Organic farming

Organic farming is the form of agriculture that relies on techniques such as crop rotation, green manure, compost, biological pest control, and mechanical cultivation to maintain soil productivity and control pests on a farm. Organic farming excludes or strictly limits the use of synthetic fertilizers and synthetic pesticides, plant growth regulators, livestock antibiotics, food additives, and genetically modified organisms.\[1\]

Organic agricultural methods are internationally regulated and legally enforced by many nations, based in large part on the standards set by the International Federation of Organic Agriculture Movements (IFOCAM), 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..”

—International Federation of Organic Agriculture Movements\[2\]

Since 1990, the market for organic products has grown at a rapid pace, to reach $46 billion in 2007. This demand has driven a similar increase in organically managed farmland. Approximately 32.2 million hectares worldwide are now farmed organically, representing approximately 0.8 percent of total world farmland.\[3\] In addition, as of 2007 organic wild products are harvested on approximately 30 million hectares.\[4\]

History

The organic movement began in the 1930s and 1940s as a reaction to agriculture's growing reliance on synthetic fertilizers. Artificial fertilizers had been created 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. Similar advances occurred in chemical pesticides in the 1940s, leading to the decade being referred to as the 'pesticide era'.

Sir Albert Howard is widely considered to be the father of organic farming.\[5\] Further work was done by J.I. Rodale in the United States, Lady Eve Balfour in the United Kingdom, and many others across the world.

As a percentage of total agricultural output, organic farming has remained tiny since its beginning. As environmental awareness and concern increased amongst the general population, the originally supply-driven movement became demand-driven. Premium prices from consumers and in some cases government subsidies attracted many farmers into converting. In the developing world, many farmers farm according to traditional methods which are comparable to organic farming but are not certified. In other cases, farmers in the developing world have converted for economic reasons.\[6\] As a proportion of total global agricultural output, organic output remains small, but it has been growing rapidly in many countries, notably in Europe.
Methods

"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"

Soil management

Plants need nitrogen, phosphorus, and potassium, as well as micronutrients and symbiotic relationships with fungi and other organisms to flourish, but getting enough nitrogen, and particularly synchronization so that plants get enough nitrogen at the right time (when plants need it most), is likely the greatest challenge for organic farmers.\(^7\) Crop rotation and green manure ("cover crops") help to provide nitrogen through legumes (more precisely, the Fabaceae family) which fix nitrogen from the atmosphere through symbiosis with the bacteria rhizobia. Intercropping, which is sometimes used for insect and disease control, can also increase soil nutrients, but the competition between the legume and the crop can be problematic and wider spacing between crop rows is required.\(^7\) Crop residues can be ploughed back into the soil, and different plants leave different amounts of nitrogen, potentially aiding synchronization.\(^7\) Organic farmers also use animal manure, certain processed fertilizers such as seed meal and various mineral powders such as rock phosphate and greensand, a naturally occurring form of potash which provides potassium. Altogether these methods help to control erosion. In some cases pH may need to be amended. Natural pH amendments include lime and sulfur, but in the U.S. some synthetically compounds such as iron sulfate, aluminum sulfate, magnesium sulfate, and soluble boron products are allowed in organic farming.\(^8\) :43

Mixed farms with both livestock and crops can operate as ley farms, whereby the land gathers fertility through growing nitrogen-fixing forage grasses such as white clover or alfalfa and grows cash crops or cereals when fertility is established.\(^7\) Farms without livestock ("stockless") may find it more difficult to maintain fertility, and may rely more on external inputs such as imported manure as well as grain legumes and green manures, although grain legumes may fix limited nitrogen because they are harvested.\(^7\) Horticultural farms growing fruits and vegetables which operate in protected conditions are often even more reliant upon external inputs.\(^7\)

Weed control

After nutrient supply, weed control is the second priority for farmers.\(^8\) Techniques for controlling weeds have varying levels of effectiveness and include handweeding, mulch, corn gluten meal, a natural preemergence herbicide, flame, garlic and clove oil, borax, pelargonic acid, solarization (which involves spreading clear plastic across the ground in hot weather for 4–6 weeks), vinegar, and various other homemade remedies.\(^8\) :45-65 One recent innovation in rice farming is to introduce ducks and fish to wet paddy fields, which eat both weeds and insects.\(^9\)
Controlling other organisms

Organisms aside from weeds which cause problems include arthropods (e.g. insects, mites) and nematodes. Fungi and bacteria can cause disease.

Insect pests are a common problem, and insecticides, both non-organic and organic, are controversial due to their environmental and health effects. One way to manage insects is to ignore them and focus on plant health, since plants can survive the loss of about a third of leaf area before suffering severe growth consequences. To avoid using insecticides, one can select naturally resistant plants, put bags around the plants, remove dying material such as leaves, fruit, and diseased plants, covering plants with a solid barrier ("row cover"), hosing, encouraging and releasing beneficial organisms and beneficial insects, planting companion plants and polycultures, various traps, sticky cards (which can also be used to assess insect prevalence), and season extension. Biological pest control uses natural predators to control pests. Recommended beneficial insects include minute pirate bugs, big-eyed bugs, and to a lesser extent ladybugs (which tend to fly away), all of which eat a wide range of pests. Lacewings are also effective, but tend to fly away. Praying mantis tend to move slower and eat less heavily. Parasitoid wasps tend to be effective for their selected prey, but like all small insects can be less effective outdoors because the wind controls their movement. Predatory mites are effective for controlling mites.

Several of pesticides approved for organic use have been called green pesticides such as spinosad and neem. Generally, but not necessarily, organic pesticides are safer and more environmentally friendly than synthetic pesticides. The main organic insecticides used in the US are Bt (a bacterial toxin) and pyrethrum. 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). Rotenone used to be used by some organic growers in the US, however since 2005 it has not been approved by National Organic Program guidelines. Nicotine sulfate may also be used, although it breaks down quickly, it is extremely toxic, nearly as toxic as aldicarb. Less toxic but still effective organic insecticides include neem, spinosad, soaps, garlic, citrus oil, capsaicin (repellent), Bacillus popillae, Beauvaria bassiana, and boric acid. Pesticides should be rotated to minimize pest resistance.

The first disease control strategy involves keeping the area clean by removing diseased and dying plants and ensure that the plants are healthy by maintaining water and fertilization. Compost tea is sometimes promoted and can be effective, but there is concern over whether these are ineffective or even harmful when not made correctly. Polyculture and crop rotation reduce the ability of disease to spread. Disease-resistant cultivars can be purchased. Organic fungicides include the bacteria Bacillus subtilis, Bacillus pumilus, and Trichoderma harzianum which are mainly effective for diseases affecting roots. Bordeaux mixture contains copper, which can be used as an organic fungicide in various forms. Sulfur is effective against fungus as well as some insects. Lime sulfur is also available, but can damage plants if not used correctly. Potassium and sodium bicarbonate are also effective against fungus.

Standards

Standards regulate production methods and in some cases final output for organic agriculture. Standards may be voluntary or legislated. As early as the 1970s organic producers could be voluntarily certified by private associations. In the 1980s, governments began to produce organic production guidelines. Beginning in the 1990s, a trend toward legislation of standards began, most notably with the 1991 EU-Eco-regulation developed for European Union, which set standards for 12 countries, and a 1993 UK program. The EU’s program was followed by a Japan program in 2001, and in 2002 the United States created the National Organic Program (NOP). As of 2007 over 60 countries have regulations on organic farming (IFOAM 2007:11). In 2005 IFOAM created the Principles of Organic Agriculture, an international guideline for certification criteria. Typically the agencies do not certify individual farms, but rather accredit certification groups.

Materials used in organic production and foods are tested independently by the Organic Materials Review Institute.
Composting

Under USDA organic standards, manure must be subjected to proper thermophilic composting and allowed to reach a sterilizing temperature. If raw animal manure is used, 120 days must pass before the crop is harvested if the final product comes into direct contact with the soil. For products which do not come into direct contact with soil, 90 days must pass prior to harvest.[18]

Economics

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 these countries believe in the external benefits of reduced water use, reduced water contamination by pesticides and nutrients of organic farming, reduced soil erosion, reduced carbon emissions, increased biodiversity, and assorted other benefits.

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.[19]

Geographic producer distribution

The markets for organic products are strongest in North America and Europe, which as of 2001 are estimated to have $6 and $8 billion respectively of the $20 billion market (2003:6). However, as of 2007 organic farmland is distributed across the globe. 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. See also Organic farming by country.

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).

Growth

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 2007 more than $46 billion according to Organic Monitor (Willer/Kilcher 2009).

In recent years both Europe (2007: 7.8 million hectares/European Union: 7.2 million hectares) and North America (2007: 2.2 million hectares) have experienced strong growth in organic farmland. However, this growth has occurred under different conditions. While the European Union has shifted agricultural subsidies to organic farmers due to perceived environmental benefits, the United States has taken a free market approach.[20] Yet, the United States has not taken a free-market approach concerning the subsidizing of major commercial crops such as non-organic corn. As a result of this difference in policy between the US and EU, as of 2008 4.1 percent of the European Union’s farmland was organically managed compared to just 0.6 percent of United States farmland (Willer/Kilcher 2009). The growth of organic farmland area in the EU was 21% from 2005 to 2008 reaching a total of 7.8 million hectares [21].
IFOAM’s most recent edition of The World of Organic Agriculture: Statistics and Emerging Trends 2009 lists the countries which had the most hectares in 2007. The country with the most organic land is Australia with more than 12 million hectares, followed by Argentina, Brasil and the US. In total 32.2 million hectares were under organic management in 2007. For 1999 11 million hectares of organically managed land are reported (Willer/Kilcher 2009). In recent years organic agriculture has grown tremendously. Considering this rapid growth, it is within the nature of organic farming to keep it from becoming a large scale industrial business as conventional farming has become (Duram 183). Duram, Leslie. Good Growing. Santa Cruz: Bison Books, 2005.

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 researcher attributes this to a relative lack of expensive fertilizers and pesticides in the developing world compared to the intensive, subsidy-driven farming of the developed world. Nonetheless, the researcher purposely avoids making the claim that organic methods routinely outperform green-revolution (conventional) methods.[22] This study incorporated a 1990 review of 205 crop comparisons which found that organic crops had 91% of conventional yields.[23] 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.[24]

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.[25] A study of 1,804 organic farms in Central America 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.[26]

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.[27] 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.[28] 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".[29]

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.[30]

In 2008 the UN Environmental Programme (UNEP) and UN Conference on Trade and Development (UNCTAD) issued a report which stated that "organic agriculture can be more conducive to food security in Africa than most conventional production systems, and that it is more likely to be sustainable in the long-term".[31] The report assessed 114 projects in 24 African countries, finding that "yields had more than doubled where organic, or near-organic practices had been used" and that soil fertility and drought resistance improved.[32]
In 2009, a review concluded that organic production was more profitable in Wisconsin, when including price premiums.\(^{33}\)

**Macroeconomic impact**

Organic methods often require more labor,\(^{34}\) providing rural jobs but increasing costs to urban consumers.

**Motivations**

Agriculture in general imposes external costs upon society through pesticides, nutrient runoff, 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.\(^{35}\) A 2000 assessment of agriculture in the UK determined total external costs costs for 1996 of 2343 million British pounds or 208 pounds per hectare.\(^{36}\) A 2005 analysis of these costs in the USA concluded that cropland imposes approximately 5 to 16 billion dollars ($30 to $96 per hectare), while livestock production imposes 714 million dollars.\(^{37}\) Both studies concluded that more should be done to internalize external costs, and neither included subsidies in their analysis, but noted that subsidies also influence the cost of agriculture to society. Both focused on purely fiscal impacts. The 2000 review included reported pesticide poisonings but did not include speculative chronic effects of pesticides, and the 2004 review relied on a 1992 estimate of the total impact of pesticides.

**Pesticides**

Most organic farms use fewer pesticides than conventional farms, some pesticides damage the environment or with direct exposure human health. The main five pesticides used in organic farming are Bt (a bacterial toxin), pyrethrum, rotenone,\(^{38}\) copper and sulphur.\(^{39}\) Surveys have found that fewer than 10% of organic vegetable 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). Reduction and elimination of chemical pesticide use is technologically challenging.\(^{40}\) and organic pesticides are often used to complement other pest control strategies.

Pesticide runoff is one of the most significant effects of pesticide use. The USDA 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".\(^{41}\)

Pest resistant genetically modified crops are an alternative to pesticide use, however concerns over the safety and the long term benefits of genetically modified food, result in the genetic modification being widely opposed in the
organic farming movement.\[9\]

**Food quality and safety**

Organic food is widely believed by the public to be healthier than conventional food,\[42\] although the research is inconclusive.\[42\] Animals fed organic diets appear to have slightly better health and reproductive performance, but similar tests in humans have not been performed.\[42\] In some vegetables and cereals there is a lower concentration of protein, but it is of higher-quality. Nutrients appear to be similar with the exception of a trend towards slightly higher vitamin C in organic leafy vegetables and potatoes.\[42\]

Only tentative conclusions can be drawn on the relative safety of organic food. "Organic fruits and vegetables can be expected to contain fewer agrochemical residues than conventionally grown alternatives; yet, the significance of this difference is questionable."\[43\] Organic food also appears to have lower nitrate concentrations, but the health impact of nitrates is debated. Both organic and conventional food are expected to have similar concentrations of persistent organic pollutants and heavy metals. Data is limited on natural plant pesticides and their health effects, as well as the relative risks from bacterial pathogens.\[43\]

Concerns have been raised that the higher expense of organic food (ranging from 45 to 200%) could limit the recommended consumption of 5 servings per day of vegetables and fruits, which are known to improve health and reduce cancer regardless of whether they are organic or conventional.\[43\]

Two studies have found that children fed organic diets experienced significantly lower organophosphorus pesticide exposure than children fed conventional diets.\[44\]\[45\] 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". A 2010 study associated these pesticides with an increased risk for ADHD. 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.\[46\]

Extensive scientific research is 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 has been investigating the differences at over 200 farms. It 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 published in 2007 found that organic foods have more nutritional value.\[47\] A recent study found that organically grown produce has double the flavonoids, an important antioxidant.\[48\] . A 2007 study found that organically grown kiwifruit had more antioxidants than conventional kiwifruit.\[49\]

**Clothing quality and safety**

Recently, organic clothing has become widely available, due to both ecological concerns and personal health concerns. Although many consumers of organic clothing merely have a dislike of synthetic chemicals, a significant portion of the organic clothing market comes from those suffering from Multiple Chemical Sensitivity, a chronic medical condition characterized by symptoms that the affected person says are adverse effects from exposure to low levels of chemicals.

Ecological concerns primarily focus around pesticide use, as 16% of the world's pesticides are used in the production of cotton.\[50\]
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 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.

Although opposition to the use of any transgenic technologies in organic farming is strong, agricultural researchers 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. See GM food controversy.

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 manure applications in organic farming are better at building up the soil than no-till despite tillage.

Climate change

In The Organic Answer to Climate Change, Anthony Meleca argues 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.

According to the Rodale Institute, which has been comparing organic agricultural systems and conventional systems since 1981, organic agriculture also can be used to mitigate global warming by decreasing fossil fuel emissions and sequestering carbon in the soil. The elimination of synthetic nitrogen in organic systems decreases fossil fuel consumption by 33 percent (LaSalle) and carbon sequestration takes CO$_2$ out of the atmosphere by putting it in the soil in the form of organic matter which is often lost in conventionally managed soils. Carbon sequestration occurs at especially high levels in organic no-till managed soil according to the Rodale Institute.

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. However, it is clear that agriculture has been undervalued and underestimated as a means to combat global climate change. Soil carbon data recorded by The Rodale Institute show that regenerative organic agricultural practices are among the most effective strategies for mitigating CO$_2$ emissions.
Nutrient leaching

Excess nutrients 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".\(^{[59]}\) Researchers at the United States National Academy of Sciences found 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".\(^{[60]}\)

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.\(^{[61]}\)

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.\(^{[62]}\)

A 2005 study found a strong link between agricultural runoff and algae blooms in California.\(^{[63]}\)

Biodiversity

A wide range of organisms benefit from organic farming, but it is unclear whether organic methods confer greater benefits than integrated agri-environmental conventional programs.\(^{[64]}\) 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.\(^{[65]}\)\(^{[66]}\) Spanning all associated species, there is an average of 30% more on organic farms versus conventional farming methods.\(^{[67]}\) 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.\(^{[66]}\) Many weed species attract beneficial insects that improve soil qualities and forage on weed pests.\(^{[69]}\) 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.\(^{[65]}\) Increased biodiversity, especially from soil microbes such as mycorhizae, 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.\(^{[70]}\) 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)\(^{[71]}\). 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.

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.\(^{[72]}\) 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 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.\(^{[70]}\)
Sales and marketing

Organic farmers report that marketing and distribution are difficult obstacles. Most of organic sales are concentrated in developed nations. These products are what economists call credence goods in that they rely on uncertain certification. As food prices rise, organic products may experience a decrease in quantity demanded. A 2008 survey by WSL Strategic Retail found that interest in organic products had dropped since 2006, and that 42% of Americans polled don't trust organic produce. The Hartman Group reports that 69% of Americans claim to occasionally buy organic products, down from 73% in 2005. The Hartman Group says that people may be substituting local produce for organic produce.[73]

Distributors

In the United States, 75% of organic farms are smaller than 2.5 hectares and in California 2% of the farms account for over half of the sales (Lotter 2003:4). Groups of small farms join together in cooperatives such as Organic Valley, Inc. to market their goods more effectively.

Over the past twenty years, however, most of these cooperative distributors have merged or been bought out. Rural sociologist Philip H. Howard has researched the structure and transformation of the organic industry in the United States. He claims that in 1982 there were 28 consumer cooperative distributors but as of 2007 there are only 3, and he has created a graphic displaying the consolidation.[74] His research shows that most of these small cooperatives have been absorbed into large multinational corporations such as General Mills, Heinz, ConAgra, Kellogg, and assorted other brands. This consolidation has raised concerns among consumers and journalists of potential fraud and degradation in standards. Most of these large corporations sell their organic products through subsidiaries, allowing them to keep their names off the labels.[75]

Farmers' markets

Price premiums are important for the profitability of small organic farmers, and so many sell directly to consumers in farmers' markets. In the United States the number of farmers' markets has tripled from 1,755 in 1994 to 5,274 in 2009.[76]

Capacity building

Organic agriculture can contribute to meaningful socio-economic and ecologically sustainable development, especially in poorer countries.[77] On one hand, this is due to the application of organic principles, which means efficient management of local resources (e.g. local seed varieties, manure, etc.) and therefore cost-effectiveness. On the other hand, the market for organic products — at local and international level — has tremendous growth prospects and offers creative producers and exporters in the South excellent opportunities to improve their income and living conditions.

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 easily 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

A number of critics contest the notion that organic agricultural systems are more friendly to the environment and more sustainable than high-yielding farming systems. Among these critics are Norman Borlaug, father of the "green revolution", Nobel Peace Prize laureate, who asserts that organic farming practices can at most feed 4 billion people, after expanding cropland dramatically and destroying ecosystems in the process[78], and Prof A. Trewavas.[79]

The debate has been summarized in an exchange between Trewavas and Lord P. Melchett, and published by a major supermarket[80], concerned about examining the issues.

A study from the Danish Environmental Protection Agency assessed the overall consequences of phasing out the total or partial use of pesticides. They looked at farming, market gardening, fruit growing, and forestry, and the effects of pesticides on health and the environment. It was estimated that phasing out all pesticides would result in an overall reduction of yield of about 25%. Environmental and health effects were assumed but hard to access, studies were recommended. In their conclusion they said, " The Committee recommends a reduction of the use of pesticides. The Committee finds that the optimisation of pesticide use could facilitate a reduction of treatment frequency in the treated areas of agriculture...without significant operating and socioeconomic losses."[81]

In 2008 a study from UN Environmental Programme concluded that organic methods greatly increase yields in Africa and[31] a review of over two hundred crop comparisons argued 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.[22]

That analysis has been severely criticised by Alex Avery, who contends that the review claimed many non-organic studies to be organic, misreported organic yields, made false comparisons between yields of organic and non-organic studies which were not comparable, counted high organic yields several times by citing different papers which referenced the same data, and gave equal weight to studies from sources which were not impartial and rigorous university studies[82].

Urs Niggli, director of the FiBL Institute contends that the wave of newspaper articles like 'Organic food exposed' or 'The hypocrisy of organic farmers'[83] 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.[84]

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.[84][85]

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."[86]

See also

- Agroecology
- Biodynamic agriculture
- Certified Naturally Grown
- Industrial agriculture
- List of organic gardening and farming topics
- Motivations for organic agriculture
- Organic clothing
- Organic food
- Organic movement
- Permaculture
Organic farming

- Seasonal food
- Sustainable agriculture
- Wildculture
- Organic Farming Digest
- Australian Organic Farming and Gardening Society
- WWOOF
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References

Further reading


External links

- Organic Farming [95] at the Open Directory Project
- Organic Eprints [96] Database of organic agriculture research papers
- Organic Farming - European Commission [97]
- Food and Agriculture Organization of the United Nations' Organic Agriculture Program [98]
- Organic Production and Organic Food: Information Access Tools. [99] Identifies sources to research on organic agriculture topics from the Alternative Farming Systems Information Center, National Agricultural Library.
- Organic Agriculture Information from the eOrganic Community of Practice with eXtension - Information from America's Land Grant University System and Partners
- List of Organic Farming related Organizations on WiserEarth [101]
- Importance of Organic Farming in Terms of Food Safety [102] A featured article on Agriculture Guide
- Organic farming can feed the world, U-M study shows [103], University of Michigan, 2007

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