Impact of Organic Farming on Sustainable Agriculture System and Marketing Potential: A Review

G. T. Patle¹, S. N. Kharpude**, P. P. Dabral¹ and Vishal Kumar¹

¹College of Agricultural Engineering Post Harvest Technology, Central Agricultural University, Gangtok, Sikkim, India.

ABSTRACT

Organic farming helps to improve the health of agro-ecosystem by its holistic approach using on-farm agronomic, biological and mechanical methods in exclusion of all synthetic off-farm inputs. Although the organic farming is eco-friendly, question arises about possibility to adopt the organic farming for the large scale and its impacts on maintaining the productivity of land to meet the food security challenges from the ever-increasing population of the world. But at the same time, consumer’s behaviour and consciousness toward the safe and healthy food enforced the thinking of farmers toward the organic farming which is more lucrative due to high market demand and value of organic produce. This paper mainly addresses about the present status and future scope of organic farming especially in North eastern region of India, State of Sikkim, Indian and Global scenario and to investigate the major external and internal factors that influence the whole organic system including production and marketing of organic commodity.

Keywords: Organic farming; sustainable agriculture; organic markets; organic food; consumer behaviours etc.
1. INTRODUCTION

The exploiting population and to meet out their need for food full of nutritional values is an incredible concern of world since early 21st century. The resources available through nature are bending their backs with limited reserves and over exploitation by human beings is making scenarios worst for current agriculture practices. The interdependency on environment and ecosystem for valuable resources for own benefits of peoples are largely indicating much broader scenarios and worst future for upcoming generations for exploiting and sustaining livelihood for food and nutrition. [1–6] These changing scenarios have forced major advancements in global food system. Despite increasing quantity of food production in last few decades, the climate change in agriculture and malnutritional food production causing widespread environmental and health impacts are seen due to overdosing and excessive use of chemical fertilizers, plant protection agents and pesticides on ecosystem.[7–10] The worldwide impacts both incremental and decremental are seen through declining performance of modernized agriculture.[11–13]

Last few decades of Indian agriculture have shown drastic changes with phase of Green evaluation to farm mechanization, irrigation advancements, use of high yielding varieties, chemical fertilizer and pesticide exploitation. Conventional farming practices have shown food grain production increase in many folds and achieved food self-sufficiency in India. The achieved practice has yielded lots of problems like degradation of soil health, human health issues and climate change. Majority of soil degradation issues like salting, waterlogging, soil acidity, alkalinity and erosion are increasing with use of synthetic pesticides and fertilisers. Also, production processes based on conventional fuels is attributing to climate change by pollution. Currently, agriculture is seen as major contributor of Greenhouse gas (GHG) emissions.[14–18] According to Patra and Babu (2017)[19] India is one of largest contributor to GHG emissions and climate change and being signed a Paris agreement, India is making bold moves to mitigate GHG emissions and climate change through various initiatives and promotion to organic agriculture is one of it. This review has been based on various researches, reports, reviews and communications as mentioned in references and is formulated on the concept of providing a deep review of organic food, its status in India and abroad, comparison of organic and conventional agricultural practices, soil health, food packaging and marketing and consumer behaviour.

2. ORGANIC FOOD AND CONSUMER’S BEHAVIOUR

Consumer’s perspectives of organic farming and organic foods are misunderstood despite they are not new to them. Practice of Organic farming is not new and has been employed by humans in last few thousands of years. [20–22] The rise of health issue and carcinogenic problems has made people aware of healthy practices of food through organic food. There is consensus that organically produced food is healthier than conventional food.[23–26] But there are some researchers which do not agree the proposition and reported no significance difference present in the organic and conventional food. [27–35] The nutritional organically grown food consisting of free radicals, antioxidants and minerals can cure and protect the human beings from numerous diseases and has the potential to cure cancer.[36–40] scientific studies focusing on nutritional balances of organic foods and their other products has revealed that polyphenol, minerals, vitamins and antioxidant level in the food may increase with adaptation of organic farming. This increase can be seen in vegetables, fruits, grains and dairy products used in daily diet recommended for proper body maintenance and calorie control. [41–50]

Now a day’s people are searching for sustainable agriculture which means the good yield per unit area with minimum impact on ecological system.[51–55] But the question is that can it produce a surplus amount fulfilling the needs of all? The study by Storstad and Bjorkhaug (2003) has shown that there is complete and considerable difference in application attitude of farms towards environment and animal welfare issues when shifting from conventional to organic farming.[56] The critics and various researchers have argued about lower yield from organic farming practices and cannot feed exploiting population as production per hectare is lowering and more agricultural areas are required to produce same amount of food. More required land can lead to issues affecting ecosystem through deforestation and biodiversity loss. It is also reported that organic yields are lower than the yield obtained through conventional farming, ranging from 5% to 34%. [57–62]
Organic food consumers have always shown a positive approach for buying but the number of consumers is still very low compare to inorganic food. It is below one per cent in some southern, central and eastern European countries and 5% in Austria and Denmark.[63–67] A lot of literature is available on the theoretical and practical aspect of different organically managed food and organically processed food. [68–70] This paper mainly focuses on the concept organic farming, organic food production, processing and marketing strategies and future growth of organic market along with the status of organic market throughout the world.

3. WHAT IS ORGANIC AND WHY ORGANIC?

It is evitable that organic farming system and its products are beneficial for environment and health compared to conventional farming practices. [23,33,53,58,62,71,72] The regulation of organic farming at international level is governed by various bodies like Food and Agriculture Organisation (FAO), European Commission (EC), United States Department of Agriculture (USDA) and international federation of organic agriculture movements (IFOAM) through various Codex Alimentarius, EC guidelines, USDA organic regulations and IFOAM standards. [73] Despite variable definitions and conceptuality of organic farming and organic food, basic idea remains same globally. According to Nadia Scialabba [74], organic agriculture is defined as a holistic approach of agriculture production and management which avoids use of synthetic soil enhancers and crop protection methods, biotechnological advanced organisms to minimise the environmental pollution and health impacts optimizing the health and productivity of interdependencies. According to the IFOAM, organic agriculture is a production system that have sustainability of soils, ecosystem and people by relying on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of adverse affecting inputs and which combines traditional, innovative and scientific way to benefit all ecosystem, people and environment. [75] In Indian context, the term organic food can be referred as the food or product produced from agricultural activity, processed organic crops without using chemical and synthetic agents for consecutive three years.[76] Promotion of organic farming or agriculture provides the aim of balancing environment thus can have synonyms like ecological farming, biological farming or zero budget farming. [77–79] The organic system follows system the organically fed animals and have less fat content as compare to conventionally fed animals. Weight of organically fed hen’s egg albumen reported as 54.6% of egg’s total weight whereas, conventionally fed hen’s egg albumen weight reported 55.7% of total egg’s weight. [80,81]

3.1 Overview of World’s Organic Status

Inorganic farming practices and grown food have impacted drastic issues throughout world. The focus of whole world is shifting towards organic farming.[82,83] According to recent data till 2018 about 186 countries started actively practicing organic farming. But the share of organic farming land to the total agricultural land is only 1.5 % which is very low. In the last few decades, the dramatic increase in the total organic agricultural land was observed, total organically managed land in 1999 was 11 million hectares only but in 2018 it reached to 71.5 million hectares. Due to increase in the total land and market size, farmers showed interest in organic farming. Thus, involvement of farmers increased in organic farming and it reached to 2.8 million in 2018. India ranked 1st with 1.149 million organic producers in the world followed by Uganda and Ethiopia. In 1999, organic market size was reported to 15.1 billion Euros but in year 2018, it reached to 96.5 billion Euros.[84] The growth rate of organic market seems very fast as compared to other markets. [85,86]

From the Fig. 1, it is observed that there is almost linear growth towards the increase in number of countries for adopting the organic agriculture over the period and the world’s attention is increasing towards the organic sector. Fig. 1 also revealed that gradually more countries are participating in the organic mission throughout the world. More attraction for the adoption of organic agriculture may be due to degradation in the health of soil and human which mainly due to the use of inorganic substances in the modern farming system. According to recent survey about 70% consumer purchase organic food to avoid the hazardous effects of pesticides.[87–90] The world is having numerous scopes for marketing opportunities of organic produce. USA is the largest single market in the world followed by European Union and China.[84]

From Fig. 2, it is observed that Oceania had the maximum organically managed agricultural land
followed by Europe, Latin America, Asia, North America, and Africa. Socio-economic conditions of the region may be the reason for least contribution of Africa in the organic farming.

3.2 Overview of India’s Organic Status

India is a home for organic producers and farming is the main business of Indian population as 60% people directly rely on it. India accounts about 2.4% of the world’s geographical area and provides shelter to about 17% of the world’s human population and 15% of the livestock. Continuous developments in the agriculture and agri-based sectors have played an important role towards the sustainable growth and development of the Indian economy. Total geographical area of the country is 328.73 million hectares consisting of about 142.02 million ha net sown area. Organic farming is a state of art in India and is being followed by the farmers from the ancient times. In India, small and marginal farmers cultivate 44% of the area but their contribution towards national food security is immense.

![Fig. 1. Development of the number of countries with organic agriculture (Source: FiBL-Ifoam-SOEL-Surveys 1999-2018)](image)

![Fig. 2. State-wise details of total area under organic certification process (Source: FiBL survey, 2017)](image)
Being applied and used from ancient times, the organic farming system in India shows promising views as a method of farming produces sustainable production and can utilize available organic farm wastes in location itself. [95,96] Organic farming system avoids the use of synthetic and artificial inputs and rely on natural resources only. India has a lot of potential for producing organic produce due to its various agro climatic regions. India holds promise for the organic producers to tap the market which is growing steadily in the domestic market related to the export market. As per the available statistics, India’s ranks 9th in terms of world’s organic agricultural land. [84] The total area under organic certification is 3.56 million hectare (2018). This includes 50% cultivable area with 1.78 million hectare and rest 50% (1.78 million Hectare) forest and wild area for collection of minor forest produces. Area under organic farming in India increased from 42,000 hectares in 2003-04 to more than 14.89 lakh ha in 2015-16.[97] State-wise details of total area under organic certification process are presented in Fig. 3. It is observed that Madhya Pradesh has largest area under organic certification followed by Maharashtra, Rajasthan, Telangana, Odisha, Karnataka and Uttar Pradesh among the states. India produced around 1.71 million MT (2018) of certified organic products which includes all varieties of food products, oilseeds and fibres etc. The total volume of export during 2015-16 was 5.48 Lakh MT. The organic food export realization was around 516 million USD. Oil seeds (50%) lead among the products exported followed by Cereals and millets (10.4%), Plantation crop products such as Tea and Coffee (8.96%), Dry fruits (8.88%), Spices and condiments (7.76%) and others.[97]

### 3.3 Prospect of Organic Farming in the NEH Region of India

As agriculture in NEH region is rain fed and resource poor farmers are unable to use agro-chemicals, the farming is more or less organic. [98] As the organic farming, in general, has now become economically attractive and rewarding in addition to offering health and environmental benefits, the region is trying to achieve sustainability in organic farming. The organic farming in true sense is related to resource conservation agriculture with no use of chemical inputs. The north-eastern region occupies eight per cent of India’s land area and is home for four percent of its population. Agriculture provides livelihood to 70% of the region’s population. The NEH region is a net importer of food produce to fulfill for their own consumption productivity is lower and facilities have low proportion of irrigated area and low investment in building irrigation. The region has shown its efforts in growth of fruits, vegetables, and other horticulture products. [98–100]

Fig. 4 shows State-wise details of total area under organic certification process in North eastern region of India.

![Fig. 3. Share of Farm area state wise for India (Source: FiBL survey, 2017)](image-url)
4. ORGANIC FARMING SYSTEM

With the growing population, demand of food supply is also increasing every year and to accomplish the requirement of increasing food demand, several techniques of organic farming came into limelight that has helped the farmers to produce maximum production per unit land with the minimum use of natural resources.[101,102] For the growth and development of plant, it required different types of nutrients and minerals.[103,104] It is already reported by Bhattacharya (2004)[105] 16 minerals are essentially important for proper growth and development of plants (Table 1).

There is a wide range of management practices that can be utilized by the organic farmers and growers to maintain and develop the soil fertility in order to achieve the goal of maximum productivity per unit organically managed land.[72,106] It was reported that there were about 2.0 million hectares more of organically managed agricultural land in 2018 than in 2016. [84] The trend for organic agriculture and other tends to change with location, region and climate

---

**Table 1. Essential elements required for growth of plant**

| S. No. | Essential Element | Category | Source |
|-------|------------------|----------|--------|
| 1.    | Carbon           | NR       | Air    |
| 2.    | Oxygen           | NR       | Air    |
| 3.    | Hydrogen         | NR       | Water  |
| 4.    | Nitrogen         | MACN     | Soil   |
| 5.    | Phosphorous      | MACN     | Soil   |
| 6.    | Potassium        | MACN     | Soil   |
| 7.    | Calcium          | MACN     | Soil   |
| 8.    | Magnesium        | MACN     | Soil   |
| 9.    | Sulphur          | MACN     | Soil   |
| 10.   | Iron             | MICN     | Soil   |
| 11.   | Manganese        | MICN     | Soil   |
| 12.   | Boron            | MICN     | Soil   |
| 13.   | Zinc             | MICN     | Soil   |
| 14.   | Copper           | MICN     | Soil   |
| 15.   | Molybdenum       | MICN     | Soil   |

# NR, Nutrient; MACN, macronutrient; MICN, micronutrient

---

![Fig. 4. State-wise details of total area under organic certification process in North eastern region of India](chart.png)
also [25,107,108]. According to Kumar et al. (2017)[76] continuous decline in the area and production of major cereal crops were found in Sikkim, India which is a matter of concern in the context of food security in state. Based on the use and purpose of management organic land can further divided into different categories. Apart from cultivation, organic land can be used for rough grazing, permanent pasture, temporary ley, arable production, livestock farming and production of horticultural crops. Conversion from the conventional farming to organic farming, changes the soil nutrient composition and chemical availability in soil. Clark et al. (1998)[109] reported that in organic farming, soil had higher organic C, soluble P and exchangeable K and pH. For the plant nutrients, some of the potential organic sources are crop rotation, crop residue, organic manure, farmyard manure, night soil, sludge, agricultural waste, blood meal, press mud, oil cakes, bio-fertilizers etc. In organic agriculture practice proper soil health management can be maintained through seasonal soil analysis and natural nutrient balancing.[110] There is another aspect of organic farming researched by various researchers stating that the soils with heavy metals are not feasible for organic agricultural practices as chemical nutrient management strategies are needed to be supplemented.[111,112] Some management techniques are discussed in this paper.

4.1 Mixed Farming System

4.1.1 Crop rotation method to manage soil fertility

Crop rotation is technique in which different plants are grown in a chronic, defined sequence. In crop rotation techniques, cash crops are mixed with the fertility building crops like leguminous that help in nitrogen fixation that maintains the fertility of soil. It is the main mechanism for supply of nutrient within the organic system with addition of external agents to improve the health of soil.[113–115] Rotations can also be designed to minimize the spread of weeds, pests and diseases. A complete crop rotation have different phases including, nitrogen building and depletion phase, availability of other minerals etc. but these all phenomenon should be in the balanced rate to maintain the long term fertility of the soil and optimum production of organic crops.[113–117] Atmospheric nitrogen fixed by the legume-rhizobium symbiosis is made available to subsequent cash crops when the ley is incorporated and the nitrogen is mineralized through the action of soil microorganisms.[118] Complicated weed management is another drawback of organic farming but studies reveal that weed population density and biomass production may be noticeably control using the crop rotation and intercropping method.[119–122]

4.1.2 Management of crop residue

Crop residues have several potential uses by the people such as food, shelter, feed, fuel and soil amendment. Residue obtained from the crop can be as major source of nutrients for the subsequent crop of the field and this technique can provide additional nutrient to crop and amplify the productivity. Crop residues have the potential for enhancing soil and water conservation and thus, improve the soil productivity and crop yields. According to study conducted by Wilhelm et al. (1986)[123], a positive linear response was found between production of corn and soybean and stover yield and amount of residue applied to the soil surface. The 0.10 Mg ha$^{-1}$ and 0.30 Mg ha$^{-1}$ reduction has been observed for grain yield and residue yield respectively. Similar type of study conducted by Wilhelm et al. (2007)[124] reported that the amount of corn Stover needed to maintain soil carbon, were 5.25 – 12.50 Mg ha$^{-1}$. This study showed that Stover and other residues improve the productivity and maintain the nutrient in the soil; it also restricts the wind erosion and control water for the high production from the land.

4.1.3 Managing additional nutrient in organic farming

Major objective of use of bio-fertilizers is crop improvement and maintenance of nutritional value of a crop. Use of microorganism in agriculture became popular in recent few decades. Biologically nitrogen and phosphorous solubilization/mobilization by microorganism can provide surplus additional nutrient to soil for the high productivity and healthy yield in organic agriculture. Microorganism metabolic function mainly responsible for the enhancement for the nutrient in soil. By N-fixation, P-solubilization, transformation, decomposition and other biological activities microorganism increase the nutrient content of agriculture land. There are basically three bio-fertilizers used in the organic farming Nitrogenous biofertilizers (NBF), Phosphorous bio-fertilizers (PBF) and Compost bio-fertilizers (CBF). Rhizobium, Azotobacter,
Azospirillum, Blue green algae and Azolla are some microorganism that can use in the organically managed land as NBF for enhancement of nitrogen content of land. Whereas, Bacillus, pseudomonas, VA Mycorrhiza or VAM are some microorganism recommended for all crops as a PBF. [105] Saadatnia et al. (2009)[125] reported that rice seed treated with cyanobacteria, germinated faster than control and increased 53% in the plant height, 66 % in root length, 58% fresh leaf and stem weight, 80% in fresh root weight, 20% in soil moisture, 28% soil porosity and decrease of 9.8% in the soil bulk density and 4.8% in soil particle density. The application of bio-fertilizers not only helps in physical growth but it also increases the chemical and nutrient content in the crops. Akladious et al. (2012)[126] reported that when the seed and soil of the maize treated with Trichoderma harzianum T22 caused an increase of all parameters including physical growth parameters, chlorophyll content, starch content, total protein contents and phytohormones content of applied maize plant. The concept of use of pesticides and fungicides is now a days popular in organic farming with a concept that it should be derived from natural sources. There are number of organic fungicides like Sulfur, Copper, Oils and Bicarbonates are being used in organic farming for disease prevention. [127,128]

4.2 Organic Farming and Resource Conservation Technologies

Organic farming is described as a unique production management system which promises and enhances agro-ecosystem health including biodiversity, biological cycles and soil biological activity. [129–132] Organic farming has been recommended by National Commission on Farmers as a tool for second green revolution for regions like rainfed areas, hilly and mountain regions of India.[132,133] Organic farming is also believed to be a viable option for sustainable development of farming based rural livelihood of small farmers. In organic farming, use of chemicals, be it fertilizer, insecticides or pesticides, is avoided and the entire ecosystem i.e. plants, animals, soil, water and microorganisms is to be protected.[134–137] Comparison between traditional methods and recommended management practices are presented in Table 2.

The conservation agriculture that features little or no soil disturbance, no burning of crop residues, direct seeding into previously unttled soil, crop rotations and permanent soil cover through the retention of crop residues and mulching are highly relevant in organic farming. The potential benefits of resource conservation technology in terms of agricultural sustainability, relative to conventional farming are given in Table 3. Some of the advantages and few weaknesses towards the adaptation of organic farming are summarized in Fig. 5.

4.3 Marketing of Organically Produced Commodity in India and World

The world is moving toward organic food and market for organic foods is developing rapidly throughout Europe.[134,138–141] In the purchase of organic food, the major factor play key roles are knowledge about the organic food, consumer perception and cost acceptability of organic commodity. There is growing demand for

| Traditional methods                        | Recommended management practices (RMPs)                                      |
|--------------------------------------------|--------------------------------------------------------------------------------|
| Biomass burning and residual removal       | Residue return as surface mulch                                              |
| Conventional tillage and clean cultivation | Conservation tillage, no till and mulch farming                              |
| Bare/idle fallow during off season         | Growing cover crops during off-season                                         |
| Continuous monoculture                     | Crop rotations with high density                                              |
| Low input subsistence farming and soil     | Judicious use of off-farm input                                              |
| fertility mining                           |                                                                                |
| Intensive use of chemical                  | Integrated nutrient management, fertilizers with compost, bio-solids and nutrient cycling, precision farming |
| Intensive cropping                         | Integrated trees and livestock with crop production                          |
| Surface flood irrigation                    | Drip, furrow or sub irrigation                                               |
| Indiscriminate use of pesticides           | Integrated pest management                                                   |
| Cultivating marginal soils                 | Conservation reserve programme, restoration of degraded soils through land use programme |
Table 3. Resource conversion technology and potential benefits to conventional farming

| Key resource conversion technology | Potential benefits relative to conventional farming |
|-----------------------------------|-----------------------------------------------------|
| Zero tillage                      | Reduced water use, carbon sequestration, increased yield and income, reduced GHGs emission, more tolerance to heat stresses. |
| Direct Seeding (of rice)          | Reduced water requirement, saving in time, better condition of field for succeeding crop, adequate root growth, better tolerance to water and heat stress, reduced methane emission. |
| Raised bed planting               | Less water use, improved drainage, better residue management, less lodging of crop, more tolerance to water stress. |
| Diversification                   | Efficient use of water, increased income, increased nutrient security, conservation of soil fertility, reduced risk |

Fig. 5. The advantages and few weakness towards the adaptation of organic farming
organic food driven by consumer’s perception of the quality and safety factor of these food and positive impact on the environment. [134,138–141] Consumer’s behavior toward the acceptability of organic also directly depends on motivational factor. [142,143] For consumers organic food is related to less interference, less processing activities, less or no artificial additives during any stage of processing. [144] Deaton and Muellbauer (1980) [145] explained consumer’s behavior in language of preferences and opportunities of choice available. The principal obstacle in the organic farming is lack of information regarding the organic products within the consumers. Organic food several times misunderstood in different prospective by the consumers due to several contradiction and claims and due to lack of proper and defined definition of organic. [145–148] According to researchers the issue of organic food safety and higher nutritional content and potential to cure diseases still under the controversial claims and not proven yet. [27,149,150] According to recent data reported by Willer et al. (2020) [84] and various other resources, organic food market is having higher growth rate as compared to other product market and probably it could happened due to several disease epidemic like foot-and-mouth epidemic, Belgian dioxin scandal, mad cow diseases etc. in the numerous places of the world derived from the conventional food. [151,152] Major challenge in the organic marketing is lacking of branding and certification of organic products. According to result presented by Kumar et al. (2017) [76], Sikkim is 100% organic state of India but still only 19.9% consumers can differentiate between the organic and inorganic foods and 75% consumers prefer organically food products. [153,154] There are three sections of consumer behavior that need to be addressed carefully for the successful marketing of organic food and products: psychological influences, socio-cultural influences and situational influences. [155–157]

Apart from the above mention reasons location and types of food products available in market also affect the choice and preference of consumers. In addition to this distribution of organic food has been dominated by supermarket trend in the most of developed and developing countries. [155,158,159] In UK, four chains of supermarket control over 80% sales of organic commodity, whereas; in Australia only two supermarket chains account about 80% organic sales. [160–164] Similarly, in Sikkim, India about 31.41% consumers prefers to purchase organic commodity from the supermarket. Government owned shops and other regulated shops by different agencies are also working for the growth of organic market and providing scopes to farmers for the better growth of organic market. [165] Preferences and believe of the consumers also give direction to the organic market, according to conclusion of survey reported by Schobesberger et al. (2007) [166] more than 33.33% of respondent having purchased organic fruits and vegetable. Similar result also reported by Kumar et al. (2017) [76] about 28% consumers preferred vegetable and fruits in Sikkim, India. But at the same time world organic market is growing at very high rate for example US organic industry is flourishing with annual increase in consumption of 20% per year. [167,168] As well as world organic market growth rate predicted to increase at the rate of 30%. [169,170] A simple route for marketing of organic commodity including production, marketing, processing and impact on ecosystem is presented in Fig. 6.

4.4 Primary Processing

Primary processing of organic commodity includes operation like cleaning, sorting, grading, waxing, washing and other simple operation that do not change the form of the commodity. Primary processing before packaging help to increase the self-life of commodity and reduce the cost of transportation by eliminating the defected sample from the lot of commodity. Cleaning / washing are required to remove the undesirable parts from the commodity like soil, dirt and other contaminants. Waxing is another primary processing that insures reduction in the water loss during the storage and transportation; natural waxes can be used for waxing of organic commodity to increase the self-life of the commodity. [171–173]

4.5 Packaging of Organic Commodity

The packaging protects from external threat like contamination, mechanical damage, microbial attack, environmental conditions and other external affairs. The package must suit the nature of the containing material. Biological material (Organically produced food) shows respiration, ethylene production, release the heat and other biological activities after the harvesting. Thus, maintaining the level of O2, CO2 and other gaseous composition play major role in safe and sound transportation of organically produced commodity. Packaging of the commodity known as the silent salesman that
contains all the essential and important information about the product. [174–178]

According to Zagory et al. (1988)[179], many factors must be taken into consideration in creating gaseous micro-environment for packaged produce to maintain the quality of fresh biological materials (fruits and vegetables). Modified Atmospheric Packaging (MAP), Controlled Atmospheric Packaging (CAP), Active Packaging and other packaging method are useful in protecting and transportation of Organic commodity to short and long distance.[180,181] The presence of mycotoxins i.e. metabolites produced from fungi has to be mentioned on packaging and labels of organic food products as they have harmful impacts on humans and animals. [182,183]

### 4.6 Marketing Status of Organic Food

India has very big market for the organic food crop and provides number of opportunities to the organic grower for high market value of their organic produce. India having more than 300 million of middle class population which is potential consumers for the organic food market.[180,181] In the recent few years the area under the organic cultivation has increased rapidly. According the recent data in 2013 – 2014 area under the organic cultivation has increased by 0.2 million hectares in India. Major organic crops exported from the India to the different countries consists of oil seed (50%), processed food products (25%), cereals & millets (17%), Tea (2%), Pulses (2%), spices (1%), dry fruits (1%), others (2%).

![Fig. 6. Simple route for marketing of organic commodity including production, marketing, processing and impact on ecosystem](image_url)
Indian Agriculture having significant potential to meet the requirement of organic food to the domestic and international market. India having more than 720000 hectares of land under the organic agriculture which is only 0.4% of total land under the organic cultivation worldwide by 2014. Major livelihood function in India is agriculture in which more than 6,50,000 farmers are involved in organic activities by 2014. [184–186] India produced about 1.35 million MT (2015-16) of certified organic products. The major countries where these products get exported are US, Canada, New Zealand, South East Asian Countries, European Union, Australia, Switzerland etc.[187,188] It includes not only food but organic cotton fibers, functional food products also. The major food crops in India which are organically produce are sugarcane, oil seed, cereals & millets, cotton, pulses, medicinal plants, tea, fruits, spices, dry fruits, vegetables, coffee etc.[97]

5. CONCLUSIONS

Worldwide conventional mechanized farming helped to increase the food production but over the period come with a host of problems including human health, pollution, degradation of soil and water, and impact on eco system. Organic farming system avoids the use of synthetic inputs and mainly relies upon crop rotations, crop residues, animal manures, off-farm organic waste, and biological system of nutrient mobilization and plant protection. Organic agriculture is potentially capable to serve the twin role of countries’ food security and the environment protection. Even though the increasing trend in the organic agricultural area in the country, there is still need for further improvement, especially in the areas of research, extension and awareness among personnel directly or indirectly involved in the organic farming.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Mahendra Dev S, Sharma AN. Oxfam India working papers series OIWPS-VII Food Security in India: Performance, Challenges and Policies; 2010.
2. Grandgirard J, Poinsot D, Krespi L, Nénon JP, Cortesero AM. Costs of secondary parasitism in the facultative hyperparasitoid Pachyceroideus dubius: Does host size matter? Entomol Exp Appl 2002;103:239–48. Available:https://doi.org/10.1023/A
3. Aggarwal PK. Global climate change and Indian agriculture: Impacts, adaptation and mitigation. Indian J Agric Sci. 2008;78:911–9.
4. Funk CC, Brown ME. Declining global per capita agricultural production and warming oceans threaten food security. Food Secur. 2009;1:271–89. Available:https://doi.org/10.1007/s12571-009-0026-y
5. Cakmak I. Plant nutrition research: Priorities to meet human needs for food in sustainable ways. Plant Soil. 2002;247:3–24. Available:https://doi.org/10.1023/A:1021194511492
6. Margat J, Vallée D. Mediterranean Vision on water, population and the environment for the 21st Century. 2000:1–66.
7. Carvalho FP. Agriculture, pesticides, food security and food safety. Environ Sci Policy. 2006;9:685–92. Available:https://doi.org/10.1016/j.envsci.2006.08.002
8. Carvalho FP. Pesticides, environment, and food safety. Food Energy Secur. 2017;6:48–60. Available:https://doi.org/10.1002/fes3.108
9. Sharma N, Singhvi R. Effects of Chemical Fertilizers and Pesticides on Human Health and Environment: A Review. Int J Agric Environ Biotechnol. 2017;10:675. Available:https://doi.org/10.5958/2230-732x.2017.00083.3
10. Bourguet D, Guillemaud T. Sustainable Agriculture Reviews. 2016:19. Available:https://doi.org/10.1007/978-3-319-26777-7
11. Hamuda HE a FB, Patkó I. Relationship between Environmental Impacts and Modern Agriculture. 2010:1–87–98.
12. Altieri M. Ecological Impacts of Modern Agriculture in the United States and Latin America. Glob Rural Environ. 2001:123–37.
13. Pugliese P. Organic farming and sustainable rural development: A multifaceted and promising convergence. Sociol Ruralis. 2001;41:112–30. Available:https://doi.org/10.1111/1467-9523.00172
14. Sen A. An aspect of Indian agriculture. Econ Wkly. 1962;14:243–6.
15. Singh T. An Overview n.d.
16. Sarkar A, Aronson KJ, Patil S, Hugar LB, vanLoon GW. Emerging health risks associated with modern agriculture practices: A comprehensive study in India. Environ Res. 2012;115:37–50. Available:https://doi.org/10.1016/j.envres.2012.03.005
17. Arjun KM. Indian agriculture-status, importance and role in Indian economy. Int J Agric Food Sci Technol. 2013;4:343–6.
18. Kumar KSK, Parikh J. Indian agriculture and climate sensitivity. Glob Environ Chang. 2001;11:147–54. Available:https://doi.org/10.1016/S0959-3780(01)00004-8
19. Kumar N, Suresh B. Mapping Indian agricultural emissions: Lessons for Food System Transformation and Policy Support for Climate-Smart Agriculture; 2017.
20. Korcak RF. Early Roots of the Organic Movement: A Plant Nutrition Perspective. Horttechnology. 1992;2:263–7. Available:https://doi.org/10.21273/horttech.2.2.263
21. Ramesh P, Singh M, Subba Rao A. Organic farming: Its relevance to the Indian context. Curr Sci. 2005;88:561–8.
22. Trewavas A. Urban myths of organic farming. Nature. 2001;410:409–10. Available:https://doi.org/10.1038/35068639
23. Forman J, Silverstein J, Bhatia JJS, Abrams SA, Corkins MR, De Ferranti SD, et al. Organic foods: Health and environmental advantages and disadvantages. Pediatrics. 2012;130. Available:https://doi.org/10.1542/peds.2012-2579
24. Kledal PR, El-Araby A, Salem SG. Country report: Organic food and farming in Egypt. World Org Agric Stat Emerg Trends. 2008 2008:160–3. Available:https://doi.org/10.4324/9781849775991
25. Häring A, Dabbert S, Offermann, H, Offermann F, Nieberg H. Benefits of organic farming for society. Eur Conf Food Farming-Towards Partnersh Action Eur Copenhagen, Denmark. 2001;10:2001.
26. Popa ME, Mitelut AC, Popa EE, Stan A, Popa VI. Organic foods contribution to nutritional quality and value. Trends Food Sci Technol. 2019;84:15–8. Available:https://doi.org/10.1016/j.tifs.2018.01.003
27. Bourn D, Prescott J. A comparison of the nutritional value, sensory qualities, and food safety of organically and conventionally produced foods. Crit Rev Food Sci Nutr. 2002;42:1–34. Available:https://doi.org/10.1080/10408690.2002.10390544
28. Bernacchia R, Preti R, Vinci G. Organic and conventional foods: Differences in nutrients. Ital J Food Sci. 2016;28:565–78. Available:https://doi.org/10.14674/1120-1770/ijfs.v224
29. García JM, Teixeira P. Organic versus conventional food: A comparison regarding food safety. Food Rev Int. 2017;33:424–46. Available:https://doi.org/10.1080/87559129.2016.1196490
30. Tsakiridou E, Boutsouki C, Zotos Y, Mattas K. Attitudes and behaviour towards organic products: An exploratory study. Int J Retail Distrib Manag. 2008;36:158–75. Available:https://doi.org/10.1108/09590550810853093
31. Magkos F, Arvaniti F, Zampelas A. Organic food: Nutritious food or food for thought? A review of the evidence. Int J Food Sci Nutr. 2003;54:357–71. Available:https://doi.org/10.1080/096374802012092071
32. Williams CM. Nutritional quality of organic food: shades of grey or shades of green? Proc Nutr Soc. 2002;61:19–24. Available:https://doi.org/10.1079/pns2001126
33. Trewavas A. A critical assessment of organic farming-and-food assertions with particular respect to the UK and the potential environmental benefits of no-till agriculture. Crop Prot. 2004;23:757–81. Available:https://doi.org/10.1016/j.cropro.2004.01.009
34. Dall’Asta M, Angelino D, Pellegrini N, Martini D. The nutritional quality of organic and conventional food products sold in Italy: Results from the food labelling of Italian products (flip) study. Nutrients. 2020;12:1–13. Available:https://doi.org/10.3390/nu12051273
35. Lester GE. Organic versus conventionally grown produce: Quality differences, and guidelines for comparison studies. HortScience. 2006;41:296–300. Available:https://doi.org/10.21273/hortsci.4.1.2.296
36. Çerçi E, Erdost H. Stem cell. Ataturk Univ Vet Bilim Derg. 2019;14:221–8.
   Available: https://doi.org/10.17094/ataunivbd.483253
37. Doyle C, Kushi LH, Byers T, Courneya KS, Demark-Wahnefried W, Grant B, et al. Nutrition and Physical Activity During and After Cancer Treatment: An American Cancer Society Guide for Informed Choices. CA Cancer J Clin. 2006;56:323–53.
   Available:https://doi.org/10.3322/canjcclin.5.6.6.323
38. Magkos F, Arvaniti F, Zampelas A. Organic food: Buying more safety or just peace of mind? A critical review of the literature. Crit Rev Food Sci Nutr. 2006;46:23–56.
   Available:https://doi.org/10.1080/10408690.490911846
39. Bishop B. Organic Food in Cancer Therapy. Nutr Health. 1988;6:105–9.
   Available:https://doi.org/10.1177/02601060.8800600204
40. Lobo V, Patil A, Phatak A, Chandra N. Free radicals, antioxidants and functional foods: Impact on human health. Pharmacogn Rev. 2010;4:118–26.
   Available:https://doi.org/10.4103/0973-7847.70902
41. Benbrook C. Elevating Antioxidant Levels in Food Through Organic Farming Processing: An Organic Center State of Science Review. Organic Center; 2005.
42. Aulakh CS, Ravisankar N. Organic farming in Indian context: A perspective. Agric Res J. 2017;54:149.
   Available:https://doi.org/10.5958/2395-146x.2017.00031.x
43. Aruoma OI. Nutrition and health aspects of free radicals and antioxidants. Food Chem Toxicol. 1994;32:671–83.
   Available:https://doi.org/10.1016/0278-6915(94)90011-6
44. Lombardo S, Pandino G, Mauromicale G. Nutritional and sensory characteristics of “early” potato cultivars under organic and conventional cultivation systems. Food Chem. 2012;133:1249–54.
   Available:https://doi.org/10.1016/j.foodchem.2011.10.005
45. Murador D, Braga AR, Da Cunha D, De Rosso V. Alterations in phenolic compound levels and antioxidant activity in response to cooking technique effects: A meta-analytic investigation. Crit Rev Food Sci Nutr. 2018;58:169–77.
   Available:https://doi.org/10.1080/10408398.2016.1140121
46. Wootton-Beard PC, Ryan L. Improving public health?: The role of antioxidant-rich fruit and vegetable beverages. Food Res Int. 2011;44:3135–48.
   Available:https://doi.org/10.1016/j.foodres.2011.09.015
47. Mdithsha A, Magwaza LS, Tesfay SZ, Mbili N. Postharvest quality and composition of organically and conventionally produced fruits: A review. Sci Hortic (Amsterdam). 2017;216:148–59.
   Available:https://doi.org/10.1016/j.scienta.2016.12.033
48. Davies N, Andrews P, Zhao X, Yáñez J, Benbrook C. Nutritional Superiority of Organic Food. Org Cent. 2008:53.
49. Timsina J. Can organic sources of nutrients increase crop yields to meet global food demand? Agronomy. 2018:8:1–20.
   Available:https://doi.org/10.3390/agronomy8100214
50. Matt D, Ewa Rembiawksa, Anne Luik, Elen Peetsmann, Sirli Pehme. Quality of Organic vs. Conventional Food and Effects on Health. 2011:4.
   Available:https://doi.org/10.1016/j.jlivsci.2008.04.006
51. Brentrup F, Küsters J, Lammel J, Barraclough P, Kuhlmann H. Environmental impact assessment of agricultural production systems using the life cycle assessment (LCA) methodology II. The application to N fertilizer use in winter wheat production systems. Eur J Agron. 2004;20:265–79.
   Available:https://doi.org/10.1016/S1161-0301(03)00039-X
52. Spiertz JH, Nitrogen JHJS, Agronomy A. Nitrogen , sustainable agriculture and food security . A review To cite this version : HAL Id : hal-00886486 2010.
53. Tuomisto HL, Hodge ID, Riordan P, Macdonald DW. Does organic farming reduce environmental impacts? A meta-analysis of European research. J Environ Manage. 2012;112:309–20.
   Available:https://doi.org/10.1016/j.jenvman.2012.08.018
54. Jensen ES, Bedoussac L, Carlsson G, Journet E-P, Justes E, Hauggaard-Nielsen H. Enhancing Yields in Organic Crop Production by Eco-Functional
Intensification. Sustain Agric Res. 2015;4:42.
Available:https://doi.org/10.5539/sar.v4n3p42

55. Horrigan L, Lawrence RS, Walker P. How sustainable agriculture can address the environmental and human health harms of industrial agriculture. Environ Health Perspect. 2002;110:445–56.
Available:https://doi.org/10.1289/ehp.02110445

56. Storstad O, Bjerkhaug H. Foundations of production and consumption of organic food in Norway: common attitudes among farmers and consumers? Agric Human Values. 2003;20:151–63.

57. De Ponti T, Rijk B, Van Ittersum MK. The crop yield gap between organic and conventional agriculture. Agric Syst. 2012;108:1–9.
Available:https://doi.org/10.1016/j.agsy.2011.12.004

58. Seufert V, Ramankutty N, Foley JA. Comparing the yields of organic and conventional agriculture. Nature. 2012;485:229–32.
Available:https://doi.org/10.1038/nature11069

59. Badgley C, Moghtader J, Quintero E, Zakem E, Chappell MJ, Avilés-Vázquez K, et al. Organic agriculture and the global food supply. Renew Agric Food Syst. 2007;22:86–108.
Available:https://doi.org/10.1017/S1742170507001640

60. Pandey J, Singh A. Opportunities and constraints in organic farming: an Indian perspective. J Sci Res. 2012;56:47–72.

61. Connor DJ. Organic agriculture cannot feed the world. F Crop Res. 2008;106:187–90.
Available:https://doi.org/10.1016/j.fcr.2007.11.010

62. Murphy KM, Campbell KG, Lyon SR, Jones SS. Evidence of varietal adaptation to organic farming systems. F Crop Res. 2007;102:172–7.
Available:https://doi.org/10.1016/j.fcr.2007.03.011

63. Basha MB, Mason C, Shamsudin MF, Hussain HI, Salem MA. Consumers attitude towards organic food. Procedia Econ Financ. 2015;31:444–52.
Available:https://doi.org/10.1016/s2212-5671(15)01219-8

64. Aertsens J, Verbeke W, Mondelaers K, van Huylenbroeck G. Personal determinants of organic food consumption: A review. Br Food J. 2009;111:1140–67.
Available:https://doi.org/10.1108/00070700910992961

65. Padel S, Foster C. Exploring the gap between attitudes and behaviour: Understanding why consumers buy or do not buy organic food. Br Food J. 2005;107:606–25.
Available:https://doi.org/10.1108/00070700510611002

66. Singh A, Verma P. Factors influencing Indian consumers’ actual buying behaviour towards organic food products. J Clean Prod. 2017;167:473–83.
Available:https://doi.org/10.1016/j.jclepro.2017.08.106

67. Shafie FA, Rennie D. Consumer Perceptions Towards Organic Food. Procedia - Soc Behav Sci. 2012;49:360–7.
Available:https://doi.org/10.1016/j.jsbspro.2012.07.034

68. Aarset B, Beckmann S, Bigne E, Beveridge M, Bjorndal T, Bunting J, et al. The European consumers’ understanding and perceptions of the “organic” food regime: The case of aquaculture. Br Food J. 2004;106:93–105.
Available:https://doi.org/10.1108/00070700410516784

69. Hemmerling S, Hamm U, Spiller A. Consumption behaviour regarding organic food from a marketing perspective—a literature review. Org Agric. 2015;5:277–313.
Available:https://doi.org/10.1007/s13165-015-0109-3

70. Specht K, Siebert R, Hartmann I, Freisinger UB, Sawicka M, Werner A, et al. Urban agriculture of the future: An overview of sustainability aspects of food production in and on buildings. Agric Human Values. 2014;31:33–51.
Available:https://doi.org/10.1007/s10460-013-9448-4

71. Meier MS, Stoessel F, Jungbluth N, Juraske R, Schader C, Stolze M. Environmental impacts of organic and conventional agricultural products e Are the differences captured by life cycle assessment? J Environ Manage. 2015;149:193–208.
Available:https://doi.org/10.1016/j.jenvman.2014.10.006

72. Koen M, Joris, Aertsens and Guido Van H, van Huylenbroek G, Mondelaers K,
82. Gomiero T, Paoletti MG, Pimentel D. Energy and environmental issues in organic and conventional agriculture. CRC Crit Rev Plant Sci. 2008;27:239–54.

Available: https://doi.org/10.1080/07352680.80225456

83. Gomiero T, Pimentel D, Paoletti MG. Environmental impact of different agricultural management practices: Conventional vs. Organic agriculture. CRC Crit Rev Plant Sci. 2011;30:95–124. Available: https://doi.org/10.1080/07352689.2011.554355

84. Willer H, Schlatter B, Trávníček J, Kemper L, Lernoud J. The world of organic agriculture. Statistics and emerging trends 2020. World Org Agric Stat Emerg Trends. 2020;2020.

85. Le-anh T, Nguyen-to T. Consumer purchasing behaviour of organic food in an emerging market. 2020:1–11. Available: https://doi.org/10.1111/iijcs.12588

86. Dhiman V. Organic Farming for Sustainable Environment: Review of Existed Policies and Suggestions for Improvement. 2020;7.

87. Gifford K, Bernard JC. Influencing consumer purchase likelihood of organic food. 2006:155–63. Available: https://doi.org/10.1111/j.1470-6431.2005.00472.x

88. Nguyen HV, Nguyen N, Nguyen BK, Lobo A, Vu PA. Organic food purchases in an emerging market: The influence of consumers' personal factors and green marketing practices of food stores. Int J Environ Res Public Health. 2019;16:1037. Available: https://doi.org/10.3390/ijerph16011037

89. Commentary I, Interview AA. Association of Frequency of Organic Food Consumption With Cancer Risk Findings From the NutriNet-Santé Prospective Cohort Study. 2018;178:1597–606. Available: https://doi.org/10.1001/jamainternmed.2018.4357

90. Lin J, Guo J, Turel O, Liu S. International Journal of Information Management Purchasing organic food with social commerce: An integrated food-technology consumption values perspective. Int J Inf Manage. 2019;102033. Available: https://doi.org/10.1016/j.ijinfomgt.2019.11.001

91. Welfare F. Sub-mission on Agricultural Mechanization Government of India. 2018;110001.

92. Kalra S. A Study of Land Utilization in Different Areas of India. 2018;4:631–6.
93. Patle GT, Badyopadhayy KK, Kumar M. An overview of organic agriculture: A potential strategy for climate change mitigation; 2014.

94. Wani S, Chand S, Najar G, Teli M. Organic farming: As a climate change adaptation and mitigation strategy. Curr Agric Res J. 2013;1:45–50. Available:https://doi.org/10.12944/carj.1.1.06

95. Raizada O, Goswami RG. Concept of organic farming. Biot Res Today. 2020;2:465–8.

96. Mariappan K. A Threat of Farmers Suicide and the Opportunity in Organic Farming for Sustainable Agricultural Development in India; 2019.

97. APEDA A& PFPEDA. Organic_Products @ apeda.gov.in; 2020. Available:http://apeda.gov.in/apedawebsite/organic/Organic_Products.htm#:~:text=As on 31st March 2018,%25) for wild harvest collection.

98. Yadav GS. Productivity and profitability assessment of organically grown vegetables embedded in rice based cropping sequences in Sikkim Himalayas, North East India; 2020. Available:https://doi.org/10.22438/jeb/41/1/MRN-1146

99. Meek D, Anderson CR. Agroecology and Sustainable Food Systems Scale and the politics of the organic transition in. Agroecol Sustain Food Syst. 2019;00:1–20. Available:https://doi.org/10.1080/21683565.2019.1701171

100. Swami S. Chapter - 8; 2020. Available:https://doi.org/10.22271/ed.book.787

101. Davis KF, Gephart JA, Emery KA, Leach AM, Galloway JN, D’Odorico P. Meeting future food demand with current agricultural resources. Glob Environ Chang. 2016;39:125–32. https://doi.org/10.1016/j.gloenvcha.2016.05.004

102. Duro JA, Lauk C, Kastner T, Erb KH, Haberl H. Global inequalities in food consumption, cropland demand and land-use efficiency: A decomposition analysis. Glob Environ Chang. 2020;64:102124. Available:https://doi.org/10.1016/j.gloenvcha.2020.102124

103. Bhattacharyya PN, Jha DK. Plant growth-promoting rhizobacteria (PGPR): Emergence in agriculture. World J Microbiol Biotechnol 2012;28:1327–50. Available:https://doi.org/10.1007/s1274-011-0979-9

104. Soetan KO, Olayia CO, Oyewole OE. The importance of mineral elements for humans, domestic animals and plants: A review. African J Food Sci 2010;4:200–22.

105. Bhattacharyya P. Organic food production in India: Status, strategy and scope. Agrobios (India); 2004.

106. Watson CA, Bengtsson H, Ebbesvik M, Læs A-K, Myrbeck A, Salomon E, et al. A review of farm-scale nutrient budgets for organic farms as a tool for management of soil fertility. Soil Use Manag. 2002;18:264–73. Available:https://doi.org/10.1079/sum2002127

107. Tuck SL, Winqvist C, Mota F, Ahnström J, Turnbull LA, Bengtsson J. Land-use intensity and the effects of organic farming on biodiversity: A hierarchical meta-analysis. J Appl Ecol. 2014;51:746–55. Available:https://doi.org/10.1111/1365-2664.12219

108. Padel S, Zander K, Gössinger K. Regional production 'and ' Fairness ' in organic farming: Evidence from a CORE Organic project Ethical concerns of organic stakeholders compared with the European Regulation. 2010:1793–802.

109. Arden-Clarke C, Hodges RD. The environmental effects of conventional and organic/biological farming systems. II. soil ecology, soil fertility and nutrient cycles. Biol Agric Hortic. 1988;5:223–87. Available:https://doi.org/10.1080/01448765.1988.9755147

110. Howard A. The soil and health: A study of organic agriculture. University Press of Kentucky; 2006.

111. Pandey J, Pandey U. Accumulation of heavy metals in dietary vegetables and cultivated soil horizon in organic farming system in relation to atmospheric deposition in a seasonally dry tropical region of India. Environ Monit Assess. 2009;148:61–74. Available:https://doi.org/10.1007/s10661-007-0139-8

112. Kars N, Dengiz O. Assessment of potential ecological risk index based on heavy metal elements for organic farming in micro catchments under humid ecological condition. Eurasian J Soil Sci. 2020;9:194–201.
113. Baldivieso-Freitas P, Blanco-Moreno JM, Armengot L, Chamorro L, Romanyá J, Sans FX. Crop yield, weed infestation and soil fertility responses to contrasted ploughing intensity and manure additions in a Mediterranean organic crop rotation. Soil Tillage Res. 2018;180:10–20. Available:https://doi.org/10.1016/j.still.2018.02.006

114. Doltra J, Gallejones P, Olesen JE, Hansen S, Freseth RB, Krauss M, et al. Simulating soil fertility management effects on crop yield and soil nitrogen dynamics in field trials under organic farming in Europe. F Crop Res. 2019;233:1–11. Available:https://doi.org/10.1016/j.fcr.2018.12.008

115. Voisin AS, Guéguen J, Huyghe C, Jeuffroy MH, Magrini MB, Meynard JM, et al. Legumes for feed, food, biomaterials and bioenergy in Europe: A review. Agron Sustain Dev. 2014;34:361–80. Available:https://doi.org/10.1007/s13593-013-0189-y

116. Miranda B, Yamakami A. A Multiobjective Approach for Crop Rotation Planning; 2019.

117. Kumari P, Maurya S, Meena MK. Disease management by organic farming. 2020;9:1907–10.

118. Watson C.A., Atkinson D, Gosling P, Jackson LR, Rayns FW. Managing soil fertility in organic farming systems. Soil Use Manag. 2002;18:239–47. Available:https://doi.org/10.1079/sum2002131

119. Society E, Applications E. Crop Rotation and Intercropping Strategies for Weed Management Author ( s ) : Matt Liebman and Elizabeth Dyck Reviewed work ( s ) : Published by : Ecological Society of America Stable URL : Crop Rotation and Intercropping. 2011;3:92–122. Available:http://www.jstor.org/stable/1941795

120. Melander B, Rasmussen IA, Bárberi P. Integrating physical and cultural methods of weed control—examples from European research. Weed Sci. 2005;53:369–81. Available:https://doi.org/10.1614/ws-04-136r

121. MacLaren C, Storkey J, Menegat A, Metcalfe H, Dehnen-Schmutz K. An ecological future for weed science to sustain crop production and the environment. A review. Agron Sustain Dev. 2020;40. Available:https://doi.org/10.1007/s13593-020-00631-6

122. Merfield CN. Integrated weed management in organic farming. Elsevier Inc.; 2018. Available:https://doi.org/10.1016/B978-0-12-813272-2.00005-7

123. Wilhelm WW, Doran JW, Power JF. Corn and Soybean Yield Response to Crop Residue Management Under No-Tillage Production Systems.1. Agron J. 1986;78:184–9. Available:https://doi.org/10.2134/agronj1986.00021962007800010036x

124. Wilhelm WW, Johnson JMF, Karlen DL, Lightle DT. Corn stover to sustain soil organic carbon further constrains biomass supply. Agron J. 2007:99:1665–7. Available:https://doi.org/10.2134/agronj2007.0150

125. Saadatnia H, Riahi H. Cyanobacteria from paddy fields in Iran as a biofertilizer in rice plants. Plant, Soil Environ. 2009;55:207–12. Available:https://doi.org/10.17221/384-pse.

126. Samia Ageeb Akladious. Application of Trichoderma harzianum T22 as a biofertilizer supporting maize growth. African J Biotechnol. 2012;11:8672–83. Available:https://doi.org/10.5897/ajb11.4323

127. Porterfield A. Organic fungicide copper sulfate endangers humans, animals and insects. 2020;1–10.

128. Beckerman J. Using Organic Fungicides n.d.:1–4.

129. Oberč BP, Schnell AA. Approaches to sustainable agriculture. Exploring the pathways towards the future of farming; 2020. Available:https://doi.org/10.2305/IUCN.C.H.2020.07.en

130. Chitale SA. Present status and future prospects of medical libraries in India. Libri. 1954;3:134–6. Available:https://doi.org/10.1515/LIBR

131. Duru M, Theron O, Martin G, Martin-Coulaire R, Magne MA, Justes E, et al. How to implement biodiversity-based agriculture to enhance ecosystem services: a review. Agron Sustain Dev. 2015;35:1259–81. Available:https://doi.org/10.1007/s13593-015-0306-1
132. Santhoshkumar M. A Review on Organic Farming - Sustainable Agriculture Development. Int J Pure Appl Biosci 2017;5:1277–82. Available: https://doi.org/10.18782/2320-7051.5649

133. Institute of Organic Farming D. Research accomplishments NPOF_Dharwad.pdf; 2011.

134. Rigby D, Cáceres D. Organic farming and the sustainability of agricultural systems. Agric Syst. 2001;68:21–40. Available: https://doi.org/10.1016/S0308-521X(00)00060-3

135. Lumpur K, Lumpur K. Organic Farming a viable option for the global food supply and livelihood sustainability n.d.

136. Das S, Chatterjee A, Pal TK. Organic farming in India: a vision towards a healthy nation. Food Qual Saf. 2020:69–76. Available: https://doi.org/10.1093/fqsafe/fya018

137. Horgan FG, Kudavidanage EP. Use and Avoidance of Pesticides as Responses by Farmers to change Impacts in Rice Ecosystems of Southern Sri Lanka. Environ Manage. 2020;65:787–803. Available: https://doi.org/10.1007/s00267-020-01272-x

138. Baker P, Friel S. Food systems transformations, ultra-processed food markets and the nutrition transition in Asia. Global Health. 2016;12. Available: https://doi.org/10.1186/s12992-016-0223-3

139. Vicentini A, Liberatore L, Mastrocola D. Functional foods: Trends and development. Ital J Food Sci. 2016;28:338–52.

140. Peng M. The growing market of organic foods: Impact on the us and global economy. Elsevier Inc; 2019. Available: https://doi.org/10.1016/B978-0-12-812060-6.00001-5

141. Wier M, Calverley C. Market potential for organic foods in Europe. Br Food J. 2002;104:45–62. Available: https://doi.org/10.1108/00070700210418749

142. Lockie S, Lyons K, Lawrence G, Grice J. Choosing organics: A path analysis of factors underlying the selection of organic food among Australian consumers. Appetite. 2004;43:135–46. Available: https://doi.org/10.1016/j.appet.2004.02.004

143. Thøgersen J. The Motivational roots of norms for environmentally responsible behavior. Basic Appl Soc Psych. 2009;31:348–62. Available: https://doi.org/10.1080/01973530.903317144

144. Verhoog H, Matze M, Van Bueren EL, Baars T. The role of the concept of the natural (naturalness) in organic farming. J Agric Environ Ethics. 2003;16:29–49. Available: https://doi.org/10.1023/A

145. Deaton A, Muellbauer J. Economics and consumer behavior. Cambridge university press; 1980.

146. Zanoli R, Naspetti S. Consumer motivations in the purchase of organic food: A means-end approach. Br Food J. 2002;104:643–53. Available: https://doi.org/10.1108/00070700210425930

147. Berlis A, Schaller C, Meyer B, Frings J, Möller K, Pavlidis C, et al. Neuroradiological aspects in computerized simulation and individualization of pressure and flow within the rabbit aorta. Neuroradiol. 1999;41:S107.

148. Engel W. Determinants of consumer willingness to pay for organic food in South Africa. Africa (Lond). 2008;1:126.

149. Hassauer C, Roosen J. Toward a conceptual framework for food safety criteria: Analyzing evidence practices using the case of plant protection products. Saf Sci. 2020;127:104683. Available: https://doi.org/10.1016/j.ssci.2020.10.04683

150. Serra-Majem L, Raposo A, Aranceta-Bartina J, Varela-Moreiras G, Logue C, Laviada H, et al. Ibero-American consensus on low- and no-calorie sweeteners: Safety, nutritional aspects and benefits in food and beverages. 2018;10. Available: https://doi.org/10.3390/nu10070818

151. Elumalai SD. Evaluating the microbial safety status of products from sustainable organic agriculture. 2016:1–154.

152. Siderer Y, Maquet A, Anklem E. Need for research to support consumer confidence in the growing organic food market. Trends Food Sci Technol. 2005;16:332–43. Available: https://doi.org/10.1016/j.tifs.2005.02.001

153. Singh AB. Quality parameters and biochemical characteristics of produces under organic farming. Mod Concepts
Pract Org Farming Safe Secur Sustain Food Prod n.d.:461.
154. Verma N, Panwar AS. GENDER ROLE IN ORGANIC FARMING. Mod Concepts Pract Org Farming Safe Secur Sustain Food Prod n.d.:488.
155. Asioli D, Aschemann-Witzel J, Caputo V, Vecchio R, Annunziata A, Naes T, et al. Making sense of the “clean label” trends: A review of consumer food choice behavior and discussion of industry implications. Food Res Int. 2017;99:58–71. Available:https://doi.org/10.1016/j.foodres.2017.07.022
156. Lopez MO. Consumer Buying Behavior as Loyalty Antecedents at Selected Fast Food Chain Restaurants. 2018:186–201.
157. Oyserman D. Identity-based motivation: Implications for action-readiness, procedural-readiness, and consumer behavior. J Consum Psychol. 2009;19:250–60. Available:https://doi.org/10.1016/j.jcps.2009.05.008
158. Pearson D, Henryks J, Jones H. Organic food: What we know (and do not know) about consumers. Renew Agric Food Syst. 2011;26:171–7.
159. Justin P, Jyoti R. Consumer behavior and purchase intention for organic food. J Consum Mark, 2012;29:412–22. Available:https://doi.org/10.1108/07363761211259223
160. Angood KM, Wood JD, Nute GR, Whittington FM, Hughes SI, Sheard PR. A comparison of organic and conventionally-produced lamb purchased from three major UK supermarkets: Price, eating quality and fatty acid composition. Meat Sci 2008;78:176–84. Available:https://doi.org/10.1016/j.meatsci.2007.06.002
161. Lyons K. Supermarkets as organic retailers: Impacts for the Australian organic sector. Supermarkets Agri-Food Supply Chain Transform Prod Consum Foods. 2007:154–72.
162. Moore JB, Hori A, Fielding BA. Evaluation of the nutrient content of yogurts: A comprehensive survey of yogurt products in the major UK supermarkets. BMJ Open. 2018;8:1–11. Available:https://doi.org/10.1136/bmjopen-2017-021387
163. Cavaliere A, Peri M, Banterle A. Vertical coordination in organic food chains: A survey based analysis in France, Italy and Spain. Sustain. 2016;8. Available:https://doi.org/10.3390/su8060569
164. Steffen A, Doppler S. Building consumer trust and satisfaction through sustainable business practices with organic supermarkets: The case of Alnatura. Elsevier Ltd; 2018. Available:https://doi.org/10.1016/B978-0-08-102037-1.00014-1
165. Kumar J, Pradhan M, Singh N. Sustainable organic farming in Sikkim: An inclusive perspective BT - Advances in Smart Grid and Renewable Energy. In: SenGupta S, Zobaa AF, Sherpa KS, Bhoi AK, editors., Singapore: Springer Singapore; 2018:367–78.
166. Roitner-Schobesberger B, Darnhofer I, Somsook S, Vogl CR. Consumer perceptions of organic foods in Bangkok, Thailand. Food Policy. 2008;33:112–21. Available:https://doi.org/10.1016/j.foodpol.2007.09.004
167. Raynolds LT. The globalization of organic agro-food networks. World Dev. 2004;32:725–43. Available:https://doi.org/10.1016/j.worlddev.2003.11.008
168. Willer H, Lernoud J. The world of organic agriculture. Statistics and emerging trends 2019. Research Institute of Organic Agriculture FiBL and IFOAM Organics International; 2019. Available:https://doi.org/10.4324/9781849775991
169. Bazarlu O, Yatsenko O, Zakarchuk O, Ovcharenko A. Dynamic Development of the Global Organic Food Market and Opportunities for Ukraine n.d.:1–19.
170. Luh YH, Tsai MH, Fang CL. Do first-movers in the organic market stand to gain? Implications for promoting cleaner production alternatives. J Clean Prod. 2020;262:121156. Available:https://doi.org/10.1016/j.jclepro.2020.121156
171. Ilić ZS, Fallik E, Manojlović M, Kevrešan Ž, Mastilović J. Postharvest practices for organically grown products. Contemp Agric 2018;67:71–80. Available:https://doi.org/10.2478/contagri-2018-0011
172. Das K. Role of organic and environment friendly post harvest management of organically grown horticultural produces. Int J Chem Stud. 2020;8:1553–6. Available:https://doi.org/10.22271/chemi.2
173. Gibbs M, Steele P. Post harvest technology of horticultural crops. Scientific e-Resources; 2018.
174. Seo S, Ahn HK, Jeong J, Moon J. Consumers’ attitude toward sustainable food products: Ingredients vs. packaging. Sustain. 2016;8. Available:https://doi.org/10.3390/su8101073
175. Gifford K, Bernard JC. Packaging of organic and conventional products - a comparison. J Food Distrib Res. 2004;35:107–8.
176. Wieczyńska J, Cavoski I. Antimicrobial, antioxidant and sensory features of eugenol, carvacrol and trans-anethole in active packaging for organic ready-to-eat iceberg lettuce. Food Chem. 2018;259:251–60. Available:https://doi.org/10.1016/j.foodchem.2018.03.137
177. Paunonen S, Pitkänen M, Vähä-Nissi M, Leminen V, Kainusalmi M. Comparison of organic food packaging in Denmark, Finland, Germany, Great Britain and Italy. J Appl Packag Res. 2019;11:6.
178. Sturm B. Final report for the CORE Organic Plus funded project. Development of quality standards and optimised processing methods for organic. 2018.
179. Zagory D, Kader AA. Modified atmosphere packaging of fresh produce. Food Technol. 1988;42:70–7.
180. Ghoshal G. Recent trends in active, smart, and intelligent packaging for food products.