Organic Farming

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Glossary

CMS Cytoplasmic male sterility

Roughage Fresh or processed grass, leaves, stems and similar coarse materials with relatively high amount of indigestible material. Roughage contributes to a healthy intestinal flora and gives a prolonged satiety as well as green materials adds to a healthier composition of fatty acids in dairy products, eggs and meat.

Introduction

Organic farming is an agricultural production form which has become increasingly important globally, due to a series of challenges and problems caused by traditional, industrialized agriculture. This concerns contamination of soils, drinking water and surface water; erosion and depletion of soils; an intensive industrialized animal production where animals have no access to outdoor areas, which puts pressure on animal welfare; degradation of nature and decreasing biodiversity; social poverty and cultural impoverishment.

The organic production and the organic commodities that the production supplies the consumer market with continuously develops, consistent with a continuous build up and exchange of knowledge in parallel to an increasing acknowledgement of this type of agriculture by authorities and decision makers as a multi-functional tool to achieve improvements of society. Organic production deviates from conventional farming by being based on local fertility of soils, recirculation of resources, high diversity in crops, consideration for the surrounding nature, more space and access to outdoor areas for animals as well as prevention rather than treatment.

Definitions

In 2005 the international organization of organic farmers, the International Federation of Organic Agriculture Movements (IFOAM) adopted the following definition of organic farming:

> 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 (ifoam.bio, n.d.-a).

Organic farming is a production form that aims at exploiting soils and keeping livestock in a more sustainable manner than intensive, conventional farming, which is characteristic for modern industrialized agricultural production. The notion of organic farming seriously spread through Europe and the USA in the 1970s and 1980s as a reaction to agricultural environmental problems—problems which became apparent during this period and which were often debated publicly. Meanwhile, the origin of the idea of organic farming is much older.

Depending on language and nation, various terms are used to describe organic products, for instance, organic, ecological and biological/biologique. At the same time, the terms do have ordinary, semantic connotations—organic refers to the living; ecology is the scientific wording for the studies dealing with the household of nature, that is, the description of interactions among living organisms and their ambient environment; and biology deals with the learning and teachings about the living.

This concurrent set of meanings may lead to unclear perceptions concerning aspects of production, the origin of food items and their quality.

The terms mentioned above are protected terms regarding food within the European Union (EU) and are reserved products that meet the standard of certified organic production (europa.eu, n.d.).

In addition to this, the term agro-ecology is used about environmentally friendly and sustainable production forms in developing countries where production is not necessarily certified, for instance, due to lack of infrastructure.

History

Today organic farming is connected to a set of production standards, certification, labelling and branding with relations to a market economy. Meanwhile, the off-set to the idea is different, as the pioneers at the beginning of the 20th century saw the

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establishing of a good and fertile soil as a proper response to poverty and low yields in agriculture. Other aspects were respects for traditions, life forms and social wellbeing, that some already considered to be threatened by the process of industrialization.

Experiments with new techniques capable of increasing soil fertility were initiated all over the world. Sir Albert Howard attracted some attention by introducing ways of composting, and in 1924 Rudolf Steiner gave his famous speeches on agriculture (Steiner, 1924) and founded the biodynamic movement and praxis, which developed throughout the 1930s and gained some popularity. At the same time agriculture in general took a different turn, due to the chemist Justus von Liebig's theories on specific minerals as nutrients of plants. With this knowledge and recognition followed the development and use of artificial fertilizers, that after the Second World War took over as a prevailing paradigm.

Biodynamic agriculture represented the holistic approach to farming, until the idea of organic farming gained support in the 1970s in line with an increasing environmental awareness in society among—among other things triggered by the consequences of environmental pollution due to agricultural activities.

As opposed to biodynamic farming, organic farming takes science as its starting point, and organic farmers and their organizations worldwide seek from the very beginning to establish a foundation of practice based on experiments, tests and exchange of knowledge. The first experimental evidence and comparisons between organic and conventional farming methods were described in "The Living Soil" authored by Lady Eve Balfours. It formed the basis of the Soil Association in the UK as early as in 1946. Soil Association served as inspiration to grassroots all over the world. The purpose of the organization was to work for soil fertility, animal welfare, nutritious food products and farming which does not have a negative influence on the surrounding environment (soilassociation, n.d.).

It is the Soil Association which in 1972 takes the initiative to form the International Federation of Organic Agricultural Movements, IFOAM. Thereby, a formal cooperation among organic grassroot movements and NGOs all over the world is established. Today, IFOAM facilitates knowledge exchange, is responsible for international conferences and formulates the basic principles of organic farming.

Standards and regulations are based on these principles and have developed along with the development and establishing of real market for organic food products.

Four Governing Principles

Organic farming is based on four governing principles described and adopted by IFOAM, the international umbrella organization that organic movements worldwide are members of (ifoam.bio, n.d.-b). The principles deal with a set of overall ethical principles which are meant to serve as inspiration to implementation of concrete action locally and regionally. The four principles are:

Health

Organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and indivisible.

This principle points out that the health of individuals and communities cannot be separated from the health of ecosystems—healthy soils produce healthy crops that foster the health of animals and people.

Health is the wholeness and integrity of living systems. It is not simply the absence of illness, but the maintenance of physical, mental, social and ecological well-being. Immunity, resilience and regeneration are key characteristics of health.

The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organisms from the smallest in the soil to human beings. In particular, organic agriculture is intended to produce high quality, nutritious food that contributes to preventive health care and well-being. In view of this it should avoid the use of fertilizers, pesticides, animal drugs and food additives that may have adverse health effects.

Ecology

Organic agriculture should be based on living ecological systems and cycles, work with them, emulate them and help sustain them.

This principle roots organic agriculture within living ecological systems. It states that production is to be based on ecological processes, and recycling. Nourishment and well-being are achieved through the ecology of the specific production environment. For example, in the case of crops this is the living soil; for animals, it is the farm ecosystem; for fish and marine organisms, the aquatic environment.

Organic farming, pastoral and wild harvest systems should fit the cycles and ecological balances in nature. These cycles are universal but their operation is site-specific. Organic management must be adapted to local conditions, ecology, culture, and scale. Inputs should be reduced by reuse, recycling and efficient management of materials and energy in order to maintain and improve environmental quality and conserve resources.

Organic agriculture should attain ecological balance through the design of farming systems, establishment of habitats and maintenance of genetic and agricultural diversity. Those who produce, process, trade, or consume organic products should protect and benefit the common environment including landscapes, climate, habitats, biodiversity, air, and water.

Fairness

Organic agriculture should build on relationships that ensure fairness with regards to the common environment and life opportunities.

Fairness is characterized by equity, respect, justice and stewardship of the shared world, both among people and in their relations to other living beings.

This principle emphasizes that those involved in organic agriculture should conduct human relationships in a manner that ensures fairness at all levels and to all parties—farmers, workers, processors, distributors, traders, and consumers. Organic agriculture should provide everyone involved with a good quality of life, and contribute to food sovereignty and reduction of poverty. It aims to produce a sufficient supply of good quality food and other products.

This principle insists that animals should be provided with the conditions and opportunities of life that accord with their physiology, natural behavior and well-being.

Natural and environmental resources that are used for production and consumption should be managed in a way that is socially and ecologically just and should be held in trust for future generations. Fairness requires systems of production, distribution and trade that are open and equitable and account for real environmental and social costs.

Care

Organic agriculture should be managed in a precautionary and responsible manner to protect the health and well-being of current and future generations and the environment.

Organic agriculture is a living and dynamic system that responds to internal and external demands and conditions.

Practitioners of organic agriculture can enhance efficiency and increase productivity, but this should not be at the risk of jeopardizing health and well-being. Consequently, new technologies need to be assessed and existing methods reviewed. Given the incomplete understanding of ecosystems and agriculture, care must be taken.

This principle states that precaution and responsibility are the key concerns in management, development and technology choices in organic agriculture.

Science is necessary to ensure that organic agriculture is healthy, safe and ecologically sound. However, scientific knowledge alone is not sufficient. Practical experience, accumulated wisdom and traditional and indigenous knowledge offer valid solutions, tested by time.

Organic agriculture should prevent significant risks by adopting appropriate technologies and rejecting unpredictable ones, such as genetic engineering. Decisions should reflect the values and needs of all who might be affected, through transparent and participatory processes.

Organic Farming Management

When it comes to practical implementation of the principles of organic farming one will notice differences between countries and regions as well as among farmers. Often a common set of standards has been adopted which sets the standard for the practice of producers and production methods.

Guide to Best Practise

IFOAM has developed a guide "Best Practise Guideline for Agriculture and Value Chains," which sets the direction for formulation of specific standards for organic farming management. The guide contains examples of organic farming management of soil and water resources, husbandry, nature values and genetic diversity (ifoam.bio, n.d.-c) (**Table 1**).

Plant Production

In brief, plant production in an organic farming system deviates from that of conventional farming by the absence of mineral fertilizer, pesticides and genetically modified crops. As an alternative, organic farmers use organic fertilizers and leftovers from livestock and plants. Weeds, pests, and diseases are reduced by crop rotation, mechanical weeding and the establishing of biotopes with higher species diversity and adequate living space for beneficials.

Meanwhile, we are not dealing with absolutes. Certain mineral fertilizers are still allowed in case of risk of severe crop damage. The same applies to pesticides based on naturally occurring compounds such as plant extracts. In some regions compounds that are known to have damaging effects on environment are still in use as an exception, for instance, copper against fungal diseases in fruits and wine. There is, however, a mutual understanding that such substances should be phased out. In addition, the ban against the use of genetically modified crops is continuously challenged by technological achievements in plant breeding. In practice, it has been shown that it is difficult to define whether modern technology can be identified as genetical modification or not. CMS hybrid seed production is an example of such technologies.

Table 1 Best practise guideline for agriculture and value chains, selected examples

Soil and fertility
- Soil is protected from loss due to erosion and exposure to the elements. Soil is kept covered by living plants and mulch
- Organic matter content is increased. Farmers enhance biological activity of the soil and are careful with heavy equipment
- Perennials and agroforestry are promoted
- Farms obtain their soil fertility primarily from the farm itself due to crop rotation, recycling of plant residues, nitrogen-fixing species, cover crops and manure
- Manure from intensive conventional animal production is not used
- Farmers rely on crop rotation, natural enemies and biodiversity management to control pests, diseases and weeds
- Synthetic and toxic pesticides are avoided

Biodiversity
- Not all land on any given holding is used for production. At least some is set aside for biodiversity habitat
- Farmers maintain or re-establish natural vegetation areas around springs, along natural watercourses, on steep slopes and other sensitive parts of the ecosystem. Natural wetlands should not be drained
- Avoidance of mono-cropped areas
- Farmers choose varieties that can be multiplied on the farm and avoid varieties and breeds, that rely on a continued use of high levels of off-farm inputs
- Organic farmers choose organically grown seeds when possible. GMO breeds are not used
- Farmers raise animal breeds, that reproduce naturally and give birth without routine human intervention

Animal husbandry
- Farmers raise no more animals than can be carried by the land itself and takes into consideration the potential impact on pollution, non-renewably energy use, greenhouse gas emissions and nutritional profile of the animal products
- Feed is all organic
- Farmers provide animals with their most natural diet. A diversity of feeds and forage types is desirable
- Farmers create an environment where animals can access their food as much as possible in the field, e.g., through grazing or foraging for insects and worms
- Ideally, feed is grown on the farm itself or on closest possible farms and grasslands
- Animals are allowed to express their natural behaviors, they have access to outdoors, pasture and shelters if needed
- Animals are protected against stress. They are grouped and managed in a way, that keep them from harming each other
- Avoidance of mutilation
- Livestock health are maintained through proper diets and living conditions. Natural remedies are used before synthetic materials, if treatment is necessary

Atmosphere and energy
- Farmers optimize use of trees, permanent pastures and perennials to sequester carbon and reduce greenhouse gas emissions
- Farmers optimize manure use and slurry storage, application method and timing to prevent losses of methane and nitrous oxide
- All operations work to minimize carbon emissions from internal combustion engines and strive to increase energy efficiency and reduce dependence on non-renewable sources of energy

A relevant and ongoing discussion is for how many generations organic farming must be practised for the crops produced to be organic and certified as such. Would it be sufficient that the seeds used for sowing are derived from organically produced plants or should the parental generations to these plants also be produced according to organic standards? Today organic farmers do only to a certain extent have access to organic seeds in the market. Due to increased research efforts, knowledge distribution and growth in organic area and number of producers a gradual development towards increasing integrity in organic farming is generally observed. This will eventually apply to plant breeding and propagation too. Meanwhile, it has been shown to be difficult to keep plant material healthy and disease free when producing organically over generations.

Actual breed of varieties adapted to organic farming exists but is still not wide spread, primarily because the market for organically grown seeds is economically uninteresting to multinational companies working on plant breeding. Some organic farmers and organizations do work on locally adapted varieties and farm based breeding.

Nature and biodiversity

Organic farming affects soil, water, flora and fauna on and in soil surface in the cultivated areas as well as surrounding non-cultivated areas. Organic farmers are committed to consider their agricultural system as part of a larger ecosystem, and they must protect, restore or remediate natural elements on the farm. Organic farming has positive effects on nature and uncultivated areas close to the farms. It has been observed that organically grown fields and nearby biotopes contain 30% more plant and animal species than conventionally managed fields and their surroundings. This also applies to soil living organisms such as earthworms. The reason for difference is first and foremost the absence of chemical pesticides, but the use of organic manure and compost as well as a more diverse composition of crops—including perennial species—also play a significant role (Bengtsson *et al.*, 2005; Hole *et al.*, 2005).

Table 2 Five freedoms

- Freedom from hunger and thirst; by ready access to water and a diet to maintain health and vigor
- Freedom from discomfort; by providing an appropriate environment
- Freedom from pain, injury and disease; by prevention or rapid diagnosis and treatment
- Freedom to express normal behavior; by providing sufficient space, proper facilities and appropriate company of the animal's own kind
- Freedom from fear and distress; by ensuring conditions and treatment, which avoid mental suffering

Livestock Production

Organic livestock production is characterized by an ambition to offer production animals living conditions that meet their specific requirements and need to express normal behaviour in a system that supports health and a minimum need of medical interference.

Animal welfare

Animal welfare is central to the practice of organic livestock production. Animal welfare can be described as particular considerations to animals for their own sake. Animal welfare is difficult to measure. A common approach used is to define welfare in accordance with what the animals are free to do, and what they are free from. A definition based on such a view may be found in "the five freedoms" presented by the Farm Animal Welfare Committee, UK (gov.uk, n.d.) (**Table 2**).

Regarding animal welfare, free access to outdoor facilities for all animal groups for their entire life or at least part of it is central to organic livestock production. For cattle, an example might be access to pasture. For pigs and poultry, it might be access to express natural foraging activities such as digging and scraping in soils. The standard that animals must have access to outdoor areas is a simple standard, which contributes to ensure several of the freedoms mentioned above to individuals as well as to groups. Plenty of space and freedom to move around also allow the animals to express social behavior, forage and take care of their plumage and brood. Meanwhile, outdoor access does not solve all welfare related problems. It can be dangerous to be a chicken or a new born piglet in outdoor managed systems where they are exposed to attacks by predators. Access to a natural life does not necessarily correspond to good animal welfare. Nature is not considerate and just. Consideration of the natural behaviour of animals must therefore be matched against the protection that any animal keeper is obliged to exhibit. In free production systems surveillance and intervention is more difficult, and may consequently lead to increased mortality of piglets, calves and laying hens.

In an organic farming perspective animal welfare includes a divers and most natural diet. Therefore, it is mandatory that all animals—not only ruminants—are given roughage like clover grass and other green feeds. The diet for organic cattle is typically based on grass, whereas conventional diets are based on maize, corn, and waste products.

Clover grass and similar fodder are natural food sources of cattle, but also pigs and poultry may benefit from roughage. Roughage promotes a healthy intestinal flora and makes the animals feel full longer than corn and concentrates rich in energy would. In addition, it provides activity and can prevents stress and fights in a herd.

Animal health—prevention and treatment of diseases

The health of organic livestock is attempted to be maintained through fodder, access to the outdoor and the connected possibility to move, as well as attention to the overall surroundings in general. At the same time, organic livestock may be less productive, grow slower, give less milk etc. Hence illness is in general less abundant as in intensive, indoor, stable-based production systems.

Resistance and risks of infection

A significant societal impact of the organic production system is a noteworthy lower use of antibiotics in organic livestock. The use of antibiotics in the industrialized livestock production—curative as well as preventive/growth enhancing—leads to development of bacteria resistant to antibiotics, which poses a threat to public health. FAO/UN has adopted an action plan seeking to avoid antimicrobial resistance (FAO, n.d.).

Methicillin-resistant *Staphylococcus aureus* (MRSA) and Salmonella sp. infections are present in organic livestock production systems, but to a much lower extent than in conventional systems. A Danish investigation carried out in 2016 demonstrated MRSA to be present in 6% of organic pig herds as compared to 70%–80% of conventional pig herds. This despite the fact, that organic livestock brings in conventional animals for breeding purposes. A European research project on antibiotic resistance concludes that resistance is common among organic slaughter pigs, but occurs on significantly lower levels than is the case with conventional slaughter pigs (Aabo, 2014).

It may be difficult to point out causal relations, but an explanation might be that access to fresh air, space and roughage prevent the resistant bacteria from surviving and multiplying.

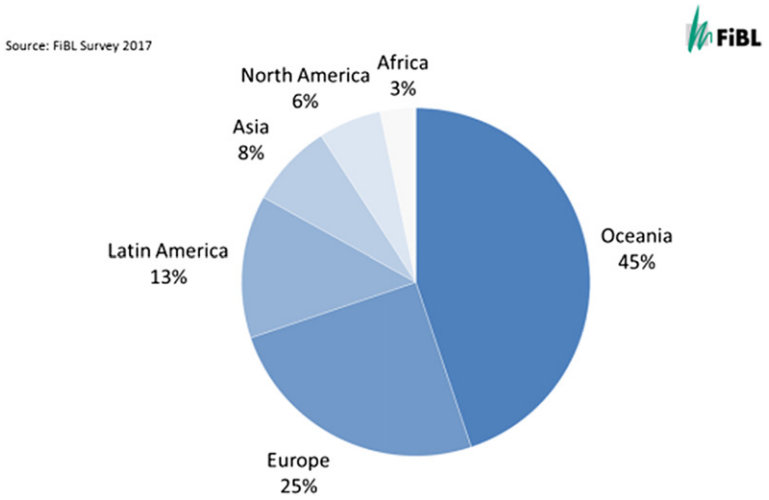

Fig. 1 Distribution of organic agricultural land by region 2015.

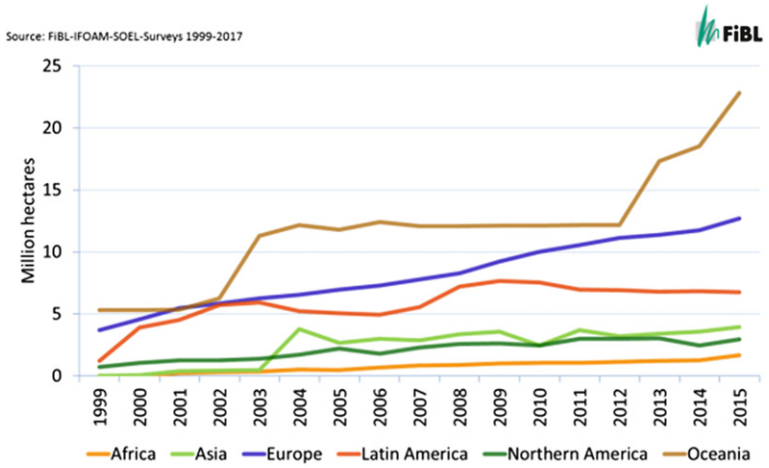

Fig. 2 Growth of the organic agricultural land by continent 1999–2015.

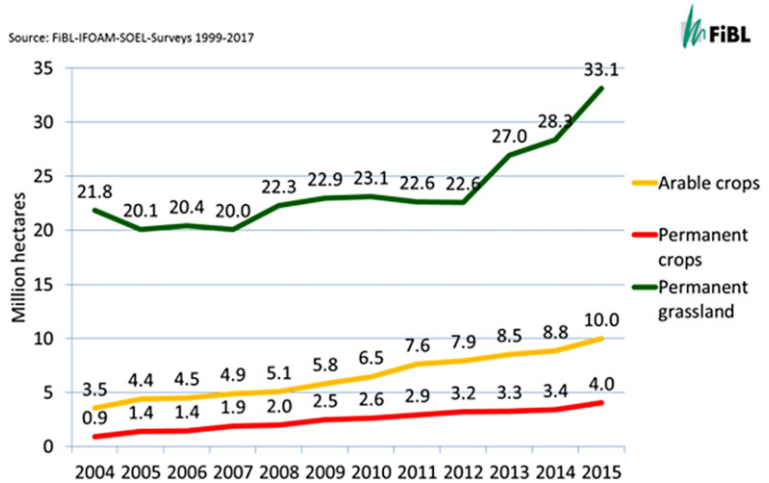

Fig. 3 Development of the organic land by land use type 2004–2015.

Global Organic Farming

Organic Farming in the Industrialized Part of the World

The market for organically grown products is particularly well developed in industrialized countries such as the United States and Europe, where purchasing power and willingness to pay for food free from pesticides and with high standard of animal welfare exists and is relatively high. Here one may find a wide spread environmental consciousness as well as a production and processing apparatus that is heavily regulated and authorized through legislation or standards and certification set by private organizations.

Organic farms in this part of the world are characterized by yields which are 20%–30% lower than yields obtained by normal conventional agriculture (de Ponti *et al.*, 2012). The reason for this is primarily the absence of artificial fertilizers and pesticides.

The explanation for the lower yield is the fact that the soil potentials for production are almost fully exploited. When the use of artificial fertilizers, pesticides, GMO etc. are left out, the result will be a decrease in yields as crop rotation and natural enemies are not efficient to compensate. However, organic farming could on a longer time scale contribute to a significant carbon sequestration in soils, increased species diversity, more pollinators and similar effects which gives benefit to society. Such effects are not measurable on a short time scale.

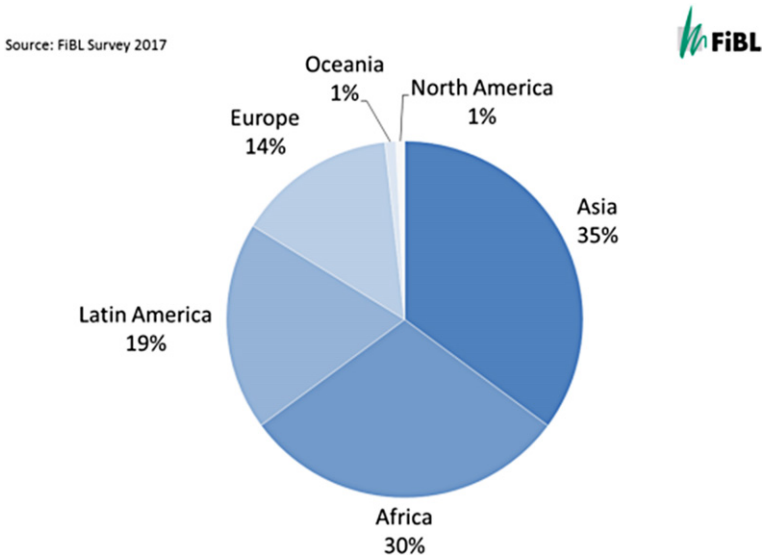

Fig. 4 Distribution of organic producers by region 2015.

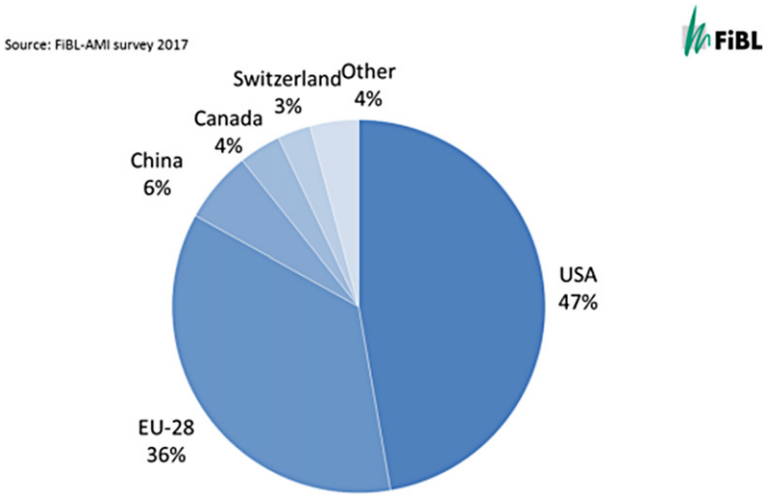

Fig. 5 Distribution of retail sales by single market 2015.

Organic Farming in Developing Countries

While organic farming in western intensive agricultural system are characterized by a production yield being approx. 20% lower, organic farming at small farm scale in developing countries hold the potential to increase yields and stabilize economy. A UN-report from 2008 based on the examination of 114 African studies concludes that organic farming gives double the yield as conventional farming (UNEP-UNCTAD, n.d.). Other studies showed more diverse results, but all in all there seems to be a potential for yield growth by implementing organic farming methods.

The explanation of the difference is that the yield potential in intensive agricultural systems at present seems to have been exploited to a maximum level. This is far from being the case in extensive farming systems. The use of rotation crops, agroforestry and soil amendment using organic compost as fertilizer etc. contribute to an increased production per area unit.

Likewise, the use of artificial fertilizers and pesticides would possibly contribute to an increasing yield, but to many small-scale farmers such aids are out of reach as they require capital and thereby poses an increased risk in an environment that is already threatened by climate changes, draught, flooding, erosion, etc. Agricultural methods based on organic farming principles on the other hand makes the soil and crops more resilient with regards to such threats. At the same time, organic farming serves to stabilize yields, which is often more important to the family farmers than a potential but risky increase.

Organic or agro-ecological methods

Organic farming in developing countries is not necessarily certified. Certification connects to a market and trade with goods. For most small-scale farmers certification is not a crucial issue. Meanwhile, the implementation of organic farming principles can bring small scale farmers in a situation where they produce a surplus of food which makes access to a market a relevant issue.

An increasing middle class in the larger cities of developing countries demonstrates an increasing concern about food safety which leads to an increasing demand of organically grown food products without pesticides. Meanwhile, this market is still inaccessible to many small-scale farmers and excess production is sold at the local markets without certification. When a farmer uses techniques of cultivation based on organic farming principles but does not meet the demands of certified production one may say the food item is produced by agro-ecological methods.

Organic Farming and the SDG's of United Nations

In 2015 The United Nation (UN) adopted 17 Sustainable Development Goals for achieving a sustainable world (SDG's). The SDG's outlines the direction for national and international strategies of development and points out targets to achieve the goals towards 2030 (un.org, n.d.).

The principles of organic farming in many ways comply with the SDG's and offers solutions that can be achieved within several goals. This is particularly valid to the sustainable use of resources, improvements of health and the fight against pollution. According to Food and Agricultural Organization (FAO) of the United Nations, it is possible to improve food safety, local rural development, and sustainable living and environmental protection by implementing agricultural farming and through capacity building (fao.org, n.d.) (**Figs. 1–5**).

Growth and Extension of Organic Farming

Organic farming is growing on a global level. This applies to cultivated areas, the number of organic farmers and turnover expressed in market share as well as actual value (Willer & Lernoud, 2017) (**Table 3**).

Table 3 17 sustainable development goals—goals where organic farming may play a particularly important role and offer relevant solutions are in bold (by author)

End poverty
End hunger
Improved health and wellbeing
Ensuring quality and access to education
Gender equality
Ensuring clean water and sanitation
Ensuring access to energy
Decent jobs and economic growth
Industrial innovation and infrastructure
Reduce inequality
Sustainable cities and communities
Responsible consumption and production
Climate action
Sustainable use of the oceans and marine resources
Sustainable use of terrestrial ecosystems
Peace, justice and strong institutions
Partnerships for the goals

Area and Area Use

50.9 millions hectares are managed organically, which corresponds to 1.1% of the globally cultivated areas. In addition, 39.7 millions hectares are non-cultivated organic areas for production of honey, collection of raw materials, forests, etc. The area used for organic farming has grown to a level which is fivefold that of 1999. Two thirds of the organic farming area are permanent grasslands. This crop type has increased dramatically and reflects among others the restructuring of vast areas in Australia to organic farming. Other perennial crops, like coffee and fruits, make up 8.0% of the area—the largest crop being coffee followed by olives and nuts. Only 20% of the area used for organic culture is in rotation—with corn being the dominating crop.

Organic Producers

The number of organic farmers on a world level is uncertain due to lack of data on the topic. The latest accounting estimates 2.4 millions of organic farmers. Approximately one third of these live in Asia—India being the country with the highest number of organic farmers. In the period from 2014 to 2015 the number of organic farmers has increased by 21%.

The Organic Market

The turnover of organic food at world level is estimated to 75.7 billion €, half of this in the United States alone. The turnover corresponds to a per capita average of 10.3 €. The numbers are uncertain due to lack of reports.

See also: Ecological Data Analysis and Modelling: Agriculture Models. Terrestrial and Landscape Ecology: Ecological Engineering: Overview

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