Measuring and Communicating the Environmental Benefits of Organic Food Production

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Abstract

Perceived environmental advantages are a key motivation for the interest in organic farming. The comparison between the environmental effects of organic and conventional farming poses a number of methodological challenges. Empirical evidence shows that organic farming is ranked at least equal, and in a number of instances better, than conventional farming for key environmental indicators. In communicating these advantages to consumers, the concept of credence characteristics is important; attempts to sell organic products to consumers on their non-use values alone are likely to fail. The positive environmental effects of organic farming can, under certain circumstances, justify policy intervention. Organic farming as an agro-environmental policy instrument is particularly useful where the goal is overall improvement of a large number of environmental indicators; in such instances its comparatively lower transaction cost is a distinct advantage. However, organic farming cannot address all agro-environmental problems.

Introduction

The International Federation of Organic Agriculture Movements (IFOAM) — the umbrella organization of organic farming organizations — has formulated principles for organic farming:

"Principle of health: Organic agriculture should sustain and enhance the health of soil, plant, animal and human as one indivisible. [...]"

Principle of ecology: Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them. [...]"

Principle of fairness: Organic agriculture should be built on relationships that ensure fairness with regard to the common environment in life opportunities. [...]"

Principle of care: Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment. [...]" (14).

These principles make it obvious that organic farming sees itself as not being limited to producing positive effects on the environment alone, although it is clear that environmental friendliness or benefits for the environment are
a key concept of organic farming. For many outside the organic farming movement, such environmental benefits are the most interesting.

The organic principles addressing environmental benefits cannot be measured directly. However, for organic farming to uphold its principles it is necessary that it performs better than conventional agriculture with respect to environmental indicators. This implies that a comparison of the environmental performance of organic farming to conventional farming is a useful undertaking.

The Methodological Challenge

There are numerous studies comparing environmental impact of organic and conventional farming. Most studies measure and compare only a small subset of environmental indicators and are limited to a specific region or even to an experimental site. Such comparisons are quite interesting in their specific context, but difficult to transfer to other situations. Consumers who prefer organic food generally consume food from a variety of sources and origins. Agricultural and food policies often have a national and, increasingly, an international dimension. These arguments underpin the necessity to amalgamate earlier studies in an attempt to create an overview of the environmental benefits of organic farming across regions and countries, including broad sets of indicators. This synthesis would need to be based on the original measurements and studies mentioned above. However, the data must first be critically examined. The issues most important to this task will be addressed here.

Organic farming is in itself a diverse system. Within organic farming the intensity of land use differs widely, depending on factors like soil, climate, and market access but also on belief systems and preferences of farmers. This is also true of conventional farming. Due to such sources of variation even within these two agricultural methods, a first and fundamental challenge for any comparison study is to define appropriate subunits for comparison between organic and conventional systems.

A possible approach would be to compare representative samples of all existing organic and conventional farms in a region, state, or country. However, in reality organic farming is not evenly distributed, geographically speaking, so this might be misleading. Within Europe, organic farming is more likely to be found in disadvantaged, mountainous, and extensively managed areas (5). For organic farming and conventional systems to be compared, they should, as much as possible, be in the same region and under similar natural conditions.

Also quality of management differs in farming, especially in comparisons on the basis of field-trials suffered in the past from this intervening factor. For comparison quality of management should be at the same level in both systems.

Most studies relate the environmental effects of organic farming to land area. Under certain circumstances a case could be made for relating the environmental impact to the unit of manufactured product. Because yields in organic farming are frequently lower, the latter method will tend to give larger figures for organic farming, whether in terms of positive or negative environmental effects. In cases where the agricultural area is not considered scarce, there is a good argument for relating the environmental benefits to area. This seems to be the case for instance in the European Union, where set-aside is still a political instrument in order to limit the quantity of agricultural products. If not land area but total output is measured, it may be found that conventional agriculture uses less land to produce the same amount of output. The surplus land could then, in theory, be used for environmental purposes.
In such a situation, it might make sense to evaluate environmental effects per unit of manufactured product.

In a study by Stolze et al. (18), a per-area comparison was used because most previous studies use this method and often do not contain enough information to convert measurements into per-output comparisons. Although under current political conditions, for many industrialized countries, the assumption of agricultural land being more or less constant seems to be justified.

Proponents of the method see organic farming as a broad concept which should improve environmental status in general, rather than an approach targeted to solve specific environmental problems. If we follow this line of thought, then it is important to look for key indicators to structure the empirical evidence. The Organisation of Economic Co-operation and Development (OECD) (16) has developed such a system of indicators, which is used widely in agricultural research. The assessment presented in the next section of the paper is based on this system with some simplifications and modifications.

Aggregation and presentation of indicators is important for communication. A quantitative presentation on a cardinal scale would be desirable, but is not feasible in this context because existing studies are difficult to compare with respect to quantitative measurements. They relate to different regions and circumstances and often use specific indicators which form part of broader indicators. Thus, it was decided to rate indicators on a qualitative scale. In order to arrive at prudent results, the hypothesis was that there is no difference between the two farming systems unless clearly shown by studies. From this, a scale was developed where organic farming performs much better, the same, worse or much worse than conventional farming.

In many circumstances, it is difficult to communicate detailed indicators; questions are posed such as: "Is organic farming better for the soil?" In order to answer such questions, it is necessary to integrate the results for several soil indicators, such as soil organic matter, biological activity, soil structure, and erosion. Again, for lack of a quantitative aggregation procedure, the synthesis of results was done by a group of four scientists conducting the study. In the original publication (18), every integration step is clearly indicated, so the reader can judge whether he or she agrees with the method, and can also draw their own conclusions from the material presented.

**Empirical Evidence: A Synopsis**

The results of the comparison of organic and conventional farming systems are presented in Table 1 and Box 1. A summarizing assessment of the indicators and subjective confidence interval is given. This should remind the reader that, in some cases, the studies differ quite substantially with respect to their results. In view of the literature published since 2000, the results of Table 1 have been recently checked (12). While clearly the scientific level of more recently published research on the environmental effects of organic farming has risen, the inclusion of more recent studies did not change the results in any substantial way. Some examples of this are given here.

In the overall assessment, organic farming is ranked at least equal to conventional farming for each indicator. In many cases organic farming performs better or much better. With respect to the indicators erosion and nitrate leaching, it was judged that under certain circumstances organic farming performs worse than conventional farming. For a number of indicators no clear difference between the two farming systems was found.

For the indicator "biodiversity", these results are supported by a meta-analysis of Bengtsson et al. (2). They concluded that "organic farming usually
increases species richness, having on average 30% higher species richness than conventional farming systems" (2). They also point to the high variability among studies. Of the studies examined, 16% showed organic farming to have a negative effect on species richness. They conclude that "the attitude of individual farmers, rather than which farming systems is used, is probably the most important factor determining biodiversity at the farm level" (2).

Similarly, Hole et al. (13) summarize their synopsis on biodiversity in stating: "The majority of the 76 studies reviewed ... clearly demonstrates that species abundance and/or richness, across a wide range of taxa, tend to be higher on organic farms than on locally representative conventional farms."

For the indicator "biodiversity," it can be concluded that a meta-analysis independently done by other authors came to largely the same results as those of Stolze et al. (18).

Auerswald et al. (1) performed a large scale modeling exercise to compare the effects of organic and conventional farming on erosion. They found that "on average organic agriculture will cause about 24% less erosion than conventional agriculture." They also pointed to a large variation in extent of erosion for both systems, showing that within both systems erosion could be reduced considerably. This finding is completely in line with the description of Stolze et al. (18) on the topic of soil erosion. Green et al. (11) point to potential disadvantages of organic farming with respect to erosion if it is compared to no-till systems.

Recent results report considerable potential for carbon sequestration by conversion to organic technology (10).
Table 1. Assessment of organic farming's impact on the environment compared to conventional farming (18).

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Organic farming performance: ++ much better, + better, o the same, – worse, – – much worse than conventional farming; if no data was available, the rating was "o the same"

Subjective confidence interval of the final assessment which is marked with X.
Box 1. Background on the environmental impact of organic farming on the indicator categories given in Table 1 (18).

**Ecosystem indicators: Floral and faunal biodiversity, habitat diversity and landscape conservation.** Organic farming performs better than conventional farming in respect to floral and faunal diversity due to the ban of synthetic pesticides and N-fertilizers, with secondary beneficial effects on wildlife conservation and landscape. Diverse crop rotations in organic farming provide more habitats for wildlife due to the resulting diversity of housing, breeding and nutritional supply. However, direct measures for wildlife and biotope conservation depend on the individual activities of the farmers. With respect to habitat and landscape diversity, research deficits were identified. As with any other form of agriculture, organic farming cannot contribute directly to wildlife conservation goals. Nevertheless, in productive areas, organic farming is currently the least detrimental farming system with respect to wildlife conservation and landscape.

**Soil indicators: Soil organic matter, biological activity, structure and erosion.** Organic farming tends to conserve soil fertility better than conventional farming systems. This is mainly due to higher organic matter content and higher biological activity. Therefore, organic farming seems to control erosion more effectively. A more continuous soil cover due to close crop rotations also supports this. In contrast, no differences between the farming systems were identified for soil structure.

**Ground and surface water indicators: Nitrate leaching and pesticides.** Organic farming results in lower or similar nitrate leaching rates than other farming systems. Leaching rates per hectare are up to 57% lower. However, the leaching rates per ton of produced output were similar or slightly higher. Ploughing legumes at the wrong time, unfavourable crop rotations, and composting farmyard manure on unpaved surfaces increase the possibility of nitrate leaching in organic farming. However, awareness of the problem and alternative measures have been developed and introduced in practice. The risk of ground and surface water contamination with synthetic pesticides is zero.

**Climate and air. CO₂, N₂O, CH₄, NH₃, pesticides:** Research on CO₂ emissions shows varying results: On a per-hectare scale, the CO₂ emissions are 40 to 60% lower in organic farming systems than in conventional ones, whereas on a per-unit output scale, CO₂ emissions tend to be higher in organic farming systems. Similar results are expected by experts for N₂O and CH₄ emissions, although to date, no research results exist. Calculations of NH₃ emissions in organic and conventional farming systems conclude that organic farming bears a lower NH₃ emission potential than conventional farming systems. Nevertheless, housing systems and manure treatment in organic farming should be improved to reduce NH₃ emissions further. Air contamination with synthetic pesticides is significantly lower due to their ban under organic standards.
**Farm input and output: Nutrient, water, and energy use:** Nutrient balances of organic farms are generally close to zero because organic farms rely heavily on internal nutrient cycling; N surpluses of organic farms were significantly lower than on conventional farms, for P and K deficits prevail. Energy efficiency of annual and permanent crops seems to be higher in organic farming than in conventional farming, mainly due to lower inputs which require a high energy input, i.e., N. Research results on water use in organic and conventional farming systems are not available.

**Animal health and welfare.** Husbandry, healthy housing conditions, and health status depend highly on farm-specific conditions. Thus housing conditions do not differ significantly between organic and conventional farms. Preventive use of synthetic, allopathic medicines is restricted by some national standards and recently also by EU rules. Although the application of homeopathic medicines should be preferred, conventional veterinary measures are permitted and used in acute cases of disease. Health status seems to be closely related to economic relevance of animal husbandry on the farm: Significantly fewer incidences of metabolic disorders, udder diseases, and injuries were found when dairy production was properly managed. Organic dairy cows tend to have a longer average productive life than conventional dairy cows.

**Communication with Consumers**

An important aspect of communication with consumers is the concept of "credence characteristics" (6). The fact that a product is organic is not immediately apparent to the consumer. There is no way for the consumer to directly check whether a product has been produced organically or not. With the exception of direct sales from farmer to consumer, a well-functioning certification and labeling system is an important pre-requisite for successful communication with the consumer. It has to be made credible for the consumer that the product is actually organic, and organic products have to be easily distinguished from non-organic products.

Environmental advantages of organic food can also be regarded as a credence characteristic. Even if the consumer is sure that the product he or she is buying is organic, he or she must also believe that, during production, environmental advantages have been realized.

But are consumers really interested in the attribute "environmentally friendliness" of organic food? A review of the literature (15,17,19,20) shows that environmental friendliness of the production process of organic food is generally only the second most important argument for purchase. Magnusson et al. (15) found "health concern is a better predictor than concern for the environment" and interpret this as an indication "that egoistic motives seem to be stronger than altruistic motives." Wier et al. (19) conclude that consumers generally acknowledge non-use benefits of organic products, "but only those having use values in addition actually purchase organic to a high degree."

Two conclusions emerge from this: First, attempts to sell organic products to consumers based only on reference to their non-use values are likely to fail. On the other hand, evidence from the literature suggests that
communication about the non-use values as a secondary aspect can have positive effects on sales.

This understanding of the organic farming market can, for instance, be found in the slogan used by the most successful German organic supermarket chain ALNATURA: "Organic — makes sense for man and earth." Another example of practical implementation is the information campaign on organic farming by the Federal Ministry of Consumer Protection, Food and Agriculture in Germany, which stresses the advantages of organic food for the individual and puts the societal advantages second (8).

**Policy Relevance**

There are two major reasons why organic farming can justify policy intervention. Government regulation can define clear (minimum) standards, transparent certification and labeling of organic food which helps the market function better. The two biggest markets for organic food in the world – the US-market and the European market — are examples where this type of government intervention has taken place. The other argument in favor of government intervention is based on the notion that organic farming benefits the public. Among these benefits, the environmental effects of organic farming are often mentioned. In general, an economic argument can be made for public support because relying on the private provision of such environmental benefits would most likely lead to an insufficient supply.

Within the EU, this argument has been of major importance for introducing political support for organic farming. Within the context of agro-environmental programs, organic farming has been policy supported in nearly all member states, mostly on a per-hectare basis (5). The European Union regards these measures as being under the green box of WTO and thus non-distorting to international trade. This type of environmentally motivated support for organic farming can influence markets for organic food which has led to a call for balancing these measures with other measures in support of organic farming. This call has been taken up by the European Commission to a certain extent (3,4).

In communicating the environmental benefits of organic farming to policy makers, it is important to consider the following: If looked at as an agro-environmental policy instrument, organic farming will lead to a broad, but not targeted, improvement for a large number of environmental indicators. If a specific environmental problem in a region needs to be addressed, it is likely that using specific measures within conventional farming is a more cost-effective way to reach the objective than to convert to organic farming. Thus, it is clear that organic farming as an agro-environmental policy instrument is only suitable in certain situations and with the objective of a move towards a more environmentally friendly farming system in general.

Organic farming will not address all agro-environmental problems. If cultural heritage systems in agriculture are to be sustained, a conversion to organic farming will not necessarily do the job. Also, if some extensive grazing systems are demanded for specific environmental purposes, conversion to organic farming might not be a sufficient replacement for these systems. In such cases, an additional agro-environmental program might be needed to help deliver the desired environmental outcome.

If politicians are interested in supporting environmentally friendly farming systems, organic farming is an interesting choice, because consumers bear much of the increased cost for producing organic foods. On the other hand, making a conventional system more environmentally friendly by means of agro-environmental programs, the additional cost is borne by the public. However, this argument only holds if the environmental support of organic
farming will not completely distort the existing markets for organic food.

Politicians interested in organic farming should note that the system is quite sensitive to the way in which it is regulated; an ongoing discussion on a revised version of the EU organic regulation (7) shows that since organic farming is a market-oriented system, stakeholders may react quite harshly to changes in the regulatory system. A lesson to be learned is that regulation of organic farming is not a purely technical problem on how best to achieve environmental performance but also a problem of good governance dealing with questions like stakeholder participation and subsidization (7).

Organic farming is a dynamically evolving system – as is conventional farming. Any comparison of the environmental benefits from either of these systems may change over time, for example by introduction of new regulations in organic farming or conventional farming. With more stringent environmental regulations for all types of agriculture, the relative benefit from organic farming might decrease, while a tightening of the standards for organic farming might increase its relative advantage. The advent of new technologies and their introduction into agricultural practice, like genetically modified organisms, also change the picture over time.

Within the context of these dynamic changes, organic farming can currently be seen as a role model for creating an environmentally friendly farming system. This role model can have an indirect influence on conventional farming whose effects might even go beyond the direct effects of organic farming on the environment. Keeping such a role model alive and developing it further through research and other measures might also be a way to improve environmental friendliness of farming in general. Seen in this light, the influence of organic farming could grow far beyond its present borders.

**Literature Cited**


http://www.plantmanagementnetwork.org/pub/cm/symposium/organics

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