

## Organic Agriculture's Contribution to Sustainability

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Sustainability is about ecosystem integrity, social well-being, economic resilience, and good governance. According to the current state of knowledge and development, how does organic agriculture contribute to each of these sustainability dimensions?

Sustainability has first been equated with environmental soundness in order to ensure the continued provision of goods and services to present and future generations. Organic agriculture, as defined by the Codex Alimentarius Commission, "is a holistic production management system that avoids use of synthetic fertilizers, pesticides and genetically-modified organisms, minimizes pollution of air, soil and water, and optimizes the health and productivity of interdependent communities of plants, animals and people."

In organic agriculture, limiting external inputs necessitates adaptation to local conditions in order to harness ecosystem services and increase production efficiency. To this end, the main organic strategies include: rotations, diversification and integration of crop, livestock, tree, and fish to the extent possible in order to optimize nutrient cycling; use of local varieties and breeds in order to increase the system resilience to stress; use of biological pest control to enhance predators; and promotion of symbiotic nitrogen fixation and biomass recycling.

Organic management is associated with several positive impacts on land and water, including: increased soil fertility and thus, enhanced productivity; better soil structure that increases stability to environmental stress; better soil moisture retention and drainage, which result in 20 to 60% less irrigation requirements; less water pollution and nitrate leaching in groundwater; reduced erosion by wind, water, and overgrazing (currently, 10 million hectares of land is lost annually by unsustainable agricultural practices); and better soil carbon sequestration rates. A new meta-analysis indicates that soil organic carbon stocks were 3.5 metric tons per hectare higher in organic than in non-organic farming systems and that organic farming systems sequestered up to 450 kg more atmospheric carbon per hectare and year through CO<sub>2</sub> bound into soil organic matter.

Overall, energy use by organic farms may be reduced by one-third, as compared to conventional enterprises, due to more efficiency in biological nitrogen fixation. Existing studies report less energy use on organic farms, from 10-70% in Europe and 29-37% in the USA, with exceptions for some crops. The heart of the matter is that chemical agriculture uses 2 kcal of fossil fuel to produce 1 kcal of food energy. This low energy efficiency is compounded by higher oil prices that lead to higher farm input prices, in addition to peak oil, sooner or later. The energy issue requires more attention to paradigms such as organic agriculture in order to face future food challenges.

In line with the Intergovernmental Panel for Climate Change 4th Assessment Report recommendations for agriculture, organic management addresses climate change through inherent practices such as: crop rotations and farming system design; nutrient and manure management; livestock management,

pasture and fodder supply improvement; maintenance of fertile soils and restoration of degraded lands. Requirements imposed on organic agriculture by US and EU regulations reduce greenhouse gas (GHG) emissions as follows: abstaining from N-fertilizers use reduces agricultural emissions 10%; the prohibition of intensive animal husbandry in feedlots and requirement for an adequate animal/land ratio prevents intensive methane and nitrous oxide emissions; recommended nutrient management plans result in less nitrous oxides and higher soil carbon sequestration. The International Federation of Organic Agriculture Movements (IFOAM) also recommends a prohibition on land clearing, which would avoid deforestation (which alone is responsible for 12% of global GHG emissions); generally, GHG emissions from organic agriculture are always lower than conventional agriculture systems, based on production area.

Existing life-cycle analysis (LCA) studies on greenhouse gas emissions per kg of product show that organic plant products and milk perform better than their conventional counterparts, while for organic meat and egg products, better performance is not always ensured. Most importantly, organically managed soils contain higher soil organic content (SOC) (expressed in mass%age), as well as carbon stocks (expressed as absolute masses) than non-organic soils. SOC stocks are key for assessing carbon sequestration potential and organic soils usually have deep rooting with SOC stocks up to 80-cm depth, due to grass-legume mixtures and deep-digging earthworms. Globally, the cumulative advantages of several organic practices (i.e., no use of N-fertilizers, reduced nitrous oxide emissions on farms, and soil carbon sequestration) has a GHG reduction potential from 5.1 to 6.1 GT CO<sub>2</sub> equivalents.

As to climate change adaptation, organic management takes a preventive and precautionary approach through diversification, generally adopted as a risk splitting strategy. In fact, diversified farms go through natural stages of succession that best adapt the agroecosystem to change. Rotational grazing and organic pasture management have huge potential in mitigating climate change. Spatial and temporal integration on organic farms (e.g., agroforestry, hedges, rotations, corralling) represent ecofunctional features conducive to climate-proofing of agroecosystems.

Sustainability is also about equity among and between generations. The main contribution of organic agriculture to social well-being is through avoided harm and healthy community development. Avoided harm ranges from loss of arable soil, water contamination, biodiversity erosion, GHG emissions, food scares, and pandemics associated with chemical agriculture, as well as pesticide poisoning of 3 million persons per year resulting in 220,000 deaths, let alone farmers indebtedness for inputs and suicides (e.g. 30,000 deaths in Maharashtra, India, from 1997 to 2005).

With regards to health, organic food commonly contains 10-60% more healthy fatty acids, organic dairy usually has more omega-3 fatty acids, organic crops tend to have 5-90% more vitamin C and 10-50 more secondary metabolites. Organic foods generally have higher dry matter and mineral content and organic diets seem to be less associated with allergies, with records of more immunity in children and animals. Although scientific evidence is mounting but not yet established, organic diets seem to result in less cancer cell proliferation.

Organic farming appears to generate 30% more employment in rural areas and labor achieves higher returns per unit of labor input. By using local resources better, organic agriculture offers dual benefits: it facilitates smallholders access to markets and thus income generation; and relocalizes food production in market-marginalized areas, especially where the hungry and the poor reside. The economic performance of organic systems depends on: previous intensity of conventional management; organic farmers' managerial background and skills; and the suitability of used varieties and breeds to low-input systems. Generally, organic yields are 20% less as compared to high-input systems in developed countries but could be up to 180% higher as compared to low-input systems in arid/semi-arid areas. In humid areas, rice paddy yields are

equal, while the productivity of the main crop is reduced for perennials, though agroforestry provides additional goods.

Farm profitability depends on: market opportunities and input/output prices; governmental support to agricultural policy; and mostly, farmer's management abilities. Variable organic production costs are significantly lower than conventional production, ranging from 50-60% for cereals and legumes, to 20-25% for dairy cows and 10-20% for horticulture products; this is due to lower input costs on synthetic inputs, lower irrigation costs, and labor cash costs that include both family labor and hired workers. Total costs are, however, only slightly lower than conventional, as fixed costs increase due to new investments during conversion (e.g., new orchards, animal houses) and certification.

Lower production costs on organic farms in association with price premiums generally compensate for reduced yields and net returns are similar to or higher than conventional systems in both developed and developing countries. Even without premiums, organic systems may be more economically profitable and, with economy of scale, premiums are less needed since post-harvest and certification costs are bound to decrease with greater quantities.

Good governance is ensured in organic systems because transparency and traceability are provided through the organic label. Legal protection of the organic claim ensures fair competition of farmers, as well as protection of consumers and the right to choose. Compliance is ensured with clear environmental and, sometimes, social standards. The food system, from standard definition to labeling, is based on participation and necessary public-private partnerships, whereby smallholders are integrated into highly demanding markets. Last but not least, the diversity of food cultures and traditional knowledge are safeguarded by organic agriculture.