NATURAL RESOURCES MANAGEMENT AND ENVIRONMENT DEPARTMENT

COMPARATIVE ANALYSIS OF ORGANIC AND NON-ORGANIC FARMING SYSTEMS: A CRITICAL ASSESSMENT OF FARM PROFITABILITY

By

Noémi Nemes

Food and Agriculture Organization of the United Nations

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Comparative analysis of organic and non-organic farming systems: A critical assessment of farm profitability

Executive summary

The last decades have seen a proliferation of economic studies that have compared the economic performance of organic and non-organic farming systems. Several criticisms were formulated questioning the validity of such comparisons, partly because of the inherent difference between the two systems (in terms of complexity, diversity and objectives other than yield maximalisation), and partly due to the difficulty in excluding 'non-system' determined factors that also have an influence on profitability. Furthermore, the adequate selection of a reference group for comparisons has proved to be fundamental for relative profitability: which organic farms are put on the profit measuring scale by researchers with which conventional farms determine the outcome.

The list of profitability studies compiled in this paper involve more than 50 different cases, mostly from U.S.A, where several universities started long-term experimental field studies in the eighties and from European countries. Just over a dozen shorter-term studies have been collected from developing countries on high-value export crops. Most studies have used a case-study approach selecting between five up to hundreds of farms for the collection of data on farm economics.

The following main conclusions are evidenced by analysing the studies listed in the Appendix:

- The overwhelming majority of cases show that organic farms are more economically profitable, despite of frequent yield decrease;
- Organic crop yields are higher in cases of bio-physical stress (e.g. drought);
- The higher outcomes generated by organic agriculture are due to premium prices and predominantly lower production costs;
- The different value and accountability given to labour costs, including both hired and family labour, differs through countries, thus yielding to opposite results;
- The major difference in the profitability of the two systems is very often determined by the different management skills of the farmers thus, accounting for these seem to be fundamental for correct interpretations of results;
- There is a wide range of discrepencies among studies related to what variable and fixed costs entail and without agreeing upon which input costs shall be included under which circumstances in economic studies, no clear-cut conclusion on profitability can be drawn when analysing available literature.

Nevertheless, the analysis of the compiled studies demonstrates that, in the majority of cases, organic systems are more profitable than non-organic systems. There are wide variations among yields and production costs, but either higher market price and premiums, or lower production costs, or the combination of these two generally result in higher relative profit in organic agriculture in developed countries. The same conclusion can be drawn from studies in developing countries but there, higher yields combined with high premiums are the underlying cause for higher relative profitability.

Finally, this paper draws attention to the fact that existing economic comparisons are heavily biased becaused they do not internalize externalities neither account for the the fact that non-organic farms receive higher governmental support and better research and extension services. This paper argues that the profitability of a farming system must balance economic costs against environmental, social and health costs, as these costs have delayed impacts and indirect implications on farm economics.

CONTENTS

1. INTRODUCTION

Organic agriculture has triggered a controversial debate in the last decades, most importantly because it shed light on the darker sides of chemical-intensive conventional farming by offering an alternative. By now, there is a strong body of evidence showing that organic farming is more environmentally friendly: potential benefits from organic production arise from improved soil fertility, organic matter content and biological activity; better soil structure and reduced susceptibility to erosion; reduced pollution from nutrient leaching and pesticides; and improved plant and animal biodiversity (Kasperczyk and Knickel, 2006).

As more and more attention has been put on determining whether organic systems are environmentally better or not, it is not clear whether organic agriculture could be economically attractive enough to trigger wide spread adoption. If organic farming offered a better environmental quality, and potentially healthier foods, but not sufficient economic returns to the majority of farmers, it would obviously remain a luxury way of food production available to a very tiny fraction of farmers. However, the continued growth of organically managed lands worldwide, especially in developing countries, does not support this hypothesis.

The number of studies devoted to the question of how profitable organic agriculture is when compared to non-organic management is over hundred; however long-term studies analyzing the development of profits in comparative studies are much less numerous. Regrettably, the geographical distribution of these studies is very much biased towards developed countries (mainly U.S.A) and certain cash crops (e.g. corn, soy, wheat). Still, a general trend can be identified when considering economic comparisons made in the last three decades.

The aim of this paper is to analyze existing literature on the economic performance of organic versus conventional (defined as non-organic) farms, to determine the critical factors for success in the evaluation of organic agriculture in different socio-political settings, and to offer some critical insights into how comparative studies differ. Only studies using data from certified organic farms have been considered, covering a minimum of three years (for developed countries) after conversion and undertaken after 1980 (see Appendix). Due to the lack of availability of long-term economic studies in developing countries, the minimum length requirement was not taken rigidly and studies covering one and two years have also been included from these countries. Studies evaluating yields and certain production costs, but not analyzing profits were not considered. Although an effort was made to compile as many available economic studies as possible, the list in the Appendix is not exhaustive.

2. ANALYSIS OF PROFITABILITY STUDIES

2.1. Scope of profitability

2.1.1. Problems in defining farm profitability

The different meanings of profitability could be as numerous as the number of researchers conducting studies on profitability. 'Profit' is generally one of the most common and accepted indicators for the success of an economic activity (Offermann and Nieberg, 2000). However, the definitions for 'profit' differ between countries and studies, which make the comparability of profitability calculations between countries even more challenging. The meaning of profitability, as well as the different methodologies used for such studies, vary according to the different objectives of these studies. The objective of profitability studies could either seek to inform farmers on the consequences of choosing organic management (farm profitability), or seek to inform policy makers on the advantages of spending more on organic research (system profitability).

Besides the differing definitions related to different objectives of studies, there are other reasons that complicate the task of comparing economic studies across space and time, including: different costs of living and purchasing power; different interpretations of labour costs; changing economic and political environment, etc. Moreover, methodological choice, the time period analyzed and the selection procedure for comparable conventional farms considerably influence the results with respect to profitability. Similarly, extent of the economic assessment can be different in studies, resulting in different outcomes, with some studies focusing merely on the farm level, while others broaden the picture to the level of society. Depending on this choice, opportunity costs and externalities can be included (society level) or excluded (farm level). For instance some negative off-farm effects - like nitrate leaching - have no effect on the farm operation as such.

Profitability (defined as the level of farm profits) must be distinguished from relative profitability of an organic farm, which refers to the changes in the relation of agricultural income of organic farms to the agricultural income of non-organic farms. Differences in prices, yields, production costs, direct payments and non-agricultural outputs are identified as the main determinants of the relative profitability of organic farms (Sanders, 2007).

Moreover, when looking at profitability studies, correct interpretations of data is crucial. Overall comparisons cannot be made: between case studies and field experiments; between developed and developing country results; and between studies with very good data base and studies based on farmers' opinions.

2.1.2. Determinants of farm profitability

The determinants of organic profits are in general very similar to those in conventional farming; only their relative importance may vary. Obviously for the whole farm performance, yields, prices and costs matter most in the calculations, but those are influenced by the following main determinants of profitability:

- Agricultural policy environment: the economic performance is in most developed countries significantly influenced by the support payments for organic farming, which is not the case in developing countries where government support is lacking for organic farms (though the compiled studies still showed higher profitability in the absence of government support). In the studies analyzed by Offermann and Nieberg (2000), these payments on average contributed to 16-24 percent of profits in Germany, Austria, Switzerland and Denmark. The 2003 CAP reform changed substantially the policy environment for organic and conventional farms. Similarly, the resumed Doha negotiations in 2007 aiming at agriculture liberalization policies are also expected to change the relative profitability of organic farming (Sanders, 2007).
- Market environment: an important aspect of the profitability of organic farms is the opportunity of receiving higher farm gate prices for organically produced goods than for conventionally produced ones. Prices vary between the different marketing channels and the quantities marketed via these sales channels. Organic farm gate prices also have to take into account part of the production that may be sold at conventional prices. Data from Great Britain and Germany showed that higher prices for organic products accounted for 40-73 percent of profits for arable farms, and 10-48 percent for dairy farms (Offermann and Nieberg, 2000). The incentive effect of market situation and organic prices are generally higher than of support payments (Offermann and Nieberg, 2009). In developing countries, for instance, where policy support does not exist, organic farmers are driven by the market opportunities of the North.
- Political environment: the market environment is very often influenced by political factors (and *vice versa*). For instance, accession to EU has led to a sharp decline of conventional producer prices: in combination with the support for organic farming according to EC Regulation 2078/92, this increased the relative competitiveness of organic farming (Offermann and Nieberg, 2000) in Austria, Finland and Sweden upon their accession.

- Farmers’ management abilities: although hardly measured in economic studies, farmers’ experience and decision-making abilities are one of the most crucial determinants for profitability. Farm success is often more dependent on the management ability of farmers, especially in the area of marketing, than on site-specific conditions.

2.1.3. Profitability and time lines

Inter-temporal comparisons of economic performance is very difficult for several reasons:

- The same sample of farms can hardly be used for comparisons over a long period. For instance, the samples in the EU farm accountancy data network (FADN) – which is a source of data on European organic farming’s financial performance – are changing over the years: some farms drop from the survey while others are taken up (Offermann and Lampkin, 2005). The development of average results therefore provides an insight into the average income situation of the current sample - changes in the situation however cannot easily be attributed to changes in the political or market environment as they could also be due to the changes in the samples (Offermann and Lampkin, 2005).
- Moreover, the criteria and procedure to select the conventional reference groups for the samples can and has changed during time (as in case of the EU FADN samples).
- Also, socio-economic parameters are constantly changing, influencing the determinants of profitability over time. For instance, price premiums change from year to year and their relative importance for the profitability of organic farming may decline under more liberalized market conditions, as was shown by Sanders *et al*. (2008).
- The importance of sales channels can also change over time. This can be due to different reasons as pointed out by Offermann and Nieberg (2000), including: establishing special organic sales channels may take several years; changing market structure, such as wholesalers entering the organic market; the quantities sold in direct marketing are generally limited. Older data on farm gate prices is even scarcer than recent data, and an analysis of time series of prices is further complicated by the price differences in the different marketing channels.

There are few available long-term observations of profits for organic and comparable conventional farms showing the changing trend in profits over several years; the ones in Germany and Switzerland done in the nineties for 8 and 7 years respectively, showed that variations in profits were similar for the two farming systems (Offermann and Nieberg, 2000). These almost-parallel profit curves (with the organic-curve constantly showing higher profits) were thus similarly shaped by external factors like climate, policies and prices. The overall comparison of the last three decades is even more difficult bearing in mind the political, economic and social changes throughout this period. Different policy frameworks were developed in the eighties than during the last years. Similarly, the weight of organic agriculture in global production has substantially changed. Neither premiums nor any policy support were yet available in the eighties and research was negligible as to providing higher-yielding organic varieties.

From this, it would follow that the profitability of organic could only increase with premiums, increased governmental support and higher yields, yet the long-term studies analyzed here did not interpret the underlying reasons for changes in relative profitability over the years. Looking for trends in relative profitability was thus beyond the scope of this paper, however the rationale behind changing relative profitability between organic and conventional systems would certainly merit further research. This being said, one should be cautious when comparing studies across time and space, since different political, social and economic conditions can lead to opposite outcomes.

2.2. Case study methodologies

In the Appendix, 54 studies are presented according to different crops (e.g. corn, soy, wheat, vegetables, fruits, livestock, coffee, rice, tea and cotton) and mixed systems, and according to studies made in developed countries (i.e. USA, Canada, EU countries, Australia, New Zealand) and developing countries (i.e. India, China, Philippines, Laos, Uganda, Mexico, Guatemala, Costa Rica).

The compiled list include case studies as well as field experiments and model calculations based on farm data.

The work undertaken for this paper considered the studies featured in the Appendix, as well as other studies that were not included in the Appendix for the following reasons: studies of less than 3 years were not retained for developing countries; studies focusing mainly on the period of conversion to organic management; studies comparing sustainable (i.e. not certified organic) and conventional systems. Although such studies were excluded for comparative purposes from this paper, they offered important insights for the critical assessment adopted for this paper. One one-year study was included as exception in the Appendix from a developed country (McBride and Greene, 2008), due to its large scale focus, involving more than 2200 farms from 19 states in U.S.A.

Most studies compiled were based on the approach of real farm comparisons, although the majority of those from U.S.A were conducted on experimental fields. The selection of a reference group for comparisons has proved to be fundamental for relative profitability, thus the decision about what to compare with what becomes of crucial importance. Yet, not always the most suitable comparisons were found, for instance, Canavari *et al*. (2007) and McBride and Greene (2008) used very different number of samples in both groups, Chase *et al.* (2008) compared three rotations, all from different years without specifying the basis of comparison. Similarly hard to draw far-reaching conclusions when the sample size is very small (e.g. Wynen (2001) used 5 pair comparisons) or when the exact years for comparisons are not given (e.g. Hirschi (2000) calculated a higher net revenue for organic, but was not clear which years were used as basis of economic comparison).

Main criteria for economic comparison used by different authors

- Geographical proximity: Reganold et al., 1993; Dobbs and Smolik, 1996; Canavari et al., 2007;
- Physical similarities, such as size, soil and farm type: Dobbs and Smolik, 1996; Wynen, 2001; Canavari et al., 2007;
- Managerial similarity, such as experience: Mendoza, 2002; and management skills, e.g. Wynen, 2001;
- Cropping type similarity, such as mixed farms with livestock: FAT, 1993; Dobbs and Smolik, 1996.

Besides comparing the two production systems, several studies included the comparison of different management strategies, or added another type of production system:

- Two and four year rotations were compared both in organic and conventional systems (Clark *et al*., 1999; Olson and Mahoney, 1999);
- Continuous cropping system of different crops and several rotations were compared (Helmers *et al*., 1986; Chavas, Posner and Hedtcke, 2009);
- Row crops and small grains were compared in organic, conventional and minimum tillage systems (Smolik *et al*., 1995);
- Organic, conventional and low-input systems were compared (Mazzoncini *et al*., 2000; Chase *et al*., 2008);
- Organic contract farming versus non-contract conventional farming was compared in one study (Setboonsarng, 2008) - it was not clear whether contract farming itself, or the organic system was responsible for higher profits.

2.3. Yields

Evidence from the studies analyzed showed that yields in well-established organic farms are most often lower than conventional, to varying degrees. Most European studies including cereals, vegetables and mixed farming systems produced somewhat lower yields (FAT, 1992-97; BMELF, 1991-98; Offermann and Nieberg, 2000), whereas milk yields most often showed similar results when measured in liters per cow (Younie *et al*., 1990; FAT, 1993; Offermann and Nieberg, 2000). On the other hand, the majority of long-term studies involving soy-corn rotation in U.S.A, showed that organic yields on average were not significantly different (Chase and Duffy, 1991; Hanson *et al*., 1997; Drinkwater *et al*., 1998; Delate *et al*., 2002; Pimentel *et al*., 2005). Despite of lower soy yields in some other U.S. studies (Mahoney *et al*., 2004; Chase *et al*., 2008; McBride and Greene, 2008) high premiums (McBride and Greene, 2008) or lower production costs (Mahoney *et al*., 2004; Chase *et al*., 2008) rendered all organic systems more profitable.

Several of the U.S. studies investigated drier areas as well and found higher organic yields (Stanhill, 1990; Diebel *et al*., 1995; Dobbs and Smolik, 1996; Hanson *et al*., 1997; Pimentel *et al*., 2005.), suggesting that organic systems are more resistant to drought. Similarly, studies in developing countries showed that organic yields were generally higher under normal or favourable conditions (IFAD, 2003; Raj *et al*., 2005; Gibbon and Bolwig, 2007; Setboonsarng *et al*., 2008), but significantly higher under less favourable conditions (Mendoza, 2002). Overall, the majority of economic studies from developing countries showed higher yields for organic production, whereas not one study from developed countries showed increased yields when compared to conventional.

Examples of cotton yield increases in India

A study conducted by IWMI in 2003 in India showed that organic cotton yields were somewhat higher than in conventional farms (Shah *et al.*, 2005). A 13 percent increase of yield was found in another organic cotton project in Andhra Pradesh by Raj *et al.* in 2005. Similarly, the Central Institute of Cotton Research in Nagpur found that organic treatment resulted in 11-21 percent higher yields (Eyhorn *et al.*, 2005). Another study by Jackson (2005) found that organic cotton yields in Kutch were on average 2.5-2.75 t/ha, similar to or even in excess of those obtained under non-organic systems, and much more than irrigated conventional hybrid cotton yields in other states, such as Punjab and Andhra Pradesh. Factors explaining these differences lie in low pest populations due to dry climate, the widespread use of Desi varieties and greater attention paid to soil fertility.

Some difficulties arise when analyzing yields of the compiled comparative studies:

- *Object of comparison (commodity or whole farm based?)*: some authors only look at yields of one or two cash-crops separately (Chase and Duffy, 1991; Dobbs and Smolik, 1996; studies from developing countries), whereas others also evaluate average yields of the whole rotation (Hanson *et al*., 1997; Chase *et al*., 2008) and of intercrops (Eyhorn *et al*., 2005) - the later is more relevant, although more complex for meaningful results;
- *Unit of comparison (per ha or product?):* some evaluate cow performance on a hectare basis (which is usually lower in organic, due to lower stocking densities), others per animal basis (which often yield equal results), and this makes comparisons difficult;
- *Different varieties:* varieties bred for intensive-external input conditions are hardly suitable in low-external input systems. Organic systems especially in developing countries often use local breeds and varieties which have lower yields but which are more adapted to low-external input conditions (require less nutrients and water inputs or have higher pest/disease resistance) and authors do not specify that differences in yields may come from different varieties;
- *Different growth periods:* using different varieties also influence the economics of the whole rotation: for example, many organic farmers use Desi cotton, which is a whole-season crop, thus after harvest farmers cannot grow anything else in the rotation. Most conventional farmers grow hybrid varieties under irrigation, which enables the growth of two or three crops per year (Jackson, 2005);
- *Managerial background:* the previous intensity of conventional management very much determines the yield decreases during and after conversion to organic and often the background of organic farms are not clear from the studies, although it influences the comparative baseline.

Farmers' background influences yield performance

The increase or decrease in yields with the conversion to organic is not a universal phenomenon, but depends on how crops have been produced conventionally, as well as other factors such as soils, climatic conditions, etc. For instance, Birzer and Badgery (2006) found in a survey of organic wheat farmers across five Australian states that farmers who produced conventionally before noted a decline in yields, however after the fourth year yields showed improvements; whereas farmers who already used mainly organic methods did not see a drop in yields. Similarly, several studies in developing countries showed that where small farmers have little access to agrochemicals, the conversion from conventional to organic usually represented an increase in yield from 15 percent (Bray *et al*., 2001) to 50 percent (IFAD, 2003) in Mexico and 67 percent in Guatemala (Damiani, 2002).

When converting to organic agriculture, a change in paradigm shift must take place from the external input packages that treat problems to the preventive management and intensive knowledge inputs. Yields are not a characteristic of a production system *per se*, but very much dependent on farm management. Although organic produce is generally yielding less, yield losses can be mitigated to a certain extent by proper soil management, shade trees (such in coffee), timely removal of diseased plants, and a healthy balance between pests and natural enemies as biological controls (Van der Vossen, 2005). Nevertheless, although an important element for profitability, yields alone do not indicate profitability.

2.4. Production costs

There is a wide difference among authors in how to aggregate production costs. Total costs include:

- operating/variable costs: all production practices including planting, pest and weed management, harvesting, etc.;
- cash overhead: land rental, property taxes, etc; and
- non-cash costs: depreciation and opportunity costs for equipment, irrigations systems, tools and buildings.

In economics, fixed costs are business expenses that are not dependent on the activities of the business. They tend to be time-related, such as salaries or rents; by contrast, variable costs are volume-related (Sullivan and Sheffrin, 2003). In farm economics, there is no absolute definition of what has to be considered as variable costs or as fixed costs; it depends on the aim of the research. Some studies take only variable costs into account to calculate gross margins (Younie, 1990), others include fixed costs in their studies (Wynen, 2001; Gibbon and Bolwig, 2007) and yet others do not differentiate between variable and fixed costs (Olson and Mahoney, 1999; Delate *et al*., 2002). By definition, fixed costs are part of the total farm costs that do not vary significantly with the volume of output and that can only be changed in the long run, whereas variable costs are those that vary directly with the volume of output. The differentiation between variable and fixed costs is actually only important when gross margins are calculated since for those, fixed costs are not accounted for. However, fixed costs are crucial for farm profitability: for conversion for instance, several substantial investments have to be made (e.g. new animal friendly housing system, new orchard varieties to better withstand bio-physical stress) that are often counted as fixed costs and for many farmers, these costs actually define whether converting to organic may be profitable or not. Even though most studies make the distinction between the two types of costs, they may not specify exactly what costs are included among them. Mentioning merely variable and fixed costs does not allow the appreciation of the variables used and thus, proper comparisons.

An even more complicated issue is the inclusion of labour costs: some comparisons omit labour costs from the whole calculation of net revenues (e.g. Hanson *et al*., 1997; Delate *et al*., 2002), while most include hired labour as variable costs (Wynen, 2001; Eyhorn *et al*., 2005; Gibbon and Bolwig, 2007; Chase *et al*., 2008); some account for (hired) labour costs as fixed costs thus leaving them out from gross margin results (FAT, 1993; BMELF, 1994); and yet others count family labour as opportunity costs or leave them out completely (as most studies do in developing countries). Yet, another approach is used by Wynen (2001), who included hired labour as variable and family labour as fixed cost. Very often in developing countries, only cash costs are included and non-cash costs (like own labour and seed) are excluded (Setboonsarng *et al*., 2008). Whether labour costs are treated under fixed and/or variable costs, the most important is that they are treated consistently within the case study and are not overlooked.

Another challenge is the economic analysis of livestock operations, since sometimes they are handled on their own without taking the interactions between animals and the cropping systems into account. For instance, Younie *et al*. (1990) calculated gross margins with including categories on the costs side like purchased feeds, forage and other; similarly the FAT investigations (1993) in Switzerland took mostly concentrates, veterinary and medicinal costs into account, and thus left all costs related to the on-farm feed/manure production out of the calculation. Moreover, reduced expenditure on synthetic chemicals for forage production further lowers production costs in organic agriculture: however, this later is also not included in livestock comparisons.

From this, it follows those overall conclusions about production costs cannot be drawn from the economic studies compiled. Even if cost elements would be standardized, variations among production costs would occur due to the unique character of the operations and factors outside the control of the farmers: machinery costs depend also on the age, size and usage of equipments; irrigation costs are subject to variations in rainfall, temperature and efficiency of irrigation systems; and labour costs depend on wage rates, working conditions and efficiency of workers.

This being said, production costs tend to be lower in established organic systems, as most of the cases elaborating on input costs showed (e.g. Helmers *et al*., 1986; Hanson *et al*., 1997; Olson and Mahoney, 1999; Delate *et al*, 2002; Mendoza, 2002; Eyhorn *et al.,* 2005). In most European studies analyzed by Offermann and Nieberg in 2000, total costs of organic farms were on average slightly lower than on comparable conventional farms: while variable costs were generally significantly lower (60-70 percent), fixed costs were up to 45 percent higher than those of the conventional reference group in several countries. The few cases with significantly higher production costs were the ones focusing on vegetable production or the ones done in developing countries.

It has to be noted here that all analyzed studies relied on relatively cheap input costs (based on cheap fossil fuel) that have been varying tremendously the last year. Input costs are bound to increase on the long run: global nitrogen fertilizer prices surged by 160 percent during the first quarter of 2008 and although oil prices have deflated during the second half of 2008, fossil fuel based agricultural inputs (a substantial part of production costs) will sooner or later substantially affect conventional systems that rely on the intensive use of synthetic fertilizers and pesticides. In the case of organic agriculture, oil-based inputs negatively affect product costs where plastic mulch is used and more generally, when the system is mechanized.

2.4.1. Variable costs

It is important to understand the differences between organic and conventional systems in a given agro-climatic region in order to consider all relevant variable costs. For instance, weed control in organic agriculture may include manual pick-up or mechanical tillage, plastic mulching and flaming: these costs will not be captured if only herbicide costs are accounted for. Similarly, using transplants (e.g. tomatoes) in organic agriculture but not in conventional systems raises variable costs for organic, so do cover crops, purchased composted manure, legumes, green manure and labour for hand and hoeing costs. These are different costs than what a conventional system may entail with the dominance of fertilizer and pesticide costs.

Generally, variable costs include:

- ploughing and tillage,
- seeds and transplants,
- fertilizers, manure, mulch,
- pesticides, herbicides,
- energy, fuel,
- labour (operator labour, regular and seasonal hired labour),
- machine repair and maintenance,
- renting equipment,
- cold storage,
- transport,
- variable irrigation expenses,
- other materials (e.g. packing containers for fruits),
- record keeping and,
- certification costs.

Additionally, livestock productions include costs related to feed, health, bedding and breeding herd. Besides these, some studies included post-harvest handling and processing activities (Gibbon and Bolwig, 2007) and crop insurance, miscellaneous, pre-harvest interest expense (Chase *et al*., 2008) as variable costs.

As previously said, costs like machinery and labour, are sometimes treated as fixed costs in some studies (FAT, 1993; BMELF, 1994). The explanation for this was that farm accounting systems did not allocate machinery costs to production enterprises but presented a summary of all machinery costs under fixed costs. Olson and Mahoney (1999) also grouped all machinery costs (fuel, maintenance, repairs, labour, overhead) together, whereas most studies made the division between depreciation of machinery and equipment as fixed cost and fuel as variable cost (e.g. Wynen, 2001). Moreover, Lampkin and Padel (1994) noted that expenditure on marketing, certification, costs of training and advice were also calculated under fixed costs in some studies. The authors concluded when analyzing dozens of economic studies that variable costs were typically 50-60 percent lower for organic cereals and legumes, 10-20 percent lower for potatoes and horticultural crops and 20-25 percent lower for dairy cows. On the other hand, few studies showed that higher costs were due to the purchase of composts and other organic fertilizers. Higher input costs can also result from the use of transplants (Clark *et al*., 1999; Brumfield *et al.*, 2000), labour for hand weeding and harvesting, and higher level of packaging, storing and processing (Gibbon and Bolwig, 2007).

2.4.2. Fixed costs

Fixed costs generally include:

- purchase and rental of land,
- land charges and administrative costs,
- interest on farm-related loans, and
- replacement values of machines including depreciation, interest and insurance.

Again, there was a wide difference in the analyzed studies as to what was included under fixed costs: Gibbon and Bolwig (2007) took the purchase and transport of planting materials, long-term fertilization costs, scheme membership costs into account; Wynen (2001) listed family labour; and the German study by BMELF (1991-98) considered all labour and machinery costs as fixed costs. Some studies also added the annualized cost of past investments, where these were still utilized. Overall, fixed costs generally account for the smaller part of total production costs (except for when labour and machinery costs are treated as fixed costs), therefore these costs are important but not decisive for determining farm profitability.

2.5. Gross margins and net returns

Most studies use net income/returns per hectare as a measure of profitability. Net returns are calculated by subtracting total costs from gross revenues. Gross revenues are the average yields per hectare multiplied by the commodity farm-gate price. Other studies use gross margins to measure economic performance; gross margins are calculated by subtracting variable costs from the total farm income.

Critiques of the use of gross margins

Farmers in Europe, Australia and New Zealand use mostly gross margins and thus leave-out fixed costs from the calculus due to the different levels of debt servicing, ownership structure and other fixed costs. Several critiques were formulated by Lampkin and Padel (1994) related to gross margins:

- farms receiving higher prices through better marketing showed in their gross margins the higher price, however the related costs of processing, storage and marketing was often left out;
- no information is given on labour inputs (in the case where labour was considered as fixed cost);
- conventional variable costs (i.e. fertilizer, herbicides) can be substituted by fixed costs in organic, such as machinery, labour and other tools, such as plastic mulch.

Most studies from Europe and Canada reported similar or higher gross margins for organic, but besides lower costs, higher prices were required to compensate for reduced yields. In several cases (Younie *et al.*, 1990; FAT, 1992-97; BMELF, 1991-98) lower variable costs resulted in similar or higher gross margins. Similarly, where premiums were available and the proportion of higher-value crops such as vegetables were bigger, gross margins were higher (BMELF, 1991-98).

Main reasons for higher profitability of organic systems

- *Higher market prices and premiums*: even with less yields and higher production costs, organic remained more profitable due to 400 percent higher market price (Younie, 1990; IFAD, 2005); even with much higher costs and significantly lower yields, price premium made organic more profitable (Brumfield *et al.*, 2000; Lyngboek *et al.*, 2001; McBride and Greene, 2008); higher prices for organic accounted for 40-75 percent of profits in Germany and Britain for arable farms, and 10-48 percent for dairy farms (Offermann and Nieberg, 2000);
- *Lower production costs*: lower production costs caused significant difference in net returns even without premiums (Mendoza, 2002; Mahoney *et al*., 2004);
- *Combination of premiums and lower production costs*: low production cost along with the 20 percent premium on organic was the prime reasons for higher profit margin (Shah *et al.*, 2005);
- *Combination of higher yields and premiums:* IFAD, 2003; Gibbon and Bolwig, 2007; Setboonsarng, 2008.
- *Combination of higher yields and premiums and lower production costs:* Jalees, 2008.

Net returns which take total costs into account most often proved to be higher in organic systems. Overall, reduced costs and/or higher market prices and premiums were given as main explanations for higher profits on organic farms. Yet, in several studies, the organic rotations profited equally or better even without premiums (Diebel *et al.*, 1995; Smolik *et al*., 1995; Dobbs and Smolik, 1996; Hanson *et al*., 1997; Olson and Mahoney, 1999; Hirschi, 2000; Delate *et al*., 2002; Eyhorn *et al*., 2005; Pimentel *et al*., 2005).

Although yields in organic systems tend to be lower, input costs are usually lower, making these systems competitive with conventional systems, sometimes even before including organic price premiums. Welsh (1999) reviewed six long-term studies in the Midwest: without premiums, in three of the studies the more diverse organic systems were as profitable as the conventional systems; with premiums, however, in all six studies the organic systems had higher net returns. Thereafter, Mahoney *et al*. (2004) found in south-western Minnesota that a four-phase organic rotation (corn-soybean-oat-alfalfa) had equal net returns to a two-phase conventional rotation (corn-soybean) even without price premiums. Similarly, Delate *et al*. (2003) had the same findings in Iowa. Pimentel *et al.* (2005) reported that in the Rodale study in Pennsylvania, a three-phase organic legume-based system had similar net returns as the conventional corn-soybean rotation, again before organic price premiums were factored in.

Nevertheless, the impact of the organic price premiums is large. In other studies, price premiums were needed to break even the conventional income (Helmers *et al.*, 1986; Chase and Duffy, 1991; Brumfield, 2000; Lyngboek *et al*., 2001; McBride and Greene, 2008; Chavas *et al*., 2009). As Chavas, Posner and Hedtcke (2009) showed, when organic price premiums are included along with the government payment, returns to the organic grain system increased by 85 to 110 percent, and in the forage system by 35 to 40 percent, placing both of them with higher returns than any of the Midwestern standards of no-till corn-soybean, continuous corn, or intensive alfalfa production.

Thus, looking at the economic performance of over 50 studies, a common conclusion can be drawn that premium prices and/or lower variable costs most often compensate for reduced yields and give similar or higher net returns/gross margins.

2.6 Profitability in developing countries

In less developed countries, very few studies have been conducted on the profitability of organic agriculture and none used farm budget-related data. Long-term studies are hardly existent: only about a dozen studies compared both yields and net income, mostly focusing on coffee and cotton. There are several outstanding characteristics that make comparative studies in developing countries different from those in developed countries. Some of these differences are the following:

- Non-cash costs are often not taken into account (Mendoza, 2002): they are not treated as costs by farmers since it does not involve money on their part. Most farmers view their work as their main occupation, having no alternative off-farm source of income. Thus, opportunity costs for family labour are not considered, whereas they contribute to a substantial part of production costs as opportunity costs in developed countries.
- Many farmers are tenants and do not own the lands in developing countries, and as a consequence have less motivation in investing into better management practices. Mendoza (2002) found that all organic farmers were landowners (and indeed they had higher yields), whereas only three out of the studied 17 conventional rice farmers owned their lands.
- Livestock represents a critical element of organic farming in developing countries; animals are not only a source of manure, but also of farm power and immediate cash. Yet, most economic studies leave them out from the calculus of costs and revenues (Julees, 2008).
- Most studies in developing countries rely on interviews with farmers. Consequently, many of the responses may be based on perceptions rather than on well-kept records. In many areas, farmers are mostly illiterate, so they do not keep written accounts and find it difficult to recall earlier costs of different inputs. Thus, data in these studies are mostly approximate figures, giving a rather indicative idea of economic performance.
- Many studies in developing countries do not calculate fixed costs in a discounted form, since farmers are usually enable to recall exactly when and for how much they have made investments and how long those investments were to be utilized.
- Farmers most often cannot recall the scale and timing of earlier investments, neither can they estimate how long into the future current investments are utilized. For these reasons, calculation of fixed costs in a discounted form has not been attempted in most studies (e.g. Gibbon and Bolwig, 2007).
- Public support schemes, such as price support, provision of research extension and marketing services are non-existent. However, farmers who are members of contract farming schemes are entitled to free certification and training (Gibbon and Bolwig, 2007).
- Organic farmers have higher variable costs on post-harvest handling and processing activities in order to meet the higher quality standards set by the organic exporters.

All complied studies in developing countries showed higher profitability in organic agriculture (except for one study by Pülschen and Lutzeyer, 1993), partly because of higher yields and reduced costs (Mendoza, 2002; Eyhorn *et al*., 2005; Jalees, 2008), partly because of much higher market prices (IFAD, 2005). It is important to carefully consider the quality of organic farming data in developing countries, especially when studies are based on interviews with farmers: Mendoza (2002), Carpenter (2003), IFAD (2005), Jalees (2008).

Profitability of organic cotton production

An Indo-Swiss research team compared agronomic data of 60 organic and 60 conventional farms over two years (Eyhorn *et al.*, 2005) and came to the conclusion that cotton-based organic farming is more profitable: variable production costs were 13-20 percent lower, inputs were 40 percent lower, yet yields were 4-6 percent higher in the two years, and as a consequence gross margins for cotton were also 30-43 percent higher. Although crops grown in rotation with cotton were sold without a price premium, organic farms achieved 10-20 percent higher incomes from conventional agriculture. Similarly, an impact assessment study for organic cotton farmers in Kutch and Surendranagar commissioned by Agrocel concluded that farmers who participated in the project enjoyed a net gain of 14-20 percent resulting from higher revenues and lower costs. The updated version of the study surveying 125 organic cotton farmers concluded that 95 percent of respondents saw their agricultural income risen since adopting organic agriculture, on average by 17 percent, most of them attributing this largely to the reduced cost of production and increase in cost of selling (MacDonald, 2008). Similarly, Raj *et al.* (2005) found in Andhra Pradesh that organic cotton was much more profitable, since conventional cotton did not have any profits (income was + $13 versus -$30). In conclusion, all studies found organic cotton farming more profitable than conventional.

3. CRITICAL QUESTIONS FOR COMPARATIVE STUDIES

3.1. What methodology is used?

Different studies use different methodologies and rely on different sets of data. The most common ones found in the compiled studies can be grouped in the three categories described below.

3.1.1. Experimental trials

The use of production data from university trials and research institutions database to estimate enterprise budgets (Helmers *et al*., 1986; Diebel *et al*., 1995; Smolik *et al*., 1995; Olson and Mahoney, 1999; Hirschi, 2000; Delate *et al*., 2002). These field studies use replicated in randomized blocks (Hanson *et al*., 1997), or compare different production regimes using adjacent parcels (Clark *et al*., 1999). While field studies allow for the exclusion of many external factors influencing profitability (and thus the effect of the production systems themselves on economic performance is more obvious), this methodology fails to consider land and labour charges on the costs side and real marketed quantities on the revenue side (not all organic harvest can be sold as organic at a premium price). Not all harvested produce could get premium price also because of the necessity to meet certain quality requirements – these aspects could only be covered by studies relying on data from existing farms. Yet the biggest problem with this approach is that it ignores the farmer as an entrepreneur since it keeps as many factors as possible constant (whereas farmers may change practices, such as rotation, as soon as prices change or certain problems arise). Nevertheless, several criteria could be used to improve experimental trials, such as: sufficiently large size; inclusion of human input; and several years' comparison after the conversion period.

3.1.2. Farm operations

Direct comparison using data from operating farms, surveys or case studies is the most often preferred methodology for comparative studies. Obviously, the comparability increases with the number of selection criteria used. Farm surveys can take the shape of sample-groups, matched pairs and clustered groups and they use enterprise budgets. One critique of case studies and of surveys comparing individual organic farms with averaged group data for conventional farms is the inability of generalization, since individual farms cannot be considered representative of the population. Other surveys compare group averages for organic and conventional farms, but variations within the groups may be as large as as any difference between the groups. Case studies allow understanding of interrelationships and causality, at the expense of comparability and statistical analysis (Lampkin, 1994).

To assess the relative profitability of organic agriculture, one of the most crucial considerations is the selection of the comparison group. The German long-term study by BMELF between 1983-94 showed that if organic is compared to a carefully selected comparison group, than it receives higher profits, whereas if compared with 'main income' German farms, than organic profits are lower.

There are different approaches for selecting comparable conventional farms, both with respect to the choice of selection variables and to the applied matching procedures. Consequently, results between studies and countries cannot be easily compared. Attempts have been made to develop guidelines on the selection process for comparisons; Offermann and Lampkin (2005) have suggested to include farms with similar environmental conditions, localization, equipment of production factors, and farm type. Within the EU research project EU-CEE-OFP, guidelines for the harmonization of income comparisons of organic and conventional farms have been developed, which can serve as a basis for a 'code of good practice' (Offermann, 2004). The preferred approach is to select a group of similar conventional farms to compare with each individual organic farm, so that the impact of differences in management ability can be minimized (Offermann and Lampkin, 2005). If there is high number of organic farms present in a region, the comparison procedure becomes easier: specific matching is not needed anymore, as the organic farms can simply be compared to all conventional farms of similar farm type and same size in the respective region.

Comparisons can be made between: groups of similar farms; between two representative farms; between farms based on „minimum similar criterion"; or between farms with similar characteristics in production system, size and location (Cisilino and Madau, 2008). Sample size shall not be too small, otherwise it is hard to do any statistical tests of differences. Comparing a large-scale conventional farm with a smallholder organic would give radically different results compared to when sizes are similar. Due to economies of scale, large farmers are more likely to purchase seeds and chemicals for lower prices from wholesale outlets, by-passing local sales people. Furthermore, similar number of farms shall be chosen in both groups in order to have substantial homogeneity between organic and conventional farms as regards structural, environmental and managerial aspects. According to Offermann and Nieberg (2000), the advantage of this system is that it minimizes the risk of including „non-system determined" aspects that can affect the results, since both farm types show an average potential endowment[1].

Non-system determined factors – such as location, size, land tenure, land characteristics, financial circumstances, production, marketing and managerial influences (Dabbert, 1990) – are better to be ruled out if the intent is to assess the financial performance of different production systems. It is best to compare similar farm types (arable, dairy, mixed, etc.) with similar intensity of external input use under similar agro-ecosystem and socio-economic conditions. Yet, the risk of choosing non-similar systems will always remain, due to technological or management differences.

3.1.3. Modeling studies

The modeling comparisons of organic and conventional farms based on empirical (econometric) or normative models is rarely used. A USDA study (1980) and a study in Iowa (James, 1983) were one of the first modeling studies and both showed that organic agriculture had consistently lower returns. Although these models allowed for non-system determined factors to be excluded, they involved high level of abstraction and simplicity. The previous studies can be criticized for assuming that soil structure, infiltration rates, erosion rates were the same and these did not influence the economic outcome. Since there are significant differences between the two systems in terms of replacing needed nutrients and water, these costs will be manifested over time. Moreover, the diversity of crops on organic farms can provide economic benefits that are usually also not captured (e.g. resilience to

[1] Several studies compared unequal number of farms: in Vermont, 7 organic and 182 conventional dairy farms were compared (McCrory, 2001); in Emilia-Romagna, Italy, comparison was made between 83 organic and 1781 conventional farms and in Minnesota between 42 organic and 2897 conventional (Canavari *et al.*, 2007).

natural and economic shocks). Another example that such models do not necessarily reflect reality is the economic simulation model used by Diebel *et al.* (1995) that assumed equal yields.

3.2. What indicator is used for the comparison?

Net revenue or gross margin per hectare/acre is used most often as main indicator of profitability. The evaluation of results strongly depends on whether profits per family work unit are tested, which are usually equal to, or higher, in organic, or profits per hectare of utilizable agricultural area is tested, which is often lower than those of conventional farms (Offermann and Nieberg, 2000). Similarly, if the average market value of crops produced on farms is evaluated, conventional will most often outperform organic, due partly to differences in the relative amount of land devoted to each crop.

If one considers the indicators for yields, and yield per hectare of a single crop is measured, it would be probably lower in an organic farm than on a conventional growing mostly that crop. Whereas, if total production per hectare of all crops is taken into account, than organic may easily outperform conventional. Conventional systems focus on cultivating high-value crops in most areas, whereas organic farms have to limit high-value crop acreages for enabling rotation. Consequently, systems with a higher proportion of such crops (like soybean grown in a soy-corn rotation or tomatoes in a two-year conventional rotation) tend to have higher net returns (Helmers *et al*., 1996). Clark *et al.* (1999) concluded that the two-year conventional rotation was most profitable due to greater frequency of high-cash crop (tomato). However, the study showed that when high value crops were grown in a longer (conventional) rotation, organic rotation outperformed the conventional one.

3.3. Is organic treated as a whole system?

The concept of a farm as an independent system of which components are operating together for a common purpose, has been recognized for long (Lampkin and Padel, 1994). Organic agriculture specifically requires a systems approach due to its complexity. Conventional and organic farms represent different systems. Thus, the usual simplified approach of comparing them on the basis of few variables looking at few cash crops may not be sufficient. Let alone the negative off-farm implications of specialized conventional systems as opposed to organic ones aiming at semi-closed systems if we want to analyze profitability on the society scale..

Furthermore, evaluating the profitability of a single crop may is not appropriate in a whole-farm system, since it would disregard the interactions between farm elements. Organic cultivars are in many cases different and do yield less: for example, fertility enhancing legumes take at least 1-2 years in the rotation and bring less in direct cash than a high-yielding conventional cash crop. The same legumes may, however, double the yields of the subsequent cereal crop. Overall, a multi-disciplinary approach that involves the whole farm (including crop and livestock operations) and takes note of the management skills and objectives of the farmers is a more favourable option.

3.4. Are farmers' objectives taken into account?

When measuring profitability, researchers cannot put aside farmers' objectives. Maybe, some organic and for that matter conventional farms may not aim to the highest possible returns, but have other priorities, such as stress less lives in the countryside, production of healthy food, better family health, etc. Thus, even though an organic farmer could have a lower profit than the conventional counterpart, his/her main objectives could be met while still having a sufficient income for the family.

Dobbs and Smolik (1996) showed that organic farms still earned acceptable profits since net revenues were high enough to cover all costs, including land charges and family labour wages. Profitability is thus rather understood in the context of the farmers' goals; excluding these from economic studies would require a very careful interpretation of results. If profitability of an organic farm is related to the profitability of a conventional farm, as is done in comparative studies, it is not clear whether the relative profitability of farms draws a valid picture of reality or distorts it. Farmers may for example have other income sources that balance-out a less impressive profit, such as agritourism, eventual carbon sink payments or other off-farm activities. The question is whether farmer's average profits over the years is satisfactory or not in relation to farmers' set objectives. Another factor to be considered is indebtness due to previous investments and the extent to which profits can enable the pay-back of loans. Such factors play an important role in determining farm profitability and could be captured through household surveys.

3.5. Are price premiums taken into account?

Farmers can receive premiums for various commodities thus, making organic agriculture more profitable. Premium prices for organic crops are widely available for most developed countries (and much less in developing ones), but the size of the premium varies among crops and countries. Not only that premiums vary but not all products may be sold at premium prices due to quality requirements (e.g. colour, size specifications) or lack of market demand. Thus, these would be sold as conventional. The importance of domestic organic markets and local demand is thus crucial in order to sell all produce with premiums and not just one proportion of a single export crop, according to trader's specifications.

Premiums breaking even conventional profits

Most studies in the eighties and early nineties by land-grant universities in U.S.A. did not take premiums into account (Diebel *et al*., 1995; Smolik *et al*., 1995). The Wallace Institute review of six midwestern university studies found that organic grain and soybean production systems earned higher profits with premiums, and even without them, half of the organic systems were more profitable. Welsh (1999) noted, when calculating the required premiums for some of the organic systems, that the greater the number of crops commanding premiums in the rotation, the smaller the size of the premiums required to break even, as compared to the conventional system. He calculated for the Minnesota experimental trials that, if premiums were available for all crops (i.e. corn, oats, alfalfa), a 19 percent premium/crop/year would be needed, whereas if only corn and oats got premiums, 35.4 percent was necessary to break even conventional profits.

Premiums depend on many factors – such as commodity, location, access to organic markets and marketing skills of the farmer – and can take several forms: constant, seasonal or for established amount of products per month[2]. In many cases, it is the premium price that makes organic systems more profitable. However, even without premiums, organic systems may be more profitable than conventional. With economy of scale in organic agriculture, premiums are less needed since post-harvest and certification costs are lower with greater quantities. Overall, omitting premium prices – when they are available – would run counter to economic realities. Yet, many studies warned that reliance on price premium may jeopardize the long-term economic viability of organic farming (Clark *et al*., 1997). Since the market for high-value crops can get saturated, and premiums can fall as a consequence, a strategy of diversification is advised in which lower premiums are given to all crops in the rotation.

3.6. Is governmental support taken into account?

Different payments are awarded to organic farms, depending also on the crops grown. It is important to take these into account to accurately show the relative profitability of the two systems. In most countries, existing governmental policies benefit organic agriculture much less than conventional ones (Smolik *et al*., 1995). Much is revealed on this aspect when researchers compared differences in economic profitability in relation to the presence or absence of government payments. Diebel *et al*. (1995) showed that without governmental payments, organic returns were 143 percent greater than conventional, yet if government payments were taken into account, the difference in favour of organic was 'only' 78 percent greater than conventional returns. In the EU, member states can support organic farming directly via agri-environmental measures. Offermann and Nieberg (2000) calculated that for

[2] Larson, Kliebenstein and Honeyman (2002) explained that in the case of organic pork production, a constant premium encourages over-production of summer farrowed pigs (when costs are much less) and thus, a seasonal premium is much to be preferred to trigger production during winter periods.

organic farms in Austria, Denmark and Germany, the share of governmental payments in profits are at around 20 percent, whereas in Great Britain this share is much lower due to both the relatively low level of payments, and the fact that only converting farms are eligible for payments under the organic farming scheme.

3.7. Are differences in profitability caused by non-system differences?

When there is a difference between the two production systems, it is important to determine whether these differences are because of the system itself or due to external factors, such as management skills of farmers. Whether a farming system is financially beneficial depends also on what is included in the analysis: off-farm effects are very difficult to quantify, though they are extremely relevant for determining the efficiencies of a particular farming system.

Failure to choose the right comparison groups by accounting for the non-system determined factors may lead to the question whether these or the type of production system is responsible for differences in profitability. Many studies compare the profitability of organic versus conventional and treats results in different profits as arising from differences between the systems. Several others, however, conclude (Fox *et al*., 1991; Dobbs, 1994; Canavari *et al*., 2007) that the differences lay in other factors, such as variations in the production systems, climate, soil and crop types. It has to be observed that annual results on profitability of organic and conventional farms show similar variations, indicating that not necessarily the farming system *per se* but other factors – climate, soil type, input and output prices, premiums, policies and exchange rates all dependent on the particular country and on the time when farming takes place – determine the profitability of a farm (Wynen, 2006).

Different 'non-system' influences on farm profitability

- *Within-system variations*: Welsh (1999) concluded that within-system variations (e.g. region, environment) had a greater effect on profits than between-system variation of organic and conventional. Similarly, Nieberg and Offermann (2002) came to the conclusion that the development of profits was comparable in organic and conventional farms and rather external, non-system factors influence on the two production systems in a very similar way. Also, Smith, Clapperton, and Blackshaw (2004), who conducted an analysis of organic and conventional crop rotations in the northern Great Plains of Canada, concluded that there was as much variation in net returns within organic and conventional systems as between the two.
- *Physical characteristics*: Murphy (1992) reported that large differences in farm size, farm enterprise structure (i.e. proportion of land cropped), land quality and location often had a greater influence on income levels than the production system itself.
- *External factors*: the parallel changes of conventional and organic profits in the German long-term study by BMELF between 1983-94 showed that the impact of external factors, such as climate and agricultural policy changes, was substantial.
- *Unmeasurable influence:* Canavari *et al.* (2007) concluded that due to inaccessibility of individual data, the significance of differences could not be tested thus, it was not possible to prove whether income difference was system-related.

3.8. Are compared farms still in conversion?

Comparison between a conventional farm and an organic farm in conversion is unfair as often, organic conversion involves investment costs for adoptions to organic farming in terms of e.g. varieties for perennial crops, animal-friendly housing systems and adapted machinery. During conversion, organic farms cannot earn premiums and yield reduction is common, until farmers learn and adjust to organic farming practices and the equilibrium of the agro-ecosystem is restored. Throughout this period, financial loss can be severe: less profitable crop rotations may be required; yields may decrease due also to higher weed infestations; and normally, three or four years have to pass until crop rotations become established and yield begin to increase.

According to Dabbert and Madden's (1986) model simulations, the rotational effect on income is not over till the sixth year, when the legumes begin to deliver their maximum contribution to the farm's nitrogen supply. Wynen (2001) showed that organic farms that had been under organic management for longer times achieved higher yields than the latest entrants. Thus, this transitional phase is the most challenging one for organic farmers and should not be taken for the purpose of comparative studies with other conventional farms. It is, of course, another matter if the objective is to find out the change in farm economics during conversion. In such cases, one full crop rotation cycle, in addition to the conversion period of three years, is the recommended minimal period for conversion experiments (Standhill, 1990).

3.9. Are multi-year comparisons designed to include the whole organic rotation?

Studies covering only one year may be strongly impacted by certain climatic, economic or other factors prevailing in a given year. The weakness of several studies (especially of those with annual crops, where rotation is a must in organic) is their relatively short length. Organic rotations usually cover 3-4 years, whereas conventional ones are shorter. In order to accurately evaluate the profitability of organic farms, the whole rotation must be taken into account. Moreover, benefits of „rotation effects" manifest themselves usually several years after rotations so ideally, a multi-year comparisons should be designed for determining farm economics (Welsh, 1999). Soil quality tends to improve over time and weed, insect and disease populations decrease in the organic system with good management, thus lowering nutrient and pest management input costs. These reductions in costs can only be captured in a long-term study. This would also allow the yielding of full benefits from investments made in early years of an organic system (biological pest control, changes in buildings, fencing, breeding livestock, etc). Moreover, a multi-year comparison could ensure that variability in annual prices and net returns are duly taken into account.

Overall, a long-term study - covering at least three years starting after the conversion period is over - is an imperative to understand farm economics. Another important consideration is the precise definition of what is understood by one year: some authors consider the full calendar year, others include the cropping year usually covering two calendar years. If only the growing of the cash crop is accounted for, and no pre-seeding or post-harvest costs are included (e.g. cover crops, legumes, green manure), important costs (especially labour, seed and machinery) and benefits (erosion control, weed, pest and disease management) are disregarded.

3.10. How is family labour accounted for?

Labour costs can be counted as numbers of full-time equivalent (FTE) or in terms of hours. Hanson *et al.*(1997) proved that in organic systems, greater amounts of family labour was needed. Wynen (2001) showed that in both production systems, family labour (which is not a cash cost) is actually three quarters of total labour costs. Small farms are usually having higher labour use and requirements per hectare than larger organic enterprises (Lampkin and Padel, 1994).

Labour costs can be measured in several ways depending on the farmers' (and researchers') perception of the value of their own work on farm. If the farmer views his/her time spent on the farm in terms of opportunity costs, labour costs tend to be higher in organic. If the farmer does not view off-farm income (i.e. income earned outside the farm) as an alternative source of income, labour costs between the two systems are similar (RUTGERS, 2008). Both family and hired labour are accounted for in most studies in developed countries, whereas in developing countries, opportunity costs for family labour is omitted. In the European studies evaluated by Offermann and Nieberg (2000), labour use on organic farms was higher (10-20 percent) than on comparable conventional farms, but its extent was strongly dependent on the farm type.

Higher labour costs due to higher wages

Labour costs can be high also because of higher wage costs, not necessarily due to more labour need. Delate *et al*. (2002) used three different hourly rates to cover a typical range of Iowa farmers, and the authors found that increasing labour charges did not change the significantly higher net returns of organic corn and soybeans. In the German (BMELF, 1994) and Swiss (FAT, 1993) studies, organic wage costs were two to four times as high as conventional.

Further questions arise when deciding upon the inclusion of the time spent in marketing and seed selection with labour hours of the farmer, and of his/her off-farm labour. The FAT (1993) investigations proved that organic farms received higher off-farm income, which made their total net income closer to that of conventional farms.

3.11. How are loans dealt with?

Farmers often take short or long-term loans to pay for supplies, labour and purchased inputs. To account for these, it is suggested that interest on operation capital is included as a cost of production, charged on total variable costs at a rate of, for example, 10 percent per annum. For annual crops, interest can be calculated for the growing period till the harvest, and for perennial crops, for the full year (RUTGERS, 2008).

Conventional farmers are usually more indebted

Most studies did not evaluate the debt issue and thus did not take previous investments in agriculture into account. Some authors, however, noted that conventional farmers were significantly more indebted, especially in developing countries (Eyhorn *et al*., 2005; Shah *et al*., 2005; Jalees, 2008). Eyhorn *et al*. (2005) noted that most conventional cotton farmers in Central India bought inputs on loan, at annual interest rates between 10-15 percent (from cooperative societies) to over 30 percent (from private money lenders). Since production costs were usually lower, the necessity in organic agriculture to take up loans was far less. As Jalees (2008) indicated, the main cause for India's extremely high farmers' suicide rate is debt servicing for start-up costs, mainly GM seeds and chemical inputs.

3.12. What agro-climatic areas and what crops are studied?

Climatic characteristics can be crucial determinants of relative profitability. Production costs vary greatly by region, climate and production system. Studies showed that in wetter areas (e.g. Corn Belt) conventional is outperforming organic, whereas in drier areas, it is the opposite. Organic systems have been proven to be more competitive in drier areas of U.S.A. (Diebel *et al.*, 1995).

Organic production may be a good option for areas with low disease and pest pressure, but it is much more difficult in other areas where productions costs are too high. For instance, feed costs are much higher especially for organic farms in some areas (e.g. New England) than in others (e.g. Corn Belt) where the price of organic grain increases the farther one moves away from the Corn Belt. Consequently, the financial performance of an organic dairy farm in Wisconsin looks very different from that of a New England farm where higher cost of paid labour and purchased feed nullified much of the milk price advantage (Kriegl, 2006). Thus, it is very important to consider which climatic areas are selected and what crops are grown there.

3.13. Are livestock operations included?

There are very scare financial data on livestock farms. Most studies excluded livestock operations, even if they were present in both farming systems; others included only the manure but excluded all other aspects (Helmers *et al*., 1986; Wynen, 2001[3]; Chase *et al*., 2008). This creates an unrealistic

[3] Wynen (2001) argued that she excluded livestock operations in the comparison because sheep may be used either for wool or for fat lambs, both of which should be treated as different enterprises, and also because different classes of wool get different prices.

picture, since livestock is a crucial element for optimum economic performance of organic farms. When analyzing whole-farm performance, livestock has a crucial importance in within-farms transfers of nutrients and energy in organic agriculture. For instance, organic alfalfa grown in the rotation may be fed to animals instead of being sold on the market for premium if possible and this would immediately change the input and output calculations.

Many studies using data from non-operational farms assume that all manure inputs have to be purchased from off-farm sources (e.g. Clark *et al*., 1997). Dabbert and Madden (1986) found that it was more profitable to seed the crops and purchase the manure than to feed the crops to beef in a fattening enterprise. Chase *et al.* (2008) included manure as available source, yet other aspects of livestock operations were left out. Smolik *et al.* (1995) assumed that all grain was sold on the market and not fed to livestock, although rotations patterned mixed farms in South Dakota. In the Swiss investigations (FAT, 1993), gross margins were calculated separately for livestock operations - instead of calculating the gross margin for the whole mixed farm - without taking into account neither the cereal production for feed, nor the import of feed (only concentrates). Organic feeding practices are significantly more expensive than conventional practices. For all these reasons, assumptions on the source and cost of manure and feed have a dramatic effect on the outcome of economic comparisons. In comparative dairy studies in North America, higher costs of feed were the largest and most important difference between organic and conventional farms (Kriegl, 2006).

Studies with livestock have to be more cautious when determining whether feed and compost is bought or produced on-farm, because they may lead to contrasting economic results. Another question that can influence the profitability of livestock operations is whether gross margins or net returns are calculated per animal or per kg/liter base (which can be higher in organic) or per hectare base (which can be lower due to lower stocking rates in organic farms). Where quotas are limiting, the margin per liter produced is a more relevant performance measure.

3.14. Are processing and transaction costs taken into account?

Calculating processing costs is not straightforward, as many crops can be sold in processed or unprocessed form. For instance, cocoa beans can be sold as fermented or unfermented. Coffee beans can be sold in raw form, as pulped and not dried, and as pulped and dried (parchment). Organic farming scheme operators usually purchase fermented cocoa and fully dried coffee beans (Gibbon and Bolwig, 2007). However, the picture gets more complicated since not all produce can be sold as fermented or dried.

Example of higher processing costs in organic

On average, in a study in Uganda, organic cocoa farmers sold 57 percent of their crop as organic, 24 percent in fermented form as conventional and 18 percent in unfermented form. Similarly, conventional cocoa farmers sold 58 percent of their crop fermented, and 42 percent in unfermented (Gibbon and Bolwig, 2007). The same study found that the higher costs of coffee processing in case of organic can be explained by the fact that a higher level of processing was required for organic coffee.

Transactions costs are associated with the marketing and delivery of products from the farm to the customer. These include post-harvest handling, packaging and storage, labour to sell, invoice and delivery of product. Chase *et al*. (2008) advised to make a separate transaction cost report as a companion for each enterprise budget. Since production costs do not vary by marketing outlet, he suggested to evaluate marketing decisions separately. By contrast, the New Jersey Agricultural Experiment Station advises marketing costs to be included as a cost of production. Farmers usually sell products through a third party, an auction or a broker, for which a selling charge has to be paid. If however, farmers are contracted to an organization (as are organic farmers) or to a processor, no selling charges are included in the budget.

On top of processing and transaction costs, wastage accounts for another important element that influences returns: especially in case of fresh vegetables and fruits, a high percentage of harvest may be lost for different reasons (e.g. bad storage, weather). Economic studies do not specify explicitly the amount of harvest that is wasted and thus not sold, although it would be useful to know how much potential there is to reduce wastage and thus, increase profitability.

3.15. How are the different levels of farmers' experience captured?

Many studies conclude that it is not the difference of systems between organic and conventional that determines profitability, but the difference in management experiences. Fowler (1999) noted that technical knowledge and management ability were obvious in the best performing farms. Paine (2003) also confirmed that the highest profit farmers had the strongest management skills. To thoroughly account for farmers' experience, one could compare the best third (e.g. in terms of revenues per year) of the conventional producers of a certain operation (e.g. dairy farming) and the best third of the organic farmers, similarly the medium third and the worst third from a large sample base.

Good management enhances returns

Zentner *et al.* (2002) found in Canada that including oilseed and pulse crops in the organic rotation with cereals contributed to higher and more stable net farm income in most soil-climatic regions. The Glenlea long-term rotation study in Canada showed that yield loss due to organic management can be reduced by using a combined grain-forage rotation (Entz *et al*., 2005). Yield reduction averaged 63 percent in the organic system for the grain rotation (wheat-pulse-wheat-flax), 46 percent for the green manure rotation (wheat-red clover-wheat-flax) and 14 percent for the integrated grain-forage rotation (wheat-alfalfa-alfalfa-flax). So choosing the right crop rotation with a combined grain-forage system is crucial for the profitability of organic wheat farms since it enhances organic production thus, increases revenues.

Management skills depend on the availability of extension and technical support, on the social network of the farmer, and on his/her experience. Collecting farm household data on managerial influences, including the number of years into farming, farm size, other crops planted, membership to organizations, reasons for farming methods used, business goals and skills and management ability could capture this important aspect. Most studies done in developing countries collect household data in order to help explaining the differences in profitability (Setboonsarng, 2008). Yet, it is quite a challenge to assess management ability objectively. For instance, Wynen (2001) asked farmers to rate their management ability, and results were included in the assessment. By its nature, only studies using data from operational farms could make use of a more qualitative assessment. Nevertheless, even these field studies could exclude managerial ability as non-system factor influencing profitability: in a study done by Delate *et al.* (2002), all operations were implemented by one farm manager in both systems.

Farm household data in some economic comparative studies

- Philippines: number of years into farming, land size, crops, membership to organisations, reasons for farming method, lessons learned in farming - Mendoza (2002);
- Lao: family size, land size, value of production, consumption and transportation assets, distance from farm to market - Setboonsarng (2008);
- Australia: age, number of years into farming (and organic farming), self-rating and of neighbours on ability to manage farm, land size, area cropped as percentage of arable area - Wynen (2001).

3.16. How is price determined?

Some studies use farm-gate prices, others use prices received by the elevator (storage building for grains) source or wholesale through larger outlets. Farm-gate prices are obtained from local or regional buyers at the time of harvest. Profitability is very much determined by the type of market channel where products are sold (prices realized via direct marketing to the consumer often being twice as high as those received from wholesalers) and the timing of sale. Which market is more profitable is dependent upon the competition, the customer and costs. Farmers may receive higher prices in farmers' markets than, for example, in institutional markets, but whether it would be profitable depends on how transaction costs change. However, one may receive higher prices at a certain marketing channel (e.g. direct marketing), but if the amounts that can be sold there are limited, the overall contribution of these sales to the total revenues is modest.

Marketing effects on profitability

A study made on social impacts of technical innovations confirmed (Shah *et al.*, 2005) that the right timing of cotton sales proved to be a crucial variable in the crop economics for a farmer. The price of cotton is at its peak when the harvest of pre-monsoon cotton takes place and the lowest when the monsoon cotton is harvested. Shah *et al.* (2005) showed that an organic farmer can receive up to 30 percent higher price when selling the pre-monsoon cotton, as compared to conventional farmers selling their monsoon cotton.

Due to price variations, several studies undertook a sensitivity analysis to determine the effects that this may have in terms of variations in profitability (Diebel *et al*., 1995; Smolik *et al*., 1995). Although prices for organic are much higher than conventional, a significant portion of organic products are sold on the conventional market. Obviously, prices and premiums should refer to the actual year when production costs have been studied and should not be used for retrospective analysis of previous years (e.g. the farm models carried out by Repstad and Eltun (1997) used production data from 1990 to 1996 in Eastern Norway, but the prices that were used for organic products were from 1996).

3.17. Are certification costs included?

For organic farmers, certification is an important additional cost items, yet the majority of the economic studies did not specify whether they accounted for these costs. Certification costs vary according to the fees of inspection and certification, individual or group certification, farm size, location, volume of production and the product itself. One of the major constraints of organic agriculture in developing countries is the high cost of certification, especially for smallholders and isolated locations, because of high inspection costs, when available. High certification fees (especially when foreign inspectors are flying long distances) and training costs represent for small producers a huge barrier to entry in the organic market. Contract farming and internal control systems are practical solution for small growers, since these schemes provide for shared group services and thus, reduced fees (Gibbon and Bolwig, 2007).

Small farms are often charged a much higher percentage (according to a U.S.A study, about six times more) of their annual sales for certification than very large farms (Ferguson, 2004). In many countries (e.g. UK), application fee covers certification for the holding, free technical and marketing support and a first inspection. Usually, certification costs involve both fixed and variable costs covering certification and inspection. Again, as with labour and machinery costs, different authors treat certification and associated costs differently. In the EU, certification costs are most often included among fixed costs (Padel and Zerger, 1994), though in an Africa study, Gibbon and Bolwig (2007) included cost of scheme membership among fixed costs. In gross margin calculations, treating certification and associated costs as fixed costs would mean leaving them outside of the economic evaluation.

4. SEEKING FAIR ECONOMIC COMPARISONS

This part of the paper will step out of the farm level to the wider level of society to highlight the wider implications of profitability. Organic agriculture faces an unfair competition in the marketplace due to the distorting effect of current subsidy schemes that favour conventional production; the unequal availability of research and extension services; and the failure to capture the real environmental, social and health externalities in market prices of conventional foods.

4.1. Government support

National or regional agricultural programmes and subsidies are mostly geared towards large-scale, chemically intensive agriculture that artificially lower the price of conventional products. Painter (1991) compared net returns of organic and conventional farms at the end of the eighties: average governmental subsidy per hectare was 38 percent higher in conventional. Authors in the nineties also found that conventional systems benefited more from governmental payments (Diebel *et al*., 1995; Smolik *et al*., 1995) than organic ones. If subsidies were expanded to support long-term aspects of agricultural productivity, such as soil-building grass and legume crops, profitability of organic farming would be much increased.

In the EU – as in most of developed countries - the financial performance of organic and conventional farming is highly influenced by the direct payment policy. The European Union introduced the agri-environmental support programme in 1994 and organic farming was one of the supported schemes (others included reduced inputs, schemes for specific habitats, etc.). Since 2000, the EU agri-environmental schemes have been integrated into the Rural Development Programme (EC Reg. 1257/1999), but the current allocation for this programme is just five percent of the total Common Agriculture Policy (CAP) budget (IFOAM, 2008). While organic farms receive considerable support from agri-environmental programmes, the design of the first pillar put organic farming at a disadvantage in the past. The 2003 CAP reform has changed this situation particularly by decoupling direct payments. Still, organic farms received 11 percent less in direct payments from the first pillar in 2004/05 (Nieberg and Kuhnert, 2007). Yet, the statistical analysis of FADN data from the years 2003/04 and 2006/07 suggests that differences in payments from the first pillar decreased, affecting positively the relative profitability of organic farms (Sanders, Offermann and Nieberg, 2008). However, according to a survey result, only 11 percent of the organic farmers think that decoupling has had a positive impact on their farm profits (Sanders, Offermann and Nieberg, 2008).

There is much debate on how inappropriate the current levels of organic support are. Nevertheless it becomes clear that a sharp redirection of public support from polluting activities to sustainable practices is necessary both in developed and developing countries, with subsidies encouraging positive externalities, combined with advisory and institutional mechanisms, legal measures and economic instruments correcting negative externalities.

4.2. Research and extension

The achievements of conventional farming system are based on several decades of intensive research and support, whereas organic research is still in its child shoes. Conventional farmers often have better access to information from extension services and university researchers. Organic farmers often need more time and greater managerial efforts to acquire the necessary knowledge of organic practices, prices, marketing opportunities, etc. Both yield levels and gross margins of rotation crops would probably increase if extension systems would also provide training and advice on managing these crops organically (Eyhorn *et al*., 2005). As long as no similar research and extension investments are directed into organic agriculture, yield comparisons, and consequently farm economics, can be considered unfair.

4.3. Externalities

We could only talk about the profitability of a system, when economic costs are balanced against environmental and health costs (hidden costs that society is bearing) and benefits and the outcome is still positive. At the moment, economic comparative studies only put economic inputs and outputs into the equation, and broadly overlook the environmental, social and health costs. Accounting for externalities, such as costs associated with run-off, spills, depletion of natural resources, health costs of farming exposed to pesticides, etc. are lacking. Yet organic is most often delivering public goods such as environmental and health benefits (see boxes on environmental and health impacts of organic agriculture below). Taking the differences in external costs and benefits into account would give us the true profitability picture of the different systems.

4.3.1. Negative externalities

Environmental, social and health costs, such as off-site damage from soil erosion, pollution of surface water and groundwater, hazards to human and animal health, and damage to wildlife are all costs presently borne by society and not factored into costs of farm production (Reganold, 1992). On the health costs side, dietary exposure to pesticide residues has been linked to gastrointestinal and neurological complaints, breast milk contamination and changes in sperm quality parameters (Heaton, 2002). Organic standards on the other hand prohibit additives and ingredients such as hydrogenated fats, aspartame, artificial colourings, phosphoric acid, etc., implicated in various health concerns (Heaton, 2002).

Example of health costs

IFAD (2005) case studies in India showed that that none of the 30 farmers interviewed in Karnataka have experienced any feelings of illness after working in the organic rice fields, whereas more than half of the conventional farmers had sometimes suffered from nausea and vomiting. In Kerala, a number of farmers were hospitalized after local groundwater was contaminated with pesticide run-off from neighbouring tea estates.

According to the World Health Organization (1992), roughly three million pesticide poisonings occur annually and result in 220 000 deaths worldwide. Both economically and in terms of human lives, these poisonings represent an enormous cost for society.

Example of social costs

According to the National Crime Records Bureau in India, between 1997- 2005, approximately 30 000 farmers committed suicide in Maharashtra, mostly in Vidarbha region. In 2007 alone, 1211 distressed farmers took their own lives in this region, where most BT cotton is grown, due to repeated cotton failure and indebtness. In a study done by Jalees (2008), nearly 91 percent of the farmers growing BT cotton were indebted, whereas only 4 percent of farmers cultivating organic cotton had debts.

The World Resources Institute reported that after accounting for all the external costs of soil loss, water contamination, and environmental degradation caused by conventional farming practices, the average farm showed a net loss, instead of a net profit. A study carried out by Pretty *et al.* (2000) went further and calculated that the total external cost to the environment and to human health of organic agriculture was much lower than for conventional agriculture.

Examples of environmental costs

The annual external costs of UK agriculture in 1996 showed £2343 million (US$3648 million), equivalent to £208/ha (US$324/ha) of arable and permanent pasture. This was 89 percent of average net farm income for 1996. Significant costs arose from contamination of drinking water with pesticides, nitrate and phosphate, from damage to wildlife, habitats, hedgerows, from emissions of gases, from soil erosion and organic carbon losses, from food poisoning, and from BSE (Pretty *et al*., 2000). Another study calculating the external costs of agriculture in U.S.A (including damage to water sources, to soil and air resources, to wildlife and ecosystem biodiversity and to human health) estimated to be at $5.7-16.9 billion annually, per cropland hectare at US$29-96 (Tegtmeier and Duffy, 2004). These studies only estimated externalities that gave rise to financial costs, thus they were likely to underestimate the total negative impacts of chemical-intensive agriculture.

4.3.2. Positive externalities

Organic methods offer considerable benefits in environmental, social and health aspects, including landscape and aesthetic value, recreation, nutrient recycling and fixation, soil formation, storm protection and flood control and carbon sequestration. Organic farms rely less heavily on purchased inputs and external energy, suffer less from soil loss, contain more organic matter, protect biodiversity, offer greater rural employment and more superior food in terms of food safety and nutritional content.

Positive health impacts of organic food

- Several studies indicate that 10-60 percent more healthy fatty acids (like CLA's) and omega-3 fatty acids occur in organic dairy (e.g. Butler et al., 2008);
- In crops, vitamin C ranges 5-90 percent more and secondary metabolites 10-50 percent more in organic. Also, less residues of pesticides and antibiotics are present (Huber and van de Vijver, 2009);
- Organic food contains higher minerals and dry matter and 10-50 percent higher phytonutrients (Heaton, 2002);
- Decreased cell proliferation of cancer cells was observed on extracts of organic strawberries (Olsson, 2006);
- The Parsifal study showed 30 percent less eczema and allergy complaints and less bodyweight among 14 000 children fed with organic and biodynamic food in five EU countries (Alfven, 2005);
- In animals, organic feed leads to increased fertility (Staiger, 1988) and increased immune parameters (Finamore, 2004).

If yield comparisons would take into account the quality of the target crop - e.g. dry matter content in fresh organic produce has been shown to be higher (Woese *et al.*, 1997) - this could compensate for lower total yields in organic agriculture in developed countries. When comparing relative yield and composition of vegetables during 12 years, Lampkin (1990) showed that although conventional yielded 24 percent more, organic had 28 percent higher dry matter in its produce.

Subsidies are one way of helping organic farmers in continuing environmentally-friendly farming Practices. However, price supports may actually take the form of compensation for rewarding farmers for the ecosystem and societal services (e.g. landscape) they are doing for the common good. Both external costs and benefits can be quantified in economic terms (e.g. pollution abatement costs) and thus, could be taken into account in comparative studies. This would mean a redirection of economic thinking, but it would enhance the realization of the true cost of farming practices and hopefully, trigger the re-formulation of policies so that they no longer support polluting activities but those that provide the correction of negative externalities to the highest extent possible.

Positive environmental impacts of organic agriculture

- *Increased soil fertility:* biodynamic farms had better soil quality: greater in organic matter, content and microbial activity, more earthworms, better soil structure, lower bulk density, easier penetrability, and thicker topsoil (Reganold *et al.*, 1993); agricultural productivity doubled with soil fertility techniques: compost application and introduction of leguminous plants into the crop sequence (Dobbs and Smolik, 1996; Drinkwater, 1998; Edwards, 2007);
- *More energy efficiency:* growing organic rice was four times more energy efficient than the conventional method (Mendoza, 2002); organic agriculture reduces energy requirements for production systems by 25 to 50 percent compared to conventional chemical-based agriculture (Niggli *et al*., 2009);
- *Carbon sequestration*: German organic farms annually sequester 402 kg Carbon/ha, while conventional farms had losses of 202 kg (Clark *et al.*, 1999; Küstermann *et al.*, 2008; Niggli *et al.*, 2009);
- *Less water pollution:* in conventional farms, 60 percent more nitrate are leached into groundwater over a 5-year period (Drinkwater, 1998);
- *More water capture:* enhanced organic soil structure reduces risk of floods (Lotter *et al.*, 2003);
- *Increased soil fauna:* organic soil fauna increases by 148 percent (Dumaresq and Greene, 2001);
- *Enhanced biodiversity:* organic farms' biodiversity increases resilience to climate change and weather unpredictability (Niggli *et al.*, 2008);
- *Reduced erosion:* organic agriculture reduces erosion caused by wind and water as well as by overgrazing at a rate of 10 million hectare annually (Pimentel *et al.*, 1995).

5. CONCLUSION

Generally it is hard to conclude that one system is more profitable than the other – it depends on site and crop specific factors, availability of marketing opportunities, labour availability, agronomic factors, etc. Several variables could impact overall farm performance, thus a multi-disciplinary approach that involves the whole farm (with livestock operations if there are) and takes into account the management skills and objectives of the farmers is a more favourable option.

Dozens of studies have been analyzed in terms of their research on farm profitability, and though methodological differences prevent us from comparing them systematically, the similarities between the studies from many countries and contexts allow us to draw some general conclusions.

Profitability certainly depends on the crop choice, which of course is determined partly by environmental conditions and partly by the demand for products and available governmental programmes supporting those crops. Selection of the comparison group seems to have a strong influence on profitability. Farm size, farm type, location are all important factors in selecting the suitable candidate farms for a comparison. The availability of price premiums seem to be a crucial factor in good economic performances of organic systems and in most cases, make organic farms more profitable.

However, as at least a dozen studies showed that price premiums are not always necessary for organic systems to be more profitable than conventional systems. If higher prices are not available to compensate for the organic yield loss, than financial profitability depends entirely on achieving cost reductions. Overall, the complied data suggest that organic agriculture is economically more profitable, and even though yields decrease in developed countries, higher premiums and lower production costs compensate for these losses.

Increased profitability of organic agriculture very much depends on consumer demand, market prices and the availability of premiums. One of the biggest potentials to further improve the profitability of organic farms in developing countries lies in establishing organic markets for staple crops (organic soybeans, wheat, chilies, etc) that are part of the rotation; if these crops could be sold with a premium price, incomes of organic farms would further increase. In developed countries, premiums are most often available, so besides the market prices which farmers are unable to influence, the further reduction of production costs (energy, fuel, feed) and the use of better varieties (in terms of resistance, yield, etc.) could result in an increase of relative profitability in organic farms.

Still to date, organic agriculture faces an unfair competition in the marketplace due to: the current subsidy schemes that favour conventional production; the unequal availability of research and extension services; and the failure to capture the real environmental, social and health externalities in market prices of conventional foods. Besides directing much more research and extension investments into organic agriculture and shifting the bulk of public support from polluting activities to sustainable practices to give an equal footing to profitability studies, such studies need to take the differences in external costs and benefits into account to capture the real and multiple profits of agriculture.

REFERENCES

Alfvén T. *et al*., 2006. Allergic diseases and atopic sensitization in children related to farming and anthroposophic lifestyle - the PARSIFAL study. Allergy. 2006 April, 61(4):414-21. Institute of Environmental Medicine, Karolinska Institute, Stockholm, Sweden.

Birzer T. and Badgery W., 2006. Organic wheat farming in Australia: issues farmers face. AFBM Journal Farm Business and Farming Systems Management. Vol. 3, No. 2, 2006.

BMELF, 1991-1998. Agrarbericht. Bonn: Bundesministerium für Ernährung, Landwirtschaft und Forsten.

BMELF, 1994. Agrarberichte der Bundesregierung. Bundesministerium für Ernährung, Landwirtschaft und Forsten, Bonn. Quoted: Padel S. and Zerger U., 1994. Economics of Organic Farming in Germany. In: Lampkin, N.H. and Padel S., 1994. The Economics of Organic Farming: an International Perspective. CAB International, Wallingford.

Bray D.B., Plaza Sanchez J.L. and Murphy E.C., 2001. Social dimensions of organic coffee production in Mexico: lessons for eco-labelling initiatives. Soc. Nat. Resour. 15, 429– 446.

Butler *et al.*, 2008. Fatty acid and fat-soluble antioxidant concentrations in milk from high- and low-input conventional and organic systems: seasonal variation. J. Sci Food Agric 88: 1431–1441.

Cacek T. and Langner L.L., 1986. The economic implications of organic farming. American Journal of Alternative Agriculture. Vol. 1, No. 1, pg. 25-29.

Canavari M. *et al*., 2007. A comparative profitability analysis of organic and conventional farms in Emilia-Romagna and in Minnesota. In: Canavari M. and Olson K.D., 2007. Organic Food Consumers' Choices and Farmers' Opportunities. Springer New York 10.1007/978-0-387-39582-1.

Chase C., 2008. Pricing for Profit. Ames, IA: Iowa State University, Iowa State University Extension. at http://www.extension.iastate.edu/agdm/wholefarm/html/c1-55.html

Cisilino F. and Madau F. A., 2008. A Comparative Analysis of Organic and Conventional Farming through the Italian FADN. Paper presented at AIEA2 International Conference 2007 "Knowledge, Sustainability and Bio-Resources in the further development of Agri-Food System", Londrina Parana Brasil, July 22-27, 2007.

Dabbert S. and Madden P., 1986. The transition to organic agriculture: A multi-year simulation model of a Pennsylvania farm. American Journal of Alternative Agriculture. vol. 1, No. 3, pp. 99-107.

Damiani O., 2002. Organic Agriculture in Guatemala: A Study of Producer Organizations in the Cuchumatanes Highlands. Office of Evaluation and Studies, IFAD, Rome.

Edwards S., 2007. The impact of compost use on crop yields in Tigray, Ethiopia. Institute for Sustainable Development (ISD). Proceedings of the International Conference on Organic Agriculture and Food Security. FAO, Rome. at: ftp://ftp.fao.org/paia/organicag/ofs/02-Edwards.pdf

FAT, 1992-97.

FAT, 1993. Bericht über biologisch bewirtschaftete Betriebe 1991. Eidg. Forschungsanstalt für Betriebswirtschaft und Landtechnik, Tänikon, Switzerland. Quoted: Mühlebach I. and Mühlebach J.

1994. Economics of Organic Farming in Switzerland. In: Lampkin N.H. and Padel S., 1994. The Economics of Organic Farming: an International Perspective. CAB International, Wallingford.

Ferguson J.J., 2004. Organic Certification Procedures and Costs. HS971, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. May 2004. at http://edis.ifas.ufl.edu/pdffiles/HS/HS20800.pdf

Finamore A. *et al*., 2004. Novel approach for food safety evaluation. Results of a pilot experiment to evaluate organic and conventional foods. J. Agric. Food Chem. 52:7425-7431.

Fox G. *et al*., 1991. Comparative Economics of Alternative Agricultural Production Systems: A Review. Northeastern Journal of Agricultural and Resource Economics. Vol. 20.

Fowler S., 1999. Factors Affecting the Profitability of Organic Farms. Welsh Institute of Rural Studies (WIRS). Elm Farm Research Centre Bulletin No. 46, December 1999.

Gibbon P. and Bolwig S., 2007. The economics of certified organic farming in tropical Africa: A preliminary assessment. DIIS Working Paper 2007:3, January 2007.

James S.C., 1983. Economic consequences of biological farming. In: Robert B. Dahlgren, (ed.) Proceedings of the Management Alternative for Biological Farming Workshop, pg. 17-26. Cooperative Wildlife Research Unit, lowa State University, Ames.

Hanson J.C., Lichtenberg E. and Peters S. E., 1997. Organic Versus Conventional Grain Production in the Mid-Atlantic: An Economic and Farming System Overview. Amer. J. Alternative Agric. 12(1):2-9.

Heaton S., 2002. Assessing organic food quality: Is it better for you? In: in Powell J. et al., (eds.) Proceedings of the UK Organic Research 2002 Conference, pg 55-60. Organic Centre Wales, Institute of Rural Studies, University of Wales Aberystwyth.

Huber M. and van de Vijver L., 2009. Overview of research linking organic production methods and health effects in the lab, in animals and in humans. Department of Health Care and Nutrition, Louis Bolk Institute, Netherlands. at http://www.organicfqhresearch.org/downloads/newsletter/fqh_news_march2009.pdf

IFOAM, 2008. Criticisms and Frequent Misconceptions about Organic Agriculture: The Counter-Arguments. at http://www.ifoam.org/growing_organic/1_arguments_for_oa/criticisms_misconceptions/Misconceptionscompiled_JKA_20090112.pdf

Jackson G.J., 2005. Organic Cotton Farming in Kutch, Gujarat, India. Outlooks on Pest Management. February 2005.

Kasperczyk N. and Knickel K., 2006. Environmental Impacts of Organic Farming. In: Kristiansen P. (ed) Organic agriculture: a global perspective. CSIRO, 2006, pg 259-282.

Kriegl T., 2006. Summary of Economic Studies of Organic Dairy Farming in Wisconsin, New England, and Quebec. College of Agricultural and Life Sciences and Cooperative Extension, University of Wisconsin. at http://cdp.wisc.edu/pdf/Organic percent20Econ percent20in percent20N percent20E, percent20Q, percent20& percent20W1.pdf

Küstermann B., Kainz M. and Hülsbergen K.-J., 2008. Modeling carbon cycles and estimation of greenhouse gas emissions from organic and conventional farming systems. Renewable Agriculture and Food Systems 23, 38-52.

Lampkin N.H., 1990. Organic farming. Farming Press, Ipswich.

Lampin N.H., 1994. Researching Organic Farming Systems. In: Lampkin, N.H. and Padel S., 1994. The Economics of Organic Farming: an International Perspective. CAB International, Wallingford.

Lampkin N.H. and Padel S., 1994. The Economics of Organic Farming: an International Perspective. CAB International, Wallingford.

Larson B, Kliebenstein J. and Honeyman M., 2002. Comparison of Premiums and Returns in Organic Pork Production. Iowa State University Department of Economics.

Lee H. and Fowler S., 2002. A critique of methodologies for the comparison of organic and conventional farming systems. Paper presented at UK Organic Research Conference of the Colloquium of Organic Researchers, Aberystwyth, 26-28 March 2002.

Lotter D., Seidel R. and Liebhardt W., 2003. The Performance of Organic and Conventional Cropping Systems in an Extreme Climate Year. American Journal of Alternative Agriculture 18: 146-154.

McCrory L., 2001. An Economic Comparison of Organic and Conventional Dairy Production, and Estimations on the Cost of Transitioning to Organic Production. Northeast Organic Farming Association of Vermont's Dairy Technical Assistance Program. May 2001.

Murphy M.C., 1992. Organic Farming as a Business in Great Britain. Agricultural Economics Unit, University of Cambridge, 1992.

Nieberg H. and Kuhnert H., 2007. Policy Support for Organic Farming in Germany. Landbauforschung Völkenrode 1/2007 (57) pg. 95-106.

Nieberg H. and Offermann F., 2002. The profitability of organic farming in Europe. In: OECD, Organic agriculture: sustainability, markets and policies. OECD workshop on organic agriculture, Washington, D.C., 23-26 September 2002.

Niggli U. *et al.*, 2008. Vision for an Organic Food and Farming Research Agenda to 2025. Organic Knowledge for the Future. at http://www.tporganics.eu/upload/TPOrganics_VisionResearchAgenda.pdf

Niggli U. *et al.*, 2009. Low Greenhouse Gas Agriculture: Mitigation and Adaptation Potential of Sustainable Farming Systems. FAO, May 2009, Rev. 1 - 2009.

Olsson M.E. *et al.,* 2006. Antioxidant levels and inhibition of cancer cell proliferation in vitro by extracts from organically and conventionally cultivated strawberries. J. Agric Food Chem. 54:1248.

Offermann F. and Lampkin N., 2005. Organic farming in FADNs – issues and analysis. In: PACIOLI-13 workshop: microeconomic data on farm diversification, rural businesses and intra-generational transfer. The Hague, Netherlands. pp 45-57.

Offermann F. and Nieberg H., 2000. Economic Performance of Organic Farms in Europe. Organic Farming in Europe. Economics and Policy. Vol. 5. Universität Hohenheim.

Offermann F. and Nieberg H., 2009. Impacts of the 2003 CAP Reform on Organic Farms. Eurochoices 8(1), 2009.

Paine L., 2003. Study Paints Profitability Picture. State of Wisconsin, Department of Agriculture, Trade and Consumer Protection. November 2003.

Painter K., 1991. Does sustainable farming pay: A case study. Journal of Sustainable Agriculture 1, 3:37-48.

Pimentel D. *et al*., 2005. Environmental, energetic, and economic comparisons of organic and conventional farming systems. Bioscience 55, 573-582.

Pretty J. *et al.*, 2000. An Assessment of the Total External Costs of UK Agriculture. Agricultural Systems 65 (2), 113-136. August 2000.

Reganold J.P., 1992. Effects of Alternative and Conventional Farming Systems on Agricultural Sustainability. Washington State University, Department of Crop and Soil Sciences. at http://www.agnet.org/library/bc/44001/

RUTGERS, 2008. Methodology for Calculation of Costs and Returns of Production. New Jersey Agricultural Experiment Station.at http://aesop.rutgers.edu/~farmmgmt/ne-budgets/METHODOLOGY.HTML

Sanders J., 2007. Economic Impact of Agricultural Liberalisation Policies on Organic Farming in Switzerland. PhD Thesis. Research Institute of Organic Agriculture / Forschungsinstitut für biologischen Landbau (FiBL), Frick, Switzerland.

Sanders J. *et al*., 2008. Impact of agricultural liberalisation on the relative importance of price premiums for the profitability of organic farming. 16th IFOAM Organic World Congress, Modena, Italy, June 16-20, 2008. at http://orgprints.org/12546

Sanders J., Offermann F. and Nieberg H., 2008. Impact of the CAP reform on Organic Farming in Germany. Paper prepared for the 109th EAAE Seminar "The CAP after the Fischler Reform: National Implementations, Impact Assessment and the Agenda for Future Reforms". Viterbo, Italy, November 20-21st, 2008.

Standhill G., 1990. The comparative productivity of organic agriculture. Agri. Ecosyst. Environ. 30:1-26.

Staiger D., 1988. The nutritional value of foods from conventional and biodynamic agriculture. IFOAM Bulletin No. 4, pg 9-12.

Sullivan A. and Sheffrin S.M., 2003. Economics: Principles in action. Upper Saddle River, New Jersey 07458: Pearson Prentice Hall. pg. 111.

Tegtmeier E. M. and Duffy M., 2004. External Costs of Agricultural Production in the United States. International Journal Of Agricultural Sustainability. Vol. 2, No. 1.

U.S. Dep. of Agriculture, 1980. Report and Recommendations on Organic Farming. Washington.
WHO, 1992. Our planet, our health: Report of the WHO commission on health and environment. Geneva: World Health Organization.

Woese K. *et al*., 1997. A comparison of organically and conventionally grown foods: results of a review of the relevant literature. Journal of the Science of Food and Agriculture 74, 281–293.

Wynen E., 2001. The economics of organic cereal-livestock farming in Australia revisited. Proceedings of the RIRDC Inaugural Conference on Organic Agriculture, Sydney, 27-28 August.

Wynen E., 2006. Economic management in organic agriculture. In: Kristiansen P, Taji A. and Reganold J.P. (Eds): Organic Agriculture - a Global Perspective, Chapter 8, CSIRO Publishing, Melbourne.

Zentner R.P. *et al.,* 2002. Economics of crop diversification and soil tillage opportunities in the Canadian prairies. Agron. J., 94.

Crop	Country	Profitability (Gross margin / Net returns)	Production Costs	Yield	Period (year)	Research	Source(s)
DEVELOPED COUNTRIES							
Corn-soy rotations							
	U.S.A.	Without premiums, net revenues compare favourably.	12% lower in OA, but much higher family labour.	Similar yields but higher for OA in drought years.	1982-95 13 yrs	Rodale Institute Research Center	**Hanson J.C., Lichtenberg E. and Peters S. E., 1997**. Organic Versus Conventional Grain Production in the Mid-Atlantic: An Economic and Farming System Overview. Amer. J. Alternative Agric. 12(1):2-9.
	U.S.A.	Premium of 35.4% for OA corn and oats necessary to break even CV rotation (premium was 54% for oats and 45% for corn).	-	Corn yields lower in OA than CV rotation, but higher than in continuous corn system.	1988-97 10 yrs	Iowa State University, Northeast Research Centre experimental comparison trials	**Duffy M.,** Department of Agricultural Economics, Iowa State university. Quoted: **Welsh R., 1999.** The Economics of Organic Grain and Soybean Production in the Midwestern United States. Greenbelt, MD: Henry A. Wallace Institute for Alternative Agriculture.
	U.S.A.	Lower net income in OA.	Direct costs other than labour double on CV.	Similar corn yields (but higher in OA in drought yrs), lower soy yields.	1985-92 8 yrs	South Dakota pair case study	**Dobbs T.L. and J.D. Smolik. 1996.** Productivity and profitability of conventional and alternative farming systems: a long-term on-farm paired comparison. J. Sustainable Agriculture 9(1):63–79.
	U.S.A.	Without premium, similar net returns (not counting conversion period and labour costs).	-	Similar, but OA higher in drought years (1988-99: 22% higher organic corn yields).	22 yrs	Rodale Institute Farming Systems Trial	**Pimentel D. et al., 2005**. Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems. Bioscience, vol. 55, nr 7, July 2005.
	U.S.A.	Even without premium, OA higher than CV.	Lower for OA.	No significant yield difference.	1999-2001 3 yrs	Neely-Kinyon Long-term Agroecological Research site	**Delate K. et al., 2002.** Long-term agroecological research (LTAR) in Iowa: An economic comparison of organic and conventional grain crops. Amer. J. Alternative Agric., 18(2): 59-69.
	U.S.A.	OA higher than CV and modified CV (with sorghum and alfalfa).	-	Similar, but OA much higher in drought years.	1981-96 16 yrs	Rodale Institute Farming Systems Trial	**Drinkwater L.E. et al., 1998.** Legume-based Cropping Systems Have Reduced Carbon and Nitrogen Losses. Nature 396:262-265.
	U.S.A.	Much higher (143%) net returns for OA even without premiums and governmental programs.	-	Assumed equal yields.	1986-90 4yrs	Simulation model at Kansas State University, using database of 332 farms	**Diebel P.L., Williams J.R. and Llewelyn R.V., 1995.** An economic comparison of conventional and alternative cropping systems for a representative northeast Kansas farm. Review of Agricultural Economics 17(3):120–127.
	U.S.A.	Net returns higher for OA, even without premium.	Lowest for OA.	-	1990-96 7 yrs	University of Minnesota trials	**Olson K.D. and Mahoney P.R., 1999.** Long-term cropping studies at the University of Minnesota: The variable input cropping management system study. U.S. Dept. of Agriculture–Economic Research Service, Washington, DC, April 21, 1999.
	U.S.A.	Highest net returns in systems with highest proportion of soy. OA rotation needed 13% premium for corn, soy, oats to have same net returns.	Lowest for OA.	-	1978-86 9 yrs	University of Nebraska trials	**Helmers G.A., Langemeier M.R. and Atwood J., 1986.** An economic analysis of alternative cropping systems for east-central Nebraska. Am. J. Altern. Agric. 1:153–158.
	U.S.A.	Net returns substantially higher for OA (more than double).	Production costs for corn 19% lower in OA and similar in soy.	17-20% less corn, soy yields; the rotation average yields considerably lower in OA.	10 yrs for OA	Iowa State University, rotation 2 at Neely-Kinyon Research Farms	**Chase et al., 2008.** Economic Analysis of Three Iowa Rotations. ISU Extension PMR 1001. at http://www.extension.iastate.edu/Publications/PMR1001.pdf
	U.S.A.	Without premiums, but with federal farm program payments, net income of OA rotation equal and more profitable (depending on rotation).	Lower costs (except labour).	Lowest yields for corn, equal for soy, and slightly more for spring wheat in OA.	1986-92 7 yrs	South Dakota State University trials	**Smolik J.D., Dobbs T.L. and Rickerl D.H., 1995.** The relative sustainability of alternative, conventional, and reduced-till farming systems. Amer. J. Alternative Agric. 10(1):25–35.

	U.S.A.	Without premium, no significant difference. With premium OA significantly higher.	Lower for OA.	Lower yields for OA.	1990-99 10 yrs	Southwestern Minnesota experimental data	**Mahoney P.R. et al., 2004.** Profitability of Organic Cropping Systems in Southwestern Minnesota. Renewable Agriculture and Food Systems. 19(1):35-46.
	U.S.A.	Highest profit in OA with premiums and governmental programs, otherwise, no till corn soy system is most profitable.	-	-	1993-2006 14 yrs	Wisconsin Integrated Cropping Systems Trial on two experimental farms	**Chavas J.P., Posner P.L. and Hedtcke P.L., 2009.** Organic and Conventional Production Systems in the Wisconsin Integrated Cropping Systems Trial: II. Economic and Risk Analysis 1993–2006. Agron J 101:288-295, March 2009.
	U.S.A.	With premium, OA much more profitable.	Much higher costs in OA.	Significantly lower yields.	2006	on-farm data from 19 states	**McBride W. D. and Greene C., 2008.** The Profitability of Organic Soybean Production. Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Orlando, Florida, July 27-29, 2008.
Wheat							
	Australia	On average less income in OA.	40% less total costs.	Much lower yields.	1998-2000 3 yrs	5 pair case studies in Victoria and New South Wales	**Wynen E., 2001.** The economics of organic cereal–livestock farming in Australia revisited. In: RIRDC (ed.) The Organic Challenge: Unity through Diversity. RIRDC's Inaugural National Organics Conference 2001. Darling Harbour, Sydney, Australia, 27–28 August 2001.
	Australia	Gross margin for OA 148% higher.	74% that of CV.	45% less yields in OA.	10 yrs	Australian National University study	**Dumaresq D. and Greene R., 2001.** Soil Structure, Fungi, Fauna & Phosphorus in Sustainable Cropping Systems. RIRDC Publication No 01/130.
Vegetables							
tomatoes, safflower, corn, bean	U.S.A.	Most profitable the CV two-yr tomato-corn rotation. OA more profitable in both corn and tomato among four-yr rotations.	Highest for OA.	No significant difference, though last 2 yrs 5% higher in OA.	1989-96 8 yrs	UC, Davis	**Clark et al., 1999.** Crop-yield and economic comparisons of organic, low-input, and conventional farming systems in California's Sacramento Valley. Amer. J. Alternative Agric. 14(3):109–121.
tomatoes, pumpkin, sweet corn	U.S.A.	Without premium, lower returns in OA, with premiums 5-16% higher.	28-34% higher in OA.	15-19% lower in OA.	1991-93 3 yrs	Budgeting methods	**Brumfield R.G. et al., 2000.** Comparative Cost Analyses of Conventional, Integrated Crop Management, and Organic Methods. HortTechnology 10: 661-840.
Fruits							
apple	U.S.A.	None showed net annual profit. Breakeven point for OA 9 yrs, for IPM 15yrs, for CV 17yrs.	-	Overall, similar yields.	1994-99 6 yrs	Randomized complete block in Washington State	**Reganold J.P. et al., 2001.** Sustainability of three apple production systems. Nature, 410: 926-930.
Mixed crops							
arable farms	Switzerland	OA system showed excellent profits mainly due to higher prices.	-	Yield reductions of 19% over 4 organic arable crops and of 14% is temporary lays are included.	1997-2002 6 yrs	Organic arable compared with 2 integrated (IP extensive and intensive) farms on 6 plots in a 6-yr rotation.	**Padruot F.M. et al., 2005.** How economic is organic? Results of a long-term trial at Burgrain/Lucerne, Switzerland. Paper presented at Researching Sustainable Systems -International Scientific Conference on Organic Agriculture, Adelaide, Australia, Sept. 21-23, 2005.
maize, wheat, tomato, durumwheat rotation	Italy	28% higher OA net income but not higher than low-input farms.	-	Except for tomatoes, yields decreased in OA.	4 yrs	Randomized complete block in central Italy	**Mazzoncini et al., 2000.** Agronomic and economic evaluation of conventional, low input and organic farming systems in central Italy. Proc. 13th Intern. IFOAM Scientific Conference, Basel, Switzerland, 28-31 August 2000.

wheat, barley, peas, forage crops	Canada	Much variations within and among the 2 systems. OA higher most times with premiums.	-	-	1997-2000 4 yrs	Field plot data from Great Plains	**Smith E. G., Clapperton J.M. and Blackshaw R.E., 2004.** Profitability and Risk of Organic Production Systems in the Northern Great Plains. Renewable Agriculture and Food Systems. 19(3):152-158.
Livestock							
dairy farms	UK	Much higher gross margin both per head and per hectare in OA.	Very similar variable costs.	Similar yield (litres per cow).	1988-1990 3 yrs	Comparative trial	**Younie D. et al., 1990.** Organic Beef in Practise. Scottish Agricultural College, Aberdeen.
dairy farms	Norway	Average profit per ha was 83-109% of the conventional reference group.	-	-	1989-1992 3yrs	Data from 11 OA dairy farms compared to 2 groups of CV farms (regions with high and low crop yields).	**Vittersø H., 1995**. Foretaksøkonomiske tilpasninger i økologisk melkeproduksjon. Oslo: The Norwegian Agricultural Economics Research Institute. NILF-rapport 1995:8.
dairy farms	Norway	Average net income per cow on the organic farms was 80% of the conventional reference group.	-	-	1989-1996 7yrs	9 organic dairy farms were analysed.	**Vittersø H., 1997**. Økonomien ved omlegging til økologisk melkeproduksjon på ni gårder. Oslo/Tingvoll: The Norwegian Agricultural Economics Research Institute and The Norwegian Centre for Ecological Agriculture. NILF-rapport 1997:1.
dairy farms	Belgium	Gross margin per cow was 12% higher on OA than on conventional ones, but due to lower stocking density, the gross margin per ha was lower.	-	Based on 1996 data, dairy yield kg/cow/yr was higher on organic.	1994-96 3yrs	Farm data from Wallonia	**Ghesquiere P., 1997**. Le lait biologique. CARAB asbl (ed.). Information leaflet. Jodoigne.
different farm types							
vine, dairy, fruits, etc.	Italy and U.S.A.	Overall similar net returns in Emilia-Romagna, but lower for OA in Minnesota.	-	Lower yields in Minnesota.	2000-03 4 yrs	Bookkeeping data from Emilia-Romagna (Italy) farms and University of Minnesota database	**Canavari M. et al., 2007.** A comparative profitability analysis of organic and conventional farms in Emilia-Romagna and in Minnesota. In: Canavari M. and Olson K.D., 2007. Organic Food Consumers' Choices and Farmers' Opportunities. Springer New York 10.1007/978-0-387-39582-1.
vegetables, fruits, grain, dairy, etc.	New Zealand	Biodynamic farms just as financially viable on a per hectare basis as CV.	-	-	1987-1991 5 yrs	Several farm pairs with same crop and livestock enterprise	**Reganold J.P. et.al., 1993.** Soil quality and financial performance of biodynamic and conventional farms in New Zealand. Science 260:344-349.
mixed farms	Norway	Similar net farm income for the 2 systems with livestock production, higher on OA for the stockless scenario, with net farm income being higher by 20% per ha (using organic prices from 1996).	-	-	1990-96 7 yrs	Model calculations with and without livestock scenario based on experiments on 15 farms.	**Repstad K. and Eltun R., 1997**. Økonomi ved konvensjonelle, integrerte og økologiske driftsmåter. Kapp/Oslo: The Norwegian Agricultural Economics Research Institute and The Norwegian Crop Research Institute. NILF-rapport 1997:3.
cereals, potatoes, beans, livestock,	UK	Profitability higher on organic stockless arable experiments; equal on commercial mixed farms.	Lower variable costs in OA.	Lower yields in OA.	1993-97 5 yrs	Analysis of field-scale experiments at Terrington, and of 10 commercial OA farms	**Cormack W. F., 1998.** Organic Arable Systems at ADAS Terrington OF0112. Report, ADAS.
cereals, potatoes, livestock, etc.	Switzerland	Equal gross margin in dairy (organic milk marketed as conventional), 21-27% higher in organic cereals. Whole-farm income 92% of conventional (due to high wage costs).	20% less variable costs in livestock production; 42-54% less in cereals and 35% less in potatoes.	Yields of wheat, rye, barley, potatoes 75-80% less in OA; milk yield is similar.	1989-1991 3 yrs	Comparison of 34 farm enterprises	**FAT, 1993.** Bericht über biologisch bewirtschaftete Betriebe 1991. Eidg. Forschungsanstalt für Betriebswirtschaft und Landtechnik, Tänikon, Switzerland. Quoted: Mühlebach I. and Mühlebach J. 1994. Economics of Organic Farming in Switzerland. In: Lampkin N.H. and Padel S., 1994. The Economics of Organic Farming: an International Perspective. CAB International, Wallingford.

different farm types	Switzerland	Organic profits on average are 10% higher than in CV farms.	9% less total costs in OA due to much less variable costs, in 1996.	Significantly lower crop yields, dairy organic yields per cow/yr are 89% that of CV yields (FAT, 1997).	1990-96 7 yrs	Data based on national farm accounting system.	**FAT, 1992-97.** Bericht über biologisch bewirtschaftete Betriebe 1990-96, Ergebnisse der Zentralen Auswertung von Buchhaltungsdaten. Tänikon: Eidgenössische Forschungsanstalt für Agrarwirtschaft und Landtechnik.
cereals, vegetables, grassland, livestock	EU	Most OA achieve profits between 100-130% of CV farms, with wide variation between countries and farm types. Long-term studies in 4 countries showed also higher profits.	-	Cereal yields 60-70% of CV; vegetable yields similar; pasture and grassland 70-100% of CV; livestock performance per animal is similar, per hectare lower.	1-9 yrs (in AT, CH, NL, DE: 6 9 yrs)	Data from 18 EU countries	**Offermann F. and Nieberg H., 2000.** Economic performance of organic farms in Europe. Organic farming in Europe: Economics and Policy. Vol. 5. University of Hohenheim, Germany.
cereals, potatoes, livestock, etc.	Germany	Similar whole-farm gross margins. With carefully selected comparison group, OA showed higher profit.	Lower variable costs in OA.	Yield differences of up to 40% for wheat and potatoes; milk yields about 80% that of CV.	1983-1994 12yrs	Data from German farms with different samples	**BMELF, 1994.** Agrarberichte der Bundesregierung. Bundesministerium für Ernährung, Landwirtschaft und Forsten, Bonn. Quoted: Padel S. and Zerger U., 1994. Economics of Organic Farming in Germany, In: Lampkin, N.H. and Padel S., 1994. The Economics of Organic Farming: an International Perspective. CAB International, Wallingford.
cereal-grazing livestick and dairy farms	Germany	Higher gross margins (102-126% that of CV) in all years for different farm types.	In 1995-97, total costs in OA are lower, fixed costs are equal but variable costs are	Lower yields for organic cereals and milk.	1990-97 7 yrs	Data from national farm monitoring system, about 100 organic and 500 comparable CV farms.	**BMELF, 1991-1998.** Agrarbericht. Bonn: Bundesministerium für Ernährung, Landwirtschaft und Forsten.
arable and grazing livestock farms	Germany	Premium prices are necessary to achieve similar or higher profits. OA profits 124-168% that of comparable CV per ha for different farm types.	-	Significantly lower crop yields, milk yields are similar.	1992-94 2 yrs	Investigated 107 farms that had converted to OA in 1990.	**Nieberg H., 1997.** Produktionstechnische und wirtschaftliche Folgen der Umstellung auf ökologischen Landbau - empirische Ergebnisse aus fünf Jahren ökonomischer Begleitforschung zum Extensivierungsprogramm. Braunschweig: Bundesforschunganstalt für Landwirtschaft, Institut für Betriebswirtschaft, Arbeitsbericht 1/97.
arable and grazing livestock farms	Germany	Organic farms had on average a 60% higher profit than the conventional reference group. First year organic profits were 191%, second year 161% that of CV profits per ha.	-	Significantly lower crop yields, similar milk yields.	1994-96 2yrs (cont.)	Continuition of previous study – data from 58 OA farms and comparable CV farms	**Nieberg H., 1999.** Produktionstechnische und wirtschaftliche Folgen der Umstellung auf ökologischen Landbau - erste Ergebnisse der Langfristanalyse. Braunschweig: Bundesforschunganstalt für Landwirtschaft, Institut für Betriebswirtschaft, Agrarstruktur und ländliche Räume.
different farm types	Italy	Organic farms had 20-24% higher returns per ha UAA.	Lower variable, higher fixed costs, overall similar total costs.	Significantly lower crop yields.	1994-96 3 yrs	Data of 28 organic farms in Marche region with carefully selected sample of CV farms.	**Zanoli R., Fiorani S. and Gambelli D., 1998.** Analisi dei risultati economici di un campione di aziende biologiche marchigiane (1994-96). University of Ancona.
mixed farms	Italy	Organic profits were 75% that of the regional conventional average.	Much higher costs in OA due to four times higher fixed costs.	Lower yields for OA (except lentils).	1992-94 3 yrs	Data from 19 organic farms in Umbria were compared to average CV farms in Umbria.	**Santucci F. M. and Chiorri M., 1996.** Economia delle produzioni biologiche: il caso dell'Umbria. Perugia: Università degli Studi di Perugia. Quaderni dell'Istituto di Economia e Politica Agraria di Perugia - nr. 19.

different farm types	Austria	Very similar gross margins (91-108% that of CV) per ha.	-	Higher yields of conventional crops.	1994-96 3 yrs	Comparison of data from above 1000 organic and comparable conventional farms (may include in-conversion farms)	**BMLF, 1995.** Grüner Bericht 1994. Wien: Bundesministerium für Land- und Forstwirtschaft. **BMLF, 1996.** Grüner Bericht 1995. Wien: Bundesministerium für Land- und Forstwirtschaft. **BMLF, 1997**. Grüner Bericht 1996. Wien: Bundesministerium für Land- und Forstwirtschaft.
DEVELOPING COUNTRIESDEVELOPING COUNTRIES							
Coffee							
	Costa Rica	Premiums compensated for lower yields.	Slightly higher production costs in OA.	22% lower mean in OA.	3 yrs	10 pairs of smallholder farms in five regions.	**Lyngboek A.E., Muschler R.G. and Sinclair F.L., 2001.** Productivity and Profitability of Multistrata Organic versus Conventional Coffee Farms in Costa Rica. Agrofor. Syst. 53, 205–213.
	Mexico, Guetamala	Net revenues more than double in Guatemala and in Mexico CV revenues are negative, whereas OA above 340$/ha.	Higher production costs in OA.	Significantly higher yields in OA.	2001	Case studies	**IFAD, 2003.** The Adoption of Organic Agriculture Among Small Farmers in Latin America and the Caribbean Thematic Evaluation. Report No. 1337, April 2003.
	Mexico	Organic farm slightly negative net income despite the 20% premium.	Production costs 6% higher in OA.	38% lower yields in OA.	1990	Case study on Finka Irlanda estate and nearby CV plantation.	**Pülschen L. and Lutzeyer H.-J., 1993.** Ecological and economic conditions of organic coffee production in Latin America and Papua New Guinea. Angewandte Botanik 67: 204–208. In: Van der Vossen H.. 2005. A critical analysis of the agronomic and economic sustainability of organic coffee production, Experimental Agriculture, Vol. 41: 449-473.
Coffee, cocoa vanilla, pineapple	Uganda	Net farm income in OA significantly higher.	pineapple and cocoa-vanilla, somewhat lower for coffee.	Higher yields for cocoa, and significantly higher for coffee.	2005-06 2 yrs	Using smallholder farms budget-type data, 179 OA and 152 CV	**Gibbon P. and Bolwig S., 2007**. The economics of certified organic farming in tropical Africa: A preliminary assessment. DIIS Working Paper 2007:3, January 2007.
Rice							
	Philippines	Incomes 48% higher than CV in 'grain equivalent' terms.	-	12% less in OA.	2000	interviews with 9 farmers	**Carpenter D., 2003.** An investigation into the transition from technological to ecological rice farming among resource poor farmers from the Philippine island of Bohol, Agriculture and Human Values, Vol. 20: 165-176
	Philippines	OA 70% more productive than CV.	Lowest costs in OA.	38% higher yield under favourable (dry season), and 60% higher under less favourable (wet season) conditions in OA.	1998-2000 2 yrs with 4 cropping seasons	23 farmer interviews	**Mendoza T.C., 2002.** Comparative productivity, profitability and energy use: intensity and efficiency of organic, LEISA and conventional rice production in the Philippines. Proceedings of the 14th IFOAM Organic World Congress, "Cultivating Communities", Victoria Conference Centre, Canada, 21-24 August 2002.
	Lao	Significantly higher profit in OA under contract.	Higher cash costs (without own labour, own seed).	Higher yields in OA.	2004	Regression model based on household survey covering 585 farms	**Setboonsarng S. et al., 2008.** Profitability of Organic Agriculture in a Transition Economy: the Case of Organic Contract Rice Farming in Lao PDR. Poster presented at Cultivating the Future Based on Science: 2nd Conference of ISOFAR, Modena, Italy, June 18-20, 2008.
Tea							
	India, Chin	With premium OA three times more profitable in India.	Double for OA (due to labour).	OA yields 30% less in India, in China by 4th year yields equalized.	4 yrs (including conversion)	Case studies	**IFAD, 2005.** Organic Agriculture and Poverty Reduction in Asia: China and India Focus. Report No. 1664
Cotton							

	India	Organic systems, primarily because of price premiums, more profitable.	Lower production costs in OA.	Higher yields in OA.	2002-03 2 yrs	Case studies in Maharashtra and Madhya Pradesh	**IFAD, 2005**. Organic Agriculture and Poverty Reduction in Asia: China and India Focus. Report No. 1664
	India	OA much more profitable.	-	13% yield increase in OA.	2004	Case study with 34 farmers from 2 villages in Andhra Pradesh	**Raj D.A. et al., 2005**. Case Study on Organic versus Conventional Cotton in Karimnagar, Andhra Pradesh, India. Second International Symposium on Biological Control of Arthropods Volume I. USDA Forest Service Publication FHTET-2005-08.
	India	OA income is nine times higher.	Inputs in OA 46% that of BT cotton inputs.	13% higher in OA.	2008	Comparing OA and BT cotton farms in Vidarbha	**Jalees K., 2008.** Vidarbha: Failure of BT Cotton and Change in Cropping Pattern. Navdanya, New Delhi.
	India	52-63% higher gross margins from organic cotton; 30-43% higher gross margins in organic cotton and wheat.	13-20% lower in OA.	4-6% higher in OA.	2003-04 2 yrs	Case studies in India with 60 OA and 60 CA farms	**Eyhorn F., Mader P. and Ramakrishnan M., 2005.** The Impact of Organic Cotton Farming on the Livelihoods of Smallholders. FIBL Research Report, October 2005.
	India	50% higher net profit.	Average production costs 20% lower in OA.	Yield differences are not significant.	2003	Survey of 170 farmers in 45 villages and interviews with wholesalers, retailers	**Shah T. et al., 2005.** Social Impact of Technical Innnovations. Study of Organic Cotton and Low Cost Drip Irrigation in the Agrarian Economy of West Nimar Region. at www.fibl.org
	India	Net gain of 14-20% in OA.	Lower costs in OA.	-	2001-04 4 yrs	Field survey of smallholder cotton growers	**MacDonald D.M., 2004.** Agri Impact Assessment Study for Organic Cotton Farmers of Kutch & Surendranagar. Agrocel Industries Ltd. 215945AA01/01/0/14 September 2004.