Organic farming

Organic cultivation of mixed vegetables on an organic farm in Capay, California. (Source: Hajhouse (Own work) [Public domain], via Wikimedia Commons)

Organic farming is a form of agriculture that relies on crop rotation, green manure, compost, biological pest control, and mechanical cultivation to maintain soil productivity and control pests, excluding or strictly limiting the use of synthetic fertilizers and synthetic pesticides, herbicides, plant growth regulators, livestock feed additives, and genetically modified organisms. Arguably, the term can be interpreted to include animal husbandry practices. Also, often there is confusion as to use of the term organic farming, especially since many food processors choose to use the term *organic* to induce consumers to purchase a food brand, even though all the standards of organic farming may not have been met.

Organic agricultural methods are regulated internationally and enforced legally by many nations, based in large part on the standards set by the International Federation of Organic Agriculture Movements (IFOAM), an international umbrella organization for organic organizations established in 1972.

IFOAM defines the overarching goal of organic farming as follows:

> "Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.."

Since 1990, the market for organic products has grown at a rapid pace, averaging 20 to 25 percent per year to reach $33 billion in 2005. This demand has driven a similar increase in organically managed farmland. Approximately 306,000 square kilometers (30.6 million hectares) worldwide are now farmed organically, representing approximately 2% of total world farmland. In addition, as of 2005 organic wild products are farmed on approximately 62 million hectares (IFOAM 2007:10).

History

The organic movement began in the 1930s and 1940s as a reaction to agriculture's growing reliance on synthetic fertilizers. Artificial fertilizers were first produced during the 18th century, initially with superphosphates and then ammonia derived fertilizers mass-produced using the Haber-Bosch process developed during World War I. These early fertilizers were cheap, powerful, and easy to transport in bulk. The 1940s has been referred to as the 'pesticide era'.

Sir Albert Howard is considered by many to be the father of organic farming. Rudolf Steiner, an Austrian philosopher, made important strides in the earliest organic theory with his biodynamic agriculture. More work was done by J.I. Rodale in the United States, Lady Eve Balfour in the United Kingdom, and others across the world.

Organic output has been small as a proportion of total global agricultural output since its beginning, but it has been growing rapidly in many countries, notably in Europe. As environmental awareness and concern increase, the originally supply-driven movement has become demand-driven. Standardized certification has brought premium prices, and in some cases, government subsidies have attracted farmers to convert to organic methods. In the developing world, many farmers farm according to traditional organic practices, but are not certified as organic farmers. Other farmers in the developing world have converted to organic farming out of necessity.

Methods of organic farming

"An organic farm, properly speaking, is not one that uses certain methods and substances and avoids others; it is a farm whose structure is formed in imitation of the structure of a natural system that has the integrity, the independence and the benign dependence of an organism"

—Wendell Berry, "The Gift of Good Land"

The term holistic is often used to describe organic farming, Enhancing soil health is the cornerstone of organic farming. A variety of methods are employed, including crop rotation, green manure, cover cropping, application of compost, and mulching. Organic farmers also use certain processed fertilizers such as seed meal, and various mineral powders such as rock phosphate and greensand, a naturally occurring form of potash. These methods help to control erosion, promote biodiversity, and enhance the health of the soil.

Pest control targets animal pests (including insects), fungi, weeds and disease. Organic pest control involves the cumulative effect of many techniques, including: allowing for an acceptable level of pest damage, encouraging or even introducing beneficial organisms, careful crop selection and crop rotation, and mechanical controls such as row covers and traps. These techniques generally provide benefits in addition to pest control—soil protection and improvement, fertilization, pollination, water conservation, season extension—and these benefits are both complementary and cumulative in overall effect on farm health. Effective organic pest control requires a thorough understanding of pest life cycles and interactions.

Weeds are controlled mechanically, thermally and through the use of cover crops and mulches.

Standards

The basic rule for organic agriculture is to allow natural substances and prohibit synthetic. For livestock like these healthy cows, however, vaccines play an important part in animal health—especially since antibiotic therapy is prohibited. Photo courtesy Pleasantview Farm, an Ohio certified organic dairy farm, 2012. (Source: U.S. Department of Agriculture (Flickr: organic cattle) via Wikimedia Commons)

Organic farming is distinguished by formal standards regulating production methods, and in some cases, final output. Standards may be voluntary or legislated. As early as the 1970s, private associations created standards, against which organic producers could voluntarily have themselves certified. In the 1980s, governments began to produce organic production guidelines. Beginning in the 1990s, a trend toward legislation of standards began, most notably the EU-Eco-regulation developed in the European Union. As of 2007 over 60 countries have regulations on organic farming (IFOAM 2007:11).

In 1991, the European Commission formulated the first government system to regulate organic labeling, setting the rules for 12 countries. Organic certification became mandatory and was also required for organic imports. The mandatory certification solidified consumer trust in organic products.

The international framework for organic farming is provided by IFOAM. For IFOAM members, organic agriculture is based upon the Principles of Organic Agriculture and the IFOAM Norms. The IFOAM Norms consist of the IFOAM Basic Standards and IFOAM Accreditation Criteria.

The IFOAM Basic Standards are a set of "standards for standards." They are established through a democratic and international process and reflect the current state of the art for organic production and processing. They are best seen as a work in progress to lead the continued development of organic practices worldwide. They provide a framework for national and regional standard-setting and certification bodies to develop detailed certification standards that are responsive to local conditions.

Legislated standards are established at the national level, and vary from country to country. In recent years, many countries have legislated organic production, including the EU nations (1990s), Japan (2001), and the US (2002). Also, non-governmental national and international associations have their own production standards. In countries where production is regulated, these agencies must be accredited by the government.

Since 1993 when EU Council Regulation 2092/91 became effective, organic food production has been strictly regulated in the UK.

In India, standards for organic agriculture were announced in May 2001, and the National Programme on Organic Production (NPOP) is administered under the Ministry of Commerce.

In 2002, the United States Department of Agriculture (USDA) established production standards under the National Organic Program (NOP) to regulate the commercial use of the term organic. Farmers and food processors must comply with the NOP standards in order to label their products organic. The materials used are tested independently by the Organic Materials Review Institute.

Current status

The markets for organic products are strongest in North America and Europe, which were estimated to have $6 and $8 billion respectively of the $20 billion market as of 2001 (2003:6). Despite the dominance of North America and Europe in the organic markets, as of 2007 organic farmland is distributed across the globe.

In recent years both Europe and North America have experienced strong growth in organic farmland. Each added half a million hectares from 2004 to 2007 -- for the US this is a 29 percent change (IFOAM 2007:11,27). However, the growth in these two areas has occurred under different conditions. While the European Union has shifted agricultural subsidies to organic farmers in recognition of its environmental benefits, the United States has taken a free market approach[3]. As a result, as of 2001, 3 percent of European farmland was organically managed compared to just .3 percent of United States farmland (Lotter 2003:7). By 2005 Europe's organic land was 3.9 percent while the United States' had risen to 0.6 percent (IFOAM 2007:14-15).

IFOAM's The World of Organic Agriculture: Statistics and Emerging Trends 2007 lists the countries which added the most hectares and had the highest percentage growth in 2007 (IFOAM 2007:27-28). Among these, China is listed third in adding the most hectares behind the United States and Argentina. China jumped from approximately 300,000 hectares of organic land in 2005 to approximately 3.5 million hectares in 2006 -- an increase of over a thousand percent. This rise can be attributed to the certification of China's Organic Food Development Center in 2002 by IFOAM. The end of 2005 marks the end of the three-year transition period begun in 2002.
Australasia has 39% of the total organic farmland with Australia's 11.8 million hectares, but 97 percent of this land is sprawling rangeland (2007:35), which results in total sales of approximately 5% of US sales (2003:7). Europe has 23 percent of total organic farmland (6.9 million hectares), followed by Latin America with 19 percent (5.8 million hectares). Asia has 9.5 percent while North America has 7.2 percent. Africa has a mere 3 percent.

Besides Australia, the countries with the most organic area are Argentina (3.1 million hectares), China (2.3 million hectares), and the United States (1.6 million hectares). Much of Argentina's organic farmland is pasture, like that of Australia (2007:42). Italy, Spain, Germany, Brazil, Uruguay, and the UK follow the United States by the amount of land managed organically (2007:26).

As of 2001, the estimated total market value of certified organic products was estimated to be $20 billion. By 2002 this was $23 billion and by 2005 $33 billion, with Organic Monitor projecting sales of $40 billion in 2006 (IFOAM 2007:11). The change from 2001 to 2005 represents a compound growth of 10.6 percent.

Economic issues

The economics of organic farming, a subfield of agricultural economics, encompasses the entire process and effects of organic farming in terms of human society, including social costs, opportunity costs, unintended consequences, information asymmetries, and economies of scale. Although the scope of economics is broad, agricultural economics tends to focus on maximizing yields and efficiency at the farm level. Mainstream economics takes an anthropocentric approach to the value of the natural world: biodiversity, for example, is considered beneficial only to the extent that it is valued by people and increases profits. Some governments such as the European Union subsidize organic farming, in large part because of external benefits such as reduced water use, reduced water contamination by pesticides and nutrients of organic farming, reducedsoil erosion, reduced carbon emissions, and increased biodiversity.
Organic farming is labor and knowledge-intensive whereas conventional farming is capital-intensive, requiring more energy and manufactured inputs. Organic farmers in California have cited marketing as their greatest obstacle.

Productivity and profitability

A 2006 study suggests that converted organic farms have lower pre-harvest yields than their conventional counterparts in developed countries (92%) and that organic farms have higher pre-harvest yields than their low-intensity counterparts in developing countries (132%). The study attributes the disparity to a relative lack of expensive fertilizers and pesticides in the developing world compared to the intensive, subsidy-driven farming of the developed world.

This study incorporated a 1990 review of 205 crop comparisons which found that organic crops had 91% of conventional yields. A major US survey published in 2001, analyzed results from 150 growing seasons for various crops and concluded that organic yields were 95-100% of conventional yields.

Lotter (2003:10) reports that repeated studies have found that organic farms withstand severe weather conditions better than conventional farms, sometimes yielding 70-90% more than conventional farms during droughts. A 22-year farm trial study by Cornell University published in 2005 concluded that organic farming produces the same corn and soybean yields as conventional methods over the long-term averages, but consumed less energy and used zero pesticides. The results were attributed to lower yields in general but higher yields during drought years. A study of 1,804 organic farms in Central American hit by Hurricane Mitch in 1998 found that the organic farms sustained the damage much better, retaining 20 to 40% more topsoil and smaller economic losses at highly significant levels than their neighbors.

On the other hand, a prominent 21-year Swiss study found an average of 20% lower organic yields over conventional, along with 50% lower expenditure on fertilizer and energy, and 97% less pesticides. A long-term study by U.S Department of Agriculture Agricultural Research Service (ARS) scientists concluded that, contrary to widespread belief, organic farming can build up soil organic matter better than conventional no-till farming, which suggests long-term yield benefits from organic farming. An 18-year study of organic methods on nutrient-depleted soil concluded that conventional methods were superior for soil fertility and yield in a cold-temperate climate, arguing that much of the benefits from organic farming are derived from imported materials which could not be regarded as "self-sustaining".

While organic farms have lower yields, organic methods require no synthetic fertilizer and pesticides. The decreased cost on those inputs, along with the premiums which consumers pay for organic produce, create higher profits for organic farmers. Organic farms have been consistently found to be as or more profitable than conventional farms with premiums included, but without premiums profitability is mixed (Lotter 2003:11). Welsh (1999) reports that organic farmers are more profitable in the drier states of the United States, likely due to their superior drought performance.

Environmental issues

Agriculture in general imposes external costs upon society through pesticides, nutrient runoff, excessive water usage, and assorted other problems. As organic methods minimize some of these factors, organic farming is believed to impose fewer external costs upon society.

Pesticides

Due to the increased concern for the risk to human health, as well as the recent and ongoing development of pesticide resistance, need to reduce use of pesticides is well recognized but implementation for reduction and elimination of pesticide is technologically very difficult. Most organic farm producers use reduced pesticide claims but very few manage to eliminate the use of pesticide entirely.

While organic farming can, with extra cost, easily substitute chemical fertilizer with organic ones, finding an alternative method for eliminating weeds as well as insects which feast on crops is difficult. Pest resistant GM crops are an alternative to pesticide use, but one which is unacceptable to many in the organic farming movement.

One natural method to control pests is to introduce a natural predator in place of the pesticide, though this approach has various control issues. Another method is crop rotation, which restricts expansion of the insect population. For weed elimination, the traditional method is to remove weeds by hand, which is still practiced in developing countries by small scale farmers. However, this has proven too costly in developed countries where labor is more expensive. One recent innovation in rice farming is to introduce ducks and fish to wet paddy fields, which eat both weeds and insects.

Runoff

Pesticide runoff is one of the most significant effects of pesticide use. The USDA's Natural Resources Conservation Service tracks the environmental risk posed by pesticide water contamination from farms, and its conclusion has been that "the Nation's pesticide policies during the last twenty six years have succeeded in reducing overall environmental risk, in spite of slight increases in area planted and weight of pesticides applied. Nevertheless, there are still areas of the country where there is no evidence of progress, and areas where risk levels for protection of drinking water, fish, algae and crustaceans remain high".

Nutrient Leaching

Excess nutrient concentrations in lakes, rivers, and groundwater can cause algal blooms, eutrophication, and subsequent dead zones. In addition, nitrates are harmful to aquatic organisms by themselves. The main contributor to this pollution is nitrate fertilizers whose use is expected to "double or almost triple by 2050". Studies done by panels convened by the United States National Academy of Sciences found that that organically fertilizing fields "significantly [reduces] harmful nitrate leaching" over conventionally fertilized fields: "annual nitrate leaching was 4.4-5.6 times higher in conventional plots than organic plots".

Scientists believe that the large dead zone in the Gulf of Mexico is caused in large part by agricultural pollution: a combination of fertilizer runoff and livestock manure runoff. A study by the United States Geological Survey (USGS) found that over half of the nitrogen released into the Gulf comes from agriculture. The economic cost of this for fishermen may be large, as they must travel far from the coast to find fish.

At the 2000 IFOAM Conference, researchers presented a study of nitrogen leaching into the Danube River. They found that nitrogen runoff was substantially lower among organic farms and suggested that the external cost could be internalized by charging 1 euro per kg of nitrogen released.

A 2005 study published in Nature found a strong link between agricultural runoff and algae blooms in California.

Soil conservation

In *Dirt: The Erosion of Civilizations*, geomorphologist David Montgomery outlines a coming crisis from soil erosion. Agriculture relies on roughly one meter of topsoil, and that is being depleted ten times faster than it is being replaced. No-till farming, which some claim depends upon pesticides, is regarded as one way to minimize erosion. However, a recent study by the USDA's Agricultural Research Service has found that organic farming is even better at building up the soil than no-till.

Soil carbon and Climate Change

Agricultural production in most parts of the world will face less predictable weather conditions to those experienced during the intensification of agriculture over the last century. Intensive agriculture was, and remains, a short-sighted option. Organic agriculture is fast emerging as the only sustainable long-term approach to food production. Its emphasis on recycling techniques, biodiversity, low

external input and high level output strategies make it an ideal replacement for the petroleum intensive agricultural methods that are currently contributing to global warming. In *The Organic Answer to Climate Change*, Anthony Meleca explains that organic agriculture - with its emphasis on closed nutrient cycles, biodiversity, and effective soil management - has the capacity to mitigate and even reverse the effects of climate change.

Genetically modified organisms

A key characteristic of organic farming is rejection of genetically engineered products, including plants and animals. On October 19, 1998, participants at IFOAM's 12th Scientific Conference of IFOAM) issued the Mar del Plata Declaration, where more than 600 delegates from over 60 countries voted unanimously to exclude the use of genetically modified organisms in food production and agriculture. From this point, it became widely recognized that GMOs are categorically excluded from organic farming.

Despite this vehement opposition to use of any transgenic technologies in organic farming, such agricultural researchers as Luis Herrera-Estrella and Ariel Alvarez-Morales continue to advocate integration of transgenic technologies into organic farming as the optimal means to sustainable agriculture, particularly in the developing world. Similarly, some organic farmers question the rationale behind the ban on the use of genetically engineered seed because they see it a biological technology consistent with organic principles.

Although GMOs are excluded from use in organic farming, there is concern that the pollen from genetically modified crops is increasingly contaminating organic and heirloom genetics making it difficult, if not impossible, to keep these genetics from entering the organic food supply. International trade restrictions limit the availability GMOs to certain countries.

The actual dangers that genetic modification could pose to the environment or, supposedly, individual health, are hotly contended.

Food quality

Healthy soils equals healthy food equals healthy people is a basic tenet of many organic farming systems.

There is extensive scientific research being carried out in Switzerland at over 200 farms to determine differences in the quality of organic food products compared to conventional in addition to other tests. The FiBL Institute states that "organic products stand out as having higher levels of secondary plant compounds and vitamin C. In the case of milk and meat, the fatty acid profile is often better from a nutritional point of view. As far as carbohydrates and minerals, organic products are no different from conventional products. However, in regard to undesirables such as nitrate and pesticide residues, organic products have a clear advantage. A £12m EU-funded investigation into the difference between organic and ordinary farming has shown that organic foods have far more nutritional value. A recent study found that organically grown produce has double the flavonoids, an important antioxidant. A 2007 study found that organically grown kiwi fruits had more antioxidants than conventional kiwi.

A 2007 study found that consumption of organic milk is associated with a decrease in risk for eczema, although no comparable benefit was found for organic fruits, vegetables, or meat.

Health Risks

Organic farms use few pesticides, although they are allowed to use some natural ones. The main three are Bt, pyrethrum and rotenone. However, surveys have found that fewer than 10% of organic farmers use these pesticides regularly; one survey found that only 5.3% of vegetable growers in California use rotenone while 1.7% use pyrethrum (Lotter 2003:26). Nevertheless, rotenone has been linked to Parkinson's in rats and can be considered toxic to humans (Lotter 2003:26).

On the other hand, conventional farming uses large quantities of pesticides through techniques such as crop dusting. Studies have shown that people who work with pesticides have an increased risk of developing Parkinson's disease. The pesticides examined in these two long-term studies, paraquat and dieldrin, are not allowed on organic farms. The herbicide paraquat and fungicide maneb together, but not alone, have been shown to cause brain damage in mice.

Around 31,000 tonnes of pesticides are used in the UK every year, and 40% of fruit, vegetables, and bread sampled in the UK were found to have pesticide residues in 2004.

Children's health

Some parents are concerned about the potential neurological health risks posed to children by trace pesticide residues in food. A 2001 study demonstrated that children fed organic diets experienced significantly lower organophosphorus pesticide exposure than children fed conventional diets. A similar study in 2006 measured the levels of organophosphorus pesticide exposure in 23 preschool children before and after replacing their diet with organic food: levels of organophosphorus pesticide exposure dropped dramatically and immediately when the children switched to an organic diet. Although the researchers did not collect health outcome data in this study, they concluded "it is intuitive to assume that children whose diets consist of organic food items would have a lower probability of neurologic health risks."

Organic farming and associated biodiversity

Benefits to biodiversity

Nearly all non-crop, naturally-occurring species observed in comparative farm land practice studies show a preference in organic farming both by population and richness. Spanning all associated species, there is an average of 30% more on organic farms versus conventional farming methods. Birds, butterflies, soil microbes, beetles, earthworms, spiders, vegetation, and mammals are particularly affected. Organic crops use little or no herbicides and pesticides and thus biodiversity fitness and population density benefit. Many weed species attract beneficial insects that improve soil qualities and forage on weed pests. Soil-bound organisms often benefit because of increased bacteria populations due to natural fertilizer spread such as manure, while experiencing reduced intake of herbicides and pesticides commonly associated with conventional farming methods. Increased biodiversity, especially from soil microbes such as mycorhizzae, have been proposed as an explanation for the high yields experienced by some organic plots, especially in light of the differences seen in a 21-year comparison of organic and control fields.

Impact of increased biodiversity

The level of biodiversity that can be yielded from organic farming provides a natural capital to humans. Species found in most organic farms provides a means of agricultural sustainability by reducing amount of human input (e.g. fertilizers, pesticides). Farmers that produce with organic methods reduce risk of poor yields by promoting biodiversity. Common game birds such as the ring-necked pheasant and the northern bobwhite often reside in agriculture landscapes, and are a natural capital yielded from high demands of recreational hunting. Because bird species richness and population are typically higher on organic farm systems, promoting biodiversity can be seen as logical and economical.

Farmers' benefits from increased biodiversity

Biological research on soil and soil organisms has proven beneficial to the system of organic farming. Varieties of bacteria and fungi break down chemicals, plant matter and animal waste into productive soil nutrients. In turn, the producer benefits by healthier yields and more arable soil for future crops. Furthermore, a 21-year study was conducted testing the effects of organic soil matter and its relationship to soil quality and yield. Controls included actively managed soil with varying levels of manure, compared to a plot with no manure input. After the study commenced, there was significantly lower yields on the on the control plot when compared to the fields with manure. The concluded reason was an increased soil microbe community in the manure fields, providing a healthier, more arable soil system.

Capacity building

Organic Agriculture is a very knowledge intensive production system. Therefore capacity building efforts play a central role in this regard. There are many efforts all around the world regarding the development of training material and the organization of training courses related to Organic Agriculture. Big parts of existing knowledge is still scattered and not easy accessible. Especially in Developing Countries this situation remains an important constraint for the growth of the organic sector.

For that reason, the International Federation of Organic Agriculture Movements created an Internet Training Platform whose objective is to become the global reference point for Organic Agriculture training through free access to high quality training materials and training programs on Organic Agriculture. In November 2007, the Training Platform hosted more than 170 free manuals and 75 training opportunities.

Controversy

There are contentions that organic farming is unsustainable. One study from the Danish Environmental Protection Agency found that, area-for-area, organic farms of potatoes, sugar beet and seed grass produce as little as half the output of conventional farming. Findings like these, and the dependence of organic food on manure from low-yield cattle, has prompted criticism that organic farming is environmentally unsound and incapable of feeding the world population. Among these critics are Norman Borlaug, father of the "green revolution," and winner of the Nobel Peace Prize, who asserts that organic farming practices can at most feed 4 billion people, after expanding cropland dramatically and destroying ecosystems in the process. Yet, organic agriculture can reduce the level of negative externalities from (conventional) agriculture. Whether this is seen as private or public benefits depends upon the initial specification of property rights.

One study published in Renewable Agriculture and Food Systems argues that organic farming could produce enough food per capita to sustain the current human population; the difference in yields between organic and non-organic methods were small, with non-organic methods resulting in slightly higher yields in developed areas and organic methods resulting in slightly higher yields in developing areas.

Urs Niggli, director of the FiBL Institute contents that the wave of newpaper articles like 'Organic food exposed' or 'The hypocrisy of organic farmers' are a part of a global campaign against organic farming that take their arguments mostly from the book 'The truth about organic farming', by Alex Avery of the Hudson Institute.

In 1998, Dennis Avery of the Hudson Institute claimed the risk of E. coli infection was eight times higher when eating organic food rather than non-organic food, using the Center for Disease Control (CDC) as a source. When the CDC was contacted, it stated that there was no evidence for the claim. The New York Times commented on Avery's attacks: "The attack on organic food by a well-financed research organization suggests that, though organic food accounts for only 1 percent of food sales in the United States, the conventional food industry is worried."

In the UK, some of the debate has been summarized in an exchange between Prof A. Trewavas and Lord P. Melchett, and published by a major supermarket, concerned about examining the issues. Trewavas contests the notion that organic agricultural systems are more friendly to the environment and more sustainable than high-yielding farming systems.

Source:
http://www.eoearth.org/view/article/51cbee947896bb431f698db5/?topic=51cbfc79f702fc2ba8129ece