possible for an individual to work for the maximum number of hours per day, 16, for more than 6 days.

Table A4 - "Crop1" and "Crop2" Levels and Shares Comparison

COUNTRY	Participation		Levels (USD, Survey Year)		Shares	
	Crop1	*Crop2*	*Crop1*	*Crop2*	*Crop1*	*Crop2*
Africa						
Ghana 1992	87.0%	87.1%	70	632	44.5%	66.2%
Ghana 1998	87.2%	87.8%	142	409	41.7%	55.0%
Madagascar 1993	92.8%	93.4%	228	183	37.0%	57.3%
Madagascar 2001	81.5%	83.6%	211	210	56.9%	59.5%
Malawi 2004	83.2%	96.3%	28	194	17.5%	56.1%
Nigeria 2004	87.5%	88.7%	424	634	71.7%	73.5%
Asia						
Bangladesh 2000	61.5%	81.6%	97	94	15.8%	15.5%
Nepal 1996	88.8%	92.6%	176	114	37.7%	32.1%
Nepal 2003	89.4%	93.4%	188	93	29.4%	20.3%
Pakistan 1991	44.4%	60.3%	1,196	1,352	17.4%	31.5%
Vietnam 1992*	92.1%	95.1%	145	123	48.3%	50.9%
Vietnam 1998	92.7%	97.8%	319	300	42.4%	41.5%
Eastern Europe						
Albania 2002	79.6%	91.8%	135	327	15.5%	15.1%
Albania 2005	93.4%	94.7%	888	600	24.5%	17.2%
Bulgaria 1995	45.6%	89.3%	28	275	2.6%	19.8%
Bulgaria 2001	62.5%	68.3%	685	57	19.5%	3.9%
Latin America						
Ecuador 1995	68.8%	73.5%	677	583	18.4%	9.0%
Ecuador 1998	63.5%	68.3%	240	430	35.8%	22.1%
Guatemala 2000	69.9%	87.8%	189	367	19.2%	27.6%
Nicaragua 1998	73.7%	71.1%	155	231	19.0%	22.9%
Nicaragua 2001	83.6%	84.8%	216	267	-9.0%	20.6%
Panama 1997	45.8%	87.5%	402	232	16.4%	15.5%
Panama 2003	48.6%	78.4%	80	263	5.5%	15.8%

Annex 2 - Stata Syntax

Outlier Checks

The RIGA project defines outliers as values greater than or less than three standard deviations from the median when checking for extreme values by some relevant subgroup. The RIGA-CLSP[96] team developed a Stata command (ado-type) to facilitate the checking of outliers. The command, called "imputeout", has a standard syntax structured as follows:

imputeout *varlist1* [if] [weight] , bylist(*varlist2)* range(#)

where *varlist1* is the list of variables to check for outliers, *varlist2* is the sorting category by which *varlist1* will be checked for outliers (not an option), and "range(#)" identifies the number of standard deviations according to which an outlier will be defined (the default is 3). Missing values and zero values are

[96] CLSP stands for Comparative Living Standards Project. This project is based at the World Bank with the objective of creating an online database of comparative living standards indicators. The RIGA project collaborated with CLSP in the construction of the income aggregates, which will be incorporated into the online database. More information on CLSP can be found on http://go.worldbank.org/YIOLNP2T40.

automatically excluded from the outlier check when using this command. The command and corresponding help file are available from the team[97].

For a variable "exvar" and a bylist variable of "byvar", the above syntax is equivalent to:

```
(1) g exvarm   = .
(2) g exvarimp = exvar
(3) bys byvar: egen exvarme = median(exvar) if exvar != 0
(4) by  byvar: egen exvarsd = sd(exvar)     if exvar != 0
(5) replace exvarsd = 0 if exvarsd == .
(6) replace exvarm = exvarme if !(exvar >= (exvarme - 3*exvarsd) & exvar <= (exvarme + 3*exvarsd)) &
    exvarm == . & exvar != . & exvar != 0
(7) replace exvarimp = exvarm if exvarm != .
```

The outlier check procedure can be summarized as follows. When checking for outliers, each variable that is identified as an outlier is flagged. A flag variable (*exvarm*, above) is constructed, named the same as the variable being checked for outliers, plus an "m"(e.g. the flag for "*exvar*" is "*exvarm*"). In our sample Stata syntax (above), the variable **exvarme** contains the values to be used as replacements for outlier values when outliers are identified. These replacement values are the median value of **exvar** for each subgroup identified by **byvar**. The flag variable **exvarm** is either a missing value or the value identified by **exvarme** if **exvar** was an outlier. The dataset also includes the imputed variable, **exvarimp** in this example. The variable **exvarimp** contains the original values when no imputations are necessary and the imputed values when an outlier is identified.

In order to flag and impute outliers in the variable **exvar,** the variables **exvarm** and the variable **exvarimp** are created in lines (1) and (2). At this stage, the variable **exvarm** consists only of missing values and the variable **exvarimp** is equal to the original variable, **exvar**. Lines (3) and (4) calculate the median and standard deviation of **exvar** by the relevant subgroup category (**byvar**). Line (6) flags any outliers in **exvar** by replacing in **exvarm** the missing value with the median of **exp**. In the last line of the program (7), the original value (in **exvarimp**) is replaced by the median value (in **exvarm**) if an outlier is identified.

As mentioned earlier in this paper, there are two amendments to the outlier check procedure in the RIGA-L database: the use of logs and weights to flag outliers. These amendments are explained below:

Using the coding above for the RIGA database, step (3) and step (4) are replaced by the following codes:

```
(*)  gen lnexvar = ln(exvar)
(**) sum lnexvar if byvar==`i' [aw=weight],detail
(3)  scalar lnexvarmed=r(p50)
(4)  scalar lnexvarsd=r(sd)
```

The new step (*) creates the log of **exvar**. Step (**) summarizes the weighted log of the **exvar** variable by the sorting variable **byvar**. This procedure is later repeated for every **byvar** category "**i**". Then, similarly as the original coding, steps (3) and (4) calculate the median and the standard deviations but of **lnexvar** by the relevant subgroup category **byvar**.

---

[97] A version of the routine that applies the logarithmic transformation of the variable before imputing the outliers is also available ("imputeoutlog"), but is only used in the construction of the RIGA-L database.

We include a new code (5) of the original coding to create an additional flag variable sorted by the **byvar** categories ***i*** (**outlier_exvar*i***), following the rule of 3 standard deviations lower or higher than the median:

```
(5) gen outlier_exvari =(abs(lnexvar - lnexvarmed)>(3*lnexvarsd)) & byvar ==`i'
```

Then, in step (6) we proceed to replace the flag variable **exvarm** with the exponent of ln**exvar**. The procedure is repeated for all the categories of **byvar**.

```
(6) replace exvarm = exp(lnexvar) if outlier_exvari ==1
```

Finally, in step (7) we replace **exvarimp** with the exponent of **lnexvarmed**. The operation is repeated for all the categories of **byvar.**

```
(7) replace exvarimp = exp(lnexvarmed) if outlier_exvari ==1 & exvar !=. & exvar !=0
```

Imputeout in RIGA-L was not used for outlier checks. This is because the procedure in RIGA-L is different and also because at the time when this project was initiated, the RIGA-CLSP team had not yet created the command.

Price Imputations

The following lines of Stata syntax demonstrate the approach used to estimate a standard set of prices by which to value income and expenditures that were reported in quantities rather than monetary units. In the example, line 1 demonstrates the generation of the price variable when the dataset is at the most disaggregated level. Lines 2 through 21 indicate how the median prices are obtained at different geographic/administrative levels by saving datasets at the cluster, province, district, urban and unit levels. The prices are then merged into the dataset containing the variables for which values will be imputed and assigned prices as demonstrated in lines 22 through 38. The same procedure is used for the estimation of prices from the food expenditures module.

```
* Generate overall price variable
(1) gen price = salesvalue / soldquantity


* Save median prices at different levels
(2) preserve
(3) collapse (median) pricedata1=price , by(crop unit urban district cluster)
(4) sort crop unit urban district cluster
(5) save $OUT\prodprice_clust.dta, replace
(6) restore
(7) preserve
(8) collapse (median) pricedata2=price , by(crop unit urban district)
(9) sort crop unit urban district
(10) save $OUT\prodprice_district.dta, replace
(11) restore
```

```
(12) preserve
(13) collapse (median) pricedata3=price , by(crop unit urban)
(14) sort crop unit urban
(15) save $OUT\prodprice_urban.dta, replace
(16) restore
(17) preserve
(18) collapse (median) pricedata4=price , by(crop unit)
(19) sort crop unit
(20) save $OUT\prodprice_unit.dta, replace
(21) restore

***
* Merge in estimated prices
(22) sort crop unit urban district cluster
(23) merge crop unit urban district cluster using $OUT\prodprice_clust.dta
(24) drop if _merge==2
(25) sort crop unit urban district
(26) merge crop unit urban district using $OUT\prodprice_ district.dta
(27) drop if _merge==2
(28) sort crop unit urban
(29) merge crop unit urban using $OUT\prodprice_ urban.dta
(30) drop if _merge==2
(31) sort crop unit
(32) merge crop unit using $OUT\prodprice_ unit.dta
(33) drop if _merge==2

* Assign prices
(34) generate value = .
(35) replace value = quantity * pricedata1 if value==.
(36) replace value = quantity * pricedata2 if value==.
(37) replace value = quantity * pricedata3 if value==.
(38) replace value = quantity * pricedata4 if value==.
```

Annex 3 - Raw Material Expenditures in Non-farm Enterprises

The cost of raw materials reported among the expenses of non-farm enterprises, as collected in most surveys, generally refers to the previous month. However, the initial inclusion of these expenditures, when annualized using our standard approach for non-farm enterprises (multiplying the monthly expenditure by the number of months the business was in operation and then weighting by the share of the business owned by the household[98]), was found to lead, in some cases, to over-stated costs and overall negative net self employment income.

Studying this category of expenditures in greater detail yielded the conclusion that due to the large magnitude of these expenditures in certain surveys, the values reported for raw materials expenditures may not necessarily represent regular, monthly spending, but rather bulky purchases that generally can be assumed to take place less frequently. In some cases, raw material expenditures are naturally excluded from the estimation of self employment income since the survey questionnaire identifies the items which characterize this expenditure as non-frequent/non-recurrent costs. For example, the Guatemala ENCOVI 2000 and Panama ECV 2003 surveys group raw materials with capital investment purchases rather than with the set of regular monthly costs while the Pakistan 2001 survey classifies raw materials as a "Special Operating Expense." Some other surveys, such as Panama 1997, do not attach a special label but do separate the expenditure from the list of regular monthly expenditures, indicating that raw materials are characterized differently from other recurrent costs. As survey questionnaires are generally written with consideration to the local-context, clearly there may be a degree of country-specificity about the nature of raw material costs: the Pakistan 1991 survey highlights the ambiguity of this expenditure category by allowing raw material expenditures to be reported as both frequent and infrequent expenses while the Ecuador 1995 and Nicaragua 2001 survey lists them with capital investments (infrequent expense) and also as an autonomous question regarding raw materials purchases (frequent expense).

For the following surveys we were obligated to impose a different approach, or to exclude, raw materials from the estimation of net self employment income: Albania 2002, Vietnam 1992 and Vietnam 1998. For Albania 2002 we implemented a modified outlier check, using a stricter definition of outliers and taking into consideration the expenditure distribution of each cost category. For the Vietnam 1992 and Vietnam 1998 surveys we excluded raw material costs after determining that even modifications to the standard outlier check approach were insufficient to deal with the extreme values, leading us to assume that raw material expenditures may encompass investment-type purchases.

It should also be noted that even with the more explicit reporting in the Guatemala 2000 and Panama 2003 surveys, due to data limitations on the non-farm enterprise module of the survey (income information was not asked for alongside the expenditure questions), raw material expenses were not explicitly considered since net self employment income was instead estimated from the employment module of the questionnaire. In consequence, so to preserve over-time comparability, the Panama 1997 income aggregate also estimates self employment income from the wage employment module of the questionnaire.

[98] The frequency with which the expense was made is also factored in, if that information was included in the survey.

Farm Families, Rural and Urban Non-Farm Families and the Incidence of Low Income in Canada

Culver David, Cally Dhaliwal, Fay Abizadeh
Agriculture and Agri-Food Canada (AAFC), Ottawa, Ontario, Canada

Abstract: *Determining the incidence of low income for farm families compared to non-farm families is complicated by the diversity of farm family types. Most farm families earn income from farm self-employment which is often unstable from year to year, from off-farm employment and many have a higher level of wealth from owning land and other assets associated with the farm operation.*
In Canada there are three different methods for determining a low income threshold level. The Low Income Cut-Off (LICO) is based on the expenditures of an average family in a base year. The LICO is set at the income level at which the average family would be spending 20 percentage points more on the basic necessities. The LICO is adjusted for inflation each year and is available by family and community size. The Low Income Measure (LIM) is set at 50 percent of the median of adjusted family income; family income is adjusted for family composition using an equivalence scale. The LIM is available at the national level only with no adjustment for cost-of-living differences. The Market Basket Measure (MBM) is based on the cost of purchasing a basket of household goods and services. It is available for the largest urban centres in Canada and numerous communities of different sizes.
Each of these measures a level of income below which families would be considered to be in low income. This paper reports on the income level and the incidence of low income for farm families, rural families and urban families for the time period 2002-2006. The incidence of low income is based on annual data. This paper uses the LICO and LIM to measure the incidence of low income in Canada. The LICO takes into account the cost of living which is generally lower in rural areas than the urban areas of Canada.
The paper also measures low income using longitudinal tax data for the period 2002-2006. Using longitudinal data, low income is based on average family incomes and on average LICO's and LIM's for the five year period. In a business such as farming incomes can vary significantly from year to year therefore taking an average income may produce a more accurate measure of a families well being than a measure based on annual data.
Using averages takes into account both the high income years and the low income years.
The analysis also considers different farm sizes since only families operating large and very large farms receive the majority of their family income from the farm.
This paper will provide useful information in developing relevant indicators for low income families including farm and rural families and will illustrate the benefits of longitudinal data. Longitudinal data can perhaps provide a better measure of family well being than measures based solely on annual data. This paper may also provide useful information for agricultural policy.

Keywords: farm, rural and urban family income, incidence of low income, longitudinal family data.

1. Introduction

Comparing the economic well-being of farm families and non-farm families in terms of income is complex. There are several factors to be considered including the definition of *income*, the definition of family by *type* *and composition*; the method used to *determine families with low income* and the *type of data* used in the analysis.

This paper discusses the issues involved in comparing the income situations of Canadian farm and non-farm families using both annual and longitudinal tax data. The paper consists of five sections. Part 1 is the introduction; Part 2 describes the purpose of the paper; Part 3 describes the concepts and data; Part 4 presents the results based on different family types, different low income measures and for annual and longitudinal family data; and Part 5 provides a summary of some of the issues involved in comparing the economic well-being of Canadian farm and non-farm families.

Acknowledgements: *The authors would like to thank Jeffrey Smith of the Agriculture Division, Statistics Canada and Yan Zhang, Sylvain Cloutier and Marie-Josée Bourgeois of the Small Area Administrative Data Division, Statistics Canada for their valuable contribution to this paper.*

2. Purpose

The purpose of this paper is to build on the issues related to measuring family income and well-being as discussed in the *Rural Households' Livelihood and Well-Being Handbook* (Wye Group). The paper uses annual and longitudinal Canadian tax data to illustrate some of the complexities in comparing the economic well-being of farm families in terms of income, both within the farm family population, by size class, and with the non-farm family population living in rural and urban areas. The family income of these family types is also compared based on a broad definition and a narrow definition of family. The broad definition compares all Canadians living both in family units and as individuals; therefore providing a perspective on farm families within the broader social context. The narrow definition includes couple families only. Since a higher percentage of farm families are couple families, this definition provides a more direct comparison between farm and non-farm families.

The analysis also provides a comparison of the percentage of Canadian farm and non-farm families with low income. The incidence of low income is compared for two methods used in Canada to determine families with low income. One measure is the Low Income Measure (LIM) which does not account for differences in living costs; the other measure is the Low Income Cut-Off (LICO) which does reflect differences in living costs between rural and urban areas and by the number of family members.

Finally, income and economic well-being issues of farm versus non-farm families are explored using both annual and longitudinal Canadian tax data. Analysis using longitudinal data allows income and other variables to be defined over periods of time other than annually. This is important for some types of families, such as farm families, in which there is more variability in income from year to year.

3. Concepts and Methods

3.1 Families

This section provides details of the concepts and methods used for the analysis. Census families[99] are the main unit of analysis. The analysis is performed for two different concepts of family. All census families and persons not in census families are used as the family definition in the first part of the analysis to show the position of farm families in a broader social context. This analysis provides an overall indicator of economic well being in terms of income of all Canadians including those in families and those individuals not in families. As shown in Table 1 the income of persons not in families is generally lower than the income of families.

[99] A Census family is defined as a married couple and the children, if any, of either or both spouses; a couple living common law and the children, if any, of either or both partners; or, a lone parent of any marital status with at least one child living in the same dwelling and that child or those children. All members of a particular census family live in the same dwelling. A couple may be of opposite or same sex. Children may be children by birth, marriage or adoption regardless of their age or marital status as long as they live in the dwelling and do not have their own spouse or child living in the dwelling. (Statistics Canada 2009)

The second part of the analysis focuses on couple families only. Approximately eighty percent of farm families are couple families compared to just over fifty per cent of non-farm families. Couple families therefore provide a more direct basis for comparison of the family income of farm and non-farm families.

Table 1 shows populations and median income by family composition from the T1 family file. In 2006, 24 million individual Canadians filed a tax return. These 24 million tax returns represented 31 million persons once tax filers were linked with family members. Of this 31 million, 26 million belonged in 9 million families. There was 14 million of what could be considered "households" or individual separate dwellings or 9 million census families in addition to 5 million individuals not in census families.

The number and percent of families (and persons) and couple families with family income below the Low Income Measure (LIM) is also shown.

Table 1 - Number of tax filers, persons and families, Canada, 2006

	Number	Median income	Number with income below LIM-IBT	Percent with income below LIM-IBT
	(#)	($)	(#)	(%)
Tax filers	24,258,900			
Persons	31,492,030		5,691,780	26.05.00
Persons in census families	*26,355,000*			
Persons not in census families	*5,137,030*	*22,8*		
Families	9,020,650	63,6		
Couple families	*7,629,330*	*70,4*	*807,23*	*10.08*
Lone-parent families	*1,391,330*	*33,0*		
Families and persons not in census families	14,157,680		2,997,578	21.07

Source: Statistics Canada, T1 Family File

3.2 Farm Families

Families (or persons) are defined as farm families if the tax return reports gross farming income greater than zero and/or net farming income not equal to zero. Farm families are categorized into four size groups by the amount of gross farming income: less than $100,000; $100,000 to $249,999; $250,000 to $499,999; and $500,000 and over. Families that report no gross farm income, but do report net farm income are included as families operating a small farm. There were approximately 15,000 families in this situation in 2006.

The farm family population used for this analysis only includes families operating unincorporated farms. Since the data comes from individual tax records, only individuals operating an unincorporated farm will be included. Incorporated businesses are required to file a separate tax return.

3.3 Non-Farm Families, Rural and Urban

All families and persons not in census families who do not report net or gross farm income are categorized as non-farm families; these non-farm families are sub-categorized according to whether they reside in a rural or urban area. Rural and urban areas are delineated according to the statistical area classification (SAC).[100] Rural areas are all areas outside of a census metropolitan area (CMA) or a census agglomeration (CA). Urban areas are all areas inside a CMA/CA.[101]

[100] The SAC groups census subdivisions (CSD) according to whether they are a component of a census metropolitan area, a census agglomeration, a census metropolitan area and census agglomeration influenced zone (strong Metropolitan Influenced Zone (MIZ), moderate MIZ, weak MIZ or no MIZ), or the territories (Yukon, Northwest Territories and Nunavut).

[101] Both tracted and non-tracted CAs is included in urban areas. CAs are subdivided into tracts if the core CSD falls below 50,000 people.

3.4 Family Income

Family income is defined as the sum of all income as reported for tax purposes for all individuals who reported income in a census family. It includes all income from taxable sources and includes an adjustment for dividends, capital gains, refundable tax credits and non-taxable income. Family income is before-tax.

3.4.1 Gross Farming Income

Gross farming income is the total income from the tax filer's unincorporated farming operation, before costs and expenses are deducted. If the enterprise is a partnership, each partner reports income from the entire operation. When gross farming income is reported for more than one person in a family, the family and parents aggregate levels contain only the amount from one of these persons, the highest value. It has been assumed that when more than one person in the family reports this self-employment income, these family persons are all working for the same business. (Statistics Canada 2008)

3.4.2 Net Farming Income

Net farming income is the tax filer's share of income (gain or loss) from an unincorporated farming operation, after all expenses including depreciation are deducted. These expenses also include salaries paid to family members which are reported as non farm income for tax purposes. Amounts reported by tax filers might be positive, negative or zero. (Statistics Canada 2008)

3.5 Families in Low Income

The incidence of low income in Canada is determined using a low income threshold level. Two methods for determining a low income threshold are used: the Low Income Cut-Off (LICO); and the Low Income Measure (LIM). Both are calculated based on income before tax.

The Low Income Cut-Off (LICO) is based on the expenditures of an average family in a base year. The base year currently in use is 1992. A family expenditure survey[102] is used to calculate the average percentage of income spent on the basic necessities of food, clothing and shelter. In 1992 the average Canadian family spent 43 percent of their after-tax income on these basic necessities. The LICO is the level of income at which families are expected to spend 20 percentage points more than the average family on basic necessities. The LICO is adjusted for inflation every year and is available by family and community size. Table 2 shows the LICO's for 2006.

[102] Statistics Canada, Family Expenditure Survey, 1992.

Table 2 - Low Income Cut-Offs - Income before-tax - (LICO-IBT), Canada, 2006

	Community size				
		Urban areas			
	Rural areas	Less than 30,000 people	30,000 to 99,999 people	100,000 to 499,999 people	500,000 and over people
	Dollars				
1 person	14,593	16,603	18,144	18,257	21,199
2 persons	18,168	20,668	22,588	22,728	26,392
3 persons	22,334	25,409	27,769	27,941	32,446
4 persons	27,118	30,851	33,716	33,925	39,393
5 persons	30,756	34,990	38,240	38,476	44,679
6 persons	34,689	39,463	43,128	43,396	50,390
7 persons	38,620	43,936	48,017	48,314	56,102

Source: Statistics Canada, Catalogue no. 75F0002M

The Low Income Measure (LIM) is equal to one-half of median adjusted family income. Family income is first adjusted using an equivalence scale[103] to take into account the number of people in the family sharing the income. Once the threshold level of income is determined on a per person basis it is adjusted using the equivalence scale to account for family composition. The LIM is available at the national level only with no adjustment for cost-of-living differences by community size.

Table 3 - Low Income Measures - Income before-tax (LIM-IBT), Canada, 2006

	Number of children					
	0	1	2	3	4	5
	Dollars					
1 adult	17,437	24,412	29,643	34,874	40,105	45,336
2 adults	24,412	29,643	34,874	40,105	45,336	50,567
3 adults	31,387	36,618	41,849	47,08	52,311	57,542
4 adults	38,361	43,593	48,824	54,055	59,286	64,517

Source: Statistics Canada, Catalogue no. 75F0002M

There is a third measure of low income available in Canada, but not in this analysis. The Market Basket Measure (MBM) is based on the cost of purchasing a basket of household goods and services. It is calculated for a reference family of two adults and two children, for the largest urban centres in Canada and numerous communities of different sizes.

Each of these methods determines a level of income below which families would be considered to be in low income or economically disadvantaged. For this analysis low income is on a before-tax basis to cancel out any effects of different tax treatment between family types.

[103] The equivalence scale assigns a factor of 1 for the oldest individual in the family, 0.4 for the second oldest in the family regardless of age; 0.4 for each additional adult and 0.3 for each additional child.

3.6 Data

3.6.1 T1 Family File (T1FF)

The main data source for this analysis is individual income tax records. In particular the T1 Family File (T1FF).

The T1FF is a yearly cross-sectional file of all tax filers and their families. Individual tax records are linked to form family units. Various fields on the tax form (the T1) are used in the linkage process including the Social Insurance Number (SIN), address, marital status, gender, age, and surname. Any tax filers who are not matched in the "family formation process" are designated 'persons not in census families' (see Table 1).

3.6.2 Longitudinal Administrative Data Bank (LAD)

The LAD is a random, 20 percent sample of the T1FF. An individual is selected to be included in the LAD based on their social insurance number and once selected; they remain in the sample and are selected every year from the T1FF if they appear on the tax form for that year. These individuals are linked across years by a unique identification number to create a longitudinal profile of each individual. New tax filers are added each year so that the data bank consists of 20 percent of tax filers for every year. The 20 percent sample represented almost 5 million tax filers in 2006, an increase of 54 percent from 1982 when the series began. The increase reflects an increase in the Canadian population and an increase in the incidence of tax filing over this period. (Statistics Canada 2008).

The LAD is organized into 4 levels of aggregation: the individual; spouse/parent; family and child(ren) levels. The data bank contains information on demographics, income, and other taxation data at the different levels of aggregation from 1982-2006, with new years of data being added as the information becomes available. (Statistics Canada, 2008)

For this analysis the same family type categories were used for the same period, 2002-2006 as in the previous two parts using the T1FF. However, since this is longitudinal analysis, for any variable, the condition for including a family had to be met in every year. For example, families were only included as farm families if they reported gross farm income greater than zero in every year of the analysis; non-farm rural families had to have resided in a rural area for all five years and so on. In addition, the farm families were classified into size groups based on the average gross farm income amount reported for all of the five year period. The same criteria applied for families in low income: only families with 2002-2006 average total family income below the five year average low income threshold level were included.

4. Results

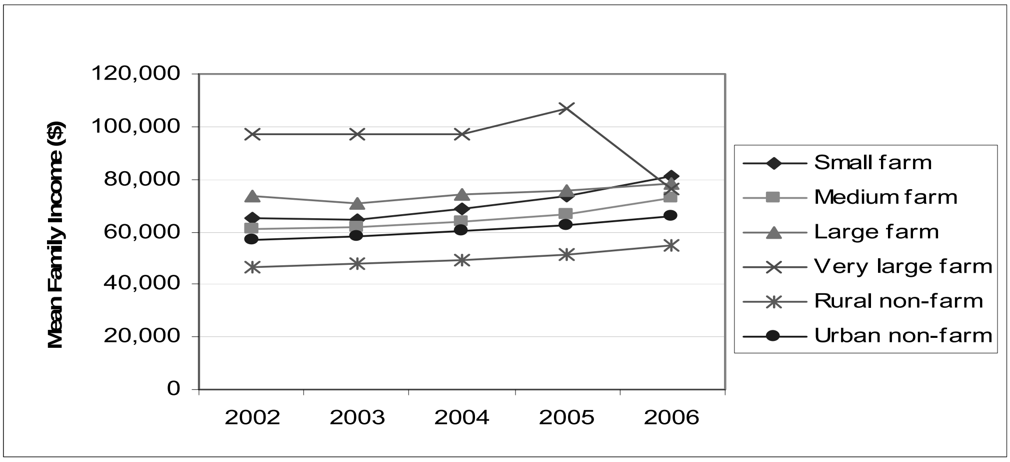
Results of the analysis are presented in three parts. Section 4.1 uses a broad definition of family that includes all families and person not in families. This broad definition of families provides a comparison of the economic well being of all Canadians in terms of income regardless of what type of family unit they lived in. This section also presents results for two low income measures used in Canada, the LIM and the LICO. Section 4.2 presents the results for a more narrow definition of family which is a couple family. This definition of family provides the most direct comparison of farm families with non-farm families living in rural and urban areas. Section 4.3 provides results for longitudinal data where family income amounts are an average for the five-year period 2002-2006.

4.1 All Families and Individuals

4.1.1 Level of income

Figure 1 shows the annual average income of families by type. In general the mean family income of farm families was higher than non-farm families in all years of the analysis.

Figure 1 - Annual Average total family income, Canada, from 2002 to 2006



On average families operating very large farms reported the highest total family income of all family types, but the income level fluctuated more ranging from $97,000 from 2002 to 2004 rising to $106,000 in 2005 before dropping to $76,000 in 2006 (Figure 1). The mean income of rural non-farm families was the lowest of all family types over this period.

Table 5 compares the mean with the median of family income for 2002-2006. Compared to the mean, the median income levels are lower and are within a narrower range for all family types. The median income level of farm families was in the range of almost $50,000 for rural non-farm families to $56,000 for farm families operating a large farm.

The difference between the mean and median is an indicator of the range of values within each family type category. The much larger difference between the mean and median levels of income for families operating very large farms (Table 5) indicates that some very large farm families report very high levels of income relative to other families of the same type.

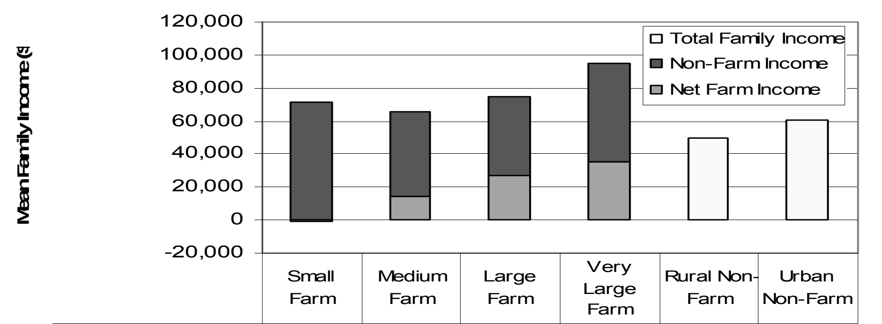
Table 5 - Mean and Median total family income, from 2002 to 2006

	Average total family income, 2002-2006		
	Mean ($)	Median ($)	Difference ($)
Small farm	70,460	51,100	19,360
Medium farm	65,140	50,520	14,620
Large farm	74,540	56,660	17,880
Very large farm	94,880	54,840	40,040
Rural non-farm	49,960	38,140	11,820
Urban non-farm	60,820	42,960	17,860

4.1.2 Distribution of Income by source and family type

The distribution of income by source and by family type at the mean and at the median is shown in Figures 2 and 3.

Figure 2 - Mean family income, 2002-2006

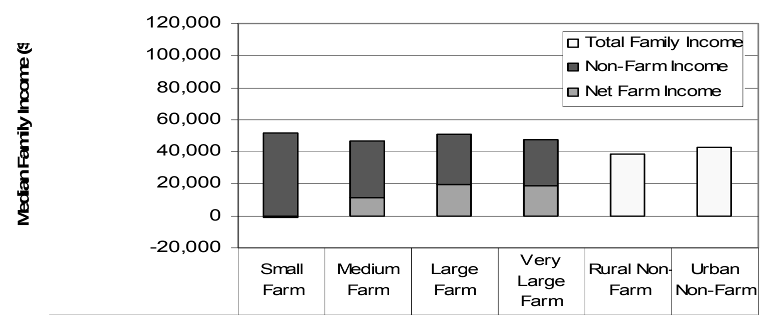


	Small Farm	Medium Farm	Large Farm	Very Large Farm	Rural Non-Farm	Urban Non-Farm
Total Family Income	70480	65160	74540	94880	49960	60820
Non-Farm Income	71080	50860	47180	59140		
Net Farm Income	-600	14300	27360	35740		

In Figure 2 farm families operating small farms earned, on average, all of their income from non-farm sources and reported negative income from farming. Large and very large farm families both earned about one-third of family income from farm income.[104] Farm income accounts for about one-fifth of income on medium-sized farms.

At the median (Figure 3) income levels were similar across family types. The relative shares of income by source did not change significantly at the median compare to the mean. Small farms again earned all income from non-farm sources, reporting negative farm income and the highest income of all family types. Farm income at the median as with the mean, represented about one-third of family income for families operating large and very large farms and about one-fifth for families on medium-sized farms.

Figure 3 - Median family income, 2002-2006



	Small Farm	Medium Farm	Large Farm	Very Large Farm	Rural Non-Farm	Urban Non-Farm
Total Family Income	50540	46660	50520	47220	38140	42960
Non-Farm Income	51380	34960	31120	28440		
Net Farm Income	-840	11700	19400	18780		

4.1.3 Families and persons in low income

Table 6 shows the percentage of farm and non-farm families with before-tax income below the Low Income Measure (LIM-IBT). In general, a smaller percentage of farm families (15.5 percent) had low income compared to non-farm families (21.7 percent) over the period of analysis.

[104] The non-farm income amount includes wages and salaries earned on the farm by spouses and children.

Also worth noting in Table 6 is the relatively high incidence of low income for families on very large farms (25.1 percent) compared to other farm families (17.5 percent for families on large farms, 18.6 percent for families with medium-sized farms) over the 2002-2006 period. The explanation for this could be that the very large farms are more specialized resulting in greater vulnerability to downturns in markets for the agricultural commodities they produce. For example cattle farms have low margins so sales have to be high to generate an adequate return for a full time operation.

Table 6 - Percentage of families* with income below the LIM-IBT, Canada, 2002-2006

	2002	2003	2004	2005	2006	2002-2006
Small Farm	14.5	15.6	15.5	14.1	12.3	14.4
Medium Farm	16.9	18.3	19.7	18.7	19.6	18.6
Large Farm	16.0	17.4	17.6	17.3	19.0	17.5
Very Large Farm	16.7	16.9	19.8	18.0	39.9	25.1
All Farm Families	15.0	16.1	16.2	15.0	15.1	15.5
Rural Non-Farm	23.0	22.5	23.3	22.6	22.0	22.7
Urban Non-Farm	21.4	21.5	22.1	21.7	21.3	21.6
All Families	21.5	21.5	22.2	21.7	21.3	21.7

*All families and persons not in census families.
Source: Statistics Canada, T1 Family File

Table 7 shows the percentage of families with income below LICO-IBT. Using the LICO-IBT measure of low income, the incidence of low income for farm families was 12.1 percent compared to 28.8 percent for non-farm families.

Table 7 - Percentage of families with income below LICO-IBT, Canada, 2002-2006

	2002	2003	2004	2005	2006	2002-2006
Small Farm	11.6	12.9	12.1	10.8	9.4	11.4
Medium Farm	12.5	14.5	14.6	13.9	15.2	14.1
Large Farm	11.6	13.5	13.1	12.8	14.9	13.2
Very Large Farm	13.3	13.5	14.8	13.7	29.0	18.8
All Farm Families	11.7	13.2	12.5	11.4	11.5	12.1
Rural Non-Farm	27.8	27.7	27.1	26.4	25.0	26.8
Urban Non-Farm	30.3	30.7	30.4	29.8	29.0	30.0
All Families	29.2	29.5	29.1	28.6	27.6	28.8

* All census families and persons not in census families.

Using the LICO-IBT, the percentage of families in low income was highest for urban non-farm families (30 percent) indicating a higher cost-of-living in urban areas which is taken into account in the LICO measure of low income.

4.2 Couple families

This section focuses on couple families (excludes persons not in census families and lone-parent families). As shown in Table 8, couple families account for eighty per cent of all farm families compared to just over fifty per cent for non-farm families. Comparing farm couple families with non-farm couple families compares families with a similar composition and removes the influence of relatively low income levels of individuals and lone parent families.

Table 8 - Couple families as a percentage of all families and persons not in families, Canada, 2002-2006

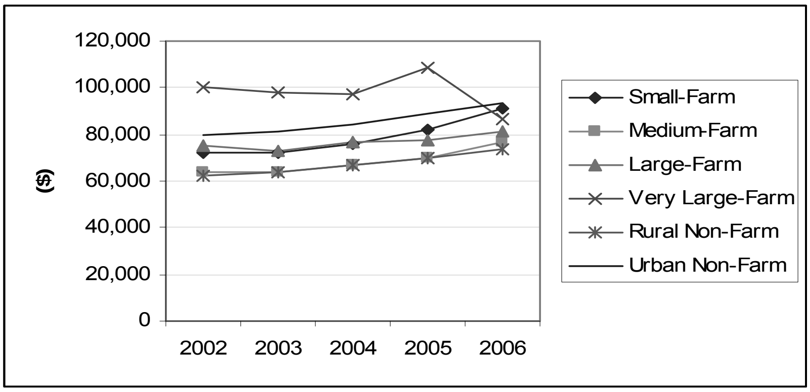
	2002	2003	2004	2005	2006	2002-2006
Small-Farm	78.4	78.1	78.1	77.7	77.3	77.9
Medium-Farm	87.5	86.8	86.7	86.0	85.4	86.5
Large-Farm	90.2	89.7	89.7	89.3	88.8	89.5
Very Large-Farm	90.6	89.1	89.6	89.5	80.2	86.6
All Farm Families	80.7	80.2	80.1	79.7	79.1	80.0
Rural Non-Farm	56.6	56.1	56.1	55.5	55.7	56.0
Urban Non-Farm	53.2	52.7	53.1	52.4	52.8	52.8
All Families	53.2	52.7	53.0	52.4	52.7	52.8

4.2.1 Level of Income – Couple families

In general, focusing only on couple families resulted in higher income levels for all family types, but for urban non-farm families in particular, compared to the income levels observed in the previous section (for all families and individuals not in families (Section 4.1)). Family income for couple families was generally higher for urban non-farm families compared to farm families.

On average, income levels were highest for families operating very large farms and non-farm families in urban areas (Figure 5).

Figure 5 - Mean family income of couple families, by family type, Canada, 2002-2006



Very large farm family income fluctuated within the three years 2004 to 2006. Small farms and large farms had similar levels of income in most of the years as did non-farm families in rural areas and families operating medium sized farms.

Table 9 compares the mean and median income levels for couple families in the 2002-2006 period. At the median, families operating medium-sized farms and rural non-farm families reported the lowest and similar levels of income.

The difference between the mean and median was higher for couple families operating a very large farm indicating some of these families earned high levels of income. The difference between the mean and median was also high for couple families operating small farms relative to the other couple family types again indicating a skewed distribution of income for these families.

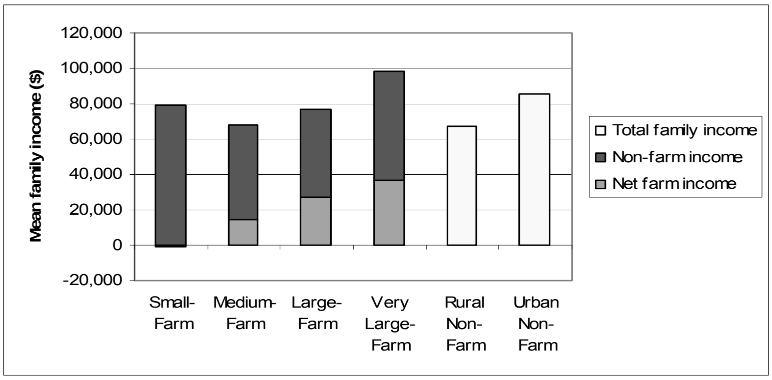
Table 9 - Mean and Median Income of couple families, by family type, Canada, 2002-2006

	Mean	Median	Difference
Small-Farm	78,640	58,580	20,060
Medium-Farm	68,100	53,580	14,520
Large-Farm	76,660	59,060	17,600
Very Large-Farm	98,080	57,440	40,640
Rural Non-Farm	67,320	56,840	10,480
Urban Non-Farm	85,540	68,000	17,540

4.2.2 Income by Source – Couple families

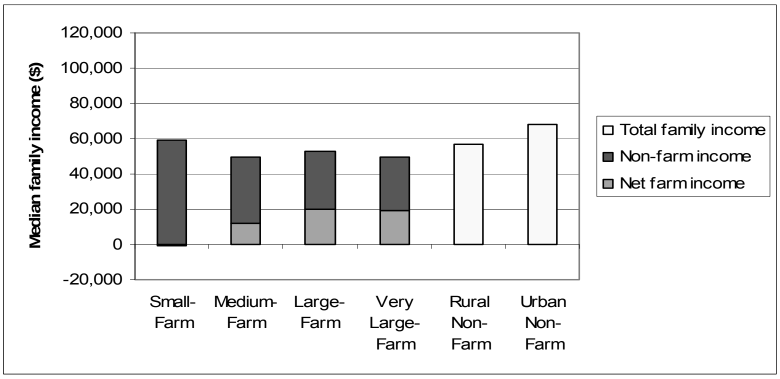
On average, couple families operating large or very large farms earned close to one-third of total family income from the farm. The addition of non-farm income for very large farms results in relatively high family income overall. Medium-sized farms and rural non-farm families reported similar levels of income and families operating a medium-sized farm reported a smaller share of total family income from the farm compared to large and very large farm families.

Figure 6 - Mean family income, by source, by type of family, Canada, 2002-2006



At the median shown in Figure 7, couple families operating a medium, large or very large farm reported similar levels of income. This income level was lower than for non-farm and small farm families who earned all of their income from non-farm sources.

Figure 7 - Median family income, by source, by type of family, Canada, 2002-2006



4.2.3 Incidence of Low Income for Couple families

Table 10 shows that the incidence of low income of couple families is higher for families operating a medium, large or very large farm (17.5 percent, 16.9 percent and 23.6 percent respectively) compared to non-farm families in rural and urban areas (10.5 percent and 10.8 percent respectively) throughout the period of analysis.

Table 10 - Incidence of low income using LIM-IBT

	2002	2003	2004	2005	2006	2002-2006
Small-Farm	12.3	13.2	13.0	11.6	9.6	12.0
Medium-Farm	16.2	17.5	18.7	17.3	18.3	17.5
Large-Farm	15.8	16.9	17.0	16.6	18.2	16.9
Very Large-Farm	16.6	16.4	19.5	17.3	37.5	23.6
All Farm Families	13.2	14.1	14.2	12.9	12.8	13.5
Rural Non-Farm	11.1	10.7	11.0	9.9	9.9	10.5
Urban Non-Farm	10.9	10.9	11.3	10.2	10.7	10.8

The percentage of families in low income was lower for couple families operating small farms (12 percent) compared to families operating larger farms which may be related to these families earning all of their income from non-farm sources.

4.3 Longitudinal – Couple families

This section presents the results using longitudinal data. As explained previously, conditions for defining a family as a farm family must hold in all five years of the analysis. All income variables are for couple families only and are averaged over the 2002-2006 period. This has the effect of smoothing out the annual highs and lows in income levels.

4.3.1 Incidence of Low Income

Table 11 shows the number and percentage of families in low income using the LIM-IBT. Using the longitudinal data the incidence of low income was again noticeably higher for families operating a very large farm and for rural non-farm families compared to the other family types. The higher incidence of low income for very large farm families may be attributable to the steep income drop experienced by these families in 2006.

Table 11 - Incidence of Low Income, by family type, Couple families, Canada, 2002-2006

	# of Census Couple Families with income below LIM-IBT	% of Census Couple Families with income below LIM-IBT
Small Farm	8,910	12.8
Medium Farm	3,225	15.8
Large Farm	1,365	14.8
Very Large Farm	700	19.0
All Farm Families	14,200	13.8
Rural Non-Farm	97,495	10.4
Urban Non-Farm	321,655	7.6
All Families	433,350	8.2

Source: Statistics Canada, Longitudinal Administrative Data Bank (LAD)

4.4 Comparison of incidence of low income

Table 12 provides a comparison by family type of the incidence of low income by data source, family composition group and low income method. The first two columns using the same source and same family composition group allows low income methods to be compared. The difference in the low income rate between these two may be attributed to the fact that the LICO-IBT takes into account cost of living differences between rural and urban areas. A lower cost of living in rural areas where the majority of farm families reside results in a smaller percentage of farm families with income below the LICO-IBT when compared to the LIM-IBT. Using the LICO-IBT also results in a larger percentage of families with low income for urban non-farm families relative to rural non-farm families. The fact that the LICO-IBT takes into account the higher cost-of-living in urban areas may account for this difference.

The third column is for couple families only. The incidence of low income for non-farm couple families is lower compared to farm couple families; it is also lower compared to the low income rate shown in column 1 with the same data source and measure of low income but different family composition.

The last column shows the low income rate using longitudinal data for couple families. Overall, the incidence of low income is higher for farm couple families (13.8 percent) compared to non-farm couple families (8.2 percent). The incidence of low income using annual data versus longitudinal data for couple families and the LIM-IBT measure of low income (comparing columns three and four in table 12) shows that using the longitudinal data source results in a smaller percentage of families in low income. The percentage is slightly higher using longitudinal data (13.8 percent) compared to the annual data (13.5 percent). However, within farm family types the percentage of families in low income using longitudinal data is lower for families operating medium, large and very large farms compared to annual data.

Table 12 - Numbers of census families and census families in low income, by population grouping and data source, average 2002-2006

Data Source	T1-Family File Average 2002-2006			LAD - Average 2002-2006
Family composition	All families and persons	All families and persons	Couple families only	Couple families only
Low Income Method	Percentage with income below LIM-IBT	Percentage with income below LICO-IBT	Percentage with income below LIM-IBT	Percentage with income below LIM-IBT
Small-Farm	14.4	11.4	12.0	12.8
Medium-Farm	18.6	11.6	17.5	15.8
Large-Farm	17.5	13.2	16.9	14.8
Very large-Farm	25.1	18.8	23.6	19.0
All Farm Families	15.5	12.1	13.5	13.8
Rural-Non-Farm	22.7	26.8	10.5	10.4
Urban-Non-Farm	21.6	30.0	10.8	7.6
All Families	21.7	28.8	10.8	8.2

5. Summary and Conclusions

The paper illustrates some of the complexities of comparing income levels between different types of families and for farm, rural and urban families. The type of family varies significantly between family, rural and urban areas. The incidence of low income is more predominant in individual and lone parent families which tend to live in urban areas and are underrepresented in operating farms. The selection of what type of family is included in the analysis has a major impact on the results. A comparison of couple only families provides the most direct comparison between the incomes of farm families and rural and urban families.

The analysis also illustrated the importance of examining the distribution of income. As shown by the differences in the mean and median the distribution of income for families operating a very large farm is not normal. Rural non farm families had the smallest difference between mean and median. Families operating very large farms had the largest difference between mean and median. The median very large farm families report income levels similar to other farm families but the average was significantly higher.

The paper also illustrates how the measurement of low income can be influenced by the type of low income measure used. The analysis used a relative measure which is LIM and the LICO which accounts for differences in living costs. The low income rate for farm families was lower using the LICO compared to the LIM maybe because the LICO takes into account cost of living differences by community size and between rural and urban areas.

Finally, the data source is important. Annual data show trends and can indicate the impact of abnormal years (2006 for very large farm families, for example). Longitudinal data averaged over five years would not show which years were abnormal, but would smooth out annual peaks and troughs in income levels. Using longitudinal data the percent of families that reported low income operating large and very large farms was lower with longitudinal data compared to annual data. The longitudinal analysis which is based on five years takes into account high income years as well as low income years. This can particularly useful in families that have significant fluctuations in income.

Glossary

Census Family: Refers to a married couple (with or without children of either or both spouses), a couple living common-law (with or without children of either or both partners) or a lone parent of any marital status, with at least one child living in the same dwelling. A couple may be of opposite or same sex. “Children” in a census family include grandchildren living with their grandparent(s) but with no parents present.

The Statistical Area Classification (SAC) groups census subdivisions according to whether they are a component of a census metropolitan area, a census agglomeration, a census **m**etropolitan area and census agglomeration **i**nfluenced **z**one (strong MIZ, moderate MIZ, weak MIZ or no MIZ), or the territories (Yukon Territory, Northwest Territories and Nunavut). The SAC is used for data dissemination purposes.

Census subdivision (CSD): Area that is a municipality or an area that is deemed to be equivalent to a municipality for statistical reporting purposes (e.g., as an Indian reserve or an unorganized territory). Municipal status is defined by laws in effect in each province and territory in Canada.

Census Metropolitan Area (CMA) and Census Agglomeration (CA): Area consisting of one or more neighbouring municipalities situated around a major urban core. A census metropolitan area must have a total population of at least 100,000 of which 50,000 or more live in the urban core. A census agglomeration must have an urban core population of at least 10,000.

Census metropolitan area and census agglomeration influenced zones (MIZ): Category assigned to a municipality **not included** in either a census metropolitan area (CMA) or a census agglomeration (CA). A municipality is assigned to one of four categories depending on the percentage of its resident employed labour force who commute to work in the urban core of any census metropolitan area or census agglomeration.

1. Strong MIZ: at least 30 percent of the municipality's resident employed labour force commute to work in any CMA or CA.
2. Moderate MIZ: at least 5 percent, but less than 30 percent of the municipality's resident employed labour force commute to work in any CMA or CA.
3. Weak MIZ: more than 0 percent, but less than 5 percent of the municipality's resident employed labour force commute to work in any CMA or CA.
4. No MIZ: fewer than 40 or none of the municipality’s resident employed labour force commute to work in any CMA or CA.

Census tracts (CTs) are small, relatively stable geographic areas that usually have a population of 2,500 to 8,000. They are located in census metropolitan areas and in census agglomerations with an urban core population of 50,000 or more in the previous census.

A committee of local specialists (for example, planners, health and social workers, and educators) initially delineates census tracts in conjunction with Statistics Canada. Once a census metropolitan area **(CMA)** or census agglomeration **(CA)** has been subdivided into census tracts, the census tracts are maintained even if the urban core population subsequently declines below 50,000.

References

UN. 2007. *The Wye Group Handbook: Rural Households' Livelihood and Well-Being: Statistics on Rural Development and Agriculture Household Income.* Economic Commission for Europe, Food and Agriculture Organization (FAO) of the United Nations, Organisation for Economic Co-operation and Development (OECD), the World Bank and the Statistical Office of the European Communities (Euro stat). www.fao.org/statistics/rural.

Statistics Canada. 2008. Longitudinal Administrative Data Dictionary 2006. Statistics Canada Catalogue no. 12-585-X. Ottawa, Ontario. 131 p. http://www.statcan.gc.ca/cgi-bin/af-fdr.cgi?l=eng&loc=/pub/12-585-x/12-585-x2006000-eng.pdf (accessed February 2009).

Statistics Canada. No date. *Table 111-0009, Family characteristics, summary, annual (number unless otherwise noted),* CANSIM (database). Using E-STAT (distributor). Last updated June 2008.

Statistics Canada. No date. *Table 111-0015, Family characteristics*, *Low Income Measures (LIM), by family type and family type composition, annual (number unless otherwise noted),* CANSIM (database). Using E-STAT (distributor). Last updated June 2008. Statistics Canada. 2009. Special Tabulations. T1 Family File (T1FF).

Statistics Canada. 2009. Special Tabulations. Longitudinal Administrative Data Bank (LAD).

Statistics Canada. No date. *2006 Census Dictionary. Family universe index. Census family status*. Modified on June 28, 2007. http://www12.statcan.ca/english/census06/reference/dictionary/fam007.cfm

Statistics Canada. No date. *2006 Census Dictionary. Geography universe index. Census metropolitan area (CMA) and Census agglomeration (CA).* Modified on December 11, 2007. http://www12.statcan.ca/english/census06/reference/dictionary/geo009.cfm

Statistics Canada. 2008. *Low Income Cut-offs for 2007 and Low Income Measures for 2006, 2006/2007*. Statistics Canada Catalogue no. 75F0002M – No. 004. Ottawa, Ontario. June 2008. 40 p. Research Paper. Income Research Paper Series. http://www.statcan.gc.ca/pub/75f0002m/75f0002m2008004-eng.pdf (Accessed February 2009).

Human Resources and Skills Development Canada. 2008. *Low Income in Canada: 2000-2006 Using the Market Basket Measure.* HRSDC Catalogue no. HS28-49/2008E-PDF. Ottawa, Ontario. 81 p. October 2008. Final Report.
http://www.hrsdc.gc.ca/eng/publications_resources/research/categories/inclusion/2008/sp-864-10-2008/sp_864_10_08e.pdf

Gathering Information on Total Household Income within an "Industry Oriented" Survey on Agriculture: Methodological Issues and Future Perspectives

Benedetto Rocchi
Department of Plant, Soil and Environmental Science
University of Florence – P.le Cascine 18 50144 (FI)
benedetto.rocchi@unifi.it

Abstract: *Increasing evidence both from developed and developing countries show that the study of rural development processes should focus on livelihood strategies (Thompson, 2001; Ellis and Harris, 2004). From this point of view the total income of households is a key concept in gathering information on rural areas relevant for policy analysis purposes (UNECE 2007).*

Even if agriculture and its growth cannot be longer considered as the only engine of rural development (Roberts, 2005; Ellis and Harris, 2004), notwithstanding farming activities are still a characterizing feature of rural areas for their prevalent use of space and, in less developed economies, as a main sector of economic activity for rural people. Furthermore economic policies for rural areas are for the largest part still sector oriented ones, i.e. they are agricultural policies.

For all this reasons the role of farming within income strategies of rural households still represents an interesting perspective in studying the nature and the evolution of linkages between agriculture and the rest of the economy within rural development processes.

At least three reasons for gathering information on THI within and "industry oriented" survey, such as a census of agriculture, can be suggested. First, the specific, technical focus on production processes that characterizes industry oriented surveys is likely to support more reliable estimates of mixed income from farming than sector oriented ones, such as Living Standard Measurement Studies. Furthermore a good estimate of mixed income from farming could facilitate the valuation of other sources of income on a comparative basis, all the more reason when farming is the major source of income of the household.

Finally an appropriate statistical coverage of agriculture as an industry also ensures statistical coverage of "agricultural community", a portion of the institutional sector of households, allowing for analysis of income distribution and poverty issues both within rural and whole economy (Allanson and Rocchi, 2008, Rocchi, 2009).

The paper will discuss the methodological issues to be addressed in following such an approach in surveying total income of agricultural households in countries at different level of development.

A specific attention will be dedicated to properly place the proposed approach within the methodological framework of 2010 Census Programme guidelines as well as to possible uses of collected data in policy analysis.

Keywords: total household income, agricultural households, income distribution, social accounting matrix.

1. Introduction

In recent years a general consent has been reached about the need for a broader approach in studying rural economies. The study of rural places should consider a multiplicity of dimensions and perspectives, including economic, social and environmental issues (Castle, 1998). Agriculture and its growth are no longer perceived as the sole engine of rural development (Roberts, 2005; Ellis and Harris, 2004). On the contrary, an increasing evidence both from developed and developing countries shows that the study of rural development processes should focus on livelihood/well-being strategies of rural households, within a multi-sector vision of rural economies (Thompson, 2001; Ellis and Biggs, 2001). From this point of view the total income of households is a key concept in gathering information on rural areas aiming to be suitable for policy analysis (UNECE 2007).

Despite this loss of centrality in rural studies, many reasons suggest to still consider farming activities as a characterizing feature of rural. In less developed countries agriculture is the main sector of economic activity for rural people and a fundamental source of self-consumption. The increase of factor productivity in agriculture is still proposed as one of the fundamental drivers for rural development in poor economies, conditional to a balanced distribution in the ownership of assets and to the development of a non-agricultural rural based economic sector (Broca, 2003). Furthermore, both in developed and in developing economies, agriculture characterizes rural areas for its prevalent use of space. Farming remains the fundamental way for societies to perform the country stewardship function and the positive or negative nature of the externalities associated to it strictly depends on the modalities adopted in the realization of production processes. A further, practical reason to give a specific attention to the role of agriculture is the fact that economic policies for rural areas are for the largest part still sector oriented, i.e. they are *agricultural* policies.

For all this reasons the role of farming within income strategies of rural households still represents an interesting perspective in studying the nature and the evolution of linkages between agriculture and the rest of the economy in rural development. As a consequence the availability of reliable microeconomic information and statistics on income and wealth of agricultural households become a condition for good economic analysis and policy making. In this paper will be discussed the advisability to gather information on total household income within "industry oriented" surveys on agriculture.

The paper is organized as follows. In the next section is stressed the importance to study the role of farming as a part of livelihood and well-being strategies of households. The third section shortly discusses the representation of the agricultural household sector within a social accounting framework. The last section is devoted to the "industry oriented" approach in surveying total income of agricultural households.

2. Income from farming as a part of households' strategies

It has been correctly pointed out that a focus on agriculture is no longer perceived as suitable in studying rural development (UNECE, 2007). The increasing distance between "agricultural" and "rural" concepts of development can be measured along two dimensions: first, rural development is generally associated to a geographical dimension of the analysis, dealing with spatial differences in the economic system; second, rural development is more and more analysed within a multi-sector framework, where agriculture become only one component, whatever its importance, of the rural economy.

This evolution is quite obvious for developed countries, where agriculture is a minor part of the economy. Empirical analysis has clearly shown that the 'economic base' of rural areas often lies beyond their borders, with an increasing role played by external sources of incomes (Roberts, 2005). To maintain a satisfying level of return from their assets, farmers often tend to differentiate their business integrating non-agricultural activities (such as tourism or food processing) in the production unit. This increasing evidence brought some scholars to challenge the justification of agricultural policy as a preferential vector for "development" in rural areas, arguing that the latter more and more show structural adjustment problems that are not so different from those of the rest of the economy (Thomson, 2001).

Also in developing economy, despite the larger share of agriculture in the composition of GDP, there is increasing evidence that farming not necessarily represents the main source of income for rural population. The proper perspective in the analysis and policy making for rural areas in poor economies should better rely on a "livelihood" concept that "… takes an open-ended view of the combination of assets and activities that turn out to constitute a viable livelihood strategy for the rural family (Ellis and Biggs, 2001: 445). According to Broca (2003) the diversification of the rural economy towards non agricultural, rural-based activities, is a necessary condition for keeping within rural areas the income growth due to gains in the productivity of agriculture. This implies not only a growth of non agricultural rural activities but also an increasing diversification within the livelihood strategies of farming families "… based on part-time farming supplemented by other activities and income sources" (Ellis and Biggs, 2001: 445).

A "livelihood" perspective in studying rural development process helps also in understanding the way agricultural production activities are carried out. Indeed, the livelihood strategy affects the way production activities are managed by the family, according to its endowments of human capital, physical assets and access to market, public utilities and environmental resources, as well as its relation with factors and products markets (Pyatt, 2003). For example, empirical studies on east and southern Africa found an inverse relation between net farm income per hectare and the share of total household income from farming activities (Ellis and Freeman, 2004).

All these arguments strongly suggest to study family farming, either in developed or in developing contexts, as the expression of a well-being/livelihood strategy. Following on from this becomes necessary to include in the analysis the differentiated socio-economic goals that pursued by households through farming.

3. Households' strategies and social accounting framework

Statistics on total income and wealth of households involved in farming activities are an obvious answer to these analytical concerns. The "Wye Group Handbook" correctly recognises this point, listing good practices in approaching the measurement of total agricultural household income and wealth (UNECE, 2007: 407 ff.).

An issue that it is worth to discuss here is the way the link between farming activities and the overall income strategy of the household may be represented in models. The reference to a Social Accounting Matrix (SAM) framework can help to highlight the point. SAMs are a disaggregated, accounting representations of the circular flow in the economy. The ability of a SAM to represent the backward and forward linkages among the components of the economy strictly depends on the disaggregation of its accounts. Basically the economic system in a SAM is subdivided in two ways: a) classifying *production activities* according to some technical criteria (classification by *industry* of the production account); b) classifying *institutions* according to some socio-economic criteria (classification by *sectors* of the current account for institutions).

The identification of the group of *agricultural households* results from crossing an *industry* with a *sector* classification criterion. Indeed, the inclusion of a household in this specific partition of the households *sector* is determined by their involvement in a specific *industry* (agriculture).

The proper level to survey (and to represent in models) this structural linkage is the *production unit*. The *agricultural holding* can be seen as an observable socio-technical system working as an interface between the institutional goals (income strategies in the case of family farming) and technical and economic features of the production process. On one side the way the factors are *organized* within the production unit (property rights on factors, technical relations in the use of factors) determine the actual distribution of income among people involved in production. On the other side the variety of management forms (relationship between entrepreneurship, land/capital ownership and labour supply) affect the technical choices in production, according to the socio-economic goals of the institution (Rocchi and Stefani 2005).

Besides this "observational" argument, also strong theoretical reasons suggest to adopt the production unit as a proper level in surveying agricultural households' features: insofar as non-separability between production and consumption decisions is assumed (De Janvry et al., 1991; Pyatt, 2003) models should explicitly represent the structural links between factor endowments, production activities and income distribution. In terms of social accounting this imply the possibility to cross institutional and technical criteria both in the classification of industries (e.g. farms by management form) and in the classification of sectors (e.g. households by industry composition of total income: Rocchi, 2007).

4. Getting data on household income within an industry oriented survey on agriculture

The adoption of a livelihood/well-being perspective in studying rural development processes and the role of agriculture in rural economy asks for a broader vision of family farming as a part of a general household strategy. The discussion above highlights the need to gather *joint* information on production units (structure, costs and revenues) and on institutions managing them. In the case of agriculture the largest part of farms are family managed both in developed and in developing economies: as a consequence information on households are essential to make surveys on agriculture suitable for policy analysis.

A logical answer could be to survey farming activities within multipurpose studies on household sector such as the Living Standard Measurement Surveys (LSMS). However an "institutional oriented" approach in surveying *agricultural* households has shown some methodological shortcomings. A first general difficulty in surveying total households income within a LSMS concerns the elicitation of income from self-managed production activities, especially when a systematic bookkeeping is not carried out (McKay, 2000). LSMS show also peculiar problems with farming activities: the "agricultural" module has been rarely implemented and with quite mixed results when used in the analysis (Reardon and Glewwe, 2000). Besides practical problem in the implementation of an agricultural module within a multipurpose survey on household, such as the different recall period (end of cropping period) with respect to the other modules, a more general problem of statistical coverage in sampling should be taken into account. A sample optimized to correctly represent the whole households sector in the economy could be unsuitable in surveying the *agricultural* sub-sector (both in general and when only rural areas are considered). First of all the "agricultural" part of the institutional sector is likely to be *under-represented*, especially in developed economies, where agriculture employs a minor part of labour. Moreover, where the distribution of agricultural households with reference to the variables used in the sample stratification was different from the average, the "agricultural" sub-sample would be also *biased*. Moreover, the sub-sample of farming households is not likely to properly represent agriculture *as an industry*: a bias toward small (household managed) production units is likely to emerge (World Bank, 2008: 23).

An alternative approach is to gather information on agricultural households within an "industry oriented" survey. For example a Farm Accounts Surveys (FAS) is the natural candidate to collect information on off-farm income sources of farming families. An example of such an approach is the REA Survey in Italy on costs and revenues of farms. REA is a sample of *holdings* designed to represent agriculture both at the national and the regional level, supplying information for National Accounts. But the questionnaire includes a module on the household composition and the level and the composition of total income, according with recommendations of FAO methodology for 2010 Census of Agriculture (FAO, 2005: 103). As a consequence the REA sample can be used to estimate totals referred to agriculture as an *industry* (such as total production and intermediate costs) as well as figures on the distribution of agricultural income among different *households groups* (classified by income level and composition). According to these properties Rocchi (2007, 2009) used the REA database to adapt a SAM of the Italian economy and to carry out a structural analysis of income distribution in the Italian agriculture.

Also surveys on agricultural structures and productions may be a valuable source of information on agricultural households. For instance the Programme for the 2010 Census of Agriculture (FAO, 2005, chapter 10) suggests that a supplementary survey on a sampling frame of holdings gathering information on costs and revenues may be carried out during the periodical census, and possibly updated in the programme of agricultural surveys, at least for few, essential data. Moreover, among the supplementary items to survey, item 0701 ("whether holding is part of an agricultural household"), is recommended "… to identify what might be termed 'genuine farmers'" (FAO, 2005: 103). A further possibility could be getting more detailed information on hired workers such as sex, age and position in the overall income strategies of their family (e.g. if the worker could be considered the reference person of his household or not).

At least three reasons can be suggested to support the use of "industry oriented" surveys in gathering information on the total income of agricultural households (TIAH). First, the specific, technical focus on production that characterizes surveys oriented to agriculture as an industry is likely to lead to more reliable estimates of mixed income from farming than the sector (institutional) oriented ones. Not surprisingly an ongoing research project in Sub-Saharan Africa, aiming to improve the quality of households-level data on agriculture gathered within the LSMS approach, explicitly recognizes the need for "… interviewer with more knowledge on agriculture" (World Bank, 2008: 21).

Furthermore a good estimate of mixed income from farming, grounded on detailed technical information on farming activities, could facilitate the valuation of the other sources of income on a comparative basis, all the more reason when farming is the major source of income of the household. Moreover, given that often the agricultural holding represents a major asset for the farming households, the technical focus of the (industry oriented) survey could represent a good basis for an assessment of the household wealth too.

Finally, an appropriate statistical coverage of agriculture as an industry is likely to lead also to a sample of "agricultural households" with desirable statistical properties, whatever the definition adopted.

Besides these advantages at least three major shortcomings in gathering data on TIAH within an "industry-oriented" survey should be taken into account.

First of all, given the technical focus of the survey, information on the "institutional" side of farming activities could be less reliable and incomplete. For example the incomplete recording of household's members, excluding child or members not involved in farming activities, could lead to an underestimation of total income and/or to a bias in weighting members according to equivalence scales for analytical purposes.

A second drawback could be generated by the incomplete overlapping between institutional and technical units. Indeed, the sampling of agricultural *holdings* allows in principle a repeated extraction of *households* managing more than one production unit. A bias in the representation of the institutional sector would follow, with a probable under-representation of units with higher incomes among the agricultural households.

A last source of error may derive from the nature of collected data on off-farm incomes. Given their complementary role within a survey focused on production activities, information on off-farm sources of incomes are in practice collected using class values and/or ordinal scales. Moreover the quantification of incomes for different sources is at risk to be biased by an implicit reference to non-homogeneous concepts of income (e.g. gross vs. net of taxes).

Despite their relevance, these problems may be properly taken into account in the survey design and in processing data for analytical purposes. Obviously information to gather should be carefully designed according to the purpose of the survey itself and the country-specific features of agriculture. Within a survey designed to support the estimation of economic accounts for agriculture, such as REA in Italy, it will probably easier to get also *quantitative* information on income level and composition; on the contrary within a survey on structures and production it will be only possible to ask to respondent "…to provide an overall assessment of their agricultural production activities in relation to the … other sources of income" (FAO, 2005: 104). Finally an accurate survey design would make easier the choice of a proper statistical approach in processing data for analysis.

Two major methodological tips should be taken into account in the implementation of the proposed approach.

- When the survey is designed only to gather data on structures and productions, the contextual implementation of an integrative (community-level) survey on markets and prices could support a standard estimation of mixed income from farming based on structural variables and to study trade margins in local (rural) markets (Reardon and Glewwe, 2000).
- Even when the gathered data on TIAH were of a qualitative, ordinal nature, the income concept (UNECE, 2007) should be shared with those adopted in surveys on the households sector. Also the questionnaire for revenues and costs of farming activities should allow calculating a residual mixed income coherent with the general definition used in the analysis of income distribution at the level of the whole economy.

All these arguments suggest to list among the "good practices" for the creation of an internationally agreed systems on income and wealth for agricultural households" (UNECE, 2007: 406) the inclusion of a set of question about total household incomes within questionnaires designed for "industry oriented" surveys on agriculture. Information on households income strategies are likely to increase the value of those referred to production processes, allowing the researcher to model the structural linkages between farming activities and income distribution *in the whole economy*. As a consequence, the representation of interdependencies of agriculture with the rest of the economy could be extended to forward linkages generated by the final demand. Data on total household income composition could be valuable also in classifying *agricultural holdings* by management types representing different socio-economic goals pursued through farming activities (Rocchi and Stefani, 2005). Finally, information on household incomes may represent a complementary source for cross-validation of other surveys dedicated to household sector, such as LSMS.

References

Allanson P., Rocchi B. (2008). A comparative analysis of the redistributive effects of agricultural policy in Tuscany and Scotland, *Review of Agricultural and Environmental Studies*, 86, 6-28.

Broca S.S. (2002). Food insecurity, poverty and agriculture: a concept paper, *ESA Working Paper* 02-15, www.fao.org/ES/ESA.

Castle, E.N. (1998). A conceptual framework for the study of rural places, *American Journal of Agricultural Economics*, 80, 621-631.

De Janvry A., Fafchamps A., Sadoulet E. (1991). Peasant household behaviour with missing markets ; some paradoxes explained, *Economic Journal*, 101, 1400-1417.

Ellis F., Biggs S. (2001). Evolving themes in rural development 1950s-2000s, *Development Policy Review*, 19, 437-448.

Ellis F., Freeman H.A., (2004). Rural livelihoods and poverty reduction strategies in four African countries, *Journal of Development Studies*, 40, N° 4, April.

FAO (2005). *World Programme for the Census of Agriculture 2010*, Statistical Development Series n.11, FAO, Rome.

McKay A. (2000). Should the survey measure total household income? in Grosh M. and Glewwe P. *Designing household survey questionnaires for developing countries. Lessons from 15 years of LSMS*, The World Bank, New York, 83-104.

Pyatt G. (2003). An alternative approach to poverty analysis, *Economic System Research*, 15, 113-133.

Reardon T., Glewwe P. (2000). Agriculture, in Grosh M. and Glewwe P. *Designing household survey questionnaires for developing countries. Lessons from 15 years of LSMS*, The World Bank, New York, 139-181.

Roberts D. (2005). The role of households in sustaining rural economies. *European Review of Agricultural Economics*, 32, 393-420.

Rocchi B., Stefani, G. (2005). The evolution of institutional structure of Italian agriculture: a historical reconstruction through the debate on agricultural holdings classification. *Proceedings of the 94th EAAE seminar, Wye (UK)*.

Rocchi, B. (2007). *Building a SAM for the analysis of Rural Policies: Insights from an Italian case study*. Paper presented at the 16th Confererence of th International Input Output Association, Istanbul. http://www.iioa.org/Conference/16th-downable%20paper.html. Accessed 18 August 2008.

Rocchi, B. (2009) The CAP reform between targeting and equity: a structural policy analysis for Italy, Forthcoming on *European Review of Agricultural Economics*.

Thomson K.J. (2001) Agricultural economics and rural development: marriage of divorce? *Journal of Agricultural Economics*, 52, 1-10.

UNECE, Eurostat, FAO, OECD, World Bank (2007). *Rural households' livelihood and well-being. Statistics on rural development and agricultural household income*, New York, United Nations, www.fao.org/statistics/rural/.

World Bank (2008). *Improving the quality and policy relevance of household-level data on agriculture in Sub-Saharan Africa*, mimeo downloaded at site siteresources.worldbank.org/INTLSMS/Resources/3358986-1233781970982/PanelSurveyAfrica_BMGF_dissemination.pdf

SESSION 3

Parallel Session 3.a

Measuring Food Security and Food Poverty

Chairman: *Mary Bohman, ERS*

Report on Parallel Session 3a:
Measuring Food Security and Food Poverty

Chairman: Mary Bohman
Economic Research Service, USDA

Overview *The papers in this session discuss various aspects of the measurement of poverty, food security and social exclusion. The three concepts can be observed in the same individual and there are also community and regional linkages. The three papers explore a range of measurement issues including the thresholds to identify the number or share of poor or food insecure people. Sibrian's presentation links the thresholds for poverty and minimum dietary energy requirements. Bienkunska's presentation covered the measurement and diagnosis of poverty and social exclusion in rural areas as related dilemmas. Polish CSO surveys provide for consistent measurement of poverty annually and every few years multidimensional analysis. Bienkunska also differences according to whether income or consumption are used. An important factor for countries with a significant share of the population living on farms is whether the analysis covers monetary income only or includes natural consumption. Statistics on social exclusion are complex and the aim of the social cohesion survey is to collect information which would support a comprehensive evaluation of the quality of life of Poles and analysis of the relationship with poverty.*
Aspects of each paper are relevant to the sections of the handbook treating rural statistics. Policy makers have a keen interest in poverty measurement and poverty alleviation is a Millennium Development Goal. The methodological parts of the paper discuss concepts to be measured, statistical techniques, and thresholds for poverty. The example for Poland formalizes measurement of social exclusion and discusses community indicators.

Indicators on Undernourishment and Critical Food Poverty at National and Sub-national Levels - *Ricardo Sibrian*

Indicators to measure food poverty and undernourishment are useful for understanding food insecurity at national level and within countries. The paper discussed two indicators: proportion of undernourishment and proportion of critical food poverty. Both indicators are based on nutritional underlying criteria and derived from food consumption and income data collected in national household surveys. Proportion of undernourishment is the Millenium Development Goal (MDG) indicator number 1.9, which is based on the distribution of dietary energy consumption (DEC); the proportion of critical food poverty is an indicator that links undernourishment to food poverty, based on the distribution of income (INC). The link is the concept of minimum dietary energy requirement (MDER) used in the FAO methodology as the cut-off value in the distribution of dietary energy consumption for estimating undernourishment. The critical food poverty line for estimating the proportion of critical food poverty is the critical income corresponding to the cost of the MDER, based on a balanced diet on energy-yielding nutrients accessible to low-income population groups. The macronutrient-balanced diet uses the recommendations of a Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases (2002, Geneva) as its point of reference. Examples illustrate the results of both indicators for a sample of countries in different countries.

Poverty and Social Exclusion in the Polish Rural Areas. Attempted Diagnosis and Measurement-related Dilemmas - *Anna Bienkunska (co-author Monika Borawska)*

The differences in the socioeconomic development between the Polish urban and rural areas as well as among particular regions of the country have also been confirmed by poverty and social exclusion statistics.

The methodological part of the paper describes the measurement methods used by Polish official statistics in the area of poverty and social exclusion, including evaluation of the basic sources of data. Some dilemmas concerning international comparison of poverty are discussed. The second part of the paper provides a concise diagnosis on poverty and selected aspects of social exclusion in Polish rural areas, with particular attention to poverty range measurement that includes various poverty lines. Over one third of the Polish population lives in rural areas and the Polish Central Statistical Office's (CSO) surveys confirm that during the last few years one-tenth of the inhabitants of these areas have been at risk of extreme poverty. In 2007, 10.5 percent of people below the poverty line that measures the subsistence minimum (versus 4 percent in towns). The highest rural poverty rates were noted among families without their own arms and living on social benefits other than retirement pay or pensions. Poverty also varies across regions and the socioeconomic characteristics of Polish rural areas.

Measuring Under-nourishment: Comparison Analysis between Parametric and Non-parametric Methods Based on Burkina Faso Agricultural Survey - *Moussa Kabore*

The paper compares the two principal methods used to measure food insecurity using data from food and agricultural survey of Burkina Faso in 2006. The parametric method estimates undernourishment by supposing that the food consumption follows a lognormal distribution. The non-parametric method estimates the proportion of undernourished people from individual data. The paper shows that the two methods converge based on the law of large numbers. The non-parametric method allows cross-analysis of household undernourishment status with other socio-economic variables and the ability to monitor MDG at sub national level.

Indicators on Undernourishment and Critical Food Poverty at National and Sub-national Levels

Ricardo Sibrian,
Senior Statistician, FAO,
ricardo.sibrian@fao.org

Abstract*: Indicators to measure food poverty and undernourishment are useful for understanding food insecurity at national level and within countries. This paper discusses two indicators: proportion of undernourishment, and proportion of critical food poverty. Both indicators are based on nutritional underlying criteria and derived from food consumption and income data collected in national household surveys. Proportion of undernourishment is the Millennium Development Goals (MDG) indicator number 1.9, which is based on the distribution of dietary energy consumption (DEC); the proportion of critical food poverty is an indicator that links undernourishment to food poverty, based on the distribution of income (INC). The link is the concept of minimum dietary energy requirement (MDER) used in the FAO methodology as the cut-off value in the distribution of dietary energy consumption for estimating undernourishment. The critical food poverty line for estimating the proportion of critical food poverty is the critical income corresponding to the cost of the MDER, based on a balanced diet on energy-yielding nutrients accessible to low-income population groups. The macronutrient-balanced diet uses the recommendations of a Joint WHO/ FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases (2002, Geneva) as its point of reference. Examples illustrate the results of both indicators for a sample of countries in different continents.*

Keywords: Food deprivation, food poverty, income deprivation, food security indicators.

1. Introduction

Traditionally undernourishment is measured as the proportion of population below the minimum level of dietary energy consumption, that is, the MDG indicator number 1.9, which uses the distribution of dietary energy consumption on per person per day as a base (FAO, 2003).

The World Bank measures poverty as the proportion of population below the *minimum* level of income (or proxy total expenditure), that is, the MDG indicator number 1.1 the proportion of population below $1 (Purchasing Power Parity) per day for international comparison, which uses the distribution of income (or proxy total expenditure) as a base (Deaton, 1997). The *minimum* level of income refers to the monetary value of the *average* dietary energy requirement of the population provided by a normative food basket using food prices of low income population groups.

More recently, it has been proposed as a measure of poverty the proportion of *critical* food poverty, that is, the proportion of population below the *critical* level of income (or proxy total expenditure), based on the distribution of income (or proxy total expenditure) as a base The *critical* level of income refers to the monetary value of the *minimum* dietary energy requirement of the population provided by a balanced energy-yielding nutrients food basket using energy-yielding nutrient prices of low income population groups (Sibrian 2008, 2009; Sibrian, Mernies and Ramasawmy, 2009).

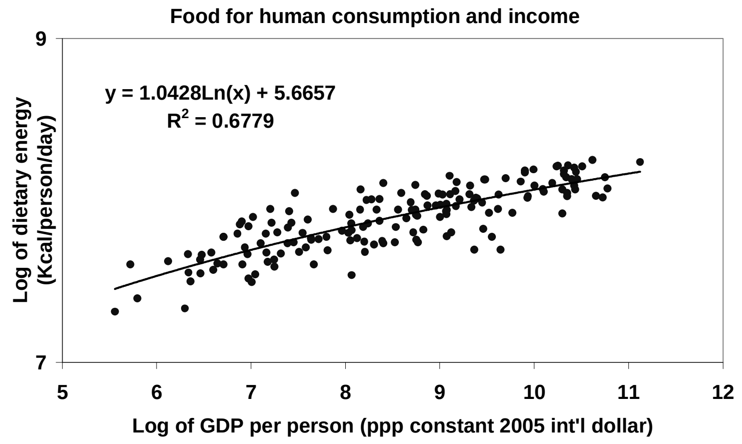
The main objective of this paper is to illustrate the indicators used for measuring undernourishment and critical food poverty national and subnational levels. Both indicators, undernourishment and critical food poverty, use the same nutritional underlying criteria; however, undernourishment is based on the distribution of dietary energy consumption while critical food poverty on the distribution of income (or total expenditure). As described elsewhere (Sibrian 2008) in estimating the proportion of food deprivation and critical food poverty, there are several methodological issues concerning the use of the underlying theoretical distribution for both dietary energy consumption (DEC) and income or proxy total expenditure.

The analysis of indicators on poverty and hunger requires understanding their contextual relationship. The paragraphs to follow illustrate these relationships.

2. Relationship between poverty and undernourishment

The relationship between poverty and undernourishment can be documented at several levels.

Figure 1

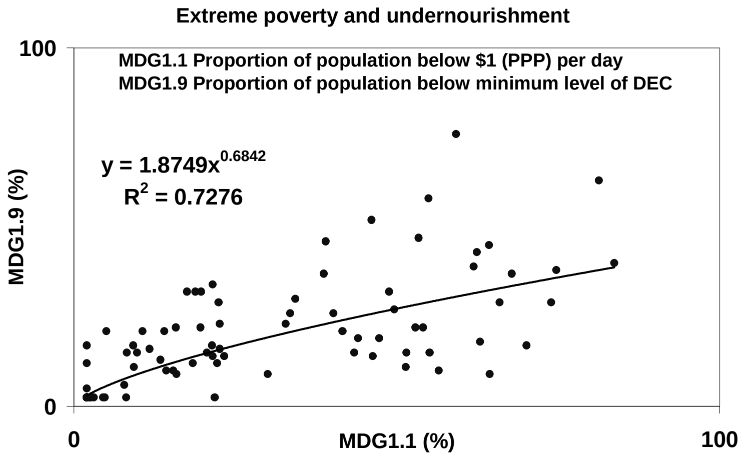


Sources: WDI, 2009 from World Bank Database and FAO, 2008a.

Figure 1 shows a strong non-linear relationship between income and food as measured by Gross Domestic Product valued at purchasing power parity (GDPppp) and dietary energy available for food consumption in selected countries, both expressed in terms of natural logarithm scale.

However the relationship depicted by these indicators in Figure 1 ignores the distributions of income and dietary energy consumption within the population in countries.

Figure 2

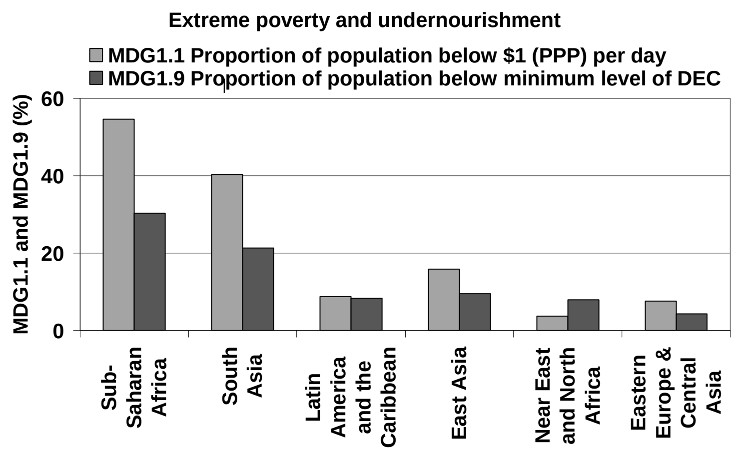


Sources: MDG 1.1 and 1.9 from UNSD-MDG Database 2009.

Figure 2 shows the non-linear relationship between poverty and undernourishment as measured by the proportion of extreme poverty (MDG 1.1 indicator) and the proportion of undernourishment (MDG 1.9 indicator). The nature of the relationship is stronger than that shown in Figure 1.

At regional level the relationship between the proportion of extreme poverty and the proportion of undernourishment is shown in Figure 3. Regions show higher levels of extreme poverty than undernourishment, except the Near East region where extreme poverty is lower than undernourishment.

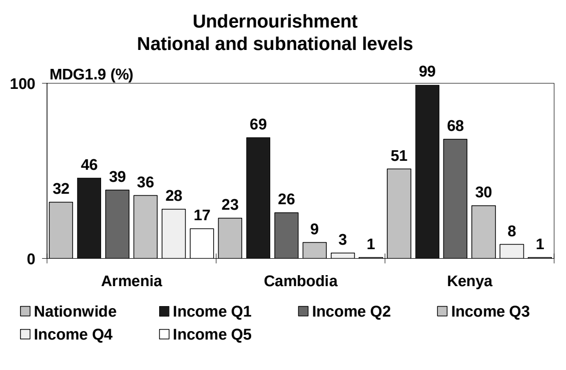
Figure 3

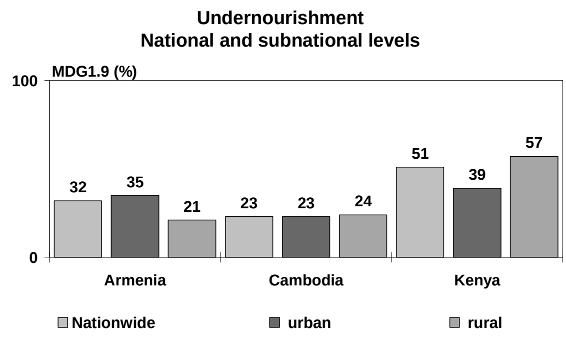


Sources: Aggregated estimates based on MDG 1.1 and 1.9 from UNSD-MDG Database 2009

At subnational levels the relationship between poverty and undernourishment is shown in Figure 4. Undernourishment estimates are higher in low income groups than in high income groups.

Figure 4



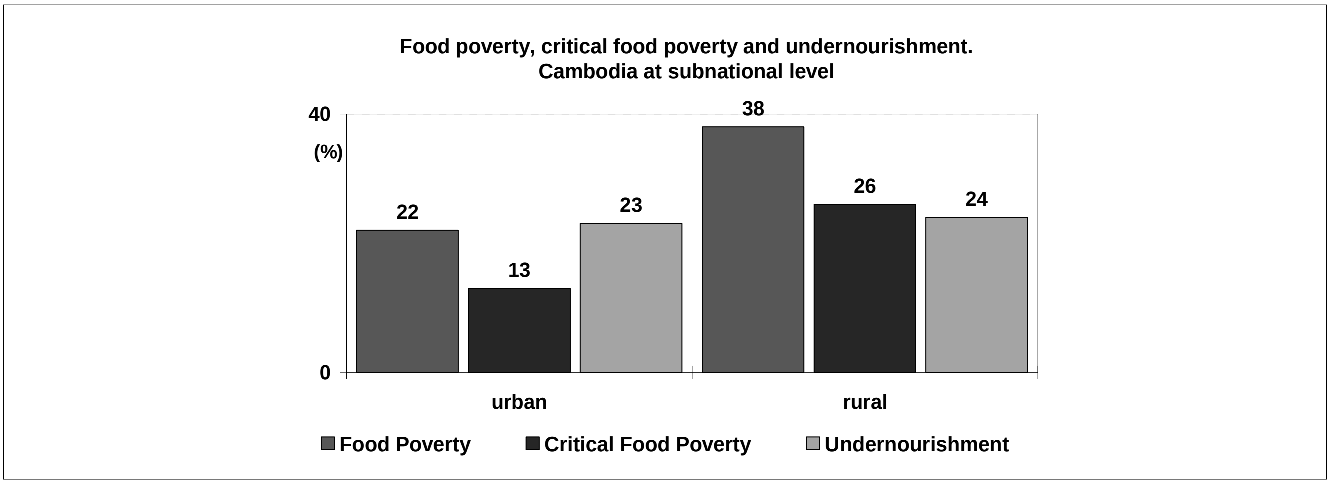


Source: Armenia, Cambodia and Kenya Lao Food Insecurity Assessments from Households Surveys

It has been argued that poverty in general is higher in rural areas; however undernourishment in households living in rural areas do not necessarily show higher undernourishment than in urban areas as shown in Figure 4; Armenia, for example, shows lower undernourishment in rural areas, in contrast Kenya the opposite situation, while Cambodia shows no difference between rural and urban.

In spite of this seemingly equality between urban and rural populations in Cambodia, the relationship between the proportions of food poverty, critical food poverty[105] and undernourishment are quite different as depicted in Figure 5. Food poverty and critical food poverty were higher in rural than in urban areas. Food poverty was higher than undernourishment in rural and not different in urban areas. Critical food poverty was lower than undernourishment in urban and not different in rural areas.

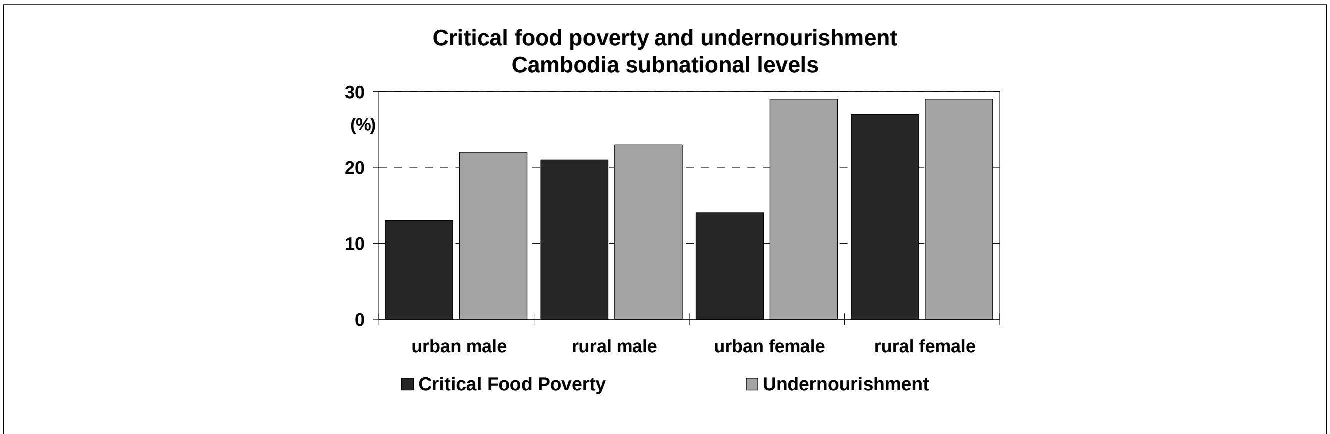
Figure 5



Sources: Cambodia, 2007

Figure 6 depicts the proportions of critical food poverty and undernourishment taking into account gender at subnational levels by area of residence in Cambodia. Female headed households showed higher critical food poverty as well as undernourishment than male headed households in both urban and rural areas.

Figure 6



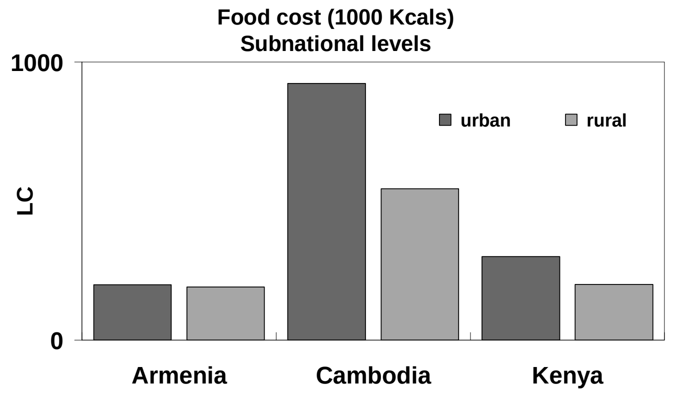
Sources: Pothy P. *et al*, 2008

Figure 7 shows dietary energy cost of food consumed in local currency (LC) for Armenia, Cambodia and Kenya (multiplied by 10). The monetary value of food consumed is expressed for 1000 kilo-calories as purchased or acquired from other sources, regardless of the edibility status of food, that is, ready to eat or uncooked. The difference between costs in urban and rural areas in Cambodia is quite high compared to Kenya

[105] Definitions of food poverty and critical food poverty presented in this paper are given in the section of "Discussion and conclusion" below.

or Armenia. The cost, as expected, is higher in urban areas than in rural areas and reflects different food consumption patterns. The cost of food produced in rural areas is higher in urban areas due to transport costs, middle-person profits in the marketing chain from production to consumption as well as food losses. The cost of processed food, for example sugar and oil, is lower in urban areas than in rural areas.

Figure 7



Source: Armenia, Cambodia and Kenya Lao Food Insecurity Assessments from Households Surveys

3. Discussion and conclusion

3.1 Undernourishment

The proportion of the population consuming less food to meet the minimum dietary energy requirement (MDER) is the proportion of undernourishment P(U). The proportion of undernourishment in total population is based on the probability distribution of DEC with density function determined by the mean and the variance of DEC, under the assumption of lognormal distribution (FAO 2008b). The mean is estimated as DEC for global monitoring of undernourishment from food balance accounts converted to dietary energy and for subnational monitoring from household surveys collecting food consumption in physical quantities. In both cases physical quantities of food are converted to dietary energy.

The variance is estimated from the CV of DEC. The CV of DEC involves two main components, thus ignoring non-relevant sources of variation. The first component CV of dietary energy consumption due to income, and the second component is CV of DEC due to energy requirements. The latter reflects differences in biological features of individuals such as sex, age and physical activity within the population and the former reflects the effect of income.

The CV of DEC due to income for global and for subnational monitoring of undernourishment is derived from income and food consumption data collected in national household surveys. It is estimated based on the variation of dietary energy consumption reflected by the averages of household dietary energy consumption on per person per day basis among income deciles.

The CV of DEC due to dietary energy requirements is derived using the variation of dietary energy requirements among sex and age groups, based on the minimum and maximum dietary energy requirements derived from standards of dietary energy requirements and the corresponding minimum and maximum body weight for attained-heights collected in anthropometric surveys and minimum and maximum physical activity levels. The standards of dietary energy requirements for minimum and maximum physical activity levels are obtained from the FAO/WHO/UNU Expert Consultation on Human Energy Requirements (FAO, 2004) and the minimum and maximum body weight for attained-heights are obtained from the BMI standards from WHO (WHO 2006, 2007).

The MDER used as cut-off point in the distribution of DEC is the population-based MDER that is derived from the FAO/WHO/UNU standards of dietary energy requirements for *minimum* physical activity level compatible with a *sedentary* lifestyle (FAO, 2004) and the *minimum* acceptable body weight for attained-heights (the fifth percentile of the WHO growth standards) as in the BMI standards from WHO (WHO 2006, 2007).

It is clear that in estimating the parameters mean of DEC and variance of DEC (function of the CV) at global level, the mean of DEC depends on the amount of dietary energy available for human consumption in the study population. DEC estimated for global monitoring from national food accounts covers household and non-household consumption, while DEC estimated for subnational monitoring at national and subnational levels from national household surveys covers food available for consumption at household level only.

If the non-household food consumption is high, for example food for tourists in hotels, soldiers in military compounds, prisoners in jails, patients in hospitals, and residents in residential compounds and so on, the DEC estimated using national food accounts may be quite different than that using household survey data. The DEC from household survey data assumes that food consumed away from home, purchased and received at workplace or school canteens as well as food given away to other families or institutions are taken into account.

The DEC estimated using household survey data depends on the food acquisition capacity of households as it was illustrated in the cases of Armenia, Cambodia and Kenya. This acquisition capacity of households may be quite different among population groups as it was shown for Cambodia between urban and rural households due to the role of food from own-consumption. The size of the effect may be different from region to region within countries and also across countries; hence the distributions of DEC are shifted to the left or to the right of the DEC at national level.

The acquisition of food by households in different income levels is due to the different capacity of purchasing or producing and consuming (own-production or own-consumption). At subnational level, for example between urban and rural areas, income plays an important role in the specification of the distribution of DEC, in particular the component of variation of DEC induced by income (economical capacity for food acquisition) captured by the CV of DEC due to income. For example CV of DEC due to income in Kenya and Cambodia were higher than in Armenia. The CV of DEC due to requirements varies among subnational population groups; however the effect of this source of variation on the spread of the distribution of DEC is lower than the effect of DEC.

In short, the distributions of DEC by subnational populations are different because the two parameters, DEC and CV of DEC are different.

In addition to this, the population-based MDER used as cut-off point in the distribution of DEC also varies among subnational population groups. One example is that low income households have lower MDER per person than high income households. This is due to low dietary energy requirements of more young members in low income household. A second example is that rural households have lower MDER per person per day than urban households. This is due to low dietary energy requirements of more young members in rural households compared to urban households. A third example is that households with female heads have lower MDER per person than male-headed households. This is due to less dietary energy requirements of missing male members in households headed by females.

The distributions of DEC among subnational population groups with different means and variances and their different MDERs call for all three inputs in estimating the proportion of undernourishment at subnational levels. This is against the common practice of using a common standard of dietary energy requirements, for example, MDER or the average dietary energy requirements use for estimating the proportion of extreme poverty as recommended by the World Bank.

3.2 Food poverty and critical food poverty

The proportions of food poverty and critical food poverty in total population are based on the probability distribution of INC with density function determined by parameters mean and variance of INC, under the assumption of lognormal distribution. The proportion of the population living on less income (or proxy total expenditure) than that required to obtain the food to meet the ***average*** dietary energy requirements -ADER (food-poverty line), is the proportion of food poverty P(FP) while the proportion of the population living on less income (or proxy total expenditure) than that required to obtain the food to meet the *MDER* (critical-food-poverty line), is the proportion of critical food poverty P(CFP).

The variance of INC is estimated by the CV of INC which one-to-one corresponding to the Gini's coefficient under the lognormal assumption. The CV of INC is derived from national income and expenditure household surveys collecting income or proxy total expenditure. It is estimated based on the variation of averages of income among income deciles on per person per day basis. The CV of INC is in general over-estimated due to the inclusion of sampling-design variation and other instrumental sources of variation. The actual distribution of INC may be flatter than the actual distribution of INC. This limitation applies to all poverty indicators, including the proportion of critical food poverty; however it is still useful for the identification of food poor and insecure population groups.

The population-based critical-food-poverty line is derived by costing the balanced MDER. This balanced MDER provides dietary energy from energy-yielding nutrients as follows: 65 percent, 22.5 percent and 12.5 percent of dietary energy from carbohydrate, fat and protein respectively, based on FAO and WHO recommendations. It does not take into account micronutrients and amino-acid patterns. The prices of these energy-yielding nutrients are accessible to households in the first income quintile. Usually (not always) the DEC of the first income quintile is NOT balanced and the balanced DEC is higher than that paid by these households. The concept of the MDER is the link between these two indicators, the proportion of undernourishment and the proportion of critical food poverty.

In short, the distributions of INC by subnational populations are different because the two parameters, INC and CV of INC are different. Furthermore, the critical-food-poverty line based on the cost of the balanced MDER which differs among population groups, as described in the previous paragraphs, call for specific subnational estimations of the proportion of critical food poverty.

3.3 Critical food poverty and undernourishment

Food costs are useful to explain differences in proportions of critical food poverty and undernourishment. In Cambodia, for example, critical food poverty and undernourishment in urban and rural areas are determined by income and food cost. The lower critical food poverty in urban areas is determined by a higher income, even if the dietary energy per unit costs more in urban areas than in rural areas. In contrast, the higher critical food poverty in rural areas is determined by a lower income, even if dietary energy per unit costs less in rural areas than in urban areas. The quality of the diet consumed in rural areas in general is lower than in urban areas. Any action aiming to poverty and undernourishment reduction needs to address income in rural areas and food costs in urban areas taking in consideration the nutritional quality of food consumed, in particular households headed by females.

3.4 Conclusion

The indicators on poverty and hunger illustrated at global and subnational levels are useful for assessing and monitoring food security. The increasing demand for indicators on poverty and undernourishment in developing countries can be met by using already collected data on food consumption in physical quantities in addition to monetary values in household income and expenditure surveys. Household surveys that for any reason have limited the data collection to monetary values can include in future surveys physical quantities for the purpose of food security analysis. These are elements useful for decision-makers in the national as well as in the international platforms engaged in the country's national food security. Hence decision-makers and stakeholders in national food security are encouraged to commission food security indicators and food insecurity assessments from national statistics offices; and, national statistics offices are encouraged to strengthen their statistical capacity to offer and users to include food security indicators derived from already collected data on food consumption (physical and monetary values) in national budget surveys.

References

Armenia, (2007). Food insecurity assessment in Armenia: Integrated Living Conditions Survey 2004 (Summary Report). National Statistical Service. Yerevan, Republic of Armenia.

Cambodia, (2007). Food insecurity assessment based on food consumption statistics derived from the 2003/05 Cambodia Socio-Economic Survey. National Institute of Statistics. Phnom Penn, Cambodia.

Deaton, Angus. (1997). The Analysis of Household Surveys: A Microeconometric Approach to Development Policy, Johns Hopkins University Press, Baltimore.

FAO. (2003). Measurement and assessment of food deprivation and undernutrition: Proceedings of the International Scientific Symposium. Rome, 26-28 June 2002. Rome, FIVIMS, FAO. Available at www.fivims.net/static.jspx?lang=en&page=iss .

FAO. (2004). Human Energy Requirements - Report of a Joint FAO/WHO/UNU Expert Consultation. Rome, 17-24 Oct. 2001. FAO Food and Nutrition Technical Report Series No. 1. Rome. Available at www.fao.org/docrep/007/y5686e/y5686e00.htm

FAO, (2008a). The State of Food Insecurity in the World (SOFI). Rome. Available at http://www.fao.org/sof/sofi/index_en.htm

FAO. (2008b). FAO methodology for the measurement of food deprivation: Updating the minimum dietary energy requirements. Rome, Statistics Division, Food Security Statistics. Available as metadata at www.fao.org/faostat/foodsecurity/index_en.htm .

Kenya, (2008). Food insecurity assessment in Kenya: Based on Integrated Household Budget Survey, 2005/06. Kenya National Bureau of Statistics. Nairobi, Republic of Kenya.

Pothy, P., Guarascio F., Curry J. and Sibrian R., (2008). Gender analysis of food security statistics by specific population group in Cambodia's CSES 2003/2005. ***In:*** Deriving food security information from National Household Budget Survey - Experience, achievements and challenges. Edited by Ricardo Sibrian. FAO, Rome. Available at http://www.fao.org/docrep/011/i0430e/i0430e00.htm

Sibrián, R., (2008). Indicators on food deprivation and income deprivation at national and sub-national levels: methodological issues. ***In:*** Deriving food security information from National Household Budget Survey - Experience, achievements and challenges. Edited by Ricardo Sibrian. FAO, Rome. Available at http://www.fao.org/docrep/011/i0430e/i0430e00.htm

Sibrián, R. (2009). Indicators for monitoring hunger at global and sub-national levels. Nutrition Reviews, 67(Suppl. 1):S17–S20. Special Issue: I World Congress of Public Health Nutrition. Available at http://www.fao.org/faostat/foodsecurity/files/wp013e.pdf

Sibrián, R., Ramasawmy, S. & Mernies, J. (2007). Measuring hunger at subnational levels from household surveys using the FAO approach: Manual. FAO Statistics Division Working Paper Series No. ESS/ESSA/005e. Available at www.fao.org/es/ess/faostat/foodsecurity/papers_en.htm .

WHO. (2003). Report of a Joint WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases. WHO Technical Report Series No. 916. Geneva: World Health Organization, 2003.

WHO, (2006). WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. Multicentre Growth Reference Study Group. World Health Organization, 2006 (312 pages). Geneva. Available at http://www.fao.org/wairdocs/who/ac911e/ac911e00.htm.

WHO, (2007). WHO Growth reference 5-19 years. Multicentre Growth Reference Study Group. World Health Organization, 2007. Geneva. Available at http://www.who.int/growthref/who2007_bmi_for_age/en/index.html

World Bank. (2009). World Development Indicators 2009. Washington.

Mesure de la sous-alimentation: analyse comparée entre la méthode paramétrique et celle non paramétrique a partir des données de l'enquête permanente agricole de 2006 au Burkina Faso

Moussa Kabore[106]
agristat@fasonet.bf
Maurice Taondyande[107]
M.Taondyande@cgiar.org

***Abstract**: Several methods are used to monitor the hunger progress in the world and particularly the objective n°1 of the millennium development. The idea of this article is not to make an exhaustive inventory on the methods of estimate of the food insecurity but to make a comparative analysis on the two principal methods used. It is about i) the parametric method based on the hypothesis normal distribution of food consumption between the households, used by FAO, and the ii) non-parametric method based on FGT index (FOSTER, GREER and THORBECKE) usually used for measurement of the incidence of monetary poverty based on the data from households living conditions survey.*
This article examines the measurement of undernourishment by the parametric method and that nonparametric using data from food and agricultural and survey of Burkina Faso in 2006. The parametric method (recommended by FAO) estimates undernourishment by supposing that the food consumption follows a lognormal distribution. The nonparametric method estimates the proportion of undernourished people from the individual data using FGT function on food consumption provided by the food and agricultural annual survey. The analysis' results shows that the distribution of the consumption per capita obtained by the survey follows indeed a lognormal distribution as predicted. With this result, we examined the mathematical bases of a possible convergence between the two methods. With the strong law of great numbers, we demonstrated that the two methods converge.
In order to use the parametric method, which offers more flexibility for measurement of undernourishment at national level but, regard to available data, inadequate to set subnational undernourishment at province or region level in Burkina Faso, it is necessary to study the stability of the dispersion of distribution of food consumption on several different crop years.
Moreover, that challenges the countries which lead such investigations annually to reflect on the manner of determining food consumption in urban area through an extension of the geographic coverage of the agricultural survey which are always remained in the whole as well in the methodology as of the field set of themes covered with their situation of year 70-80 whereas since then, the paradigm of food safety strongly evolved.

Keywords: food insecurity, measurement of under nourishment, parametric and non parametric methods of estimate.

1. Introduction

La mesure de la sous-alimentation est nécessaire pour le suivi des objectifs du millénaire en particulier l'objectif n°1 : « réduire de moitié la proportion de personnes souffrant de la faim d'ici 2015 ». Elle permet également de :

- Réaliser une cartographie de l'insécurité alimentaire,

[106] Ingénieur statisticien économiste, Directeur des statiques agricoles au Burkina.
[107] Ingénieur statisticien économiste, Expert en suivi/évaluation au SystèmeRégional d'Analyse Stratégique et de Gestion des Connaissances (ReSAKSS), ex-cadre de la direction générale des prévisions et des statistiques agricoles au Burkina.

- Faire un suivi de l'insécurité alimentaire dans le temps,
- Identifier les groupes les plus vulnérables au sein d'un pays,
- Identifier les causes de l'insécurité alimentaire,
- Suivre l'impact des politiques et des projets, afin d'améliorer les décisions prises en la matière.

Plusieurs méthodes sont utilisées pour cerner le phénomène. Elles s'appuient sur des sources de données de nature différente. L'idée de cet article n'est pas de faire un inventaire exhaustif sur les méthodes d'estimation de l'insécurité alimentaire mais de faire une analyse comparative sur les deux principales méthodes utilisées. Il s'agit de la méthode paramétrique basée la distribution de la consommation alimentaire entre les ménages, elle est utilisée par la FAO, et la méthode non paramétrique basée sur l'indice FGT (FOSTER, GREER et THORBECKE) qui est aussi utilisée pour la mesure de l'incidence de la pauvreté monétaire.

Cet article a pour objectif de rechercher une éventuelle convergence entre les deux méthodes en vue de permettre aux systèmes statistiques nationaux de mesurer régulièrement l'incidence de l'insécurité alimentaire en fonction de la nature des données disponibles.

Nous décrirons dans un premier temps les deux méthodes avant de passer à l'estimation de l'incidence de l'insécurité alimentaire par les deux méthodes. Les données utilisées étant uniquement sur le milieu rural, nous proposerons une méthode d'estimation pour la prise en compte du milieu urbain.

2. Description de la méthode parametrique

La méthode est basée sur la distribution de la consommation alimentaire énergétique par tête. De façon pratique, l'incidence de la sous-alimentation est estimée de la façon suivante :

$$P\,(U) = P(x < r_L) = \int_{x<rl} f(x)\,dx = F_x(r_L) \text{ où :}$$

- P(U) représente la proportion de la population sous-alimentée dans la population totale,
- X est la consommation énergétique alimentaire par individu,
- rl est le besoin énergétique minimum et
- f(x) est la fonction de densité de l'alimentation au sein de la population. Dans la littérature, on suppose que f suit la loi log-normale.

Sa mise en œuvre nécessite la consommation alimentaire énergétique moyenne par tête et l'écart type de la distribution. La consommation alimentaire moyenne peut être obtenue à partir du bilan alimentaire ou d'une enquête sur la consommation alimentaire. L'estimation de l'écart type requiert nécessairement une enquête sur la consommation alimentaire. Elle offre l'avantage d'une mise en œuvre rapide une fois les paramètres de la distribution connus. Cependant, son utilisation au niveau sous national requiert la connaissance de ces paramètres pour les entités sous nationales, ce qui peut être difficile à obtenir.

3. Description de la méthode non parametrique

Elle est basée sur l'indice FGT qui est décrite de la formule suivante:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{q}\left(\frac{Z - Y_i}{Z}\right)^{\alpha}$$

Avec :

- Z le seuil de pauvreté énergétique,
- Yi la consommation énergétique de l'individu i,
- q le nombre d'individus de la population considérée comme pauvre énergétique,
- N l'effectif total de la population et α un paramètre (α = 0 dans notre cas).

La mise en œuvre de cette méthode nécessite nécessairement une enquête sur la consommation alimentaire physique des individus. Il faut rappeler que la méthode FGT est utilisée pour le calcul de l'incidence de la pauvreté monétaire. Elle offre la possibilité de désagrégation au niveau sous national et comme elle est calculée à partir d'une enquête ménage, des possibilités de croisement avec les autres variables sont offertes pour cerner les causes de l'insécurité alimentaire et la vulnérabilité des ménages.

4. Presentation des données

Les données utilisées pour cette étude proviennent de l'enquête permanente agricole du Burkina Faso de 2006/2007. C'est une enquête réalisée à partir d'un plan de sondage à deux degrés sur un échantillon de 4000 ménages ruraux**.** Les unités au premier degré sont les villages et celles du second degré sont les ménages. Un des questionnaires de l'enquête permet d'établir l'équilibre ressources-emplois de chaque produit utilisé par les membres du ménage entre le 1er octobre de l'année n-1 et le 30 septembre de l'année n. En ressources, les informations suivantes sont collectées pour chaque produit:

- Production
- Achat
- Cadeaux reçus
- Stock initial

En emplois, on a :

- Vente
- Stock final
- Dons

On déduit ainsi la consommation en faisant l'équilibre ressources-emplois. Toutes ces informations sont collectées en unité locale de mesure (ULM) et par membre du ménage, ce qui améliore la qualité des réponses. En outre, la production est mesurée de façon objective à partir des carrés de rendement et les stocks initiaux et finaux des céréales sont pesés par l'agent enquêteur.

La table de conversion des différents produits permet de passer des quantités physiques aux quantités énergétiques. La consommation énergétique individuelle s'en déduit par simple ratio entre la consommation énergétique totale du ménage et la taille de celui-ci. L'inconvénient de cette méthode est qu'elle ne permet pas de prendre en compte les inégalités dans l'accès aux ressources alimentaires au sein du ménage. Mais à défaut d'une enquête sur la consommation individuelle qui sera difficile à mettre en œuvre, nous utilisons la consommation énergétique moyenne au sein du ménage comme proxy.

5. Estimation par la méthode parametrique

5.1 Traitement des valeurs aberrantes

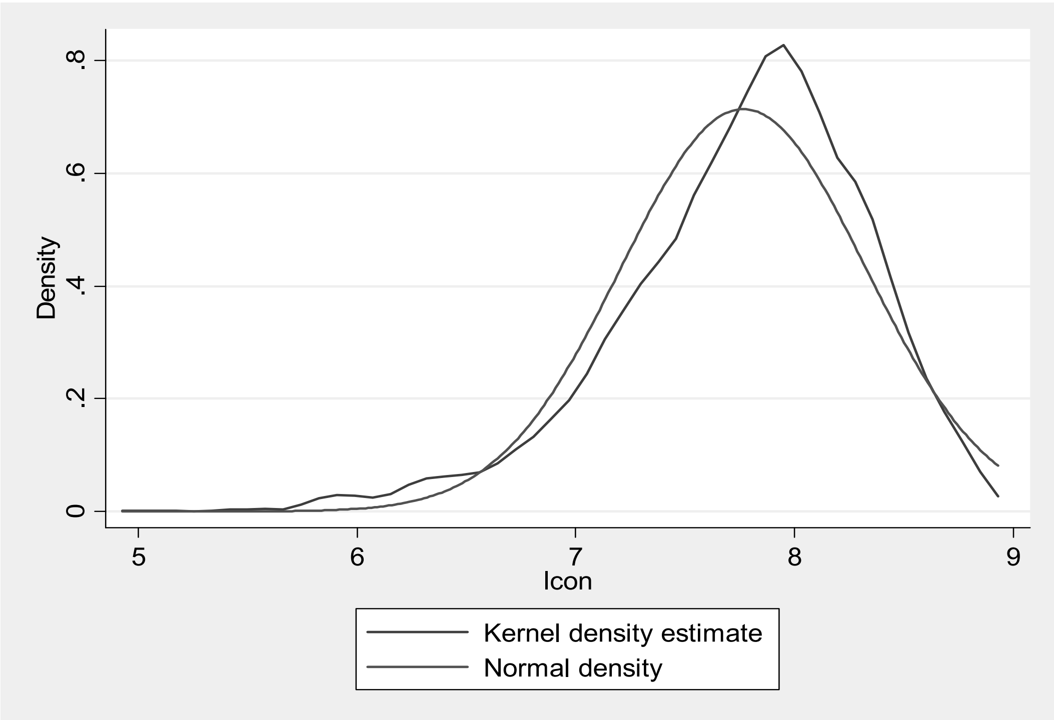
Dans un premier temps les valeurs liées certainement aux erreurs de collecte ou de saisi ont été corrigées .Toutes les observations situées à l'extérieur de l'intervalle

$]Q_1 - 1,25*(Q_3 - Q_1); Q_3 + 1,25*(Q_3 - Q_1)[$ ont été remplacées par la moyenne des valeurs situées dans l'intervalle $[Q_1 - 1,25*(Q_3 - Q_1); Q_3 + 1,25*(Q_3 - Q_1)]$ où Q_1 est le premier quartile et Q_3 est le troisième quartile.

5.2 Analyse de la distribution de la consommation alimentaire en milieu rural

Après la correction des valeurs extrêmes, une nouvelle distribution Y=ln(X) est générée. Le Kernel density estimate du logiciel STATA permet d'estimer la fonction de densité de la distrubution.

Kernel density estimation avec ln(consotete)



Test de normalité de la distribution

Skewness/Kurtosis tests for Normality avec ln(consotete)

Variable	Pr(Skewness)	Pr(Kurtosis)	------- joint ------ chi2(2)	Prob>chi2
lncon	0.000	0.000	402.09	0.0000

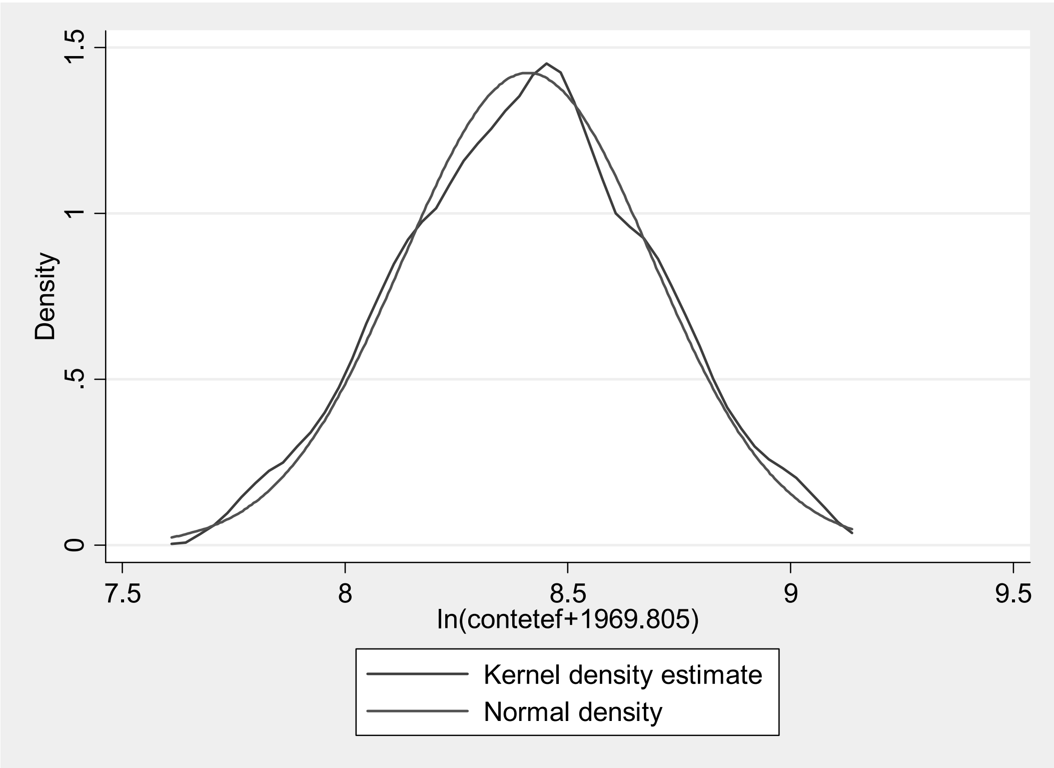
Le test conclut à la normalité de la distribution.

Une procédure sur STATA assure une estimation robuste de la fonction de densité. Il s'agit du « Find zero Skewness». C'est une procédure qui permet de trouver un réel K qui annule le Skewness de la distribution ln(contete-K).

Intervalle de confiance de K

Transform	k	[95% Conf. Interval]		Skewness
ln(contetef-k)	-1969.805	-2588.918	-1499.001	-0.0000731

La densité de la nouvelle distribution ln(contete-K) est :



Sa moyenne et son écart-type sont consignés dans le tableau ci-dessous.

Variable	Obs	Weight	Mean	Std. Dev.	Min	Max
lncon0	3843	11141964.5	8.410604	0.280089	7.659576	9.090232

5.3 Estimation du besoin énergétique minimum

Le besoin énergétique minimum est estimé de la façon suivante :

$$r_l = \Sigma_{ij}(BEM_{ij}\ P_{ij})$$

Où :
BEM_{ij} = besoin énergétique alimentaire minimum par personne par jour selon l'âge et le sexe
Pij = structure de la population selon l'âge et le sexe

A partir de la structure de la population et du tableau ci-dessous, on obtient :
r_1 =2102 Kcal/pers/jour en milieu rural

5.4 Estimation de la sous alimentation avec la méthode paramétrique

Ln(contete-K) suit la loi normale N(8,41 ; 0,28)
Ainsi P(contete < X_0)= P(ln(contete-K) < ln(X_0-K)) =F(ln(X_0-K))=36,2%
où F est la fonction de distribution de Ln(contete-K).
Ainsi 36,2% de la population rurale vivait en insécurité alimentaire en 2006.

6. Estimation de la sous alimentation par la méthode non parametrique

Cette estimation est faite à l'aide de la fonction FGT ci avant décrite avec α = 0. A partir de la consommation énergétique par tête calculée à partir des données de l'enquête ménage, les individus sont classés pauvres alimentaires ou non pauvres en comparant leur consommation alimentaire par jour au besoin énergétique minimum qui est de 2102 Kcal/pers/jour. Il ressort ainsi que 35,7% de la population rurale était en insécurité alimentaire en 2006.

Fondement mathématique de la convergence entre les méthodes

Soit $(X_n)_{n\in N}$ une suite de variables aléatoires indépendantes de même loi X

Alors $$\frac{1}{n}\sum_{i=1}^{n} 1_{(X_i<x_0)} \xrightarrow{n\to+\infty} p = P(X<x_0) = F(x_0)$$

Où $1_{(X_i<x_0)}(x) = 1$ si $X<x_0$ et 0 sinon.

Démonstration

Soit $(Y_n)_n$ une suite de variable aléatoire définie comme suite :
Y_n=1 si X_n<X_0 et 0 sinon. Y_n suit la loi de Bernoulli de paramètre p= P(X<X0) qui est même temps son espérance.

Ainsi Y_n= $1_{(X_n<x_0)}$

L'espérance de Y_n=p. Les Y_n sont iid car les X_n le sont.

D'après la loi forte des grands nombres, $\frac{1}{n}\sum_{i=1}^{n} Y_n \longrightarrow p = P(X<x_0) = F(x_0)$

Application pratique à notre cas

Dans notre cas, X_i désigne la consommation énergétique de l'individu i et X_0 le besoin énergétique minimum.

Or $\frac{1}{n}\sum_{i=1}^{n} 1_{(X_i<x_0)} = \frac{q}{n}$ n'est rien d'autre que l'incidence de la sous alimentation selon l'indice FGT ($\alpha = 0$).

q étant le nombre d'individus sous alimentés.

Les deux méthodes (paramétrique et non paramétrique) convergent quasiment puisque le logarithme de la distribution énergétique par tête suit pratiquement la loi normale. Il faut rappeler qu'il existe un théorème qui assure la convergence entre les deux méthodes dès que la distribution s'ajuste effectivement à la loi normale (voir encadré ci-dessous).

7. Proposition d'une méthode d'estimation de l'ecart type de la distribution au niveau national

L'estimation de l'écart type de la distribution dont la normalité pour l'ensemble de la population rurale et urbaine ne sera pas à démontrer, concerne uniquement le milieu rural. Son estimation pour le niveau national pourrait faite en utilisant la formule de décomposition de la variance. La décomposition de la variance stipule que la variance de la population totale est égale à la moyenne des variances des différentes sous populations augmentée de la variance des moyennes des différentes sous populations.

Cela se traduit par :

$$V = \underbrace{\frac{1}{n}\left[n_1 V_1 + n_2 V_2\right]}_{\textbf{Variance intra}} + \underbrace{\frac{1}{n}\left[n_1(\bar{Y}_1 - \bar{Y})^2 + n_2(\bar{Y}_2 - \bar{Y})^2\right]}_{\textbf{Variance inter}}$$

Où:

- V est la variance de la consommation énergétique au niveau national.
- $\bar{Y}$ représente la consommation énergétique moyenne par individu obtenue à partir du bilan alimentaire où d'une enquête sur la consommation alimentaire physique.
- $\bar{Y}_1$, $\bar{Y}_2$ la moyenne de la consommation énergétique en milieux urbain et rural.
- V_1, V_2 les variances en milieux urbain et rural.

L'absence des quantités physiques consommées dans les enquêtes sur les conditions de vie des ménages rend difficile l'estimation de la variance de la consommation en milieu urbain. Certaines études ont essayé de dériver les quantités consommées à partir des valeurs monétaires en utilisant des prix moyens par produit ,mais cela a conduit à des estimations biaisées compte tenu de la différence des prix entre les zones excédentaires et déficitaires.

Pour contourner ce problème, nous proposons simplement d'utiliser la variance des dépenses alimentaires par tête comme proxy de celle de la consommation énergétique, toute chose égale par ailleurs.

8. Conclusion et perspectives

L'analyse révèle la quasi convergence entre les deux méthodes. Cela offre des perspectives aux pays pour une évaluation prévisionnelle de l'incidence de la sous alimentation dès les résultats prévisionnels de la campagne agricole au mois d'octobre s'ils arrivent à évoluer effectivement vers le bilan alimentaire prévisionnel[108] en lieu et place du bilan céréalier ou s'ils trouvent un modèle de prédiction de la consommation alimentaire énergétique moyenne à partir du bilan céréalier.

Cependant il est nécessaire d'étudier la stabilité de l'écart type de la distribution en fonction des disponibilités alimentaires. Autrement dit, il s'agit de vérifier si la dispersion de la consommation alimentaire

[108] Le Comité Inter Etat de Lutte contre la Sécheresse au Sahel (CILSS) appuie les pays en ce sens

entre les différentes catégories de ménages n'est pas modifiée en fonction des disponibilités alimentaires de la campagne agricole. Une faiblesse des disponibilités alimentaires se traduirait par une baisse de la consommation des ménages vulnérables tandis que les plus nantis augmenteront certainement leurs dépenses pour couvrir leurs besoins énergétiques, ce qui a pour conséquence une modification de la dispersion de la distribution. Une étude comparée sur des campagnes agricoles de nature différente s'avère nécessaire.

References bibliographiques

«Méthodologie de la FAO pour mesurer la prévalence de la sous-alimentation». Division de la statistique, Rome 2003.

«International Scientific Symposium on Measurement and Assessment of Food Deprivation and Undernutrition», FAO, du 26 au 28 juin 2002.

«Travaux de recherche sur l'état des lieux sur la norme de consommation céréalière au Burkina Faso». DGPSA, 2006.

«A class of decomposable poverty measures», Econometrica, vol. 52, No. 3, pp: 761-766. 1984, FOSTER J.E, GREER J. et THORBECKE E.,

SESSION 3

Parallel Session 3.b

Towards a Core Set of Indicators

Chairman: *Ray Bollman, Statistics Canada*

Report on Parallel Session 3b:
Towards a Core Set of Indicators

Chairman: Ray Bollman, Statistics Canada

Developing Countries' Perspective: Selecting a Core Set of Indicators for Monitoring and Evaluation in Agriculture and Rural Development in Less-than-Ideal Conditions and Implications for Countries Statistical System,
Naman Keita (FAO), Nwanze Okidegbe and Sanjiva Cooke (World Bank), Tim Marchant, Consultant

Naman Keita summarized the main themes discussed in the recent report: GDPRD/FAO/World Bank: Tracking results in agriculture and rural development in less-than-ideal conditions, 2008

Composite Indices for Multidimensional Development and Poverty: an Application to MDG Indicators,
Pasquale de Muro (University of "Roma Tre"), Matteo Mazziotta and Adriano Pareto (ISTAT)

The measurement of development or poverty as multidimensional phenomena is very difficult because there are many theoretical, methodological and empirical problems. The set of indicators gives complete information but the multidimensionality can complicate the reading and the analysis of the results. The possibility to have a unidimensional measure that summarizes the information - in order to make it immediately clear and interpretable - can simplify considerably both data analysis and reading of complex phenomena.

For this reason, we propose a new and alternative composite index (MPI – Mazziotta Pareto Index) which, starting from a linear aggregation, introduces penalties for the countries or geographical areas with 'unbalanced' values of the indicators.

As an example of application of the MPI, we consider a set of indicators in order to measure the MDGs and we present a comparison among HDI (Human Development Index) methodology, HPI (Human Poverty Index) methodology and the MPI.

Discussion

Most of the discussion related to the philosophy of various alternatives for selecting weights to generate a composite index. Even the use of market prices as weights in a composite price index is assuming that the price has a direct relationship to the value of the item. The authors referred the discussion back to the note in their paper from A. Sen that argued for a transparent and inclusive democratic process to select these weights.

One suggestion for the paper by Keita et al. was that the name of each indicator should define the variable (say, as a row in a table) and then another dimension of the table (say, as columns) should define the geographic grid in which the variable is to be reported (say, rural, urban, all areas).

Developing Countries' Perspective: Selecting a Core Set of Indicators for Monitoring and Evaluation in Agriculture and Rural Development in Less-than-Ideal Conditions and Implications for Countries Statistical System

Naman Keita (FAO)
naman.keita@fao.org

Nwanze Okidegbe and Sanjiva Cooke (World Bank)
NOkidegbe@worldbank.org, SCooke@worldbank.org

Tim Marchant, Consultant
tim@uow.edu.au

***Abstract**: The Wye Group Handbook on Rural Household Livelihood and well-being, in its part I discusses several issues related to rural development statistics, including policy issues, conceptual framework, approaches to rural development statistics, inventory of indicators, data sources and approaches to selecting a core set of indicators. However, most of the references relate to OECD countries and the handbook presents essentially an inventory of good practices in developed countries or international organisations. Therefore, as recognised in the preface, the handbook needs to be complemented by more developing country perspective to widen its coverage. Also, more work is needed in defining a core set of indicators which are relevant to agriculture and rural development, comparable across countries and can be compiled by a large number of countries at various stages of statistical development. This will be a value added and a continuation of the work of the handbook.*

Keywords: agriculture, rural development, developing countries, core set of indicators, national statistical system.

This paper builds on a recent publication prepared by FAO and the World Bank[109] under the auspices of the Global Donor Platform for Rural Development on *Tracking results in agriculture and rural development in less-than-ideal conditions* **-** A sourcebook of indicators for monitoring and evaluation. The Sourcebook provides a number of workable approaches for defining a monitoring and evaluation system for agriculture and rural development activities in developing countries with more focus on results level indicators (outcome and impact). It provides a menu of 86 core indicators which have been tested and validated in five developing countries with difficult statistical conditions (Cambodia, Nicaragua, Nigeria, Senegal, and Tanzania). Nineteen of these indicators are identified as priority indicators, selected specifically as starting points for M&E in less-than-ideal conditions based on their relative simplicity and the cost-effectiveness with which they can be gathered. These indicators are also intended to meet the very most basic data requirements of international agencies responsible for global level M&E. The complete list of indicators including data sources, core data requirements, and technical notes is provided in the Sourcebook. A range of data collection methods and their relevance to specific indicators are discussed as well as an indication of the magnitude of the cost since budgetary limitations are a major constraints in many developing countries. The articulation with the National Statistical System and particularly the National Strategy for Development for Statistics are also discussed. It appears that good M&E system for tracking results in Agriculture and Rural Development must be underpinned by a database of core agriculture and rural statistics and improving countries capacity to produce this core set of statistics is a major priority for countries and the International Community.

[109] This Sourcebook was prepared by a joint team of staff from the World Bank and the Food and Agriculture Organization of the United Nations (FAO), led by Nwanze Okidegbe (World Bank) and consisting of: Tim Marchant (principal consultant); Hiek Som, Naman Keita, Mukesh K. Srivastava and Gladys Moreno-Garcia, (FAO Statistics Division); and Sanjiva Cooke, Graham Eele, Richard Harris and Diana Masone (World Bank).

1. Agriculture and Rural Development Policy Issues in Developing Countries and M&E framework for tracking Results

A major role of statistics is to provide decision makers and other stakeholders with quantitative information in order to help them analyse constraints, define policy and programme objectives and implementation strategies, monitor and evaluate the results.

While in developed countries, agriculture is less and less the economic base of rural areas, this continues to be the case in many developing countries where agricultural sector employs 40 percent of the workers and contributes over 20 percent of their GDP[110]. In these countries around 75 percent of the poor still live in rural areas and the proportion of rural population to total population is comprised between 59.5 percent in less developed regions in 2000 (estimate of 56.8 percent in 2005) and 74.8 percent in least developed countries (72.3 percent in 2005).[111]

The major policy issues and agriculture and rural development programmes in most developing countries are therefore related to sustainable agriculture and rural development and long term improvement of the people's living standard, particularly the rural population. Ensuring food security for the population is a related basic policy issue. Sector-wide approach (SWAP) is being adopted by many countries as a means of promoting and coordinating sector-wide and national development planning and programme implementation and as a result, there is a growing demand for verifiable evidence of the results and impacts of development programs.

However most of the indicators that development practitioners have traditionally used in tracking progress toward achieving project objectives are focused on the workings of the development project or programme itself. These performance indicators relate chiefly to lower-level inputs and outputs, and are used to populate management information systems. Higher level indicators are used to measure progress in achieving the ultimate objectives of projects and programs, and in bringing about larger impacts. These results indicators have become increasingly prominent in the wake of recent international resolutions such as the *Paris Declaration on Aid Effectiveness* in 2005 and the *Monterrey Consensus on Financing for Development* in 2002.

While no conflict exists between performance and results indicators; and while effective monitoring and evaluation (M&E) systems necessarily track both – no unifying principles apply to ensure their synchronicity either. A project that is diligently monitored and evaluated for financial oversight and compliance with sound management and performance principles may very well achieve no impacts. The emphasis on aid effectiveness and results-based development obliges practitioners to empirically demonstrate the impacts of their projects and programs. This has shifted the focus of M&E from a concentration on inputs and outputs to a concentration on outcomes and impacts.

The ability to measure and demonstrate outcomes and impacts relies on the use of indicators that are based on reliable data, and on the capacity to systematically collect and analyze that information. The conditions in which M&E are carried out vary widely, depending on the demand for information, the extent to which it is used to inform decision making, and the reliability of the systems that are in place to capture and convey that information. Throughout much of the developing world these conditions are "less-than-ideal." Information is irregular and often lacking altogether. In these conditions there is a lack of effective demand for information on the part of policy makers. The conditions are often especially pronounced in rural areas, where the costs of data collection are very high, and that quality of existing data is particularly low. Supporting and building capacity for M&E in these conditions is therefore a pressing imperative for interventions in the agriculture and rural development sector. Strengthening capacity for M&E begins at the national and sub-national levels, where addressing the weaknesses of national statistical systems is a common priority.

The data collected and reported within countries must not only be of sufficient quality to inform planning and policy formulation, they must also be consistent between countries. Standardizing the information collected by global databases facilitates comparisons across countries by international agencies such as the World Bank

[110] *Wye Group Handbook on Rural Household Livelihood and well-being* pages 11 and 12.
[111] *Wye Group Handbook on Rural Household Livelihood and well-being* page 11.

and FAO that compile development indicators that point to regional and global trends and realities. Reliable statistics are vital for measuring progress toward the Millennium Development Goals.

2. The analytical framework

Systematically measuring the impact of a development program or project involves the application of an analytic or logical framework (logframe) in which indicators are classified as *performance indicators* and *results indicators.* In results-based systems, relatively greater weight is attached to indicators that are used to measure impact than to performance indicators, which are comparatively cheap and easy to monitor. This represents a departure from conventional M&E.

Performance indicators are used to measure the effective use of inputs to generate outputs, and to compare the actual effects of the inputs to their expected effects. Inputs are the financial, physical, and human resources that are employed by the project to produce outputs. Outputs are the project's products – the goods and services produced by introducing the inputs. Monitoring performance by determining how effectively and efficiently inputs are converted into outputs consists largely of book keeping and analyzing financial records to produce financial reports and data that are entered into financial and management information systems. This information is used for cost-benefit analysis, and to calculate the costs per unit of output and a variety of input-output ratios that are used for financial reporting and in periodic progress reports.

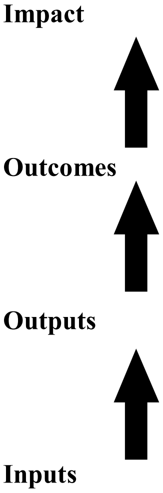
Results indicators are generally classified as outcomes and impacts. Outcomes are changes in people's behavior – often through their response to incentives – that result from their access or exposure to project outputs. Optimally, these behavior changes will advance the intended goals or impacts of the project. Impacts are the ultimate effects of the project, whether intended or unintended. Monitoring these higher-level effects of a program is significantly more involved than examining the information internally available in financial and management information systems, and entails soliciting information from clients and beneficiaries about how the program has affected them. It is important to correct any misapprehension that results indicators are monitored after performance indicators, for no such sequence applies. Results need to be tracked throughout the program's implementation so that corrective action can be taken mid-course – for instance identifying intended beneficiaries who are not being reached and determining why. This tracking of early results addresses a traditional weakness in M&E that is attributable to the time lag between when project outputs are provided and when higher level outcomes are or are not achieved.

3. The indicators

There is an abundant literature regarding the selection of appropriate indicators, and extensive lists have been prepared suggesting suitable indicators for monitoring different types of projects. These are useful reference materials, but in many cases, impractical to apply. Not only are there hundreds of indicators, but also, the data that underpin them usually cannot be secured with the necessary precision or regularity. When choosing indicators, the starting point should be the question, "Is this proposed indicator measurable?" This helps considerably in the quest to identify a minimum list that requires the lightest of M&E structures. Even so, the range of possible indicators is still sizeable, which reflects the fact that the M&E systems still have to satisfy the needs of a broad range of users, and that their needs are not identical by any means. Table 3 is there to serve as a checklist – a menu from which a selection of indicators can be picked. The actual selection of indicators should be a reflective and participative activity involving the key stakeholders who are most intimately associated with the project design and implementation – not an imposition of demands from outside. The FAO/WB Sourcebook outlines a systematic approach that can be adopted to help prioritize the most critical indicators that need to be selected. It provides examples of how the methodology can be applied and used for different ARD subsector programmes.

It should be noted that the number of indicators and the data required to compute them can grow rapidly. Even though there will always be good reasons for which the list of indicators needs to be expanded, there are also good reasons for starting small and making use of whatever data are available before collecting more. The

Sourcebook strongly encourages the idea of integrating statistical capacity building into national M&E programmes from the beginning, so as to ensure a reliable supply of core statistics from which the required indicators can be extracted.



The methodology for selecting indicators is initially introduced in the context of a project-level M&E system, but the process is the same even if one is working on indicators for monitoring a national poverty reduction strategy. The starting point is to establish a framework using the widely used logical framework approach (*logframe*). In very simplified terms, this is a conceptual device that describes the project in terms of its intended goal or *impact*. In order to achieve this impact, people's behaviour is expected to have changed in a way that will help with the achievement of the project goals. These behavioural changes are known as the project *outcomes***,** and it may take several years before they become apparent. In order for these outcomes to occur, the project must generate *outputs* (goods and services). These outputs in turn require that the necessary combination of *inputs* (financial, physical and human) become available at the right time, place and quantity. Thus, in reverse order, the inputs will generate outputs, which will yield outcomes and eventually an impact. For example, the aim or goal of the project may be "to increase agricultural revenues, particularly of the poorest households, through the introduction and use of small-scale irrigation." In order to achieve the expected yield increases, farmers must have access to and start using, the irrigation services. Farmers would have to change their agricultural practices and learn how to manage and control water supply (outcomes). The degree to which farmers change their behaviour might be best measured by monitoring "adoption rates" of the new practices. Increasing adoption rates may require the project to facilitate the creation of the necessary infrastructure, to organize a farmers' awareness programme, including extension visits, demonstration plots and radio programmes, etc. These project outputs will only be generated if the necessary inputs are made available in the right quantity and at the right time, and with the knowledge of how to implement and use them.

The logframe is well known as a tool for project design and is a useful aid to better understand the logic that defines the development process. It has, however, a second application, which is to provide the framework for developing a project M&E system that includes all stages of the project from beginning to completion and beyond. Once the logic of the project had been defined using the logframe, it should then, in principle, be a relatively simple process to monitor progress at each of the four levels. This idea has immense appeal because it helps to reduce the information needs for monitoring the project's success down to a relatively small number of key indicators – which, as already noted, is a desirable feature.

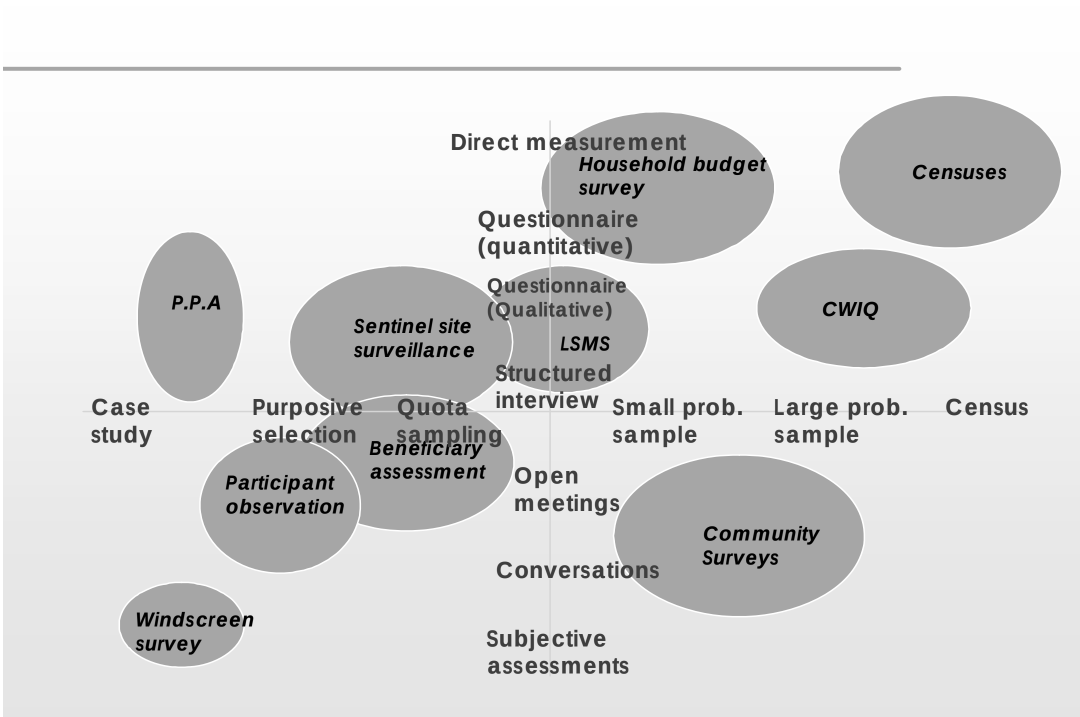
The *Sourcebook* presents a list of 86 core indicators which are used to measure early, medium-term, and long-term outcomes. The list includes the core data requirements needed to construct the indicators and the data sources from which the information is derived. The first 20 indicators are sector-wide, followed by a list for monitoring agricultural and rural subsectors, including crops, livestock, fisheries and aquaculture, forestry, rural microfinance and small and medium enterprise finance, agribusiness, agricultural research and extension, and irrigation and drainage. These are followed by a list of thematic indicators for community-based rural development, natural resources management, land policy and administration, and policies and institutions. The selection of this menu of 86 indicators was an iterative process which involved validation in five developing countries (Cambodia, Nicaragua, Nigeria, Senegal and Tanzania) where the relevance and feasibility of a larger set of indicators was reviewed by country M&E practitioners and statisticians, including Development Partners. The results of this validation exercise are summarized in the Table 1 in annex.

Out of the menu of 86 indicators, 19 are identified as *priority indicators,* selected specifically as starting points for M&E in less-than-ideal conditions based on their relative simplicity and the cost-effectiveness with which they can be gathered. These indicators are also intended to meet the very most basic data requirements of international agencies responsible for global level M&E. They are given in red in the following list. The list of indicators including data sources, core data requirements, and technical notes is provided in the *Sourcebook* itself. Table 3 in annex provides the menu of 86 indicators with the 19 priority indicators highlighted.

4. The data framework

It is clear that even the lightest of monitoring systems can make extensive demands on the data supply system. In order to meet the needs of monitoring at each of the four levels (inputs, outputs, outcomes and impact), the M&E system needs to draw on information coming from a variety of different sources. It is not just that each level requires different indicators, but also that the requirements in terms of periodicity, coverage and accuracy vary according to the level of indicator. Input indicators are required to inform short-term decision-making. They therefore need to be produced frequently and regularly – possibly once every 1-6 months. The same applies to output indicators, but here the reporting period can likely be longer, say, one year. As one moves further up the results chain and starts to collect more information about clients rather than the servicing institution, the task of data collection becomes more complicated, the tools less reliable, and the results more questionable. To counteract this, it is advisable to use information from different sources and use different methods to arrive at a reasonable estimate of the outcome under review. On the other hand, the timeframe can be relaxed – a little. Time must be allowed for clients to become aware of and start using public services. One may see little evidence of outcomes for the first few years. Therefore, it may be acceptable to build a programme around the reporting schedule of, for instance, 1-2 years. But it is important that the process is initiated at the very beginning of the project with a view to using the first report for establishing the baseline situation. The evaluation of the eventual impact comes much further down the line – often years after the project has been completed. Although the time frame may be more relaxed, the analytical challenge is not, and from the data collection perspective, experience teaches us that it is vital that the outline on how the project is to be evaluated is agreed from the very beginning, since it may involve setting up an experimental design to try to isolate the "with/without" project effect.

The Sourcebook provides the following list of data collection methods which is not comprehensive, but each supports a different part of the M&E aspect. They include different types of household surveys, rapid appraisal and participatory methods. All are used to provide the necessary data for the calculation of the "upper end" indicators, namely outcomes and impact indicators. They include both quantitative and qualitative assessment tools.



Most of the statistical surveys are to be found in the top right-hand quadrant, whereas the more qualitative studies tend to be in the lower left-hand quadrant.

5. Capacity of National Statistical Systems

As indicated earlier, monitoring even a core set of indicator requires primary data most of which will come from surveys which costs may vary from one survey to another or from one country to another but which require minimum level of resources (human and financial). Table 2 in annex provides an indicative level of resources needed for various types of surveys and their relevance to different types of indicators. The question is therefore does the developing countries have the capacity to produce this core set of data?

In many developing countries, National Statistical Systems have been severely under-resourced and have been failing to deliver both in terms of timeliness and data reliability. Their primary responsibility is to collect and be the custodian of all the nation's official statistics. Yet, the national statistical databases are filled with gaps or with imputed values that are themselves prone to gross errors. This has led the users to become increasingly dismissive of the efforts of the National Statistical Offices (NSO), and in the process to stop providing feedback on where and how the databases could be improved. The inevitable knock-on effect of this is that resources for statistics are further reduced. In Africa today, there is almost no NSO that is functioning without significant flows of donor funds. Yet, until recently, donor support has not been well coordinated and has actually had a distorting effect on survey programmes and priorities, leading to unproductive and wasteful use of statistical services.

The findings from several recent assessments[112] of countries capacity in agricultural statistics indicates that national statistical capacity has significantly deteriorated over the last decades, as a result of a lack of donor interest and a parallel decline in priority and resources at the national level. In fact the quantity and quality of data coming from national official sources has been on a steady decline since the early 1980s, particularly in Africa. Official data submissions to FAO from African countries are at their lowest level since before 1961, with only one in four reporting basic crop production data. Many developing countries, especially in Africa, do not have at the moment the capacity to collect even the most basic production statistics, although that capacity existed in the 1970s.

Agricultural and rural sector statistics cover a broad range of topics for many different primary products, including production, inputs trade, resources, consumption and prices. The list becomes much broader if one adds closely related topics such as the environment and climate statistics. They come from many different sources – both governmental and non-governmental. They may come from institutions operating within the agriculture and rural sector as well as from outside. Some come from international sources. Primary responsibility for collating all these data rests mainly either with the Ministry of Agriculture or with the NSO. Until the 1990s, most national statistical survey programmes consisted of traditional sectoral-focused surveys, including Labour Force Surveys (LFS), health and education surveys and Household Budget Surveys (HBS), as well as agricultural surveys. For better-off countries, this continues to be the case, except that multi-topic household surveys have been added to the list. For the poorest countries, however, as resources became increasingly constrained, cuts and adjustments had to be made. Given the high cost of household surveys, the move towards integrated surveys was considered good value for the money, because multiple objectives could be met using just the one survey instrument. In these countries, multi-subject surveys started to replace other household surveys. While this has a number of advantages, the production of agricultural statistics has suffered in the process, because agricultural surveys – traditionally used to collect information on production, area, yield and prices – have been conducted with increasingly less frequency.

[112] FAO, Report of the external evaluation of FAO Work in Statistics, 2008 and internal assessment studies conducted recently by FAO as part of the preparation of the global strategy for improvement of agricultural statistics, 2009.

Budget cuts have also meant that NSOs have had to lay off staff. One of the primary assets that many of them had built up was a permanent cadre of field staff spread across the country and living frequently in or near the actual primary sampling units of an NSO master sample frame. They were trained and ready to conduct any survey to which they might be assigned. This gave the NSO an enormous comparative advantage over other agencies. But with the layoffs, this advantage has been lost. In many cases, the permanent staff have been replaced with mobile teams of enumerators – again, cost-effective but statistically less satisfactory, because of problems of language in the different regions and because any outsider arriving in the village was always treated with more suspicion than a permanent enumerator.

The following main problems are common to many developing countries:

- limited staff and capacity of the units that are responsible of for collection, compilation, analysis and dissemination of agricultural statistics;
- lack of adequate technical tools, packages and framework to support countries data production efforts;
- insufficient funding allocated of agricultural statistics from development partners and national budget;
- lack of institutional coordination which results in the co-existence of not harmonised and integrated data sources;
- lack of capacity to analyse data in a policy perspective which results in a significant waste of resources as large amounts of raw data are not properly used;
- difficult access to existing data by users with no metadata and indication of quality.

The urgent need to reverse the negative trend in the availability of food, agricultural and rural statistics has lead the United Nations Statistical Commission to recommend the preparation of a global strategy for improving agricultural statistics. This Strategy is being developed under the auspices of Friends of the Chair Working Group composed of representatives from countries and international organisations, with the leadership of FAO.

In summary, the strategic plan will provide the framework to integrate a core set of agricultural and rural statistics into the national and international statistical systems, identify a suite of methodologies for the data collection, provide a framework for integrating agricultural and rural statistics with the overlapping data requirements of other sectors, and address the need to improve statistical capacity. Finally, it will propose a governance structure for coordination not only between the national statistical organisations and other country ministries, but also between national statistical organisations of other countries, donors, and regional and international organisations.

This global Strategy will be discussed by senior experts during the upcoming International Statistical Institute Satellite meeting to be held 13-14 August 2009 in Maputo, Mozambique.

Table 1 - Results of the country validation studies

SUBSECTOR	Total indicators	No. of generic indicators currently available				
		Cambodia	Nicaragua	Nigeria	Senegal	The United Republic of Tanzania
A. Core ARD sector indicators	28	8	7	9	8	3
B. Agribusiness and market development	13	2	4	4	3	3
C. Community-based rural development	9		2	4		2
D. Fisheries (aquaculture)	6	3	3	1	1	
E. Forestry	13	5	3	3	5	3
F. Livestock	8	5	5	7	6	2
G. Policies and institutions	18	6	11	11	7	6
H. Research and extension	7	4	3	4		
I. Rural Finance	7		5	5		4
J. Sustainable land and crop management	9	6	6	5	2	
K. Water resource management	13	1	7	3	6	4
Total	**131**	**40**	**56**	**56**	**38**	**27**

From the original list of approximately 130 indicators, Nicaragua and Nigeria claim to be producing 56; Senegal, 38; Cambodia, 40; and the United Republic of Tanzania, 27. Each country also provided an additional list of proxy or similar indicators currently available. When compared with the generic list, it was apparent that the gap was actually not large and that many of the alternative or proxy indicators were in fact very close to or even the same as those on the generic list. Nevertheless, the weak capacity of NSSs is still a major constraint to the establishment of effective M&E procedures.

Table 2 - Comparison of key features of different surveys

SURVEYS	1	2	3	4	5	Best used for:		
	Sample size	Duration	Visits to household	Question-naire size	Cost ($m)	Time series	Sub- nat'l	Counter-factual
Population census	Full coverage	3-6 months	1	4-8	15-25	☒	√√	☒
Agricultural census	20.000-40.000	1-1.5 years	2-4	8-12	5-12	☒	√√	☒
LSMS/integrated survey	5.000-10.000	1-1.5 years	2	40+	1-2	☒	√	√√
Household budget survey	4.000-10.000	1-1.5 years	15-25	15-20	1-3	☒	☒	√√
Community survey	100-500	4-6 months	1	4-6	0.2-0.4	√	√	☒
Service delivery survey (CWIQ)	10.000-15.000	2-3 months	1	8	0.2-0.4	√√	√	☒
Focus group interviews	40-50	2-3 months	1-3	-	0.05-0.1	√	x	√
Windscreen survey	10-20	2-3 weeks	0		0.01	√	x	☒

x = not suitable
√ = adequate
√√ = good

Table 3 - Menu and priority indicators

A. Sector-Wide Indicators for Agriculture and Rural Development

Early outcome	**1.**	**Public spending on agriculture as a percentage of GDP from the agriculture sector**
	2.	**Public spending on agricultural input subsidies as a percentage of total public spending on agriculture**
	3.	**Percentage of underweight children under five years of age in rural areas**
	4.	Percentage of population who consider themselves better off now than 12 months ago
Medium-term outcome	**5.**	**Food Production Index**
	6.	**Annual growth (percentage) in agricultural value added**
Long-term outcome	**7.**	**Rural poor as a proportion of the total poor population**
	8.	Percentage change in proportion of rural population below US$1 per day or below national poverty line
	9.	Percentage of the population with access to safe or improved drinking water
	10.	Consumer Price Index for food items
	11.	Agricultural exports as a percentage of total value added in agriculture sector
	12.	Proportion of under-nourished population
	13.	Producer Price Index for food items
	14.	Ratio of arable land area to total land area of the country
	15.	Percentage change in unit cost of transportation of agricultural products
	16.	Percentage of rural labour force employed in agriculture
	17.	Percentage of rural labour force employed in non-farm activities
	18.	Percentage of the labour force underemployed or unemployed
	19.	Annual growth rate of household income in rural areas from agricultural activity (percentage)
	20.	Annual growth rate (percentage) of household income in rural areas from non-agricultural activity

B. Specific indicators for Subsectors of Agriculture and Rural Development

		1. Crops (inputs and services related to annual and perennial crop production)
Early outcome	21.	Access, use and satisfaction with services involving sustainable crop production practices, technologies and inputs
Medium-term outcome	**22.**	**Percentage change in yields of major crops of the country**
Long-term outcome	23.	Yield gap between farmers' yields and on-station yields for major crops of the country
	24.	Percentage of total land area under permanent crops
		2. Livestock
Early outcome	25.	Indicators of access, use, satisfaction with respect to livestock services
Medium-term outcome	**26.**	**Annual growth (percentage) in value added in the livestock sector**
Long-term outcome	27.	Livestock birth rate
	28.	Percentage increase in yield per livestock unit
	29.	Percentage change in livestock values
		3. Fisheries and Aquaculture
Early outcome	30.	Indicators of access, use, satisfaction with respect to fisheries/aquaculture services
	31.	Water use per unit of aquaculture production
Long-term outcome	**32.**	**Capture fish production as a percentage of fish stock**
	33.	Share of small-scale fishers in the production of fish
	34.	Percentage of total permitted catch earmarked for local fishing communities as rights
	35.	Annual percentage change in production from aquaculture farms
		4. Forestry
Early outcome	36.	Indicators of access, use, satisfaction with respect to the forestry services:
	37.	Employment in forestry-related activities (full-time equivalents)
	38.	Value of removals of wood and non-wood forest products
	39.	Value of services from forests
Medium-term outcome	40.	Area of forest under sustainable forest management
Long-term outcome	**41.**	**Percentage of land area covered by forest**
	42.	Annual growth in rural household income from forest-related activities
	43.	Growing stock per hectare (m^3/ha) of forest
	44.	Percentage rate of deforestation
		5. Rural Micro and SME Finance
Early outcome	45.	Indicators of access, use, satisfaction with respect to rural finance
	46.	**Percentage of the rural population using financial services of formal banking institutions**
	47.	Percentage of bank branches that are located in rural areas
Long-term outcome	48.	Percentage of total savings that are mobilized from rural areas
	49.	Percentage of rural population using non-bank financial services
	50.	Recovery rate of rural credit
		6. Agricultural Research and Extension
Early outcome	51.	Indicators of access, use, satisfaction with research and extension advice
	52.	**Public investment in agricultural research as a percentage of GDP from the agriculture sector**
Long-term outcome	53.	Percentage change in yields resulting from improved practices, for major crops of the country
	54.	Change in farmer income as a result of new technologies (by gender)

	7. Irrigation and Drainage
Early outcome	55. Indicators of access, use, satisfaction with respect to irrigation and drainage services
	56. Irrigated land as percentage of crop land
	57. Percentage of users who report a significant increase in crop yields as a result of irrigation and drainage services
	58. Service fees collected as a percentage to total cost of sustainable Water User Association (WUA) activities
Long-term outcome	59. Percentage change in average downstream water flows during dry season
	60. Percentage change in agricultural value added created by irrigated agriculture
	61. Percentage of irrigation schemes that is financially self-sufficient
	62. Percentage increase in cropping intensity
	8. Agribusiness (agricultural marketing, trade and agro-industry)
Early outcome	63. Indicators of access, use and satisfaction with respect to agribusiness and market services,
	64. Percentage change in number and value of activities managed by agroenterprises
	65. Percentage of agroenterprises adopting improved/ certified hygiene/food management system
Medium-term outcome	**66. Percentage change in sales/turnovers of agro-enterprises**
Long-term outcome	67. Percentage change in number of agricultural inputs outlets
	68. Percentage increase in private sector investments in agriculture
	69. Percentage increase in market share of cooperatives/agribusiness enterprises

C. Indicators for Thematic Areas Related to Agriculture & Rural Development

	1. Community-based Rural Development
Early outcome	70. Access, use, satisfaction with respect to services provided by community-based rural evelopment organizations
	71. Percentage of farmers who are members of community/producer organizations
	72. Proportion of community/producer organizations capable of meeting the production and marketing needs of their members
	73. Proportion of producer organizations/NGOs with functional internal system of checks and balances
	74. Percentage change in number of community associations exercising voting power in local government budget
Long-term outcome	75. Percentage increase in number of local enterprises in rural area
	2. Natural Resource Management
Medium-term outcome	**76. Withdrawal of water for agricultural as a percentage of total freshwater withdrawal**
	77. Percentage change of land area formally established as protected area
	78. Percentage change in soil loss from watersheds
Long-term outcome	79. Percentage change of farm l and under risk of flood/drought
	3. Land Policy and Administration
Early outcome	80. Percentage of land area inventoried
	81. Percentage of land area for which there is a legally recognized form of land tenure
Long-term outcome	82. Percentage change of land over which there are disputes
	83. Percentage of agricultural households that have legally recognized rights to land
	84. Percentage change in number of formal land transactions (quarterly or yearly basis)
	85. Percentage change in land access for women and minority groups
	4. Policies and Institutions
Long-term outcome	86. Ratio of average income of the richest quintile to the poorest quintile in rural areas

References

Wye Group Handbook on Rural Household Livelihood and well-being, 2005.

GDPRD/FAO/World Bank: Tracking results in agriculture and rural evelopment in less-than-ideal conditions, 2008.

FAO: Report of the External Evaluation of FAO work in Statistics, 2008.

Fred Vogel: Draft paper: Global Strategy for improving Agricultural Statistics, 2009.

Working documents: FAO assessment of countries capacity in agricultural statistics, 2009.

Composite Indices for Multidimensional Development and Poverty: an Application to MDG Indicators

Pasquale De Muro
University of "Roma Tre", Roma,
demuro@uniroma3.it

Matteo Mazziotta
ISTAT, Roma,
mazziott@istat.it

Adriano Pareto
ISTAT, Roma,
pareto@istat.it

***Abstract**: The measurement of development or poverty as multidimensional phenomena is very difficult because there are many theoretical, methodological and empirical problems. The literature of composite indicators offers a wide variety of aggregation methods, all having pros and cons. In this paper, we propose a new and alternative composite index denoted as MPI (Mazziotta-Pareto Index) which, starting from a linear aggregation, introduces penalties for the countries or geographical areas with 'unbalanced' values of the indicators. As an example of application of the MPI, we consider a set of indicators in order to measure the MDGs and we present a comparison among HDI (Human Development Index) methodology, HPI (Human Poverty Index) methodology and the MPI.*

Keywords: composite indicators, development, poverty, ranking.

JEL Classification: C43 – Index numbers and aggregation; I32 - Measurement and Analysis of Poverty; O10 – Economic development: general.

1. Introduction[113]

Many socioeconomic phenomena are complex and therefore difficult to measure and to evaluate. Complexity implies also multidimensionality. Development and poverty are two socioeconomic important concepts that for a long time have been substantially regarded as unidimensional, especially by economists: the first has been usually measured by personal income or by per capita product, while the second has been measured as lack of income or low expenditure.

Recently, there is a growing international consensus about the multidimensional nature of both development and poverty, and their irreducibility to the income dimension.[114]

The Millennium Development Goals, adopted by the United Nations General Assembly in 2000, reflect this advanced vision.[115]

The shift from a single dimension to multiple dimensions, by enlarging and enriching the scope of the analysis, represents an important theoretical progress and has some relevant advantages in terms of policy. However, notwithstanding those benefits, the multidimensionality makes the measurement and evaluation of development and poverty more difficult. In fact, while measuring and assessing a given single dimension can be done with a single indicator, multiple dimensions require a set of various indicators. This multiplicity implies a

[113] The paper is the result of the common work of the authors: in particular P. De Muro has written Sects. 1 and 2; M. Mazziotta has written Sects. 4.1 and 5; A. Pareto has written Sects. 3, 4.2 and 4.3.
[114] This concerns also other related socioeconomic phenomena such as well-being, quality of life, and standard of living.
[115] For further information about the MDGs see the web site http://www.un.org/milleniumgoals.

number of theoretical and statistical problems, especially when we need to make comparisons over time and/or space.

The fundamental question is what is the better approach to (re)present complex phenomena and multidimensional realities. This work try to give some answers. The aim of the work is twofold. Firstly, we briefly discuss the main theoretical and methodological problems related to the multidimensional analysis of development and poverty (Section 2). Secondly, we consider the need to build composite indices of development and poverty that have some desirable properties. To this end, we propose a new composite index, the Mazziotta-Pareto Index (MPI) and compare it with some existing composite indices (Sections 3 and 4). The empirical comparison is made by using a number of national and regional single indicators that are included in the set of indicators chosen by the UN to monitoring the progress toward the MDGs (Section 5). Finally, we briefly discuss the results of the comparison and draw some conclusions (Section 6).

2. Measuring development and poverty

2.1 From one to many dimensions

The modern concept of development has entered the international political and economic discourse soon after the end of World War II. Since then, most of the international development scholars and organizations has evaluated the development level and process mainly by using the per capita product or income. Of course, many other variables have been generally used to analyze the development process, but per capita product or income has been always used as the main – and often only – measure of the ultimate outcome of this process. In other terms, per capita product or income has been the paramount measure of development for decades. In this dominant view, development was essentially unidimensional and largely coincided with economic growth.

From the end of the 1950s (Galbraith, 1958), but especially in the 1960s and 1970s there has been an increasing dissatisfaction with this approach: «...it has become increasingly evident, particularly from the experience of the developing countries, that rapid growth at the national level does not automatically reduce poverty or inequality or provide sufficient productive employment» (World Employment Conference, 1976, p. 15). «Dudley Seers talked about "dethroning the GNP"» (Ranis, 2005) and in the *The Meaning of Development* he defined development as «the reduction and elimination of poverty, inequality and unemployment within a growing economy» (Seers, 1969).

The critique about the meaning of development gave birth in the Sixties and Seventies to new lines of research on unconventional measures of development. If the main goal of development was meeting (basic) human needs (World Employment Conference 1976; 1977), than the appropriate measure of development should not be based on (per capita) income, but rather on the quality of life of people and its progress.

The scientific research on alternative measures of development was carried out firstly at the United Nations Research Institute for Social Development (UNRISD), where composite indices of development were elaborated using a bundle of physical, social and cultural indicators (UNRISD, 1970). Another important contribution was given by two researchers (Morris and Liser, 1977) at the Overseas Development Council that created the Physical Quality of Life Index (PQLI).

By the end of the Seventies there was a large consensus among social scientists about the fact that «the phenomenon of "development" or the existence of a chronic state of "underdevelopment" is not only a question of economics or the simple quantitative measurement of incomes, employment and Gini coefficient», but «is now viewed as a multidimensional process» (Todaro, 1979, p. 224).

A further fundamental contribution in this direction has been given in the following decades by Amartya Sen (1985, 1992, 1999) and other scholars, that elaborated the "capability approach", and by the *Human Development Reports* (HDRs),[116] prepared by the United Nations Development Programme (UNDP), that put into practice some of Sen's ideas together with the research experience of the previous decades. The HDRs propose a comprehensive multidimensional approach to development – the human development paradigm – that has a sound theoretical reference (the capability approach) and includes a battery of composite indices of development and poverty. Two of those indices, the Human Development Index (HDI) and the Human Poverty Index (HPI), will be discussed and used in the following sections of this work.

[116] See the web site http://hdr.undp.org.

The UNDP indices are not the only composite indices that have been produced in the last thirty years. In fact, along with a mounting attention toward multidimensional development,[117] there is a growing number of composite indices that have been proposed worldwide by scholars and institutions. Here we can not present a review of those indices. The OECD Global Project "Measuring Progress of Societies"[118] is working on indicators that go beyond GDP and undertakes methodological research on accounting frameworks and composite indices.

Regarding poverty, the persistence of the unidimensional income-based approach has been longer and stronger than in the case of development. As a matter of fact, most of the official measurements of poverty at national or international level are made even now with reference to monetary income or consumption. In the scientific literature there are still a few examples of multidimensional poverty indices. The HPI (Anand and Sen, 1997), introduced by UNDP in the 1997 HDR, has been one the first examples of non-monetary composite index of poverty.

2.2 Working with many dimensions

Once the multidimensionality is recognized, measuring development has a number of theoretical and methodological problems that are not present in the conventional unidimensional approach.

The first problem concerns the choice of the development dimensions: which and how many dimensions are relevant and should be considered or privileged. This is also called by Sen the problem of the appropriate "informational basis" (Sen, 1999), that is which information is included or excluded in the evaluation exercise. This selection is often driven by the availability of statistics, but it has actually deep theoretical implications and strongly affects the results of the evaluation. In fact, each informational basis correspond to a particular concept of justice or ethics (Sen, 1999). Therefore, the choice of the informational basis should not avoid an explicit discussion and value judgement. A related technical problem concern the choice of the indicators that adequately represent each of the selected dimensions. In this work we will not discuss the problem of the informational basis, because it is outside the scope of the work. In the following sections, as informational basis we will use the eight MDGs and their related indicators.

The second problem concerns the use of the included information. The following sections will focus on this problem. Once the relevant dimensions and indicators have been selected and normalized, we often need to compare them in time and/or space in order to make evaluations. There are at least two alternative ways to make comparisons with multiple indicators: the first is to use "development profiles"; the second is to combine the various indicators into a composite index.

A development profile shows how the various indicators of development varies across dimensions. This approach has some advantages: there is no lost of information and the performance in each single dimension is transparent, allowing for an detailed check-up. However, there is also an important drawback: unless all the values of the indicators are lower or higher for one country (or in one period) compared to the others, we cannot rank the countries (or the periods). In order to illustrate this problem, we present in Figure 1 a comparison between development profiles of four countries.

The eight indicators that have been used are a sample taken from the official list of 60 MDGs indicators. Each indicator refers to a different development goal (or dimension). Looking at the figure it is clear that by simply comparing the four profiles, while is possible to say which country is doing better in each single dimension, it is not possible to say which country is globally doing better. In other words, it is not possible to rank the countries if we do not aggregate the indicators.

The second way to make comparison in time and/or space is to combine the various indicators in a composite index. Composite indices have the advantage of allowing the ranking of countries (or periods), because they represent the overall development level in one number. Notwithstanding, building composite indices implies loosing a certain amount of information and produce results that are less transparent. Furthermore, composite indices have been criticized because, in a way, they re-introduce unidimensionality.

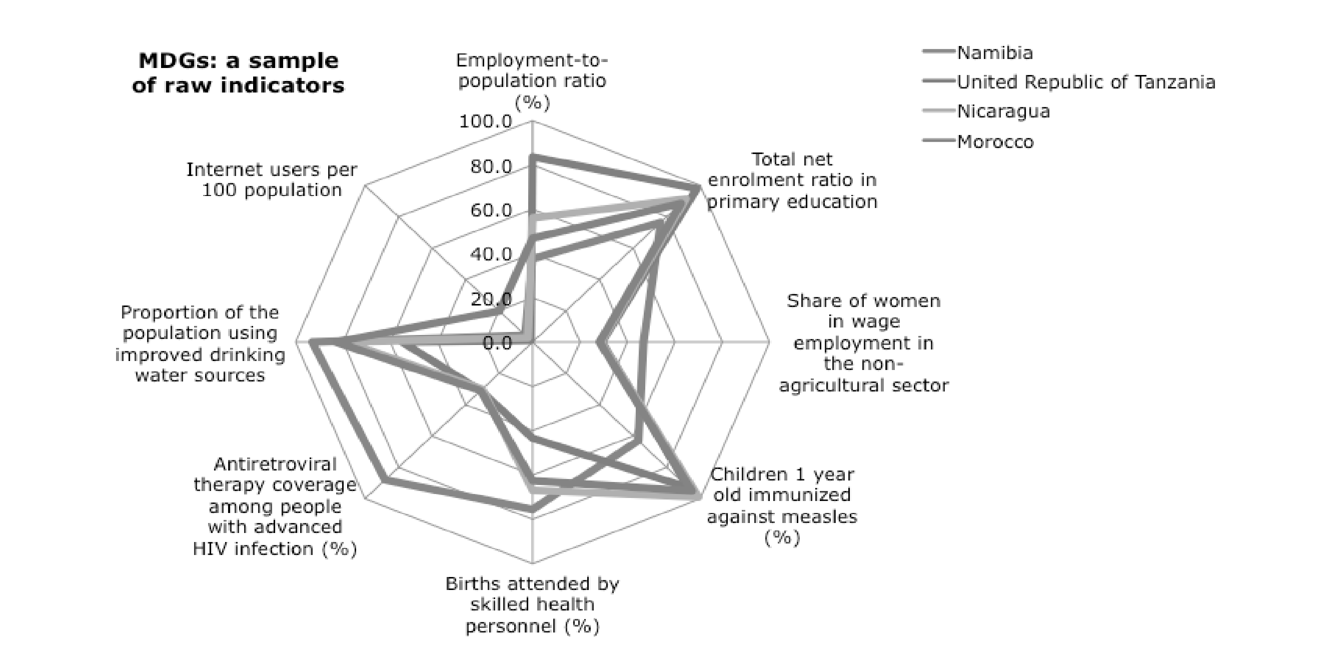
However, as monitoring progress toward development goals often requires overall comparison over space or time, composite indices are very useful for specific purposes.

[117] See the notable International Conference "Beyond GDP" organised jointly by the European Commission, the European Parliament, the Club of Rome, the WWF and the OECD in 2007.

[118] See the web site http://www.oecd.org/progress.

For instance, if we want to know which countries are doing more progress toward the overall eight MDGs and which countries are doing less progress, we need to build a composite index.

Figure 1 - Comparing development profiles



The main problem in the construction of composite indices of development is how to aggregate the information. The aggregation problem concerns two interrelated aspects: the assignment of weights to the components when combining them (Scott, 2004) and the choice of the synthetic function. After having normalized (or also standardized) the indicators,[119] there are a number of possible aggregation strategies:

1. Using the arithmetic mean. This approach is often used, because is very simple and easy to apply and to interpret. An implication of the arithmetic mean is that the weights of the components are completely arbitrary. The approach has two versions:
   a) Simple (non weighted) mean. This implies that all the weights are equal and that all the components (dimensions) are perfectly substitutable. Although the equal weights give the impression that this is a "neutral" approach in which there is no hierarchy between dimensions, indeed this approach makes an implicit very strong assumption about the perfect substitutability between dimensions. This assumption has a weak theoretical justification, especially when the components are fundamental dimensions like health and knowledge. This approach has been used to build the HDI by the UNDP;
   b) Weighted mean. In this case, if the weights are not equal, that implies that the substitutability between components is not perfect. This approach is more theoretically consistent, but the weights remains arbitrary;
2. Using factorial analysis (e.g. principal components, correspondence analysis). Apparently, this approach seems more "objective" because the weights are not assigned by the researcher but rather by a statistical technique. In this way, weights seems not arbitrary and more "scientific", because they are extracted from the data. However, this approach has a couple of serious shortcomings. First, given that the weights are obtained from the data, they are not constant over both time and space and this make very difficult the comparisons. Second, the factorial analysis assigns weights to the original variables on the basis of their

[119] This part of the methodology will be discussed in the following sections.

variance and covariance. This criteria not necessarily reflects the relative socioeconomic importance of the various dimensions. Therefore, even if with this statistical approach the weights are apparently objective, yet they have not a sound theoretical foundation;

3. Using a power mean or an adjusted mean. With this approach we can have both imperfect substitutability and implicit non arbitrary weights.

   a) A power (or generalized) mean of order greater than one is very useful when we wish to build composite indices of poverty. This mean «places greater weight on those dimensions in which deprivation is larger» (Anand and Sen, 1997, p. 16). This approach has been used to build the HPI by UNDP. Similarly, a power mean of order smaller than one (but grater than zero) can be used to build composite indices of development when we wish to place greater weight on those dimensions in which development is lower. In this case, the power mean penalizes countries (or periods) that have a more "unbalanced" development across dimensions.
   b) An adjusted mean. Another way to penalize unbalanced performances is to adjust the arithmetic mean by using a penalty coefficient or function. This can be done in different ways. In section 4, we will present a methodology for building a class of composite indices of development or poverty (MPI) which includes a penalty coefficient that is function of the variability across dimensions ("horizontal variability").

According to Sen (1999, p. 81): «there is … a strong methodological case for emphasizing the need to assign explicitly evaluative weights to different components of quality of life (or of well-being) and then to place the chosen weights for open public discussion and critical scrutiny». In principle, this would require to use the approach "1b", rather than «some wonderful formula that would simply give us ready-made weights that are "just right"» (Sen 1999, p. 79). However, in some cases to assign evaluative weights and then submit them to open public discussion is not possible. In the latter cases, the approach "3" is the best one.

In the following sections, we will present and compare three composite indices of development and poverty and their properties – the HDI, the HPI and the MPI. The indices uses different aggregation criteria: we will apply those aggregation criteria to a set of MDGs indicators in order to discuss how the different approaches affect the results.

3. HDI and HPI methodologies

In this section, we consider the methodological aspects related to the Human Development Index (HDI) and Human Poverty Index (HPI) construction (UNDP, 2007).

3.1 The Human Development Index

The HDI is a composite indicator of human development based on the arithmetic mean. It is measures the average achievements in a country or geographical area in three basic dimensions: (i) wellbeing, (ii) knowledge, (iii) standard of living. The list of used indicators is showed in table 1.

Table 1 - List of individual indicators of the HDI

N.	Description	Minimum value	Maximum value
	WELLBEING		
1	Life expectancy at birth (years)	25	85
	KNOWLEDGE		
2	Adult literacy rate (%)	0	100
3	Combined gross enrolment ratio (%)	0	100
	STANDARD OF LIVING		
4	Gross Domestic Product per capita (PPP US$)	100	40,000

The steps in the construction of the HDI are the following.

i) Normalization

Let $\mathbf{X}=\{x_{ij}\}$ be the matrix with n rows (countries or geographical areas) and 4 columns (indicators in table 1). The normalized matrix $\mathbf{Y}=\{y_{ij}\}$ is computed as follows:

$$y_{ij}=\frac{x_{ij}-\min(x_j)}{\max(x_j)-\min(x_j)}$$

where $\min(x_j)$ and $\max(x_j)$ are the minimum and maximum values (*goalposts*) for the j-th indicator reported in table 1.[120]

ii) Aggregation

The HDI is given by:

$$\text{HDI}_i=\frac{y_{i1}+y_{i5}+y_{i4}}{3}$$

where

$$\text{y}_{\text{i5}}=\frac{2y_{i2}+y_{i3}}{3}.$$

The HDI is then computed as a simple arithmetic mean of the three dimension indices.

The main characteristic of this methodology is that it assumes a complete substitutability among the dimensions of human development: a deficit in one dimension can be compensated by a surplus in another (e.g. a good standard of living can always substitute any knowledge deficit).

3.2 The Human Poverty Index

While the HDI measures average achievement, the HPI measures deprivations.

There are two type of HPI: the HPI-1 for developing countries and the HPI-2 for selected OECD countries. Both the indices are based on the mean of order three.

[120] Let us note that the logarithm of income is used for the GDP per capita normalization.

The HPI-1 measures deprivations in the three basic dimensions of human development captured in the HDI while the HPI-2 captures social exclusion too. Calculating HPI-1 and HPI-2 is more straightforward than calculating HDI since the indicators used to measure the deprivations are already normalized between 0 and 100.

In this context, we will refer to HPI-1. The indicators used are listed in table 2.

Table 2 - List of individual indicators of the HPI-1

N.	Description	Minimum value	Maximum value
	WELLBEING		
1	Probability at birth of not surviving to age 40 (times 100)	0	100
	KNOWLEDGE		
2	Adult illiteracy rate (%)	0	100
	STANDARD OF LIVING		
3	Percentage of population not using an improved water source	0	100
4	Percentage of children under weight-for-age	0	100

Being $\mathbf{X}=\{x_{ij}\}$ the matrix with n rows (countries or geographical areas) and 4 columns (indicators in table 2), the formula used to compute the HPI-1 is:

$$\text{HPI-1}_i = \left(\frac{x_{i1}^3 + x_{i2}^3 + x_{i5}^3}{3} \right)^{1/3}$$

where

$$x_{i5} = \frac{x_{i3} + x_{i4}}{2}$$

In this case, the use of the mean of order three for calculating the composite indicator allow to give greater weight to the dimension in which there is the most deprivation.

4. An alternative methodology: the MPI

4.1 General aspects

The MPI (Mazziotta and Pareto, 2007) wants to supply a composite measure of a set indicators that are considered "non-substitutable" (all components must be "balanced").

It is designed in order to satisfy the following properties:

i) normalization of the indicators by a specific criterion that delete the unit of measure and the variability effect (Delvecchio, 1995);
ii) synthesis independent from an "ideal unit", since a set of "optimal values" is arbitrary, non-univocal and it can vary during the time;
iii) simplicity of computation.

These properties can be satisfied by the following approach. It is known, the distributions of different indicators, measured in different way, can be compared by the transformation in standardized deviations (Aureli

Cutillo, 1996). Therefore, it is possible to convert the individual indicators to a common scale with a mean M=100 and standard deviation S=10: the obtained values will range approximately in the interval (70; 130).[121]

In this type of normalization the "ideal vector" is the set of the mean values and it is easy individuate both the units that are over the mean (values greater than 100) and the units that are under the mean (values less than 100).

In this context, it is possible to introduce a penalty coefficient that is function, for each territorial units, of the indicators variability in relation to the mean value ("horizontal variability"): this variability can be measured by the *coefficient of variation*. The proposed approach penalizes the score of each units (the mean of the standardized values) with a quantity directly proportional to the "horizontal variability". The purpose is to favourite the units that, mean being equal, have a greater balance among the indicators values.

Finally the use of standardized deviations allows to obtain a "robust" measure and less influenced by *outliers* (Mazziotta C. et al., 2008).

4.2 Steps for computing the MPI

The MPI building proceeds in the following stages.

i) Normalization

Let X={xij} be the matrix with n rows (countries or geographical areas) and m columns (development or poverty indicators) and let M_{x_j} and S_{x_j} denote the mean and the standard deviation of the *j*-th indicator:

$$\mathrm{M}_{x_j} = \frac{\sum_{i=1}^{n} x_{ij}}{n}; \quad \mathrm{S}_{x_j} = \sqrt{\frac{\sum_{i=1}^{n}(x_{ij} - \mathrm{M}_{x_j})^2}{n}}.$$

The standardized matrix **Z**={z_{ij}} is defined as follows:

$$z_{ij} = 100 \pm \frac{(x_{ij} - \mathrm{M}_{x_j})}{\mathrm{S}_{x_j}} 10$$

where the sign ± depends on the relation of the *j*-th indicators with the phenomenon to be measured (+ if the individual indicator represents a dimension considered positive and − if it represents a dimension considered negative).

ii) Aggregation

Let cv_i be the coefficient of variation for the *i*-th units:

$$\mathrm{cv}_i = \frac{\mathrm{S}_{z_i}}{\mathrm{M}_{z_i}}$$

where:

$$\mathrm{M}_{z_i} = \frac{\sum_{j=1}^{m} z_{ij}}{m}; \qquad \mathrm{S}_{z_i} = \sqrt{\frac{\sum_{j=1}^{m}(z_{ij} - \mathrm{M}_{z_i})^2}{m}}.$$

Then, the generalized form[122] of MPI is given by:

[121] On the basis of Bienaymé-Cebycev theorem, the terms of the distribution within the range (70; 130) are at least 89 percent of the total of terms.

[122] It is a generalized form since it includes "two indices in one".

$$\mathrm{MPI}_i^{+/-} = \mathrm{M}_{z_i}(1 \pm \mathrm{cv}_i^2) = \mathrm{M}_{z_i} \pm \mathrm{S}_{z_i}\mathrm{cv}_i$$

where the sign of the penalty (the product $\mathrm{S}_{z_i}\mathrm{cv}_i$) depends on the kind of phenomenon to be measured and then on the direction of the individual indicators (De Muro, Mazziotta and Pareto, 2008).

If the indicator is "increasing" or "positive", i.e. increasing values of the indicator correspond to positive variations of the phenomenon (e.g. the development of the country or geographical area), then MPI^- is used. Vice versa, if the indicator is "decreasing" or "negative", i.e. increasing values of the indicator correspond to negative variations of the phenomenon (e.g. the poverty of the country or geographical area), then MPI^+ is used.

4.3 MPI as development and poverty measure

The possibility to add or subtract the penalty depending on the phenomenon nature allow to construct appropriate measures of development and poverty.

1) Development Index

The MPI of development is given by:

$$\mathrm{MPI}_i^- = \mathrm{M}_{z_i} - \mathrm{S}_{z_i}\mathrm{cv}_i$$

where the mean of the standardized values is adjusted subtracting a quantity proportional to the standard deviation and direct function of the coefficient of variation.

The higher is the index, the more developed is the country or geographical area. The index assumes high value when the mean is high and the standard deviation is low.

The MPI^- results are different from HDI methodology because the second one does not penalize in the case of an "unbalanced" set of indicators.

2) Poverty Index

The MPI of poverty is obtained as:

$$\mathrm{MPI}_i^+ = \mathrm{M}_{z_i} + \mathrm{S}_{z_i}\mathrm{cv}_i$$

where the mean of the standardized values is adjusted adding a quantity proportional to the standard deviation and direct function of the coefficient of variation.

The higher is the index, the poorer is the country or geographical area. The index assumes high values when the mean is high and the standard deviation too.

The MPI^+ results are very similar to the HPI methodology because both indices penalize in the same "direction".

5. An application to MDGs indicators

In order to compare the different methodologies considered, a double application is presented where seven human development indicators (the data are referred to the years 2006-2008) and seven poverty indicators (years 2003-2006) from MDGs are selected. The list of indicators is reported in table 3.

The indicators are intentionally chosen so that they have the property of non-substitutability: it is very important that there are not compensative effects among indicators so relevant for the description of the regions development and poverty. In fact, the indicators have been selected so that they treat different subjects about development and poverty. The geographical domains are the 10 world macro-areas (tables 4 and 5) but it is also presented a focus on singles countries (Figures 2 and 3).

Table 3 - List of individual indicators of human development and poverty

DESCRIPTION	Label
HUMAN DEVELOPMENT	
Total net enrolment ratio in primary education (%)	D1
Literacy rate of 15-24 year-olds (%)	D2
Employees in non-agricultural wage employment who are women (%)	D3
Proportion of seats held by women in national parliament	D4
Proportion of 1 year-old children immunised against measles	D5
Proportion of population using an improved drinking water source	D6
Number of internet users per 100 population	D7
HUMAN POVERTY	
Proportion of population living below $1 (PPP) per day	P1
Prevalence of underweight children under-5 years of age (%)	P2
Proportion of population below minimum level of dietary energy consumption	P3
Infant mortality rate	P4
Under-5 mortality rate per 1,000 live births	P5
Maternal deaths per 100,000 live births	P6
Number of tubercolosis cases per 100,000 population	P7

The individual indicators are normalized by MPI method (section 4.2) and so they have the same mean (M=100) and variability (S=10) (in tables 4 and 5, the indicators values are not standardized). The aim is to compare three different aggregation methods in order to measure the development and the poverty of the ten macro-areas. The functions are the mean (HDI method), the mean of order three (HPI method) and the MPI.

In table 4, the MPI is calculated with the negative sign because we are measuring the development (MPI^-).

Table 4 - Human development indicators - Years 2006-2008

REGIONS	D1	D2	D3	D4	D5	D6	D7	Mean (HDI method)	Mean of order 3 (HPI method)	MPI-
CIS Europa	92.8	99.7	52.2	13.9	99.0	97.0	20.2	109.847	110.130	109.561
Latin America	95.5	97.0	42.3	22.2	93.0	92.0	18.7	109.190	109.317	109.065
Eastern Asia	94.3	99.2	41.1	19.8	93.0	88.0	12.5	106.416	106.482	106.351
CIS Asia	93.9	99.6	47.9	13.9	95.0	88.0	6.0	104.227	104.637	103.807
South-Eastern Asia	95.0	95.6	37.8	17.4	82.0	86.0	9.9	102.756	102.893	102.619
Northern Africa	95.0	86.5	21.3	8.3	96.0	92.0	10.4	99.579	100.178	98.974
Western Asia	88.3	92.8	20.3	9.1	88.0	90.0	13.5	98.951	99.367	98.524
Southern Asia	89.9	79.9	18.6	12.9	66.0	87.0	9.7	94.215	94.745	93.676
Sub-Saharan Africa	70.7	72.1	30.8	17.3	72.0	58.0	3.4	88.652	89.598	87.721
Oceania	78.0	70.6	36.4	2.5	70.0	50.0	5.2	86.166	86.775	85.570
Mean	89.3	89.3	34.9	13.7	85.4	82.8	11.0			
Standard Deviation	8.0	10.8	11.2	5.6	11.5	14.8	5.2			

The differences among the methods are very low and it is useless to compute the respective rankings. Nevertheless, it is interesting to note that the MPI^- values are lower than the mean (HDI method) values because there is the penalty effect.

In table 5, the MPI is calculated with the positive sign because we are measuring the poverty (MPI^+). The main aspect seems to be the convergence among the mean of order three and MPI^+ results; in fact, for many areas it is necessary to add more of three decimals in order to find the differences. Therefore, if the aim is to evaluate the poverty of areas the HPI and MPI^+ methods produce the same results.

Table 5 - Human poverty indicators - Years 2003-2006

REGIONS	P1	P2	P3	P4	P5	P6	P7	Mean (HDI method)	Mean of order 3 (HPI method)	MPI+
Sub-Saharan Africa	50.3	28.0	31.0	94.0	157.0	900.0	521.0	121.088	121.306	121.312
Southern Asia	38.6	46.0	21.0	61.0	81.0	490.0	287.0	111.089	111.323	111.319
South-Eastern Asia	17.8	25.0	12.0	27.0	35.0	300.0	264.0	100.564	100.728	100.728
CIS Asia	5.4	7.5	20.0	40.0	47.0	51.0	140.0	97.584	97.849	97.846
Eastern Asia	17.8	7.0	12.0	20.0	24.0	50.0	197.0	95.840	95.972	95.972
Western Asia	3.8	13.0	9.0	32.0	40.0	160.0	51.0	95.142	95.218	95.219
Latin America	8.0	8.0	10.0	22.0	27.0	130.0	67.0	94.098	94.115	94.115
Northern Africa	3.8	6.0	4.0	30.0	35.0	160.0	45.0	93.200	93.295	93.296
CIS Europa	5.4	2.4	3.0	15.0	17.0	51.0	118.0	91.394	91.450	91.450
Mean	16.8	15.9	13.6	37.9	51.4	254.7	187.8			
Standard Deviation	15.9	13.5	8.4	23.6	41.2	265.0	144.4			

The results of the three methodologies, both for development and for poverty indicators, are very similar because the normalization method of the elementary data is the same. Besides, it is difficult to find many differences when there are few geographical areas.

This last assumption is not true when there are many territorial units; in figure 2, a specific example is presented in the case of human development measure. There are two countries: the Rwanda has many indicators approximately at the same level and only one with a very high value (high development in the indicator D4); the Ghana has all indicators more or less at the same low level. The mean is calculated and the result is a ranking of the world countries: Rwanda is in position 73 and Ghana in the position 126; subsequently the MPI^- is computed and Rwanda passes in position 95 and Ghana in position 123. Rwanda loses 22 positions because the indicators distribution is not uniform and the “horizontal variability” is the function that penalizes the arithmetic mean. The Ghana ranks (mean vs. MPI^-) are similar because the variability of the indicators distribution is very low.

In figure 3, an example in the case of human poverty measure is presented; so, in this case, the verse of the indicators is opposite and the higher is the indicator the poorer is the country: the penalty function is added to the mean. The mean is calculated: the Tajikistan is in the position 37 and Turkey in the position 111; the MPI^+ is computed and Tajikistan is 30 and Turkey is 111. The Tajikistan is penalized (7 positions) because the indicators distribution is variable and presents two values very different than the others; the Turkey position is constant because the indicators variability is very low.

Figure 2 - Human development measure: a comparison of countries

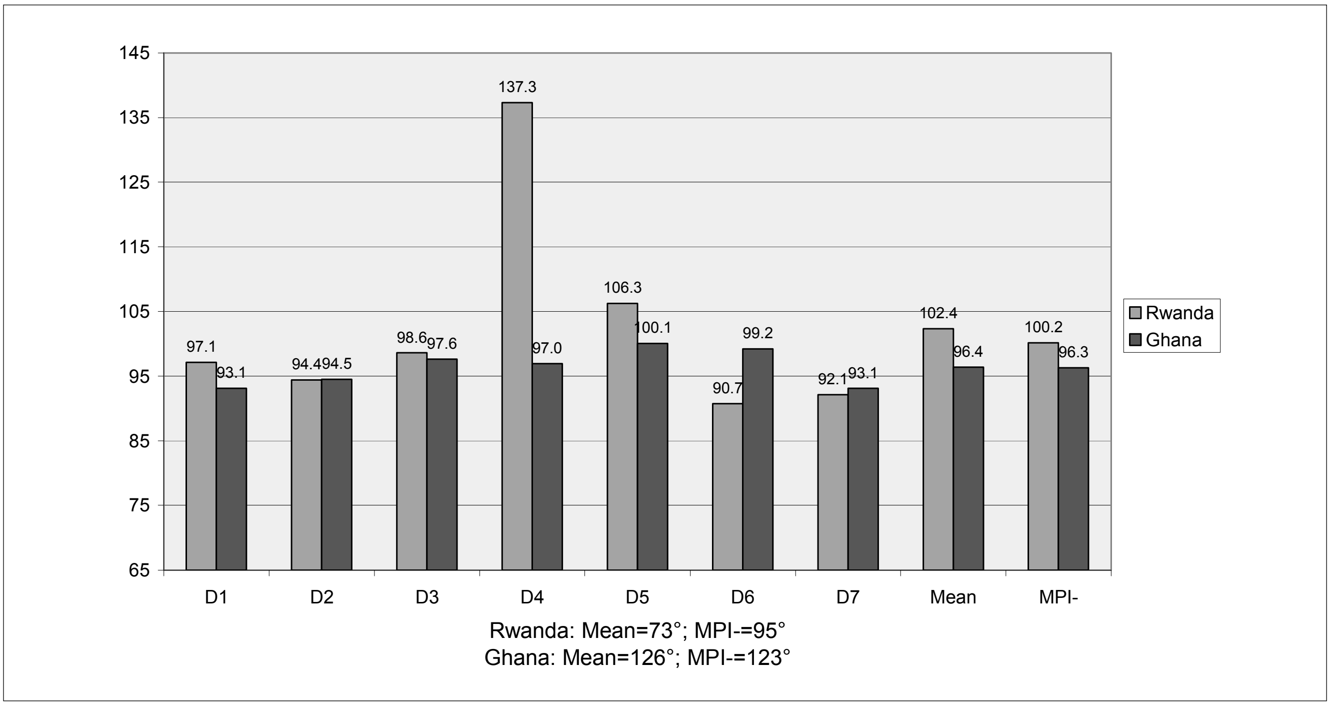
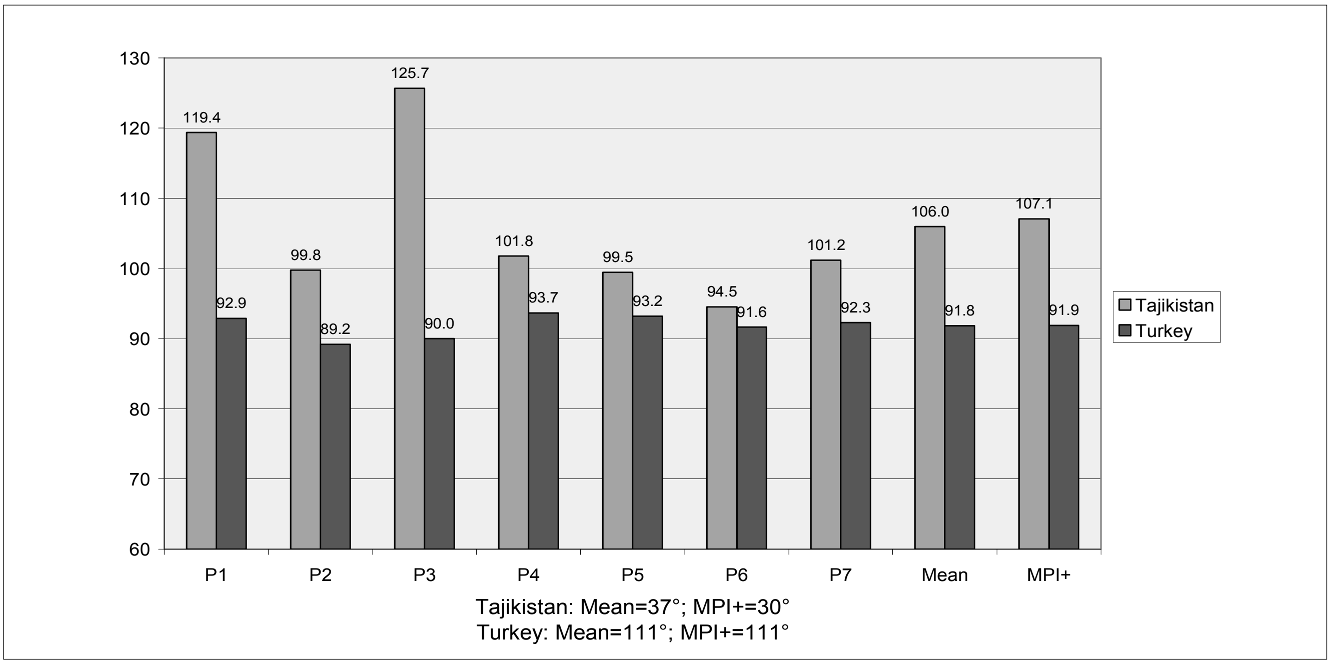


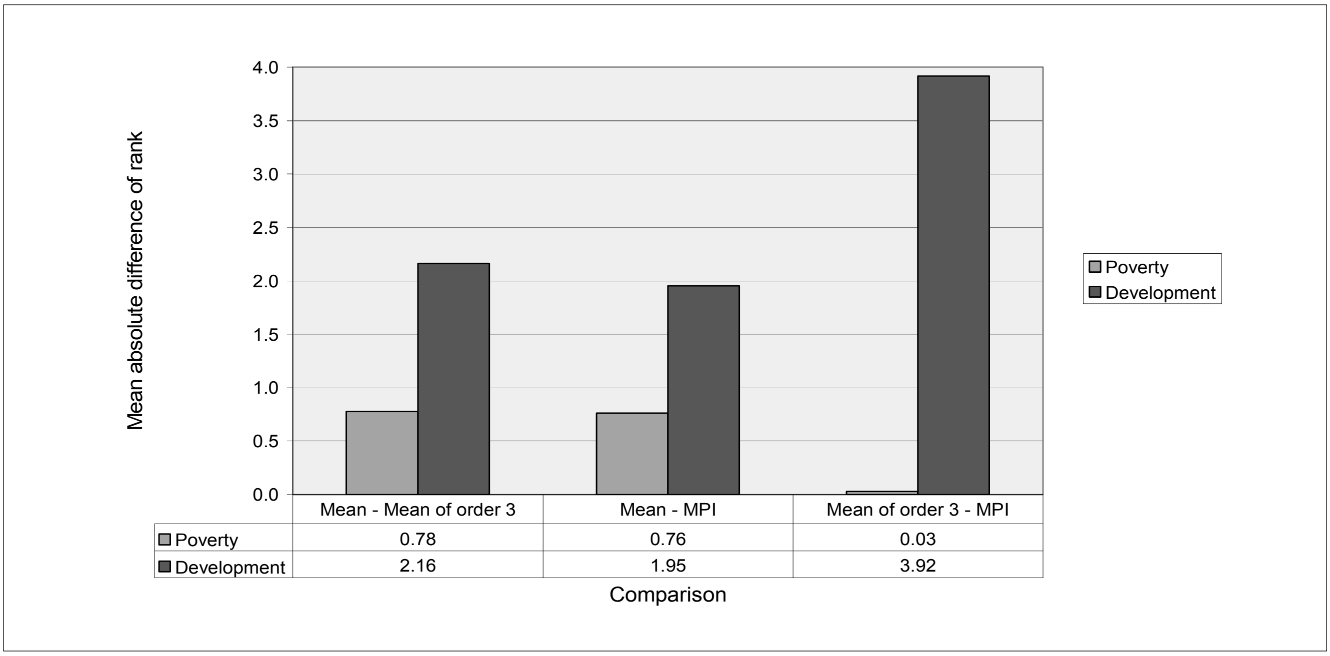
Figure 3 - Human poverty measure: a comparison of countries



In figure 4, a comparison of countries rankings is shown and the "tool" used is the mean absolute difference of rank. In the case of poverty measure, the differences among the three aggregation methods are very low in fact they are under 1; in particular the mean absolute difference of rank between the Mean of order three and MPI^+ is substantially equal to 0. In the case of development measure, the distances are more relevant specially for the comparison between Mean of order three and MPI$^-$ in fact, on average, every country changes, more or less, 4 positions.

Finally, these two aggregation methods are coincident when the poverty is measured and they are very different when the development is measured.

Figure 4 - Comparison of final rankings by different aggregation methods



6. Concluding remarks

The change from unidimensional to multidimensional development and poverty measurement is without any doubt an important theoretical progress and presents many advantages for policy-making. However, there is also a flip side, because multidimensional measurement implies many theoretical, methodological and empirical problems.

The international literature on composite indices of development and poverty offers a wide variety of aggregation methods. We have discussed the pros and cons of some methods. Considering the desirable properties that such composite indices should have, we have proposed a new and alternative composite index denoted as MPI (Mazziotta-Pareto Index) which, starting from a linear aggregation, introduces penalties for the countries or geographical areas with ‘unbalanced’ values of the indicators. In this way, MPI assumes imperfect substitutability between various dimensions of development or poverty.

We have applied the MPI to a set of MDGs indicators. The MDGs represent a multidimensional approach to development: in fact, they include eight goals that are measured by 60 different indicators. In order to synthesise the information about each country or to monitoring overall progress toward the goals it is useful to aggregate the indicators and to build composite indices. Using MDGs data, we have presented a comparison among HDI (Human Development Index) methodology, HPI (Human Poverty Index) methodology and the MPI.

HPI metodology and MPI results are similar when the poverty is measured because both indices penalize in the same “direction”. On the contrary, MPI is different from HDI methodology when the development is measured because the second one does not penalize in the case of an “unbalanced” set of indicators.

In summary, the MPI is an alternative composite index based on the property of non substitutability of indicators that wants, in the scientific outline, both to respect the desirable characteristics of a composite index and to be validly applied to different scientific contexts.

In fact, this methodology leaves from the versus and from the range of the elementary indicators. Therefore, the MPI can be a useful "tool" to synthesize multidimensional phenomena, with particular regard to the poverty and development measure.

References

Anand S., Sen A. (1997). Concepts of Human Development and Poverty: A Multi-dimensional Perspective, in: United Nations Development Programme, *Human Development Report 1997 Papers: Poverty and Human Development*, New York.

Aureli Cutillo E. (1996). *Lezioni di statistica sociale. Parte seconda, sintesi e graduatorie*, CISU, Roma.

Delvecchio F. (1995). *Scale di misura e indicatori sociali*, Cacucci editore, Bari.

De Muro P., Mazziotta M., Pareto A. (2008). MPI: un indice sintetico generalizzato per la misurazione dello sviluppo e della povertà, in: *Seminari CREI, Università "Roma Tre"*, Roma.

Galbraith J. K. (1958). *The affluent society*, Houghton Mifflin Company, Boston.

Mazziotta M., Pareto A. (2007). Un indicatore sintetico di dotazione infrastrutturale: il metodo delle penalità per coefficiente di variazione, in: *Lo sviluppo regionale nell'Unione Europea - Obiettivi, strategie, politiche. Atti della XXVIII Conferenza Italiana di Scienze Regionali*, AISRe, Bolzano.

Mazziotta C., Mazziotta M., Pareto A., Vidoli F. (2008). La costruzione di un indicatore sintetico di dotazione infrastrutturale: metodi e applicazioni a confronto, in: *Conoscenza, sviluppo umano e territorio. Atti della XXIX Conferenza Italiana di Scienze Regionali*, AISRe, Bari.

Morris D. M., Liser F. B. (1977). The PQLI: Measuring Progress in Human Needs, *Communique on Development Issues*, 32.

Ranis G. (2005). The Evolution of Development Thinking: Theory and Policy, in: F. Bourguignon & B. Pleskovič, *Annual World Bank Conference on Development Economics 2005: Lessons of Experience*, World Bank Publications, Washington, 119-140.

Scott W. (2004). Tracking Human Development: The Use of Statistics in Monitoring Social Conditions, UNDP BRC, Bratislava.

Seers D. (1969). The Meaning of Development, *International Development Review*, 11 (4), 3-4.

Sen A. (1985). *Commodities and capabilities*, North-Holland, New York.

Sen A. (1992). *Inequality reexamined*, Russell Sage Foundation, New York.

Sen A. (1999). *Development as Freedom*, Oxford University Press, Oxford.

Todaro M. P. (1979). Current Issues in Economic Development, *Economic Perspectives,* 1.

UNDP (2007). *Human Development Report 2007/2008*, Rosenberg & Sellier, Torino.

UNRISD (1970). *Contents and Measurement of Socio-economic Development*, UNRISD, Geneva.

World Employment Conference (1976). *Employment, growth and basic needs: tripartite World Conference on Employment, income distribution and social progress and the international division of labour*, Report of the Director-general of the International Labour Office, International Labour Office, Geneva.

World Employment Conference (1977). *Meeting basic needs: strategies for eradicating mass poverty and unemployment*, Conclusions of the World Employment Conference 1976, International Labour Office, Geneva.

Social Well-Being, Economic Development and Sustainability in Rural and Urban Areas A Comparison of Indicators

Veronica Gianfaldoni
University of Pisa, V. C. Ridolfi 10
veronica.gianfaldoni@gmail.com

Edoardo Pizzoli
National Institute of Statistics (ISTAT), V. Cesare Balbo 16
pizzoli@istat.it

Abstract: *Development theories suggest alternative indicators to be used in official statistics to monitor social well-being, economic development and sustainability. Several representations of development could be depicted by using different combination of indicators, even if, in some cases, they can be strongly correlated over time and across different geographical areas, producing an excess of information in statistical terms.*
The objective of this paper is to consider essential indicators available in areas and countries with data gaps to monitor Millennium Development Goals. Strictly economic versus human and social scenario will be considered.

Keywords: well-being, development, economic growth, statistical indicators, Millennium Development Goals

1. Introduction

Development, economic growth and well-being have conceptually different meanings and they should be studied by using different indicators.

In this paper, emphasizing and concentrating on well-being, several interpretations are given to this concept in economic, physical, environmental, social and "life" terms. A logical framework is introduced to present the relevant indicators, which are selected among Millennium Development Goals (MDGs) and social-economic theories' indications: from Classical, Neoclassical and Keynesian, to environmental accounting, human and sustainable development.

The suitable data and variables necessary to calculate indicators are selected considering the data constrain in most developing countries.

In the second part of the paper a statistical analysis is applied to reduce the number of indicators and to reach a minimum core set.

2. A logical framework to present indicators

Relevant indicators have been clustered in five homogeneous topics. Some of them have traditionally been suggested by growth theory and are normally used in economic analysis, while others come from the new development theories.

The following list shows for each topic the selected indicators and the variables necessary for their calculation.

1. TOPIC: *Economic well-being*

VARIABLES: Income, GDP, Population, Occupation, Facilities, Poverty line, Debt

INDICATORS: GDP per capita
Gross Capital Formation per capita and as percentage of GDP
External debt per capita
Inequality of dietary energy consumption
Inequality of income
Concentration of land
Population below national poverty line, total
Population below national poverty line, rural
Population below 1$ per day
Electric power consumption, kWh per capita
Energy use, kg. of oil equivalent per capita
GDP energy intensity, energy uses per unit of GDP
Roads paved

2. TOPIC: *Physical well-being*

VARIABLES: Quality of life, Population, Mortality, Sanitation facilities, Dietary energy, Weight for age group

INDICATORS: Life expectancy at birth, total
Population growth, annual percentage
Mortality rate under-5, per 1.000
Improved sanitation facilities, urban, population with access
Per capita dietary energy supply, calories
Malnutrition prevalence, weight for age, children uder-5, percentage
Maternal mortality ratio, modeled estimate, per 100.000 live births

3. TOPIC: *Environmental well-being*

VARIABLES: Quality of air and water, Use of land, CO2 Emissions, Fish stock, Forest, Roads

INDICATORS: CO2 emissions, metric tons per capita
Proportion of land covered by forest
Forest area per capita
Roads normalized index
Population density
Proportion of fish stock within safe biological limits
Ecological Footprint
Total Material Requirement

4. TOPIC: *Social well-being*

VARIABLES: Knowledge, Participation, Access to education, drinking water and drugs, Slum population

INDICATORS: Primary completion rate, total, percentage of a relevant group
Ratio of girls to boys in primary and secondary education, percentage
Proportion of population using an improved drinking water source, total
Proportion of population with access to affordable essential drugs on a sustainable basis
Slum population as percentage of urban

5. TOPIC: *Subjective well-being*

VARIABLES: Happiness, Satisfaction

INDICATORS: HPI, Happy Planet Index
Life satisfaction

Where, in this context, the term "life" is used in its largest interpretation concerning both Human and Earth life.

While economic variables and indicators are easily available, some problems may occur for the others topics due to the luck of data. Unfortunately some indicators are only theoretically defined and others are rarely available.

The following is a list of definitions, from available data sources, concerning critical indicators that have a limited diffusion in official and most used statistics:

- *Ecological Footprint:* is the land (and water) area of the planet or particular area required for the support either of humankind's current lifestyle or the consumption pattern of a particular population. It is the inverse of the carrying capacity of a territory. (OECD, 2001)
- *Total Material Requirement:* this indicator includes, in addiction to Domestic Material Input, the upstream hidden material flows which are associated with imports and predominantly burden the environment in others countries. It measures the total "material base" of an economy; that is, the total primary resource requirements of the production activities. Adding these upstream flows converts imports into their "primary resource extraction equivalent" (in economy-wide flow accounting). (OECD, 2005)
- *Roads Normalized Index:* (100 = expected total length) is the total length of roads in a country compared wit the expected length of roads, where the expectation is conditioned on population, population density, per capita income, urbanization, and region-specific dummy variables. A value of 100 is "normal". If the index is more than 100, the country's stock of roads exceeds the average. (WB, 2000)
- *Improved sanitation facilities, urban (percentage of population with access):* the proportion of the population using an improved sanitation facility, total, urban, rural, is the percentage of the population with access to facilities that hygienically separate human excreta from human contact. Improved facilities include flush/pour flush toilets or latrines connected to a sewer, -septic tank, or -pit, ventilated improved pit latrines, pit latrines with a slab or platform of any material which covers the pit entirely, except for the drop hole and composting toilets/latrines. Unimproved facilities include public or shared facilities of an otherwise acceptable type, flush/pour-flush toilets or latrines which discharge directly into an open sewer or ditch, pit latrines without a slab, bucket latrines, hanging toilets or latrines which directly discharge in water bodies or in the open and the practice of open defecation in the bush, field or bodies or water. Definitions and a detailed description of these facilities can be found at the website of the WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation at www.wssinfo.org. (United Nations site for the MDG indicators)
- *Proportion of population with access to affordable, essential drugs on a sustainable basis:* is the percentage of population that has access to a minimum of 20 most essential drugs. *Access* is defined as an having drugs continuously available and affordable at public or private health facilities or drug outlets that are within one hour's walk of the population. *Essential drugs* are drugs that satisfy the health care needs of the majority of the population. (United Nations site for the MDG indicators)
- *HPI, Happy Planet Index:* is an innovative new measure that shows the ecological efficiency with which human well-being is delivered. It differs markedly from the central indicator of national income usually referred to by commentators, and relied on by governments to measure their success – Gross Domestic Product (GDP). And it also has a different rationale to the various alternative indicators that begin with GDP, and then subtract social and environmental costs to create a more accurate measure of economic success. (New Economics Foundation, report)
- *Life satisfaction:* is an overall assessment of feelings and attitudes about one's life at a particular point in time ranging from negative to positive. It is one of major indicators of well-being. (New Economics Foundation, report)

3. Data

Data and already calculated indicators, when available, are from World Bank, United Nations, and FAO websites. Other sources, such as the New Economics Foundation, have been considered in order to introduce more indicators that can't be found in official statistics.

All 209 countries in the World Bank website are considered for 2000 year. Missing data are estimated by using values from the nearest year available.

The territorial dimension is rarely available in the data; anyway some indicators give information separated for rural and urban areas and are included in this paper.

After considering data available, the following 33 indicators are selected:

Table 1 - Legend of used indicators

TOPICS	Indicator	Definition
Economic well-being	GDP p.c.	Gross Domestic Product per capita (current US $)
	GCF percentage	Gross Capital Formation, percentage of GDP (current US $)
	GCF p.c.	Gross Capital Formation per capita (current US $)
	External Debt p.c.	External Debt per capita (current US $)
	Inequality Diet.	Inequality of Dietary Energy Consumption, Gini Coefficient, percentage
	Inequality Income	Inequality of Income, Gini Coefficient, percentage
	Concentration Land	Concentration of Land, Gini Coefficient, percentage
	Poverty Line	Population below national poverty line, total, percentage
	Poverty Line Rur.	Population below national poverty line, rural, percentage
	Pop. Below 1$	Population below $1 (PPP) per day, percentage
	Electric power cons.	Electric power consumption, kWh per capita
	Energy use	Energy use, kg of oil eqivalent per capita
	GDP Energy Intensity	Energy used over GDP, tep/Mil. US$
	Roads paved	Roads paved, percentage of total roads
Physical well-being	Life expectancy	Life expectancy at birth, total, years
	Popul. growth	population growth, annual, percentage
	Mortality rate	Mortality rate under-5, per 1,000
	Sanitation fac.	Improved sanitation facilities, perc. of urban population with access
	Diet. Energy p.c.	Per capita dietary energy supply, calories
	Malnutrition	Malnutrition prevalence, weight for age, percentage of children under-5
	Maternal mortal.	Maternal mortality ratio, modeled estimate, per 100,000 live births
Environmental well-being	CO2 Emissions	CO2 Emissions, metric tons per capita
	Land covered	Proportion of land covered by forest, percentage
	Forest Area p.c.	Forest area per capita
	Roads normal.	Roads normalized index
	Population dens.	Population density, per sq. Km
	Eco. Footprint	Ecological Footprint
Social well-being	Ratio girls to boys	Ratio of girls to boys in primary and secondary education, percentage
	Primary complet.	Primary completion rate, total, percentage of relevant age group
	Drinking water	Proportion of population using an improved drinking water source, total
	Slum population	Slum population as percentage of urban
Life well-being	Life Satisfact	Life Satisfaction
	HPI	Happy Planet Index

Summary statistical results are included in Table 2:

Table 2A - Descriptive statistics, 209 observations, missing values are skipped

TOPICS	Variable	Mean	Median	Minimum	Maximum
Economic well-being	GDP p.c.	7,436.87	2,025.60	84.95	56,459.20
	GCF percentage	21.95	21.16	3.45	61.34
	GCF p.c.	145,017.00	35,870.80	293.06	1,071,300.00
	External Debt p.c.	847.41	489.32	83.33	3819.24
	Inequality Diet.	14.68	14.00	1.00	21.00
	Inequality Income	40.13	38.00	25.00	70.70
	Concentration Land	61.62	62.00	18.00	92.00
	Poverty Line	38.87	36.00	5.00	75.00
	Poverty Line Rur.	46.16	45.00	5.00	83.00
	Pop. Below 1$	28.09	19.60	1.00	88.50
	Electric power cons.	3,695.99	2,015.45	22,90	26,220.60
	Energy use	2,464.01	1,340.83	134.19	19,581.00
	GDP Energy Intensity	0.81	0.52	0.10	4.99
	Roads paved	50.44	45.02	0.80	100.00
Physical well-being	Life expectancy	66.75	70.30	39.58	81.08
	Popul. growth	1.45	1.42	-4.59	6.73
	Mortality rate	60.86	33.40	3.60	274.20
	Sanitation fac.	75.68	87.00	14.00	100.00
	Diet. Energy p.c.	2,652.88	2,595.00	1,630.00	3,720.00
	Malnutrition	17.90	17.50	1.10	48.20
	Maternal mortal.	310.15	130.00	1.00	2,100
Environmental well-being	CO2 Emissions	4.72	2.30	0.02	58.96
	Land covered	29.55	28.00	0.00	91.00
	Forest Area p.c.	0.02	0.00	0.00	0.34
	Roads normal.	127.72	114.00	7.00	664.00
	Population dens.	378.24	69.18	0.02	21,482.50
	Eco. Footprint	2.55	1.70	0.50	9.90
Social well-being	Ratio girls to boys	93.68	99.24	10.01	122.49
	Primary complet.	81.96	94.06	0.00	147.29
	Drinking water	81.13	88.50	1.00	100.00
	Slum population	55.98	61.25	6.90	99.40
Life well-being	Life Satisfact	6.04	6.2	3.00	8.20
	HPI	43.21	42.35	16.60	68.20

Table 2B - Descriptive statistics, 209 observations, missing values are skipped

TOPICS	Variabile	Std. Dev	Coeff. Var. (CV)	Asymmetry	Kurtosis
Economic well-being	GDP p.c.	10,941.80	1.47	1.93	3.43
	GCF percentage	7.94	0.36	1.25	4.33
	GCF p.c.	221,059	1.52	1.96	3.18
	External Debt p.c.	839.04	0.99	1.59	2.15
	Inequality Diet.	2.35	0.16	-0.63	5.34
	Inequality Income	10.29	0.26	0.66	-0.22
	Concentration Land	18.37	0.30	-0.30	-0.56
	Poverty Line	18.61	0.48	0.22	-1.04
	Poverty Line Rur.	19.74	0.43	0.04	-0.87
	Pop. Below 1$	25.10	0.90	0.64	-0.79
	Electric power cons.	4,639.58	1.25	2.35	6.77
	Energy use	2,872.34	1.16	2.57	9.44
	GDP Energy Intensity	0.85	1.05	2.46	7.10
	Roads paved	33.53	0.66	0.17	-1.44
Physical well-being	Life expectancy	10.64	0.16	-0.88	-0.26
	Popul. growth	1.38	0.95	-0.04	2.34
	Mortality rate	62.80	1.03	1.22	0.56
	Sanitation fac.	25.75	0.34	-0.82	-0.64
	Diet. Energy p.c.	498.03	0.19	0.13	-0.93
	Malnutrition	12.18	0.68	0.58	-0.55
	Maternal mortal.	413.38	1.33	1.75	3.03
Environmental well-being	CO2 Emissions	7.16	1.51	3.90	21.43
	Land covered	22.75	0.77	0.63	-0.31
	Forest Area p.c.	0.04	2.54	6.09	46.61
	Roads normal.	97.16	0.76	3.02	12.57
	Population dens.	1,997.98	5.28	8.94	83.60
	Eco. Footprint	2.04	0.80	1.48	1.87
Social well-being	Ratio girls to boys	15.76	0.17	-2.90	11.38
	Primary complet.	26.22	0.32	-1.03	0.36
	Drinking water	20.30	0.25	-1.20	0.98
	Slum population	28.21	0.50	-0.16	-1.24
Subjective well-being	Life Satisfact	1.16	0.19	-0.40	-0.63
	HPI	11.80	0.27	-0.06	-0.77

Some indicators show a median value, that it is close to the mode, much lower or higher than the mean: this is an indication that the indicators' distribution is asymmetric.

To select the key indicators in each topic of the logical framework their statistical correlations are studied.

Table 3 - Correlation coefficients, 209 observations, missing values are skipped, critical values 5% *(only correlation coefficients higher than 0.70 are highlighted)*

GDP p.c.	GCF percentage	GCF p.c.	External Debt p.c.	Inequality Diet.	
1.0000	0.0445	**0.9699**	**0.8543**	-0.4682	GDP p.c.
		1.0000	**0.7878**	-0.4576	GCF p.c.
Inequality Income	Concentration Land	Poverty Line	Poverty Line Rur.	Pop. Below 1$	
		1.0000	**0.8932**	0.5283	Poverty Line
Electric power cons.	Energy use	GDP Energy Intensity	Roads paved	Life expectancy	
0.7998	**0.7260**	-0.4230	0.4687	0,5668	GDP p.c.
-0.2833	-0.4759	0.2419	-0.5422	**-0,8188**	Pop. Below 1$
Popul. growth	Mortality rate	Sanitation fac.	Diet. Energy p.c.	Malnutrition	
0.5078	**0.8314**	-0.7819	-0.6430	0.6884	Pop. Below 1$
-0.4406	**-0.9361**	**0.8102**	**0.7277**	-0.5286	Life expectancy
	1.0000	-0.8208	-0.6769	0.5967	Mortality rate
Maternal mortal.	CO2 Emissions	Land covered	Forest Area p.c.	Roads normal.	
0.7689	-0.5443	-0.1127	-0.0546	-0.0869	Pop. Below 1$
-0.4366	**0.9268**	-0.1155	0.0134	-0.1478	Energy use
-0.8635	0.4550	-0.0030	-0.1062	-0.0359	Life expectancy
0.9283	-0.4304	-0.0465	0.0643	-0.0072	Mortality rate
-0.8087	0.4299	0.0083	-0.0463	0.0410	Sanitation fac.
Population dens.	Eco. Footprint	Ratio girls to boys	Primary complet.	Drinking water	
0.2741	**0.8119**	0.1230	0.3012	0.4124	GDP p.c.
0.2730	**0.7539**	0.0981	0.3490	0.4631	GCF p.c.
0.1014	-0.5959	-0.4218	**-0.7522**	**-0.7484**	Pop. Below 1$
0.0909	**0.7335**	0.1224	0.3250	0.3976	Electric power cons.
0.1610	0.6339	0.4479	**0.7594**	**0.7249**	Life expectancy
-0.0995	-0.5797	-0.5081	**-0.8372**	**-0.8201**	Mortality rate
0.1057	0.5654	0.3741	**0.7651**	**0.7502**	Sanitation fac.
0.0354	**0.7110**	0.3680	0.5678	0.6101	Diet. Energy p.c.
-0.1037	-0.5354	-0.4507	**-0.8086**	**-0.7001**	Maternal mortal.
0.0315	**0.8181**	0.1423	0.2965	0.4135	CO2 Emissions
		Slum population	Life Satisfact	HPI	
		0.7605	-0.5504	-0.4055	Mortality rate
		-0.7915	0.4674	0.3084	Sanitation fac.
		-0.7020	0.4557	0.3478	Primary complet.
		-0.7095	0.4180	0.2620	Drinking water

Among *Economic well-being* indicators, per capita GDP is strongly correlated with per capita gross capital formation (GCF), per capita external debt, electric power consumption and energy use; population below national poverty line in rural areas is correlated with population below total national poverty line. GCF in percentage of GDP and GDP energy intensity are weakly correlated with others economic well-being indicators but they are already considered in per capita terms.

Population below 1$ per day is partially included in the others poverty lines indicators (Poverty Line, rural and total) and, furthermore, is strongly correlated with several indicators of the others groups. If only strong correlation between indicators is considered (correlation coefficient higher than 0.70), the 14 indicators can be reduced to 7.

In the second topic, *Physical well-being*, life expectancy is correlated with mortality rate under-5, maternal mortality rate, improved sanitation facilities of urban population and per capita dietary energy supply. Malnutrition prevalence is partially correlated with population below 1$ and mortality rate under-5. In this case 7 indicators can be reduced to 3.

In the third topic, *Environmental well-being*, only ecological footprint is strongly correlated with CO2 emissions, therefore a limited reduction of indicators could be possible (from 6 to 5).

Concerning *Social well-being*, primary completion rate, proportion of population using an improved drinking water source and urban slum population are correlated each other and with others topics. Indicators can be reduced to 2 or even if to 1.

Finally, about *Life well-being*, both selected indicators are correlated each other but under the threshold.

Significant cross correlations can be found also among indicators belonging to different groups: per capita GDP with ecological footprint; life expectancy with population below 1$ per day, primary completion rate, proportion of population using an improved drinking water source and urban slum population; CO2 emissions with energy use.

All previously highlighted correlations allow to simplify information in the topics, in order to get the minimum number of indicators that could be reached in statistical terms.

4. Results

The following is a list of useful graphical representations that show trends, variability and correlations among previously selected indicators. Furthermore, this is a way to highlight the relationships among different well-being interpretations.

Figure 1 - Key indicators with respect to per capita GDP and life expectancy

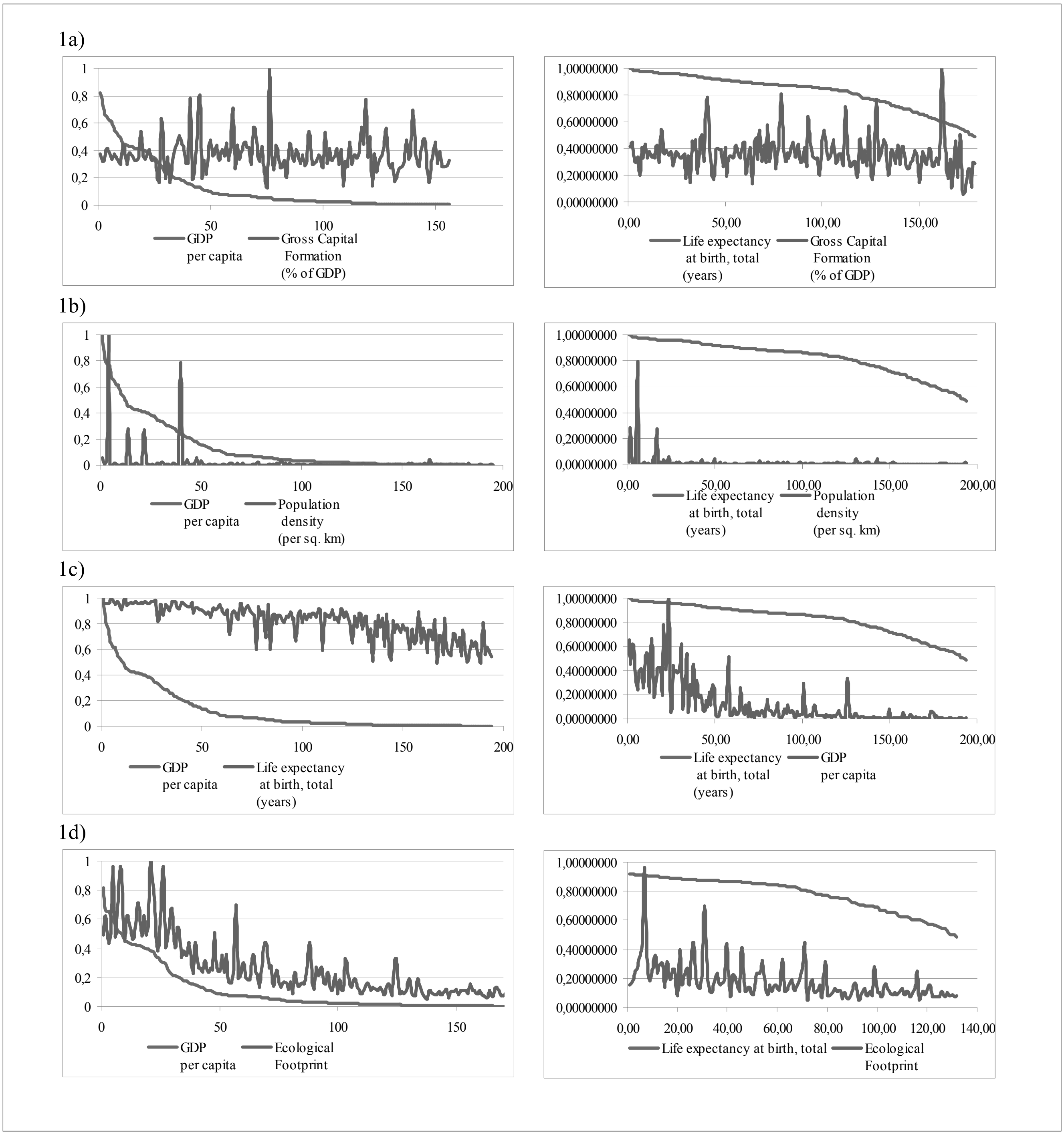
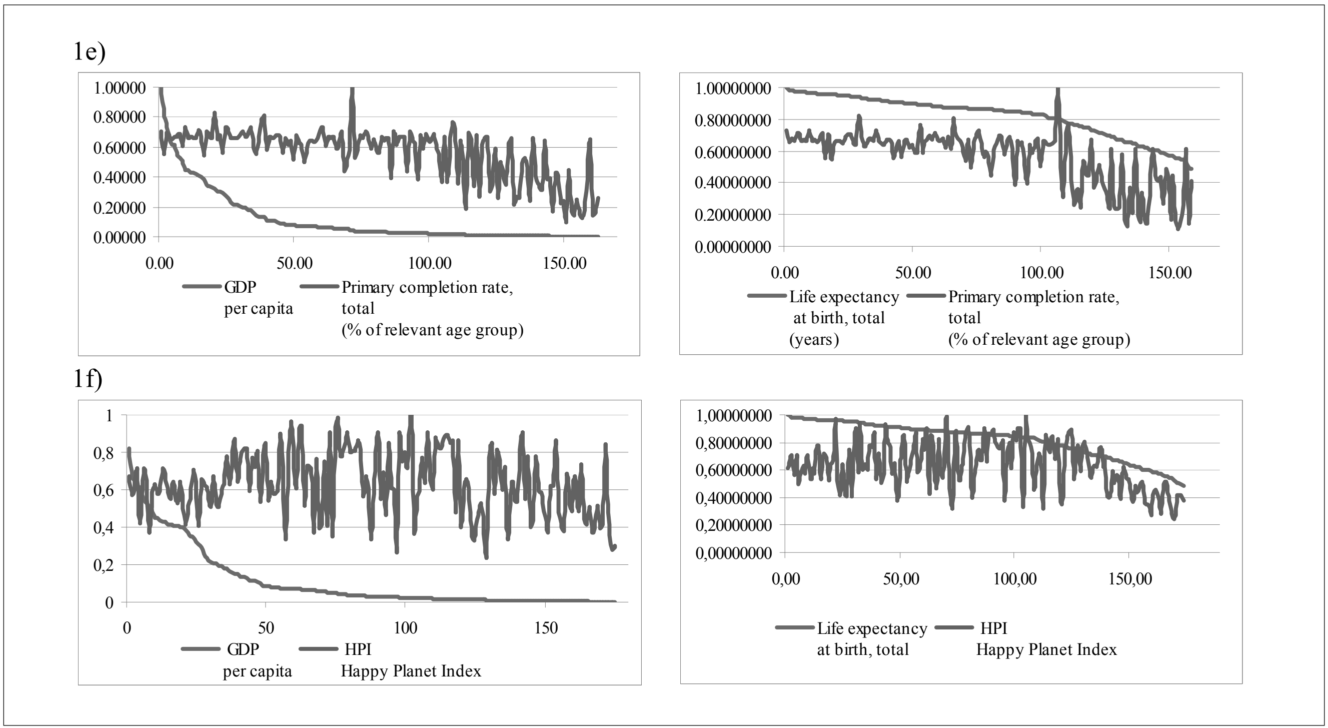


Figure 1 follows **- Key indicators with respect to per capita GDP and life expectancy**



On the left hand side of Figure 1, countries are sorted by descending per capita GDP that is the first indicator of the first topic (Economic well-being). On the right hand side, countries are sorted by decreasing life expectancy at birth, the first indicator of the second topic (Physical well-being). The two indicators used for sorting the countries are correlated (r=0.57) but under the assumed threshold (Tab.3), that is why it is interesting to consider both, separately, with respect to the same indicators.

GCF in percentage of GDP has a constant mean (21.95%) at different levels of per capita GDP and life expectancy at birth (Fig.1a); this is equivalent to the median value (Tab.2a) and the distribution results to be symmetric over the 209 countries. The variability is relatively high (CV=1.52) with several countries in the two intermediate quartiles that invest more than the others. As result, this indicator has a low correlation with the others, while the same variable, in per capita terms, is strongly correlated with per capita GDP (Tab.3) that shows similar descriptive statistics and distribution form.

Population density, belonging to Environmental well-being topic, has the strongest asymmetric distribution (asymmetry=8.94) and the highest variability (CV=5.28) that is mainly produced by few countries in the first quartile (Fig.1a). This indicator has a low correlation with the others and should be separately considered from Economic well-being.

In Fig.1c, per capita GDP and life expectancy at birth are compared. Concerning the trend, at high level of per capita GDP (first quartile) life expectancy is steadily high and it linearly declines at per capita GDP lower levels, with an increasing variability. The same discontinuity can be found in the countries ordering by life expectancy: in the first quartile per capita GDP shift at an higher mean value but with a very high variability.

Considering a further Environmental well-being indicators, ecological footprint, it is clear that variability and the trend increase in the first quartile, with a correlation in both cases (Fig.1d). Fitting is very good in the left hand side and, in this case, ecological footprint can be substituted by per capita GDP with a loss of variability (heteroskedasticity problem).

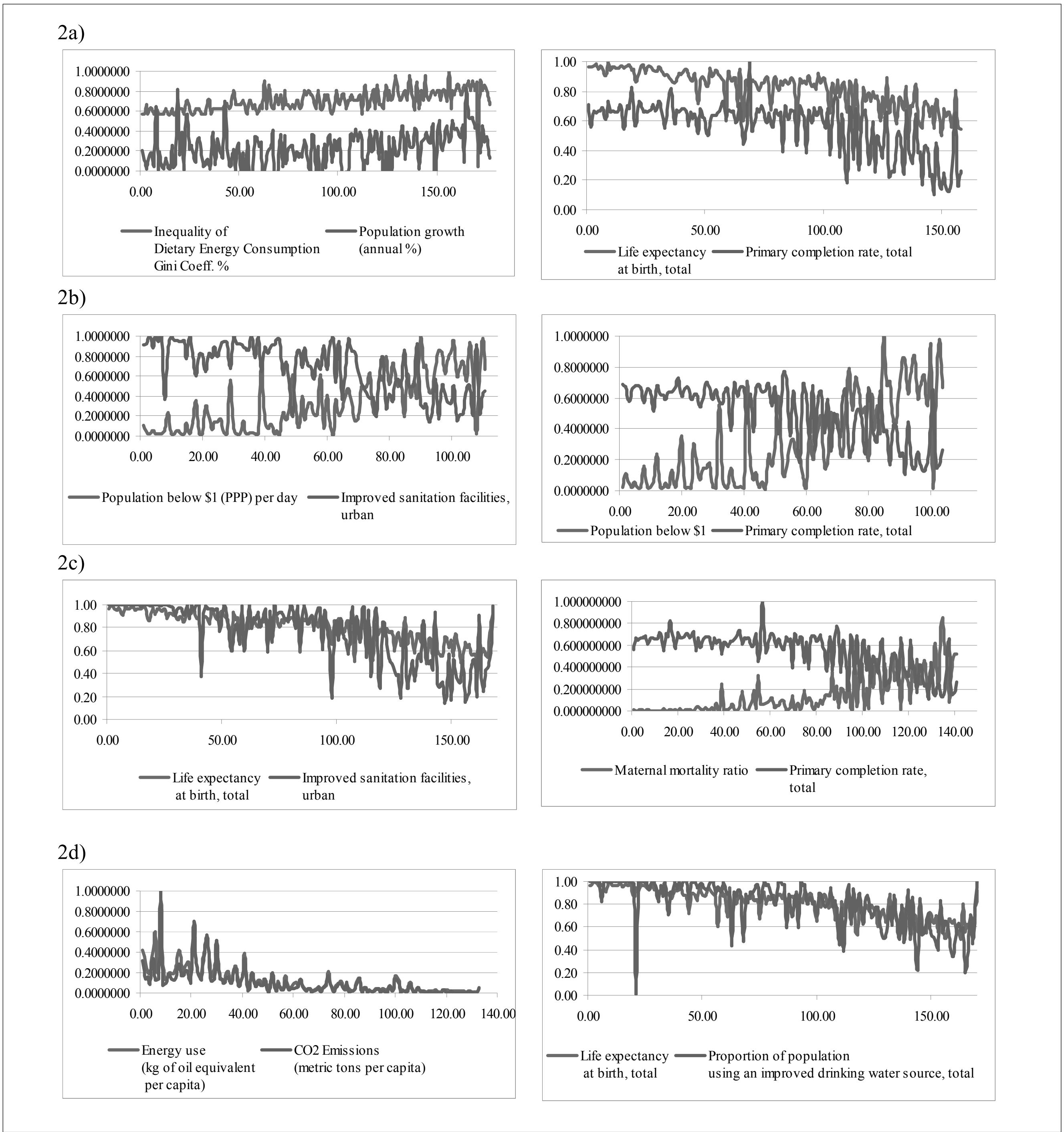
The Social well-being indicator considered is primary completion rate. It presents a declining level and an increasing variability beginning from the fourth quartile (Fig.1e): the poorest and with a low life expectancy countries present the education social problem.

At last topic's indicators, Life well-being, HPI is higher (that is a better ecological efficiency) in countries at second and third quartile but at an increasing variance. It declines at very high and very low per capita GDP and life expectancy at birth (Fig1f).

In conclusion, indicators' trends are similar on both reference base but variability plays significant role that should be considered in evaluating well-being. Per capita GDP seems not sufficient to summarize all the others indicators: for instance, life expectancy at birth and ecological footprint clearly decrease at lower per capita GDP, while for population density and gross capital formation (as percentage of GDP) only the variability is affected.

In the following group of figure (Fig.2), some key bilateral relationships between indicators at high correlation rate (over the threshold) are highlighted.

Figure 2 - Key indicators at decreasing per capita GDP



Some indicators show a similar trends and changes in variability at different per capita GDP. Decreasing per capita GDP:

- inequality of dietary energy consumption (Gini coefficient) and population growth slowly increase but at a different variability that produce in this case a low correlation; life expectancy at birth and primary completion rate both decline at an increasing variability (Fig.2a);
- population below 1$ per day exponentially increases, while improved sanitation facilities in urban areas and primary completion rate exponentially decrease, as expected for poor countries (Fig.2b);
- life expectancy, improved sanitation facilities in urban areas and primary completion rate decline while maternal mortality ratio increase at an increasing variability (Fig.2c);
- Decreasing energy use, CO2 emissions decreases in per capita terms, as expected, but only a few countries (low populated oil Arabian producer) generate an high variability among the first quartile.

Finally, life expectancy at birth decreases as improved drinking water sources reduce (Fig.2d).
In the third group of figures is useful to show some key bi-dimensional correlations of indicators.

Figure 3 - Scatter plots of key indicators

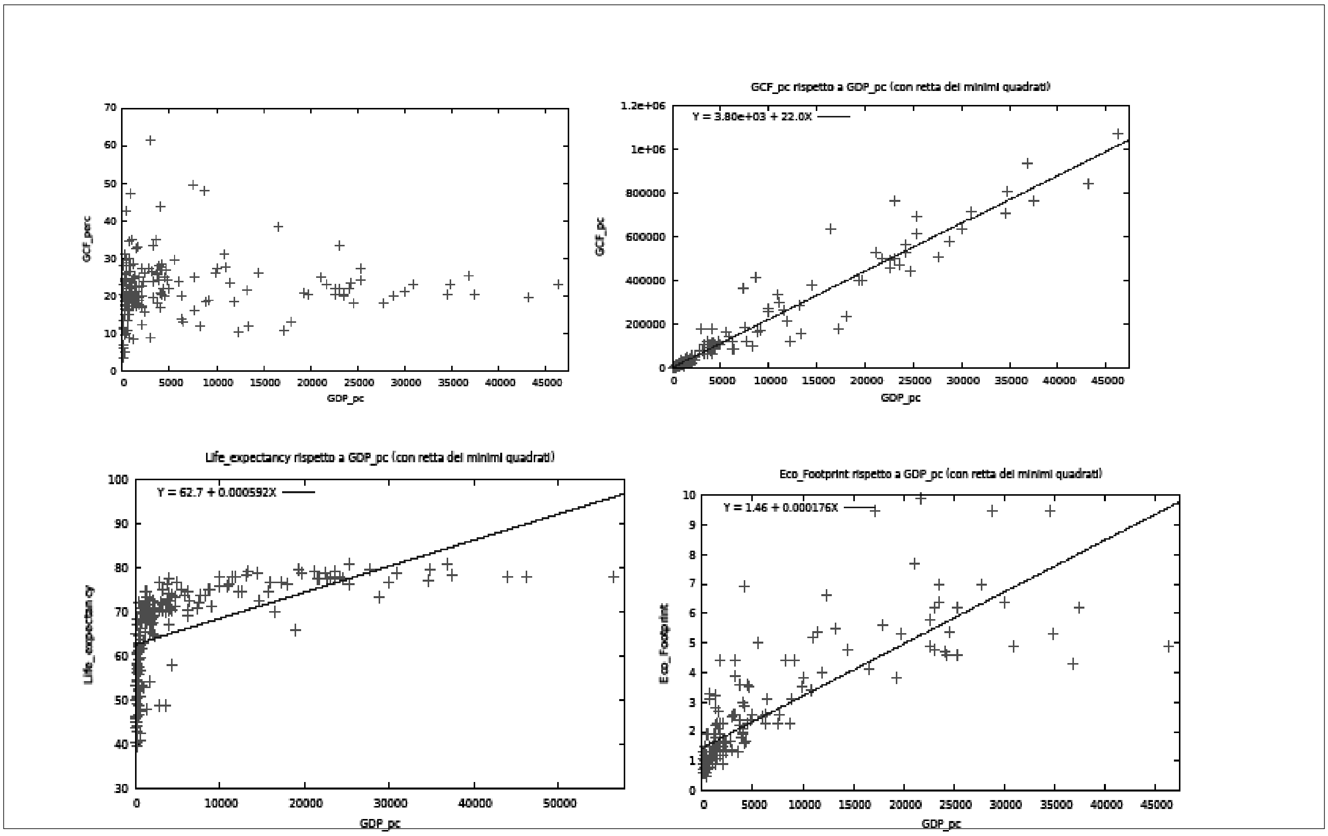
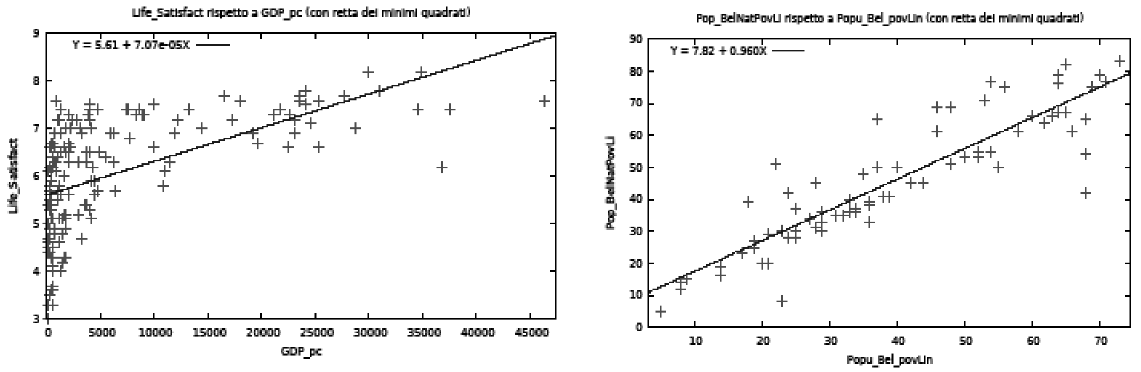


Figure 3 follows **- Scatter plots of key indicators**



In Fig.3, it is clear that GCF is correlated with per capita GDP evaluated not in percentage but in per capita terms and the fitting is good.

There is a structural break at low per capita GDP: at different life expectancy per capita GDP does not change. Increasing per capita GDP life expectancy becomes steady. As result, the correlation between the two variables is misleading. Between ecological footprint and per capita GDP is clear that variability produces uncertainly in the relationship. The same problem can be found between life satisfaction and per capita GDP. Finally, population below national poverty line in rural areas and in total show a clear and linear relationship with a limited variability.

5. Conclusions

To satisfy most political needs and the multiple dimension of countries' development, relevant indicators may be subdivided by themes as suggested by theories. A minimum set of key indicators can be selected for each of the five interpretations of well-being introduced in this paper.

Results of the statistical analysis suggest that a reduction of indicators can be done and it is necessary as many of them are strongly correlated; anyway, per capita GDP may not be sufficient to represent all of them.

From 33 indicators, which selection is based on available data, are reduced to 18. Uncorrelated indicators should be presented without further aggregations. The limitation in this approach is that the number of indicators may not be sufficiently reduced, and the resulting analysis on development, sustainability and well-being may remain complex.

References

United Nations (1997), *Glossary of Environment Statistics, Studies in Methods*, Series F, No. 67, New York

European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, World Bank (2005), *Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003*, Studies in Methods, Series F, No.61, Rev.1, Glossary, United Nations, New York, para. 3.201.

Michael P. Todaro (1981) in UNDP, *Human Development Report 1997*, Oxford University Press

Bruno Cheli (2007), *Sulla Misura del Benessere Economico: i Paradossi Del PIL e le Possibili Correzioni in Chiave Etica e Sostenibile*. Versione successivamente ampliata dell'articolo: B. Cheli (2000) *"Alcune riflessioni sulla misurazione del benessere: dai paradossi del PIL all'indice del benessere economico sostenibile, con uno spunto per l' analisi della povertà"*. Rivista Italiana di Economia, Demografia e Statistica, vol. LIV, n. 1, Gennaio -- Marzo 2000, pp. 11-34.

Heinz W. Arndt (1990), *Lo sviluppo economico. Storia di un'idea*, Il Mulino, Bologna. Traduzione di G. Panzeri.

SESSION 4

Plenary Session

Way Forward in order to Supplement Handbook

Chairman: *Jan Karlsson*

Report on Plenary Session 4: Way Forward in order to Supplement the Handbook

Chairman: Jan Karlsson

A paper by Hill and Karlsson entitled "Discussion on the Handbook – Preview of the Handbook up-date" was presented. Based on the table of contents of the Handbook the paper indicated which chapters and sub-chapters that needed to be revised or added. It was stressed that the Handbook, as it now stands, lack analysis and suggestions of good practices as concerns developing countries. For this reason a whole new section need to be added to the Handbook, addressing the particular issues of developing countries. To this end the paper discussed the problems facing the developing countries as concerns lack of basic data series and hence also basic indicators, as shown in the external review of the FAO Statistical System and the paper by FAO/World Bank: *Selecting a Core Set of Indicators for Monitoring and Evaluation in Agriculture and Rural Development in Less-than-Ideal Conditions*. This calls for, on the one hand, prudence in recommendations of data series and indicators and, on the other hand, assistance by international organizations and donor countries to focus on statistical capacity building. As developing countries are far from being homogenous it is necessary to deal with various clusters of countries having different degrees of economic development.

In the introduction to the session, the history of the Handbook was recalled as well as how work was organized and carried out. As for the revision and update of the Handbook it was suggested that an editorial board would be set up. Besides this board, the work would be carried out by engaging

- seconded staff (could be based in FAO or home countries) from National Statistical Organizations or other national agencies dealing with agriculture economics/statistics;
- interns from universities, preferably based with FAO;
- contributions by experts of the Wye Group in drafting/reviewing chapters, sub-chapters and case studies.

It was also stressed that the update had to be linked to the Global Strategy for Agriculture Statistics which will contain recommendations concerning which core indicators, data series and methodologies to focus upon from a global perspective.

As for the time table of the work of updating the Handbook the following milestones were suggested:

- Maputo August 2009 at which the Global Strategy will be presented. The work of the revision/update of the Handbook should be closely coordinated with the Global Strategy;
- Wye Group meeting in Washington in April/May 2010 organized by ERS and the World Bank. This meeting would review the revised and updated sections (but in a non-edited form). This would imply that authors of chapters and sub-chapters would have to submit to the editor their contributions by February 2010.
- Final update to be presented to ICAS V in Kampala in October 2010.

Among the issues proposed to be included in the revision/update can be mentioned:

- Policy issues concerning poverty and hunger
- Definition of clusters of countries
- More detailed review of data sources (for developing countries, rather the lack of basic data series)
- Methodologies including new technology
- Inventories of rural development and household income for developing countries similar to that which was done for UNECE/OECD countries

- Case studies of good practices (China, India, Brazil, Canada, United Kingdom, United States. Italy and the Netherlands based on papers presented to the meeting)
- Linkage to the Global Strategy
- Include definition of all types of farms, family farms as well as non-family farms
- Suggest data collection system that allow for a continuously changing farm and household structure

As for the particular chapters to be revised and updated it was also suggested (besides what was mentioned in the Hill/Karlsson paper) as follows:

Chapter II Specific policy issues for developing countries.

Chapter VI Refers to suggestions of the Global Strategy. Include remote sensing and other innovation tools

Chapter VII Should be revised to include core set of indicators and a menu of indicators as will be suggested by the Global Strategy and also listed in the FAO/World Bank: *Selecting a Core Set of Indicators for Monitoring and Evaluation in Agriculture and Rural Development in Less-than-Ideal Conditions*.

Chapter VIII A unified framework for agriculture households in all countries irrespectively of stage of development. It should also discuss in more detail the complexity of farming whether it is family farming or non-family farming as well as on multifunctionality activities

Chapters IX – XIII Revision, additions and updates for developing countries, in particular concerning vulnerability and risk for low income countries, consumption indicators, gender perspective and housing policies for rural development.

Discussion on the Handbook
Overview of the Handbook Up-date

Berkeley Hill and Jan Karlsson[123]
b.hill@imperial.ac.uk , jan.karlsson@wanadoo.fr

1. Introduction

At the conclusion of the first Wye Group meeting (York, 2008) several issues related to the Handbook were identified that should be progressed at the second meeting to be held in 2009. These fell into two categories.

A. Revisions of the handbook that are designed to update it generally

Specific items that were identified included the following:

- A stronger focus on *poverty* (for countries at all levels of development). Other discussions linked poverty with rural income and well-being, and measures of unemployment were also mentioned. There was a need to make improvements in each of these related areas;
- A more detailed treatment of the *classification of rurality* of geographical locations (with case studies). It was suggested that a useful addition to the handbook would be to include detailed case studies of how rural definitions are developed. The UK's England and Wales definition was suggested as a possibility (an approach appropriate in relatively densely populated regions where rural land use takes place in proximity to urban centres);
- Clarification of *terminology used about statistics* within the process of rural development (e.g. statistics relating to inputs, outputs, results, impacts and outcomes);
- The need to recognise the *complexity of the farm concept* and forms of ownership**.** For example, further consideration should be given to households on farms that have their own legal status or have other forms of non-personal operators. Multiple-ownership was a factor relevant (in different ways) at various levels of economic development;
- Expansion in the *number of case-studies* in those parts of the handbook that are structured to receive them (e.g. rural statistics in Poland, early results from the EU-SILC project, and data sources on agricultural household incomes in EU Member States);
- *Changes* that would facilitate better links between users and providers of statistics.

The responsibility for proposing updates to the Handbook at the 2009 Rome meeting and organising the session in which these were discussed was given to the editors of the 2005/2007 Handbook.

B. Actions and revisions of the handbook to increase its utility to developing countries (arising from the work of the sub-group established under point 3.1 of the York meeting minutes)

It was agreed that the Handbook could be expanded to have a much deeper coverage of developing countries, though recognition had to be given to the very diverse nature of such countries and in their statistical capacities and needs. This expansion was to include the revision of the sections on indicators (following the World Bank report that formed an element of Session 1 of the York meeting), general principles of planning statistical systems for rural areas (core indicators etc.) and problems of measuring living standards in developing countries.

[123] Berkeley Hill is Emeritus Professor, University of London (b.hill@imperial.ac.uk). Jan Karlsson was formerly the chief of economic statistics with the UNECE, Geneva (jan.karlsson@wanadoo.fr).

It was proposed that a sub-group comprising experts on developing countries along with some of those involved in writing the Handbook would be formed to take these issues further forward. The subgroup consists of members from FAO, World Bank, DFID, LEI Netherlands, Imperial College London, with responsibility for organising it being given to FAO.

B.1 Illustration of the scarcity of relevant data in developing countries

The availability of data is a universal constraint in the choice of indicators for operational information systems on rural areas and the income situation of farm families. In 2008, an independent evaluation of FAO's role and work in statistics highlighted the difficulties of receiving reliable data from developing countries. The following quotations from the evaluation give a good illustration of the problems:

"*Ensuring the quality of the data in FAO statistical products has been a major challenge because the availability of reliable data can vary greatly among countries and even within countries. In 1997, an ESS paper estimated that only 16 out of 54 countries in Africa had reliable basic statistics (for crops and livestock). Similarly, a review of FAOSTAT in 2001 indicated that 30 countries worldwide lacked relevant statistics for five or even ten years.*[124] *In FAOSTAT, missing official or semi-official data must be estimated through various available techniques. The continuing problem of low data quality is a major concern for FAO, which needs to have comprehensive and reliable data coverage.*

Based on current data from ESS, the Evaluation Team found that submissions of official production data and official trade data from countries in Africa are at their lowest level since 1961, at 26 percent and 66 percent respectively (Figures 1 and 2). Submissions of production data from countries in Asia Pacific, Latin America and the Caribbean have also been on the decline over the last 10 years.

Figure 1 - Crop Production Data for Africa

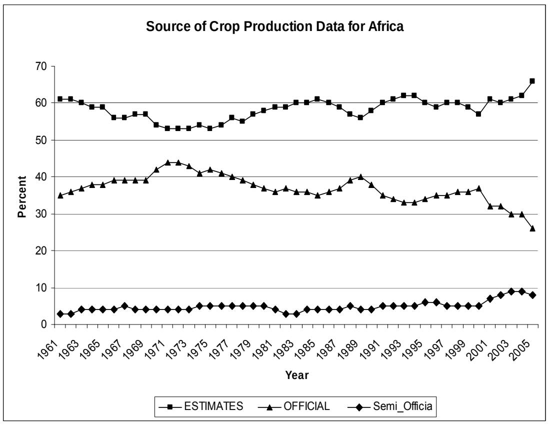
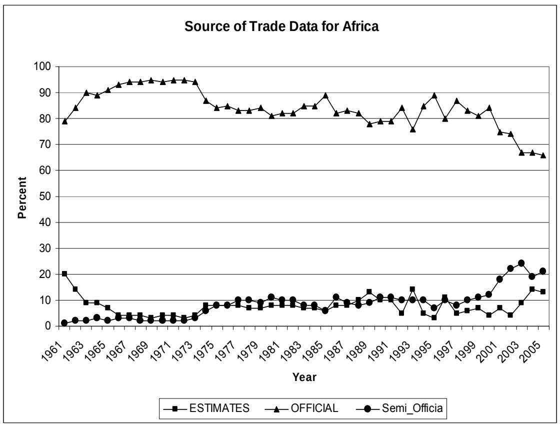


Figure 2 - Trade Data for Africa



The Evaluation Team concluded that the current situation is a reflection of a few inter-related circumstances:

- *The* ***lack of country capacity*** *to collect basic data on agriculture following a period of deterioration in overall national statistical capacity.*
- *The* ***low priority*** *given in the past by FAO to work with countries in improving the quantity and quality of their data submissions.*
- *A* ***limited field presence*** *(both at country and regional level) and poor networking with member countries and partners to keep FAO and the countries and partners themselves abreast of recent developments*."

[124] Evaluation of Programme 2.2.2 (Food and Agriculture Information) Activities related to agricultural statistics, May 2003, page 13, para. 32.

Another illustration of the problems of constructing indicators in developing countries due to scarcity of available data sources is found in the World Bank and FAO study: *Indicators fro Tracking Results in Less-than-ideal Conditions* (2008). Besides methodological surveys, in-depth studies were carried out for the following five countries: Cambodia, Nicaragua, Nigeria, Senegal and Tanzania. A menu of core indicators was set up containing a total of 145 indicators, see table 1. The availability of indicators in the five countries on a total basis amounted to 28 percent in Camboia, 39 percent in Nicaragua, 39 percent in Nigeria, 27 percent in Senegal and 19 percent in Tanzania. Out of 27 core agriculture and rural development indicators Cambodia and Nicaragua could provide 8, Nigeria 11, Senegal 10 and Tanzania only 4.

Table 1 - Availability of indicators in selected developing countries

CLASS OF INDICATOR		No. of indicators	Cambodia	Nicaragua	Nigeria	Senegal	Tanzania
A	Core Ag. And rural dev. indicators	27	8	8	11	10	4
B	Agribusiness and market development	16	3	4	3	2	2
C	Community-based rural development	9		2	4		2
D	Fisheries	7	2	2	1	1	
E	Forestry	16	5	3	3	5	3
F	Livestock	8	4	4	6	5	1
G	Policies and institutions	19	6	11	11	7	6
H	Research and extension	10	4	3	4		
I	Rural Finance	8	1	6	6	1	5
J	Sustainable land and crop management	8	6	6	5	2	
K	Water resource management	17	1	7	3	6	4
	Grand total	**145**	**40**	**56**	**57**	**39**	**27**
	Percentage share of grand total		27.6	38.6	39.3	26.9	18.6

Source: World Bank and FAO: Indicators for Tracking Results in less-than-ideal Conditions

The examples given above clearly speak in favour of being very careful in suggesting in setting up ideal lists of indicators and instead taking a pragmatic view of suggesting indicators that actually can be produced from available data sources.

For the 2005/2007 Handbook extensive questionnaire surveys were carried out in UNECE/OECD countries concerning availability of statistics on rural development and income of agriculture households and their components, see Annex I. For developing countries surveys were only carried out for a limited number of countries and, because of lack of time, these were rather rudimentary (see Chapter XIII.2.2 of the Handbook). As the update of the Handbook will have a focus on developing countries it might be a good idea to carry out a more thorough survey of these countries, based on the questionnaires used for the UNECE/OECD countries, with some necessary modifications

2. Procedure for making changes to the Handbook[125]

It was agreed at York in 2008 that for both improvements to the Handbook falling into A and B the 2009 Rome meeting would be required to ratify (a) the list of items that are to be addressed, (b) designate authors, (c) arrange for an editorial process to take place, and (d) make provision for the incorporation of new text in the electronic version of the handbook on the FAO website (which may be printed as hard copy at a later stage).

[125] In addition to the Handbook but related to it, mention was made of a number of possible supplementary Reports to deal with specific issues. Also a Supplement to the Handbook was discussed, specifically to deal with the treatment of developing countries.

Proposals for changes in the content of the Handbook, item (a), are dealt with separately below. In terms of the other items the proposals are as follows:

- The appointment of an Editorial Panel, comprising a General Editor and two Specialist Editors, one to cover OECD countries and the second to cover developing country issues. The latter is expected to have experience in working in such countries or international institutions dealing with them.
- The Editorial Panel would be responsible for arranging for authors to contribute and for editing their work to a form that is compatible with the Handbook. However, suggestions of people who could be potential authors can come from any member of the Wye City Group and need not be confined to it.
- The Editorial Panel would be responsible for setting a specific timetable within a general framework agreed by the Wye City Group (see section 4 below).
- FAO should be responsible for incorporating new text agreed by the Editorial Panel into the electronic version of the Handbook. This should contain information on the date of last revision.

3. Changes proposed for the Handbook

In terms of improvements falling into A, this paper contains in specific proposals for making changes to the Handbook in line with the intentions outlined in York. These are given in *BOLD CAPITALS* on the Table of Contents that forms the Annex II to this short paper. In a few cases the names of proposed authors of the basic material are attached (their contributions will, of course, be edited). Some of these additions are of general application, irrespective of the level of development of individual countries.

However, for those changes falling into B, relating specifically to developing countries, the situation is more complex. In reality, the sub-group that was given the responsibility at York for carrying issues forward for developing countries has not met or deliberated, so the Rome meeting has to give consideration as to how this situation can be resolved. Consequently, only indicative suggestions for changes have been shown in the Annex II, and are in *ITALIC CAPITALS.*

As for the text on World Bank, FAO, Eurostat and OECD activities, each organization would have to provide the necessary updates and additions.

It is understood that any changes and additions to the main text of the Handbook will need to be reflected in the Executive Summary, Introduction and Background, and other sections as is appropriate. This is the responsibility of the general editors.

4. Necessary steps to carry the Handbook forward

We have identified several steps that are necessary if the Handbook is to be taken forward in an efficient manner. We ask the Wye City Group to resolve the following:

- To confirm the concept of an Editorial Panel, and to consider who might act as Specialist Editor for material relating to developing countries. The editors of the 2005/2007 Handbook (Hill and Karlsson) have indicated a willingness to continue their previous roles. There may be an issue of providing resources to enable the Editorial Panel to function.
- To set a date for a meeting of the sub-group charged with clarifying the issues for developing countries (FAO, World Bank, DFID, LEI Netherlands, Imperial College London). This might be an electronic meeting.
- To comment on the proposed improvements already listed (see Annex II).
- To establish a mechanism that invites further suggestions for updating the Handbook, and the principle that these are to be channelled via the Editorial Panel.

- To consider the proposal by the Editors for further electronic survey(s) of developing countries, as a means to update the Handbook and make it more comprehensive.
- To consider who will author new sections and revise existing ones, and to confirm the role of the Editorial Panel to deal with unresolved issues concerning authorship where this is impractical to consult the full Wye City Group.
- To set a timetable for updating the Handbook, and the amount of progress to be achieved by the next meeting of the Wye City Group.

Statistics on Rural Development and Agriculture Household Income

Wye City Group Meeting
Rome 11-12 June 2009

The Wye City Group of the United Nations Statistical Division (UNSD) promotes the refinement and adoption of international standards in statistics for rural areas and agriculture household incomes. The city group has the mandate to determine the need for any changes or updates to the handbook *'Rural Households Livelihood and Well-being: Statistics on Rural Development and Agriculture Household Incomes'*.

The second meeting of the city group consisted of four half-day sessions which focused on issues related to the first revision of the handbook. Specific sessions covered emerging issues in a changing rural world, related data needs and the use of new technological tools in rural statistics specific to characteristics of countries at different levels of development. Contributions from invited keynote speakers and discussion papers were collected in these proceedings.

ISBN 978-88-458-1670-3

9 788845 816703

1F012010123000000