

## **Systemic sustainability characteristics of organic farming: a review**

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**Abstract.** Agriculture for food production has come to crossroads: while conventional agriculture needs to improve environmental and social performance, organic agriculture needs to increase the production volumes and to re-establish the connectedness between producers and consumers. Through re-localising the food production there is an increasing convergence of the farming practices towards sustainable agriculture acknowledging the prospects, advantages and limitations of the different production systems. The aim is to find a combination of production methods that is optimal in given circumstances and to adapt the production system accordingly. Assessment of the environmental impacts should be integrated into the assessment of the overall sustainability. Formulation of the management strategies requires evaluation and integration of research results from many different disciplines, and the focus of the interdisciplinary research should be on food systems and bioregions rather than on the level of farms or farming systems.

The present article is a review on today's discussion and research dealing with conventional, organic and local farming for food production. The future prospects of organic production to respond to the challenges of advancing global food security and to contribute to overall sustainable development are discussed. It seems that as a developing production mode organic agriculture has a role to play in the green global network of local food systems.

**Key words:** productivistic agriculture, organic agriculture, sustainable agriculture, systemic sustainability

### **INTRODUCTION**

Agricultural production and food distribution has experienced successive developmental phases during history, showing dialectic developmental tendencies. The productivistic agricultural mode, currently still representing the mainstream, was succeeded by alternative agricultural modes with extensive production. Recently, sustainability through re-localisation of and moderation of inputs for food production has been suggested as the ultimate aim towards which the production systems need to be geared. From the normative sustainability point of view, changes in food systems are to be implemented interactively both by dynamic response to ever changing circumstances and also by controlling those so as to secure human and ecosystem health locally and across distances. These developments suggest that disposition needs to be taken in regard to different agricultural production modes on the basis of their respective sustainability features. Particularly organic and sustainable agriculture

become close to each other evoking the question, how sustainable is organic agriculture. On the basis of literature review this paper sums up first the dialectic agricultural developments from intensive to extensive to sustainable agriculture. Second, systemic sustainability characteristics of organic agriculture are evaluated from the normative standpoint of sustainable agriculture, as they are presented in the literature. The paper concludes with an understanding about the sustainability and developmental aspects of organic agriculture, which is suggested to exhibit sustainable features locally and bioregionally in particular adapted production lines.

### **Dialectic developments: from intensive to extensive to re-localised agriculture**

*Conventional farming, agrochemicals and efficiency.* The focus of the mainstream conventional food production is the economic profit and the volume of the food. Prevailing economic conditions that favour scaling-up of industrial production and establishment of fewer, larger trans-national food corporations have driven the food trade towards a globalised system of centralisation and increasingly intensive production (e.g. Whatmore 2002). The productivity is highly reliant on the input of agrochemicals, fertilisers and various biocides, antibiotics against animal diseases and chemical supplementation for improved nutritional status of the livestock. The focus on increasing the production volumes resulted in an era of agrochemicals. Synthetic fertilizers grew the dominant source of plant nutrition, and the control of weed, pests and fungal diseases became heavily dependent on application of the chemical biocides. The production is restricted to only a few cultivated species, and the landrace animals have given way to new races that have been bred to maximize the production of the large-scale industrialized agriculture (Lang & Heasman, 2004; WRI 2006).

The externalities of the present global food markets imply high costs to the environment and animal and human health. The current agricultural practices contribute to environmental disbenefits such as erosion and severe deterioration of the arable soils, pesticide pollution, pest adaptation and resistance, desertification, water eutrophication, decrease of biodiversity and climate change. The critical natural resources, water, plant nutrients and arable land are increasingly scarce, and with the food production distanced from food consumption the environmental impacts are alarmingly accumulated in the source areas of food production; all this results ultimately in significant losses of yields worldwide (e.g. Atkinson et al., 2005; Gliessman, 2007). With the present high price of energy and agrochemicals, it also decreases economic profitability to the farmers.

The strivings to slow down the climate change are not compatible with the continuous increase of non-renewable fossil energy consumption in food production and transports. Substitution of the fossil energy with cultivated energy crops is no solution as it would compete for the shrinking resources of land (Millennium Ecosystem Assessment 2005). In addition, there are significant socio-economic flaws due to distortions of the global food markets such as starvation in developing countries, and obesity and other food related health problems both in developed and developing countries as well as the rising prices of food, fuel and agrochemicals, that make the present situation most unsustainable.

*Organic farming.* Environmental awakening was largely a consequence of the agrochemical efficiency era, when the adverse impacts such as deteriorating quality of

cultivated soils, erosion, pollution of both the groundwater and watercourses and coastal seas with concomitant changes in the terrestrial and aquatic ecosystems, became evident both within and outside the agroecosystems. This created social pressure to reduce environmental impact by promoting organic production that relies on nature benign agricultural practices. The aim is to secure ecosystem health by preserving soil fertility through conservative soil management practices, intercropping, cover crops, mulching, flaming, reduced tilling and crop rotation. These measures are also essential for the control of weeds as the use of chemical herbicides is banned. Pests are controlled biologically with predator insects (Altieri & Nicholls, 2004; IFOAM 2008; Watson et al., 2008).

Organic production is strictly regulated by national and international laws. Requirements vary from country to country, but generally involve a set of production standards for farming and processing that include avoidance of synthetic chemical fertilizers, pesticides, antibiotics, food additives etc., genetically modified organisms, irradiation and the use of sewage sludge, use of farmland that has been free from chemicals for a number of years, keeping detailed written audit trail, and maintaining the organic products strictly separated from other, non-certified products (EC 2007; IFOAM 2008). Organic certification, thus, defines the conditions for production, but there are no commitments as to geographic location of the production. Therefore, organic food may be of local produce or as well part of international food chains.

Organic production was an early solution to the environmental disbenefits of food production. With the focus on the environment, it has not met with the demands for productivity globally and by all production organisms. Another emerging problem can be traced back to the consumers' keen interest in organic products. This has created business opportunities to provide niche products with high premium and profits for the agrifood corporations. Consequently, organic products have become increasingly part of the mainstream global food trade where production is controlled by the large agrifood corporations (Pollan, 2006). International trade means long transports and placeless food with the producers and consumers distanced from each other (Follett, 2009).

*Local food movement.* Local food movement is a reaction to this criticism, and contemporary consumer campaigns aim at promoting re-localisation of food production by directing the consumers toward more local food purchasing as part of sustainable eating habits (Norberg-Hodge et al., 2002; Jaffee et al., 2004; Nestle, 2006; Sonnino, 2007). Re-localisation of food production aims at assuring the environmental protection by truly challenging the foundations of the conventional global food and of the big organic with standardized products, price-based competition and consolidated power (Follett 2009).

'Local food' is a broad term containing different dimensions ranging from physical space to historical, cultural and social features and covering also high-quality specialist food products with a guarantee for origin or traditional speciality (e.g. DuPuis & Goodman, 2005; Holloway et al., 2006). A more geographically tuned definition implies, that food production and consumption are spatially 'close' (e.g. Kloppenburg et al., 1996; Tansey & Worsley 2000; Renting et al., 2003; Watts et al., 2005; Risku-Norja et al., 2008) and indeed, farming is local only relative to consumption of food. In terms of primary production "local" means balancing supply and demand and is, thus, not fixed in regard of geographic distance, but varies

depending on the size of the population within the area including both the hinterlands of production and the urban sinks of food consumption. Because of increasing specialization among the producers, 'local' varies also among the different foodstuffs (Risku-Norja et al., 2008). Local farming comprises concepts such as farmers' markets, community supported agriculture (CSA) and food co-operatives. 'Local food' is often paralleled with organic production. It may well be organic, although not necessarily certified as such, but it may also rely on the farming practices of conventional production.

As with organic production there is a danger that through niche products customized for specific consumer groups, large corporations usurp also local production (Pollan, 2006; Hinrichs & Allen, 2008). Some critics suspect also that revival of local farming in western countries may turn out to limit exportation from developing countries and reducing, thus, the income for poor farmers (Nestle, 2006).

### **Systemic sustainability characteristics of organic agriculture**

The main concern of the proponents of organic production deals with environmental issues. Organic production means fewer or no synthetic agrochemicals, cleaner waters supplies, better soils (IFOAM 2007). However, organic agriculture relies on machinery as does conventional agriculture, rendering the production far from independent from fossil fuels. Major source of GHG emissions of agriculture is the cultivated soil, and these emissions are difficult to reduce (Lucas et al., 2007). Due to the extensive production mode the GHG emissions both from soil and associated with energy consumption are, therefore, high compared to conventional farming (Foster et al., 2006; Thomassen et al., 2006; Risku-Norja et al., 2008) .

Organic production systems have been criticised for relying on soils' nutrient reserves, that have been built up by fertiliser additions prior to organic management; organic farming cannot therefore sustain itself for longer (e.g. Gosling & Shepherd, 2005). There is also evidence that organic farming increases nitrate leaching because of the inefficient use of nitrogen by plants (Rosen & Allan, 2007), but research provides also good evidence of positive nutrient budgets for organic systems (Marinari et al., 2006; Liu et al., 2007). Because organic farms recycle only on-farm waste and approved food waste, it has been claimed that instead of promoting nutrient cycling, organic farming may prohibit adaptation of other more effective solutions for nutrient use in agricultural systems (Kirchmann et al., 2007). Introduction of predator insects for biological pest control may also be a risk, because it involves manipulation of natural environment (Boisclair & Estevez, 2006). In some cases decreasing pesticide use may also enhance toxicity risk in food, although the pesticide residues in food are a more common problem (LeBail et al., 2005).

The major problem is, however, the generally remarkably lower productivity, the yields being 20–65% from those of conventional production (Goklany, 2002; Kirchmann et al., 2007; Rosen & Allan, 2007). On the other hand, comparable yields from organic and conventional production have also been reported for many cultivated species (Pimentel et al., 2005; Badgley et al., 2007), even yield increases have been reported during the transition from conventional to organic farming practices (Gopinath et al., 2008) suggesting locally or regionally favourable conditions to be utilized in organic agriculture. Yield level variations need to be known because e.g. due

to weather conditions of growing season organic production methods may sometimes be inadequate and the more flexible methods and predictable crop levels could outweigh the advantages of organic agriculture.

Today social issues are one of the key elements of organic production and hence must be addressed in certification (IFOAM 2007). Organic agriculture is, therefore, presented as ideal in terms of human and economic relations. However this may not necessarily be the case (Beus & Dunlap, 1990; Mikkola, 2008). There are indications that conventionalized organic agriculture with monocultures controlled by powerful companies does not pay much attention to farmers, labourers, rural communities or the society as a whole. Furthermore, with the large agrifood corporations and supermarket distribution increasingly dominating the organic food market, consumers and producers gradually lose their power (Follet, 2009). More organic acreage means better sales for the companies, but not necessarily better deals for producers nor increased trust between producers and consumers (Pollan, 2006).

## DISCUSSION

Among the voluminous agro-environmental research, different focii can be identified which have sought to solve questions posed at different times. They are, thus, firmly anchored to the socio-material reality and reflect the state of the art and the conceptions of their era. Today conventional production is regulated so as to conform to both the production and environmental targets, and conservative farming practices aiming at preserving the soil fertility are increasingly exploited in conventional farming. Organic certification has expanded so as to address social issues as well. Conventional versus organic comparisons usually neglect the inherent difference in the basic approach, which dictates the focus - environment vs. efficiency and profit - of the research design. In regard of environmental impacts, the twist has been whether the impacts should be measured per ton product or per hectare cultivated area. Conventional agriculture favours the per ton approach and argues for the better efficiency, while those focussing on the environment prefer per hectare approach.

Since the problem is not so much the agrochemicals *per se*, but their lavish and inefficient use (Lal, 2009), conventional and organic farming need not to be mutually exclusive in terms of learning and developing new production methods. Through re-localising food production there is an increasing convergence of farming practices towards improved sustainability. The more permissive concept of sustainable agriculture acknowledges the prospects, advantages and limitations of the different production systems (Gliessman, 2007; Lichtfouse et al., 2009). Instead of bluntly rejecting either one of the approaches, the aim is to find an optimal combination for given circumstances and adapt the production system accordingly by taking advantage of high technology and conservative soil management practices, biological pest control and effective recycling of off-farm wastes (Lal, 2008). The criterion for sustainable agriculture is that the production system comprising environmental, socio-cultural and economic capital can sustain itself over a long period of time. Regardless of the farming system the aim should be a balance between the yield and the environment. This is a matter of optimal trade-off and requires, among other things, expanding the genetic basis of production with the native livestock breeds and crop varieties that provide material for breeding new genotypes to secure adaptation to changing

environments (Patterson, 2000; Sanchez et al., 2008). The aim is to secure the productivity of soil, improve ecoefficiency i.e. product/input ratio, to optimize use of off-farm wastes, and to secure subsistence of the farm households and the population dependent on agricultural production (Gafsi et al., 2006; Lal, 2008, 2009).

In recent years the contribution of sustainable agriculture to overall sustainable development has been stressed and understood more comprehensively than just as a matter of the farming system environment. The fundamental task is food production, but in managing the rural areas it also provides the society with ecosystem services such as waste management, carbon sequestration, biofuel, genetic resources and biodiversity, scenery and amenity values for recreation and, at the same time, secures viability of rural areas (e.g. Atkinson et al., 2005; Lal, 2008, 2009; Lichtfouse et al., 2009). Instead of focusing on a certain environmental issue or on farming systems, the research should be area-based with the focus on the resilience of the food systems comprising both the rural source areas of food production and the population centres of food consumption (Kloppenborg et al., 1996; Gliessman 2007; Lichtfouse et al., 2009). Evaluation and integration of research results from many different disciplines such as agronomy, ecology, sociology, economics and politics requires cross-disciplinary approach. Formulation of the management strategies and practical implementation of the measures require participatory research involving the actors and the negotiations with decision makers (e.g. Atkinson et al., 2005; Lal 2008, 2009; Lichtfouse et al., 2009). The proponents of sustainable agriculture envision alternative post-global green future comprising a global network of local food systems, whereby organic agriculture has a particular niche as bioregionally adapted production mode both in the global North and South.

## CONCLUSIONS

- ✓ Environmental performance should be assessed embedded within the issues concerning labour standards, animal welfare, rural communities, equity, quality and cultural aspects of food as part of the overall sustainability assessment specifically designed for the concerned area.
- ✓ Re-localising food production is likely to enable better control, because it is reasonable to assume that the closer production is to the consumers, the better the environmental aspects are taken care of, and it is also easier to justify sharing the costs of the measures aimed at environmental improvement within the society. Re-localisation *per se* does not necessarily reduce environmental load, unless serious efforts are made to adjust to variability of local conditions.
- ✓ Re-localised organic food production, although not necessarily certified as such, would become close to sustainable agriculture by providing identifiable products and by avoiding long transports and their implicated environmental impacts and other externalities such as traffic congestions, noise and accidents, costs of constructing and maintaining infra-structure etc..
- ✓ Impact of organic production on yields seems to vary geographically. Therefore, the actual capacity of organic agriculture should be seriously accounted for at local and national scales before advocating large-scale conversion to organic practices.
- ✓ Organic production is not a solution for sustainable food production, if it

- works with the logic of large-scale global food trade.
- ✓ Genetic resources of native livestock breeds and crop varieties should be secured.

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