Summary

Organic farming represents a promising, if still imperfect, approach to improving the sustainability, quality and health impacts of agriculture. Production standards have become highly codified and regulated to protect consumers and enable producers to benefit from specialist markets. Certified organic farming is now widely adopted in many countries. While the regulations make the concept appear unduly rigid to some, the underlying scientifically-based, agro-ecological understanding and principles are fundamental to the development and management of successful organic systems, having wider applicability beyond certified organic production. Research studies have demonstrated that organic management practices and systems have, to varying extents, direct and indirect impacts on soil ecosystems, plant and animal health, productivity, food quality and the environment, both in industrialised and developing countries. At the same time, the lower yields associated with organic systems in industrialised countries present a challenge both to find ways of better assessing the total productivity of farming systems, including ecosystem services, and to develop improved systems to close the productivity gap and enhance organic farming’s potential contribution to sustainable food security.

Introduction

Since the early 1990s, organic farming has grown significantly. It now accounts for close to 5% of European agricultural land use, with levels approaching 10% in Wales and Southwest England, and 20% in Sweden and Austria. Globally, certified organic farming in 2008/9 involved 1.4 million producers on 35 million ha and a market retail sales value of more than US$ 50 billion (Willer and Kilcher 2010). There is also a significant area of uncertified land managed organically, often by subsistence farmers, for which no statistical data are available. Despite its long history and current scale, organic farming continues to be controversial, with myths and misconceptions in abundance on both sides of the debate. Given the extent of public and private investment in organic farming, it is pertinent to ask what lies behind it and does it deliver any benefits?

Glossary

Eutrophication: degradation of water quality owing to enrichment by nutrients, primarily nitrogen (N) and phosphorus (P), which result in excessive plant (principally algae) growth and decay. Ecosystem services: Environmental benefits which sustain and enhance human activities and the general environment.

What is organic farming?

Organic farming is commonly misconceived as being simply about the non-use of synthetic chemicals in agriculture. While this is (up to a point) a characteristic of the approach, it says nothing about what organic management involves and why certain technologies and practices are preferred over others. Simply not using synthetic inputs and doing nothing else (organic farming by default) is likely to be a failure in productivity, financial and environmental sustainability terms. The idea that organic farming is how all farming used to be, or at least agriculture before the mid 20th Century, is also a long way from reality.

Organic farming can be defined as an approach to agriculture where the aim is to create integrated, humane, environmentally and economically sustainable production systems (Lampkin, 2003). This encompasses key objectives relating to achieving high levels of environmental protection, resource use sustainability, animal welfare, food security, safety and quality, social justice and financial viability. Maximum reliance is placed on locally, or farm-derived, renewable resources (working as far as possible within closed cycles) and the management of self-regulating ecological and biological processes and interactions (e.g. biological nitrogen fixation and biological pest control via agro-ecosystem management (Altieri 1995)), in order to provide acceptable levels of crop, livestock and human nutrition, protection from pests and diseases, and an appropriate return to the human and other resources employed. Reliance on external inputs, whether chemical or organic, is reduced as far as possible in order to promote a self-reliant, self-sustaining system.

The term 'organic', first used in this context in the 1940s, refers not to the type of inputs used, but to the concept of the farm as an organism (or system in modern terminology), in which all the component parts – the soil minerals, organic matter, micro- organisms, insects, plants, animals and humans – interact to create a coherent and stable whole. In many European countries, organic agriculture is known as biological or ecological agriculture, reflecting the emphasis on biology and ecosystem management rather than external inputs.

The ideas and principles underpinning organic farming as a coherent concept go back almost 100 years (e.g. to King 1911; see also Lockeretz 2007). Since then, different issues have come to the fore at different times, from soil conservation and the dustbowls in the 1930s (Howard 1940; Balfour 1943), to pesticides following Silent Spring (Carson 1962), energy following the 1973 oil crisis (Lockeretz 1977), and subsequently to current concerns about animal welfare, biodiversity loss, climate change, resource depletion and food security. These ideas are also reflected in the four fundamental principles of organic farming – health, ecology, fairness and care – defined by the International Federation of Organic Agriculture Movements (IFOAM, 2005).

The definition of organic farming and the debate surrounding it is further influenced by the development of the market for organic food since the 1970s, a relatively recent development in the history of organic farming (Lockeretz 2007). In order to maintain the financial viability of organic systems in the absence of government policy support, producers looked to consumer willingness to pay higher prices for the perceived benefits of organic food. In some cases, this reflected more altruistic environmental, animal welfare and social concerns; in others more 'self- interested' concerns relating to food quality and safety, in particular issues relating to pesticide residues and health. To protect consumers and bona fide producers, the development of the organic market involved the development of production standards. As the market developed and grew, many countries, including the USA and those in the EU, introduced legal regulation. The original EU regulation (EC 1991) was substantially revised in 2007 (EC 2007), in particular to include a clearer statement of the underlying principles of organic farming that might be used in future as a basis for determining acceptability, or otherwise, of specific practices. For many, these regulations have become the standard definition of organic farming, even though they contain some black/white distinctions, when in practice shades of grey may be more appropriate.

The role of science in organic farming

Organic farming is sometimes challenged as being unscientific, or worse 'anti-science'. This is far from the case. The scientific method has a fundamental role to play in understanding how agriculture and ecosystems work, and in understanding how they can be managed to help sustain food production and other ecosystem services on which our existence depends. As such, science has played, and still does play, a particularly important role in the development of organic farming concepts and their validation, and is central to research on organic farming (e.g. Niggli et al. 2008). The scientific method that has delivered so much to the development of human knowledge and understanding is central to that process, although we may still struggle at the frontiers of methodology, particularly with respect to the understanding of complex systems.

Technology, on the other hand, so often closely intertwined with science, is a different matter. The acceptability or otherwise of a particular technology, such as renewable or nuclear energy, GM or non-GM plant cultivars, or the fertilisers, pesticides and agricultural mechanisation that drove the Green Revolution, however well founded in science, should depend on careful assessment of costs and benefits, encompassing economic, environmental, health, social, cultural and ethical aspects. Science may well be essential to help us make these assessments, to test the evidence with respect to different options. However, different individuals, with their different life experiences and perspectives on the importance of the various costs and benefits, may well come to different conclusions about the appropriateness of a particular technology. That is the nature of discourse and debate and not necessarily a pro- or anti-science perspective.

The wide range of issues reflected in the development of organic farming as a concept also explain why it is possible to find some inconsistencies in the way the idea of organic farming is presented by its proponents. Many of these are lay people who may not always have the same facility with scientific understanding, or communication, as trained scientists, but that should not necessarily invalidate their contribution to the debate.

Impacts of organic farming practices

Minimising external inputs

While it is true that organic standards prohibit most synthetic fertilisers and pesticides, the reasons for this do not include the idea that there is a difference between synthetically- derived and naturally-derived molecules. Although it may be sometimes clumsily expressed by lay proponents, the idea of ‘chemical-free’ food is also nonsense, as all food (not to mention all organisms and elements) contain chemicals.

The main reasons for the exclusion of, or reduced reliance on, synthetic inputs in organic standards relate to the desire to conserve non-renewable resources and to apply the precautionary principle with respect to potential environmental impacts. This is reflected in the ideas of:

a) trying to work with locally or farm- derived renewable resources, as far as possible within closed cycles, in order to conserve resources and enhance self-reliance; and

b) trying to work where possible with the agro-ecosystem to deliver ecosystem services and sustain productivity. However, this can also impact on soil ecosystem and plant and animal health, because the form in which nutrients are applied does make a difference.

This is most easily illustrated with respect to nitrogen inputs. All plants (and for that matter animals) require nitrogen – it is a basic component of proteins amongst other things. Nitrogen normally exists as nitrogen gas in the atmosphere, but cannot be taken up by plants in this form – plants take up virtually all their nitrogen in solution as either nitrate ($NO3^-$) or ammonium ($NH4^+$) ions (not molecules). Nitrogen gas can enter the soil ecosystem and be available for uptake in a variety of forms through a process of fixation requiring significant energy inputs, which may happen atmospherically (via lightning, to a limited and uncontrollable extent), industrially (in the Haber process, typically but not exclusively using fossil energy), and biologically (often in a symbiotic relationship where the energy source is solar energy captured by photosynthesis). Biological fixation is preferred in organic farming, as it is consistent with the ecosystem management approach and use of non-renewable, fossil energy inputs is reduced.

Pathways of fixed nitrogen through the soil ecosystem (see e.g. Brady 1984) vary depending on the form in which nitrogen has been fixed. In particular, nitrate ions, often a form in which industrially fixed nitrogen is applied, are very prone to leaching, while biologically fixed nitrogen is initially bound in the protein of soil organisms and plants, eventually being broken down through the mineralisation process to form ammonium ions which can be taken up by plants. However, as a positive ion, ammonium may also be held by negatively charged clay particles and humic acids in the soil and therefore it is not leached to the same extent as nitrate, although it may be oxidised to nitrate form if not held in the soil or utilised by plants.

Surplus ammonium taken up by plants cannot be stored, whereas plants can store surplus nitrate ions in the sap. The stored nitrate can act as a nutrient reserve for pests (e.g. aphids) and pathogens, enabling more rapid growth and reproduction, potentially leading to the development of plant health problems (Huber and Watson 1974). Excess nitrate content of vegetables has been a significant focus for food safety standards too, owing to concerns about potential impacts on human health.

It is also often claimed that there is no difference between nitrogen as plant food obtained from mineral fertiliser or from organic manures. However, with organic manures, nutrients are applied to the soil together with organic matter, providing a source of energy (stored in carbon compounds) for the soil ecosystem that is not available with mineral fertilisers. While soil organisms will seek to utilise the nutrients supplied by either source, they also need an energy source for respiration, growth and reproduction. In the mineral fertiliser case, soil organisms seeking to utilise the nutrients applied will need to break down existing soil organic matter, contributing to the declining soil organic matter levels that have been associated with intensive cropping systems (Boardman and Poesen 2006).

So, while all plants require nitrogen, whether provided organically or not, there are potentially significant environmental, resource use, quality and health issues related to the way in which nitrogen is captured, and the form in which it is applied, that the organic approach seeks to address and consequently impacts (Reganold et al. 1987; Reganold et al. 1993; Mäder et al. 2002).

Production methods and food quality

It is well established that plant and animal breeding can lead to quality differences, as for example between Jersey and Holstein dairy breeds and between milling and feed wheat cultivars. Management practices can also make a difference, for example the timing/quantity of nitrogen fertiliser inputs is known to be critical to the management of protein levels in cereals and sugar levels in sugar beet. The impacts of soil mineral deficiencies on plant nutritional value and animal/human health are also well known. There is therefore no question that the way food is produced can, and often does, influence its quality and there is therefore a reasonable basis for positing a scientific hypothesis that there may be differences in the quality of food from organic and non-organic systems (whether for better or for worse is another issue).

The problem in making an overall assessment of organic food quality, however, is that there is a huge variation in organic systems globally, ranging from intensive horticulture to extensive mountain sheep ranging, and from tropical to Nordic climatic and geographical conditions, with wide variations in underlying soil types and genetic materials. Apart from a quite general finding that organic products tend to have lower pesticide residue levels (the significance of which can be debated), it is virtually impossible to reach a positive conclusion that organic food is always better quality than non-organic. There have now been a number of reviews of organic food quality in peer-reviewed journals and more systematic reviews (e.g. Woese et al. 1997; Brandt and Molgaard 2001; Bourn and Prescott 2002; Williams 2002; Benbrook et al. 2008; Dangour et al. 2009). Each of these reviews contains its own strengths and weaknesses, but all provide some evidence of differences even though for example Dangour et al. (2009) conclude the differences are unimportant.

However, rather than attempt the impossible to prove overall superiority, it may be more helpful to focus on examples where clear differences have been shown and the mechanisms leading to the differences have been understood, so that all producers, whether organic or not, can benefit from understanding how to improve the quality of their products.

For example Temperli et al. (1982) found that organic lettuce typically had lower nitrate levels than non- organic, but when produced in winter, the differences disappeared. In summer, under conditions of high light intensity, the available nitrogen was fully utilised by the organic crops, but not by the conventional. However, lower light intensity levels in winter meant that in neither case was there full use of the available nitrate taken up by the crop. This indicated that modifications to fertility management practices, which needed to be adapted to seasonal conditions, could influence quality. In an earlier study, Schuphan (1975) examined nitrate and vitamin C levels in spinach and found that increasing levels of mineral fertiliser use led to higher nitrate and lower vitamin C contents as well as declining total sugar levels. Williams (2002) reported on studies of a more general consensus of comparisons in which mineral fertilisation resulted in higher nitrate and lower vitamin C levels, that Benbrook et al. (2008) attribute to plant physiological processes. The impacts on sugar levels are consistent with the more general understanding in sugar beet production of the need to restrict nitrogen fertiliser levels in order to maintain sugar content.

Various recent studies have demonstrated that organic milk has higher Omega 3 levels than non- organic milk (Bergamo et al. 2003; Robertson and Fanning 2004; Ellis et al. 2006). However, not all studies show similar results. In practice, the major reason for the difference in Omega 3 content can be attributed to the balance between grass and concentrates in the diet. Milk from cows fed on a high forage, low concentrate diet will have a higher Omega 3 content (Dewhurst et al. 2003). While organic producers tend to work with less concentrates in line with organic principles, this is not always the case where organic standards are pushed to their limits in order to boost production.

In conclusion, it is clear that the way food is produced can affect its quality, and that some aspects of organic practice do have specific impacts on food quality. However, it is not possible on the basis of current evidence for a general presumption in favour of organic products. That does not mean that some quality issues relating to organic food are not worthy of further scientific investigation – the results could have much wider agricultural and public health relevance.

Productivity and food security

Throughout its (post-1940s) history, the organic approach has been challenged that lower yields will result in reduced food security. Earl Butz, Secretary of the US Department of Agriculture, declared in 1971: ‘before we go back to an organic agriculture in this country, somebody must decide which 50 million Americans we are going to let starve or go hungry’ (Lockeretz 2007). In the 1980s, the agricultural input manufacturers in the UK placed full page advertisements in the national press showing the cricket fields of England having to be ploughed up if organic farming became more widespread. With food security once again high on the political agenda, these concerns have resurfaced.

There is no question that organic yields are often lower than non-organ- ic, with the extent of the difference related to prevailing levels of nitrogen fertiliser use. Where conventional N input use is high, for example for wheat in the UK, the yield difference may be as high as 40-50% (Moakes and Lampkin 2010). However, in other situations where conventional input use is low, for example wheat in the USA, yield differences may be only 10- 20% or non-existent, as with grain legume crops (Mäder et al. 2002; Pimentel et al. 2005; Badgley et al. 2007). While some might compare current yields with pre-1950 yields to make a point, these comparisons are irrelevant as organic farming has benefited from many of the advances in breeding and production techniques that have taken place since then. UK organic wheat yields currently average 4-5t/ha (Moakes and Lampkin 2010) with some producers achieving twice that, while global average wheat yields are still at around 3t/ha.

The combination of lower yields with the need for a fertility building break in organic rotations is used by some critics to argue that to produce crops organic farming needs three times as much land as is needed for non- organic. However, this analysis does not take account of the livestock feed, biofuel feedstocks and other ecosystem services that may be generated from the clover/grass leys; total system productivity needs to be considered when making such comparisons, not just individual crop yields. Similarly, higher stocking rates for livestock on conventional farms are more often related to increased reliance on purchased feedstuffs (from productive land elsewhere in the world) than on differences in grassland output. A preliminary, unpublished assessment by the author of productivity data for different farm types obtained from Moakes and Lampkin (2010) indicate that for most UK farm types involving livestock, the overall productivity gap is only about 10%. The ability to achieve this with reduced reliance on non-renewable inputs (see below) means organic systems actually have a potential contribution to make to sustainable food security, even in industrialised countries. However, larger differences exist for cropping and horticultural farm types, indicating a need for these organic producers to consider how better use might be made of the fertility building phase of their rotations, for example by using the biomass produced as a bio-fuel feedstock.

Despite this, the issue of food security is much bigger than the question of the relative productivity of organic and non-organic systems in the UK. Factors of distribution and access to food (food sovereignty), diet, waste in processing, retailing and domestic consumption are all relevant and should be addressed before we engage in the pursuit of more food production. With energy, society is finally beginning to learn the lesson that conservation and reducing demand is as important as new generating capacity. If we are to ensure a food system that can be sustained into the long term then we need a similar approach.

So far, this discussion assumes that people have the financial resources to buy food that is available on world markets, or to buy the inputs needed to generate high levels of productivity. In some cases, producers in developing countries can even take advantage of the premium price organic export markets for cocoa, coffee and tropical fruit and vegetables (ITC 2004). However, in many developing countries resource poor, subsistence farmers have neither the ability to purchase inputs, nor the ability to buy food at the prices represented by global markets. Food sovereignty, the capacity to meet food requirements locally in a manner appropriate to specific communities, is a key issue. There are now many examples or organic/agro-ecological approaches being successfully implemented to increase (not decrease) the levels of productivity these producers can achieve, by making better use of their existing resources through improved knowledge and technical ability (Scialabba and Hattam 2002). A study by ICROFS and IFPRI scientists (Halberg et al. 2006) concluded that, while yields in Europe and North America would be reduced, this would be offset by increases in self-sufficiency and decreased net food imports in South Asia and Sub-Saharan Africa. This outcome would owe to the potential improvements in yields from (non-certified) organic/agro-ecological approaches, compared with current low input systems, provided that the change is supported by capacity building and research.

Farmland biodiversity and ‘natural’ inputs Organic farming practices have both direct and indirect impacts on the environment, in particular on biodiversity. This in part arises from the very significant reduction in the use of biocides in arable and horticultural production, so that not only in field margins, but also within the crop itself, greater species diversity can be found. Indirect benefits may result, for example, from the prohibition on herbicides leading to a more even distribution of winter and spring cereals in organic rotations for weed management purposes, in turn providing better over-wintering conditions for farmland birds.

There are, however, a (very) small number of pesticides and fungicides that continue to be permitted under organic standards, including ‘natural’ pesticides such as pyrethrum and ‘traditional’ copper-based fungicides. This does not reflect a view that because they are ‘natural’ they must be ‘alright’, but more that for certain problems it has so far proved difficult to develop alternative solutions that more closely reflect organic/agro- ecological principles. Where they exist, the health and environmental risks of these products are well recognised and their use has been restricted, and kept under review (e.g. rotenone) or prohibited (e.g. nicotine).In most cases (apart from vineyards and orchards) their use is infrequent. In the case of copper sulphate and other permitted copper-based fungicides, the negative impacts are acknowledged and there is an intensive programme of research to identify alternative management approaches so that their use can be brought to an end.

Unlike the food quality debate, there is a substantial body of evidence demonstrating the benefits of organic farming (e.g. Stolze et al. 2000; Shepherd et al. 2003; Bengtsson et al. 2005; Fuller et al. 2005; Hole et al. 2005; Norton et al. 2009; Gabriel et al. 2010). Where comparisons have been made, organic systems often outperform integrated farming systems, but both represent improvements on intensive conventional systems. This does not mean that there will not be studies where organic systems fare worse under some parameters, for example the Rhone-Poulenc sponsored Boarded Barns comparison of conventional, organic and integrated systems in the 1990s (Higginbotham et al. 2000). These individual studies, while giving pause for thought, do not invalidate the overall body of evidence in favour of organic farming.

However, as with the food quality comparisons, there is a very wide range of organic systems practiced. Within each farm type individual farms will achieve environmental outputs to a greater or lesser extent, depending on the priorities, knowledge and expertise of the farmer. It is therefore difficult to guarantee a consistent level of environmental outputs from systems approaches, such as organic or integrated farming. All agriculture involves disturbance of the 'natural' environment with some negative environmental impacts. No system can achieve a perfect level of sustainability, so it is more relevant to focus on relative performance between systems and incremental improvements that move agriculture in the right direction.

Profitability and efficiency of resource use.

The usual definition of productivity in terms of output per unit of land ignores productivity (or efficiency) in response to other potentially limited inputs. As these other resources become scarcer, this is an important issue. In general terms, organic systems use less non-renewable resources (in particular fossil energy and mineral fertilisers) per hectare than do conventional systems (Stolze et al. 2000). In many cases the differences are such that the use of these resources per unit of food produced is also lower (Pimentel et al. 2005; Lampkin 2007).

Even in the case of land as a resource, improvements in soil quality and reductions in soil erosion associated with organic management are important factors in ensuring soil conservation and maintaining the land available for agriculture. While the perception is that organic farming involves increased mechanisation for soil cultivation and weed control, intensive tillage occurs less frequently in organic systems (because continuous arable cropping is not practiced) and the fertility building phase in organic crop rotations restores soil carbon levels, soil biological activity and soil quality following cultivation (e.g. Reganold et al. 1987; Mäder et al. 2002). There are also active efforts to develop decreased tillage systems compatible with organic standards.

With water, oil, soil, biodiversity and mineral resources (in particular phosphates) all increasingly under pressure, systems that can improve productivity with respect to these resources may be as, or even more, important than those that achieve high productivity with respect to land area alone. The issue of which of these resources is most seriously limiting for food security is one which still needs more debate.

The intensive use of resources such as oil and mineral nutrients is associated with downsides from emissions and environmental pollution, notably greenhouse gases and eutrophication. Organic systems have demonstrated benefits that mirror the reduced reliance on non- renewable resources (e.g. Stolze et al. 2000; Schader 2010). However, this might involve a trade-off between improved performance in some areas and reduced performance in others. For example, with organic milk production, increased methane emissions per litre milk are likely because of lower yields per cow, but these increases may be counter- balanced by reduced nitrous oxide emissions owing to the restrictions on nitrogen fertiliser use, yet resulting in an overall improvement with respect to greenhouse gas emissions (Lamp- kin 2007).

Owing to the lower yields associated with organic farming in industrialised countries, it is often assumed that organic farming involves reduced profits. Increasing yield has always been a key strategy of farmers to help spread overhead costs and reduce costs of production in response to falling prices, so this view is understandable. By significantly reducing the use of inputs, such as fertilisers and pesticides, there is some potential for cost savings, but this is usually insufficient to compensate fully for the reductions in crop yields. The 50-100% premium prices for crops obtainable in the UK organic market (determined mainly by supply and demand interactions) are therefore essential to close the gap, but these prices generally more than compensate for the remaining differ- ences, leading to higher gross margins per hectare (Lampkin and Padel 1994; Offermann and Nieberg 2000; Pimentel et al. 2005; Lampkin et al. 2008; Moakes and Lampkin 2010).

Owing to the use of legumes, differences in output from grassland are smaller than for other arable crops, and there is more potential for cost savings on inputs, especially nitrogen fertiliser, to make up the difference for cattle and sheep enterprises. This is important, as price differentials tend to be lower than for crops (10-25% in the UK). However, the organic certification requirement to use organic purchased feeds can add to costs despite the lower quantities used. For pigs and poultry, the requirements to use free range systems, longer finishing periods and organic feeds can add substantially to costs and may not be covered by the prices received.

When similar farm types are compared, labour, machinery, power, rent and interest and other general farm costs do not differ significantly (Offermann and Nieberg 2000; Moakes and Lampkin 2010). While some have claimed significant increases in labour requirements for organic farming, in practices the differences are not large – the main differences occur where high value horticultural, processing or direct-marketing activities are introduced and the increased labour costs can be justified by these activities. However, similar fixed costs per farm often translate into higher fixed costs per tonne owing to the reduced output.

The overall effect of output reductions, cost savings from reduced inputs, similar fixed costs and agri- environmental policy support is that organic farms make similar or slightly higher incomes than their conventional counterparts (Offermann and Nieberg 2000; Moakes and Lampkin 2010). In a European context, both entrepreneurial marketing activities and agri- environmental policy support are important factors in maintaining similar relative incomes (Offermann et al. 2009; Stolze and Lampkin 2009; Schader 2010).

Conclusions

It is certainly valid to argue that some of the differences identified between organic and conventional systems can be attributed to specific management practices that can be adopted by any farmer whether organic or not. However, it is important to remember that the organic approach represents an attempt to combine several practices in a way that will deliver broad sustainability, health and quality objectives. It is the combination of these different components/practices that defines the organic system, and it is the interactions between these practices that make comparisons at systems level relevant. A practice that has advantages in one respect but disadvantages in another may have those disadvantages offset by another practice in the bundle. The need for more rigid definitions of these 'bundles' of practices comes if there is an attempt to realise a market premium. Conceptually, this is not different from similar attempts to define (different) 'bundles' of practices that make up integrated farming systems (Higginbotham et al. 2000) and to achieve a market premium for them, for example as LEAF Marque in the UK (LEAF 2010). Neither is the concept different from other approaches to improve agricultural sustainability, including the Sustainable Agriculture standard currently under development in the USA.

However, while the organic market has played a very important role in maintaining the financial viability of organic systems, there is a real danger that it can become an end in itself, rather than a means to an end, that of supporting the development of more sustainable farming systems. 'Minimalist' organic systems, designed to just comply with organic standards by substituting permitted 'organic' inputs for prohibited 'non-organic' inputs may not deliver the expectations of consumers, citizens or policy-makers. In addition, the regulatory system, particularly at international level, may become so rigid because of the difficulties involved in getting international consensus for change, that the development of concepts and improved practices in response to new scientific understanding may be constrained.

There is therefore a need, scientifically and otherwise, to continue working outside the box and to continue challenging long held views. Genuine efforts are being made by organic producers and those working with them in the scientific community to improve the sustainability, quality and health impacts of food production in the context of the current institutional and legal framework within which they operate. Rather than denigrate them, it would be better if we could engage in open dialogue about the strengths and weaknesses of all the different farming approaches currently open to us and assess their relative contributions. In facing the coming challenges of climate change, biodiversity loss, resource scarcity and food security, we need to keep all options open to us – an evolving approach to organic farming remains one of them.

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Comments