

Review Article

Organic Agriculture in India: A Sustainable Approach towards Hygienic and Nutritious Country

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ABSTRACT

Food quality and safety are the two important factors that have gained ever-increasing attention in general consumers. Adoption of Green revolution technologies in our country led to self-sufficiency in food grain production. However, this intensive cultivation has not only resulted in pollution of soil, surface and underground water but also affected the human health. So, protection of environment and human health along with production sustainability is the concern now-a-days. Organic farming methods rely on organic inputs and recycling of farm waste for nutrient supply, emphasize cropping rotation and soil biological processes for pest management and ban applications of synthetic fertilizers and pesticides, and hence may reduce negative effects attributed to conventional farming. Conventionally grown foods have immense adverse health effects due to the presence of higher pesticide residue, more nitrate, heavy metals, hormones, antibiotic residue, and also genetically modified organisms. Moreover, conventionally grown foods are less nutritious and contain lesser amounts of protective antioxidants. In the quest for safer food, the demand for organically grown foods has increased during the last decades due to their probable health benefits and food safety concerns. Organic food production is defined as cultivation without the application of chemical fertilizers and synthetic pesticides or genetically modified organisms, growth hormones, and antibiotics. Organic farming also protects the environment and has a greater socio-economic impact on a nation. India is a country that is bestowed with indigenous skills and potentiality for growth in organic agriculture. Although India was far behind in the adoption of organic farming due to several reasons, presently it has achieved rapid growth in organic agriculture and now becomes one of the largest organic producers in the world. Therefore, organic farming has a great impact on the health of a nation like India by ensuring sustainable development. During initial years, the yield levels are low, but after the conversion period, better soil biological activity leads to augmented yield levels. Reduced availability of nitrogen and no use of synthetic pesticides create stress on plants that enhance the synthesis of active Phyto-chemicals, such as phenols, flavonoids and anti-oxidants which enhance the quality of food. Improvement in soil health, soil carbon sequestration, bio-diversity protection, reduced energy requirement per unit area, reduced nitrate leaching and emission of nitrous oxide are also achieved due to organic farming. Therefore, adoption of organic farming would promote agricultural diversification and sustainable production of healthy food, augment family income as well as can solve environmental issues. The popularity of organically grown foods is increasing day by day owing to their nutritional and health benefits.

Keywords

Food safety,
Organic food, Soil
health,
Biodiversity,
Sustainable
farming,
Conventional
farming

Introduction

Food quality and safety are two vital factors that have attained constant attention in common people. Growing environmental awareness and several food hazards (e.g. dioxins, bovine spongiform encephalopathy, and bacterial contamination) have substantially decreased the consumer's trust towards food quality in the last decades. Intensive conventional farming can add contamination to the food chain. For these reasons, consumers are requested for safer and better foods that are produced through more ecologically and authentically by local systems. Organically grown food and food products are believed to meet these demands (Rembialkowska, 2007).

In recent years, organic farming as a cultivation process is gaining increasing popularity. Organically grown foods have become one of the best choices for both consumers and farmers. Organically grown foods are part of go green lifestyle. But the question is that what is meant by organic farming? (Chopra *et al.*, 2013). The term 'organic' was first coined by Northbourne, in 1940, in his book entitled 'Look to the Land'.

Northbourne stated that 'the farm itself should have biological completeness; it must be a living entity; it must be a unit which has within itself a balanced organic life (Northbourne, 2003)'. Northbourne also defined organic farming as 'an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity'. According to Winter and Davis (2006), 'it is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony'.

They mentioned that organic produce is not grown with synthetic pesticides, antibiotics, growth hormones, application of genetic

modification techniques (such as genetically modified crops), sewage sludge, or chemical fertilizers.

Whereas, conventional farming is the cultivation process where synthetic pesticide and chemical fertilizers are applied to gain higher crop yield and profit. In conventional farming, synthetic pesticides and chemicals are able to eliminate insects, weeds, and pests and growth factors such as synthetic hormones and fertilizers increase growth rate.

As synthetically produced pesticides and chemical fertilizers are utilized in conventional farming, consumption of conventionally grown foods is discouraged, and for these reasons, the popularity of organic farming is increasing gradually.

Organic farming is a technique, which involves cultivation of plants and rearing of animals in natural ways. This process involves the use of biological materials, avoiding synthetic substances to maintain soil fertility and ecological balance thereby minimizing pollution and wastage. In other words, organic farming is a farming method that involves growing and nurturing crops without the use of synthetic based fertilizers and pesticides. Also, no genetically modified organisms are permitted. It relies on ecologically balanced agricultural principles like crop rotation, green manure, organic waste, biological pest control, mineral and rock additives.

Organic farming makes use of pesticides and fertilizers if they are considered natural and avoids the use of various petrochemical fertilizers and pesticides. International Federation of Organic Agriculture Movements (IFOAM), an international organization established in 1972 for organic farming organizations defines goal of organic farming as: "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.

Why we need to take up organic farming?

The population of the planet is skyrocketing and providing food for the world is becoming extremely difficult. The need of the hour is sustainable cultivation and production of food for all. The Green Revolution and its chemical-based technology are losing its appeal as dividends are falling and returns are unsustainable. Pollution and climate change are other negative externalities caused by use of fossil fuel-based chemicals. In spite of our diet choices, organic food is the best choice you'll ever make, and this means embracing organic farming methods.

Here are the reasons why we need to take up organic farming methods:

1. To accrue the benefits of nutrients
2. Stay away from GMOs
3. Natural and better taste
4. Direct support to farming
5. To conserve agricultural diversity
6. To prevent antibiotics, drugs, and hormones in animal products

Principles of organic farming

The four principles of organic agriculture are as follows:

Principle of health

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.

Principle of 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.

Principle of fairness

Organic Agriculture should build on relationships that ensure fairness with regard 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. 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.

Principle of 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. 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 and food processing practices

Organic farming and food processing practices are wide-ranging and necessitate the development of socially, ecologically, and economically sustainable food production system. The International Federation of Organic Agriculture Movements (IFOAM) has suggested the basic four principles of organic farming, i.e. the principle of health, ecology, fairness, and care (Figure 1). The main principles and practices of organic food production are to inspire and enhance biological cycles in the farming system, keep and enhance deep-rooted soil fertility, reduce

all types of pollution, evade the application of pesticides and synthetic fertilizers, conserve genetic diversity in food, consider the vast socio-ecological impact of food production, and produce high-quality food in sufficient quantity (IFOAM, 1998).

According to the National Organic Programme implemented by USDA Organic Food Production Act, agriculture needs specific prerequisites for both crop cultivation and animal husbandry. To be acceptable as organic, crops should be cultivated in lands without any synthetic pesticides, chemical fertilizers, and herbicides for 3 years before harvesting with enough buffer zone to lower contamination from the adjacent farms. Genetically engineered products, sewage sludge, and ionizing radiation are strictly prohibited. Fertility and nutrient content of soil are managed primarily by farming practices, with crop rotation, and using cover crops that are boosted with animal and plant waste manures. Pests, diseases, and weeds are mainly controlled with the adaptation of physical and biological control systems without using herbicides and synthetic pesticides. Organic livestock should be reared devoid of scheduled application of growth hormones or antibiotics and they should be provided with enough access to the outdoor. Preventive health practices such as routine vaccination, vitamins and minerals supplementation are also needed.

Advantages of organic farming

Safety health and nutritional advantages

Magnusson *et al.* (2003) mentioned that the growing demand for organically farmed fresh products has created an interest in both consumer and producer regarding the nutritional value of organically and conventionally grown foods. According to a

study conducted by AFSSA (2003), organically grown foods, especially leafy vegetables and tubers, have higher dry matter as compared to conventionally grown foods. Although organic cereals and their products contain lesser protein than conventional cereals, they have higher quality proteins with better amino acid scores. Lysine content in organic wheat has been reported to be 25%–30% more than conventional wheat.

Organically grazed cows and sheep contain less fat and more lean meat as compared to conventional counterparts. In a study conducted by (Rembialkowska, 2007), organically fed cow's muscle contains fourfold more linolenic acid, which is a recommended cardio-protective ω -3 fatty acid, with accompanying decrease in oleic acid and linoleic acid. found that meat from an organically grazed cow contains high amounts of polyunsaturated fatty acids. The milk produced from the organic farm contains higher polyunsaturated fatty acids and vitamin E. Vitamin E and carotenoids are found in a nutritionally desirable amount in organic milk. Higher oleic acid has been found in organic virgin olive oil. Organic plants contain significantly more magnesium, iron, and phosphorous. They also contain more calcium, sodium, and potassium as major elements and manganese, iodine, chromium, molybdenum, selenium, boron, copper, vanadium, and zinc as trace elements (Rembialkowska, 2007).

According to a review of Lairon (2010) which was based on the French Agency for food safety (AFSSA) report, organic products contain more dry matter, minerals, and antioxidants such as polyphenols and salicylic acid. Organic foods (94%–100%) contain no pesticide residues in comparison to conventionally grown foods.

Fruits and vegetables contain a wide variety of phytochemicals such as polyphenols,

resveratrol, and pro-vitamin C and carotenoids which are generally secondary metabolites of plants. In a study of Lairon (2010), organic fruits and vegetables contain 27% more vitamin C than conventional fruits and vegetables. These secondary metabolites have substantial regulatory effects at cellular levels and hence found to be protective against certain diseases such as cancers, chronic inflammations, and other diseases.

According to a Food Marketing Institute (2008), some organic foods such as corn, strawberries, and marionberries have greater than 30% of cancer-fighting antioxidants. The phenols and polyphenolic antioxidants are in higher level in organic fruits and vegetables. It has been estimated that organic plants contain double the number of phenolic compounds than conventional ones (Rembialkowska, 2007). Organic wine has been reported to contain a higher level of resveratrol. Salicylic acid is a naturally occurring phytochemical having anti-inflammatory and anti-stress effects and prevents hardening of arteries and bowel cancer (Butler *et al.*, 2008).

Total sugar content is more in organic fruits because of which they taste better to consumers. Bread made from organically grown grain was found to have better flavour and also had better crumb elasticity. Organically grown fruits and vegetables have been proved to taste better and smell good (Rembialkowska, 2007).

Organic vegetables normally have far less nitrate content than conventional vegetables. Nitrates are used in farming as soil fertilizer but they can be easily transformed into nitrites, a matter of public health concern. Nitrites are highly reactive nitrogen species that are capable of competing with oxygen in the blood to bind with haemoglobin, thus leading to methemoglobinemia. It also binds to the secondary amine to generate

nitrosamine which is a potent carcinogen. As organically grown foods are cultivated without the use of pesticides and sewage sludge, they are less contaminated with pesticide residue and pathogenic organisms such as *Listeria monocytogenes* or *Salmonella* sp. or *Escherichia coli*. Therefore, organic foods ensure better nutritional benefits and health safety.

Environmental benefits

The potential environmental benefits of organic farming are in the areas of better soil health, carbon sequestration, maintenance of bio-diversity, reduced energy requirement per unit area, reduced nitrate leaching and emission of nitrous oxide.

Soil carbon capturing

Soil carbon sequestration refers to the capture of atmospheric CO₂ in soil in passive pools of organic matter making it resistant to rapid oxidation. In organic farms, nutrients to crops are supplied through green manure, farmyard manure/ compost utilizing the on-farm residues of crops and livestock, but in conventional systems, only mineral fertilizers are applied to supply nutrient to the crops. Higher sequestration of soil organic carbon in organic system is probably due to addition of higher amounts of organic manure and adoption of crop rotation including pastures and legume crops. So, this practice may counterbalance emissions of greenhouse gases like nitrous oxide and methane from agriculture sector (UNFCCC, 2008).

Soil properties

Soils under intensive cultivation are prone to degradation and require higher attention with the use of fossil fuel in terms of fertilizers, pesticides and irrigation to offset the process of degradation. But these manipulations

result in pollution of environment, health problems, destruction of natural habitats, higher energy consumption and ultimately lead to unsustainable agricultural production system.

Physical-chemical properties

Addition of organic manures, incorporation of legume component in space and time lead in organic farming system to build up of organic carbon which helps in reducing bulk density, increasing water holding capacity and formation of water stable aggregates. This further increase infiltration rate so, there is less soil erosion as compared conventional farming system. Organic farming also lowered bulk density by 2.3 per cent, improved water holding capacity and porosity of soil by 28.4 and 16.5 per cent, respectively over conventional farming (Suja *et al.*, 2012). From a 6-year study, organic farming improved the organic carbon and available Zn content in soil whereas, conventional system led to higher pH and exchangeable sodium in Central India. (Suja *et al.*, 2012).

Biological properties

Adoption of organic farming leads to building of organic matter which is a source of energy for micro-organisms and hence greater diversity and number of micro-organisms is found in organic farming system which is reflected by their biomass and greater enzymatic activities and respiration in soil. Some of the enzymes are also helpful in solubilizing the nutrient and making them available to plants. Benbi *et al.* (2016) noted significantly higher total carbon, soil organic/inorganic carbon, microbial biomass carbon, soil organic carbon stock and microbial activities under organic farming than its conventional counterpart at different depths (0–7.5 and 7.5–15 cm). Thus, better soil fertility and greater microbial bio-diversity in

organic farming may reduce the dependence on external inputs.

Biodiversity

Biodiversity is the key player for agro-ecosystem stability and it is also true for getting stable supply of foods. Bio-diversity in organic farms are maintained or enhanced by several ways including adoption of diversified crop rotations, production of crop and livestock in a single farm. The practice of intercropping and crop rotation help to build up natural enemies whose population increase under organic farming due to avoidance of chemical pesticides. Organic soil management results in diverse species and greater population of bacteria, fungi, actinomycetes and earthworms that help in building fertile soil with stable soil aggregate which is less prone to erosion by soil.

Leaching of NO_3^- & Gaseous losses of nitrous oxide

Nitrate form nitrogen is prone to leaching loss and when it reaches ground water causes ground water pollution and when used for drinking purpose creates human health problems. Nitrous oxide (N_2O) is potential greenhouse gas with global warming potential of about 300 times than carbon dioxide (CO_2). Both nitrate leaching and nitrous oxide emission are less in organic farming due to limited nitrogen availability. There was 32 per cent reduction in nitrous oxide emission under organic farming than conventional farming (Benoit *et al.*, 2015).

Characteristics of organic farming and crop production

Organic farming methods rely on organic inputs and recycling of farm waste for nutrient supply, emphasize cropping system design and soil biological processes for pest

management, and ban applications of synthetic fertilizers and pesticides. They may thus reduce negative effects attributed to conventional farming. Organic farmers also use improved varieties of crops and modern equipment's and adopt soil and water conservation practices (Reaganold and Wachter, 2016). Furthermore, due to utilization of locally available resources, utilizing the family member for labour intensive operations and selling the farm product at premium prices will give economic advantage to them, while adopting organic farming. Organic farming differs significantly from conventional farming in terms of input cost for plant protection and labour cost for manuring and weeding operations resulting in significant increase in total labour cost and cost of cultivation of organic farming than conventional counterpart though both were comparable in terms of gross cost and net returns per hectare (Tashi and Wangchuk, 2015).

Impact of organic agriculture on crop productivity

In general, during the initial years of transition from conventional to organic farming, a decline in yield is seen which can be attributed to requirement of time for the adaptation of soil biological activity to a new situation (Sacco *et al.*, 2015). The major factor for reduced productivity of organic production systems is attributed to reduced nitrogen availability in soil. On the other hand, high levels of reactive nitrogen (NH_4^+ , NO_3^-) in soils may contribute to the emission of nitrous oxides, which is a major source of agricultural emissions. Appropriate selection of organic manure, fertilizer and amendments will help to supply the crop with nitrogen is depended upon the pattern and timing of N mineralization and its synchronization with the N demand of the crop with minimal environmental pollution (Sacco *et al.*, 2015).

Grain yield of rice and the recovery, and agronomic efficiency of nitrogen reduce significantly whereas, its physiological and partial factor productivity increases under organic farming than conventional one (Huang *et al.*, 2016).

Impact of organic agriculture on climatic condition

Organic farming has a protective role in environmental conservation. The effect of organic and conventional agriculture on the environment has been extensively studied. It is believed that organic farming is less harmful to the environment as it does not allow synthetic pesticides, most of which are potentially harmful to water, soil, and local terrestrial and aquatic wildlife (Oquist *et al.*, 2007). In addition, organic farms are better than conventional farms at sustaining biodiversity, due to practices of crop rotation. Organic farming improves physico-biological properties of soil consisting of more organic matter, biomass, higher enzyme, better soil stability, enhanced water percolation, holding capacities, lesser water, and wind erosion compared to conventionally farming soil (Edwards, 2007). Organic farming uses lesser energy and produces less waste per unit area or per unit yield. In addition, organically managed soils are of greater quality and water retention capacity, resulting in higher yield in organic farms even during the drought years (Pimentel *et al.*, 2005).

Impact of organic agriculture on socio economic consideration

Organic cultivation requires a higher level of labour, hence produces more income-generating jobs per farm. According to Winter and Davis (2006), an organic product typically costs 10%–40% more than the similar conventionally crops and it depends on multiple factors both in the input and the

output arms. On the input side, factors that enhance the price of organic foods include the high cost of obtaining the organic certification, the high cost of manpower in the field, lack of subsidies on organics in India, unlike chemical inputs. But consumers are willing to pay a high price as there is increasing health awareness. Some organic products also have short supply against high demand with a resultant increase in cost (Mukherjee *et al.*, 2018). Biofertilizers and pesticides can be produced locally, so yearly inputs invested by the farmers are also low. As the labours working in organic farms are less likely to be exposed to agricultural chemicals, their occupational health is improved. Organic food has a longer shelf life than conventional foods due to lesser nitrates and greater antioxidants. Nitrates hasten food spoilage, whereas antioxidants help to enhance the shelf life of foods (Shreck *et al.*, 2006). Organic farming is now an expanding economic sector as a result of the profit incurred by organic produce and thereby leading to a growing inclination towards organic agriculture by the farmers.

Impact of Organic Agriculture on Food quality

Food quality is a complex function of the nutrients in a food, the concentration of those nutrients, the form in which they exist, free from mycotoxins and chemical contaminants and organoleptic quality (taste, flavor, aroma, appearance, mouth feel). Besides traditional nutritional components (fat, protein, carbohydrate, calories, vitamin and mineral levels), a wide range of polyphenols, flavonoids and anti-oxidants are also of great importance in promoting healthy growth and in preventing diseases and ageing. Several past investigations suggest that production system can affect crop quality. Reduced availability of nitrogen and no use of pesticides create stress on plants that enhance

the synthesis of active Phyto-chemicals, such as phenols, flavonoids and anti-oxidants which enhance the quality of food. With respect to food quality, Oliveira *et al.* (2013) noticed an increment of 55 per cent vitamin C and 139 per cent total phenolics in tomato fruits from organic farming than from conventional farming. Higher hydrolysable polyphenols in peel and pulp of organically grown oranges and papaya and higher antioxidant in banana, papaya and mango peel over conventional farming have also been noticed. Milled rice from organic mode took less cooking time with less gruel solid loss and the values for length: breadth ratio, chewiness and gumminess were higher than conventional ones (Kaur *et al.*, 2015). Singh *et al.* (2012) found higher amylose and carbohydrate content, and lower protein content in organic milled rice than those from conventional and integrated mode of production. The organic foods are safe and of high quality has a great demand in the international markets.

Organic agriculture is the stepping stone for sustainable development

The concept of sustainable agriculture integrates three main goals— environmental health, economic profitability, and social and economic equity. The concept of sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs.

The very basic approach to organic farming for the sustainable environment includes the following (Yadav, 2017):

1. Improvement and maintenance of the natural landscape and agro-ecosystem.
2. Avoidance of overexploitation and pollution of natural resources.
3. Minimization of the consumption of non-

renewable energy resources.

4. Exploitation synergies that exist in a natural ecosystem.
5. Maintenance and improve soil health by stimulating activity or soil organic manures and avoid harming them with pesticides.
6. Optimum economic returns, with a safe, secure, and healthy working environment.
7. Acknowledgement of the virtues of indigenous know-how and traditional farming system.

Long-term economic viability can only be possible by organic farming and because of its premium price in the market, organic farming is more profitable. The increase in the cost of production by the use of pesticides and fertilizers in conventional farming and its negative impact on farmer's health affect economic balance in a community and benefits only go to the manufacturer of these pesticides. Continuous degradation of soil fertility by chemical fertilizers leads to production loss and hence increases the cost of production which makes the farming economically unsustainable. Implementation of a strategy encompassing food security, generation of rural employment, poverty alleviation, conservation of the natural resource, adoption of an export-oriented production system, sound infrastructure, active participation of government, and private-public sector will be helpful to make revamp economic sustainability in agriculture (Soumya, 2015).

Social sustainability

It is defined as a process or framework that promotes the wellbeing of members of an organization while supporting the ability of future generations to maintain a healthy community. Social sustainability can be improved by enabling rural poor to get benefit from agricultural development, giving respect to indigenous knowledge and

practices along with modern technologies, promoting gender equality in about, full participation of vibrant rural communities to enhance their confidence and mental health, and thus decreasing suicidal rates among the farmers. Organic farming appears to generate 30% more employment in rural areas and labour achieves higher returns per unit of labour input (Pandey and Singh, 2012).

Eminence of organic farming in India; yielding, demand, monetary expansion

Organic food and farming have continued to grow across the world. Since 1985, the total area of farmland under organic production has been increased steadily over the last three decades (Willer and Lernoud, 2019). By 2017, there was a total of 69.8 million hectares of organically managed land recorded globally which represents a 20% growth or 11.7 million hectares of land in comparison to the year 2016. This is the largest growth ever recorded in organic farming.

The countries with the largest areas of organic agricultural land recorded in the year 2017 are given in Figure 2. Australia has the largest organic lands with an area of 35.65 million hectares and India acquired the eighth position with a total organic agriculture area of 1.78 million hectares (Willer and Lernoud, 2019).

In 2017, it was also reported that day to day the number of organic produces increases considerably all over the world. Asia contributes to the largest percentage (40%) of organic production in the world and India contributes to be largest number of organic producer (835 000) (Figures 3 and 4). The growth of organic farming in India was quite dawdling with only 41 000 hectares of organic land comprising merely 0.03% of the total cultivated area. In India during 2002, the

production of organic farming was about 14 000 tonnes of which 85% of it was exported (Chopra *et al.*, 2013).

The most important barrier considered in the progress of organic agriculture in India was the lacunae in the government policies of making a firm decision to promote organic agriculture. Moreover, there were several major drawbacks in the growth of organic farming in India which include lack of awareness, lack of good marketing policies, shortage of biomass, inadequate farming infrastructure, high input cost of farming, inappropriate marketing of organic input, inefficient agricultural policies, lack of financial support, incapability of meeting export demand, lack of quality manure, and low yield (Figure 5; Bhardwaj and Dhiman, 2019)

Recently, the Government of India has implemented a number of programs and schemes for boosting organic farming in the country. Among these the most important include

- (1) The Paramparagat Krishi Vikas Yojana,
- (2) Organic Value Chain Development in North Eastern Region Scheme,
- (3) Rastriya Krishi Vikas Yojana,
- (4) The mission for Integrated Development of Horticulture (a. National Horticulture Mission, b. Horticulture Mission for North East and Himalayan states, c. National Bamboo Mission, d. National Horticulture Board, e. Coconut Development Board, f. Central Institute for Horticulture, Nagaland),
- (5) National Programme for Organic Production,
- (6) National Project on Organic Farming, and
- (7) National Mission for Sustainable Agriculture (Yadav, 2017).

Zero Budget Natural Farming (ZBNF) is a method of farming where the cost of growing

and harvesting plants is zero as it reduces costs through eliminating external inputs and using local resources to rejuvenate soils and restore ecosystem health through diverse, multi-layered cropping systems. It requires only 10% of water and 10% electricity less than chemical and organic farming. The micro-organisms of Cow dung (300–500 crores of beneficial micro-organisms per one-gram cow dung) decompose the dried biomass on the soil and convert it into ready-to-use nutrients for plants. Paramparagat Krishi Vikas Yojana since 2015–16 and Rastriya Krishi Vikas Yojana are the schemes taken by the Government of India under the ZBNF policy (Sobhana *et al.*, 2019). According to Kumar (2020), in the union budget 2020–21, Rs 687.5 crore has been allocated for the organic and natural farming sector which was Rs 461.36 crore in the previous year.

Indian Competence Centre for Organic Agriculture cited that the global market for organically grown foods is USD 26 billion which will be increased to the amount of USD 102 billion by 2020 (Chopra *et al.*, 2013).

The major states involved in organic agriculture in India are Gujarat, Kerala, Karnataka, Uttarakhand, Sikkim, Rajasthan, Maharashtra, Tamil Nadu, Madhya Pradesh, and Himachal Pradesh. India ranked 8th with respect to the land of organic agriculture and 88th in the ratio of organic crops to agricultural land as per Agricultural and Processed Food Products Export Development Authority and report of Research Institute of Organic Agriculture (Willer and Lernoud, 2017).

But a significant growth in the organic sector in India has been observed in the last decades. There have been about a threefold increase from 528 171 ha in 2007–08 to 1.2

million ha of cultivable land in 2014–15. As per the study conducted by Associated Chambers of Commerce & Industry in India, the organic food turnover is increasing at about 25% annually and thereby will be expected to reach USD 1.36 billion in 2020 from USD 0.36 billion in 2014 (Willer and Lernoud, 2017).

Environment Programme, organic farming methods give small yields (on average 20% lower) as compared to conventional farming. As the yields of organically grown foods are low, the costs of them are higher. The higher prices made a barrier for many consumers to buy organic foods (Lairon, 2010). Organic farming needs far more lands to generate the same amount of organic food produce as conventional farming does, as chemical fertilizers are not used here, which conventionally produces higher yield. Organic agriculture hardly contributes to addressing the issue of global climate change. During the last decades, the consumption of organic foods has been increasing gradually, particularly in western countries

Organic foods have become one of the rapidly growing food markets with revenue increasing by nearly 20% each year since 1990. The global organic food market has been reached USD 81.6 billion in 2015 from USD 17.9 billion during the year 2000 (Figure 6) and most of which showed double-digit growth rates (Willer and Lernoud, 2019).

Outlook probabilities of organic farming in India

India is an agriculture-based country with 67% of its population and 55% of manpower depending on farming and related activities. Agriculture fulfils the basic needs of India's fastest-growing population accounted for 30% of total income. Organic farming has

been found to be an indigenous practice of India that practised in countless rural and farming communities over the millennium. The arrival of modern techniques and increased burden of population led to a propensity towards conventional farming that involves the use of synthetic fertilizer, chemical pesticides, application of genetic modification techniques, etc.

Even in developing countries like India, the demand for organically grown produce is more as people are more aware now about the safety and quality of food, and the organic process has a massive influence on soil health, which devoid of chemical pesticides. Organic cultivation has an immense prospect of income generation too (Bhardwaj and Dhiman, 2019). The soil in India is bestowed with various types of naturally available organic nutrient resources that aid in organic farming (Deshmukh and Babar, 2015).

India is a country with a concrete traditional farming system, ingenious farmers, extensive drylands, and nominal use of chemical fertilizers and pesticides. Moreover, adequate rainfall in north-east hilly regions of the country where few negligible chemicals are employed for a long period of time, come to fruition as naturally organic lands (Gour, 2016).

Indian traditional farmers possess a deep insight based on their knowledge, extensive observation, perseverance and practices for maintaining soil fertility, and pest management which are found effective in strengthening organic production and subsequent economic growth in India.

The progress in organic agriculture is quite commendable. Currently, India has become the largest organic producer in the globe and ranked eighth having 1.78 million ha of organic agriculture land in the world in 2017

(Willer and Lernoud, 2019).

Various newer technologies have been invented in the field of organic farming such as integration of mycorrhizal fungi and nanobiostimulants (to increase the agricultural productivity in an environmentally friendly manner), mapping cultivation areas more consciously through sensor technology and spatial geodata, 3D printers (to help the country's smallholder), production from side streams and waste along with main commodities, promotion and improvement of sustainable agriculture through innovation in drip irrigation, precision agriculture, and agro-ecological practices.

Another advancement in the development of organic farming is Bee Scanning App, through which beekeepers can fight the Varroa destructor parasite mite and also forms a basis for population modelling and breeding programmes (Nova-Institute GmbH, 2018).

Inhana Rational Farming Technology developed on the principle 'Element Energy Activation' is a comprehensive organic method for ensuring ecologically and economically sustainable crop production and it is based on ancient Indian philosophy and modern scientific knowledge.

The technology works towards,

(1) energization of soil system: reactivation of soil-plant-microflora dynamics by restoration of the population and efficiency of the native soil microflora and

(2) energization of plant system: restoration of the two defence mechanisms of the plant kingdom that are nutrient use efficiency and superior plant immunity against pest/disease infection (Barik and Sarkar, 2017).

Future need's in organic farming for proper research as in the research line of sustainable crop production

Crop variety selection for organic farming or breeding for varieties under organic farming system.
Studies on management aspects (weed management, disease and insect management).
Development of organic fertilizer and their

registration and standardization of dose and timing for different crops under different agro-ecosystems.

Studies on nitrogen conservation after legume cropping.

Increasing nutrient use efficiency in organic systems with high yield. Isolation of elite strains of microbes for P, K, Zn and Si solubilisation and multi-nutrient solubilising plant growth promoting rhizomicrobes

Fig.1 Principles of organic farming (IFOAM 1998)



Figure.2 Country-wise areas of organic agriculture land, 2017 (Willer and Lernoud, 2019)

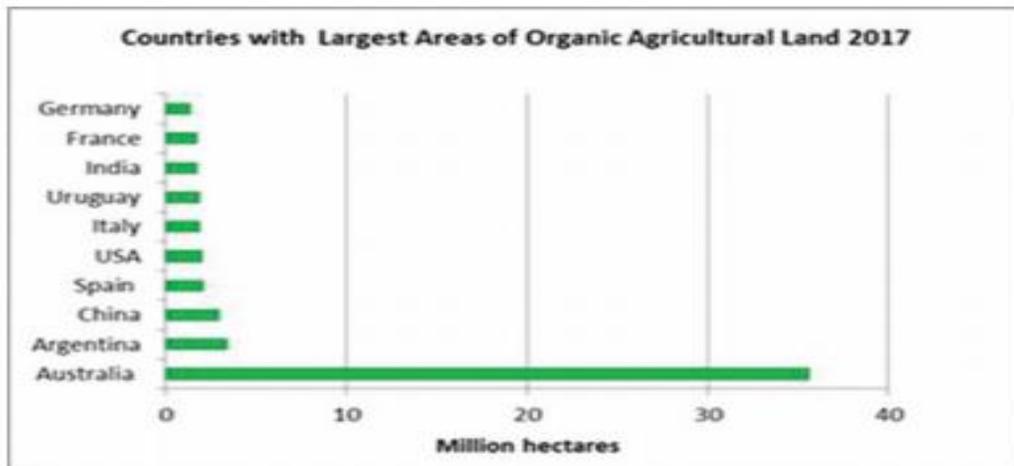


Figure.3 Organic producers by region, 2017 (Willer and Lernoud, 2019)

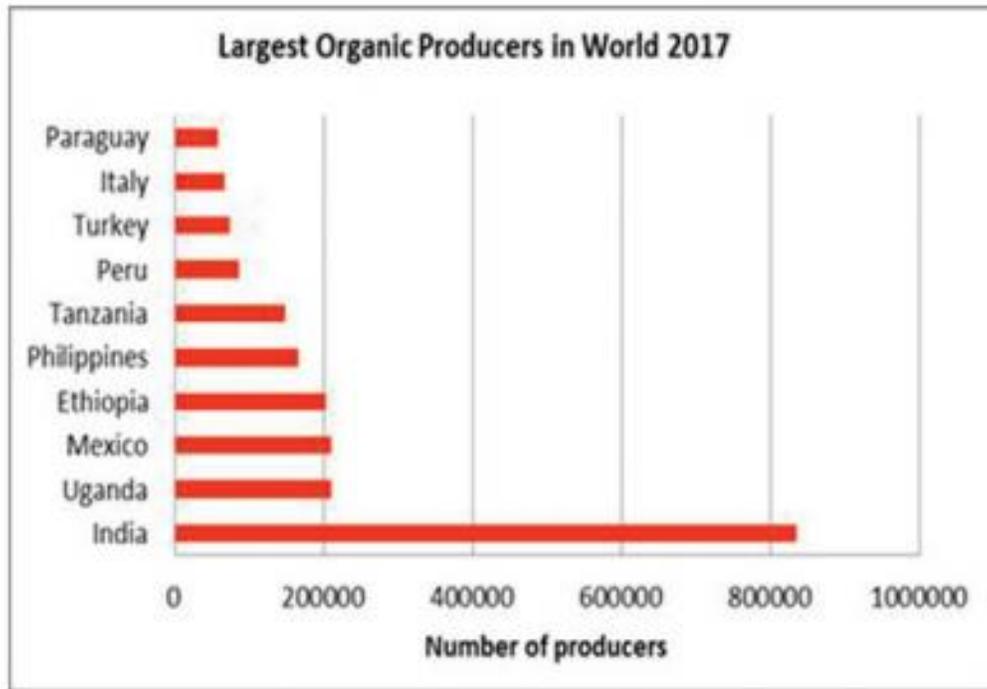


Figure.4 Largest organic producers in the world, 2017 (Willer and Lernoud, 2017)

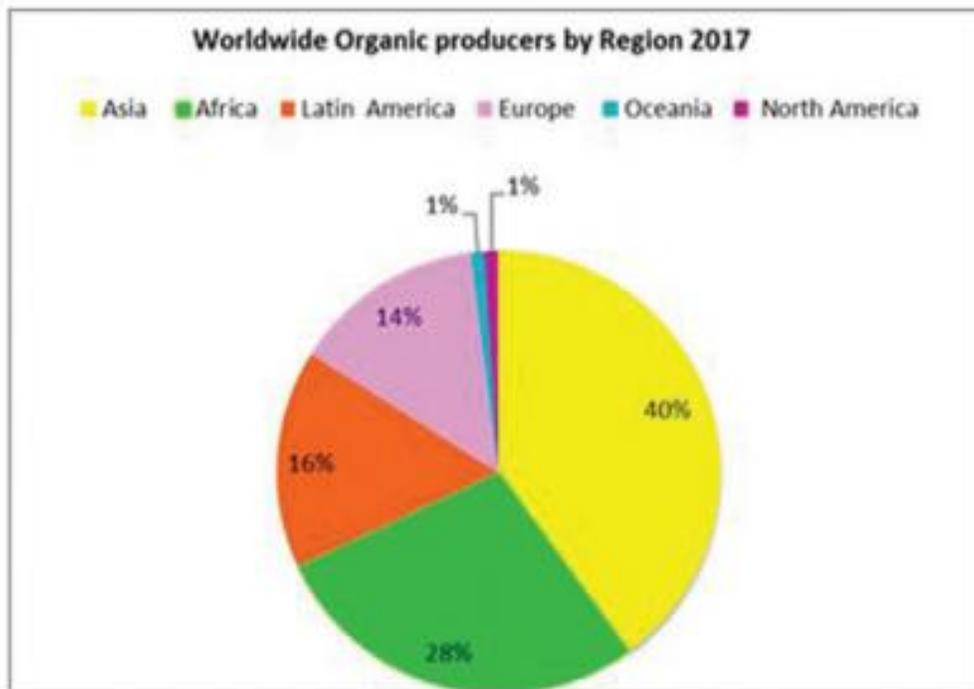
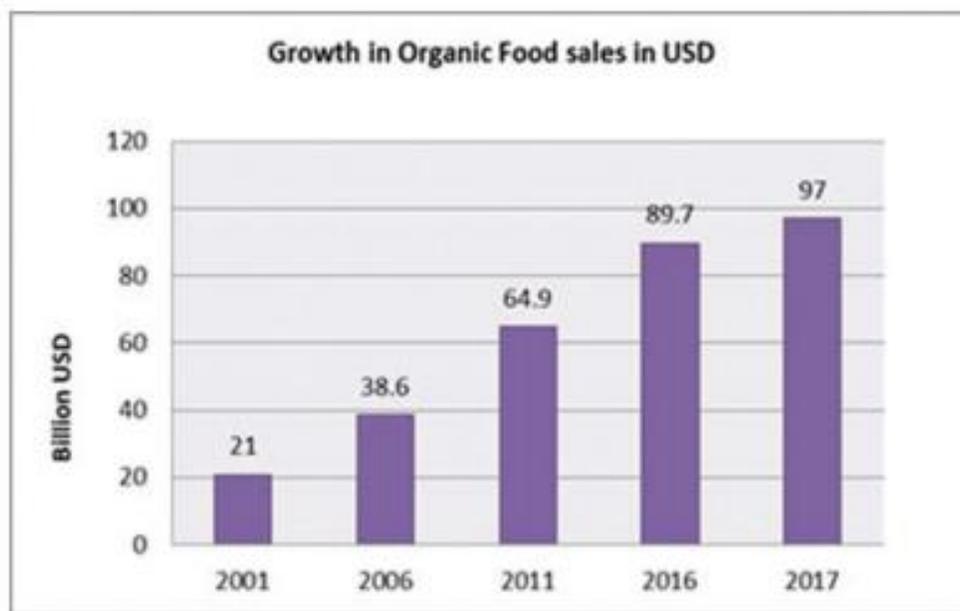


Figure.5 Constraints of organic farming in India in the past (Bhardwaj and Dhiman, 2019)

CONSTRAINTS OF ORGANIC FARMING IN INDIA IN THE PAST	
1	Lack of awareness
2	Lack of good marketing policies
3	Shortage of biomass
4	Inadequate farming infrastructure
5	High input cost of farming
6	Inappropriate marketing of organic input
7	Inefficient agricultural policies
8	Lack of financial support
9	Inability to meet the export demand
10	Lack of quality standards for manure, and
11	Low yield
12	Lack in governmental polices to promote organic agriculture

Figure.6 Worldwide growth in organic food sales (Willer and Lernoud, 2019)



In conclusion, organic farming yields more nutritious and safe food. The popularity of organic food is growing dramatically as

consumer seeks the organic foods that are thought to be healthier and safer. Thus, organic food perhaps ensures food safety

from farm to plate. The organic farming process is more eco-friendly than conventional farming. Organic farming keeps soil healthy and maintains environment integrity thereby, promoting the health of consumers. Moreover, the organic produce market is now the fastest growing market all over the world including India. Organic agriculture promotes the health of consumers of a nation, the ecological health of a nation, and the economic growth of a nation by income generation holistically. India, at present, is the world's largest organic producers (Willer and Lernoud, 2019) and with this vision, we can conclude that encouraging organic farming in India can build a nutritionally, ecologically, and economically healthy nation in near future.

Adoption of organic farming would promote agricultural diversification and can potentially contribute towards increasing family income as well as can solve environmental issues. Considering the multiple benefits of organic farming and ensure sustainable, and quality food production without harming the environment. Its practice should be adopted in large scale with enforcement of proper guidance, financial support, market development involving all key partners from farmers to input dealers, government agencies bankers, NGOs and agencies engaged in different levels of Agri-marketing.

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