

Organic Agriculture, Ecosystem Services and Sustainability: A Review

Sagar Maitra¹, Tanmoy Shankar², Dinkar J Gaikwad³, Jnana Bharati Palai⁴, Lalichetti Sagar⁵

^{1,2,3,4,5} MS Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha – 761211, India

Corresponding author:

Dinkar J Gaikwad

MS Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha – 761211, India

Abstract

Intensive agriculture enhanced agricultural productivity to a large extent by using high energy inputs, improved seeds and cultivars, assured irrigation and mechanization. After some decades, the ill effects of mentioned technologies were pronounced on agro-ecosystem and these created hindrances in achieving agricultural sustainability. During the end part of the previous century, the thought of agricultural sustainability became an important concern. Organic agriculture was also started to flourish during the same period with some promises of ecofriendly concept as well as Ecosystem Services (ES). Greater Ecosystem Service (ES) is related to agricultural sustainability and thus organic agriculture has a huge potential to ensure agricultural sustainability by mitigating adverse impacts of intensive agriculture on agroecosystem. The article focuses on scope and positive effects of organic agriculture on ES vis-à-vis sustainable agriculture.

Introduction

Agriculture was enriched with biodiversity up to the first quarter of the previous century. The versatility in farming was the key consideration for farming sustainability on those days. Over time increased demand for food and other agricultural products created intensification of agriculture. Intensive agriculture was totally based on input-supply driven technologies and it used huge inputs in the form of chemical nutrients, plant protection chemical, irrigation water, labour and capital. However, it grew enough to meet the needs world population few decades ago (Smil, 2000). By seeing the success of intensive agriculture in developed countries, rest part of the world also inclined towards that direction and in this way land use was changed (Goldewijk and Ramankutty, 2004; Sandhu et al. 2010) and degradation of agro-ecosystem was also started (Tilman et al. 2001). Sustainability of agricultural production and food and nutritional security necessitates not only that access to sufficient nutritious food to all, but also that the agricultural production system should be of lacking any negative ecological effect. In other words, it may be stated that the sustainable agriculture is such a production system that should fulfill the needs of the present without impairing the natural resource and assuring the ability of future generations to meet their needs. That expectation is missing and it is very much clear that modern agriculture will not be able to fulfill the requirements of sustainability.

Organic Agriculture

Organic agriculture focuses to create the best possible relationship between the earth and men. During the last three decades, there was a significant consciousness and actions worldwide for protection of environment as well as agro-ecosystem and production of quality food. The modern organic agriculture is dissimilar to its original concept with a target of promise for healthy soil, food and people. Different prominent organizations defined organic agriculture or organic farming in various ways, but the basic approaches like sustainability and ecosystem services remained as integral parts of these definitions (Figure 1).

Definitions of Organic Farming /Agriculture	
IFOAM (2008)	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 good quality of life for all involved.
Roul Adamchak (2008), Britannica	Organic farming is an agricultural system that uses ecologically based pest controls and biological fertilizers derived largely from animal and plant wastes and nitrogen-fixing cover crops. Modern organic farming was developed as a response to the environmental harm caused by the use of chemical pesticides and synthetic fertilizers in conventional agriculture, and it has numerous ecological benefits.
FAO (1999)	Organic agriculture is one of several approaches to sustainable agriculture and many of the techniques used (e.g. inter-cropping, rotation of crops, double-digging, mulching, integration of crops and livestock) are practised under various agricultural systems. What makes organic agriculture unique, as regulated under various laws and certification programmes, is that almost all synthetic inputs are prohibited, and 'soil building' crop rotations are mandated.
USDA (1995)	Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony.

Figure 1. Definitions of organic farming/ agriculture as per reputed authorities

Indian Scenario

Agriculture plays a pivotal role to human society for its existence as it provides food, natural fibre, fuel and some raw materials for industry along with ecosystem services. Agriculture is the most important source of livelihood that shows prominence in economic progress of a developing nation like India. Indian economy is one of the fastest growing economies among the developing world. In India agricultural supports employment of 54 per cent of the population and still contributes to satisfactory gross domestic product. The agriculture sector in India has made massive pace in the past seven decades. But modern industrialized agriculture is a major source of environmental degradation, contributing to emission of greenhouse gasses and thus causing climate change and global warming and degradation of natural resources through some man-made practices. These are misuse of natural resources, non-judicious use of chemical inputs for plant nutrition and plant protection and others. Agricultural production system is directly related to the natural resources which are degrading. Presently, the country produces sufficient food grain, but the modern agriculture flops in attaining the aims of sustainability. The yield plateauing has been observed in the most productive areas of the country where natural resources are over-exploited; pollution due to faulty agricultural practices are prominent and eventually deterioration of natural resources. In spite of sufficiency in food grain production in India, the current agriculture fails in achieving the goals of sustainability on several ways like yield plateauing in the most productive tracts of the country where natural resources are over-exploited; agriculture induced environmental pollution and ultimately degradation of natural resources (Maitra et al. 2018a). Besides, food as well as nutritional security is a major concern. Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2003). There are one-sixth people in the developing world who are undernourished and not getting enough of nutritious foods (FAO 2010). Moreover, Swaminathan and Sinha (1986) defined 'Nutrition Security' as “physical, economic and social access to balanced diet, clean

drinking water, environmental hygiene, primary health care and nutritional literacy”. But by 2050, India needs to double the food production in addition to meeting the needs of livestock and poultry feed industry (Swaminathan and Bhavani, 2013). Considering the huge challenge and tasks, there is an urgent need for checking further degradation of natural resources targeting agricultural sustainability. Organic farming is one of the ways to check the environmental degradation, but it may not be an option for fulfillment of sufficient food grains for populous countries like India. Considering the export as well as domestic demand, progressive farmers of India showed interest in organic production. Presently organic farming is developing in India with full pace (Table 1). There are 11.5 lakh organic growers in India with 64.3% growth in organic production in a decade (Willer et al. 2020). Moreover, Government of India also promoted organic agriculture by launching the scheme “Paramparagat Krishi Vikas Yojana (PKVY)”. Madhya Pradesh has the maximum area under organic certification and other leading states are Gujarat, Karnataka, Maharashtra, Odhisa, Rajasthan, Sikkim and Uttar Pradesh. The different organic agricultural products are comprised of oilseeds, sugar cane, cereals and millets, cotton, pulses, aromatic and medicinal plants, tea, coffee, fruits, spices, dry fruits, vegetables and processed foods. The major importer countries of Indian organic products are USA, European Union, Canada, Switzerland and Australia and others. Hence, organic agriculture may be considered as one of the suitable options for economic gain in terms of export value as well as a sustainable practice in which a system approach is adopted for production of quality food with minimal ill effects to agro-ecosystems along with others concerned and it may be stated that it is the most prominent and economically viable farming systems often proposed as a solution targeting sustainable agriculture.

Table 1. Present scenario of organic farming in India

Particulars	Quantifying characters
1. Area under certified organic agriculture (31 March 2020) in million ha	3.67
a) Cultivable are under organic production in million ha	2.30
b) Wild harvest collection	1.37
2. Production of certified organic production (2019-20) in million MT	2.75
3. Volume of export of during 2019-20 in lakh MT	6.389
4. Monetary realization of organic food export in INR	4,686

Source: APEDA, 2020

Principles of organic agriculture

In broad sense, it can be said that organic agriculture is actually a farming system targeted with minimum or no damage to agro-ecosystems as well as animals and humans (FAO & WHO 2007). There are four principles suggested by International Federation on Organic Agriculture Movement (IFOAM). Organic agriculture involves ecofriendly farming system that is socially just and economically responsible and based on some principles as structured by International Federation for Organic Agriculture Movement (IFOAM) (Figure 2). At present, organic agriculture in different countries, has set its own procedure for maintaining quality and standards and followed by a certification and labeling process. There are also stipulated norms for management practices that are at par with international standards and national laws. Sustainable agriculture may be compared to organic agriculture as in organic version of farming there is not only no use of chemical inputs, but also recycling of organic resources without impairing the agro-ecological balance and inclusion of some other management practices to enhance ecological soundness. In this way organic agriculture is contributing to sustainability in agriculture by assuring environmental benefits, improving the livelihood of the farmers (as per

the principles of organic agriculture approved by IFOAM), maintaining high level of synergy amongst the activities and enhancing the quality of the produces as well as ecosystem services.

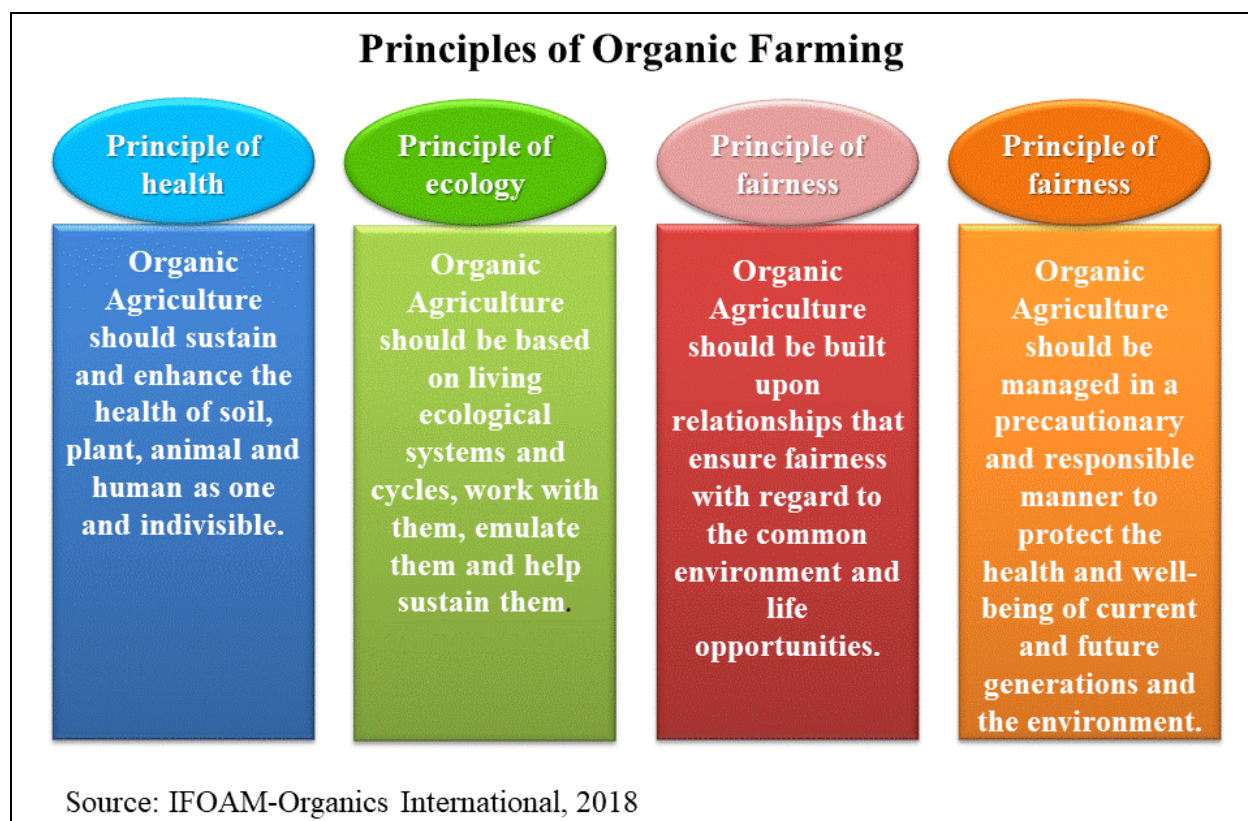


Figure 2. Principles of organic farming as stated by IFOAM

Sustainable and organic agriculture

Stockdale et al. (2001) described the advantages of organic agriculture for developed countries (environmental protection, biodiversity enhancement, and reduced energy use and CO₂ emissions) and developing nations (sustainable resources use, increased crop yield without over reliance on costly inputs, and environmental and biodiversity protection). At present, a number of countries are facing major environmental challenges like erosion of biodiversity, global warming and climate change and decline of natural resources. Therefore, all are in search for improvement of the living conditions of human population of the world along with the fulfillment of the need for food, feed and fuel for progress of the society. Therefore, it is obvious to share the natural resources economically and equitably, use technologies lesser pollutions and greenhouse gas emissions, assure minimal waste of water and energy, and to alter food consumption patterns and choices for sustainable development. This will ensure an advancement for humanity as mentioned by Douglass (1984).

The concept of sustainability lies in the heart of controversies and still the scientists, philosophers and policy makers are having debate despite of its intuitive appeal (Park and Seaton, 1996). In this regard, it may be remembered that the first definition of sustainability given by Mrs. Gro Harlem Brundtland, Prime Minister of Norway in 1987 and as per the Brundtland Report, it is defined as "a mode of development that meets the needs of the present without compromising the ability of future generations" (Stockdale et al. 2001). The sustainable development actually encompasses three dimensions of well-being, namely, economic, environmental and social. Thus, it must be ecologically sound, environmentally safe, resource caring, economically viable, commercially competitive and socially helpful as these characteristics will be able to assure long term productivity and viability of agriculture.

On the other hand organic agriculture is totally dependent of inputs of organic origin. FAO/WHO Codex Alimentarius Commission (1999) suggested "Organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems. This is accomplished by using, where possible, agronomic, biological, and mechanical methods, as opposed to using synthetic materials, to fulfill any specific function within the system." The key features of organic agriculture include management of the soil fertility by enhancing organic matter levels, fostering soil biological activity and cycle, needful mechanical interference without much disturbance, nutrient self-sufficiency through incorporation of legumes, biological N fixation and assuring nutrients availability, enhancing carbon sequestration, recycling of organic residues, farm wastes and weed by converting these into organic manures, and adopting plant protection measures relying primarily on crop rotations, natural predators, management of pest population dynamics and biological tools. The environment friendly practices of organic agriculture are presented below which can assure the sustainability in agriculture.

Ecosystem services in organic agriculture

Organic agriculture and other agri-environment schemes (AES) have been suggested as a means to alleviate the ill effects of agricultural intensification. Organic agriculture impacts on soil quality and nutrient recycling, enhancement of biodiversity or ecosystem services. Ecosystem service is related to terrestrial ecosystems that include biological control of pests (insects, weeds and diseases), nurturing of pollinators and crop diversity, soil conservation measures, the hydro-geochemical cycle, carbon sequestration and cultural services (Bengtsson et al. 2005; Hole et al. 2005; Rundlof and Smith 2006). Ecosystem services (ES) are actually a combination of natural and adapted ecosystems that support human welfare and existence on the earth through different functions and processes (Daily, 1997). Presently, ES are in United Nations' sponsored Millennium Ecosystem Assessment (MA) programme. ES associated with agriculture can be grouped into following four categories (Reid et al. 2005) and interestingly these are very closely associated with organic agriculture (Figure 3). Moreover, these services greatly match with the principles of organic farming.

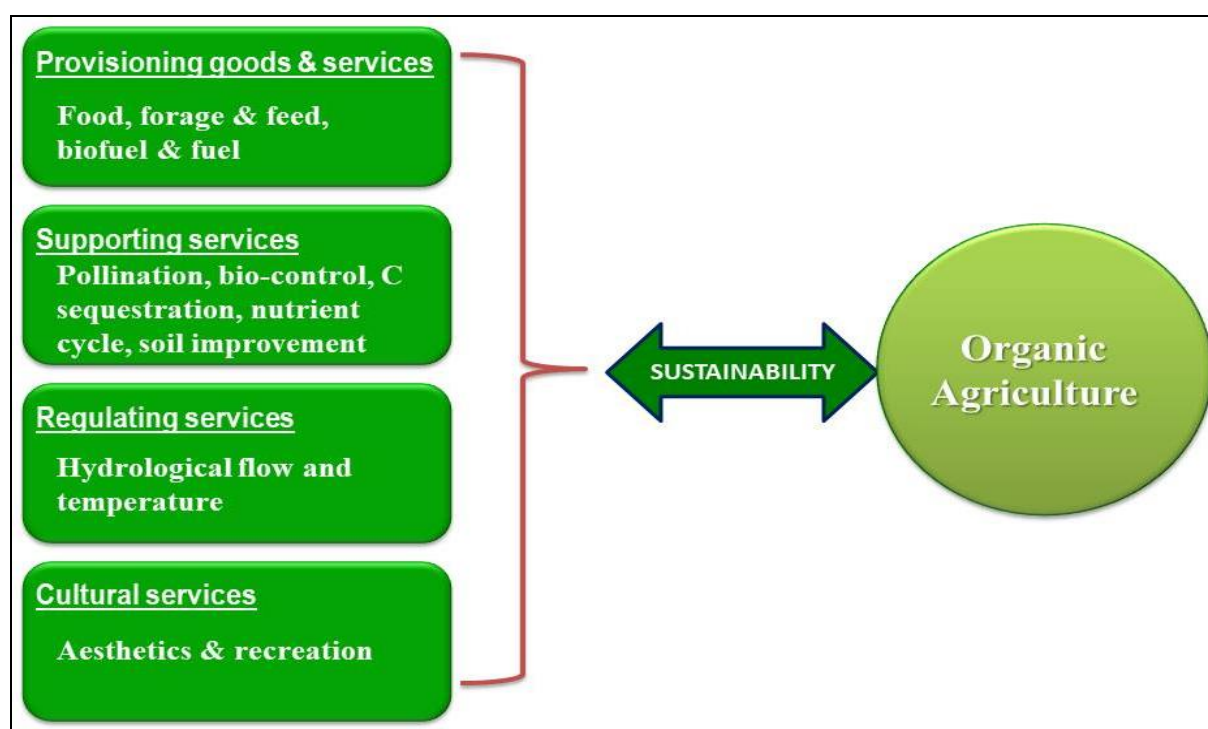


Figure 3. Ecosystem services (ES) in organic agriculture ensuring sustainability

1. *Provisioning goods and services*

These comprise of food, animal feed and fuel with diversification of crop species (Reid et al. 2005).

2. *Supporting services*

Major supports needed for agricultural production are managing pests biologically by facilitating population build-up of natural enemies, management of diseases by natural means, harboring pollinating insects, C sequestration and nutrient cycling and improvement of soil physico-chemical and biological properties (Sandhu et al. 2010).

3. *Regulating services*

Regulating services are inclusive of regulation of fluctuations in water provision and temperature.

4. *Cultural services*

Cultural services support to the human well-being (De Groot et al., 2002; Millstone and Lang, 2008).

Synergy between organic and sustainable agriculture through ecosystem services

Sustainable agriculture must assure environmental, economic and social concerns as the agricultural production systems remain viable for wellbeing of future generations. In the most of the developing countries, in marginal lands and drylands, poor farmers often fetch limitations in terms of access to inputs and irrigation due to lack of capital, infrastructure and market. Maintenance of proper biological cycle and the reduced costly inputs of organic agriculture can afford enough scope for maximization of productivity in farming systems. Organic agriculture is a way of agricultural production system based mainly on the non-use of synthetic inputs, and dependence of organic inputs, crop rotation and adoption of biological cycles related to production. Throughout the chain, farmers engaged in practicing organic production and processing comply with well-structured guidelines and specifications that favour non-polluting processes in respect of the ecosystem. Thus, Organic agriculture adds a better preservation of the crop environment and ensures higher level of ES. Organic agriculture is a key sector contributing to the national objectives of combating global warming (Maitra et al., 2018b, Maitra and Palai, 2018). Generally, the organic farmers receive higher and additional stable prices for their products (Valkila, 2009) and sometimes it is observed that organic inputs are cheaper, locally available, recycled waste materials and thus cost of production is lower (Eyhorn et al. 2007). In any production system if the cost of production lowers and produces fetch premium prices, then automatically net return will be more as observed in organic agriculture in most of the cases and thus organic agriculture is offering economic stability to the growers.

In organic agriculture, the social aspects are extremely secured as it can generate social capital and can empower the small producers as they organize into cooperatives (Rice, 2001). In organic agriculture there is scope for the use of local resources and integration of traditional and indigenous technical knowledge. In case of organic production for domestic markets, farmers can go for group certification under participatory guarantee scheme (PGS), wherever cluster activity is highly pronounced. In developing countries, rural people may get the benefit from the creation of employment as organic agriculture is labour-intensive than modern farming (Bray et al. 2002). Besides, in organic agriculture largely farming system approach is taken into account that ensures enough scope for engagement of women work force and family labourers in allied activities and so social bonding is improved. Such a diverse system can facilitate to reduce vulnerability and assures sustainability. Moreover, in organic agriculture as the farming system approaches are mostly followed with agro-ecological principles and this approach definitely yields additional stable productivity and resilience to aberrant climatic conditions (Lotter et al. 2003). Organic agriculture can offer respectable health advantages by zeroing the exposure of chemical inputs to agricultural workers and in this way it's providing safeguard to the community health. There are various ES which are used to produce food and supported by the maintenance of soil fertility, plant protection, water regulation and many other services (Takatsuka et al. 2009). Sustainable agriculture involves

the use of nature's goods and services while maintaining them for future generations (Pretty et al. 2003; Pretty, 2005). Organic agriculture is considered to be one of the production systems that aim to achieve sustainability (Lampkin and Measures, 2001) by utilizing and maintaining ES. It is well established that organic farming delivers more environmental benefits than conventional intensive agriculture.

Conclusions

Organic agriculture properly uses and nurtures ES and therefore it may be considered as a sustainable practice than modern intensive agriculture which degrades some ES. Moreover, organic agriculture organic agriculture is having the potential to give enough of food and other agricultural produces. There are increasing issues of food and nutritional security in developing countries and there is urgent need for adoption of a wide range of sustainable agricultural practices (combining some organic and conventional practices) to meet the targeted food demand for an increasing population. Organic agriculture offers great potential to develop low cost, low input, locally available eco-technologies to produce food and fibre, without causing damage to human health and the environment. There is greater need to dedicate resources for implementation of ES-enhancement strategies by implementing new mechanisms and policies to maintain and enhance agricultural sustainability without compromising yield.

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