European Commission

JRC SCIENTIFIC AND POLICY REPORTS

Sustainability and Production Costs in the Global Farming Sector: Comparative Analysis and Methodologies

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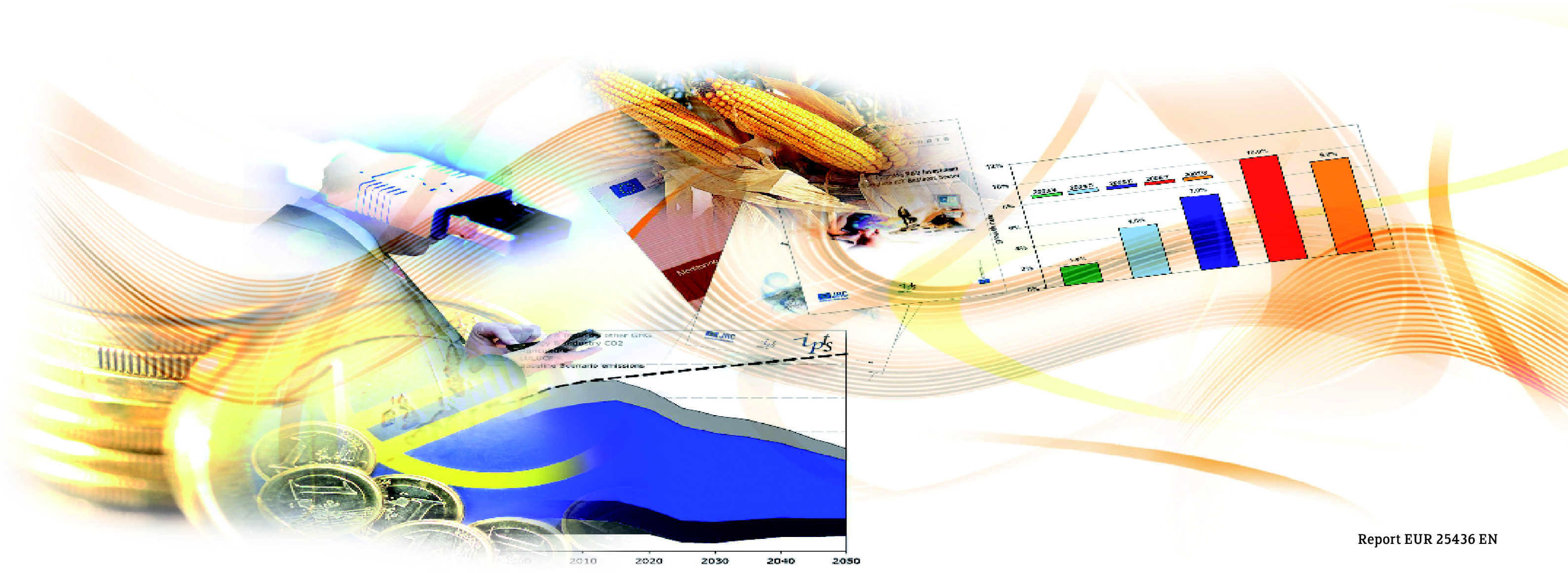
2012



Report EUR 25436 EN

Joint Research Centre

European Commission
Joint Research Centre
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http://www.jrc.ec.europa.eu/

This publication is a Technical Report by the Joint Research Centre of the European Commission.

JRC 70116
EUR 25436 EN

ISBN 978-92-79-25720-9 (pdf)
ISBN 978-92-79-25721-6 (print)
ISSN 1831-9424 (online)
ISSN 1018-5593 (print)
doi:10.2791/86305

Luxembourg: Publications Office of the European Union, 2012
Rome: Food an Agriculture Organization of the United Nations

Printed in Spain

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Acknowledgements

This report has been prepared by the IPTS editorial team comprising Stephen Langrell, Pavel Ciaian and Sergio Gomez y Paloma. We would like to thank Tassos Haniotis, Director, Directorate L, DG-AGRI, for his intervention in the workshop and for setting the scene in a political and global context, as well as Pierluigi Londero, Willie Schulz Greve, Hubertus Gay, Dangiris Nekrasius and Thierry Vard, also from DG-AGRI (Directorate L), for their close collaboration in the realization of the workshop and in their valuable comments and further inputs to this report. We thank Jacques Delincé, Head of Agriculture and Life Sciences in the Economy Unit, for his continuing support and additional input to the production of this report.

We would like to thank all participants who readily gave of their experiences and expertise of the various production cost calculation methods and approaches used across the globe in the various sectors under consideration. Details of all external participants, including internal European Commission staff, are given in the Annex.

Finally we would like to thank Folkhard Isermeyer (Johann Heinrich von Thünen-Institute, Germany), Dan L. Cunningham (University of Georgia, USA), Ashok K. Mishra (Louisiana State University, USA) and Jean-François Garnier (ARVALIS, France) for acting as rapporteurs for each of the technical sessions and their contribution to respective synthesis reports towards the production and overall realisation of this JRC report.

Table of Contents

List of Figures

List of Tables

List of Acronyms

AACREA	Argentine Association of Agricultural Consortium for Agricultural Experimentation
ASRA	Farm Income Stabilization Insurance
CNCER	National Council of Rural Economy Centre
Conab	Companhia Nacional de Abastecimento
CoP	Cost of production
Embrapa	Brazilian Agricultural Research Corporation
FACEPA	Farm Accountancy Cost Estimation and Policy Analysis of European Agriculture
FADN	Farm Accountancy Data Network
IFCN	International Farm Comparison Network
INTA	National Institute of Agricultural Technology
MAF	Ministry of Agriculture and Forestry in New Zealand
RoA	Return on assets
RoE	Return on equity
USDA	United States Department of Agriculture
50-sg	State national wide survey

Preface

This report constitutes a comprehensive compilation and synthesis of the principal issues and outcomes of the Joint Institute for Prospective Technological Studies/Directorate-General for Agriculture and Rural Development workshop on "Sustainability and Production Costs in the Global Farming Sector: Comparative Analysis and Methodologies" held in Brussels between 21-22 June 2011.

Gathering a range of international experts and specialists in the field of production costs analysis and development, covering a range of strategic agricultural sectors of global importance, the workshop aimed to review methodologies and approaches to calculating production costs used in various sectors nationally and globally, with emphasis on exploring the applicability for effective international comparisons. Particular attention was given to the methodologies and approaches for data collection and processing, factor market structure and policy inter-linkages, sectoral coverage, horizontal technical issues, and the implications for global agricultural markets. Based on participant deliberations and discussions, a number of practically based policy recommendations towards achieving such comparisons were highlighted.

The production of this report, following completion of the workshop, has been the responsibility of the IPTS. This task has been facilitated through collaboration with four internationally recognised experts (Folkhard Isermeyer, Johann Heinrich von Thünen-Institute, Germany (Chapter 2), Dan L. Cunningham, University of Georgia, USA (Chapter 3), Jean-François Garnier, ARVALIS, France (Chapter 4), and Ashok K. Mishra, Louisiana State University, USA (Chapter 5)) acting as rapporteurs for each of the workshop's four technical sessions, whose efforts in capturing the principle issues and outcomes of their respective session has been instrumental towards realisation of this report. Stephen Langrell, Pavel Ciaian and Sergio Gomez y Paloma acted as Editors and compiled Chapters 1 and 6.

This report constitutes a particular and comprehensive technical overview of the state of production costs calculations for the sectors under consideration at global level, and a consideration of the prospects for effective international comparison. It reviews methodologies applied for production costs calculation at national and global level followed by the discussion on methodologies used for animal and arable crop sectors. Finally, the report discusses horizontal issues related to production costs calculations. The report closes with expert opined policy-relevant conclusions as a basis for policy suggestions and recommendations. It is envisaged that this report will provide a valuable source of technical and conceptual information for on-going policy considerations, both at EU and third country/international level.

John Bensted-Smith
Director - IPTS

Executive Summary

This report synthesises the findings from the workshop on "Sustainability and Production Costs in the Global Farming Sector: Comparative Analysis and Methodologies" organised jointly by the IPTS-JRC and DG AGRI in Brussels on 21-22 June 2011.

The main objectives of the report are:

- To give a snapshot on available data on production costs in agriculture around the world.
- To give an overview on methodologies and approaches for data collection and processing at national and global level.
- To explore the applicability of production cost data for an effective international comparative analysis.
- To provide recommendations for conducting an effective international comparative analysis of production costs.

The report is organised in six Chapters. Four technical chapters (chapters 2-5) were written by a panel of international experts charged with capturing the principle outputs of the respective sessions of the workshop and to consider, from their own perspective, such outputs in potential policy scenarios and possible recommendations. Chapter 2, by Prof. Dr. Folkhard Isermeyer, President of the Thünen-Institute and coordinator of agri benchmark, reviews methodologies applied for production costs calculation at national and global level followed by chapters 3 and 4, by Dr. Dan L. Cunningham, Professor of Poultry Science, University of Georgia, USA and Dr. Jean-François Garnier, Crop Economist, Arvalis Institut du Vegetal, France, respectively, who discuss methodologies used for the animal and arable crop sectors. Chapter 5, by Prof. Dr. Ashok Mishra, W. H. Alexander Professor of Agricultural Economics, Louisiana State University, addresses horizontal issues related to production costs calculations. Chapter 1, an introductory discussion on the problem of cost of production (CoP), and chapter 6, summarising expert opined policy-relevant conclusions as a basis for possible policy suggestions and recommendations, were written and compiled by Stephen Langrell, Pavel Caiain and Sergio Gomez y Paloma of the IPTS (who also acted as editors). It is stressed that the views and opinions expressed in this report are those of the authors and do not in any way represent a view or opinion of the European Commission.

Chapter 1 (Pavel Ciaian, Stephen Langrell and Sergio Gomez y Paloma, European Commission, DG-JRC, IPTS) provides a conceptual introduction to the problem of CoP. Firstly, it provides an introduction to the classification of production costs as used in economics and applied business sciences. Cost is defined as the value of a factor of production (input) employed in the production of final outputs. The classification of production costs can be made along several dimensions (i) whether costs are traceable to specific farm commodities (direct versus indirect costs); (ii) between cash costs and noncash costs; (iii) according to their variation with respect to the unit of production (variable and fixed costs); (iv) with respect to the unit of comparison (total costs, average costs and marginal costs); (v) in terms of inputs usage during the production process (expendable inputs, capital costs, capital services); and (vi) with respect to the link they have with respect to farm operations (operating costs, overhead costs).

Secondly, chapter 1 reviews main cost calculation approaches. The methodology that tracks, studies and analyses all costs accrued in the production process is referred to as product costing. The aim is to classify costs by their nature and then to allocate them to different commodities according to the destination when consumed or used (typically referred to as analytical accounting). Three key methods used for allocation of costs to commodities in analytical accounting can be distinguished: direct costing, indirect costing, and activity based costing. Direct costing considers only variable costs. This type of costs is traceable, they can be relatively easily identified with the commodity on which they were actually used. Indirect costing considers indirect costs and applies an allocation scheme to disaggregate the indirect costs to commodities. Activity based costing assigns costs to specific farm activities according their actual consumption with the aim to allocate cost items only to relevant commodities subject to charge. Most applied methodologies combine several approaches for calculation of commodity costs. Direct costing tends to be applied to account for traceable costs such as direct, cash, variable, or operating costs. Indirect or activity based costing is often used for allocation of other cost types. Although activity based costing is the most exact, it is almost never fully applied in practice but only for certain types of costs (e.g. certain fixed costs) mainly due to complexity of data needs.

Chapter 2 (Folkhard Isermeyer, President of the Thünen-Institute and coordinator of agri benchmark, Germany) summarizes the workshop presentations and discussions on the national farm data surveys as used in the EU, Ukraine, USA, Canada, Brazil, Argentina, Australia and New Zealand for CoP calculation. In addition the chapter covers two worldwide networks which are conducting international CoP comparisons. The chapter also draws some conclusions and highlights several recommendations on international CoP comparison.

European Union: For intra-EU-comparisons, the Farm Accountancy Data Network (FADN) offers a harmonized data base. The great advantage of this data base is that it contains data of a large number of farms (stratified sample) and is updated annually. The main limitation is that this data base does not report CoP broken down by commodities.

USA: The Agricultural Resource Management Survey (ARMS) provides CoP data that are statistically representative. The data collection procedure is specifically designed for the calculation of CoP although there are some open questions regarding the quality of the data (especially on labour costs). The long time-interval (update only every 4-8 years) and the non-existing possibility to interview the farmers in between are severely limiting the usability of the system to produce answers for the questions mentioned above. The Agricultural and Food Policy Centre (AFPC) at Texas A&M University is operating an alternative (so-called) representative farm concept which is successfully used for farm-level policy impact assessment for the US congress. This system is based on the concept of typical (virtual) farms which are put together by regional panels on the basis of bookkeeping data and expert judgement.

Canada: There is neither a unified data collection system nor a harmonized farm data set which could be used for standardized CoP calculations. Instead there are different sources of information available, some containing very detailed data. Most schemes are operated under the responsibility of the provinces.

Brazil: CONAB, a national agency for the dissemination of information, offers CoP data for many commodities, production systems and regions. The data are collected by focus groups for typical (virtual) farms. The experience has shown that this procedure leads to a higher-quality data (especially on labour costs) than could be collected by other data collection methods. The CONAB data base is not statistically representative. CONAB does not cover the whole agricultural sector. Some commodities are analyzed by other institutions, and they also apply the concept of typical farms based on focus groups (panel discussions).

Australia: The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) is operating a representative survey on CoP. The survey is not covering all commodities; about 75% of total agricultural production is included. The data collection system (face-to-face interviews) is specifically designed to calculate CoP. For some crops, the data base contains data going back 30 years which allows interesting time series analysis.

New Zealand: The traditional monitoring system with a relatively strong statistical basis is currently being replaced by a modern system which is based on the principles of voluntary participation, strong farmer and advisor involvement, timeliness, and high usability of the benchmarking data by farmers. Up-to-date data are collected annually by face-to-face interviews, and these interviews are also used to validate the data for the previous period. The data pool is not statistically representative. About 10% of all farmers are now taking part in the system.

Ukraine: Medium- and large-scale farms are reporting data on agricultural production and sales to the district-level bodies. This data source, however, is not suitable for a profound analysis of CoP. Detailed CoP data for a handful of typical farms are collected by the Ukrainian Agribusiness Club (UCAB); this is done within the framework of the global network agri benchmark. The UCAB has also launched a project called AgriEfficiency, a national extension of the agri benchmark project that aims at collecting data from Ukrainian farms with less effort.

The chapter also presents two global networks, agri benchmark and International Farm Comparison Network (IFCN), specialised in collection and analysis of CoP worldwide. Agri benchmark and IFCN are the only institutions who provide CoP on a worldwide basis. These approaches are based on networks of experts, advisors and farmer panels located in different parts of the world who collect and process data locally. The comparison of "typical farms" is the core concept of their approach. The methods for farm selection, data collection and CoP analysis follow a standard operating procedure for all farms and all countries. An important weakness of the agri benchmark and the IFCN is low representativeness of collected data and coverage of limited number of commodities.

Overall as indentified in this chapter, very different concepts for the collection of farm-based CoP data have been implemented. In view of these extreme methodological differences on the international level, this chapter proposes three alternative conceptual strategies that could be pursued to conduct meaningful international comparison of CoP:

(1) Take the different data bases as they are, build some interfaces, and compare the resulting CoP figures across nations and continents

(2) Convince the administrations of various countries around the world to agree upon the establishment of one harmonized concept (data collection, CoP calculation).

(3) Continue the development of global networks (e.g. IFCN, agri benchmark) which have developed internationally harmonized standards for CoP calculation and work on a stepwise evolution of their network concepts

After taking into consideration drawbacks and strengths, strategy three was identified in Chapter 2 as the most appropriate to be applied for international comparison of CoP. Main disadvantage of the first strategy is that there are fundamental methodological differences between the national schemes which make international comparison of CoP difficult to implement. The main disadvantage of the second strategy might be low interest of countries to implement a harmonised system due to the fact that the existing data collection systems would need to be redesigned as well as countries which currently do not have a farm level data collection system in place may be left out (in particularly less developed countries), or, alternatively, it would require a significant amount of additional financial resources to introduce the harmonised system in these countries. The main limitations of the third strategy is that the approach relies on non-representative datasets and panel processing of data compilation may be biased by subjective perception and expert judgments.

Chapter 3 (Dr. Dan L. Cunningham, Professor of Poultry Science, University of Georgia, USA) provides examples of production cost calculations and methodologies utilized in various countries for the dairy, beef, pork and poultry industries. The countries covered are Argentina, Brazil, New Zealand and the United States. The chapter included information on reporting agencies, methodologies, sampling procedures and cost and returns calculations.

Based on the reports for dairy, beef, pork and poultry from the participating countries it is apparent that the methodologies and agencies used to estimate production costs vary considerably from country to country. Agencies involved in collecting and analyzing cost and returns data across countries included governmental, private, academic, industry and farm owner groups.

Different commodities have different business models that make cost comparisons difficult. The methodologies used with regard to sampling vary considerably from country to country and represent a major obstacle in meaningful cost comparisons. Sampling size and reporting period also vary from country to country, as well as commodity to commodity. In addition, accuracy and validation of information collected is an issue for some reports.

The variability between methodologies and production systems makes commodity comparisons between countries difficult. The following is a summary of some of the major obstacles for meaningful comparisons:

- The need for representative sample size
- The need for accurate information
- The need for discipline and timing of data collection
- Defining the ‘typical’ farm
- Validation of data
- The need for consistent reporting cost categories

Although there are significant challenges to achieving meaningful international comparisons, it may be possible with a central coordinating/directing group providing responsibility for a global approach. The IFCN program for reporting on global production costs for dairy is an example of the feasibility of such a program. A central coordinating/directing group could standardize methodologies, sampling size, reporting requirements and command the discipline necessary to produce meaningful results. Participation by various countries would depend, however, on available resources and commitment to the project.

Chapter 4 (Jean-François Garnier, Crop Economist, ARVALIS, France) firstly presents main differences between different CoP methods applied for cereals and arable crops in the USA, Canada, Ukraine and agri benchmark. In order to have a wider analysis of the current context of production costs calculation, and especially their international comparisons, two French studies (France Arvalis-Unigrains observatory and the international Arvalis observatory) and the FADN approach were also included in the analysis. Secondly, the chapter provides discussion on the main challenges in conducting international comparison of CoP for cereals and arable crops.

There are two different methodological approaches applied to calculate and compare production costs: the methods based on large representative samples and those based on a "typical farm" approach. Methods based on large representative samples are relevant for conducting policy impact analysis and therefore may represent an important source of information in support for policy decision making. Nevertheless, these methods are less suitable, in particular, to analyse the competitiveness of crop production. In order to analyse factors of competitiveness and technological improvement, it is necessary to collect more technical data which is less suitable to be conducted within this method. The "typical farm" approach of the agri benchmark network, the international Arvalis Observatory or the win-tops methods are more appropriate to analyse such issues but the representativeness of the data remains a main concern.

On the other hand, the approaches using representative samples permit conducting time series and trend analysis. This is provided the sample and the methodology are kept constant over time. For the "typical farm" approach this may be problematic. Agri benchmark, or the Arvalis International observatory, adjusts the calculation method and the definition of the "typical farm" in regular intervals making the time series and trend analysis less accurate.

The methodologies applied for CoP calculation by national systems have different underplaying objectives, and thus the structure and method for collecting, processing and reporting CoP data differs accordingly. This makes international comparisons difficult to conduct. Some national data collection systems covered in this chapter (ARMS, win-tops, 50 sg report, and France Arvalis-Unigrains observatory) are interesting to study from a methodological point of view but are less relevant to be used for international comparison due to differences in sampling strategy, cost calculation methodology and the reporting of CoP results.

Agri benchmark and the Arvalis international observatory both employ a constant methodology, although different from each other, to calculate and compare the production costs in different countries. It allows easier international comparison as compared to national data collection systems. The FACEPA project, which explores the FADN data, allows CoP comparisons within the EU, however, there is no equivalent data available in other countries to conduct CoP comparisons with non-EU countries.

For international crop competitiveness comparison, connection between the two methods would certainly permit constructive interaction at a European level. For example, an estimation of the representativeness of the typical farm, based on FADN data, using criteria such as the farm structure, crop rotation, yields etc., could be useful for the typical farm approach. On the other hand, the methods based on the "typical farm" would probably bring more field data like technical crop schedule, average doses of input, etc., that may likely refine the analysis and interpretations of international comparison.

Beyond evaluation of the economic performance of farms there is increasing interest to analyse environmental and social aspect of agricultural production, in particular the social and environmental costs and benefits. To perform the evaluation of environmental and social sustainability, detailed technical data on issues such as technical processes, input intensities, soil and climate conditions, etc., are required to be collected. The approach based on the "typical farm" may be well-positioned to expand the valuation of farm performance in this respect.

Chapter 5 (Prof. Dr. Ashok K. Mishra, W. H. Alexander Professor of Agricultural Economics, Louisiana State University, USA) presents key horizontal challenges and methodological issues on calculation of CoP related to: (1) farm heterogeneity and exchange rates; (2) inputs and policy linkages; (3) climate adjusted productivity and economies of scale; (4) opportunity cost of family labour in the United States; (5) family farm diversity and opportunity cost of family labour in Brazil; and (6) production costs and farming systems.

While the workshop provided a good understanding of various aspects of costs of production, it is abundantly clear that international comparisons of CoP needs to have a good foundation, particularly with respect to the following: (1) a common definition of a farm; (2) common methodologies to calculate various aspects of CoP, income statement, and balance sheet. These items can then be used to calculate costs of production that is easily transportable and abundantly clear as to how to calculate costs across farm type, commodities, farming region, and country; (3) unit of data collection—farm-level, typical farm, regional data, aggregate data, regional data; (4) unit of analysis—such as per arable acres, per unit of output. Amongst all the workshop presentations a common thread was farm-level data being used for analysis which may imply that a common methodology could be developed to calculate CoP of agricultural commodities and compare them across countries. However, the main challenges in accomplishing these idea would be in terms of resource constraints, specifically, the willingness to conduct such data collation and resource allocation to do so - both budgetary and personnel.

There are several recommendations that can be gleaned from these presentations. First, farm-level data is the best option to compare costs of production across countries. Second, these costs should be adjusted frequently to adjust for government subsidies and other structural changes in agriculture. Secondly, any policy that affects use of inputs should also be noted and adjusted for in the final CoP. Third, CoP comparison should be adjusted for inflation and exchange rates when comparing costs across countries. Fourth, CoP should be calculated on a per unit basis, e.g. per kg beef, or per tonne of wheat, produced. This option of collecting data and taking a "*typical farm*" into consideration can prove to be useful in developing costs of production for agricultural commodities and comparing these costs across countries. It is an alternative that is cheaper and can be pursued in the future if counties and organization choose to do so. Finally, one has to be cognizant about several other factors when comparing costs of production across various countries. These include: (1) farm heterogeneity (size); (2) diversified farm enterprises; (3) climate-adjusted productivity; and, (4) data requirements to derive an opportunity cost of unpaid labour.

One of the most controversial issues facing economists to accurately measure CoP is valuation of unpaid farm labour. Though unpaid farm labour does not generally receive a wage, it does have an economic cost. The best method to obtain opportunity cost of unpaid labour is the implicit compensation for unpaid farm labour is based on the opportunity cost of off-farm work, or the return available in the next best alternative use of this labour time and effort. All adult unpaid farm labour (and salaried labour with ownership claims) should be valued at its opportunity cost, defined to be the maximum value for non-farm uses. However, this method would require survey data, and detailed data on demographics, local labour markets, and other socio-economic variables. Consequently, although this methods is economically sound, it would require additional resources in terms of time and money. In light of this, one can use alternative methods that may be cheaper, readily available, and consistent across countries. These include: (1) hired farm worker wage rate; (2) skilled worker wage rate; (3) replacement worker wage rate; and, (4) governments can set off-farm wage rates.

Chapter 6 (Stephen Langrell, Pavel Ciaian and Sergio Gomez y Paloma, European Commission, DG-JRC, IPTS) summarises the main findings of Chapters 1 to 5 and attempts to formulate recommendations for conducting an effective global comparison of CoP.

The different concepts and approaches currently deployed regionally are either based on the large representative samples (e.g. FADN, ARMS) or the typical farm approach (e.g. agri benchmark, IFCN, CONAB). The exiting data collection systems are developed to address multiple policy objectives and are not solely design to deliver only CoP data. The difference in objectives of national and global data collection systems, and differences in their use, largely determines the methodology employed in general, and sampling strategy, in particular. If the goal is to evaluate an average production cost per country, per region, or for each major farming systems, representativeness of the studied sample will be critical (e.g. Methods ARMS, 50-sg report, France Arvalis-Unigrains Observatory, FADN). However, if the goal is to evaluate the production costs of performing farms, or to characterise the economic impact of innovative practices (e.g. minimum tillage, low input system, organic farming etc.), then representativeness is still important, but is secondary compared to the needs of having detailed and specific economic and technical data on technology, farm practices, and timing of activities through the season, etc.

Conducting robust comparative analysis of production costs across agricultural commodities and across countries requires availability of data which apply similar data collection approaches and cost calculation methodologies. Few statistical sources satisfy these requirements. The agri benchmark and the IFCN, based on the typical farm approach, are the only data sources currently available for international comparison of production costs. They apply a common methodology for costs identification and calculation across all covered countries. They can be applied without further methodological adjustments to compare production costs among available commodities and regions. However, their main disadvantage is that they are based on small and non-representative samples, unable to capture adequately variation of farming systems and structural change within regions, cover only a restricted set of commodities. Further, the involvement of experts/advisors introduces certain subjectivity and personal perceptions in the data collection process.

Most countries conduct their own collection of data on production costs as part of national agricultural data gathering exercises. However, methodological approaches vary strongly in terms of collection approaches, type of data collected, dis-aggregation of cost items, data processing, and cost calculation methodology. Hence it is problematic to use them for inter-country comparison. The application of national sources for international comparison would require further data processing and/or harmonization of methodologies. This could be potentially achieved (following the analysis of Chapters 2 to 5) at three levels:

- **Minimalistic harmonization**: Exploits existing available databases and harmonises methodologies without altering the current system of data collection and type of data collected. This approach would lead to harmonization of certain aspects of methodologies such as structuring of cost categories and the harmonization of certain cost items not connected directly to data collection processes which are less demanding in terms of resource requirements (e.g. accounting for opportunity costs of own inputs, etc.). Main disadvantages of this approach would be the comparability of CoP data across countries will remain an issue of concern due to differences in underlining methodologies.

- **Partial harmonization**: This approach proposes to harmonise the type of data collected and cost calculation methodology, while keeping current systems of data collection (e.g. sampling strategy) applied at national level unchanged. In principle this approach would require extension or adjustment of the current national systems in terms of questionnaire design (e.g. harmonization of the type of cost data collected) and cost calculation methodology (e.g. harmonization of the method to account for opportunity cost). The actual level of comparability of CoP data would depend on what aspect of the cost calculation methodology would be actually harmonized.

- **Full harmonization**: Application of common methodology for data collection and calculation of cost values in all participating countries. In principle this would lead to a redesign of whole national systems starting from harmonization of primary data collection method (e.g. sampling strategy) to harmonization of costs calculation methodologies. Main constraints might be low interest of countries to join such schemes as the existing systems would need to be replaced by new harmonised system.

The successfulness of implementing harmonization of national methodologies requires cooperation among national authorities and the level of cooperation required increases with the degree of harmonization. One of the main limitations of the harmonization approach is that in many countries farm data collection systems may not be available, nor sufficient financial resources that would enable their participation in the scheme. Many important global players might be left out as a result unless an alternative solution is found. A key challenge for this type of global data collection system, where many stakeholders are involved, relates to practicalities of over-arching coordination problems and complex processing and validation of the final datasets or databases. Experience from national systems shows that such complexity may lead to delays in finalization and publication of CoP datasets or databases.

Chapter 1. Introduction to Production Costs

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1.1. Introduction

The structure and level of cost of production (CoP) have major implications for global food markets and food security. Production costs not only shape the development of farming systems but also affect their sustainability and determine overall food production potential. The availability of good quality data on CoP is a key requirement for conducting comparative analysis at national and global level. In view of this, this report aims to explore data availability and global and national methodologies for production cost calculation, with specific focus on commodity production costs. In particular, the report aims to summarise the methodologies and approaches for data collection and processing and their appropriateness for an effective international comparative analysis of agricultural production costs.

Consequently, the main objectives of the study are:

- To give a snapshot on available data on production costs in agriculture around the world.
- To give an overview on methodologies and approaches for data collection and processing at national and global level.
- To explore the applicability of production cost data for an effective international comparative analysis.
- To provide recommendations for conducting an effective international comparative analysis of production costs.

Before going into further detail of these topics, this chapter provides a conceptual introduction to the problem of CoP. Firstly, it provides an introduction to the classification of production costs as used in economics and applied business sciences. Secondly, the chapter discuses main approaches for cost calculation and allocation to farm activities.

1.2. Classification of costs

CoP is an economic indicator assessing the economic performance of production. Cost is defined as the value of a factor of production (input) employed in the production of final outputs. The classification of production costs can be made along several dimensions. Table 1.1 summarises six possible ways of categorising production costs (AAEA 2000; Cesaro *et al.,* 2008).

Firstly, general classification is based on whether costs are traceable to specific farm commodities (i.e. direct versus indirect costs). A direct cost is a cost that can easily and conveniently be traced to the particular farm commodity under consideration. For example, the use of fertilizer is a direct cost of a particular crop on which the input was used. An indirect cost is a cost that cannot be easily and conveniently traced to the particular farm commodity under consideration. For example, if a farm produces several crop commodities, the cost item such as machinery maintenance is an indirect cost of all crops for which the machinery was utilised. Here, the reason is that machinery maintenance costs are not caused by any specific crop but are common to all. Indirect costs are incurred to support multiple activities (e.g. multiple crop commodities) and cannot be traced to each individually.[1] Indirect costs are usually constant for a wide range of outputs and are grouped under fixed factors.

It is possible to classify almost any kind of cost as either direct or indirect. Labour costs, for example, can be indirect, as in the case of maintenance personnel and managerial labour; or can be direct, as in the case of hired labour for specialised work carried out on a particular commodity. Similarly, other costs such as machinery and equipment maintenance costs, such as for tractor depreciation, are typically classified as indirect costs, while machinery and equipment used for a specific commodity (e.g. corn sowing machine), are included in direct costs.

Considering monetary flows, a second distinction is made between cash costs and noncash costs. For cash costs, monetary payments and the consumption of input are realised in the same period (e.g. cash payments for fuel, fertilizer, seed, repairs, and similar items). For non-cash costs, either the payment is not realised (opportunity cost of own inputs) or there is a time lag between the time when payment was made and when the input was used (e.g. depreciation). Depreciation costs account for the declining value of farm assets such as machinery and buildings. Opportunity costs (also referred to as implicit cost and/or imputed cost) represent the cost of own inputs (e.g. own land, labour and capital). Because own inputs are used at farm level, they forgo income which could be earned if they were employed in non-farm activities. Thus opportunity cost represents the value of own inputs in the next best alternative use (e.g. the opportunity cost of family labour is off-farm wage; the opportunity costs of own land is market rental price). The consideration of opportunity costs is one of the key differences between the concepts of economic cost and accounting cost. The latter usually does not consider opportunity costs because the actual payment transactions are not realised. Economic costs consider all explicit and implicit costs incurred by farms including opportunity costs.

Other standard cost classifications used extensively in economic theory are used according to their variation with respect to the unit of production. Variable costs change with production level, whereas fixed costs are independent of production level. In other words, variable costs are affected by the farm's actions in the period under consideration, whereas fixed farm costs incur independently of the actions undertaken by the farm in the period under consideration. Note that some fixed costs may be quasi-fixed implying that they are flat within a certain range of production but change if the range is overshot (e.g. machinery).

With respect to the unit of comparison, costs can be classified as total costs, average costs or marginal costs. The total costs represent the value of all inputs (cash and non-cash) a farm uses in a given period and they are the sum of variable and fixed costs. Average costs are total costs split per unit of measurement such as per hectare or per unit of production (e.g. per tonne). Further, average costs can be distinguished by type of costs such as average fixed or average variable costs. The marginal cost is the change in total cost that arises due to the change in one additional unit of output or input.[2] The marginal cost with respect to output is total cost change when production changes by one unit. Equivalently, the marginal cost with respect to input is total costs change when input use changes by one unit (e.g. marginal cost of labour, marginal costs of land).

1 Other terminology often used is joint costs. Joint costs are costs incurred in a production process involving more than one product which production cannot be separated from each other (e.g. wool and sheep meet production are joint products hence all sheep costs are joint costs). Joint costs can occur either as direct costs or as indirect costs. Some inputs such as fertilizer or lime, which are normally viewed as direct costs and can be assigned to a particular commodity, may have an inter-temporal or residual carry-over effect that may impact the production of other commodities.

2 Expressed mathematically, the marginal cost is the first derivative of the total production costs.

Table 1.1: Typology of production costs

Classification description	Type of costs	Description	Examples
In relation to farm activity	-Direct cost -Indirect cost	Direct cost can be assigned directly to a farm activity (e.g. commodity). Indirect costs are spent per group of products or per farm as whole.	-Direct cost: fertilizers, seeds -Indirect cost: overheads, machinery maintenance, depreciation
In relation to cash flow	-Cash cost -Noncash cost	Costs based on whether monetary payment follow input flow in a given period.	-Cash cost: fertilizers, seeds, hired labour, rental costs -Noncash cost: depreciation, opportunity cost of own inputs
In relation to unit of production	-Variable cost -Fixed cost	Variable costs change with production level; fixed costs are independent of production level.	-Variable cost: seed, fuel, machine repairs, fertilizer -Fixed cost: depreciation on buildings and machinery
In relation to unit of comparison	-Total cost -Average cost -Marginal cost	The distinguishing criterion is unit of measurement with respect to which cost change, such as per farm, per hectare, per unit of production.	
In relation to usage	-Expendable -Capital -Capital services	Expendable are inputs consumed in a given period. Capital is a stock concept. Capital services are services obtained from the capital stock in a given period.	-Expendable: seed, fuel, feed -Capital: machinery, buildings, equipment, land, human capital -Capital services: services provided by equipment, labour, etc.
In relation to farm operations	-Operating costs -Overhead costs	To what extent they related to operation of farm processes.	-Operating: seed, fuel, feed -Overhead costs: the purchase of land, buildings, machinery

Other costs distinctions, or terms, reflect input usage during the production process. Expendable are inputs that are completely used up or consumed during a single production period. Capital is a stock that is not used up during a single production period but provides services over time. Capital services are the flow of productive services that can be obtained from a given capital stock during a production period.

Finally, cost can be distinguished in the link they have with respect to farm operations. Operating costs are related directly to the operation of farm activities. They can also refer to the costs of operating a specific farm activity (e.g. wheat production). Operating costs can be either variable or fixed costs.[3] In contrast overhead costs are costs incurred on the purchase of factors such as land, buildings, machinery and equipment to be used in the production process. Unlike operating costs, overhead costs are one-time expenses and ensure that a given farm production process is in an operational status. Overhead costs are fixed and are therefore independent of the level of production.

1.3. Cost calculation approaches

Farm operations conduct a variety of activities managing many cost categories ranging from explicit cash costs on variable inputs, investment expenditure on machinery and fixed assets to implicit own input allocation. The intensity of cost levels varies widely depending on region, utilised technology, farm specialisation, farm size, etc. Key challenges in calculating production costs accurately is to assign each farm cost item to a specific farm activity (commodity). The methodology that tracks, studies and analyses all the costs accrued in the production process is referred to as product costing. The measurement of CoP is done using

3 For example, AAEA (2000) recommended that all expendable costs to be classified as operating costs and all other costs to be grouped as overheads in the commodity cost calculation method applied in the US.

accounting methods which assigns each cost item to specific farm commodities. The aim is to classify costs by their nature and then to allocate them to different commodities according to the destination when consumed or used (typically referred to as analytical accounting). The nature of the accounting approach, as well as the type of costs, typically determine the accuracy of the obtained cost values (FACEPA, 2011).

Certain types of costs can be traced to specific farm commodities relatively easily (e.g. direct, cash, variable, operating costs), whereas this may not be the case for other cost types (e.g. non-cash, overheads, or fixed costs). Inputs that are directly linked to production of a specific commodity can be straightforwardly identified with that commodity. In this case the assignment of the costs does not pose a significant challenge in terms of its allocation to commodities on which it was actually used. However, some inputs particularly those which are incurred on multiple commodities cannot be directly assigned to commodities. In this case an appropriate approach (e.g. allocation scheme) must be developed for disaggregation of costs by commodity. The accuracy of the calculated cost value then depends on the precession of the chosen approach (AAEA, 2000; FACEPA, 2011).

Three key methods used for allocation of costs to commodities in analytical accounting can be distinguished: direct costing, indirect costing, and activity based costing (FACEPA, 2011).[4]

Direct costing considers only variable costs. Because this type of costs is traceable, they can be relatively easy identified with the commodity on which they were actually used.

Indirect costing considers indirect costs and applies an allocation scheme to disaggregate the indirect costs to commodities. Standard allocation schemes are based on production shares, gross margin share, direct cost shares, direct labour cost shares, direct labour hours shares, technical coefficients, engineering formulas, estimates from pilot surveys, etc. For example, the USDA uses operating margin shares (value of production less operating costs) to allocate overheads to commodities, whereas for machinery and equipment the USDA applies survey information on production practices, technical information on machine performance, and engineering formulas determined from machinery tests (USDA 2011).

Activity based costing assigns all costs to farm activities conducted to produce farm commodities. The objective is to identify each cost item with each farm commodity. This approach is more exact than the indirect costing because it avoids using allocation schemes. For example, the use of a scheme based on production shares for allocation of machine costs may fail to represent the true value of commodity costs if the production shares do not correspond to the actual distribution of machine needs between commodities. Activity based costing requires detailed accounting of all individual farm activities and their distribution between farm commodities (for example, hours of labour and machines used for different commodities). In principle, each farm activity must be identified with each specific commodity on which it was allocated.

Most applied methodologies combine several approaches for calculation of commodity costs. Direct costing tends to be applied to account for traceable costs such as direct, cash, variable, or operating costs. Indirect or activity based costing is often used for allocation of other cost types. Although the activity based costing is the most exact, it is almost never fully applied in practice only for certain types of costs (e.g. certain fixed costs). This is because this method requires a significant amount of human and financial resources for its implementation, relying on the collection of a large size of information which is often difficult to obtain in reality given the fact that some cost categories may not be possible to distinguish by activity/commodity due to their joint nature (e.g. joint costs).

4 There are also other approaches available such us standard costing, historical costing, etc. For more details see FACEPA (2011).

Chapter 2. Methodologies and Comparisons of Production Costs – a Global Overview

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2.1. Introduction

In many conferences around the world, policymakers are currently asking similar questions with regard to the status and prospects of the global farming sector:

- Is the increase in agricultural commodity prices just a "flash in the pan"? Or are we witnessing a fundamental change towards a new world food crisis?

- How quickly, how strongly and how sustainably will different farm types in different world regions respond to high commodity prices?

- How will the expected growth of bioenergy production influence the division of labour in the global farming sector?

- How will those agricultural sectors which have been highly protected in the past, find their way into a liberalized agricultural world?

- How can regional production systems be improved (better environmental impact, more animal welfare) and still remain competitive in a globalized economy?

Such questions are not only raised by policymakers. Entrepreneurs around the world are having the same concerns and are looking for reliable information and assessments. Without such information, they are at risk to invest in agricultural enterprises that will no longer be appropriate for their location in the agricultural world of tomorrow.

The only way to provide reliable, scientifically sound answers to such questions is to calculate CoP, broken down by regions, by commodities, by farm types, and by production systems.

In many developed countries, there is lot of information on CoP available – however, only in individual farms or in farm advisory groups. In most cases this information cannot readily be used for analysis on a global scale, for a number of reasons: First, it is private and confidential information. Second, the data have been collected in different ways using different methods; comparing figures on cost of production from different sources without methodological harmonization often means comparing apples and pears.

Third, from the user´s perspective it may not be sufficient to just have "one figure per farm" on cost of production. Instead, a set of figures may be required that allow us to really understand the agricultural production process, production cost, sustainability and international competitiveness in different world regions. To achieve this goal, it is perhaps necessary to provide much more than just one figure on cost of production per farm.

Against this background, the question arises whether it might be possible to draw on government-driven farm accountancy networks that are available in some countries. In these networks, individual farm data are collected and analyzed by using harmonized methods. Hence, it might possible to introduce a few interfaces in order to internationally harmonize the national data bases. At the end of such a development, one might arrive at a globally harmonized farm data base for the analysis of cost of production.

During the workshop in Brussels, speakers from the EU, Ukraine, USA, Canada, Brazil, Argentina, Australia and New Zealand reported about their national farm data surveys that might serve as a source for an internationally harmonized global farm comparison. In an additional paper, two worldwide initiatives of research institutions have been presented which are already conducting international CoP comparisons for more than 10 years.

The report in hand has the main task to summarize the presentations and the discussions. This will be done in the following sections 1.2 and 1.3. The author has also been asked by the European Commissions to draw some conclusions. These will be presented in section 1.4.

2.2. Data Collection and Methodologies in National Surveys

This section summarizes seven reports about nation-wide farm surveys (1 from the EU, and 6 from non-EU-countries). It should be noted right at the outset that these countries represent only one segment (rather the "developed" segment) of the global farm sector.

The other segment of global agriculture which is not reported here is mainly characterized by developing countries where there is no nation-wide farm data base available that could be used for a global comparison of cost of production.

2.2.1. European Union

The Farm Accountancy Data Network (FADN) is an EU-wide system information system. It has two objectives, (a) to determine farm income and (b) to analyse business development in agricultural holdings (Vard 2011).

The system was established in 1965 and has since grown considerably. Currently data from about 81,000 commercial farms, covering over 90% of EU production, are collected annually. The FADN is a representative sample, with regard to region, farm type and farm size. The internationally harmonized farm accounts are delivered by the member states.

A wide range of data is collected: data on location of the holding (municipality, less favoured area, altitude, ...), ownership and organizational form, information on crops and livestock (areas, heads, production, sales, purchases, stocks), labour force, public support, financial situation (assets, liabilities).

Information on commodity-specific CoP cannot be taken directly from the data files because such information is not delivered by the farms or by the member states. Instead, it is necessary to estimate commodity-specific CoP. For this exercise, the FADN data set offers farm individual data on monetary inputs (e.g. expenses for fertilizer, feed, or contractor per farm) and farm individual data on production (e.g. tons of wheat, barley or sugar beet per farm). However, FADN does not offer enterprise-specific data (e.g. expenses of fertilizer per hectare of wheat).

The workshop discussions pointed to a number of restrictions with regard to the usability of the FADN data set for CoP comparisons.

As most farms are multi-product farms, the above mentioned data deficits represent an obstacle for a commodity-specific calculation of CoP. The allocation of expenses to certain enterprises must be done on the basis of additional information or on the basis of assumptions. Most of the cost components which are available in the FADN data set are not broken down into detailed cost components. For example, only data on fertilizer costs are available, but no breakdown into nitrogen, phosphorous etc., and no breakdown into input quantity and input price. This is an additional limitation for direct analytical work and its interpretation.

To be sure, there is no CoP scheme that can completely solve this problem. Phone costs, for example, are not allocated by the farmers to certain enterprises, and therefore the scientists are forced to allocate this cost component to certain enterprises by using assumptions (e.g. allocation by output share of the different enterprises). However, modern farms do keep enterprise-specific records of important cost components such as fertilizer or chemicals, and the large-scale farms go even further and monitor enterprise-specific data for labour and machinery costs. This enterprise-specific information is very important for a realistic assessment of production cost, and the ability of FADN to calculate meaningful CoP results is severely limited by the fact that only whole-farm data are collected. This is an important disadvantage compared to most of the other CoP data collection schemes discussed in this report.

There are a number of further methodological issues that complicate the calculation of meaningful farm-individual CoP data from the FADN data file for international comparsions. Just two examples for illustration: (a) The enormous variability of products poses a problem of finding a comparable denominator (e.g.: calves with 140, 150, 160, ... kg?). (b) In the absence of additional information about the workforce (e.g. hours of a child, an entrepreneur, a retired farmer, etc.), it is difficult to calculate true labour costs for certain enterprises.

However, these issues affect the usability of FADN data for CoP calculations for some commodities more than others. For example, the FADN data set is relatively well-suited to calculate cost of milk production in specialized dairy farms. These farms are characterized by a rather uniform product, and joint production only plays a minor role. In this case, the FADN-based CoP method can be advantageous because many farms are included and farm-to-farm differences can be analyzed. For commodities such as brewers grain, rapeseed or certain varieties of beef, however, it will hardly be possible to arrive at reliable, farm-individual CoP results.

These issues may explain, to a certain degree, why the European Commission does not calculate farm-individual CoP data (in terms of €/t of product). Instead, the "CoP estimate method" applied aims at the calculation of margins (Vard 2011). This method has the following features:

- Calculation of margins and cost aggregates. Different margins are calculated. (1) gross margin = revenue minus operating costs, (2) net margin = revenue minus operating costs minus depreciation, (3) net economic margin = revenue minus operating costs minus depreciation minus external factors minus own factors (estimated family wages, rent and interest).

- Selection of specialized farms, and allocation of the cost components (for the whole farm) to different commodities by using various keys (e.g. share of the commodity´s output in total farm output).

- Calculation of opportunity costs for farm-owned factors, using regional land rents, wage rates of regional agricultural workers, and interest rate of ten year national treasury/ LT bonds.

- The gross margins are being updated annually to the year n-1.

- When needed, this procedure can be applied for different "types of farms" (e.g. in beef production: breeders, breeder-fatteners, fatteners).

There are annual publications of margins and incomes for some commodities, and there are ad-hoc studies on various issues (e.g. international comparisons of CoP). Research work is going on in order to develop and improve the CoP calculation method.

During the workshop, no results on margins were presented. The publications that are available in the internet, however, demonstrate an impressive amount of empirical results on margins that have been computed on the basis of FADN data. These include box-plots, distribution curves etc. indicating that indeed farm-individual calculations are conducted (e.g. European Commission 2009).

However, a strategic move from CoP towards margins does not really solve the issue. The computation of "net economic margins" for a certain, individual FADN farm needs the same data as the computation of "cost of production" in that farm, and if the original data has not been collected it remains difficult to improve the diagnostic power of the analysis by just changing the method of computation.

This issue is particularly important for the measurement of family farm labour costs. Farm-to-farm differences in labour productivity are considered a major driver for structural change in regional, national and global agriculture.

The potential use of the FADN data for CoP calculations could be substantially enhanced if the range of collected data (including enterprise-specific data) could be widened. However, many family farms do not have such data in their files. Therefore to achieve such an objective it may be necessary to financially compensate sample farms for the extra data collection effort.

2.2.2. USA

The United States Department of Agriculture (USDA) regularly conducts an Agricultural Resource Management Survey (ARMS) (Lazarus 2011, USDA 2011). The questionnaires are developed by the National Agricultural Statistics Service (NASS) and the Economic Research service of the USDA (ERS).

ARMS is the USDA´s primary source of information about the current status and trends in the financial condition, production practices, and resources use of farmers, as well as their households´ economic wellbeing.

ARMS began in 1996 as a synthesis of former surveys on cropping practices, chemical use, and farm cost and returns, which dated back to the mid-70ies.

Data collection is done by field enumerators who are personally interviewing the farmers. ARMS is a series of interviews conducted throughout the "survey year" which runs from June to April.

- Phase I (Screening). The selected farms are screened to verify their operating status and to determine whether they produce commodities targeted for data collection. This helps to improve survey efficiency in phases II and III.

- In Phase II, randomly selected operating farms from phase I are interviewed to obtain information on their production practices and chemical use. Data are collected at the individual field or production unit level. Physical and economic input data are collected, so that a detailed analysis of CoP is possible.

- Phase III data are collected on the whole farm level. Data are collected from a nationally representative sample of farmers in order to analyze the farm-level economic situation in the reference year. Reported data for phase II are included, so that data from both surveys can be merged.

The producer surveys which are designed to calculate enterprise-specific CoP are not done every year, but only every 4 to 8 years, and they do neither cover all crops nor all livestock branches. Regional coverage also varies between interview years, i.e. in some years more states are included than in other years. In those years where no interviews are possible, adjustments with regard to inflation etc. are made (without farm interview).

Sample sizes are in the magnitude of a couple of thousands, e.g. 2.800 wheat farms and 1.500 dairy farms. Obviously, the system is somewhat limited due to financial restrictions. In a 2002 internet note, NASS and ERS stated that – for reasons of statistical accuracy – they planned to increase the number of interviewed farms up to its historical level of 18.000 to 19.000 farms annually (USDA 2002). The annual cost of the ARMS is currently estimated at 5 to 6 Mio. US-Dollars. Most of this money is used for paying the local interviewers. Their role in the system is crucial.

Three types of reports are being published: (a) farm structure and finance, (b) crop production practices, (c) commodity production costs and returns. These regular publications are spreadsheet tables for 9 regions covering the whole US. In addition, more detailed reports on special issues are being produced (e.g. impact of farm size on CoP), sometimes on the basis of time series data.

The spreadsheet tables on CoP of certain crops display "$/acre"-figures for different regions of the USA, broken down into the following compartments:

- gross value (breakdown: primary and secondary production)
- operating costs (breakdown: seed, fertilizer, chemicals, custom services, energy, repairs, irrigation, interest on operating capital)
- allocated overhead (breakdown: hired labour, opportunity costs of unpaid labour, capital recovery of machinery and equipment, opportunity cost of land, taxes and insurance, general farm overhead)

Moreover, they provide a few additional figures on price, yield, enterprise size, percent irrigated land, percent dryland.

The method of CoP calculation has been developed in 1995 by a task force of the American Association of Agricultural Economics (AAEA).

Like in other countries, there are many methodological issues that need to be solved (e.g. allocation of fix costs, opportunity costs of labour, opportunity costs of land, joint production), and since it is not possible to find completely satisfactory solutions, the usefulness of the mere CoP results remains limited.

With regard to labour, there are serious doubts whether the reported differences in wage rates between grain farms and hog operations are reflecting the true situation. Such a question can become very important when the competitiveness of grain vs. hog operations shall be assessed.

With regard to land, opportunity costs are measured by taking the regional land rent. This is not satisfactory because it creates a wrong impression about the competitiveness of farming in a certain region.

Lazarus (2011) and a number of other workshop speakers stated that the "circularity" of agricultural prices and land costs is a serious issue. Time series data clearly indicate that land prices are following corn prices; the ratio between the two is almost constant. If high agricultural prices lead to high (computed) costs the question arises: What message can be derived from the high (computed) costs? Definitely not, the message that farming has become less profitable and therefore agricultural policy has to give more support to farmers.

Besides ARMS, there are also other sources for CoP calculations in the USA. For example, CoP data on cash crops are collected by institutions in Minnesota, Kansas, Illinois, Iowa, and crop enterprise budget projections are available for many states. Obviously, the ARMS system is not able to serve all purposes (Lazarus 2011).

The ARMS system is mainly used for policy purposes because it has the advantage of being statistically representative. A weak point, however, is that in ARMS "real farm data" are only collected every 4 to 8 years so that farmers do not get the kind of information that they would need for farm management decisions. Furthermore, in the ARMS system there is often a considerable time-lag (more than 5 years) until the data is analyzed and publicly available.

Hence, the farming sector prefers other sources of information although these other sources are not statistically representative. Extension services use non-representative regional data because they are of better quality and more up-to-date. An increasing number of farms is involved in consultancy-based benchmarking activities. This could theoretically be a source for "government-administered" CoP statistics, too. Yet practically the source is not captured, and it is doubtful whether the private organizations would make their data available for public use. More likely (and sometimes already practiced) is a cooperation between private consultants and regional extension services.

It is also remarkable that for policy advice an alternative farm-based data base has been developed in the US. Only a few years after the USDA had started the predecessor of ARMS (farm cost and returns survey), in the early 80ies the Agricultural Food and Policy Research Centre (AFPC) at Texas A&M University started an alternative (so-called) representative farm concept (Richardson et al., 2011). This system has been successfully developed until today. It is based on the concept of typical (virtual) farms. These are built, validated and discussed in regional panels of farmers, advisors and AFPC scientists.

The AFPC data set is used as a prime source of information for the US congress. Proposals for agricultural policy reforms are jointly analyzed by Texas A&M and FAPRI, and for the farm-level part of these assessments AFPC uses the FLIPSIM model (farm level income and simulation model) on the basis of the typical farm data (Richardson et al., 2011). Currently, 97 representative crop, livestock and dairy operations in major production areas in 27 states are in the systems. The typical farms are regularly updated to be able to meet future policy demands. Hence, a detailed data base is available which can be used both for calculating CoP and for modelling various policy options.

In the late 90ies, the AFPC was one of the founding members of the IFCN, and the national US-concept was used as a blueprint when the agri benchmark / IFCN concept was designed for the international level (see section 3).

2.2.3. Brazil

CONAB, the national agency for supply, is a public company that produces and disseminates information, especially information about the farming sector. CONAB acts nationwide and has an office in every state in Brazil. CONAB assists the national government in formulation and execution of policies.

CONAB is compiling a lot of information on agricultural CoP in Brazil (Teixeira 2011). The service covers temporary cultures as well as semi-perennial and permanent crops, products related to poultry, pork, goats, sheep, dairy farming, and also extraction, biodiversity, and fish (sardines). In total, 428 budgets with agricultural CoP figures are available (published the internet). For many commodities, different "technological packages" (with different technical coefficients) are calculated.

The wider purpose of this exercise is to identify differences in competitiveness (a) between regions and (b) between technologies. The comparative analysis can provide useful information for services, investors, policymakers both on the regional, national and international level. The results are produced for a wide range of users (policy, business, universities, …), including international institutions (FAO, USDA). In Brazil, the main purpose is to support government decision making. It is felt necessary to have an agency that provides uniform, reliable and consistent information.

The data collection procedure is similar to the procedure developed by the agri benchmark network:

- Identification of the regional centres of production
- Organize panel meetings in these regions (15 participants)
- Survey the technical coefficients of the selected enterprises

In the panel meetings, (a) regional experts (e.g. advisors, researchers), (b) producers and (c) the CONAB analysts are taking part (Teixeira 2011). The technical and economic coefficients are collected on the basis of regional figures and expert judgement, and the panel has to agree to one coherent set of coefficients ("If everybody agrees, the cost is published").

An important feature of this system is the selection and modelling of a "modal farm". It is important not to have a statistical average of different farms in a region because the average of different farms does not form an economic unit that makes sense and could be found in reality. Therefore a decision is necessary to opt for one "technological package" which is best suited to represent the farming system in the region, and then this technology is captured and modelled (instead of unrealistic statistical averages).

Another advantage of this system is that both physical data (e.g. amount of fertilizer) and price data (e.g. fertilizer price) is collected. Compared to other systems which mainly rely on whole farm data from the profit and loss account (e.g. fertilizer purchases per farm), this gives a much more detailed picture of the production system and CoP.

The same is true with regard to machinery costs. The detailed analysis does not only include purchase value and expected life time (as many other approaches do), but also residual value and life cycle (in hours).

Standardized routines are used to transform the collected data (on input and output items) into total CoP and cost components. A closer look at the figures presented at the workshop shows that the data allow a much more detailed analysis of CoP than, for example, would be possible in the ARMS and/or FADN system. The reason is that the basic conceptual idea of the CONAB system is inspired by a commodity-oriented "engineering approach" which would be pursued by an investor and his/her operating manager.

The comparison of CONAB and FADN reveals the advantages and disadvantages of two different concepts. CONAB allows an in-depth analysis of various aspects of a typical farm, and this leads to a much better "understanding" of production systems and possible farm adjustments. However, it would not be possible to establish so many typical farms (with panels etc.) that this approach could come anywhere near "statistical representativity". In contrast, the basic conceptual idea of the FADN system is a farm-oriented "income monitoring system" which has to place much more emphasis on mass statistics, representativity, and the profit and loss account of the whole farm.

The technology package for each budget is updated every 3 years, while prices are updated monthly. Therefore CONAB can always offer up-to-date CoP figures. This has been demonstrated using a chart on soybean 2011/12 (Teixeira 2011).

The government uses the data for the minimum price policy of Brazil. For this purpose, only the results on variable cost are needed. But CONAB goes further, covering all steps on the way to total CoP.

The breakdown of CoP into cost components is done in a similar way as in other countries. Only the component is "external transport costs" is a rather unique one. This cost component, however, does not capture the cost of long-distance transports (which would be very informative with regard to international competitiveness of Brazilian agriculture) but only the transport to the first storage centre, with a maximum distance of about 80 km.

The main challenges, as identified by the CONAB administrators, are (a) how to include environmental cost and (b) how to integrate cost of crop, livestock and forest. Another challenge might be seen in expansion of the system to more farm types, regions, and commodities. Until today, the budgets cover many, but not all agricultural commodities. For example, beef is not yet included because the government did not seem to be interested, and sugar cane is not available, because this crop is covered by another institution.

Other institutions in Brazil are also collecting and analyzing CoP data but they cover less commodities than CONAB does. The parallel development started in 2003 when agri benchmark beef came to Brazil and invited institutions to participate in the world-wide network. At that time, there were no Brazilian on-farm data on beef production available. Therefore, a cooperation between agri benchmark, CNA (National Farmers Association of Brazil) and CEPEA (Centre of Advanced Studies in Applied Economics at the University of Sao Paulo) was established (de Carvalho and de Zen 2011).

From the very beginning, the Brazilian agri benchmark partners adopted the international concept (typical farms; panel-based data analysis) for the intra-Brazilian network. The Brazilian beef network currently comprises 61 finishing farms and 56 cow-calf farms in 13 states of the country. A couple of these farms are used for the global comparison of the agri benchmark network (see section 3). Besides the annual CoP-related data collection, information on prices is collected on a monthly basis (telephone interviews). CEPEA is collecting and analyzing not only CoP for beef but also for dairy and for various cash crops.

A third player that should be considered is Brazilian Agricultural Research Corporation (EMBRAPA) which is also interested in building up more knowledge in the field competitiveness of certain production systems and commodities. In the field of pig and poultry production, Embrapa has done some CoP analysis in Santa Catarina (south of Brazil) for many years; swine production cost started in the 1980s, poultry production cost in the 90ies (Miele 2011 a, b). In 2005, this EMBRAPA CoP approach was spread to 11 states throughout Brazil, using the CONAB infrastructure. Recently, Embrapa started a cooperation with slaughterhouses in order to include contract production systems in the analysis. Within the Brazilian swine network, different typical production systems in various regions are being analyzed. Labour costs are of special importance. At first, EMBRAPA tried to collect relevant data on labour costs from real farms. This approach failed because too many farms delivered low-quality data that did not lead to meaningful results. Therefore, they finally decided to follow the typical farm approach where data for a typical farm of the region are generated by a panel of farmers and researchers. This approach has led to better results.

Given the fact that so many important Brazilian institutions are now involved in CoP analysis, it would not be surprising to see a stronger cooperation and new organisational concepts developing in the foreseeable future.

2.2.4. Canada

There are four primary reasons that governments and agencies in Canada are collecting, analyzing and publishing CoP data (Koroluk 2011):

- Providing a date base for farm management extension, planning, and research ("the traditional role"):
  (a) farm budgeting, crop planning and new enterprise establishment
  (b) environmental beneficial management practices
  (c) biofuels production

- Helping to understand market development, regional profitability, and international competitiveness:

(a) assessing competitiveness, risks and opportunities in the primary agricultural sector
(b) improving policy decisions by government and producer groups
(c) identifying and promoting potential new winners

- Establishing "official" prices for commodities under the system of supply management
  (a) relevant for dairy, broiler chickens, turkeys, eggs, and hatching eggs

- Meeting program administration requirements at both federal and provincial levels
  (a) used in calculating program payments
  (b) assists in new program design

Most of the CoP information is collected by various agencies in the provinces for their specific purposes. This implies that data come from several sources and in several different formats. Some of the few national data collections are conducted by the supply managed industries (dairy, poultry) in the framework of national legislation.

Overall, there is a fairly good coverage of the main production regions. According to Agriculture and Food Canada, the division of responsibilities makes sense under Canadian conditions, because of the diversity in geography and consequent differences in agronomic condition, production practices, crops, markets, and trading patterns. Furthermore, programs are increasingly being delivered by provinces, so even administrative sources are increasingly province based.

There is no common, standardized method applied for data collection. Instead, different data suppliers use different approaches. Most common data collecting methods are (Koroluk 2011):

- Producer and retailer surveys (annual or periodic)

- Consensus budgets using producer focus groups, workshops and panels

- Budgets prepared by farm management and commodity specialists

- Marketing board surveys of producer members

- Information collected as part of analytical studies or special projects

- Budgets modified from other jurisdictions

- Program administrations

- Other data providers (e.g. university extension, accounting firms, farmers clubs)

With regard to data processing and CoP calculation, different sources make different assumptions and apply different methods.

Budgets are often integrated in production planning tools and therefore delivered per unit (ha, head, kg). Most of these budgets contain average figures, i.e. they do not take account of farm-to-farm differences. In view of the big farm-to farm differences, especially with regard to livestock, it would hardly be possible to obtain CoP data that give a realistic and representative survey of the full range of real farm situations.

Altogether, around 1.524 budgets are available, originating from the various sources.

Main challenges of the current system are:

- Primary data collection is costly, and the high cost is a deterrent to broad-based initiatives. Hence, there is very little scope for financing additional surveys.

- Differences in collection methods, variable definitions and reporting formats make CoP information difficult to compare between provinces.

- Timeliness of information and frequencies of updates is crucial for producing data that are regarded as relevant by the addressees.

- As farms become more complex, integrated and large-scale, CoP information may become less relevant (commodity-specific CoP tend to neglect aspects of joint production).

- Especially in large commercial farms willingness to participate is decreasing over time. They question whether this kind of information may be useful for them.

- The systems in place do not deliver enough information on new crops and technologies, beneficial management practices, and environmental practices to encourage adoption.

- Budget averages do not reflect the variability in CoP from farm to farm.

According to Koroluk (2011), the Canadian Farm Business Management Council (CFBMC) has tried to harmonize data (across provinces) and present the budgets on the internet, in a very comprehensive manner (e.g. including budgets for farm vacation enterprise and on-farm food processing). However, the harmonization and standardization issue (e.g. comparability across commodities) remains partly unsolved.

Regarding the financial and the income status of farms, Canada has established other information systems. Yet these systems are not able to deliver meaningful CoP information (Koroluk 2011).

2.2.5. Australia

Australian agriculture is highly exported-oriented, with about 58% of total agricultural produce being exported to other countries (Foster 2011). Hence, international competitiveness is an important issue. It is not easy, however, to conduct meaningful CoP analysis. Except from sugar cane production, Australia´s agricultural sector is characterized by mixed farms. The nature of farming varies a lot within Australia because the country extends over different climate zones, including tropical, temperate, and dry-grassland.

For the broadacre sector (cropping, mixed crop-livestock, beef, sheep) and the dairy sector (75% of all farms), the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) is doing farm surveys for 33 years.

The system is not covering all sub-sectors of the agricultural sector. Pig, poultry and fruits are missing, and sugar has only been covered once in a special study. Vegetable production is included only since 2005.

Data collection is done by interviewers who visit the farms (face to face data collection). The farms are randomly selected from the Australian business register (using business size, enterprise type, and geographic location), and the stratified sample is followed over many years. This approach has lead to a valuable data source for time series analysis. The location of the farms is geo-coded, allowing interesting additional studies.

The data are used to monitor farm cash costs, broken down into cost components (seed, fertilizer, etc.). Furthermore, whole farm data from the profit and loss account are used to calculate (a) farm business profit and (b) rate of return to capital, both excluding and including capital appreciation.

Three critical issues have been identified (Foster 2011):

- How to calculate meaningful CoP in mixed farming systems

- How to measure full cost of production (e.g. evaluation of family farm labour)

- How to use the data for international CoP comparisons

Inter-industry comparisons are possible. This is an advantage of a broad system covering many sub-sectors of agriculture and applying harmonized methods, at least within a country.

Some interesting results have been presented in the workshop:

- The one-year analysis for different vegetables (potatoes, carrots, onions, etc.) shows that one CoP figure per country and crop is not informative, unless it can be compared to product prices, to other regions, or to other years.

- The CoP data for sugar cane, displayed for a number of regions over three years, give a good example for a better CoP analysis: It shows, for example, that CoP have considerably increased between 2005 and 2007, especially in Queensland, and that New South Wales continues to be the least-cost producer in Australia.

- CoP breakdowns by farm size groups (sugar cane) and cropping intensity (sugra cane, grain) indicates that CoP per ton of product decreases with increasing farm size and that rate of return increases with increasing cropping intensity.

A long-term time series analysis of the data has lead to the result that total factor productivity (TFP) in Australia´s broadacre sector has slowed down considerably since the mid-90s (1953-1994: 2,2% p.a., 1994-2008: 0,4% p.a.). This is mainly caused by a strong TFP decrease in crop production while the TFP trend in beef and sheep production is still positive (Foster 2011).

The slowdown of agricultural TFP growth is caused by an number of reasons, the most important being: Drought, lack of new ` big gain´ -technologies, ageing farm population, fewer expansion opportunities, changing research priorities, and falling public investment in research and development.

2.2.6. New Zealand

The Ministry of Agriculture and Forestry (MAF) in New Zealand is running a farm monitoring system. In this system, farm consultants in the regions are monitoring farms, together with farm groups, and forecasting the situation of next year. This is done for all important farm types: dairy, beef, sheep, deer, cropping and horticulture. When the farm consultants come again in the following year, they monitor the past year; and by doing so, they validate the system and improve their ability to assess the situation of the farms (Shadbolt 2011).

This system is relatively new. It is an alternative to an older system called "Economic Survey of sheep and beef", which is also still being applied. The old system has a stronger statistical basis, but tends to be always outdated. The farmers complained about this system because the results were not useful for them. In general, the former systems have failed to give farmers exactly those results that they need for their daily business (with bankers, consultants, etc.).

For the development of the new system, (a) timeliness, (b) cost and (c) focus have been identified as crucial success factors. Especially timeliness is very important. The results must be available as soon as the business year ends.

For the dairy industry, the development process started in 2003 with a small group trying to achieve all three purposes. At the beginning, the system and the data situation was very fragmented. In 2006, with the introduction of DairyBase Ltd, a web-based data base was built. This meant a huge effort in harmonization of previous systems. All the big companies and institutions of the New Zealand dairy sector have been involved (Fonterra, Dexcel, Massey University), and the system is now generally accepted.

Important characteristics of the new system are (a) voluntary participation of farmers and (b) a high degree of farmer involvement. Therefore, it is not possible to make this system statistically representative in the sense that a stratified sample of all New Zealand dairy farmers is included. However, more and more farmers decided to take part, so that now about 10% of all farmers are in the system and the results give a fairly good impression of the sector´s economic development (Shadbolt 2011).

The high degree of farmer involvement is believed to be a decisive factor for top-quality farm data. In the New Zealand system, the farmers receive an intensive feedback, and in the framework of the benchmarking system they can experience each year that only true data lead to meaningful results. They learn to work with the results so that a win-win situation is created: an advantage for each individual farmer who is a analyzing his results, and an advantage for the whole sector if the data set is used to better understand the pros and cons of different management practices.

In the new system, the data belong to the farmer. That means that they have total control and can, for example, decide whether their data may be taken for a scientific study. Only aggregates go to the report that the industry receives. The farmers get their data back, and in addition they also receive a benchmark. The benchmark covers physical and financial data but no data on liquidity ("some figures are not `benchmarkable´").

Much effort is invested to train the people who are collecting the data. It is important that they understand the purpose of the overall exercise and follow standardized data collection procedures.

The combined analysis of both detailed CoP data for the dairy enterprise and whole-farm data with regard to farm asset valuation can be a challenge. However, it is necessary to cover both aspects in order to fully understand the nature of modern dairy economics. On an average, a New Zealand dairy farm currently makes a profit of 15%. Of this, about 11% is gain in farm value and only 4% comes from annual dairy production. Traditional CoP analysis is not able to reflect this situation properly. Hence, more attention should be given to the question how wealth creation can be better included into a holistic analysis. (Shadbolt 2011)

2.2.7. Ukraine

In the Ukraine, the so-called 50-sg report (State national wide survey) is a survey of all agricultural enterprises that exceed certain size limits: 200 ha; 50 cows, pigs, sheep (500 poultry); 20 workers, 150.000 UAH revenue. In total, information on about 9.000 farms is collected. The data collection is done through the 50-sg district-level bodies, using a standardized data format. Data on agricultural production and sales are collected, but the data cannot be used for a profound analysis of CoP (Slaston 2011).

A data base for the analysis of CoP is created within two projects that are both operated by the Ukrainian Agribusiness Club (UCAB):

- the AgriEfficiency project
- the agri benchmark project (embedded in the worldwide agri benchmark consortium)

The agri benchmark project is based on the concept of "typical" farms, following the standard operating procedure of the international network led by the Thünen Institute in Germany (see section 3). Only few farms from the Ukraine need to be included, but the amount of data per farm (required by the global agri benchmark consortium) is relatively high. Data collection for agri benchmark is done by face-to-face and additional phone interviews.

Because of the high effort that is necessary to meet the data collection requirements of the agri benchmark project, the UCAB has developed a less ambitious intra-national farm comparison project called AgriEfficiency. Here the data collection is done with the help of an email or fax questionnaire.

AgriEfficiency is currently collecting data on hog production but no data on beef production, and in agri benchmark it is vice versa. Data on poultry production are currently neither collected by AgriEfficiency nor by agri benchmark.

Given the special situation of Ukrainian agriculture (history, transformation, economic crisis), it is still very difficult to obtain meaningful figures from the farms. There are several comparability issues, caused by different agro-ecological zones (forest, forest-steppe, steppe), different production technology packages (traditional, conservational, minimum tillage), and accounting policies. Furthermore, heavy short-term price fluctuations and differences in the product quality (both on the inputs and on the output side) are limiting comparability.

According to Slaston (2011) main challenges besides comparability are:

- incentives for the farmers (the system should deliver the kind of feedback that they need for the development of their business)

- data reliability

- high costs of data collection, especially when disaggregated costs for different farm enterprises shall be computed

- trust and confidentiality (convince the farmers that they can trust the system and that data confidentiality is assured)

2.3. Global comparisons

This section describes two world-wide initiatives (agri benchmark; IFCN) which have been developed for CoP comparisons and analysis on a global scale.

In the first sub-section, the goals, the theoretical framework and the practical limitations of global CoP comparisons are briefly addressed. This forms the basis to derive requirements, which any global CoP comparison has to meet.

Subsequently the concept, the current status and some selected findings of the two networks agri benchmark and IFCN are presented.

Framework Conditions, Goals, Requirements

In the initial stages of the two networks, emphasis has been put on the question what the core goals of the international comparisons should be and whether alternative options were available to achieve these goals.

These discussions have lead to the important result that many goals of global CoP systems can be achieved without conducting CoP comparisons:

- If, for example, policy makers would “only” want some average CoP figures per product and nation, it would be sufficient to just compare product prices across nations. The reason is that farmers all over the world follow the rule “marginal cost should equal product price”.

- If policy makers, for example, are “only” interested in past competitiveness of certain agricultural sectors, it would – in many cases – be sufficient to compare how different agricultural sectors have gained or lost market shares.

Both alternative indicators (product prices; market shares) can be obtained easily and at relatively low cost from various sources, so that it would not be necessary to develop expensive global networks for detailed CoP comparisons.

Considerations in agri benchmark and IFCN have lead to the result that there are mainly two reasons why regular CoP comparisons on a global level a really useful and necessary:

- to understand the reasons for CoP differences between farms and/or regions

- to assess future competitiveness of productions systems, farms and/or regions

These two goals cannot be achieved by analyzing past market share developments or current product price statistics.

In the current situation, where liberalization, globalization, climate change, bioenergy and new technologies are driving world agriculture towards a major restructuring, the second reason ("assessing future competitiveness") is a very strong argument for conducting global CoP analysis.

Given that the core target of agri benchmark and IFCN is "assessing future competitiveness", the following requirements were applied for the global CoP analysis:

- The focus is on *"cost and returns per ton of traded product"*, including supply chain costs and returns (processing, by-products, transport) because at the consumer level different products or competing against each other. If possible, non-marketable cost (social and environmental impact per ton) should also be included.

- In contrast, it is *not necessary to focus on "intraregional differences in farm income"*. It is clear that we would find "income distribution curves" in each region. For the individual farmer it is necessary to understand where on this curve the own farm is located. For a global analysis of international competitiveness, however, this extra knowledge about individual farm-to-farm differences in farm income is too detailed and therefore not useable.

- The agri benchmark and IFCN CoP tools must provide detailed information on *production systems and cost structure,* and the system should also facilitate a *direct contact to the farmers* whose farms have "produced" the figures. This is necessary to understand how farms are affected and may react to changing framework conditions.

- A *network approach* is applied that creates sufficient *incentives for analysts* from various countries to participate year after year. This is important because only in the course of time analysts learn to "translate" figures from various countries into a common understanding of what they really mean.

- The system is *applicable to all world regions* that are important for the global agricultural development. Many of these countries do not have a government-administered infrastructure of farm bookkeeping systems.

- The concept is made suitable for the analysis of *both small-scale and large-scale* agriculture.

- The organisational concept has the *potential for intra-national networks* to develop according to the procedures developed by the international network. This is desirable because in the starting phase any CoP comparison system will be far from "statistically representative". The more convincing the approach is, the better the chances of permanent growth of the system, so that in the course of a more representative picture of global farming can be drawn.

- The cooperation within the network should be organized in a way that *up-to-date figures and assessments* on the situation of the branches can be derived. This is important because only analytical tools with up-to-date figures can provide relevant answers with regard to rapidly changing framework conditions worldwide.

The networks "agri benchmark" and "IFCN" have been organized according to these principles. The participating institutions are cooperating in order to analyse production systems, CoP, and framework conditions for typical farms around the world.

Partners from 25 (beef) up to 45 (dairy) countries are actively exchanging data on CoP, and they are jointly analyzing these data in annual workshops. All continents are represented. In the IFCN dairy network, institutions from another 35 countries are sending CoP data to the coordination centre and receiving results back. (Deblitz 2011, Isermeyer 2011; Shadbolt, Ndambi and Hemme 2011; Zimmer 2011, 2011; de Carvalho and de Zen 2011)

The networks for cash crops, milk and beef can already look back on a history of more than 10 years. Since then, the cash crop network has widened the scope of crops considerably and is now covering 15 different crops. Two years ago, the beef network was extended to beef and sheep. Agri benchmark networks for further branches (pork & poultry, horticulture, eventually organics) are going to be launched in 2012.

Network of partners

IFCN and agri benchmark follow similar organizational approaches, which rely (a) on partners in many countries worldwide and (b) on coordination centres that have been established in Germany.

The most important elements of the networks are the partners. These are experts (mainly farm level-oriented agricultural economists) from institutions (e.g. universities, extension services, farmers´ organizations, marketing agencies) in the participating countries, who are responsible for delivery of data, crosscheck of results and supply of further information. It is desired to include experts who can contribute data and knowledge about production systems and economics of the branch in question.

The partners participate on a voluntary basis. They decide about the annual work program and about strategic developments of the networks. The networks are independent from political parties, governments or individual companies.

When the project was launched in the late 90s, the coordination centre of all networks was located in the Federal Agricultural Research Centre (FAL) in Braunschweig (Germany). In 2005, the coordination centre of the IFCN dairy network moved to Kiel (Germany). It is now a private company, closely connected to the University of Kiel.

The coordination of the other networks (agri benchmark) is carried out by the Thünen-Institute in Braunschweig, which is the successor of FAL and one of the federal research centres of Germany, in cooperation with the German Agricultural Society (DLG), a non-profit organization involved in many international activities. In the beef & sheep network, the Australian partner is performing a major coordination part for the sheep subdivision.

The three networks which have been developed so far (beef and sheep, cash crop, dairy) rely on different financial sources. In the agri benchmark beef and sheep network, the financial basis is relatively small, and the major share comes from the Thünen-Institute and from the partners in the participating countries. In the agri benchmark cash crop network and in the IFCN dairy network, a greater share of the financial support is contributed by agribusiness partners (companies, institutions) or by project finance (e.g. EU, FAO). Compared to agri benchmark, the IFCN has become a somewhat more commercial organization, with a higher direct involvement of the agribusiness companies.

Typical farms, data collection, calculation of CoP

A strong plus of agri benchmark and IFCN is that these comparisons are the only ones available on a worldwide basis. A strong limitation is that in most participating countries only 2 or 3 typical farms per branch are represented in the global comparison. This means that the figures presented cannot represent the variety of farms in each country´s farming sector. In some countries, this disadvantage has been somewhat reduced by establishing intra-national networks of typical farms (see below).

The comparison of "typical farms" is the core of the concept. Within each of the three networks, the methods for farm selection, data collection and CoP analysis follow a standard operating procedure (SOP), so that a high degree of comparability is achieved. The methods are harmonized according to common standards which have been developed and agreed upon by the network participants.

As already stated on the example of FADN (see section 2.1) it is not so important whether the CoP analysis is based on method A or method B. Much more important is that

- the same methods are applied for all farms and all countries (international harmonization),
- the experts (a) understand the methods, (b) understand the results of their country and the other countries, (c) are able to explain differences in CoP by linking them to location factors, political framework conditions, etc.

The "typical farms" concept is the only realistic way to include the agricultural sectors in South America, Africa, Asia or Russia which are more and more important for global agriculture (Isermeyer 2011).

For example, in the agri benchmark beef and sheep network, currently 75 typical beef finishing farms from 25 countries, 46 typical cow-calf-farms from 21 countries, and 12 typical sheep farms from 12 countries are being compared. This comparison includes all countries playing a major role in world beef production.

In each country, the typical farms should represent the major production systems and regions. Based on the analysis of farm structure within a country, the basic features of the typical farms are defined. In addition to average-size farms, one larger farm is also selected in order to better understand possible future developments in the regions (cutting edge). In those countries where data on all farms are available (or representative sample data like FADN) these data can be used to show where the typical farm is sitting on the distribution curve. In other countries it is necessary to rely on the judgement of regional experts and/or farmer panels.

Until now, the assessment and documentation of the relative position of typical farms (average, above-average, etc.) has only been done rudimentarily, so that observers may misinterpret the meaning of typical-farm figures for the whole sector.

For some projects, the farmer panels of the agri benchmark network play a very important role. A panel consists of about 5 farmers who are operating a farm that is similar to the typical (model) farm. Such a panel is important to validate the data on the production system, and it is even more important to assess how the typical farm would adjust to changing framework conditions. On a global scale, it will not be possible to answer such a question sufficiently through a "model only"-approach (without panel discussion).

For each of the typical farms, data are collected and analyzed according to standardized procedures. For the IFCN, this process consists of 10 steps, going from (1) collection and validation in the country, (2) check once data arrive at coordination centre, (3) Mail traffic ... and so on, up to ... (10) Feedback on the Dairy Report.

The data are coming from the bookkeeping of real farms and from additional sources supplied by the panel participants. The main data base is (a) the profit and loss account and (b) the detailed account for single farm enterprises. If possible, farm-individual data on input prices and input quantities are collected. Furthermore, additional information with regard to the production system is compiled. Hence, the total data base for a typical farm reaches far beyond the normal scope of bookkeeping systems. There are at least two plausi-checks for the data set of each typical farm, one during the panel session and at least one more during the international comparison.

The calculation of CoP is done with the aid of farm models (TIPI-CAL, TYPI-CROP). These models start at the whole farm, so that the farm´s profit and loss-account from bookkeeping data can be used. To analyze the single enterprises (as part of the whole farm), either allocation factors are used (judgement on "which part of a whole farm cost component is attributable to the single enterprise?") or engineering-type budgets are produced (based on additional information supplied by participating farmers and advisors: "how is the production system designed?"). The models are generating various CoP and profit figures (Shadbolt, Ndambi and Hemme 2011, Zimmer 2011).

Both IFCN and agri benchmark are summarizing their core results in annual reports (Deblitz 2011; Zimmer 2010).

Further weak points and future challenges

Time series analysis

Over the years, an interesting data base for time series analysis is emerging. For some of the typical farms, there is already a 10 year data record available. These time series data can have a high potential for further economic analysis.

However, for a full exploitation of this potential it will be necessary to consider the updating procedures more carefully. Currently, input and output prices are updated annually, while farm technology and size are only updated every three years. For a meaningful time series analysis, this update can be seen as a precondition and as a disturbing factor at the same time.

As structural change proceeds in reality, it would not be correct to keep size and technology stable. However, changing the technology and size every three years is also a deviation from reality and may lead to "jumps" in the time-series analysis. Annual updates in technology and size would be costly, and they would also not reflect the real situation properly because real farms do grow with certain "jumps".

National networks and capacity building

Until now, the number of countries participating in the networks has grown considerably, but in most countries the number of typical farms has remained constant (at a low number of only 2 or 3 per branch).

There are two possibilities to overcome this problem: First, if there are national networks that follow a similar concept as IFCN / agri benchmark, cooperation with these networks can established and interfaces for data exchange can be built. Second, if such a national network is not available, it can be attempted to convince national stakeholders (e.g. agricultural policy, farmers association, agribusiness) to establish intra-national networks according to the global agri benchmark standard.

Both strategies have been successfully pursued in some countries. The first strategy (cooperation with existing networks) is working in Brazil, in the US, and partly also in Argentina where a private consultancy network is benchmarking their farms against the global agri benchmark community. The second strategy (national "multiplication" of the global concept) is working in South Africa, Australia, Colombia, Indonesia, Sweden and Spain.

A further expansion of "intra-national network strategy" would have the positive effect that actors and "multipliers" in the agribusiness (e.g. farmers, advisors, researchers, teachers) would improve their "understanding" of regional agricultural systems. The panel process forces scientist, advisors and farmers to jointly and deeply analyse a typical farm of their region. If this process is embedded into an international network, all participants have the chance to assess their local "typical farm" (CoP, sustainability, responsiveness) in a global context. This is made possible because in the agri benchmark participants exploit the same definitions within an international technical terminology and understanding. This "capacity building" aspect plays a major role in recent considerations to increasingly implement the agri benchmark concept in developing countries.

Integrated view on different enterprises

For various reasons (organizational, financial, personal), the agri benchmark networks have evolved "branchwise" in the last decade. The separate development was beneficial for the development of the single international network (quick and easy decision making). Yet, there are some questions that cannot be sufficiently answered if the networks continue to act separately.

Future competitiveness of certain branches in certain regions is finally determined by the question whether a certain branch yields a lower or higher net profit (land rent per hectare) than other branches. In other words: Understanding competitiveness requires the analysis of both international competitiveness (one branch) and intra-regional competitiveness (different branches). Up to now the CoP calculation systems (including agri benchmark) do not sufficiently capture this important intra-regional competition. They can only offer a very imperfect way by taking the cost component "land rent" as a proxy for the opportunity cost of land.

At the current stage of development, a special disadvantage of the agri benchmark / IFCN networks (compared to integrated systems as FADN or the Australian CoP anaylsis) is that – due to the "branchwise" development of the networks – there is hardly any data exchange between the networks. Therefore, at the moment it is very difficult to derive conclusions regarding the intra-regional competition of different branches. This argument supports the idea to consider a certain re-integration of the different networks.

Towards a "data, knowledge and judgement network"

The above mentioned activities are designed to further improve the network´s ability for assessing CoP, competitiveness, and responsiveness on the single-farm level. Yet, a full understanding of international competitiveness is only possible if the analysis goes beyond the single-farm level (see section 3.1).

In particular, there are two main aspects beyond the single-farm level that shall be captured in agri benchmark and IFCN: (a) downstream activities and (b) the impact of intra-regional structural change on the competitiveness of certain branches (see below). As explained in the final section, it will be impossible to capture all the important aspects "beyond the farm gate" by sound business-based CoP figures. Therefore it will be necessary to supplement CoP data by "expert judgements", e.g. expert judgements on how far regional competitiveness of milk production in a small-scale region could be improved by structural change (Isermeyer 2011).

Up to now, agri benchmark and the IFCN have addressed this isssues only to a little extend. However, due to their network design (world-wide, ongoing cooperation of regional experts) they should have a comparatively high potential to produce sound judgements which are needed to supplement the plain CoP calculations.

This leads us back to the issue of "capacity building" (see above). The network´s ability to assess future competitiveness depends on the ability of the partners

- to understand the nature of agribusiness in their region (CoP, structural change, main players)

- to share this information with colleagues from other regions (national, international)

- to compare their own assessments and projections with real development and to draw conclusions for improvements of their judgements in following years.

2.4. Summary, Conclusions, Recommendations

Data on CoP have no value per se. Such data are collected and analyzed for certain purposes, and therefore the evaluation of different concepts must start with the question "Why are we interested in information on CoP on an international level?"

The liberalization of agricultural market policies and the globalization of the agribusiness have created an environment where policymakers can no longer afford to neglect the global dimension of their decisions. For example,

- if policymakers want to increase bioenergy use they should be able to assess where the additional biomass will/should be produced and how this will affect competition with food and feed production in different parts of the world;

- if policymakers want to improve animal welfare it is necessary to analyse how the food industry may adjust to higher local standards and shift product sourcing to other world regions;

- if policymakers want to reduce greenhouse gas emissions from agriculture they should consider options in various production systems and world regions and opt for the most efficient ones, for only globally integrated strategies can solve the global climate problems.

Decision makers in the agribusiness have also developed an increasing interest in a better understanding of production system economics worldwide. In a liberalized world, political developments as well as technological breakthroughs like GMO, milking robots or disease prevention measures can change regional supply conditions very quickly, and it is highly important for entrepreneurs to analyze the economic consequences of developments as early and clearly as possible.

All these examples underline that in a globalized and liberalized economy there is a great demand for farm-based CoP because the corresponding questions can only be answered on the basis of a sound CoP analysis. Therefore, it is suggested to the answer the initial core question "Why are we interested?" as follows:

We are interested in an internationally harmonized comparison of CoP because we need to assess future competitiveness of productions systems, farms and/or regions. In particular, we want to understand how

- certain agricultural branches can compete with other world regions,

- competitiveness and sustainability of production systems can be improved,

- different farm types in different regions can (and will) react to new challenges,

- different farms are affected by (and will adjust to) agricultural policy measures.

Agricultural economists have developed comprehensive agricultural sector models that are designed to (partly) answer some of these questions, too. However, these models work on a highly aggregated level and on many assumptions about supply and demand elasticity. Therefore it is important to supplement these models by farm-based knowledge. At the same time, it must be clear that farm-based approaches cannot replace sector and trade models because market interactions cannot be modelled at the farm level.

In different regions of the world, different concepts for farm-based CoP analysis have been developed and implemented over the last decades. These concepts can be categorized by different criteria, for example:

- regional coverage (world-wide; EU-wide; national; regional)

- representativity (stratified sample; farmer groups with voluntary participation)

- individuality (single farm data; farm averages; typical farms)

- depth of the data (only whole farm data; farm enterprise data (selected or all items);

- access to farmers (delivery of bookkeeping data; interviews; panel discussions).

The results of CoP calculations depend on the method. Different ways of data collection and data calculation lead to different results. Therefore it is not possible to just assemble CoP data from different sources into one big data pool unless data collection and calculation follows an internationally harmonized protocol.

In order to check whether there are different CoP data bases available that might be suitable for a combined analysis, the situation in various countries has been briefly described in section 2. The result can be summarized as follows:

- European Union: For intra-EU-comparisons, the Farm Accountancy Data Network (FADN) offers a harmonized data base. The great advantage of this data base is that it contains data of a large number of farms (stratified sample) and is updated annually. The main limitation is that this data base is inappropriate for calculating single-farm CoP, broken down by cost components and commodities. The reason is that the FADN contains only whole farm data that are not broken down to single enterprises.

- USA: The Agricultural Resource Management Survey (ARMS) provides CoP data that are statistically representative. The data collection procedure is specifically designed for the calculation of CoP although there are some open questions regarding the quality of the data (especially on labour costs). The long time-interval (update only every 4-8 years) and the non-existing possibility to interview the farmers in between are severely limiting the usability of the system to produce answers for the questions mentioned above. The Agricultural and Food Policy Centre (AFPC) at Texas A&M University is operating an alternative (so-called) representative farm concept which is successfully used for farm-level policy impact assessment for the US congress. This system is based on the concept of typical (virtual) farms which are put together by regional panels on the basis of bookkeeping data and expert judgement.

- Canada: There is neither a unified data collection system nor a harmonized farm data set which could be used for standardized CoP calculations. Instead there are different sources of information available, some containing very detailed data. Most schemes are operated under the responsibility of the provinces.

- Brazil: CONAB, a national agency for the dissemination of information, offers CoP data for many commodities, production systems and regions. The data are collected by focus groups for typical (virtual) farms. The experience has shown that this procedure leads to a higher-quality data (especially on labour costs) than could be collected by other data collection methods. The CONAB data base is not statistically representative. CONAB does not cover the whole agricultural sector. Some commodities are analyzed by other institutions, and they also apply the concept of typical farms based on focus groups (panel discussions).

- Australia: The Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) is operating a representative survey on CoP. The survey is not covering all commodities; about 75% of total agricultural production is included. The data collection system (face-to-face interviews) is specifically designed to calculate CoP. For some crops, the data base contains data going back 30 years which allows interesting time series analysis.

- New Zealand: The traditional monitoring system with a relatively strong statistical basis is currently being replaced by a modern system which is based on the principles of voluntary participation, strong farmer and advisor involvement, timeliness, and high usability of the benchmarking data by the farmers. Up-to-date data are collected annually by face-to-face interviews, and these interviews are also used to validate the data for the previous period. The data pool is not statistically representative. About 10% of all farmers are now taking part in the system.

- Ukraine: The medium- and large-scale farms are reporting data on agricultural production and sales to the district-level bodies. This data source, however, is not suitable for a profound analysis of CoP. Detailed CoP data for a handful of typical farms are collected by the Ukrainian Agribusiness Club (UCAB); this is done within the framework of the global network agri benchmark. The UCAB has also launched a project called AgriEfficiency, a national extension of the agri benchmark project that aims at collecting data from Ukrainian farms with less effort.

This listing shows that very different concepts for the collection of farm-based CoP data have been implemented.

In view of the extreme methodological differences on the international level one might be tempted to ask: "Which CoP methodology is best?" This question, however, can lead onto the wrong track if the core target of CoP analysis disappears from view. The core target is to understand the current and future situation of productions systems, farms and/or regions (see above). Therefore the right question is: "Which concept can yield the most meaningful results to assess the current and future situation of productions systems, farms and/or regions?"

There are basically three different conceptual strategies that could be pursued:

(1) Take the different data bases as they are, build some interfaces, and compare the resulting CoP figures across nations and continents

(2) Convince the administrations of various countries around the world to agree upon the establishment of one harmonized concept (data collection, CoP calculation).

(3) Continue the development of global networks (IFCN, agri benchmark) which have developed internationally harmonized standards for CoP calculation and work on a stepwise evolution of their network concepts

The advantages and disadvantages of these three strategic options can be summarized as follows:

Option 1: Build interfaces between existing data bases

The advantage of this strategy is low cost because one can use existing data bases. It is probably relatively easy to convince institutions to provide existing data for an international comparison whereas it is much more difficult to make them change their data collection and calculation schemes.

In view of the fundamental methodological differences between the national schemes, however, this strategy is not convincing. Comparability across borders is severely limited because (a) only the EU is collecting a statistically representative data set for all agricultural sectors on an annual basis, while most of the other world regions have no statistically representative data bases to offer, and because (b) the data in many overseas locations allow an exact and detailed calculation of CoP for each commodity whereas the data basis for farm-individual, commodity-specific CoP data in the EU is quite poor.

International comparisons of CoP which have been collected on the basis of highly diverging procedures are probably as valuable as mere comparisons of product prices (see section 3.1): One can learn that there are differences but it remains unclear (a) why these differences exist, (b) how meaningful they are for competitiveness of regional branches and (c) what the impact of changing framework conditions on CoP and competitiveness will be.

A number of important features that a global scheme for the analysis of future competitiveness should provide (section 3.1) is experts knowledge for certain branches:

- Without a systematic consideration of expert judgements, it is hardly possible to include the downstream activities into the analysis. In particular, transport cost from the farms to metropolitan areas or harbours are very important because (a) for some remote locations these costs can amount to more than half of the on-farm CoP and (b) these costs are varying by product group. Hence, transport cost is one of the main drivers for regional specialization in global agriculture. Besides this, the conditions for food processing also need to be considered. Some locations offer better conditions for processing firms (e.g. water supply, regulations, markets for by-products) than others, and this can be a crucial for the competitiveness of a certain branch.

- Second, it is necessary to include the impact of intra-regional structural change on the competitiveness of certain branches. It is important to understand that, for example, a region with a high share of small-scale dairy farms can have a higher competitiveness in the global dairy sector than a region with some large scale-scale dairy producers – although each and every single-farm CoP analysis would always show that the large-scale dairy farms have lower CoP than the small-scale dairy farms. This phenomenon can be explained by two reasons: (1) High CoP in small-scale farms are mainly caused by high cost for family labour (often more than 50% of total CoP), and for these costs both the physical values (number of hours) and the process (wage rate per hour) is often highly disputable. (2) If a small scale region contains many similar farms (e.g. dairy farms) neighbouring each other, the exit of a few small high-cost farms leads to a substantial improvement of economic framework conditions for the neighbouring farms which are staying in business (more land and cow barns available, leading to lower CoP). On the contrary, in large-scale dairy regions with only a few big dairy farms left, a close-down of a dairy operation does not lead to improved conditions for milk production in the region.

At first sight, one might think that these challenges could perhaps be met by simply including further enterprises into the global comparison of CoP (e.g. transport firms; food processing firms; small-scale and part time farms) and/or by feeding these figures into more sophisticated farm-based modelling (e.g. non-linear programming for the analysis of farm adjustments; cellular automata for the analysis of structural change within regions).

However, a sober assessment of these options leads to the clear result that they would not be viable on a global level. CoP data for the processing industry are strictly confidential. Finding the "correct" wage rate of part-time farmers is practically impossible. Running sophisticated models for assessing intra-regional structural change on a global level is unaffordable.

Therefore we must accept that it will be impossible to capture all the important aspects "beyond the farm gate" by sound business-based CoP figures. We should measure everything that can be measured (e.g. there is still a lot to achieve in the fields of transport cost and price margins) but many other aspects can only be captured by "expert judgement" – and this requires international networks of experts who can provide information besides CoP and are able to assess the importance of regional CoP data in relation to these extra information.

Option 2: Establish government-administered, harmonized CoP schemes worldwide

From a European, Australian or US perspective it may seem natural to broaden the concept of government-administered CoP schemes which are geared to draw a statistically representative picture of a countries´ CoP situation (e.g. FADN or ARMS) to the worldwide arena.

However, even in a "two-country-case" it is doubtful whether the institutions in one country would be willing to replace their system in favour of a foreign system. The existing concepts (e.g. in the US and the EU) are totally different and each system is showing a strong "path dependency". Due to the pronounced differences, international harmonization would in fact result in a complete change of data collection structures in almost all countries.

Secondly, and even more important, it has to be noted that in most countries worldwide there is simply no farm data base available that would enable the administration to draw a random sample. And due to the substantial intra-national differences in many countries any strategy aiming at "statistical representativity" would require a data collection in a large number of farms. Hence, a strategy to "globalize" concepts like FADN or ARMS would become very expensive.

Additional costs would probably occur not only in developing countries but also, for example, in the EU. Most of the smaller farms in the EU do not have single-enterprise data available (broken down by cost component and commodity produced). The implementation of a global CoP analysis scheme that would really be able to calculate sound single-farm CoP data per branch (e.g. ARMS) would require collecting a lot of additional data per farm, and as these data are currently non-existent, they would have to be "produced" by the farms throughout the year.

Yet it is not only a matter of costs but also a matter of motivation for the farmers who must deliver the data. According to the experience and judgement of the workshop participants, it is important that the farmers develop a personal interest in delivering high-quality data. An enforcement of data delivery via cross compliance or similar schemes (payment for data; no payment for missing or wrong data) was not regarded as a fruitful option.

The reason is that the on-farm assessment of important CoP data such as (a) family labour hours, (b) opportunity costs per hour or (c) opportunity costs of land remains difficult. It is unlikely that any central entity or government would be able to control whether a farmer delivers reliable data on labour hours or opportunity costs of family labour. The same holds for the opportunity costs of land. If it is our goal to really "understand" the competitiveness of a certain crop in a certain region, we have to go deeper into the nature of joint production (disease break, soil fertility, labour scarcity, risk management, etc.). These dynamics determine the true opportunity costs of land which can be used for the respective crop, and the true figure and where farm bookkeeping data offers limited support in reflecting these figures. It can only be analyzed by the farmers themselves and/or a production economist who fully understands the nature of joint production in this specific region.

This train of thought suggests to base international CoP comparison schemes potentially on data stemming from voluntary advisory groups, despite the fact that the resulting data base is not representative in a statistical sense, and to closely connect CoP analysis for selected farms (a) with single farm modelling and (b) with the possibility to feed the results back to the farmers and advisors who delivered the data initially.

Option 3: Continue and broaden the existing global network activities

From where we stand, the typical farm concept is probably the most appropriate approach currently available for the intended purpose of CoP data collection and analysis on a global scale. The main advantages of this concept can be summarized as follows:

- In most countries worldwide, the majority of the farms do not have enterprise budgets for single commodities available. If these farmers are suddenly asked in a face-to-face interview to "assess" such data, the results will not be reliable. Experience has show that a "panel process" where farmers, advisors and scientists can jointly discuss the figures of one typical farm leads to much better results.

- In the few countries where single-farm data are collected for a random sample of farms, the analysis of this data base is often restricted by confidentiality arguments so that analysts can only work with "farm group averages" instead of "individual farms". A statistical average of different farms, however, is often an artificial construct that does not reveal the real farm situation and is not a useable basis for further modelling work. Hence, it is better to work with a "median farm" as created by the agri benchmark panels, instead of a "statistical average farm".

- The panel process is forcing the analysts to really "work" with the data (e.g. checking plausibility), to validate their assumptions and to defend their results (e.g. on farm reactions to changing conditions) in the panel workshops. This process is guiding all participants towards a dynamic understanding of the farm – following an important result of the Brussels workshop: "CoP is not the final destination - it can only be the starting point of the analysis".

- The direct access to farmers and advisors gives a better possibility to assess the farm-level impact of modern agricultural policies (e.g. agri-environmental measures, animal welfare programmes, traceability schemes). Such policy measures trigger farm adjustments which can only be assessed if the analysts can take a very detailed view on production methods and possible farm adjustments. This is beyond the scope of the "normal" data set that is collected in mass CoP-related inquiries.

- The in-depth analysis of typical farms is also gaining importance as the farming sector is increasingly embedded in some kind of "contract farming" (Cunningham 2011, Miele 2011 a,b). In such an environment, classical CoP analysis shows substantial farm-to-farm differences which are only attributable to different contract arrangements. For example, some farms will show high costs for manure disposal, others have given this task to the contractor and will therefore show no manure disposal costs but only a reduced price for their broilers. The resulting CoP differences can be properly understood and interpreted in an intensive panel discussion, whereas data analysis based on a mass inquiry might lead to wrong conclusions.

- Finally, the increasing differentiation of product quality is also an argument in favour of typical farm analysis. If commodities from different regions have different quality features, the €/kg CoP analysis has always the risk of comparing apples and pears. This challenge cannot be met by increasing the number of farms (mass CoP-related inquiries). Instead, a global network of experts is needed who rather "understand" a few typical farms and the connected supply chain. It is paramount that these build up knowledge and trust (a) to the entrepreneurs within their home regions and (b) to their international network partners.

The principle limitation of the typical farm concept is that the results are not representative in a statistical sense, because they are not based on a random or stratified sample of the total farm population. As long as only very few farms per country and branch are included, even the label "typical" is rather a euphemism – particularly in large countries with a high variation in farming systems.

A possible solution would be to combine the advantages of FADN-type schemes (representative data set) and agri benchmark-type schemes (in-depth analysis), for example by using FADN-type data to analyse where a certain "typical farm" is sitting on the distribution curve of all farms. Yet, as it looks from now, it is rather unlikely that other world regions would make an effort to implement FADN-type random sampling schemes on their territory.

Hence, globally, for the intended purpose of international CoP, this may mean further development and possible extension of the agri benchmark approach on its own. For this direction, the Brussels workshop yielded a number of suggestions.

First, the farmer´s motivation to participate in the survey should mainly stem from his or her interest in getting reliable benchmarking data back – and not from the chance to earn a little extra money (for the data) or from the necessity to comply with new government demands. Highly motivated farmers are a source not only for high-quality data but also for profound information on future farm development under changing conditions. Of course, a high degree of "involvement" of farmers or advisors is not only beneficial. It also bears the risk that dominant panel members are distorting the results if, for example, they replace facts or sound judgement by wishful thinking.

To keep such risks in reasonable limits, it might be a rewarding "system extension" to draw a line from the typical farm approach (based on panel discussions) to individual farm benchmarking. Individual farmers might find it attractive to compare their farm to typical farms in their country and in other world regions. In this way, for example, the new intra-national benchmarking system in New Zealand could be linked to the global benchmarking activities. The same applies to the CoP comparison that the European Dairy Farmers (EDF) are conducting each year for more than 250 dairy farms throughout Europe (Wille-Sonk 2011).

Second, as the New Zealand example is demonstrating, the representativity of voluntary benchmarking schemes can be steadily improved if these schemes are attractive for all participants in the sector (Shadbolt 2011). Brazil is heading into the same direction, with a couple of institutions competing for the most attractive typical farm concept (see section 2.3).

This is also the course agri benchmark is currently adopting. In Brazil, Colombia, South Africa, Indonesia, Ukraine, Spain and Sweden the national partners have already decided to either establish intra-national networks which are multiplying the agri benchmark network on a national scale, or to create interfaces that facilitate comparisons between the global benchmarking system and comparable national systems.

The main challenges for the global CoP comparison schemes based on typical farms can be summarized as follows:

- Are the results valuable enough to keep farmers and advisors interested?

- Are quality aspects (product differentiation, timely delivery, sustainability standards) adequately incorporated in the analysis?

- Will it be possible to "re-integrate" the disconnected networks so that whole farm issues (e.g. crop rotation, risk management, ecosystem services) are adequately captured?

- Can the concept be successfully extended to sectors like pig and poultry which are dominated by contract farming?

- Are convincing solutions available to capture the special situation of smallholder farms in developing countries (household economics; market access)?

- What is the most cost-efficient way to include transport cost into the analysis?

- Will it be possible to build up financial power, sustainable knowledge and trust in order to include downstream companies into the analysis?

This listing demonstrates once again that a modern discussion about CoP calculation and CoP data collection on a global level must reach far beyond the pure statistical and computational aspects of CoP. The real challenge is to create an infrastructure which is laying a solid foundation to understand current and future developments of farming.

For this, CoP can at best be a reasonable starting point, allowing a quick comparison of different farms, production systems, regions or points in time. As CoP cannot be a reasonable ultimate goal of the exercise, however, it is important that data collection schemes create a powerful basis for the more advanced analyses that is really needed.

As it looks from now, enterprise-specific information (production technology and cost) and direct communication with the decision-makers (regional farmers) are important features of a promising analytical approach. Given the tremendous variety of agricultural systems worldwide (e.g. product differentiation, contract farming, smallholder households), such a framework for in-depth analysis is necessary. On the other hand, such an approach will never be able to replace statistical approaches that are aiming at a full coverage of the whole farming population.

Chapter 3. Production Cost Calculations and Methodologies Used for Dairy, Beef, Pork and Poultry Industries

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3.1. Introduction

The purpose of this section was to provide examples of production cost calculations and methodologies utilized in various countries for the dairy, beef, pork and poultry industries. The countries providing reports were Argentina, Brazil, New Zealand and the United States. These countries were chosen as a result of the significance of the various commodities produced in these parts of the world. The reports included information on reporting agencies, methodologies, sampling procedures, as well as cost and returns calculations.

3.2. Commodity Reports

3.2.1. Dairy

Shadbolt (2011a) presented DairyBase production cost data from 06/07 to 08/09 for five dairy farm systems in New Zealand. The DairyBase program is a process where farm business owners working with rural professionals in New Zealand obtain and enter data into a data base reporting system for management and comparison purposes (Shadbolt, 2011b). The DairyBase program results in standard farm reports including physical data summaries, key performance indicators, operating profit calculations, financial detail and physical detail. The five dairy farm systems compared were:

- System 1. *Self- Contai*ned – No imported feed, no supplement fed, except supplement harvested off the effective milking area and no grazing off the effective milking area.
- System 2. 4-14% of total feed imported.
- System 3. *10-20%* of total feed imported to extend lactation and for dry cows.
- System 4. *20-30%* of total feed imported and used at both ends of lactation and for dry cows.
- System 5. *More than 30%* total feed imported. Feed used all year, throughout the lactation period and for dry cows. Split calving is common to this system.

In 06/07 and 07/08 there were no significant differences in operating expenses per kilogram of milk-solids produced between any of the systems. In 06/07 operating expenses ranged from $3.60-$3.80 per kilogram of milk-solids produced and from $4.80-$5.00 in 07/08 for the five systems. However, in 08/09, system 5 costs were significantly higher ($5.40) in kilograms of milk-solids produced than systems 3 ($4.80), 2 ($4.80), and 1 ($4.40). System 4 was significantly higher ($5.00) than systems 2 and 1. When costs of production (full economic costing) were compared, systems 2, 3 and 4 (~$5.00) were all significantly less than system 1 ($5.20) in 06/07. In 07/08 system 4 was significantly less ($6.60) than systems 1, 2, and 3 (~$7.00). In 08/09 there were no significant differences between any of the systems ($6.60-$7.40).

When return on assets (RoA) and return on equity (RoE) were compared for the five systems, in 2006, 2007 and 2008 there were no significant differences between the systems. These results indicated that the additional capital required to achieve the higher production delivered a consistent return per unit of capital. Conversely, in

2008/09, a significant deterioration in operating efficiency coupled with the additional assets required per hectare resulted in a significantly worse outcome under intensification. Systems 3, 4, and 5 all had significantly lower RoA than system 1. Systems 4 and 5 had significantly lower RoE than systems 1 and 2.

The results indicated that increasing production intensity improved cost leadership in average and favourable markets but this advantage disappeared under unfavourable milk price to cost ratios. When using a metric that incorporates opportunity costs of capital, the CoP per kilogram of milk-solids at worst doesn't change and, at best, reduces as systems intensify.

Nambi (Shadbolt, *et. al.*, 2011) reported on dairy global production costs using the IFCN concept. The IFCN is a global dairy network of researchers, companies and other stakeholders who are active in the dairy chain. The IFCN has a research centre with approximately 10 dairy researchers coordinating the network process and running dairy research activities. The IFCN is independent from third parties and committed to truth, science and reliable results. The mission of the IFCN is to create a better understanding of milk production worldwide. The IFCN network includes research partners in 86 counties and 80 different agribusinesses.

The IFCN methodology identifies a typical dairy farm for a region based on the largest number of dairy farms in terms of size, livestock system, labour organization, and technology used. The main objectives are to represent major milk production systems, to represent a significant number of farms in the area and capture a large amount of milk production in the area. Examples of typical dairy farms in the IFCN report range from as low as one cow and 380 farms in the Ukraine to 351 cows and 996 farms in New Zealand.

The IFCN farm comparison process incorporates a 10 step validation process including input from research partners, data checks and cross checks, discussions of results, report editing and final feedback on the report. The IFCN dairy report results in a number of outputs including conferences in January, June and September as well as a variety of public events throughout the year.

The cost methodology used is the 2011 TIPI-CAL version 5.2. The TIPI-CAL calculation model is a whole farm production and accounting model (excel based) incorporating 300-700 economic and physical variables per typical farm. Currently dairy researchers in more than 40 countries use the TIPI-CAL program. Dairy farm costs are determined from dairy related expenses (includes quota costs) and by partitioning out labour, land, machinery and building costs from whole farm costs for dairy production. Opportunity costs for family labour, land owned and capital owned are also accounted for.

The IFCN 2009 report provides detailed CoP comparisons for the 86 countries participating in the global network. The costs of milk production ranged from as low as US$5/100 kg of milk for some of the African nations to as high as US$100/100 kg of milk for some of the western European countries. Comparisons of average size farms for costs of milk production for some of the countries in the IFCN report resulted in less than US$20/100 kg of milk in African countries, US$20-30/100 kg milk for Argentina, India and New Zealand, US$30-40/100 kg milk for Australia, the United States, China and Brazil, US$50-60/100 kg milk for Germany and Canada and US$60-120 for the Scandinavian countries. Time series analysis from 2000-2010 for selected farms showed substantial increases in the costs of milk production beginning in the 2005-2006 time period with the highest costs recorded in the 2008 period.

The following were identified as challenges and opportunities for the IFCN network:

1) identification and validation of typical farms,
2) timeliness versus accuracy,

3) network of learning,
4) maintaining a common purpose,
5) academic vs. commercial model,
6) disseminating information for the common understanding,
7) enhancing the matrix of knowledge,
8) going beyond costs of production analysis, and
9) leveraging the data and the skills of the network.

3.2.2. Beef

Carvalho (Carvalho, 2011) of the Centre for Advanced Studies on Applied Economics

Table 3.1: Beef Cost Structure Example - Alta Floresta Farm, Brazil

Revenue	**Income**	**% Costs**
Administrative, tax & energy	R$ 2,161.0	4.58
Buildings maintenance	R$ 98.6	0.21
Machinery maintenance	R$ 4,385.2	9.29
Pasture maintenance	R$ 375.2	0.80
Vet and medicine	R$ 3,232.7	6.85
Hired labor	R$ 19,680.6	41.7
Mineral supplement	R$ 12,746.6	27.2
Animal purchase	R$ 4,500.0	9.5
Cash Costs	**R$ 47,179.88**	
Depreciation		
Buildings	R$ 3,944.00	
Machinery	R$ 4,424.00	
Service animals	R$ 175.00	
Pasture	R$ 1,899.70	
Pro-labor(family)	R$ 48,000.00	
Depreciation Total	**R$ 58,442.70**	
Cash Costs + Depreciation	**R$ 105,622.58**	
Total Costs -TC		
Capital return-buildings	R$ 2,103.84	
Capital return-machinery	R$ -	
Capital return-animals	R$ 19,317.02	
Capital return-pasture	R$ 341.95	
Opportunity cost of land	R$ 16,204.32	
Total	**R$ 39,623.84**	
Total Costs-TC	**R$ 145,246.42**	
Gross Revenue	**R$ 150,706.44**	
Cash Costs	**R$ 47,179.88**	
Depreciation Total	**R$ 58,442.70**	
Cash Costs + Depreciation	**R$ 105,622.58**	
Return of Capital	**R$ 39,623.84**	
Total Costs-TC	**R$ 145,246.42**	
Net Revenue	**R$ 103,526.56**	
Total Net Revenue (R-CC-Depreciation)	**R$ 45,083.86**	
Total Net Revenue (R-Total Costs)	**R$ 5,460.02**	

Source: Carvalho (2011).

(CEPEA), University of Sao Paulo, reported on production costs of beef in Brazil. The CEPEA provides research and analysis for agribusinesses related to market analysis, price evaluations, international trade, management strategies, environmental and social aspects, and family farms. The information produced is used by farmers, agribusiness agents and government. The CEPEA generates information on production costs for animal and vegetable products in Brazil. The animal products include beef and dairy while the vegetable products include corn, soybean, cotton, wheat, rice, bean, coffee, oranges, sugarcane, cassava, grape, potato and tomato.

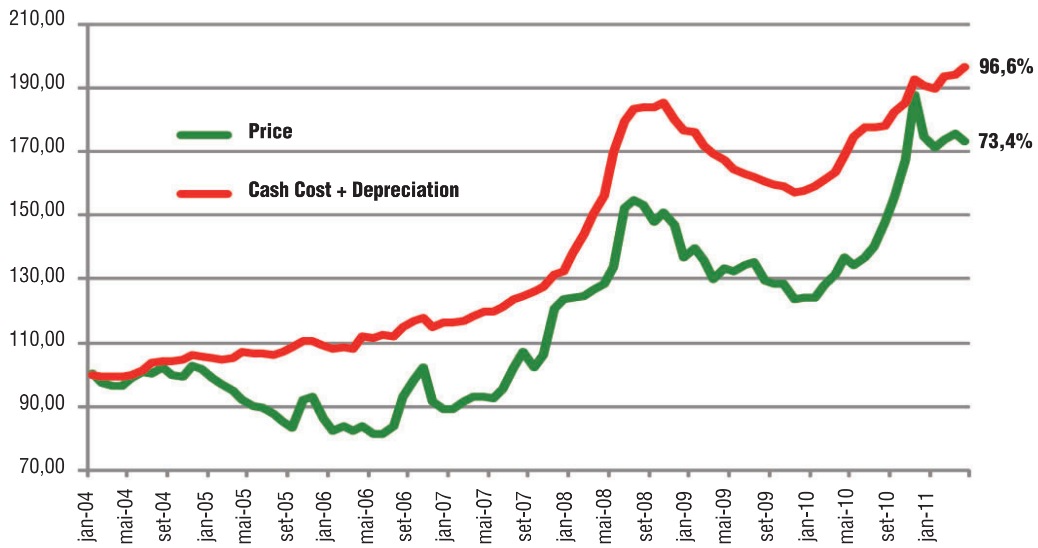
CEPEA partners with the National Farmer's Association of Brazil to derive the various production costs. CEPEA uses a panel of farmers to determine the definition of typical production systems and calculations of production costs for a region. CEPEA then produces an analysis of the modal property (i.e. the most representative of the region. Typical farms maps are produced identifying the locations and distribution of the farms participating in the analysis. The recent report included 61 finishing farms in 13 states and 56 cow-calf farms in 13 states. An example cost structure analysis for a farm in Mato Grosso state was provided (Table 3.1)

Information on increases in costs of beef production and beef prices from January, 2004 to April of 2011 in Brazil was provided (Figure 3.1). Cash costs plus depreciation expenses increased by 96.6% during this time period while prices received for beef increased only 73.4%.

Increases in individual cash costs during this period were: labour (127.09%), minerals (120.59), animal purchases (111.36%), fertilizers (63.07%), forage seeds-pasture (241.38%), fuel + maintenance (75.13%), medicine (41.0%), feeds (55.4%), energy (60.7%), animal reproduction (-8.09%), building maintenance (19.68%), and traceability (65.7%). Cash costs, depreciation and beef returns for typical cow-calf and finishing farms in the various regions of Brazil were presented. For some regions, beef returns exceeded cash and depreciation costs while cash and depreciation costs exceeded beef returns for others (Figures 3.2 and 3.3).

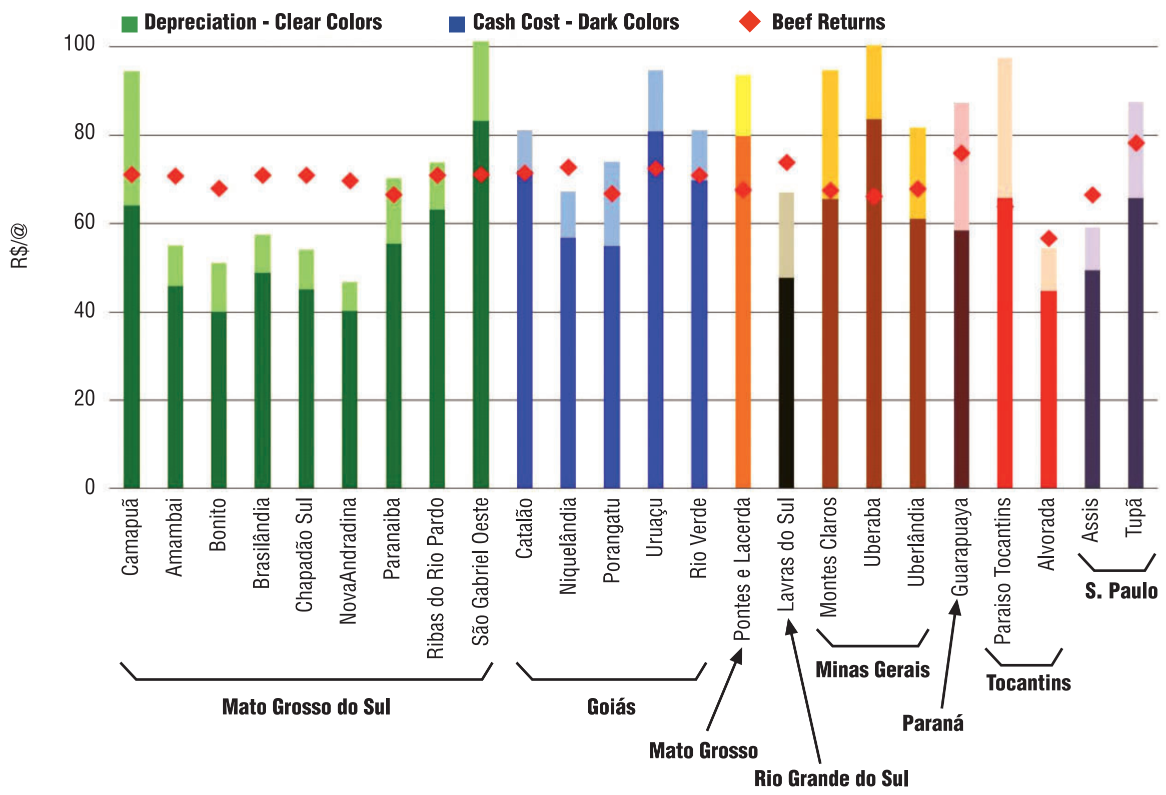
Bengtsson (2011) reported on beef production in Argentina. In order to optimize

Figure 3.1: Costs and Prices of Brazilian Beef (2004-2011)



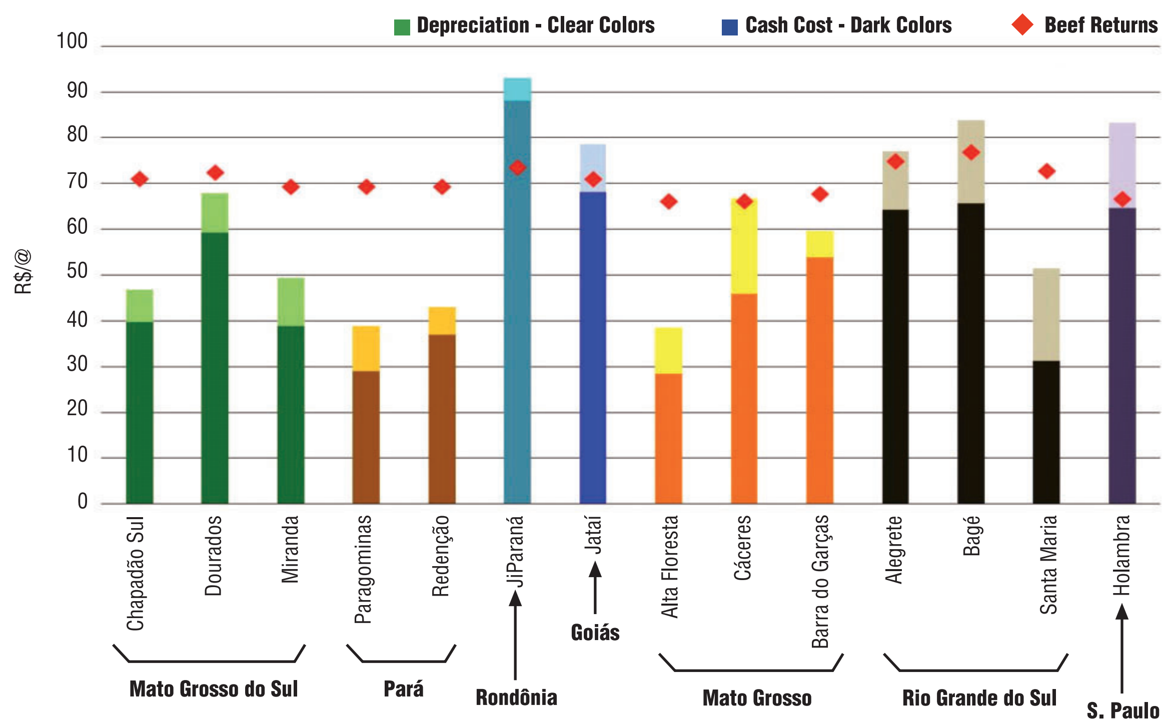
Source: Carvalho (2011).

Figure 3.2: Costs and Returns for Typical Brazilian Cow-Calf farm



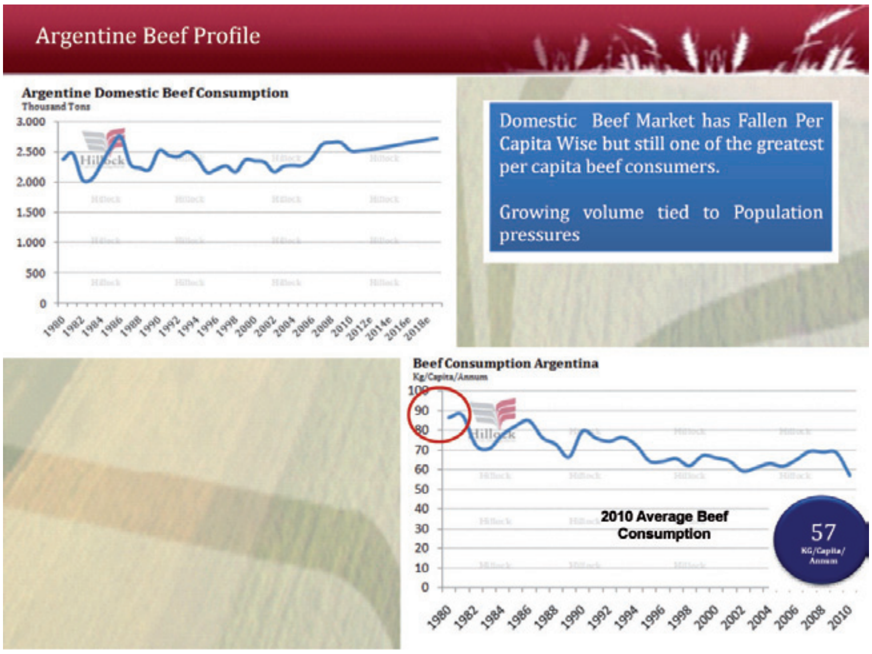
Source: Carvalho (2011).

Figure 3.3: Costs, Depreciation and returns for a Typical Brazilian Farm



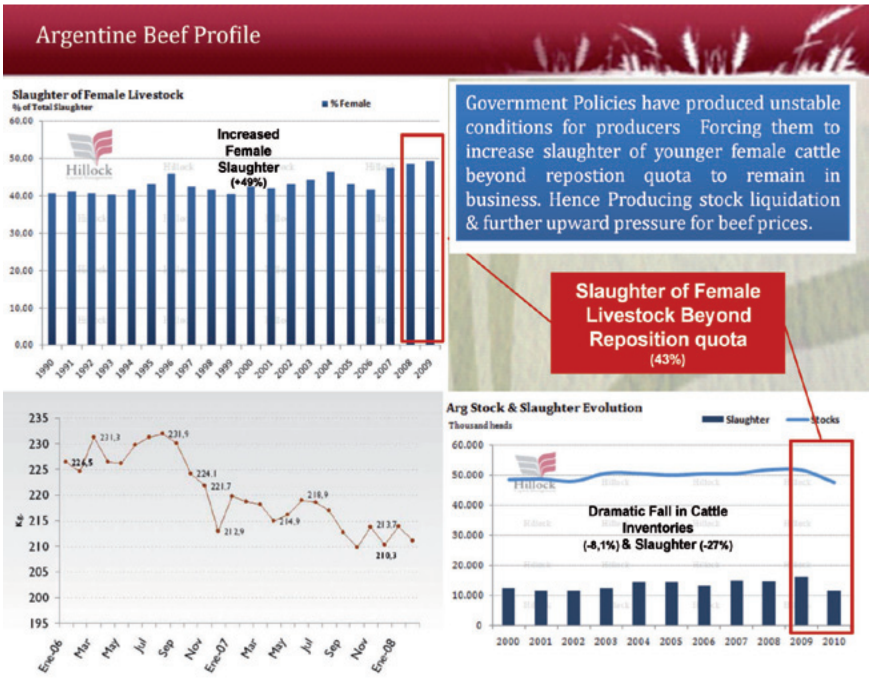
Source: Carvalho (2011).

Figure 3.4: Argentine Beef Consumption



Source: Bengtsson (2011).

Figure 3.5: Argentine Slaughter of female Livestock



Source: Bengtsson (2011).

production in each property to its full potential, they carefully design customized productive projects by getting involved in all operations and activities such as crop production, cattle raising and fattening, milk production, forestry and irrigation. Argentina is a major player in the beef industry maintaining approximately 51 million head. About 16 million head are slaughtered annually resulting in some 3.3 million tonnes of beef production. Domestic consumption (2.6 million tons) accounts for 79% of the beef produced. Annual per capita consumption has declined during the past 30 years from nearly 90 kg/capita in 1981 to 57 kg/capita in 2010 (Figure 3.4). Nevertheless, Argentina remains one of the greatest per capita beef consuming countries.

The Argentine beef sector has been reconverting. This is a result of an expansion of agriculture due to technological improvements that have enabled previously unfit land to be used for agriculture. This has shifted agriculture into traditional cattle land expelling beef producers to more marginal lands. Government policies have produced unstable conditions for producers forcing them to increase slaughter of female cattle (+49%) beyond reposition quota to remain in business. This has resulted in a dramatic fall in cattle inventories during 2009 and 2010 (Figure 3.5).

In order to benchmark costs nationwide there are several institutions in Argentina that publish reliable regional and national data for agricultural products. These include;

1. ***Argentine Association of Agricultural Consortium for Agricultural Experimentation (AACREA)***. The AACREA was founded in 1960 with the purpose of improving the business efficiency of the farmer. It is a network of farmers and experts in 18 regions consisting of 205 groups, 2000 producers and 200 technical individuals. The AACREA developed an agricultural management tool where every segment of the farm is considered as a different profit centre which should be profitable for itself carrying its own costs and selling goods or services to the other segments or profit centers at market costs.

2. ***National Organization for Animal and Food Sanitation and Quality (SENSA).*** SENA conducts strict controls on animal and food sanitation and quality. RENSPA forms are compulsory sworn statements that are completed annually. The program was originally used for sanitation control purposes but it currently intends to become a reliable traceability system for all agricultural commodities produced in Argentina.

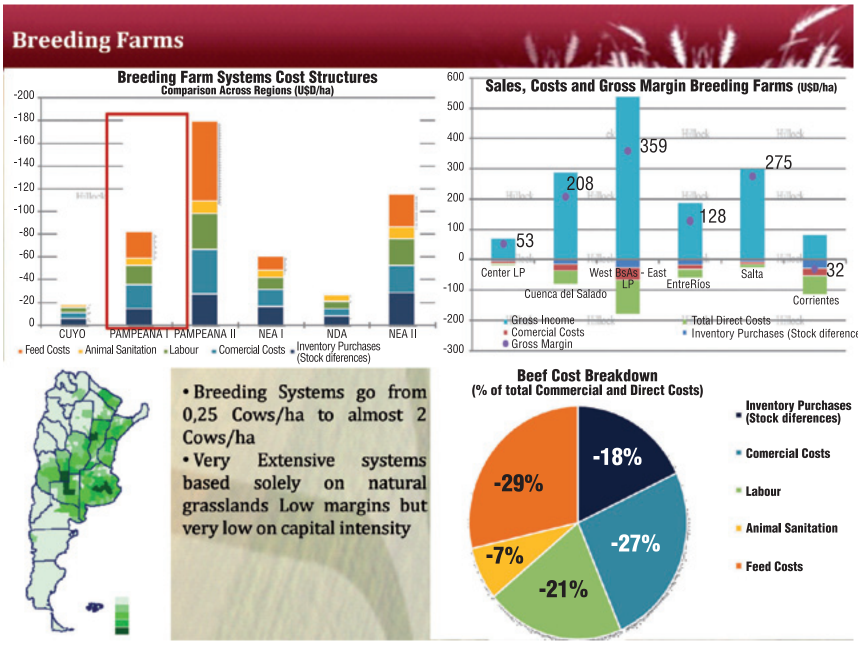
3. ***National Institute of Agricultural Technology (INTA).*** INTA continuously conducts field tests and research through stations located around Argentina.

The AACREA methodology evaluates farms for gross income (cattle and crop sales), commercial costs (sales commissions, sales taxes, freights and traceability cost), direct costs (seeding, chemical, contractor, feeding, sanitation, health and labour), overhead costs (structure costs and amortization) and opportunity costs. Beef production, both direct and commercial costs, are allocated directly to production using market values. Overhead costs include local and net worth taxes, property taxes, and management. Freight costs are from inside the farm gate to the nearest port. Feeding costs include hay, supplementation, corn silage, fodder crops, pasture amortization and maintenance. Opportunity costs include costs of maintenance and production inventories and opportunity costs for land rental.

Argentina is traditionally divided into five productive regions with different climate and land characteristics. These regions are the subtropical moonsonic (NOA), subtropical (NEA), semi-arid (CUYO), humid (PAMPEANA), and dessertic (PATAGONICA). Five types of beef production systems coexist in Argentina with each system in each area having a different cost structure. The five production systems are:

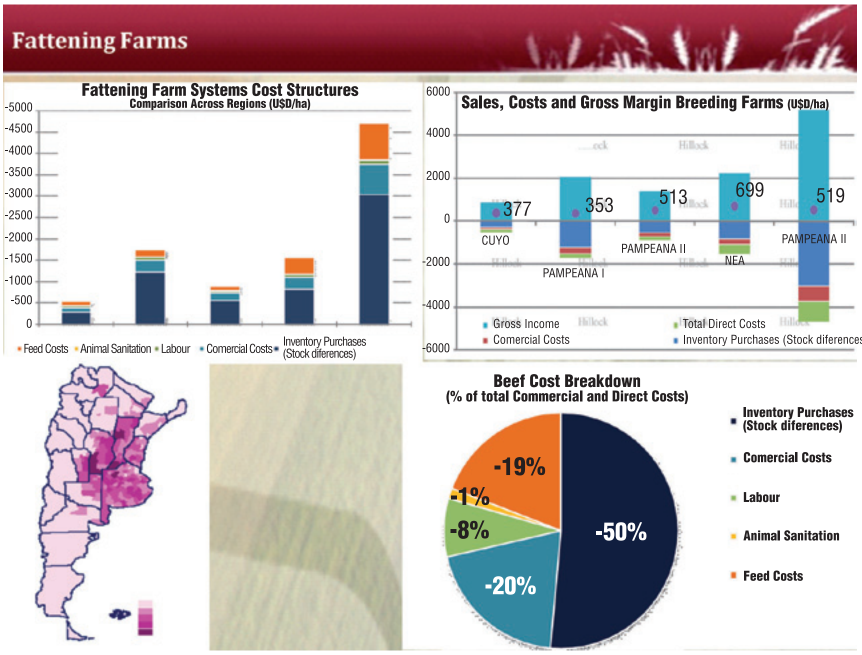
1. Breeding,
2. Rearing,
3. Breeding-Rearing,
4. Fattening, and
5. Complete Cycle.

Figure 3.6: Costs Structure and Gross Margin for Breeding Farms in Argentina



Source: Bengtsson (2011).

Figure 3.7: Cost structure and Gross Margins for fattening Farms in Argentina



Source: Bengtsson (2011).

The costs structures and gross margins for breeding and fattening farm systems in Argentina are summarized in Figures 3.6 & 3.7. The breeding operations are very extensive systems based solely on natural grasslands with low margins and very low capital intensity. These systems range from 0.25 cows per hectare to almost 2.0 cows per hectare. The breakdown of costs as a percentage of total commercial and direct costs was: inventory purchases (-18), commercial costs (-27), labour (-21), feed (-29) and animal sanitation (-7). The gross margin for this production system ranged from a low of U$D -32/ha to a high of U$D 359/ha.

The break-down of costs as a percentage of commercial and direct costs for fattening farms were: inventory purchases (-50), commercial costs (-20), labour (-8), animal and sanitation (-1), and feed costs (-19). The gross margin for these farms ranged from U$D 353/ha to U$D 699/ha.

Conclusions for the Argentine beef report were:

1) Management and CoP allocation methodology developed by AACREA has proven to be reliable and objective. This system is widely used throughout the Argentina farming sector and is currently used by farm management firms. The role of voluntary participation enabled a large network of farmers from every region. The role of INTAs' research and Senasas control and data base were also important factors.

2) More profitable activities such as agriculture and intensive fattening have forced beef production into marginal zones. Cow-calf enterprises have been forced to move to more marginal lands where breeding calves is the only choice. This same factor has led to intensification and new innovation of production systems in areas which traditionally used very extensive practices.

3) This progressive migration to marginal lands has reconverted beef production from the traditional extensive cattle breeding schemes to modern mixed production systems based on pastures, grain supplementation fodder crops and natural pastures.

4) Due to current political and economic situations in Argentina, the beef sector is going through a stagnation period and slowly recovering from erroneous government policies. In spite of this, the productive potential will tend to recover slowly with new investments.

3.2.3. Pork

Miele (2011a) reported on pork production costs in Brazil. The Embrapa swine and poultry team is composed of three rural economic

Table 3.2: *Summary of Variable Costs and Calculations for Pork*

Item	Coefficient	Price
Feed	Sows: kg/head/year Piglets and swine: kg/head	Declared market feed price X Calculated feed price based on ingredients market prices
Genetics	Sows and males Sperm dose	Purchase and cull market price Market price
Labor	Number of persons with full dedication for the standard scale	Family: minimum wage Hired: market wage + payroll charges
Electricity	kWh/sow/year or month (N and F)	Rural price
Medicines	Sows: mL or dose/litter Piglets and swine: mL or dose/head	Market price
Transportation	Distance	Market fees
Capital costs	6% p.a.	Long term interest rate
Maintenance	1% p.a. over investment	
Miscellaneous	2.5-3.0% over VC (in discussion)	
Social security	2.3% over producer gross income	

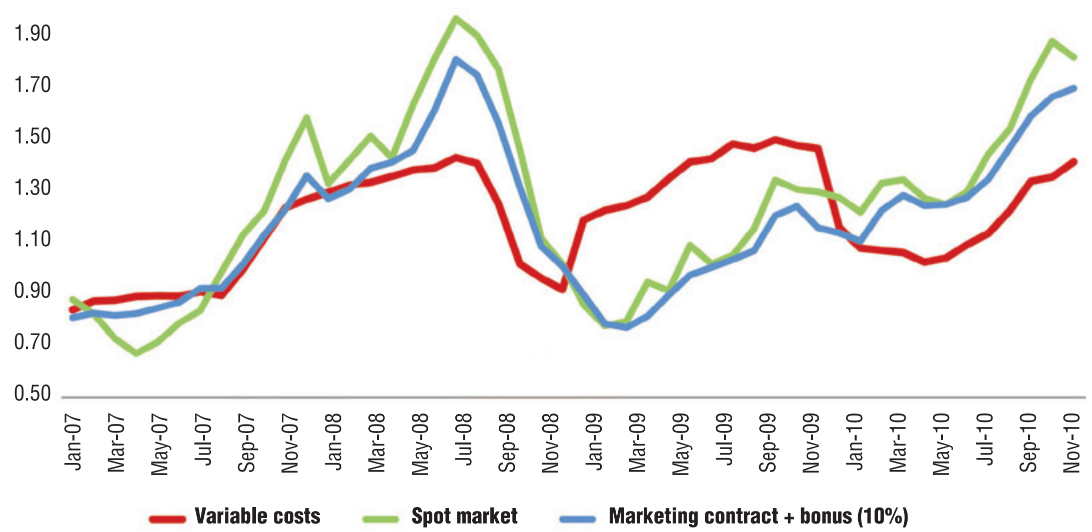
Source: Miele (2011a).

Table 3.3: *Sources of Information for Pork Costs in Brazil*

	Item	Source
Technical Coefficients	Investment	Panel with practitioners
	Labor	Producers and slaughterhouses
	Energy	
	Maintenance	
	Depreciation	
	Sows productivity and reproductive performance	Panel with practitioners and researchers Farm management database
	Weight and age	Panel with practitioners and researchers Slaughterhouses and panel
	FCR, feed formula Medicines prescriptions	Panel with practitioners and researchers Embrapa's Production Good Practices
	Prices	Conab Regional Offices Panel with practitioners Swine producers associations Slaughterhouses associations Rural economics institutions Cooperatives and industries

Source: Miele (2011a).

Figure 3.8: Cost and Price Evolution for Pork in Santa Catarina, Brazil

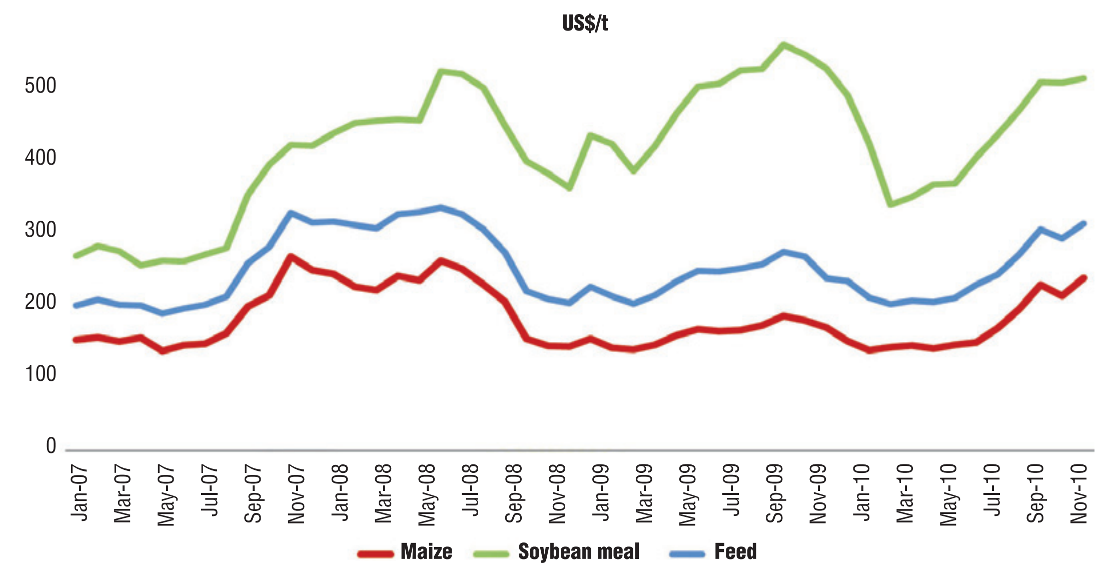


Source: Miele (2011a).

researchers, one rural economics assistant, and 49 swine and poultry researchers that help with technical expertise. Embrapa works cooperatively with Conab, the production costs division of the Ministry of Agriculture, Livestock and Food Supply on swine and poultry production costs. Conab has regional offices in 11 states in Brazil.

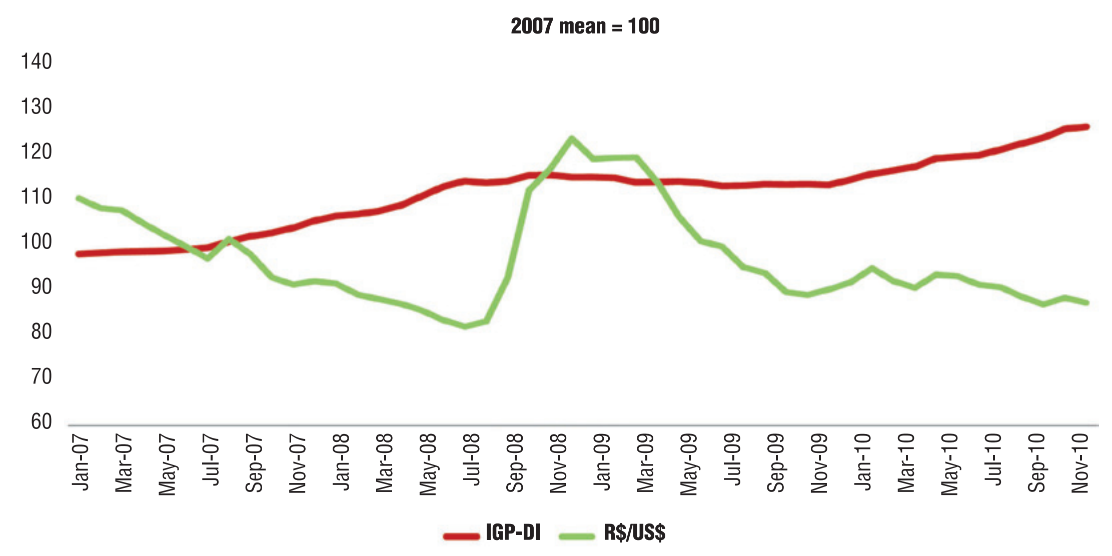
From a historical perspective, swine production costs have been collected for the south region (Santa Catarina) since the 1980s and poultry production costs since the 1990s. Swine and poultry production costs have been collected in the 11 main producer states in cooperation with Conab since 2005. Related projects include

Figure 3.9: Feed Price Evolution in Santa Catarina (2007-2010)



Source: Miele (2011a).

Figure 3.10: Inflation and Currency Exchange Rate (Brazil, 2007-2010)



Source: Miele (2011a).

the Swine and Poultry Information Centre, which conducts production costs and market analysis, Competitiveness and Public Policy Analysis, which conducts international comparisons (InterPig Network), impact of taxes and currency, and impact of technological changes, and Contract Costs.

Swine production in Brazil is divided into four major regions. The regions and their percentage of the swine heard are the north-east and north (24%), south-east (11%), south (48%), and central-west (18%). For swine slaughtered, the southern region had the highest percentage (69%) with the north-east and northern region slaughtering the lowest percentage (2%).

Types of swine production systems evaluated in Brazil are the farrow to finish, farrow to nursery, farrow to wean, nursery, and finishing. The farrow

Table 3.4: *Estimated Returns for Hogs in Iowa*

Estimated Returns for Farrowing and Finishing Hogs or Producing Weaned Pigs in Iowa[1/]												Addendum to M-1284c Cooperative Extension Service Iowa State University
	Production Period											
Farrowing Month:	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11
Sales Month:												
Sell 12# Feeder Pig	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11
Sell 270# Market Hog	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
Cost of Producing 12# Weaned Pigs:												
Com	58.98	60.48	65.97	72.53	78.72	85.98	94.04	102.27	105.88	114.12	116.92	
Soybean meal	31.00	31.76	31.12	31.90	33.36	34.00	35.18	35.12	35.13	34.06	34.46	
Vitamin & mineral	28.50	28.50	28.50	28.50	28.50	28.50	28.50	28.50	28.50	28.50	28.50	
Variable costs[2/]	173.59	173.61	173.61	173.64	173.67	173.70	173.75	173.80	173.91	173.96	173.95	
Operating Interest	4.51	4.58	4.66	4.77	4.82	4.94	5.08	5.20	5.25	5.36	5.34	
Fixed Costs	54.89	54.89	54.89	54.89	54.89	54.89	54.89	54.89	54.89	54.89	54.89	
Cost per 12# pig	37.00	37.24	37.76	38.55	39.36	40.21	41.20	42.08	42.48	43.25	43.59	
Sold as 12# feeder pig	40.71	39.71	40.68	39.62	40.62	45.75	51.93	50.98	43.40	39.29	34.82	
Profit (loss) per head	3.71	2.47	2.92	1.07	1.26	5.54	10.73	8.90	0.92	(3.96)	(8.77)	
Sow Value Change / Feeder Pig Sold	1.14	1.19	0.97	0.10	(0.53)	(0.57)	(0.60)	0.68	1.52	1.16	0.68	
Total Profit (loss) per head	4.85	3.66	3.88	1.17	0.73	4.97	10.12	9.58	2.44	(2.81)	(8.08)	
Cost of finishing 12-270# pigs:												
Feed costs:												
Com costs	53.81	58.35	62.01	65.47	68.46							
Soybean meal	20.67	20.98	21.34	21.58	21.57							
Dried distiller grain	2.58	2.79	2.96	3.13	3.24							
Vitamin & mineral	11.35	11.35	11.35	11.35	11.35							
Total feed costs	88.41	93.47	97.66	101.53	104.62							
Non-feed costs:												
Variable costs[3/]	21.83	21.86	21.91	21.94	21.95							
Operating Interest[4/]	2.95	3.08	3.21	3.32	3.38							
Fixed costs	8.45	8.45	8.45	8.45	8.45							
Average Market Hog. 270#:												
Total Costs/head	158.64	164.10	168.98	173.79	177.77							
Break-even price $/cwt.	58.75	60.78	62.58	64.37	65.84							
Selling price, $/cwt.	56.31	62.40	63.17	69.21	69.99							
Sales value	152.04	168.48	170.56	186.87	188.97							
Profit (loss) per head	(6.60)	4.38	1.58	13.08	11.20							
Sow Value Change / Hog Marketed	(0.13)	0.07	0.49	0.74	0.53							
Total Profit (loss) per head	(6.73)	4.45	2.07	13.82	11.73							

Source: Ellis (2011).

[1/] Numbers are in dollars per head, unless otherwise noted.

[2/] Variable costs per pig multiplied by 9.2 pigs per litter. Individual costs include: labor ($7.76), utilities ($1.54), vet/med ($2.32), feed delivery ($0.63), manure ($1.00).

[3/] Variable growing and finishing costs per pig include labor (3.67), utilities ($2.57), vet/med ($2.40), feed delivery ($3.68), manure ($2.00), production cost of pigs lost, and the additional cost of transporting finished hogs instead of feeder pigs.

to finish system has been evaluated in the south region of Brazil since 1980 and in the south-east, central-west, and north east regions since 2005. The farrow to nursery system has been evaluated in the south region since 2005 and the farrow to wean, nursery and finishing systems evaluated in the south region since 2010. Farrow to nursery and finishing systems have been evaluated in the central-west region since 2011.

The methodology for determining costs uses the following formula:

Total costs (TC) = Operational costs (OC) + Capital Costs (CC)

OC = Variable Costs (VC) +Depreciation (D)

CC = Fixed capital (FC) + Working capital (WC)

Calculations utilize average capital, straight line depreciation and variable costs derived from technical coefficients x market prices. The costs evaluated and details of their calculation are summarized in Tables 3.2 and 3.3.

Recent costs (2010) on a percentage basis for swine farmers were feed (71%), labour (7%), energy, maintenance and miscellaneous (7%), interest costs (4%), depreciation (5%), vet and medicines (4%) and breeding costs (2%). The cost composition for swine producers was labour (42%), depreciation (36%), energy (7%), Miscellaneous (7%), maintenance (6%), and insurance (2 %).

Regional differences in total costs for swine production in 2010 ranged from a low of US$ 0.99/kg live weight in the central-west region to as high as US$ 1.59/kg live weight in the north-east region. Tracking of variable costs and prices in Santa Catarina since January of 2007 has shown increases over this period (Figure 3.8).

The price of feed ingredients (i.e. maize and soybean meal) and swine feed from 2007 to 2011 has increased substantially in Santa Catarina (Figure 3.9). The price of maize in January of 2007 was approximately US$ 150 per ton but reached levels above US$ 300 per ton in 2008 and 2009. Soybean meal prices in January of 2007 were below US$ 300 per ton but increased to more than US$ 500 per ton in 2009. Total feed costs have increased from US$ 200 per ton in January of 2007 to more than US$ 300 per ton in 2011. Tracking of inflation and currency exchange rates during this same period shows an increase in inflation of about 25% while the exchange rate for currency (R$/US$) has declined (Figure 3.10).

The following challenges for analyzing pork production costs in Brazil were outlined: 1) comparability with changes in production systems and volatility of currency and exchange rates; 2) feed and medicine prices are inaccurate in some states; 3) discipline in schedule depends on making the results public in a comprehensible and easy form in Brazil and abroad; 4) all prices need to be collected and reviewed in a timely manner, and 5) the need to work with representative farms on an annual basis.

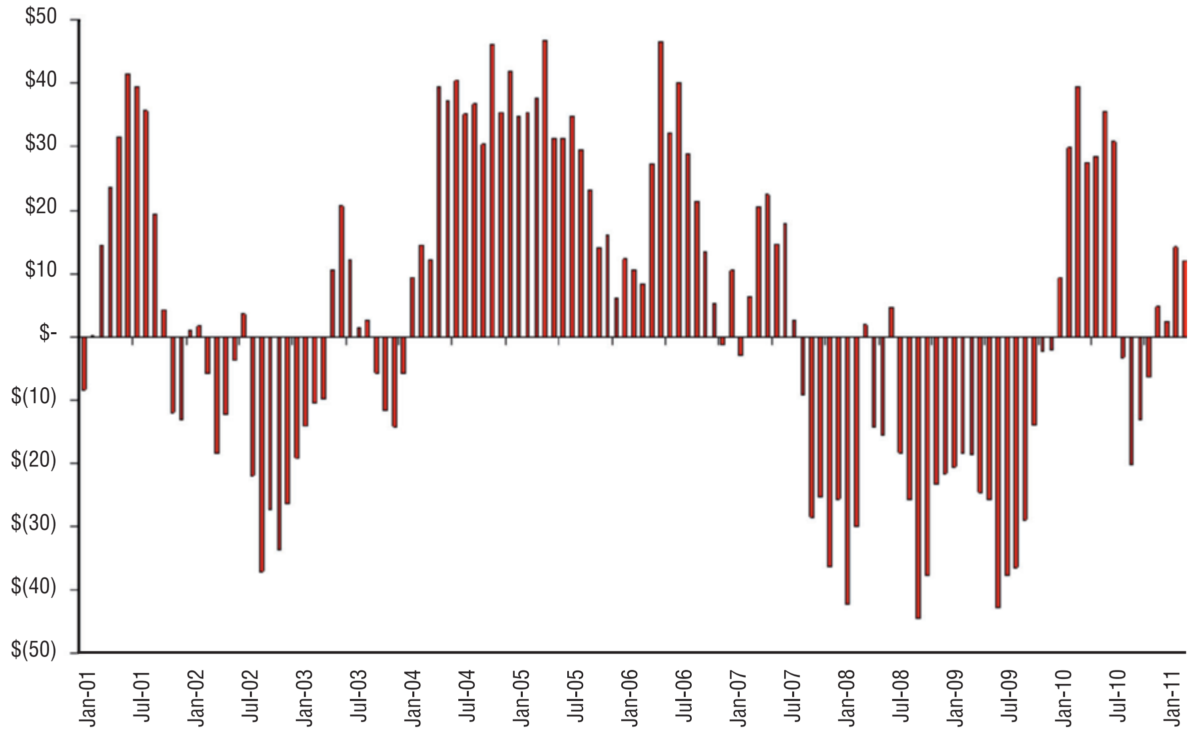
Ellis (2011) reported on hog production and cost structure in Iowa. Iowa uses a production cost estimated returns program as a barometer of profitability for the swine industry. Production costs are estimated for two production systems; 1) farrow to finish and 2) wean to finish. In recent years variable costs have become more volatile primarily as a result of increased feed costs. Corn prices have increased more than 100% while soybean prices have increased by 50%.

An example of a recent Iowa State University report on estimated costs for hogs produced in Iowa was provided (Table 3.4).

Total profit (loss) per head ranged from a low of ($6.73) in June of 2010 to a high of $13.82 in September of 2010.

Fixed costs include land value and taxes, and equipment and building depreciation. Building depreciation for farrowing barn is

Figure 3.11. Estimated Returns for Hog Operations in Iowa ($/Head)



Source: Ellis (2011).

Table 3.5: *Cost Percentages for Hogs in Iowa (2001-2011)*

Item	Jan. 2001	May 2011
Feed	45%	67%
Variable	38%	23%
Interest	3%	2%
Fixed	15%	8%

Source: Ellis (2011).

Table 3.6: *Cost Increases for Hogs in Iowa (2001-2011)*

Item	Jan. 2001	May 2011	% Change
Feed	$43.86	$119.42	172
Variable	$36.69	$ 40.23	10
Interest	$3.05	$ 3.89	28
Fixed	$14.22	14.22	0

Source: Ellis (2011).

calculated at $114/space/year, nursery at $10/space/year and finishing barn at $17/space/year. Assumed variable costs include vet and medicine, labour, utilities and repairs. Calculated variable costs include fuel, interest rates and death loss.

Estimated returns to farrow to finish hog production in Iowa from January 2001 to January 2011 were presented (Figure 3.11). Estimated returns per head of hogs produced in Iowa during this ten year period ranged from a low of nearly negative $50 to a high of close to plus $50. The estimates demonstrate a great deal of year to year variability in hog returns in Iowa during this period.

The various cost items for hog production in Iowa were compared as a percentage of total costs for January of 2001 and may of 2011(Table 3.5).

When costs per head were compared from January 2001 to May 2011, feed costs increased by 172%, variable costs increased by 10% and interest costs increased by 28% (Table 3.6).

3.2.4. Poultry

Miele (2011b) reported on poultry production costs in Brazil. Poultry production costs evaluations are a team effort with Embrapa and Conab cooperation as presented in the swine presentation for Brazil. The production systems evaluated for poultry and regional locations are outlined in Table 3.7.

The formula used for computing total cost (TC) is the same as used for swine in Brazil:

Total Cost (TC) = Operational Costs (OC) + Capital Costs

The variable costs and sources for poultry in Brazil are presented in Tables 3.8 and 3.9.

The costs composition on a percentage basis for poultry meat production in Brazil was feed (66%), breeding (17%), transport, loading and assistance (5%), labour (4%), energy (3%), depreciation (2%), and interest costs (2%).

The cost composition on a percentage basis for contract production was labour (27%), depreciation (26%), energy (15%0, poultry litter (12%), loading (10%), maintenance and insurance (6%), and miscellaneous (4%).

Regional differences in costs to produce poultry in Brazil are presented in Figure 3.12.

The central-west region had the lowest cost (US$ 0.922/kg live weight) with the north-east showing the largest cost (US$ 1.229/kg live weight).

Maize and soybean meal price evolution and inflation and currency rate changes in Brazil from January 2007 to November of 2010 are presented in Figures 3.9 and 3.10 of the swine section (page 67). The price of maize in January

Table 3.7: *Poultry Production Systems and regions in Brazil*

Period	Region	Production system	Market
1990 – 2004	SC (South region)	Manual feeding Automatic feeding Acclimatized (fan)	Putting out contract
2005 – 2011	South (3) Southeast (3) Central-West (3) North-east (2)	Manual feeding Automatic feeding Acclimatized (fan)	Putting out contract
Since 2010	South (3) Southeast (3) Central-West (3) North-east (2)	Conventional Acclimatized (fan) Acclimatized (exhausting)	Putting out contract

Source: Miele (2011b).

Table 3.8: *Variable Cost details for Poultry in Brazil:*

Item	Coefficient	Price
Feed	kg/head	Declared market feed price X Calculated feed price based on ingredients market prices
Genetics	Chick	Market price
Labour	Number of persons with full time dedication for the standard scale	Family: minimum wage Hired: market wage + payroll charges
Electricity	kWh/month or parcel	Rural price
Poultry litter	M^3/parcel and n. of parcels reused	Market prices
Heating	Firewood M^3/parcel	Market price
Medicines	In the feed	Market prices
Loading	Service (heads or m^2)	Market price
Transport	Distance	Market fees
Capital cost	6% p.a.	Long Term Interest Rate is an alternative
Maintenance	1% p.a. over investment	
Miscellaneous	1,0 – 3,0 % over VC (in discussion)	
Social security	2,3% over producer gross income	

Source: Miele (2011b).

of 2007 was US$ 150/t but reached levels of US$ 200/t in 2008 and 2009. Soybean meal prices in January of 2007 were below US$ 300/t but increased to more than US$ 500/t in 2009. Tracking of inflation and currency exchange rates during this period showed an increase in inflation of 25% while the exchange rate for currency (R$/US$) declined. Poultry feed price changes from January 2007 to November 2010 are presented in Figure 3.13.

The following challenges for analyzing poultry production costs in Brazil were outlined as: 1) comparability with changing production systems and volatility of currency exchange rates, 2) feed and medicine prices are inaccurate, 3) discipline is needed in price collection and making the result public in Brazil and abroad, and 4) implementation of a project with selected farmers to be observed by Embrapa and its' partners on an annual basis.

Cunningham (2011) reported on broiler production costs in the United States. The state of Georgia ranks number one in the production of broilers in the United States producing approximately 1.2 billion birds and 2.7 billion kg of meat each year. The economic impact of the broiler industry in Georgia is approximately $15 billion annually. Broiler production is supported by 15,000 grow-out houses on 4,000 farms within 23 integrated complexes.

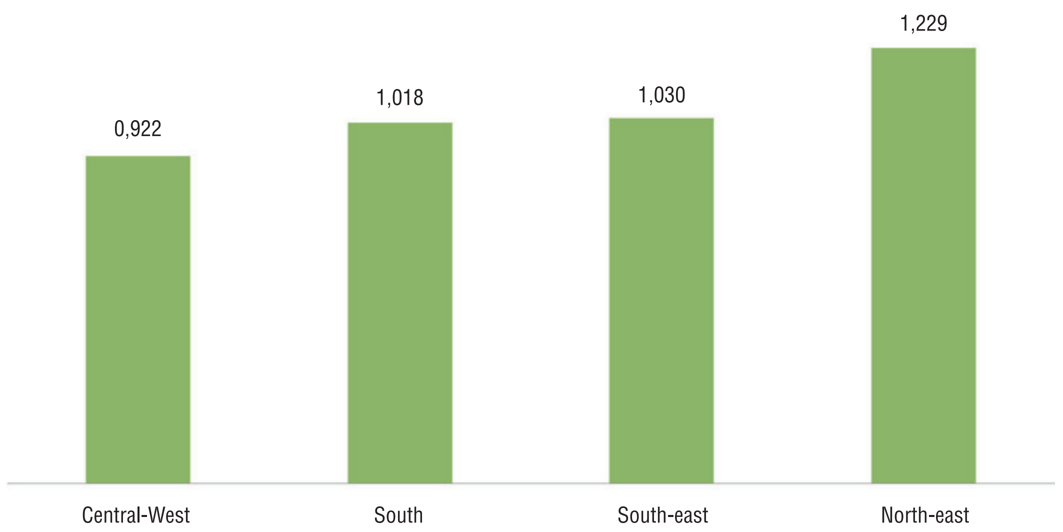
Table 3.9: *Sources for Poultry Cost Analysis in Brazil*

	Item	Source
Technical coefficients	Investment (system and scale) Labor Poultry litter Energy and heating Maintenance Depreciation	Panel with practitioners Producers and slaughterhouses negotiations
	FCR, feed formula Medicines prescription Poultry litter Weight and age	Panel with practitioners and researchers Embrapa's Production Good Practices Slaughterhouses and panel
	Prices	Conab Regional Offices at 11 states Panel with practitioners Poultry Producers State Associations Slaughterhouses State Associations Rural Economics State Institutions Cooperatives and industries

Source: Miele (2011b).

Figure 3.12: Regional Differences in Costs to produce Poultry in Brazil

(US$/kg live weight, Apr. 2011)

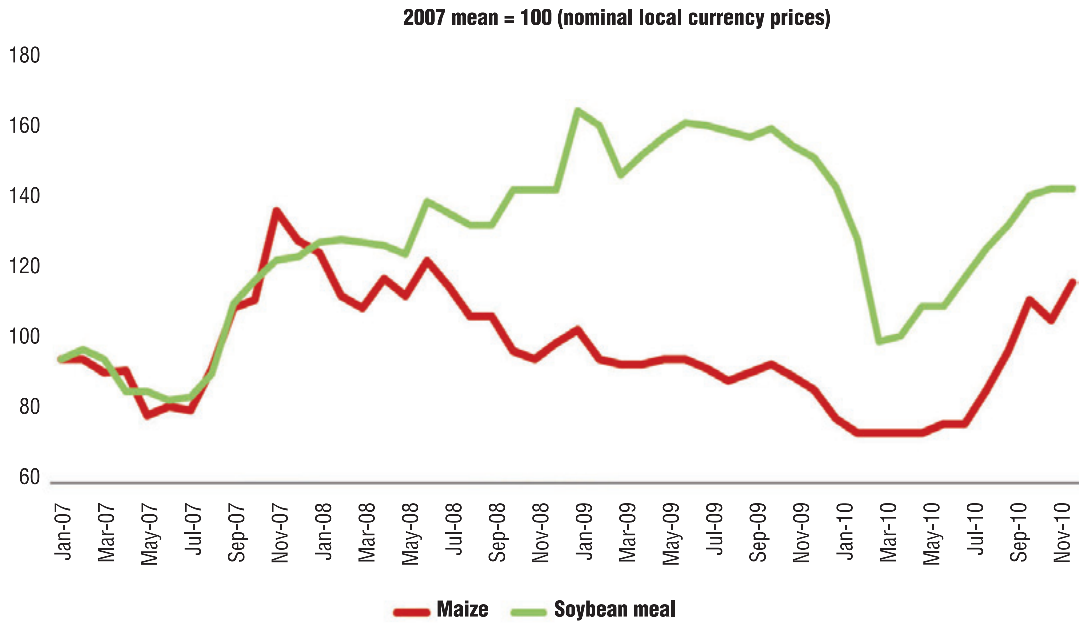


Source: Miele (2011b)

Commercial broiler production in the US employs a vertical integration system of production where companies own or control all of the key components of production. A key component of the vertical integration system is contract production where poultry companies provide farmers service contracts for the growing of chickens. This system has been in place in the US for nearly 60 years and represents one of the most successful agricultural businesses there.

Broiler contracts in the U.S. are structured such that the contract growers provide the land, labour, houses with equipment, utilities and litter.

Figure 3.13: Feed Price Evolution in Santa Catarina Brazil



Source: Miele (2011).

The poultry companies provide the chicks, feed, medicines, service programs, processing and marketing. Under the contract system, growers are paid on a price per pound of live weight produced (currently ~ $0.055/lb.). The contracts are competitive with growers with above average performances paid more than the base pay and growers with below average performance paid less than the base rate.

The Department of Poultry Science, University of Georgia, regularly publishes information on broiler costs and returns in Georgia (Cunningham and Fairchild, 2010). The information is obtained from surveys of growers, integrators, construction contractors, and bankers. The grower costs are based on an average of 40-45 farm records for each publication. The information is confidential and is published as a summary report only. Access to this information relies heavily on personal relationships developed between the University of Georgia and the poultry industry.

Costs and returns numbers for the most recent report (2009-2010) where provided for a typical four house broiler production farm in Georgia (Table 3.10).

Economic information related to broiler integrator costs and returns is not publically available in the United States. Although USDA collects and publishes economic analysis for some commodities, they do not provide economic information on poultry integrator costs and returns. Poultry companies in the US do, however, participate in a private service (*Agri Stats Inc., 6510 Mutual drive, Fort Wayne, IN 46825)* that provides detailed economic analysis and comparative data to poultry integrators. The confidential information is used extensively by poultry integrators for efficiency analysis (economic and production performances) and comparative standing within the industry. The information in these reports is presented in a coded fashion such that the identity of the individual companies and complex operations is not discernable to other participants. The individual companies are able to evaluate their performances relative to all other companies participating in the service and to address management and performance issues based on

Table 3.10: Costs and Returns for Georgia Broiler Growers (4 Houses)

Fixed Investment	
Tunnel house and equipment	$870,000
Manure removal equipment	$35,000
Manure storage	$8,000
Total Investment	**$913,000**
Grower Income	
4 house capacity (#chicks)	125,000
Batches/ year	5.5
Bird weight (lb.)	5.6
Capacity marketed (%)	96
Contract payment ($/lb.)	0.0545
Fuel bonus ($)	2,400
Litter (750 ton @ $12.00)	8,640
Total Gross Income	**$212,472**
Variable Costs	
Shavings	$4,800
Electricity	$14,990
Fuel	$24,900
Repairs & miscellaneous	$9,800
Equipment replacement	$4,074
Interest on capital	$2,343
Total Variable Costs	**$60,907**
Fixed Costs	
Building depreciation (5%)	$21,750
Equipment depreciation (6.6%)	$31,548
Interest on investment (7.5%)	$31,955
Insurance & taxes	$9,850
Owners labour	$14,400
Land	$600
Total Fixed Costs	**$110,103**
Grower Net Income	
Gross income	$212,472
Variable costs	$60,907
Fixed costs	$110,103
Net Income	**$41,462**

Source: Cunningham (2011).

their rankings within these reports. These reports are instrumental in improving poultry producer's competitiveness not only in the United States but from a global perspective as well.

Although integrator costs and returns information is not publically available in the US, recent costs and returns where estimated based on personal industry contacts (Table 3.11).

Table 3.11: Estimates for Georgia Broiler Integrator Costs and Returns

Item	2010	2011
Live production Costs ($/lb.)		
Chick Costs	0.045	0.045
Grower Costs	0.055	0.055
Feed Costs	0.235	0.325
Other	0.040	0.042
Total	**0.375**	**0.467**
RTC Costs ($/lb.)		
Eviscerated	**0.510**	**0.635**
Processing	0.222	0.230
General	0.090	0.090
Total	**0.820**	**0.955**
Georgia Dock Price ($/lb.)	**0.855**	**0.868**
Profit/ (Loss) ($/lb.)	**0.035**	**(0.087)**

Source: Cunningham (2011).

Based on the estimates provided for the US broiler industry costs and returns, most US integrators are expected to lose money in 2011. The economic conditions are similar to those experienced in 2008 where feed prices contributed to substantial losses for many producers. Feed prices, as a component of production costs now represent more than 70% of live production costs and have increased by more than 35% during the last half of 2010 and first half of 2011. Prior to 2008 feed costs typically ranged between 50-55% of live production costs.

Challenges for future poultry economic analysis in the US where provided as: 1) information on poultry economics not readily available to individuals outside the industry, 2) access to information therefore requires development of personal relationships, and 3) many production variables exists at the farm and integrator levels requiring large sample size for reliability of analysis.

3.3. Conclusions and Recommendations

Based on the reports for dairy, beef, pork and poultry from the participating countries it is apparent that the methodologies and agencies used to estimate production costs vary considerably from country to country. Variability within commodities with regard to production systems, farm size, regional differences and management programs complicate comparisons. In addition, different commodities also have different business models (e.g. contract vs. non-contract production). These variables raise issues with regard to sampling techniques, sampling sizes, sampling time periods, and accounting procedure differences between countries and commodities that make meaningful comparisons problematic.

Agencies involved in collecting and analyzing cost and returns data across countries included governmental, private, academic, industry and farm owner groups. Depending on the group or combination of groups involved, the purpose and agenda for collecting and disseminating the information can be different. For example, governmental and academic groups may be interested in providing service and education to all producers while private groups may have proprietary interests reserved for clients. In some cases relevant cost information is not publically available or easily obtained.

Different commodities have different business models that make cost comparisons difficult. Poultry and pork producers operate under a contract system in some countries and as individual non-contract producers in others. The economic factors for the two systems are substantially different and complicate comparisons for these commodities.

The methodologies used with regard to sampling vary considerably from country to country and represent a major obstacle in meaningful cost comparisons. Definitions of a "typical farm" differ substantially. For example, dairy farms in the IFCN network use size of the farm as a primary method for defining typical. Typical farms for IFCN ranged from one cow in the Ukraine to 351 cows in New Zealand. New Zealand uses five different production systems for their Dairybase program comparisons. For beef production, typical farms were defined by type of production with Brazil reporting on finishing farms and cow-calf farms whereas Argentina reported on breeding, rearing, breeding-rearing, fattening and complete cycle production models. For pork, Brazil reported on farrow to finish, farrow to nursery, farrow to wean, nursery and finishing production systems. For the United States, farrow to finish and wean to finish were the two systems compared. The US comparisons were based on estimated costs rather than sampling of farms. For poultry, production costs were compared for four regions of Brazil while costs for broiler producers in the US were based on a sample of poultry farms in the state of Georgia.

Sampling size and reporting period also varied from country to country and commodity to commodity. For the IFCN network sample size for dairy ranged from as few as 10 farms in Indonesia to as many as 1000 for China. For beef, comparisons in Brazil were based on 117 farms while Argentina reported that some 2,000 producers participate in their analysis. Reporting periods ranged from as frequently as monthly (US hogs) to as much as two years (US broilers). Cost and returns analysis for broilers in Georgia were based on a sample of approximately 40 farms every two years. The inherent variability of farms between countries, regions within countries, reporting periods, production models, and management systems, makes sampling size critical and problematic to achieving meaningful comparisons. The nature of these variables would likely require very large sampling numbers to result in any confidence in farm comparisons between countries. In addition, accuracy and validation of information collected is an issue for some reports. For example, Brazil reported problems with inaccuracy for feed and medicine prices in some states for pork and poultry analysis. The cost and returns reports for broiler production in Georgia rely on voluntary participation by farmers and personal relationships with producers without systematic validation of the data. The reports in Georgia are not intended to be a definitive statement on broiler costs but, rather, a general guide to current costs and returns for farms there.

Accounting methodologies utilized were very similar among reports. All reported the basic components of cost analysis (total costs = variable + fixed costs). Some reports also included total income estimates for the commodities. Components of the costs analysis, however, varied somewhat between reports. For example, Brazil reported administrative, tax and energy costs for beef producers while Argentina reported sales commissions, export and sales taxes, freight and traceability costs as part of their commercial costs. For labour costs, Brazil reported both hired labour and family labour while Argentina reported hired labour and management costs. For pork production Iowa reported on costs of production at the farm gate while Brazil included transportation costs to market. Brazil also included a cost for social security that was not included in the Iowa analysis. For poultry, Brazil included costs for loading, transportation and social security. Due to differences in the production systems, these costs were not part of the Georgia poultry analysis. The Georgia broiler analysis included an opportunity cost for land that was not included in the Brazil report.

The variability between methodologies and production systems makes commodity comparisons between countries difficult. The following is a summary of some of the major obstacles for meaningful comparisons:

- The need for representative sample size
- The need for accurate information
- The need for discipline and timing of data collection
- Defining the ‘typical’ farm
- Validation of data
- The need for consistent reporting cost categories

Although there are significant challenges to achieving meaningful international comparisons it may be possible with a central coordinating/directing group providing responsibility for a global approach. The IFCN program for reporting on global production costs for dairy is an example of the feasibility of such a program. A central coordinating/directing group could standardize methodologies, sampling size, reporting requirements and command the discipline necessary to produce meaningful results. Participation by various countries would depend, however, on available resources and commitment to the project.

Chapter 4. Production Cost Methodologies for Cereals and Arable Crops

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4.1. Introduction

The CoP is an economic indicator among others (margins, return on investment, etc.) that evaluates the economic performance of agricultural production. It is a useful indicator for comparing the performance of different production systems within the same farm or between farms, between regions and countries. The calculation of production cost of crops per tonne allows comparisons with output sale price and farmers to set marketing thresholds or to estimate the sustainability of different production systems. In addition, more detailed analysis of production costs can determine the factors of competitiveness and help to assess the impact of context changes (market prices, input prices, weather, political decisions, etc.). Moreover, the study of important sets of production costs also allows the assessment of competitiveness evolution over time.

There are many methods of calculating CoP throughout the world. Methodological differences in data collection and costs calculation could make international comparisons difficult. This report is based on the presentations and discussions of session 6 on cereals and arable crops of the workshop. It aims to achieve a state of the art of major studies on the subject and to conduct a critical analysis of the differences between these methods. This chapter will begin by clarifying the objectives of different studies and by defining the various costs of production calculations on field crops. Indeed, comparison results can be made if the costs of production are calculated with rather similar methodological choices. So, it is important to start by clarifying the purpose of the study. Then, by focusing on the various methods for calculating production costs, the chapter will aim to determine the main methodological differences. The chapter will also discuss the main challenges and opportunities for each method and try to give some recommendations to improve international comparisons of production costs.

The analysis and interpretations are in part based on the presentations of 22 June, session 6: Production cost for wheat in the United States (Lazarus, 2011); Production cost calculations in Ukraine (Slaston, 2011); Prairie Canadian Competitiveness and Dynamic Cost of Production (Schoney, 2011); and Global Production Cost Calculation - Cereals (Zimmer, 2011).

The report will detail the following studies: for the United States, the Agricultural Resource Management Study (ARMS) method from the USDA Economic Research Service; for Ukraine, a national method of production cost calculation: the 50-sg report method; for Canada, the method of study of the performance scale (Top Management/Top Win) will be appointed later in the Win-top method; and the method used in the agri benchmark cash crop project referred to as the agri benchmark method. Finally, we will analyse other studies which were not part of the workshop but which seem interesting and appropriate to include in the analysis. Indeed, in these other studies there are some other interesting approaches and methodological points to complete the analysis: a French national production cost observational study based on data from National Council of Rural Economy Centre (CNCER), referred to as the France Arvalis-Unigrains observatory, and also a study about international production cost comparison: the international Arvalis observatory. Moreover, in order to widen the analysis, the chapter will study methods of calculating production costs from the FADN, and the possibilities of international comparison within the FACEPA project (referred to as in the following text).

4.2. Which type of production cost?

In order to make comparisons between crop competitiveness studies, at first, it is necessary to agree on key hypotheses before going further in the methods.

4.2.1. Perimeter of calculating the cost of production

In the crops sector, the production cost is usually calculated per tonne of product, which allows a comparison with market prices.

To try to compare methods and results between studies, defining the scope of production costs calculation is essential; i.e. at which level of the supply chain are the calculations made.

It is important to determine whether the costs of production are only for agricultural production and thus calculate a cost of "farm gate" production or calculate the cost of "at port" production or even "at end users ". For "at port" production costs, storage, logistics and transport costs are added to the cost at the farm gate. "At port" or "at end user" production costs are very interesting when comparing competing products for export. For example, to the CoP calculated for wheat from the Canadian Great Plains, we must add the transport of wheat across 2000 km to export ports. Similarly, depending on the freight cost, the competitiveness for the production arriving in importing countries may differ from one exporter to another.

Most of the production costs in the different studies are calculated at "farm gate". Therefore, this chapter will be limited to this definition. It may be noted that the agri benchmark and Arvalis have made some "at port" and "at end-user" calculations.

4.2.2. Cash cost or Total cost?

There are different production cost calculations which can be simplified into two broad categories: cash costs or total costs.

The "cash" production cost:

Cash cost is a production cost that takes into account the costs disbursed during a campaign (all direct expenses, expenses of paid labour, loan repayments, rent, etc.). This "cash" cost of production determines a minimum production cost. If the crop income is equal to the cash production cost there is no deficit, but unpaid expenses such as depreciation, family labour, equity (capital, land) are not remunerated.

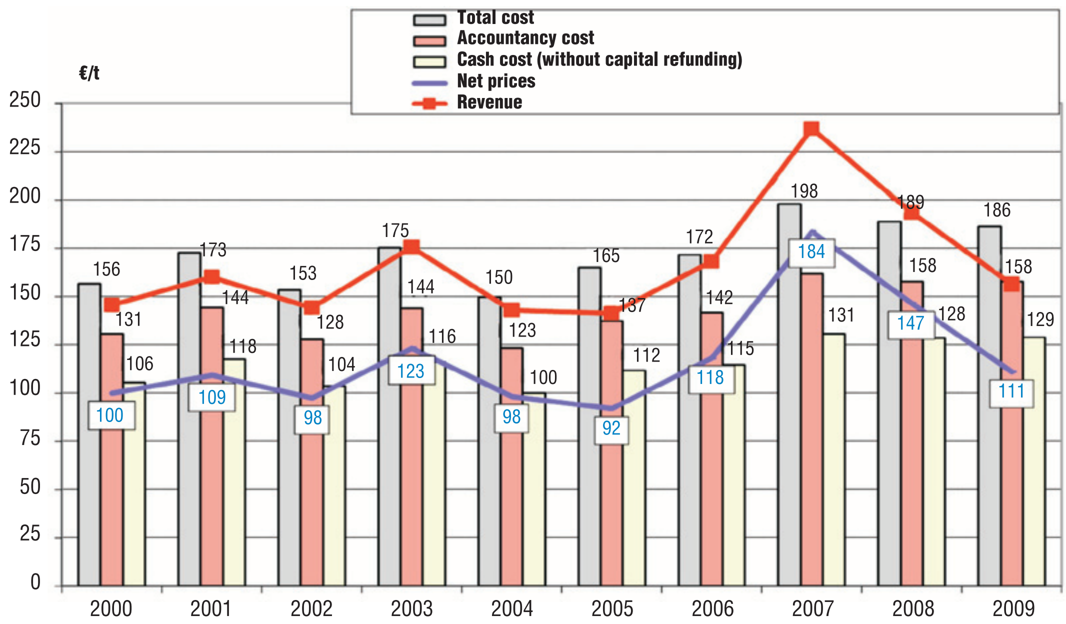
The "total" production cost:

A total production cost takes into account all charges with opportunity costs particularly for family labour and land. Machinery costs take into account all the charges including depreciation. Depreciation is either technical (based on hours of equipment use) or accounting according to the methods. The CoP includes all expenses of the production process and this study allows the assessment of the sustainability of production.

Figures 4.1, 4.2 and 4.3 give some illustration of the different costs that could be calculated, and also different ways to present the results.

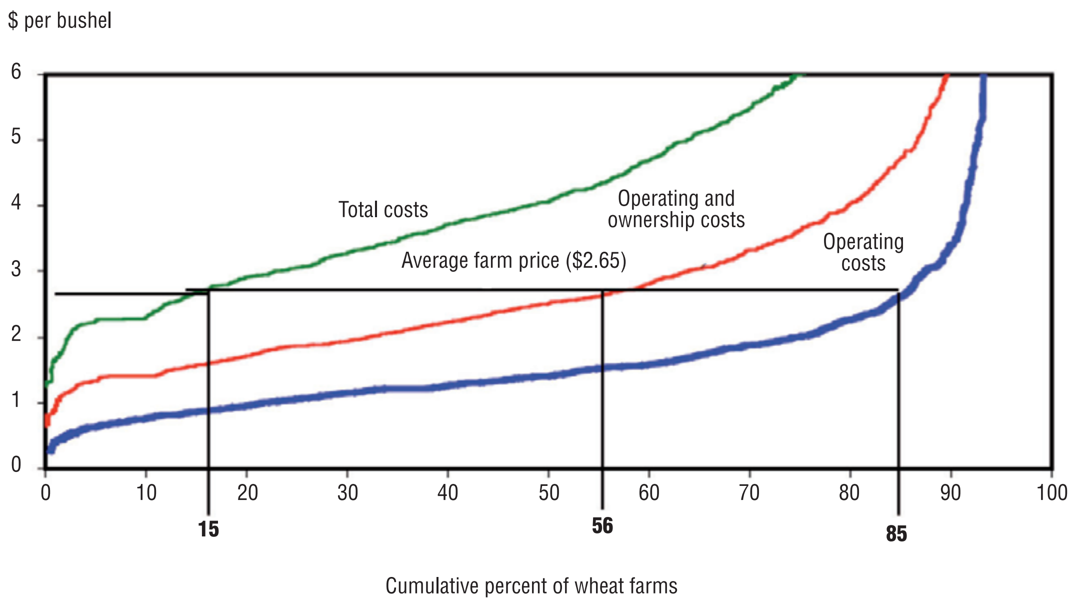
The comparison of cash cost and total cost enable us to better understand some phenomena. Indeed, in some situations when comparing total production costs to income, the total costs are consistently higher than incomes while the farms are efficient in the long-term. In this case, the comparison of cash costs helps us to better understand the situation

Figure 4.1: Cost of production of ARVALIS UNIGRAINS French wheat CNCER sample (2000-2009)



Source: ARVALIS UNIGRAINS French Wheat Farm Sample (CERFRANCE data 2000-2009).

Figure 4.2: Cumulative distribution of U.S wheat farm at different cost levels

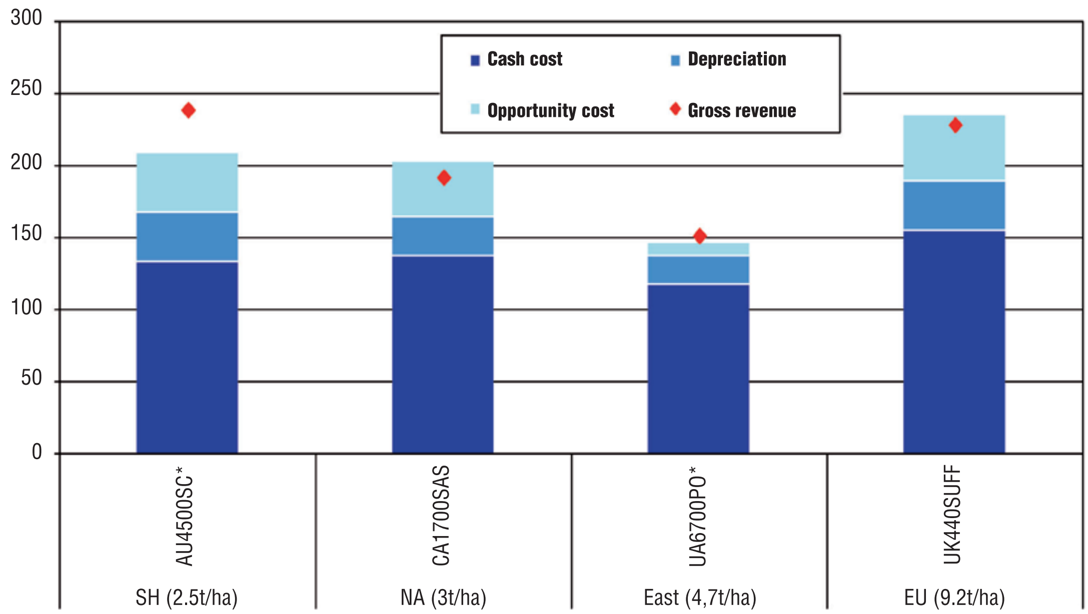


Source: USDA Agricultural Resource Management Study (1998).

and to put these first results into perspective. The inclusion of family labour and equity explains a major part of these differences.

However, the total cost of production allows comparisons between different systems and different countries with very different production contexts. Most comparisons of international production costs are made with production costs approaching a total production calculation. Thereafter we will study the total production cost.

Figure 4.3: Total cost ($/t) and gross revenue in wheat average 2008-2010 (Australia, Canada, Ukraine, and UK)



Source: Agri benchmark (2011).

4.3. Studies of competitiveness for different purposes

With the production costs calculated, the target sample and the method used depend on the study objectives, but also on the available resources. In the cases studied in this report, the main objectives of the studies are different.

If the objective is to determine an average competitiveness, with a distribution by production systems, and implement a monitoring of production cost evolution, it is necessary to ensure the representativeness of the sample base. This is often the case when the goal is to evaluate the impact of public policies or of different economic context on the competitiveness of agricultural production.

For example, the objective of the ARMS method is to have an average annual production cost per crop and for each United States department of Agriculture (USDA) agricultural region. There is also a desire to have a tool for monitoring the evolution of production costs (e.g. data since 1978 for wheat). The purpose of the France Arvalis-Unigrains observatory is similarly to follow the historical trend of French wheat and corn production costs. It may be noted that it is possible to perform average calculations also for the most efficient, or low-cost, 20%. The aim of the 50-sg report method (Ukraine) is to have representative production costs for average and large farms at national and regional levels.

The purpose of the production cost studies from the FADN is to study and compare competitiveness between the Member States of the European Union. Having long datasets of the evolution of costs, so to measure the impact of the general context and agricultural policies, is its main priority.

If we try to assess the competitiveness by focusing on efficient farms in order to have an idea of the production potential, representativeness is not crucial. Indeed the aims of such studies are to better understand the factors of competitiveness, i.e. what the explanatory factors are for a particular farm to produce at a given level of competitiveness.

The agri benchmark cash crop approach is intended to examine the competitiveness and the potential of different crop production regions. The aim is also to explain the competitiveness factors: not only "Measuring figures but looking behind; looking & understanding" (Isermeyer, 2011).

With the same idea, for the international Arvalis observatory, CoP is one indicator amongst others to assess the economic performance of different production systems. Other technical and economic indicators are calculated (e.g. labour productivity, numbers of hours worked/ ha, number of horse power / ha etc.). The production cost is also used as a diagnostic tool to determine the room for manoeuvre to evolve. International comparisons aim to place France in the worldwide competition, particularly in regards to competitors on export markets. Understanding the factors of competitiveness and their evolution in different areas of grain production worldwide is also an objective.

Studies running with the Win-tops method (Canada) try to assess the competitiveness of efficient farms with a diagnostic objective. Here, the CoP is not considered as an end in itself but as an indicator to assess the production's sensitivity to risk and the farms resilience. This is done through the utilisation of the Agent Based Simulation Model (ABSM) in order to analyse the dynamic changes of farms and to evaluate the impacts of agricultural policies.

Among the various studies' purposes, it is possible to distinguish two different goals: on one hand, the desire to obtain representative average costs and outcomes in terms of evolution, and on the other the desire to use the CoP as a diagnostic tool, to go further in the economic and technical analysis, to explain the performance factors and to evaluate room for manoeuvre.

4.4. Different methods to estimate the cost of production

The various studies on the competitiveness of crops have different objectives, which can explain the different methodological choices that we will try to explain later. Careless comparisons of results and conclusions of these studies may be difficult and even risky. Without attempting exhaustiveness, this chapter will try to provide some understanding on the main methodological differences observed.

4.4.1. Data Collection

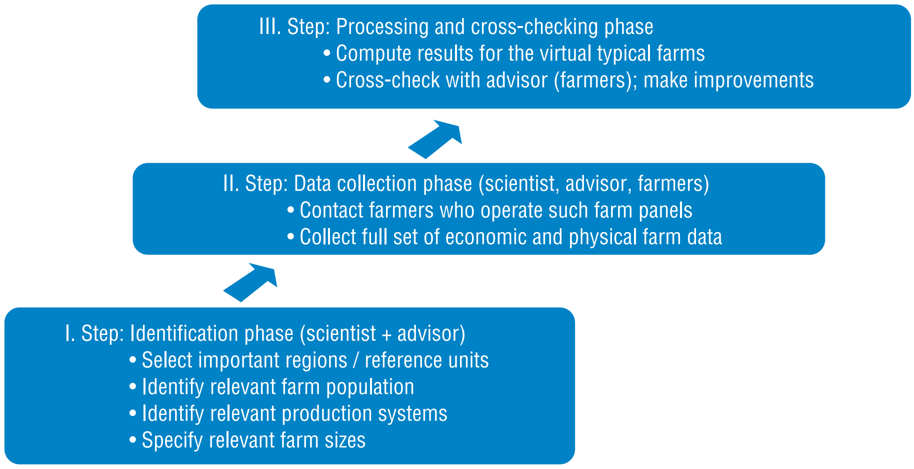
Target farms and sampling methods

Depending on the objective, the definition of the target, and thus of the sample to assess within the study, will be different.

If the goal is to evaluate an average production cost per country, per region, or for each major farming system, representativeness of the studied sample will be critical (Methods ARMS, 50-sg report, France Arvalis-Unigrains Observatory, FADN). Nevertheless, if the goal is to evaluate the production costs of performing farms (concept of production potential, anticipation of the future), or to characterise the economic impact of innovative practices (e.g. minimum tillage, low input system, organic farming etc.), then the representativeness is still important but is secondary compared to the needs of specific economic and technical data for further analysis.

In the ARMS method, each sampled farm represents a defined number of farms, which allow the data to be weighted and an estimation for the whole population to be provided. The definition of a farm is a business generating over $ 1,000 of agricultural products per year. Furthermore, the target population includes all farms operating an acre or more of the studied product. The primary sample comes from the National Agricultural Statistic Service (NASS) statistical basis by selecting the farms that exhibit certain characteristics. The second sampling is an area framed by random selection of selected agricultural land segments that are representative of all land for each farm.

Table 4.1: Method to specify a typical Agri benchmark farm



Source: Zimmer (2011).

In the France Arvalis-Unigrains observatory, calculations are made from a sample of 4000 farms from 14 departments (CNCER / UNIGRAINS collaboration). These farms are all part of a "management centre", have a cost accounting system and are specialised in crop production (OTEX 13, 14, 81, 82). Different departments are taken into account and their weight in the final production cost depends on their relative share of national production.

Concerning the 50-sg report method, farms considered in the sample are those which include at least one of the following characteristics: greater than 200 ha of cropped land or more than 20 employees or more than 150 000 hryvnia (UAH) of agricultural products' revenue.

For the agri benchmark method, the "typical farm" is based on a panel of farmers and advisers. The partner is responsible for the selection and representativeness of the farms. When there are different farms in a country, some are performing and some are the average. A process to select the typical farm is available to partners. Table 4.1 highlights the theoretical process.

In the international Arvalis observatory, "typical farms" in crop production are built from performing farms according to local experts (in the top 10-20%, and farms that will still be in place in ten years' time).

Regarding the Win-tops method in Canada, target farms are also chosen because of their efficiency and determined by an expert.

Data available for the analysis

The data available for analysis is different between various methods and samples. Some studies which focus on representativeness are directly based on the results of cost accounting (e.g. France Arvalis/Unigrains Observatory); other studies are also based on more aggregated data derived from accounts (FADN, 50-sg report). Studies developing an approach with "typical farms" based on the survey or panel's data rebuild the cost of production starting from the crop schedule (international Arvalis Observatory, agri benchmark). Other methods combine both; they use data from direct surveys and from other databases (ARMS).

Data available for calculations and analysis are also different from one study to another for various cost headings. Basically, there is data directly observed per crop, some data need to be recalculated and other data need to be reallocated to the crop.

Data directly observed per crop:

This data is directly from the farmer account or from the survey response, for example how much is paid for fertiliser by a farmer to produce a crop?

It is relatively straight forward for direct input but it could be more difficult for fuel for example because it is used not only for a single crop but for the entire farm.

Recalculated data:

For some data, particularly for input like home-grown seed or farm manure, a cost of opportunity could be used. So there is a valuation of the physical quantities with other data on input prices (i.e. national data base).

Data from a reallocation of total expenses to crop:

To calculate a cost of production per crop, the whole-farm costs have to be allocated to specific crops. Therefore there is a different allocation scheme according to the different methods. Table 4.2 reports an example of the methods used by the ARMS method to estimate the different items of the production cost.

The data available in the different studies enable us to calculate the CoP more or less easily and accurately. The data used in the FADN studies are aggregated at farm level and not per crop which requires the use of an econometric model to distribute all the cost between crops and to calculate production costs. The FACEPA (Farm Accountancy Cost Estimation and Policy Analysis of European Agriculture) project, of the European Community's Seventh Framework Programme, has developed econometric tools and methods to measure production costs for agricultural commodities in EU agriculture using the FADN (Farm Accountancy Data Network) data.

A benefit of having direct technical and economic data specific to the crop (machinery used, number of passages, inputs used, prices and doses etc.) is to be able to conduct more specific analysis on the determinants of the system competitiveness and to make simulations.

Updated data

The regularity and method of dataset updating is essential. While some methods (FADN, 50-sg report and France Arvalis-Unigrains Observatory) allow an annual update of all data including structure, it is not the case for the ARMS methods, or methods based on the "typical farm"

For the FADN method the update of the database is made every year, but due to treatment delay, the most recent data from the base is 2 years old. For the Arvalis Unigrains observatory, the analysis delay is approximately 1 year (one harvest before). There is also estimation for the current year.

Table 4.2: Approaches used to estimate commodity costs in US (Economic Research Service USDA)

Direct costing	Valuing input quantities	Indirect costing	Allocating whole-farm expenses
Purchased seed	Homegrown seed	Fuel, lube, & electric	General farm overhead
Fertilizer	Manure	Repairs	Taxes and insurance
Chemicals	Unpaid labor	Capital recovery	
Custom operations	Land		
Hired labor	Operating interest		
Purchased water	Ginning		

Source: Lazarus (2011).

Table 4.3: Approaches used to collect the data in different production cost studies

	ARMS	Ukraine 50 Sg report	FADN	Obersvatory France Arvalis-Unigrains	Agri benchmark	WinTops	Observatory international Arvalis
Main objectives	Average annual CoP by crop and by USDA agricultural region, evolution	Representative CoP at national and regional level	Representative CoP at european country level, long term series evolution	Evolution of the French wheat and corn CoP, medium and 20% low cost	Compare the competitiveness worldwide and explain the competitiveness factors	CoP of efficient canadian farm, diagnostic, teaching	Compare and explain the competitiveness worldwide for wheat and corn focus on the main exporter
Farms targeted and sampling methods	Each farm sampled represents a known number of farms. A farm : 1000$ of agricultural income >1 acres of crop considered	Farms> 200 ha of cultivated land or >20 employees or > 150 000 UAH of agricultural products revenue	Representative sample of professional farms with ecconomic Size Unit(ESU) criteria	Sample of 4000 farms with accounts specialized in crop production	"Typical farm" is based on a panel of farmers and advisers	Efficient farm determined by expert	"Typical farm" from performing farms according to expert in the study area (in the top 10%)
Up date	Farmers surveys conducted every 4-8 years for each production,updated every year based on estimates	Annual update of all data including structure	Annual update of all data including structure	Annual update of all data including structure	Input and commodities prices, yields updated every year, complete up date of "typical farm" every 2 to 4 years	No update	The update is almost annual for direct costs, labor, rent cost and yields update of the farms structures every 4-5 years

Concerning the ARMS method, estimates of production costs are based on farmers' surveys conducted every 4-8 years for each crop and updated every year based on estimates of annual prices, surface and technical innovations. For a given crop, during the campaigns with no survey, the changes are estimated using price index and other indicators. So there can be discontinuities when the new survey data replace previous estimates (changes regarding structure, techniques, sampling methods, etc.).

In the agri benchmark method, input prices, selling prices and changes in yields are updated every year. With statistics this gives an index of variability which can be applied to existing data. Depending on the speed of structural change and innovation development, a complete update of the "typical farm" is required (it is usually done every two to four years).

The update for the International Arvalis observatory is almost annual for operating expenses, labour, rent cost, selling prices and yields. The update of the farm structures is conducted every 4-5 years.

Changes in typical farms or irregular update of the farms' structures involve a difficult tracking of the competitiveness evolution over time. Methods with a representative sample and an annual update of all the expenses are better to study the evolution of production costs over the longer term. Moreover, the relative stability of the calculation method used is critical for studies regarding evolution or relative competitiveness comparisons.

Table 4.3 aims to summarise the information concerning the objectives, the farms targeted in the sample and the update of the different methods.

4.4.2. Main differing points in the calculation methods

The following section attempts to address the major methodological differences between calculation methods of crop production costs. Once again, it does not aim to be exhaustive in the comparison of methods, but tries to highlight the main points of divergence.

Valuation of organic fertilisers

The valuation of organic fertilisers may in some cases be significantly different between studies.

For the majority of the studied methods, the cost of non-purchased organic fertilisers is not included. However, in the ARMS method, costs of non-purchased organic fertilisers are valued at the fertiliser prices. First the fertilisation values are determined and then calculated with the market prices of fertiliser units.

In the agri benchmark calculation, taking into account the cost of non-purchased organic fertiliser depends on the geographic area where the farm is located. If the "typical farm" is located in an area where organic fertilisers are in excess, it is considered as free. But if the "typical farm" is in a deficit area of organic fertiliser, there is an opportunity cost with a consideration of nutrient units at half the price of mineral units.

Machinery costs

Machinery expenses are an important part of total expenses in the arable crop sector. Indeed, machinery and labour costs are often a major factor in the comparative competitiveness. Machinery costs are calculated according to different methods which can lead to bias in the analysis.

The ARMS method uses a capital recovery method to estimate asset ownership costs, using replacement prices for machinery. For agri benchmark, the depreciation is linear and is also based on the repurchase price of the equipment.

As far as the International Arvalis Observatory is concerned, machinery costs are calculated with a nonlinear "technical" depreciation based on replacement value and taking into account the use of materials and their durability.

For the Win-tops method, mechanisation charges can be calculated on replacement value or based on the use of materials. Fuel charges and repair charges are the actual one (if available).

For methods based on the results of cost accounting (FADN, France Arvalis-Unigrains Observatory) mechanisation charges are calculated from the depreciation available in cost accounting. This raises the question of a possible overestimation of mechanisation costs due to depreciation strategies related to taxation.

Cost of labour

Calculations of labour costs may also be a source of variation in the different methods results. Particularly the estimation of family labour may differ significantly.

For agri benchmark, an opportunity cost is used to pay family labour - how much the person would receive working outside the farm. In the ARMS calculation method too, family labour is an opportunity cost assessed in terms of unpaid labour hours and are valued using an estimate of the wages earned off-farm by farm operators. These opportunity costs for family labour are adjusted for age, education level and characteristics of the labour market. The calculation is derived from a regression in two steps: first the probability of working off-farm, then income.

In the international Arvalis observatory, family labour is valued at a tractor driver cost (net income) in the area concerned. For the France Arvalis-Unigrain Observatory, a number of family workers in farm are given in the accountancy. The number of hours assigned to an active full-time is 1600 h/year and the hourly cost is calculated in each region. Concerning the FADN, the family labour force is remunerated at the level of the regional agricultural worker wage of the type of farm. The region and database definition could also be a source of differences between the methods.

In the 50-sg report method, labour costs come directly from the accounting, the family labour cost is not taken into account.

Land costs

The inclusion of land costs may also be a source of bias between the methods of calculation. Indeed, the land enforcing modes (ownership, renting, different forms of sharecropping, etc.) sometimes make these cost assessments complex. In order to make comparisons between different systems, the opportunity costs are often calculated.

Concerning the ARMS method, land is valued according to the average cash rental rate for land producing the commodity in the particular area. Cost of land is valued at the land rent price from the farm part rented. Otherwise, the state average is used. For owned land, it is an opportunity cost based on the renting cost. However in some countries (e.g. United States, Argentina), rental costs are regularly negotiated and are therefore directly related to the sale price of crops. This method raises the question of the link between income and cost of crop land, especially in situations of fluctuating prices. In some alternative methods of calculation, for example the FINBIN (farm financial data base, Minnesota, United States) method the land cost is the real farmer cost which may account for much of the observed cost differences.

For agri benchmark and Arvalis, an opportunity cost for owned land based on the renting rate in the current zone is also used. For FADN, the family land is remunerated at the level of the regional land rent. The region definition could be another source of bias. Regarding the Win-tops method, a cash lease equivalent for farm land is used.

The 50 sg method does not take land in property into account. It is not such a big issue as 50 sg is calculated only for medium and big agricultural enterprises (they almost have no land in property - 99% is rented).

Interests and equity cost

When calculating the total CoP, the cost of access to finance is a factor taken into account through interests on loans and equity. This is even more crucial when comparing the competitiveness of different countries with very different economic contexts.

For ARMS method, there is long-term interest on machinery, buildings and short-term on input, fuel, repairs and oil. A long-run rate of return to farm assets out of current Income (10-year moving average) is used as the interest rate (1.23% for 2001-2010). Interest on operating inputs is based on the 6-month US Treasury Bill interest rate ("risk-free" rate). In the same way, for agri benchmark, there is interest and equity on input (rates of short-term loan and short-term deposit, less than one year) and on machinery and buildings (rates of long-term loan and long-term deposit). Similarly for FADN, other family assets are remunerated with the interest rate of 10 years National Treasury and long-term bonds.

France Arvalis-Unigrains Observatory, equity is made into a single charge including input machinery and buildings.

Regarding the International Arvalis Observatory, interests and equity are only on agricultural repurchase price machinery. These costs are neglected for inputs and buildings and not included in the analysis.

Table 4.4 shows the main differences between the studied methods concerning the valuation of organic fertiliser, machinery cost, labour cost, land cost and equity and interest.

Allocation of fixed costs to the crop

Fixed costs are expenses that are not directly related to one crop but to the whole farm. The allocation of these costs by crop is very important because the fixed costs (costs of mechanisation, labour and "overhead") represent an important part on crop production costs in agriculture.

Therefore it is clear that the differences in distribution of fixed costs between crops can lead to significant differences in the final results. In addition, as we shall see later, some expenses are allocated according to the income of crop in relation to total income. This may raise questions in the event of large variations in sale prices between crops. In particular, changes in costs per hectare can be artificially induced in response to changes in relative crop price.

The labour cost allocation to specific crops in ARMS are based on the number of hours worked per a given crop. A similar approach is applied by Win-tops; only costs not directly traceable such as overheads, farm taxes, insurance, etc. are allocated based on the share of each crop in the gross margin (share of total farm operating margin, value of production less operating costs). The cost allocation based on gross margins further raise questions in the event of negative gross margins.

The cost of mechanisation in the International Arvalis Observatory are calculated by crop based on the number of passes and hours actually given to mechanisation. The labour charges are distributed 30% per hectare and 70% depending on the hours in field worked on the crop. Other fixed costs are broken down per hectare.

Mechanisation and labour charges in agri benchmark are allocated to crops by the percentage of the total time of machines used in field. Overhead costs related to the entire farm (buildings, insurance, management fees, etc.) are assigned according to the share of each crop in the total income.

Table 4.4: Approaches used to calculate the different costs in different methods

	ARMS	Ukraine 50 Sg report	FADN	Obersvatory France Arvalis-Unigrains	Agri benchmark	WinTops	Observatory international Arvalis
Valuation of organic fertilizers	Valuation of the fertilizer units at the market prices	Not purchased organic fertilizers are considered as free	Not purchased organic fertilizers are considered as free	Not purchased organic fertilizers are considered as free	Free or an opportunity cost depending on the area	No information	Not purchased organic fertilizers are considered as free
Machinery cost	Capital recovery method using replacement prices for machinery	Depreciation available in cost accounting	Depreciation available in cost accounting	Depreciation available in cost accounting	Linear depreciation based on the repurchase price of the equipment	Replacement value or based on the use of materials	Nonlinear "technical" depreciation based on replacement value but taking into account the use of materials and their durability
Cost of labor in particular family labor	An opportunity cost is used for family labor	Costs of labor directly from accounting, family labor cost is not taken into account	Family labor force remunerated at the level of the Regional Agricultural Wages worker of the type of farm	Nb of family worker is given an active full-time is 1600 h / year the regional hourly cost is calculated	An opportunity cost is used for family labor	No information	Family labor is valued at the cost of a tractor driver in the area concerned
Land cost	Cost of land is valued at the land rent price from the farm part rented,otherwise the state average is used	Property land isn't take in account (99% rented)	Family land is remunerated at the level of the regional land rent	Cost of land is valued at the land rent price from the farm part rented	Opportunity cost for land owned based on the cost of renting in the current zone	Cash lease equivalent for farm land	Opportunity cost for land owned based on the cost of renting in the current zone
Interests and equity cost	Long-term Interest and equity on machinery, buildings, short term on input	Finance interest and equity from accounting	Other family assets remunerated with the interest rate of 10 years	A single charges included input machine and building	Long-term Interest and equity on machinery, buildings, short term on input	No information	Interest and equity only on equipment

France Arvalis-Unigrains Observatory: the distribution of overhead and labour costs is made in proportion to the crop income. The mechanisation charges are spread per hectare unless part of the industrial crops (sugar beet + potato) is greater than 10% or for potato is greater than 5% of the total area. In this case, costs of mechanisation are allocated based on the part of the crop income considered in relation to the total income.

The allocation key in the 50 sg report method is original. Indeed, production overhead costs are allocated in proportion to the direct expenses of the crop from the direct costs of all crops. This method of allocation of costs to specific crops is interesting because it is not related to the crop sale price. General overhead costs, interest and return on equity are allocated based on the share of each crop income.

With respect to the FADN, the allocation of all costs categories to specific crops largely depends on the approach undertaken which often is based on econometric estimation. The application of the econometric model might be questionable in the context of fluctuating sales prices and purchase input prices.

Commodities selling prices

Selling prices used for comparison to production costs in studies may be different (e.g. price at harvest or after the end of the marketing season), which also induces bias in the analysis. The pricing period taken into account may differ either by method choice (e.g. harvest crop prices) or because of producers' trade policy (e.g. storage). This is especially important in the current price volatility context. In addition, sales prices and production costs can vary depending on quality, so it is also important to carefully determine and communicate the quality considered.

In the ARMS method, the production costs take all costs incurred in the production of each product into account, excluding the costs of marketing and storage. Therefore income is calculated using a harvest-period price (an average price by state and month of harvest). In reality farmers are delaying the sale by storing their products to sell at a higher price than the sum price at harvest and storage cost over transport. It means that revenues calculated are slightly underestimated relative to actual income received by farmers.

The agri benchmark selling prices are estimated by the partner of the average prices for the typical farm at the data collection time.

The international Arvalis observatory uses selling prices from the same marketing year. Attention is paid to the differentiation of selling prices according to wheat quality. The quality of wheat grains considered are CRWS and HRW standards for Canada and the United States, Class 4 for Russia and Ukraine, and Trigo pan for Argentina, etc.

The other methods used the real farmer prices present in the account.

Table 4.5 shows the main differences concerning the cost allocation to crop, and selling prices.

4.4.3. Challenges and opportunities of the different methods

During the presentations and discussions, the workshop participants highlighted ways of improvement and future challenges for the different methods towards calculating CoP and their comparisons. Some concerns are common to different studies and others are more specific. For example, a major concern is the difficulty to obtain information directly from farmers. Farmers are increasingly less willing to share their data freely. Further difficulty is the cost and time required to collect and analyse data. This can lead to delays in the analysis, in particular to update detailed studies.

Table 4.5: Approaches used to allocate the different costs and to estimate selling prices in different method

	ARMS	Ukraine 50 Sg report	FADN	Obersvatory France Arvalis-Unigrains	Agri benchmark	WinTops	Observatory international Arvalis
Allocation of labor cost	Nb hours by crop	Share of direct cost in the total direct cost	All charges including direct cost are allocated by crop with econmetric model	Share of each crop in total income	Share of time of work on each crop in the total time of work	Direct use is based on actual in field use or 2) gross margin for indirect use (includes hours of indirect use)	Distributed 30% per hectare and 70% depending on the hours in field worked on the crop
Allocation of machinery cost	Cost by hectare			The machinery charges are spread per hectare unless there is a significant part of industrial crops --> allocated based on the share of each crop in the total income			Calculated by crop based on the number of passes
Allocation of overhead cost	Share of each crop in the total gross margin	Share of each crop in the total income		Share of each crop in the total income	Share of each crop in the total income	share of each crop in the total gross margin	Cost by ha
Commodities selling prices	Regional harvest-period price	Farmer prices	Farmer prices	Farmers prices	Average price	Farmer prices	Average prices

Methods based on comparisons of "typical farms" like the agri benchmark cash crop or international Arvalis observatory have to evaluate and develop the representativeness of their data, for example, in backing the "typical farm" with statistics. But complete agricultural statistics are not available in all the analysed countries and the statistics are not always usable in relation to the sample chosen.

For the ARMS method, William Lazarus suggested some points of the method which could possibly be improved. For example, compared with other sources, the costs of pesticides are probably underestimated. Moreover, the estimation for family labour can be reviewed (regression from 1988 data). Concerning mechanisation, works on the use and depreciation life of equipment are required. There are also recent interesting works to better consider the costs of maintenance and repair.

For the agri benchmark, an area for improvement is to reach the real selling price and it appear to depend on the time of data collection. If we want the data to be as up to date as possible, selling prices are often an estimation. Indeed, during the period of data collection the sale campaign of commodities is not complete so the final sale price is unknown. Yelto Zimmer opined the need to improve the consideration of the opportunity family labour especially for small-sized farms, as well as the costs for organic fertilisers.

Roman Slaston focused on the difficulty in distinguishing technologies (e.g. tillage, no till, direct seeding, etc.) used on farms in the results of the 50 sg report. Similarly, the previous crop effect is not sufficiently taken into account. The level of detail is often too low for relevant analysis and values are sometimes aberrant compared to reality. Data on pesticides are missing. In addition, the different accounting policies can cause problems later in the analysis. According to Slaston, a better definition of the quality of inputs and outputs would also help refine the analysis.

According to Dick Schoney, calculations of CoP studies are "one shot" and static, and are primarily used as a diagnostic tool. They do not take sufficient account of the notion of risk and change. The study of production costs alone does not determine the resilience of systems. Also, in his view, other points are to be developed such as better taking into account of the quality of products or transport costs. Similarly, we must seek to better integrate the rotational effects into production costs and improve the allocation of fixed costs to crop. Works on the environmental externalities of production, and the economic impacts of environmental measures, also require development.

4.5. International comparisons of crop production costs

4.5.1. Main challenges

The purpose of the next section is to highlight some important points to keep in mind when comparing international costs of production, in particular in relation to the main points of discussion at the workshop.

Exchange rate

When carrying out international comparisons of production costs, attention needs to be paid to exchange rates. In most cases the comparisons are expressed in \$/t or in €/t. The exchange rates are often averaged for the year. Recent changes in exchange rates, particularly following the financial crisis, have influenced crop competitiveness, in particular for export. In addition, the variability of exchange rates during a production campaign can be very high and can affect the costs of imported inputs and the selling prices of products. This is particularly true for Ukraine in 2009-2010, where fertilisers were purchased at high prices and selling prices were low. An average exchange rate for the year cannot account for this phenomenon.

Representativeness

The issue of representativeness and the choice of "typical farm" as in the agri benchmark studies, or the international Arvalis observatory, is a central point. The link between statistics and a "typical farm" has to be questioned.

It is possible to move the characteristics of the "typical farm" closer to the local statistics particularly in terms of cropping patterns, yields and structures. This is the first step to connect the "typical farm" to the agricultural statistics available in different countries.

Farms' structural evolution

How does a "typical farm" evolve over the years in terms of structure and innovation? In the case of agri benchmark, "typical farms" are updated in terms of structure every 2-4 years. This captures the changes in structures, crop rotation and development of innovative practices and technologies. However, this could imply some important changes in production costs following the update of the farm structure and makes the study of long production cost series difficult. The analysis is true to a lesser extent for the ARMS/USDA method. For example if the objective is to study the impact of rising energy costs on the evolution of production costs, methods based on a representative sample will certainly be more appropriate.

Cultivation of marginal lands and impacts on production costs

The high selling crop prices, and resulting attractive margins, are a strong incentive for farmers to cultivate marginal lands. These new areas for cultivation are of low productive potential and are only profitable to grow in favourable economic contexts. This may be the case for example in Australia, where lands in areas receiving less precipitation are cropped when profitability allows. Crops on these marginal lands will therefore have a higher production cost which will mechanically increase the average CoP. This can involve many hectares in different countries (Australia, Brazil, Russia, Ukraine, etc.), and it could be difficult for the studies based on "typical farms" to take this into account.

If these marginal lands are cultivated over a long period, they are theoretically captured by the farm structure updates. Moreover, it is possible to add new "typical farms" to reflect this reality. However this requires a multiplication of "typical farms" to study and therefore more work time. It must also be borne in mind that this reality is not instantaneous.

The rotation effects

Farmers grow different crops in rotation and this is for various agronomic reasons (fight against pests and diseases specific to certain crops, weed management, nitrogen effect, etc.), or work organisation (spread out the peak work at harvesting or seeding) but also to manage climatic risks and selling price risks on different crops. All these rotation effects are important for farmers, but are not sufficiently taken into account by crop production cost approaches. Similarly, phosphorus and potash fertilisation is often performed in the rotation or at least for several crops, but with the methods of calculating CoP there is a risk of affecting all the charges on a single crop. The allocation to the crop of some regulatory aspect like cover crop also poses questions.

Some crops, such as pulses, have a positive effect on the following crop. A wheat with a pulse as the previous crop does not often obtain the same yield or the same operating expenses above as a wheat with another wheat as the previous crop. Indeed, different approaches to calculate costs of production take such issues into account poorly. It must be noted that it is possible to separate crops according to their previous cultural with the approaches of a "typical farm".

Reliability of data in changing economic contexts

The consideration of risk, and particularly of the variability of production costs in general, is not sufficiently developed in production cost comparisons. Dispersion and variability of results in a single year, or over time, are generally not well made in the results of competitiveness studies. In particular, yields, and therefore production costs, can be variable in some countries especially in marginal production areas. Also the quality of obtained products can be variable depending on the year in some areas.

In addition, recent economic contexts of agricultural production are fluctuating. Indeed, prices of products, but also the purchase prices of inputs (fertilisers and oil-related energy costs), are highly variable in recent years.

4.5.2. How can we compare results from different methods?

Ensuring the equivalence of the charges included in the calculation

The results of different studies of crop production costs can be compared if it has been previously verified that the charges considered and the methods to calculate and allocate them by crop are close. This is particularly important for costs of irrigation and drying mainly for corn or labour charges (including social security charges for managers) or crop insurance. Indeed, these charges, for example, are often treated differently and may explain some of the differences in results across studies.

Another point of attention for costs allocation, mainly land, labour or mechanisation, is when two crops are grown in the same year on the same parcel which is very common in South America.

Comparing the cost item by item, in order to go further in the analysis of competitiveness factors, can be complex because the definition of cost item in the various studies could be different. Therefore if the desire is to make detailed comparisons, it is necessary to have the different cost items and their method of calculation. Here, a restatement in order to have a common result presentation format may be useful to facilitate comparisons.

Table 4.6 gives an example of a reporting format for ARMS, the agri benchmark and Arvalis international observatory. We can see that in order to do an accurate comparison between the results of the three methods, we need to reorganize the different items. In particular fuel, repairs and contract operation are sometimes counted as direct costs or as machinery costs. The equity and interest cost are not always included in the same way.

Ensuring that the target is equivalent

Having a precise definition of the "typical farm" studied, or of the core sample of the calculation, is crucial in order to compare the results of different studies. For example, in some countries the crop production is clearly divided into two categories between efficient farms, competitive regarding the global market, and the smaller farms in near self-sufficiency or orientated to the domestic market. In this case, it is illusory to compare the cost of wheat production of the country's average with the production cost of a high performing farm.

In order to compare the production costs of a crop, we must also try to identify the quality aspect (e.g. protein content of wheat) because the sale price as well as the CoP may be different, indeed the dynamic of the crop and yield could be different. The accuracy of the product quality in the study's results may be relevant.

Furthermore, it must also be checked that the studied areas are comparable. Indeed, some countries have very different soil and climatic conditions, and thus yields and production costs are very heterogeneous within the same country or region. For example, in Russia the production potentials are very different between the central black earth region, Siberia and the Kuban region

Table 4.6: Example results presentation in various posts of charges for 3 different methods

	ARMS Method	Agri Benchmark Method	International Arvalis Observatory Method
Direct costs	Operating cost: Seeds Fertiliser Chemicals Custom operations: Contract operations Technical services Commercial drying	Direct costs: Seeds Fertiliser Plant protection	Direct costs: Seeds Fertiliser Pesticides Other pesticides
	Fuel, Lube and electricity Repairs		
		Crop insurance	Crop insurance
	Purchased irrigation water	Water if irrigated crop	Water energy if irrigated crop
	Interest on operating capital	Other variable cost : Interest and equity cost on input	
Fixed cost	Allocated Overhead: Capital recovery	Operating cost: Diesel Contractor cost Machinery: depreciation maintenance, repairs	Fixed cost: Equipment (depreciation, repairs, fuel, subcontracted work, interest)
	Paid and unpaid labour: Hired labour Family labour (opp.cost)	Hired labour Family labour (opp.cost)	Employee: wages +social insurance Family labour +social security payment
	Taxes and insurance General farm overhead	Buildings Depreciation Overhead (Miscellaneous)	Other fixed costs: Insurance, phone, advice etc. Capital equity on equipment
	Opportunity cost of land, = rental rate:	Land	Land rental cost

(south). Therefore, we must pay particular attention to the samples in terms of soil and climatic zones. The choice of typical farm in different areas can lead to different conclusions for the same country. It is possible to compare farms with different potentials, but it must be clear and precise whether this is a main or a marginal production area.

Ensuring that the period of analysis is the same

The comparison has to be based on the same analysis period. In the case of comparing the average CoP, the analysis period has to be the same (e.g. average of the same 3 years, 5 years). In case of comparing the CoP each year, it must be the same year of grains marketing on which the analysis is performed. This issue may seem trivial but can be quite complicated especially in case of international comparisons with countries in the Southern Hemisphere where the production seasons are shifted. The double-cropping, common in Brazil and Argentina, increases the confusion, and complexity, as the same crop, corn in Brazil for example, can be grown in two distinct periods of the year with different conducts and returns. Given the strong intra-annual fluctuations in input prices and commodities selling prices, ill-defined periods of analysis for annual comparisons can be misleading.

Preferring comparisons of average production costs or annual production costs depends on the objectives

In some countries, the variation in inter-annual yield is high, e.g. recurrent drought in Australia, so it is risky to make comparisons of competitiveness in a single year. Indeed, the drought year with yields divided by two is not representative of the competitiveness of Australian grain production.

Therefore comparisons of average production costs over several years, or at least with average yields, allow a more accurate assessment of competitiveness and a more rational explanation of the competitiveness factors.

However, strong inter-annual yields variation is also a characteristic of some soil and climate areas. It is also important to highlight this variability in comparisons of international competitiveness in one way or another. A comparison of the history of the annual production costs may enhance this variability.

How can we present the results of international comparisons?

The issue of presentation of the results, especially when taking exchange rates into account, is a recurrent issue and does not seem to have a ready solution. The effects of exchange rates when presenting production costs in dollars or euros can hide the changes in CoP linked to production systems or regional contexts. It is important to have the data in local currency to be able to subsequently perform calculations with different exchange rates. Especially when studying the evolution of production costs in a currency different from the country of study, attention must be paid to changes in relative exchange rates. Why not also make these calculations with an average exchange rate (e.g. average of 3 years) to smooth out variations related to external factors and focus on competitive factors more related to the production system? Here, one could also think about different presentations as production costs with an index presentation.

Comparing item by item, with different charges contained in each item, can be a source of error in analysis. A common presentation mode of the results with the same expense and the same costs in each item would simplify comparisons. Indeed, it could be possible to work initially on the detailed items and then to make groups using the same nomenclature.

4.6. Conclusions and Recommendations

We have seen with this overview of the methods to calculate crop production costs, that the studies present different objectives, and thus different methods to collect and process data. This makes international comparisons with different methods difficult or even risky. However, some recommendations can be made in order to be able to better compare the results from different studies. Indeed to ensure an equivalent targeted sample, same period of analysis, similar methods of calculation and allocation and, mainly same costs taken into account, is very important to perform reliable comparisons. The result presentation is also a critical point (items, exchange rates, etc.).

On an international level, and simplifying voluntarily, there are two different methods to calculate and compare production costs: the methods based on large representative samples and the method based on a "typical farm". These methods are complementary because they do not deal with the same questions. Methods based on large sample with account results are methods that achieve a degree of representativeness important for impact measures and as support for political decisions. Nevertheless, these methods cannot be reactive (2, 3 years late), are not very precise on some charges and on their explanation of the crop competitiveness. Also, in order to more precisely analyse the factors of competitiveness, and the ways for improvement, it is necessary to have more technical data to explain what lies "behind" the data. Indeed, the assessment of competitiveness is important, but the precise explanations of these competitive factors are also.

Which factors impact the most on competitiveness? Is it crop yield, work organisation, costs of labour, input costs? What is the impact on competitiveness of a specific technical change? The methods of analysis with "typical farm" of the agri benchmark network, the international Arvalis Observatory or the win-tops method are more responsive to these issues but the representativeness of the data remains a genuine concern.

On the other hand, the representative's approaches to calculate costs of production permit the study of time series and longer trends. This is possible, provided that the sample and the methodology are constant. The observatories based on the "typical farm" do not have the same range of results. For agri benchmark or the Arvalis International observatory, the changes in calculation methods and the definition of the typical farm are too frequent in recent years to have an evolution of a long set of production costs.

Some methods exposed in this report (ARMS, win-tops, 50 sg report, France Arvalis-Unigrains observatory) are interesting to study for the method and perspective but are not really relevant for international comparison because the sample, the methods and the presentation are different. It is complicated to compare with precision such different data. It seems easier to use the same method to compare international competitiveness.

Agri benchmark and the Arvalis international observatory both employ a constant methodology, although different from each other, to calculate and compare the production cost in different countries. It allows easier international comparisons than to compare results from different methods. The FACEPA project working with FADN data allows comparisons within Europe but there is no such data available in other countries (e.g. there are few reliable statistics from Ukraine or Argentina).

Moreover, to assess the international farms' sustainability, some qualitative information is also important. The expertise of partners in the case of a network such as the agri benchmark may be important to evaluate the context of production, the long term fertility, the risk of weeds, the qualification of the workforce and the margins of progress at short to medium term.

For international crop competitiveness comparison, connection between the two methods would certainly permit constructive interaction at a European level. For example, an estimation of the representativeness of the typical farm, based on FADN data, on simple criteria such as the farm structure, crop rotation, yields, etc., could be useful for the typical farm methods. On the other hand the methods based on the "typical farm" would probably bring more field data like technical crop schedule, average doses of input, etc., that would probably refine the analysis and interpretations of international comparison.

In addition, there are demands for agricultural production performance evaluation beyond just economic performance. Indeed, how can we better consider the externalities of agricultural production, in particular the social and environmental costs and benefits? The multi-criteria analysis of production systems with simple indicators such as energy consumption, greenhouse gas emissions or the efficiency of nitrogen for example, can help to provide some answers. To perform the evaluation of agronomic and environmental sustainability, some detailed technical information such as technical procedures and input doses, or even more specific information on soil and climate conditions, are needed. Here, the study methods based on the "typical farm" may be well-positioned to expand the valuation of performance by switching to multi-criteria analysis.

Chapter 5. Horizontal Technical Issues on Production Cost Methodologies

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5.1. Introduction and Background

Production cost is a powerful indicator and has implications on location of production process, movement of resources, income of farming enterprise and farm households, and poverty status within the population. However, there is heterogeneity in CoP. This may be due to; scale of operation (large vs. small), labour intensity, soil productivity, and technology. For the last two decades agricultural productivity has slowed down and to some extent economists agree that perhaps productivity improvement has not taken place.

With an increasing emphasis on international trade and globalization of agriculture, there are several reasons for undertaking international comparisons of commodity CoP. First, involves intercountry competitiveness studies. There might be interest in knowing whether producers are competitive not only in the domestic market but also in the international market (such as importing country). One would also want to know what kind of competition they would be facing in terms of their product competing in the world market. Second, assessment of how changes in trade policies affecting tariffs, quotas, and domestic support policies might affect the competitive position of producers. Third, counties might want to compare costs of production of the commodity in question in the other country and how these costs are affected by government assistance program programs like input subsidies. Last, but not the least, international comparisons could be useful information in making investment decisions.

The International panel presented analysis from different countries regarding calculation of costs of production as it relates to: (1) farm heterogeneity and exchange rates—presented by Yves Surry; (2) inputs and policy linkages—presented by Robert Koroluk; (3) climate adjusted productivity and economies of scale—presented by Maxwell Foster; (4) opportunity cost of family labour in the United States—presented by Ashok Mishra; (5) family farm diversity and opportunity cost of family labour in Brazil presented by Wellington Teixeira; and (6) production costs and farming systems—presented by Folkhard Isermeyer.[5]

5.2. Production Allocation Costs, Farm Heterogeneity and Exchange Rates

The first presentation in this session was done by Surry (2011). He presented a theoretical basis of considering the impact of inflation and exchange rates on CoP. Surry strongly believes that exchange rates and inflation should be taken into consideration when comparing CoP of agricultural commodities across countries. Choosing the appropriate exchange rate and adjusting for inflation are problems common to all intercountry CoP estimates because all estimates have to be denominated in a common currency at one point in time in order to make

5 Although the session at the workshop discussed several topics that would be of interest to researchers and policymakers, when comparing cost of production between countries, it is essential to point out that due to time and resource constraints some issues were left out. These include method and data requirements to consistently estimate, among various countries, overhead costs and opportunity cost of land.

accurate comparisons. Choosing the appropriate exchange rate to use in converting local currency costs to US dollars can be a difficult task. The dollar is the usual currency of comparison. Its value has varied considerably against other major currencies, especially in recent years. This raises the question of not only the appropriate exchange rate to use, but also the appropriate year(s) in which to select the exchange rate. There are several methods to consider exchange rates. First, in countries with reasonably stable exchange rates, an average or mean exchange rate over a number of years adjusted by a ratio of domestic deflators can be used to test whether or not an exchange rate for a given year is appropriate. Second, with unstable currencies, one can use the World Bank measure of degree of over- or undervaluation of specific currencies. Economic studies can discount domestic costs by the degree of over- or undervaluation amount when the official exchange rate is used to convert local currency to dollars.

Similarly, inflation distorts CoP estimates in several ways. It tends to bias nominal net income upward because of the time lag between production costs and receipt of sales revenue, to increase investment in assets which hold value, to create economic uncertainty which discourages long-term investment, and to cause loss of value against foreign currencies. There are several methods to deal with inflation. First, an effort should be made to adjust all prices and values to a common point in time. Second, inter-seasonal adjustments (e.g. across years) can be accomplished by uniformly adjusting all prices and values in the CoP to the desired point in time using the country's annual and/or monthly price indexes. Third, if the country's price indexes are unavailable or unreliable, linkage to a third-country's price index or currency exchange rate can be used for inter-seasonal comparisons.

Finally, Surry (2011) discussed, at the farm level, the importance of cost allocation and farm heterogeneity. He recommended that the European Commission should come up with a minimum CoP for a given technology. Also, one should be willing to talk about hybrid cost functions and multi-functionality of agriculture.

5.3. Inputs and Policy Inter-Linkages

The presentation by Koroluk (2011) discussed the issue of inputs and policy inter-linkages. His presentation was particularly relevant to Canadian agriculture. Expenditures on inputs can have a direct impact on government payment programs. For example, several business risk management programs (BRM) in Canada have elements of inputs costs in payment calculations. Koroluk (2011) discusses the issue of costs of adopting new practices and technologies and agri-environmental and food safety policies. Other horizontal policy issues addressed by Koroluk (2011) that are linked to production costs include farm taxation policies and policies for ongoing research and development. Koroluk (2011) points out that government payment to producers, from several major business risk management programs, in Canada are based on some form of margin calculation. Specifically, Farm Income Stabilization Insurance (ASRA), AgriStability and AgriInvest are the principle programs in Canada that are based on gross margin calculations. Generally, national programs focus on whole farm margins, while some provincial programs are based on the CoP of individual sectors.

The margin-based programs typically include expenditures on direct inputs as eligible expenses, and don't require the allocation of fixed costs and joint costs.

Canada is a price taker in most major input markets (seed, fuels, nitrogen, phosphate, pesticides). By design, BRM programs in Canada provide support to farmers during periods of short-term input cost increases, as payments are based on average margin calculated over a predetermined reference period. Therefore, input costs have increased as a result of increased program payments to farmers. Further, several business risk management programs in Canada have elements of input costs in payment calculations. Structural adjustment, though, removes the impacts of input cost changes via increases in farm size (consolidation) or changing product mix.

Koroluk (2011) then discusses the costs of adopting new technologies that affect environmental and food safety policies. Specifically, nutrient management with the objective of eliminating excessive nutrients, source water protection and improvements to water quality, including: 1) efficient nutrient use; 2) input use efficiency and environmental loading; 3) GPS and precision farming; 4) tracking and tracing systems; 5) minor use pesticides and grower use pesticides; and 6) energy efficiency.

Finally, Koroluk (2011) presents other horizontal policy issues. For example, tax system considerations: (1) accelerated write-off of manure storage facilities; (2) tax exemptions for farm use of fuel; (3) ongoing public research and development; (4) enhancing productivity of land, labour and capital; and (5) use of no-till resulted in substantial reductions in production costs of Prairie grains and oilseeds. These horizontal policy issues are linked to production costs and ultimately affect government program payments and business risk management programs in Canada.

5.4. Climate-adjusted Productivity and Economies of Scale

From the Australian perspective Foster (2011) presented issue concerns regarding climate change and agricultural productivity. Foster presented the value of Australian agriculture by climate zone and found that tropical agriculture has the least production. However, farmers in tropical climate are likely to specialize in beef cattle, sheep, dairy cattle, fruits and nuts. Foster (2011) points out that 58% of Australian agricultural production, worth about $40 billion US dollars, is exported. The major agricultural commodities that are exported (50% or more) are: cotton, sugar, sheep meat, wool, wheat, and beef.

The data used in the analysis of income, balance sheet, and CoP at the national level is collected through surveys that are administered by the Australian Bureau of Agricultural and Resource Economics and Sciences. This is a detailed dataset that can be used to calculate many dimensions of agricultural production, including labour and other input costs. These data are used to construct farm financial balance sheet. Table 5.1 shows the exact calculation of farm income and balance sheet.

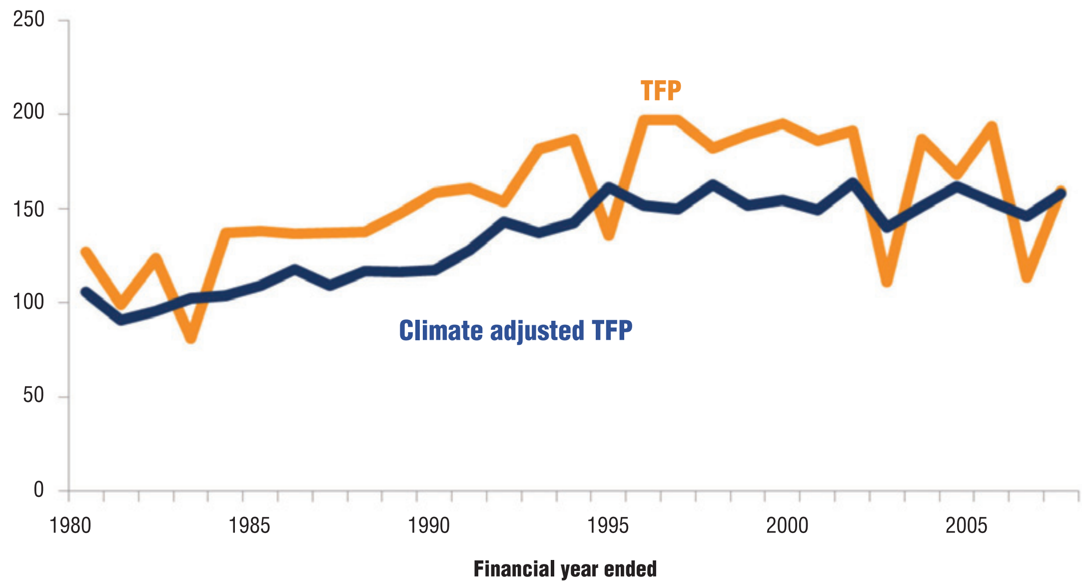
Foster (2011) then delved into agricultural productivity and reports that climate adjusted

Table 5.1: Calcuation of farm income and balance sheet, Australia

	Farm cash receipts
less	**Farm cash costs**
	Farm cash income
less	Imputed value of owner/family labour
less	Depreciation
plus	Build up in trading stocks
	Farm business profit
divided by	Total farm capital
	Rate of return on capital at full equity
	Excluding capital appreciation
	Including capital appreciation

Source: Foster (2011).

Figure 5.1: Climate-adjusted productivity, Australia



Source: Foster (2011).

total factor productivity is lower compared to the regular total factor productivity for specialized croppers and mixed crop-livestock farms (see Figure 5.1). Technical change (TC) – the availability of new technologies and knowledge—was about 1.5 per cent for 1978 to 2007-08, but slowing more recently. Technical efficiency change (TEC) – further adoption of existing technologies was about 0.3 per cent over whole period, meaning the gap between leading edge farms and average farms is increasing. Finally, Foster reported that scale and mix efficiency (SME) changes were about 0.3 per cent over the whole period. Finally, Foster reported that the opportunity cost of unpaid family labour in Australia is calculated via a federal off-farm wage rate that is dictated by the government.

5.5. Opportunity Cost of Family Labour in the United States

The United States has clearly presented and advocated the correct methodology to calculate CoP of commodities, especially for commodities that are eligible for government payments. The annual estimates are based on producer surveys conducted about every 4-8 years for each commodity and updated each year with estimates of annual price, acreage, and production changes. This essentially fixes the technology that underlies the accounts to that used in the survey year.

Commodity-specific surveys as part of the annual Agricultural Resource Management Survey (ARMS) have been used to collect the data since 1996. Data in prior years were collected as part of the annual Farm Costs and Returns Survey (FCRS). ARMS survey data collected every 4-8 years for each commodity on a rotating basis. Estimates are updated between surveys according to price changes Estimates are historical, or “after the fact”, and not projections. Estimates include all costs contributed by landlords and farm operators, and contractors and contractees. Estimates are made at the farm-level in order to summarize data for research and industry outlook. The theoretical basis and accounting methods used for the most recent estimates of commodity costs and returns conform to standards recommended by the American Agricultural Economics Association (AAEA) Task Force on Commodity Costs and Returns. In addition, accounts published in this

Table 5.2: Approaches used to estimate commodity costs in the US

Direct costing	Value input quantities	Indirect costing	Allocating farm expenses
	Crop commodities		
Purchased seed	Home-grown feed	Fuel, lube, and electric	General farm overhead
Fertilizer	Manure	Repairs	Taxes and insurance
Chemicals	Unpaid labor	Capital recovery	
Custom operation	Land		
Hired labor	Operating interest		
Purchased water	Ginning		
	Livestock commodities		
Purchased feed	Home-grown feed	Capital recovery	General farm overhead
Feeder animals	Grazing fee		Taxes and insurance
Vet medicine	Unpaid labor		
Bedding and litter	Land		
Marketing	Operating interest		
Custom service			
Fuel, lube, and electric			
Repairs			

Source: Economic Research Service, U.S. Department of Agriculture (2011).

format are presented using ERS Farm Resource Regions, which provide a consistent regional delineation across the commodities. Table 5.2 presents the approaches used to estimate commodity costs in the US.

Labour is one of the important inputs in agricultural production. How it is measured and valued is important for establishing the marginal cost (MC) of agricultural commodities; specifically, labour's share of the CoP.

Until 1999—value to unpaid farm labour was estimated as hours worked on farm multiplied by average wage rate for hired farm labour (Morehart, Shapouri, and Dismukes, 1992). Another method "current family living expenses" has also been used by economists in California (Klonsky, 1992; McGrann, 1991). However, this type of method to calculate the value of unpaid family labor is only possible in small surveys and special cases. In the agricultural productivity literature—unpaid labour is valued at the wage and salary (W&S) for "similar skilled" W&S workers in US agriculture (controls for gender, age, education, and occupation).

The presentation by Mishra (2011) focused on the calculation of opportunity cost of family labour. He pointed out that off-farm labour supply literature has improved modelling of human time use and valuation of farm household members. Total time is defined as the sum of farm, off-farm, and leisure time. Husband's and wife's time is treated as being heterogeneous because they possess different skill. Therefore, opportunity cost (OC) of time allocated to farm work is the maximum of the value of a unit time allocated to off-farm work or leisure. For off-farm to occur the OC must be equal to off-farm wage rate (OFWR) and OFWR is also the price of unpaid family labour.

Therefore, the opportunity cost of unpaid labour (farmer and spouse, in the case of US) is the value unpaid farm labour at the off-farm opportunity wage of farm workers—if less than 16 years, use minimum wage, otherwise calculate the off-farm wage, which is calculated via the following labour supply model (see Ahearn El-Osta, 1991). Specifically, Off-farm wage = f (Age, Age, Education, Region). Using this approach operators working off-farm, using 2010 Agricultural Resource Management Survey (ARMS) calculated the off-

Table 5.3: Opportunity cost of Unpaid and Hired Labour for Dairy Farms, by Farm Size, in US

Item	Fewer than 50 cows	50-99 cows	100-199 cows	200 or more cows
Dollars per hundred weight				
Unpaid labour	13.42	7.45	4.84	1.15
Hired labour	0.79	1.75	2.25	3.21

Source: Mishra (2011).

Table 5.4: Opportunity cost of Unpaid and Hired Labour for Dairy Farms, by region, in US

Item	Northeast region of US	Upper Midwest region of the US	West region of the US
Dollars per hundred weight			
Unpaid labour	10.75	6.76	1.64
Hired labour	1.60	1.61	3.28

Source: Mishra (2011).

farm and farm wage of farm operator as; (1) off-farm wage = $21.15 / hour and (2) farm wage = $9.15 / hour. However, the opportunity cost for unpaid labour in specialized farming like corn production may be much higher. For example, unpaid labour cost for corn producer in 1996 (Corn survey of ARMS) was $29 per acre and increased to about $39 per acres in 2010. Similarly, Mishra reported that opportunity cost of unpaid labour varied by enterprise and region of production. For example, opportunity cost for unpaid workers on dairy farms ranges from $13.42/hundred weight milk sold for small farms (50 or less cows) to $1.15/hundred weight milk (see Table 5.3) sold for large farms (200 cow or more cows). On the other hand, we also observe regional variation in the opportunity cost for unpaid workers on dairy farms (Table 5.4). For example, opportunity cost for unpaid workers on dairy farms ranges from $10.75/hundred weight milk sold for dairy farm workers in the Northeast of US to $1.64/hundred weight milk sold for worker in the Western US.

5.6. Family Farm Diversity and Opportunity Cost of Family Labour in Brazil

In the case of Brazil, where farming sector plays an important role in the livelihoods of many people, farmers and their families rely on income from farming. Farm income is a major component in total farm household income. More than 4 million family farms are involved in agriculture. About 12.3 million people are linked to family farms (74.4% of employed persons in agriculture), with an average of 2.6 people employed in agriculture. The non-family farming employed 4.2 million people, equivalent to 25.6% of the agricultural workforce. Family farm has a social importance and should be maintained as such. Farms are very diverse in their output (such as cassava, beans, corn, coffee, rice, and poultry). More than 16% of soybeans are produced by family farms. Companhia Nacional de Abastecimento (Conab) is responsible for collecting data related to farm costs and returns, including variable CoP, average salary of temporary employee, and opportunity cost of land (Teixeira, 2011). In Brazil, there has been a strong trend of migration of young people from farms to cities in search of employment in industries where they can find jobs with different working conditions. In this case, the opportunity cost of family labour is fundamental and must be measured to reflect the reality of the opportunities that farmer's face, in the region where farms are located. In such cases off-farm wages must be taken into account to reflect opportunity cost of family labour.

5.7. Production Costs and Farming Systems

Isermeyer (2011) described that comparison of farm income is not a good measure of international competitiveness. One needs to compare total CoP unit of output. If one is just interested in comparing CoP across regions and countries then one could simply compare product prices. However, product price may deviate in the short-run and they may be distorted by policy instruments. Moreover, for the analysis of differences of CoP it is important to have a good breakdown of cost components including opportunity costs. Isermeyer (2011) pointed out that there is an urgent need to analyse and prescribe a consistent methodology for the estimation of opportunity cost of land and labour. Opportunity cost of unpaid labour could be the payment that the farmer has to make to a person who replaces the farmer when the farmer is on vacation. Wage rate for skilled worker is also used as a proxy for opportunity cost of unpaid family labour.

It should be pointed out that small scale farms are often competitive although high CoP are calculated for them. This indicates that real opportunity costs for land or labour are probably lower than those assumed in the calculations.

Agri Benchmark is an organization[6] based in Germany that coordinates data collection, analysing cost and returns and presenting results which is homogenously applied for cash crops, beef, sheep, pork and poultry farms in all participating countries. Agri Benchmark defines a "typical farm[7]" and then contacts farm operators who operate a "typical farm" and collects full sets of economic and physical farm data on production systems, quantities, and prices of inputs. Most of the agri benchmark farm-level calculations are done on a per unit basis, for example per kg beef produced, per ton of wheat produced.

The European Commission uses the FADN (Farm Accountancy Data Network) database to calculate opportunity costs of unpaid labour and land. FADN contains information on output and subsidies per enterprise; however, as regards costs, it provides only information referring to the farm as a whole. Family labour cost is calculated on the basis of the wages the farm owner would have to pay if he were to hire employees to do the work carried out by family members. This cost is estimated as the average regional wage per hour obtained in the FADN database multiplied by the number of hours worked by family workers on the farm. However, it should be mentioned that the wage recorded in FADN corresponds to the gross wage, plus the social security costs. Moreover, it is commonly acknowledged that the hours worked by family members are sometimes overestimated. Thus, the method uses a maximum of 3000 hours per Annual Work Unit (this is equal to 8.2 hours a day, 365 days a year and corresponds more or less to the time farmers can spend milking cows on a farm).

5.8. Conclusions and Recommendations

The session on *International Panel Discussion-Horizontal Issues*, prove to be an excellent platform to discuss various issues related CoP and methodologies on various topics and countries. With increased globalization warrants comparison of costs of production of agricultural commodities. Economists and agricultural economists in this session presented their work on various topics related to CoP and its consistency in order to compare them across countries. For example, Surry concluded that inflation and exchange rates tend to bias the true CoP and hence economists and policymakers need to be mindful when comparing CoP of agricultural commodities across nations. In the case of Canada horizontal policy issues that are linked to production costs include, farm taxation policies and policies for ongoing research and development. Generally, national programs in Canada focus on whole farm margins, while some provincial programs are based on the CoP of individual sectors.

6 Visit http://www.agribenchmark.org/ for more information on this organization.

7 Typical farm has several advantages over individual farm data and average farm data surveys (FADN). These include consistency of data sets, quantity structure, data availability, timeliness, data confidentiality and cost of data collection.

The Australian Bureau of Agricultural and Resource Economics and Sciences collects farm-level data to estimate and analyse income, balance sheet, and CoP at the national level. Agricultural productivity differs with climate. Specifically, climate adjusted total factor productivity is lower compared to the regular total factor productivity for specialized croppers and mixed crop-livestock farms. American agriculture uses farm-level data that is collected every year and is used for various purposes, including calculation of CoP of various commodities. The USDA follows a set formula, as recommended by the American Agricultural Economics Association Taskforce on Cost of Production, for estimating various components of the income statement, balance sheet, cost of production, including opportunity cost of unpaid family labour. The opportunity cost of unpaid labour (farmer and spouse, in the case of US) is the value unpaid farm labour at the off-farm opportunity wage of farm workers—if less than 16 years, use minimum wage.

Brazil is becoming a major force in production of agricultural commodities. The Brazilian farming sector plays an important role in the livelihoods of many people, farmers and their families rely on income from farming. A central agency is responsible for collecting data related to farm costs and returns, including variable CoP, average salary of temporary employee, and opportunity cost of land. However, Brazilians recognize the fact that off-farm employment is becoming attractive to farm families and many are working off the farm and surmise that off-farm wages must be taken into account to reflect opportunity cost of family labour.

While the workshop provided a good understanding of various aspects of costs of production, it is abundantly clear that international comparisons of CoP needs to have a good foundation,. where we have the following: (1) a common definition of a farm; (2) common methodologies to calculate various aspects of CoP, income statement, and balance sheet. These items can then be used to calculate costs of production that is easily transportable and abundantly clear as to how to calculate costs across farm type, commodities, farming region, and country; (3) unit of data collection—farm-level, typical farm, regional data, aggregate data, regional data; and (4) unit of analysis—such as per arable acres, per unit of output. In all these presentations a common thread was farm-level data being used for analysis. If that is the case, then we can have a common methodology to calculate CoP of agricultural commodities and compare them across countries. Here, the main challenges in accomplishing these ideas maybe in terms of resource constraints, specifically, the willingness to do and resource allocation—both budgetary and personnel.

However, presenters and workshop participants argued that collection of farm-level data was too expensive, time consuming, and many countries do not have the infrastructure and the budget to collect such data on a regular basis. The session concluded with discussion of a "typical farm". Specifically, Isermeyer introduced this concept. Agri benchmark is an organization based in Germany that coordinates data collection form "typical farms", analysing cost and returns and presenting results which is homogenously applied for cash crops, beef, sheep, pork and poultry farms in all participating countries. Most of the agri benchmark farm-level calculations are done on a per unit basis, for example per kg beef produced, per ton of wheat produced.

There are several recommendations that can be gleaned from these presentations. First, farm-level data is the best option to compare costs of production across countries. Second, these costs should be adjusted frequently to adjust for government subsidies and other structural changes in agriculture. Secondly, any policy that affects use of inputs should also be noted and adjusted for in the final CoP. Third, CoP comparison should be adjusted for inflation and exchange rates when comparing costs across countries. Fourth, CoP should be calculated on a per unit basis, for example per kg beef produced, per ton of wheat produced. This option of collecting data and taking a "*typical farm*" into consideration can prove to be useful in developing costs of production for agricultural commodities and comparing these costs across countries. It is an alternative that is cheaper and can be pursued in the future if counties and organization choose to do so. Finally, one has to be cognizant about several other factors when comparing costs of production across various countries. These include: (1) farm heterogeneity (size); (2) diversified farm enterprises; (3) climate-adjusted productivity; and (4) data requirements to derive an opportunity cost of unpaid labour.

Finally, one of the most controversial issues facing economists is valuation of unpaid farm labour. Though unpaid farm labour does not generally receive a wage, it does have an economic cost. The best method to obtain opportunity cost of unpaid labor is the implicit compensation for unpaid farm labour is based on the opportunity cost of off-farm work, or the return available in the next best alternative use of this labour time and effort. All adult unpaid farm labour (and salaried labour with ownership claims) should be valued at its opportunity cost, defined to be the maximum value for non-farm uses. However, this method would require a survey data, and a detailed data on demographics, local labour markets, and other socio-economic variables. Consequently, although this methods is economically sound, it would require additional resources in terms of time and money. In light of this, one can use alternative methods that may be cheaper, readily available, and consistent across countries. These include: (1) hired farm worker wage rate; (2) skilled worker wage rate; (3) replacement worker wage rate; and (4) governments can set off-farm wage rates.

Chapter 6. Conclusions and Recommendations

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6.1. Introduction

Previous chapters provided a comprehensive comparison of methodologies and approaches for CoP data collection, processing and comparative analyses as applied across countries and at international level. Gathering production costs is a complex process encompassing issues spanning from data collection design to selection and development of methodologies for processing and analysis. The development and application of a standard methodology across countries for this purpose is far from being solved and needs further methodological and conceptual work. In this chapter we attempt to provide key summarising issues related to CoP methodologies and outline potential recommendations on global comparison of production costs. The analyses are based on previous chapters' contents reflecting the workshop presentations and discussions.

6.2. Key Methodological Challenges for global comparison of production costs

Conducting robust comparative analysis of production costs across agricultural commodities and across countries requires availability of data which apply similar data collection approaches and cost calculation methodologies. Few statistical sources satisfy these requirements. Notable exceptions are the agri benchmark and the IFCN. Both databases cover all major world trading regions and apply a common methodology for costs identification and calculation. However, their main disadvantage is that they are based on small and non-representative samples and cover only a restricted set of commodities.

Most countries conduct their own collection of data on production costs as part of national agricultural data gathering exercise. However, methodological approaches vary strongly in terms of collection approaches, type of data collected, disaggregation of cost items, data processing and cost calculation methodology, hence it is problematic to use them for inter-country comparison.

Key issues which pose problems of comparability of cost data across-countries using available statistical sources include:

- The variation in data collection method.
- The variation in the type of data available at country level in terms of quality and types of cost-related information collected.
- Differences in definition of cost items
- Differences in cost calculation methodologies.
- Variation in sampling strategy(ies)
- Identification of an appropriate methodology for allocation of common inputs (e.g. family labour, depreciation, overheads) to specific commodities.
- Identification of an appropriate methodology for accounting for opportunity costs of own inputs (farm owned labour, land and capital).
- The allocation of cost items to joint products (e.g. primary products versus by-products).

- Variation of costs by structural effects (farms size, technology, climatic zone, etc)

- Data update and timing of their availability

- Other issues: exchange rate, weather effect (unit production costs vary strongly year to year, and region by region, due to climate variation); quality differences in input factors; valuation of input factors for which there are no market transaction (e.g. opportunity costs of own labour, land and capital); crop rotation effects on production costs; inputs and policy interlinkages

6.3. Recommendations

The liberalisation of agricultural market policies, and the ever increasing global dimension of agribusiness, present clear and complex challenges to policy makers with respect to ensuring the competitiveness and viability of their various production operations across various policy arenas, in particular with respect to addressing future competiveness of production systems, farms, and/or regions. Here, the broad consensus view of expert participants at this workshop re-iterated fundamental differences in concepts and approaches to CoP calculations from across the world (typically regionally tailored to meet particular specifics for a wide range of agricultural commodities) towards international comparisons of CoP as both incompatible and of considerable difficulty to integrate and interpret in a meaningful and informative way (see Chapter 2, for further considerations). Isermeyer highlighted several factors that make an internationally harmonized comparison of CoP useful and relevant as it may satisfy a number of fundamental questions such as to better understand future competitiveness of production systems, including how certain agricultural branches can compete with other world regions, how competitiveness and sustainability of production systems can be improved, how different farm types in different regions can (and will) react to new challenges, and how different farms are affected by (and will adjust to) agricultural policy measures (Chapter 2). Garnier (Chapter 4) and Mishra (Chapter 5) pointed to several challenges that need to be taken into account when conducting international comparison of CoP such as selection of appropriate exchange rates and the issue of inflation, suitability of approach in terms of sample representativeness versus the choice of "typical farm" approach, farms' structural evolution, farm heterogeneity, variability of economic context, comparability of methods in terms of cost item definition, period of analysis, inter-annual variation in climatic condition, inputs and policy inter-linkages, and accounting for opportunity cost of unpaid labour, etc.

Indeed, in different regions of the world, very different concepts for the collection of farm-based CoP analysis have been developed and implemented over the last number of decades, categorized by different criteria, including (but not exclusively limited to): regional coverage (world-wide; EU-wide; national; regional), representativeness (stratified sample; farmer groups with voluntary participation), unit of analysis (single farm data; farm averages; typical farms), depth of the data (whole farm data; farm enterprise data), and data collection method (delivery of book keeping data; interviews; panel discussions). Further, intra-commodity variability with regard to production systems, farm size, regional differences and management programs, as well as different business models (e.g. contract vs. non-contract production) complicate comparisons, and further raise issues with regards sampling size(s), technique, timing and accounting procedures.

Of the different concepts and approaches currently deployed regionally, all are effectively based either on large representative samples (e.g. FADN, ARMS) or the "typical farm"approach (e.g. *agri benchmark*, IFCN, Conab). According to Garnier (Chapter 4) the difference in objectives of national and global data collection systems, and differences in their use, largely determines the methodology in general, and sampling strategy, in particular. If the goal is to evaluate an average production cost per country, per region, or for each major farming systems, representativeness of the studied sample will be critical (e.g. ARMS, 50-sg report, France Arvalis-Unigrains Observatory, FADN). However, if the goal is to evaluate the production costs of performing farms or to characterise the economic impact of innovative practices (e.g. minimum tillage, low input system, organic farming, etc.), then representativeness is still important but is secondary compared to the needs of having detailed and specific economic and technical data on technology, farm practices, and timing of activities through the season, etc.

Conducting robust comparative analysis of production costs across agricultural commodities, and across countries, requires availability of data which apply similar data collection approaches and cost calculation methodologies. Few statistical sources satisfy these requirements. The agri benchmark and the IFCN based on the "typical farm" approach are the only data sources currently available for international comparison of production costs. They apply a common methodology for costs identification and calculation across all covered countries. They can be applied without further methodological adjustments to compare production costs among available commodities and regions.

These approaches are based on networks of experts, advisors, panel of farmers, and statisticians located in different parts of the world who collect and process data locally. The main advantage is that they can be flexibly designated to focus specifically on topics of interest to this aspect of agricultural production, including the development and implementation of standard methodology. The typical farm method used by this approaches is a relatively inexpensive methodology from an implementation point of view, with an advantage of application on a regular basis on a wider regional scale, particularly in less resourceful countries such as Asia, South America, Russia and Africa. Important weaknesses of the agri benchmark and the IFCN is low representativeness of collected data, inability to capture adequately variation of farming systems within regions, and coverage of limited number of commodities. Improvements need to go in this direction, by building cost values from better designed samples and taking more commodities on board. A second limitation of this approach is that involvement of experts/advisors introduces certain subjectivity and personal perceptions in the whole data collection process. The approach relays predominantly on expert judgments and/or the opinion of farmer panels deciding all aspects related to CoP analysis, from typical farm selection to assigning CoP values to each cost category and activity. Finally, this approach is not well suited to capture farm structural changes (adjustment in technology, farm size, etc). Any structural change is accounted for through exogenous adjustment of typical farm in regular intervals. Although it is desirable to adjust the typical farm approach to reflect actual farm structure, it may pose a problem of comparability of CoP data over time due to the fact that characteristics of typical farms change over time.

Most countries conduct their own collection of data on production costs as part of national agricultural data gathering exercises. However, methodological approaches vary strongly in terms of collection approaches, type of data collected, disaggregation of cost items, data processing, and cost calculation methodology, hence it is problematic to use them for inter-country comparison(s). The application of national sources for international comparison would require further data processing and/or harmonization of methodologies. This could be potentially achieved (following the analysis of Chapters 2 to 5) at three levels:

- **Minimalistic harmonization**: Exploit the existing databases available and harmonise methodologies without altering the current system of data collection and type of data collected. This approach would lead to harmonization of certain aspects of methodologies such as structuring of cost categories, harmonization of certain cost items not connected directly to data collection process and which are less demanding in terms of resource requirements (e.g. accounting for opportunity costs of own inputs, etc.). This approach wiould lead to limited harmonization of methodologies across-countries and may allow conducting comparison only for selected type of cost categories (e.g. variable costs). Note that with this approach the possibility to compare CoP data across countries will still remain an issue of concern. A large part of heterogeneity in cost values will still be driven by differences in underlining methodologies (e.g. by differences in sampling strategy, cost allocation methodologies, the level detail CoP calculation) which is specific to each country's data collection system.

- **Partial harmonization**: This approach proposes to harmonise the type of data collected and cost calculation methodology, while keeping current systems of data collection (e.g. sampling strategy) applied at national level unchanged. In principle this approach would require extension or adjustment of the current national systems in terms of questionnaire design (e.g. harmonization of the type of cost data collected) and cost calculation methodology (e.g. harmonization of the method to account for opportunity costs). The partial harmonization would lead to significant improvement in comparability of cost data across-countries because many methodological differences would be removed or considerably reduced. However, the actual level of comparability would depend on what aspect of the cost calculation methodology will be actually harmonized.

- **Full harmonization**: Application of common methodology for data collection and calculation of cost values in all participating countries. In principle this would lead to a redesign of whole national systems starting from harmonization of primary data collection method (e.g. sampling strategy) to harmonization of costs calculation methodologies. This approach would lead to full comparability of cost data across countries. However, main constrain might be low interest of countries to join these schemes as the existing systems would need to be replaced by new harmonised system. The exiting national systems are developed to address multiple policy objectives and are not solely design to deliver only the CoP data. Redesigning the national system for the purpose to improve the CoP data collection may thus conflict with the delivery of data for addressing other policy objectives at national level hence making this option highly unrealistic.

The successfulness of implementing harmonization of national methodologies would require cooperation among national authorities, with an increasing level of cooperation depending on the level and degree of actual harmonization undertaken. One of the main limitations of the harmonization approach is that in many countries farm data collection systems may not be available, nor sufficient financial resources that would enable their participation in the scheme. As a result, many important global players might be unintentionally omitted unless an alternative solution is found. A key challenge for this type of global data collection system, where many stakeholders are involved, suffers from a challenge of coordination, not least complex processing and validation of the final datasets and databases. Indeed, experience from national systems shows that this complexity may lead to important delays in finalization and publication of CoP of such sets. Additionally, similar to other survey based collection systems, issues of confidentiality may prevent full exploitation of rich global farm-level datasets that might be collected.

Irrespective of, and addition to, such conceptual and methodological discrepancies, include a range of horizontal issues that further complicate meaningful integration and interpretation of international production cost estimates (Chapter 5). In addition to the general considerations of farm heterogeneity (size), diversified farm enterprises, climate-adjusted productivity, and data requirements to derive opportunity costs of unpaid labour, other regional issues of importance for the consideration of international comparisons of CoP include farm taxation policies, agricultural subsidies, ongoing R&D taxes and accounting for environmental externalities. Further, the bias of asymmetrical inflation and fluctuation of international exchange rates (which bias the true costs of production) should not be overlooked as a considerable complicating factor in CoP comparison(s). Again, from the workshop, a broad consensus existed for the (1) common definition of a "typical' farm", (2) common methodology(ies) to calculate various aspects of CoP, (3) definition and agreement on the unit of data collection (farm-level, typical farm, regional data, aggregate data, regional data), and (4) unit of analysis (e.g. per unit of output). However, it remains unclear how realistic, or probable, such criteria could be effectively satisfied at an international level.

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Annex

Programme/agenda

Day I – 21 June 2011		
09:00 – 10:00	**Session 1: Setting the scene**	**Chair: John Bensted-Smith, JRC-IPTS**
09:00 – 09:15	Welcome. Background of workshop	**John Bensted-Smith,** JRC-IPTS
09:15 – 09:30	Policy Background	**Tassos Haniotis,** DG AGRI, European Commission
09:30 – 09:50	Production cost structure(s) – implications for sustainability and food security	**Pekka Pesonen,** COPA-COGECA
09:50 – 10:00	WOC 2011 synthesis report	**Hubertus Gay,** DG-AGRI, European Commission
10:00 – 10:30	**Coffee break**	
10:30 – 12:30	**Session 2: Methodologies and comparisons – a global overview**	**Chair: Jacques Delincé, JRC-IPTS**
10:30 – 10:40	Introduction from the chair & Setting the scene	
10:40 – 11:00	Methodologies on data collections and processing in the EU	**Thierry Vard, DG** – AGRI, European Commission
11:00 – 11:20	Methodologies as applied in the USA	**Bill Lazarus,** University of Minnesota, USA
11:20 – 11:40	Methodologies as applied in Brazil	**Wellington Silva Teixeira,** Companhia Nacional de Abastecimento (Conab), Brazil
11:40 – 12:00	Methodologies as applied in Canada	**Robert Koroluk,** Agriculture and Agri-Food Canada
12:00 – 12:30	Open discussion	
12:30 – 14:00	**Networking lunch**	
14:00 – 15:45	**Session 3: Methodologies and comparisons – a global overview - continuation**	**Chair: Sergio Gomez y Paloma, JRC-IPTS**
14:00 – 14:20	Methodologies as applied in Australia	**Max Foster,** ABARES, Australia
14:20 – 14:40	Methodologies as applied in New Zealand	**Nicola Shadbolt,** Massey University, New Zealand
14:40 – 15:00	Methodologies as applied in Russia/Ukraine	**Roman Slaston,** Ukrainian Agribusiness Club
15:00 – 15:20	Global comparison of production costs	**Folkhard Isermeyer,** Thünen-Institute, Germany
15:20 – 15:50	Open discussion	

15:50 – 16:00	**Coffee break**	
16:00 – 18:00	**Session 4: International panel discussion - horizontal technical Issues**	**Chair: Ashok Mishra, Louisiana State University, USA**
16:00 – 16:05	Introduction from the chair and Setting the scene	
16:05 – 16:15	**International panellists:**	
16:15 – 16:25	**Yves Surry,** Swedish University of Agricultural Sciences	
16:25 – 16:35	**Robert Koroluk,** Agriculture and Agri-Food Canada	
16:35 – 16:45	**Max Foster,** ABARES, Australia	
16:45 – 16:55	**Wellington Silva Teixeira,** Companhia Nacional de Abastecimento (Conab), Brazil	
16:55 – 17:05	**Ashok Mishra,** Louisiana State University, USA	
17:05 – 18:00	**Folkhard Isermeyer,** Thünen-Institute, Germany	
	Open discussion	
18:00	**End of Day I**	

Day II - 22 June 2011		
09:00 – 12:30	**Session 5: Animal Products**	**Chair: Stuart Platt, DEFRA, UK**
09:00 – 09:05	Introduction from chair & setting the scene	
	Dairy	
09:05 – 09:25	Production cost calculations in New Zealand	**Nicola Shadbolt,** Massey University, New Zealand
09:25 – 09:45	Global production cost calculations	**Asaah Ndambi,** International Farm Comparison Network, Germany
	Beef	
09:45 – 10:05	Production cost calculations in Brazil	**Thiago Bernardino de Carvalho**, Centro de Estudos Avançados em Economia Aplicada, Brazil
10:05 – 10:25	Production cost calculations in Argentina	**Christian Bengtsson**, Hillock Capital Management, Argentina
10:25 – 10:40	COFFEE	
	Pork	
10:40 – 11:00	Production cost calculations in Brazil	**Marcello Miele,** Empresa Brasileira de Pesquisa Agropecuária (Embrapa), Brazil
11:00 – 11:20	Production cost calculations in USA	**Shane Ellis,** Iowa State University, USA
	Poultry	
11:20 – 11:40	Production cost calculations in Brazil	**Wellington Silva Teixeira,** Companhia Nacional de Abastecimento (Conab), Brazil
11:40 – 12:00	Production cost calculations in USA	**Dan Cunningham,** University of Georgia, USA
12:00 – 12:30	Open discussion	
12:30 - 14:00	**Networking lunch**	
14:00 –16:00	**Session 6: Cereals and arable crops**	**Chair: Jean-François Garnier, ARVALIS, France**
14:00 – 14:05	Introduction from the chair & Setting the scene	
14:05 – 14:25	Production cost calculations in USA	**Bill Lazarus,** University of Minnesota, USA
14:25 – 14:45	Production cost calculations in Ukraine and Russia	**Roman Slaston,** Ukrainian Agribusiness Club
14:45 – 15:05	Production cost calculations in Canada	**Richard Schoney,** University of Saskatchewan, Canada
15:05 – 15:25	Global production cost calculations	**Yelto Zimmer,** Thünen-Institute, Germany
15:25 – 16:00	Open discussion	

16:00 – 16:15	**Coffee break**	
16:15 – 17:00	**Session 7: Global comparisons - open discussion and general considerations**	**Chair: John Bensted-Smith, JRC-IPTS**
16:15 – 16:45	**General Discussion**	All participants
16:45 – 17:00	**Concluding remarks**	JRC-IPTS and DG AGRI
17:00	End of Workshop	

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European Commission
EUR 25436 – Joint Research Centre – Institute for Prospective Technological Studies

Title: Sustainability and Production Costs in the Global Farming Sector: Comparative Analysis and Methodologies

Authors: Stephen Langrell, Pavel Ciaian, Sergio Gomez y Paloma, Dan L. Cunningham, Jean-Francois Garnier, Folkhard Isermeyer and Ashok K. Mishra

Editors: Stephen Langrell, Pavel Ciaian and Sergio Gomez y Paloma

Luxembourg: Publications Office of the European Union

2012 – 130 pp. – 21.0 x 29.7 cm

EUR – Scientific and Technical Research series – ISSN 1831-9424 (online), ISSN 1018-5593 (print)

ISBN 978-92-79-25720-9 (pdf)
ISBN 978-92-79-25721-6 (print)
doi:10.2791/86305

Abstract

This report synthesises the findings from the workshop on "Sustainability and Production Costs in the Global Farming Sector: Comparative Analysis and Methodologies" organised jointly by the IPTS-JRC and the Directorate-General for Agriculture and Rural Development in Brussels on 21-22 June 2011. The report constitutes a comprehensive technical overview of the state of production costs calculations for a range of strategic agricultural sectors at global level, and a consideration of the prospects for effective international comparison. Particular attention was given to the methodologies and approaches for data collection and processing, factor market structure and policy inter-linkages, sectoral coverage, horizontal technical issues, and the implications for global agricultural markets. An important part of the report represents policy-relevant conclusions and recommendations towards conducting an effective international comparative analysis of production costs.

LF-NA-25436-EN-N

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Publications Office

ISBN 978-92-79-25720-9