

# A Review on Scope and Challenges of Organic Farming in India

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## ABSTRACT

India grows a diverse range of food crops, including grains, pulses, and oilseeds. In the pretext of enhanced output, a vast amount of agrochemicals are being applied indiscriminately while keeping both soil and human health factor at bay. Hence, the need of the hour is an alternative agricultural approach that can meet the needs of current food requirements while offering security against potential ecological problems. Organic farming has been shown to be a viable solution to both of these issues. Therefore, understanding the organic agriculture, area and production scenario in the world and India, management practices, scope and challenges in adopting organic agriculture is the subject of this review. Organic farming has fewer prerequisites than chemical farming, and it is capable of providing economic security to mediocre farmers in a country like India. All production practices involve eco-friendly approaches. However, fulfilling the current food requirement is quite challenging for organic farming due to some of the issues like small land holdings, scarcity of organic inputs, weed control, carbon to nitrogen ratio, low yield, insufficient marketing infrastructure, etc. Despite many challenges, organic farming has much scope due to women's employment, rural development, public health and environmental security.

**Key words :** *Conventional farming, Challenges, Organic farming, Organic food industry, Sustainable development, Food Security*

## Introduction

Agriculture covers about 38 percent of the land on Earth. More than two thirds of the population in India depends on agriculture, making it one of the agriculturally oriented nations. Conventional agriculture refers to the current method of farming that uses synthetic based inputs like chemical fertilisers, insecticides, herbicides and genetically modified crops and varieties along with some mechanical tools for various procedures. Prior to 1965, our nation used traditional farming methods avoiding artificial pesticides and fertilisers. The majority of western countries and several developing countries

have been switching back to organic farming practises during the last 20 years as a result of various issues with conventional farming like production of greenhouse gases, biodiversity loss, pesticide contamination, and soil degradation. The majority of these environmental effects are caused by arable land, which makes up around 12 percent of the land surface. It will be difficult to feed a population that is predicted to increase to 9 to 10 billion by 2050 while still conserving the environment. Our best chance of overcoming this enormous issue and preserving the security of the food supply and the ecosystem in the future is through the widespread adoption of truly sustainable farming practises.

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Concerns about conventional agriculture's unsustainable practices have increased interest in alternative agricultural systems like organic farming, integrated farming, and conservation agriculture (Reganold and Wachter, 2016). India is in a unique position among the 187 nations that practice organic agriculture with 2.30 million hectares of area (FiBL report, 2021). India is home to 30 percent of all organic producers worldwide with 15,99,010 organic farmers and producing 34,96,800.34 million tonnes of organic food on 4.7 million hectare certified organic farming which contributes 1.04 billion USD to total export (APEDA Statistics, 2022). Despite of many challenges, Government of India has been promoting the organic farming as a chemical free farming to increase the demand of organic agricultural product through dedicated schemes namely Paramparagat Krishi Vikas Yojana (PKVY) and Mission Organic Value Chain Development for North Eastern Region (MOVCNDR) since 2015-16. Both the schemes provide support to organic farmers from organic production to certification and marketing including post-harvest management like processing, packaging etc. With the government of India's schemes and policies encouraging organic farming in terms of starting, implementing, and marketing organic food products, there is an ample scope for organic food production to expand and generate revenue to help strengthen the agrarian community and Indian economy.

### Definition

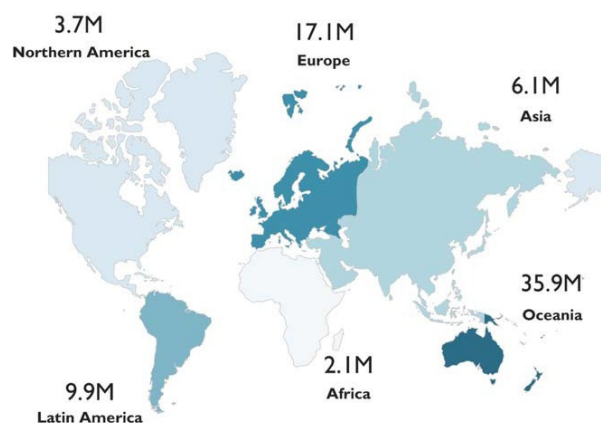
**Organic farming** is defined as, "agricultural system that uses ecological based pest controlling measures and biological fertilizers derived largely from animal and plant wastes and nitrogen-fixing cover crops". Modern organic farming was developed as a response to the environmental harm caused by the use of chemical pesticides and synthetic fertilizers in conventional agriculture, and it has numerous ecological benefits (Hemalatha, 2022). The International Federation of Organic Agriculture Movements (IFOAM) expressed 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." In another definition, National Program on Organic Production (NPOP) said "Organic agriculture is a system of farm design and management to create an eco-system which can achieve sustainable productivity without the use of artificial external inputs such as chemical fertilizers and pesticides."

### Scenario of Organic farming

#### A world view

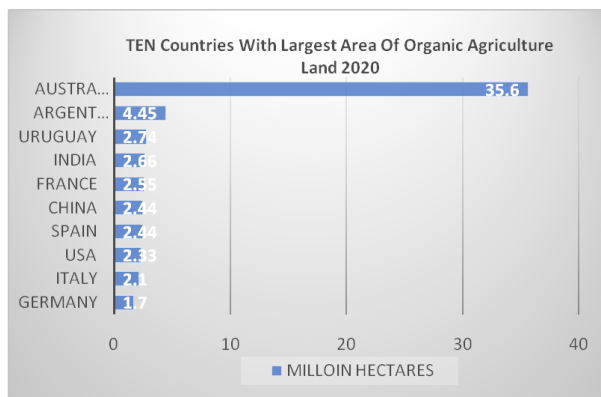
Among 187 countries, organic farming is practised and about 3.1 million farmers used organic practices to manage 72.3 million hectares of agricultural land. Australia (35.69 million hectares) has the largest amount of organic agricultural land, followed by Argentina (3.63 million hectares) and Spain (2.35 million hectares). More than 106 billion euros were spent on organic food globally in 2019 (FAO, 2021). Major exporters of organic production in 2021-22 are U.S.A. (186,339.21 MT), European union (170,762.22 MT), Canada (40,677.47 MT), Great Britain (30,221.77 MT) and Turkey (7,074.60 MT). Approximately 55 percent of Americans think that, the produce cultivated organically is healthier than the produce grown traditionally, while 41 percent feel there is no difference and 3 percent think conventionally grown fruit is superior. Most (6%) or some (34%) of the foods Americans eat, according to 40 percent of them, are organic. 75 percent of these Americans firmly believe that organic foods are healthier than those produced through traditional means (Funk



Organic agricultural land in hectares (M=millions)

Source: FiBL survey 2022

and Kennedy, 2016). Additionally, wealthy consumers frequently believe that organic farming is better for the environment, climate change mitigation, and animal welfare (Seufert *et al.*, 2017). Particularly in Europe, organic farming enjoys such a favourable public perception that it is frequently hailed as the model for sustainable agriculture (Mercati, 2016). Although there is still a lack of knowledge of organic farming in poorer nations, attitudes and food preferences in Europe are beginning to spread, especially among wealthier urban customers (Probst *et al.*, 2012).



Source: FiBL survey 2022 Research Institute of Organic Agriculture

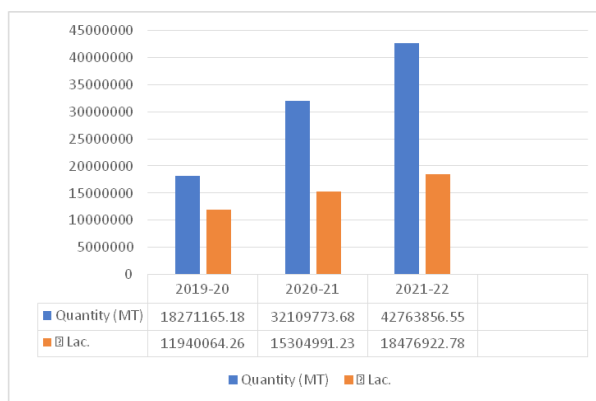
**An India view**

In India, organic farming is still in its infancy. As of March 2019, over 2.30 million hectares of cropland were being farmed organically. This amounts to 2% of the nation’s total net sown area of 140.1 million ha. Globally, India occupies 4<sup>th</sup> place under certified organic farming with 59.12 lakh hectares certified organic area (NPOP, 2022 and IFOAM Statistics, 2022). Given that a significant portion of this industry is concentrated in a small number of states, a few of them have taken the initiative to increase the coverage of organic farming. With 0.76 million acres of land under organic cultivation, Madhya Pradesh tops the list and accounts for almost 27% of all organic agricultural land in India followed by Rajasthan and Maharashtra. During 2016, Sikkim became the first state to cultivate the entire land under certified organic farming.

**Organic farming towards Indian economy**

Organic farming is a low-cost system that utilises local resources and has the potential to contribute es-

pecially to sustainable development of the world’s poorest regions (Kilcher, 2007). It is also regarded as a poverty-reduction strategy, particularly for small-holder and resource-constrained farmers in developing countries. Organic product price premiums contribute to organic farming profitability. During 2020-21 India exported 32109773.68 MT and generated the 15304991.23 lakhs (APEDA, 2022). A study comparing the economic profitability of organic and conventional farming in India found that, there is 9.2% decline in crop output due to 20-40% price premium, 11.7% reduction in production costs and 22% enhancement in farmers net profit (Ramesh *et al.*, 2010).



Source: APEDA Annual Data

**Fig. 2.** Three years organic products export summary statement (2019-20 To 2021-22)

**Scope of organic farming**

**Women empowerment**

Altenbuchner *et al.* (2017) conducted the studies on empowerment of women by organic farming in Odisha (India). The studies found that, health of the female farmers had been improved due to organic farming when compared to convention farming. By organic farming, the women achieved to maintain food security by intercropping, crop rotation and by cash crops. Women had expanded their income by organic cotton in addition to traditional livestock. They also established the crop seed bank to certified members for cash crops, which helped them to take equal decision making along with men.

**Rural employment**

Knickel and Renting (2000) studied on rural development and noticed that, rural employment and opportunities in rural areas is achieved by the or-

ganic farming and standards of people can be increased by increasing farm income. Similar study was done by Banks and Marsden (2001) and noticed that organic farming increase economy of rural people by focus on employment in organic farms, processing units and in preparation of organic inputs to crops etc.

### Health

Organic foods are frequently seen by consumers to be more nutritious and healthier than conventional foods (Seufert *et al.* 2017). The increased interest among consumers and producers in the nutritional value of both organically and conventionally cultivated food has been noted by Magnusson *et al.* (2003) and Brandt and Mlgoord (2001) among others. A study by AFSSA in 2003 found that, organically grown foods, particularly green vegetables and tubers have higher dry matter than foods grown conventionally. Similar findings were also made by Wose *et al.* (1997) and Bourn and Prescott (2002). Over the past 12 years, Sri Lanka faced the severe Chronic Kidney Disease Unidentified (CKDu) interstitial disease. Nearly 80% kidney failure were seen within 2 years, the main reason for disease is contamination of drinking water with heavy metals, long term exposure to agrochemicals, pesticide application without wearing protective measures, exposure to the sun and agrochemicals for long hours. But the CKDu disease patients had been reduced from 2011 to 2014 due to shift of country towards the organic farming. Ministry of Health had launched a plan called 'Towards a Toxin Free Country' for promotion of organic farming and health of public (Perera *et al.*, 2021).

### Environmental security

The effect of organic farming on the environment favours agro-ecosystem interactions that are essential for both agricultural production and nature preservation. By choosing organic goods, consumers may encourage a less damaging agriculture system through their purchasing power. Agriculture has lessened the unintended environmental costs of depleting natural resources (FAO, 2022). Studies conducted by Meemken and Qaim (2018) on impact of organic farming on environment found that, lower energy use (10–70% lower), greenhouse gas emission (14–31% reduced nitrous oxide emission and 39% less GHG emission), nutrient leaching (30–31% less nitrate leaching, 18% lowered ammonia emis-

sions, 1% less phosphorus losses), higher soil quality (6–7% higher soil organic matter) including larger and more active soil microbial communities and biodiversity (30–34% higher richness in species, 50% higher abundance of organisms and higher species evenness) were noticed in organic farming as compared to conventional farming.

### Crop production in Organic farming

#### Crop establishment

In organic farming monoculture is more difficult due to target of pest and weeds, hence multiple cropping provides the greater protection against biotic factors. Organic agriculture produces numerous source regions of biodiversity by preserving semi-natural habitats and promoting biodiversity within the production area, contributing to the beneficial variability of landscapes (IFOAM, 2020). All seeds and plant material must be organically certified. Cultivated species and types must be soil and climatic adaptable, as well as pest and disease resistant (Donnik *et al.*, 2016). Organic seed and plant materials must be used when they are accessible. When certified organic seed and plant materials are unavailable, conventional seed and plant materials without chemical treatment must be used. It is not recommended to use genetically modified seeds in organic farming (Azadi and Peter, 2010).

#### Nutrient management

Organic agriculture opts long term strategies to avoid the use of chemical fertilizers without adverse effect on soil fertility and crop productivity. Hence, practices which improve the physical, chemical and biological condition of soil and minimize soil erosion are given importance in organic farming (Peigne *et al.*, 2007). Nutrient requirement will be met by using organic manures, composts and biofertilizers. Managing the crop nutrients and soil fertility through rotations, cover crops, and the application of plant and animal materials like organic manures, composts and biofertilizers is necessary to maintain or improve soil organic matter (Khalid *et al.*, 2019). However, contamination of crops, soil, or water by nutrients, pathogenic organisms, heavy metals, or residues of prohibited substances should be kept in focus. Any soil-applied product, including composts or manures, must be produced in compliance with NOP regulations. Manure application leads to water contamination by phosphorus runoff hence it is recommended to follow biological nitro-

gen fixation or other nitrogen sources (Mikkelsen, 2000) like inclusion of pulses in cereal based intensive cropping systems. Nitrogen fixation is closely associated with the pulse crops which helps to increase the grain yield. Studies conducted by Amanuel *et al.* (2000) noticed that, the quantity of symbiotically fixed nitrogen in the case of faba beans, which can fix roughly 80% of total nitrogen absorption, is close to the amount of grain exported nitrogen. Panchagavya application significantly enhanced pods per plant, number of seeds per pod, grain production, and test weight over NPK and control in blackgram (Kumar *et al.*, 2011).

### Plant protection

Herbicides are typically prohibited in organic farming systems. Farmers use a variety of methods to replace them, as tillage alone is usually insufficient to control weeds. To alleviate the burden of weed infestation, organic farmers also implement preventative crop rotation, employ green manure, and cover crops. Weeds can be suppressed by selecting fast-growing cover crops that overshadow the soil (Bahadur *et al.*, 2015). Further, remaining weeds are removed mechanically by the farmer. The combination of indirect and direct procedures yields an environmentally and economically viable result (IFOAM, 2020). In organic farming the weed management is done by the utilization of techniques like stale seed bed, about 15-20% of cotton yield has been increased when stale seed bed is followed (Sanbagavalli, 2010). Das *et al.* (2016) conducted a field experiment in Meghalaya under organic farming to study the weed management in maize crop. Weed control under mulching recorded the maximum yield of 10 t ha<sup>-1</sup> which is at par with hand weeding. Mechanical and thermal weed control are natural methods that can be used as direct plant protection techniques in organic cultivation (Bond and Grundy, 2001). Letourneau *et al.* (2006) studied on crop protection in organic agriculture and noticed that, protection of crop from pest and disease can be done by preventing colonisation, eradication at low levels by methods like biological control (Gupta and Mukerji, 2000), curative biological control methods by release of selected biocontrol agents (Sharma and Pandey, 2009), crop rotation and soil and crop nutrient management practices (Venkatesh *et al.*, 2017). Development of habitat for natural enemies of pests, application of non-synthetic biological, botanical, or mineral inputs are some of the pest management

regulations recommended by Kumar and Topagi (2014).

### Marketing of organic products

In India, about 41% of organic products include tea, banana, honey, mangoes and oranges. Among all, tea is the common organic product in India (Garibay and Jyoti, 2003). Organic market in India is growing due to awareness of public on organic products and health benefits of organic foods. There are many local and large-scale private companies which are into promotion, procurement, export and domestic marketing of organic produce (Singh, 2003). In Indian market, the customers are of three types: upper class, upper middle class and lower middle class. About 90% of customers of organic products are from upper class (Garibay and Jyoti, 2003).

### Challenges to ensure food security by organic farming

#### Small land holdings

Small farmers and their families make up about 50% of India's total population, and 85% of all farms have an area of less than two hectares (Chand *et al.*, 2011). It is obvious that the condition of small farms is crucial to India's overall societal well-being (Little and Morgan, 2017). Studies conducted by Kersting and Wollni (2012) noticed that vegetable and honey producers who practised certified organic farming were less likely to be small farmers, when compared to medium to large farmers, who are more adaptable and prepared to take risks. Small farmers have a tendency to be risk-averse and are therefore less willing to try new production practises in organic farming. Studies conducted by Chandra (2014) noticed that most of the organic farmers in Jammu and Kashmir are small and poor farmers, where they are not able to sell their products directly in the market for better price due to small productive area and small out-put. Similar findings were noticed by Kaur and Toor (2015), small farmers are hard to sell their products in larger and big markets.

#### Scarcity of inputs

Organic source such as compost, vermicompost, biofertilizers availability in larger quantity is rare when compared to inorganic source availability. In developing countries like India, the organic waste like straw, stubbles, cow dung etc. lost in fields due to lack of technology and difficulty in collection.

Furthermore, Sharma *et al.*, (2011) also noticed that, people in rural regions use plant wastes such as straw, stubbles, pruned material, and cow dung to produce charcoal as an energy source because reliance on other energy sources such as LPG, diesel, petroleum products, and so on is costly.

### **Weed control**

The impact of cultural practises on crop to weed interactions often take longer time to develop in organic cropping systems than in conventional ones, both in the short term (within a crop cycle) and the long term (during one or more crop rotation cycles). As a result, crop and weed management in organic agriculture should be addressed over a long period of time and require extensive integration (Barberi *et al.*, 2002). Organic nutrition sources encourage the rapid growth of weeds, which compete with plants for resources such as space, light, water, and various nutrients. However, since weedicides are prohibited in organic farming, it is still difficult to control weeds economically (Wani *et al.*, 2017). Harrowing, hoeing, and flaming are examples of direct physical weed control (PWC) techniques that are followed in organic farming which are typically less successful than herbicides in the short- and long-term cycles. PWC like mechanical weed control may encourage new weed emergence (Kurstjens and Bleeker, 2000).

### **Carbon to nitrogen ratio**

Organic nutrition sources including farmyard manure, compost, chicken manure, straw, etc. contain very little nutrients and are insufficient to meet crops' nutrient needs, leaving a significant gap between their potential and actual use. The synchronisation of nutrient release and plant uptake is a challenging problem when there is a slow release of nutrients, particularly when the temperature is low for the most of the crop growth period. Even though numerous organic leftovers such as paddy straw, wheat straw and sugarcane trash can be employed to supplement plant nutrition, they have a broader C:N ratio. Nutrients will become temporarily unavailable if they are not completely degraded within a short period of time. Hence it is difficult to meet the nutrient requirement from organic source, if entire cultivable land is converted into organic farming (Wani *et al.*, 2017).

### **Lack of awareness**

Studies conducted by Kaur and Toor (2015) on or-

ganic farming reported that, due to recent development and focus of organic farming in India, the farmers are yet be aware about the techniques and strategies in organic farming like composting, biofertilizers, bio pesticides, composting etc. Due to lack of awareness in farmers regarding the organic farming the quantity and quality of preparation of mentioned above organic inputs are poor (Chandra, 2014).

### **Low yields**

During the conversion period of fields, the production is drastically reduced and the economical status of farmers get decreased. The lower yields are seen during the initial stages of organic farming, where stabilization of the yields may see in later stages. Dependence of long run organic farming is not feasible in present growing world population (Kaur and Toor, 2015). Studies conducted by Seufert *et al.* (2012) noticed that, in developing countries the yield of organic farming has been found 25% lower than conventional farming. Similar findings were noticed by Kirchmann *et al.* (2009) with decline of 25-50% of yields in organic farming when compared to conventional farming. Despite the fact, many food policymakers and scientists believe that total food production in organic farming could be sufficient to feed the world's population (Badgley *et al.*, 2007; Tscharncke *et al.*, 2012). Low yield in organic farming is one of the most significant issues regarding organic farming ability to improve food security. Increasing the yield is not the only answer to the problem of food insecurity but also several issues related to social, political and economic elements are also important aspects to address (Vasilikiotis, 2000; Ponisio *et al.*, 2015). According to various studies, reduced yield in organic farming is a contentious subject. While some studies claim that organic farming systems outperform traditional systems in terms of yield (Badgley *et al.*, 2007; UNEP, 2008), whereas others suggest lower yields (Bergstrom *et al.*, 2008; Aune, 2012; Seufert *et al.*, 2012; Connor, 2013; Ponisio *et al.*, 2015).

### **Lack of market,infrastructural and target groups**

The dominating problems in major developing countries like India are domestic market and low productivity. In local markets the demand for organic products is low when compared to metropolitan market due to lack of awareness in people. The higher consumer price of organic farming is due to

low consumer production (Kaellander and Rundgren, 2008). Kaur and Rundgren (2008) studied on organic farming and found that, lack of post harvesting measures, the contamination of organic products with non-organic products, processing, storage etc. are the major reasons for low production of organic products. On the one hand, there is a complete lack of target markets for organic food goods, including large hotels, restaurants, airlines, cafes, etc. who can afford to pay higher costs for premium organic foods. On the other hand, low domestic consumption indicates that the general public cannot afford to pay higher rates for food produced organically (Singh, 2003).

### Certification

Organic certification is the certificate of quality assurance, for the prevention of fraud and contamination of organic food with inorganic food based on certain standards and ethics (APEDA, 2018). However according to Jouzi *et al.*, (2017) certification process is costly due to infrastructure for monitoring and documentation, thereby the small and marginal farmers in developing countries cannot afford the certification. However, the livelihood of farmers was not much improved by organic certification (Barrett *et al.*, 2001). While a fair-trade certification raises household living standards by 30% and lessens the vulnerability of the producers (Chiputwa *et al.*, 2015).

### Conclusion

Conversion of traditional farming into conventional farming during green revolution period helped to increase the food production and to maintain food security for growing world population. However, it had parallel negative impacts like human health problems, pollution, degradation of soil and water and negative impact on ecosystem. Hence, the organic farming came into existence to overcome these negative impacts by stabilizing the health of environmental and human. Despite its benefits to human and ecosystem, it has several challenges to address. However, in a country like India, where labour is plentiful and relatively cheap, organic farming offers a tremendous potential answer to the problem caused by chemical farming methods to the environment and human health. Due to raise of awareness on organic food in developed countries, the government of India adopted the export policies

to enhance the Indian economy and health standards of public.

### References

- Agricultural and Processed Food Products Export Development Authority (APEDA), (2018), Ministry of Commerce and Industry, Government of India.
- Agricultural and Processed Food Products Export Development Authority (APEDA), Three Years Export Summary Statement (2019-20 To 2021-22). Agriculture and processed food factors export development authority (APEDA) (2022), Ministry Of Commerce & Industry, Government Of India.
- Altenbuchner, C., Vogel, S. and Larcher, M. 2017. Effects of organic farming on the empowerment of women: A case study on the perception of female farmers in Odisha, India. *In Women's Studies International Forum*. 64: 28-33.
- Amanuel, G., Kühne, R.F., Tanner, D.G. and Vlek, P.L.G. 2000. Biological nitrogen fixation in faba bean (*Vicia faba*) in the Ethiopian highlands as affected by P fertilization and inoculation. *Biology And Fertility of Soils*. 32: 353-359.
- Aune, J B. 2012. Conventional, organic and conservation agriculture: production and environmental impact. *Agroecology and Strategies for Climate Change*. 8: 149-165.
- Azadi, H. and Ho, P. 2010. Genetically modified and organic crops in developing countries: A review of options for food security. *Biotechnology Advances*. 28(1): 160-168.
- Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Chappell, M. J., Aviles-Vazquez, K. and Perfecto, I. 2007. Organic agriculture and the global food supply. *Renewable Agriculture and Food Systems*. 22(2): 86-108.
- Bahadur, S., Verma, S.K., Prasad, S.K., Madane, A.J., Maurya, S.P., Gaurav, V.V. and Sihag, S.K. 2015. Eco-friendly weed management for sustainable crop production-A review. *Journal of Crop and Weed*. 11(1): 181-189.
- Banks, J. and Marsden, T. 2001. The nature of rural development: the organic potential. *Journal of Environmental Policy and Planning*. 3(2): 103-121.
- Barberi, P. 2002. Weed management in organic agriculture: are we addressing the right issues?. *Weed Research*. 42(3): 177-193.
- Barrett, H.R., Browne, A.W., Harris, P.J.C. and Cadoret, K. 2001. Smallholder farmers and organic certification: Accessing the EU market from the developing world. *Biological Agriculture & Horticulture*. 19(2): 183-199.
- Bergstrom, L., Kirchmann, H. and Thorvaldsson, G. 2008. Widespread Opinions about Organic Agriculture—Are They Supported by Scientific Evidence?. *Organic*

- Crop Production—Ambitions and Limitations*. 1-11.
- Bond, W. and Grundy, A.C. 2001. Non chemical weed management in organic farming systems. *Weed Research*. 41(5): 383-405.
- Bourn, D. and Prescott, J. 2002. A comparison of the nutritional value, sensory qualities, and food safety of organically and conventionally produced foods. *Critical reviews in Food Science and Nutrition*. 42(1):1-34.
- Brandt, K. and Mlgaard, J.P. 2001. Organic agriculture: does it enhance or reduce the nutritional value of plant foods?. *Journal of the Science of Food and Agriculture*. 81(9): 924-931.
- Chand, R., Prasanna, P.L. and Singh, A. 2011. Farm size and productivity: Understanding the strengths of smallholders and improving their livelihoods. *Economic and Political Weekly*. 46: 5-11.
- Chandra, R. 2014. Sustainability through Organic Agrobiotechnology with special reference to Jammu & Kashmir scenario. *International Journal of Genetic Engineering and Biotechnology*. 5(2): 169-178.
- Chiputwa, B., Spielman, D.J. and Qaim, M. 2015. Food standards, certification, and poverty among coffee farmers in Uganda. *World Development*. 66: 400-412.
- Connor, D.J. 2013. Organically grown crops do not a cropping system make and nor can organic agriculture nearly feed the world. *Field Crops Research*. 144(20): 145-147.
- Das, A., Kumar, M., Ramkrushna, G.I., Patel, D.P., Layek, J., Panwar, A.S. and Ngachan, S.V. 2016. Weed management in maize under rainfed organic farming system. *Indian Journal of Weed Science*. 48(2): 168-172.
- Donnik, I., Voronin, B. and Loretts, O. 2016. Production of organic agricultural products is an important area of "Green" economy. *Indian Journal of Science and Technology*. 9(14): 91512.
- Food and Agriculture Organization of the United Nation 2022. FAO inter departmental working group on organic agriculture.
- Funk, C. and Kennedy, B. 2016. The new food fights: US public divides over food science. *Pew Research Center*. 1-100.
- Garibay, S.V. and Jyoti, K. 2003. Market opportunities and challenges for Indian organic products.
- Gupta, R. and Mukerji, K.G. 2000. Biological control of weeds with plant pathogens. 1In: Upadhyay RK, Mukerji KG, Chamela B P. *Biocontrol Potential and Its Exploitation in Sustainable Agriculture*. 1:199-205.
- Helga Willer, 2021. The world of organic agriculture, FAO. <https://www.fao.org/family-farming/detail/en/c/1378841/>.
- Hemalatha H.M. 2022. Organic farming in Mandya district. *International Journal of Advance and Applied Research*. 10(2): 71-74.
- Jouzi, Z., Azadi, H., Taheri, F., Zarafshani, K., Gebrehiwot, K., Van Passel, S. and Lebailly, P. 2017. Organic farming and small-scale farmers: Main opportunities and challenges. *Ecological Economics*. 132: 144-154.
- Källander, I. and Rundgren, G. 2008. Building sustainable organic sectors. Bonn: IFOAM.
- Kaur, A. and Toor, M. S. 2015. Organic farming: status and constraints. *Indian Journal of Economics and Development*, 11(1): 333-338.
- Kersting, S. and Wollni, M. 2012. New institutional arrangements and standard adoption: Evidence from small-scale fruit and vegetable farmers in Thailand. *Food Policy*. 37(4): 452-462.
- Khalid, S., Khan, H.A., Arif, M., Altawaha, A.R., Adnan, M., Fahad, S. and Parmar, B. 2019. Organic matter management in cereals-based system: Symbiosis for improving crop productivity and soil health. *Sustainable Agriculture Reviews*. 29: 67-92.
- Kilcher, L. 2007. How organic agriculture contributes to sustainable development. *Journal of Agricultural Research in the Tropics and Subtropics, Supplement*. 89(1): 31-49.
- Knickel, K. and Renting, H. 2000. Methodological and conceptual issues in the study of multifunctionality and rural development. *Sociologia Ruralis*. 40 (4): 512-528.
- Kumar, C.A. and Topagi, S. 2014. Integrated Pest Management Strategies in Organic Farming. *Organic Farming and Sustainability*. 171.
- Kumar, R. S., Ganesh, P., Tharmaraj, K. and Saranraj, P. 2011. Growth and development of blackgram (*Vigna mungo*) under foliar application of Panchagavya as organic source of nutrient. *Current Botany*. 10: 2(3).
- Kurstjens, D.A.G. and Bleeker, P.O. 2000. Optimising torsion weeders and finger weeders. In: *Workshop EWRS Physical Weed Control, Elspeet*.
- Letourneau, D. and Bruggen, A. 2006. *Crop Protection In Organic Agriculture*, Collingwood, Australia: CSIRO publishing. 93-121.
- Little, D. and Morgan, J. 2022. Understanding society: an interview with Daniel Little. *Journal of Critical Realism*, 1-53.
- Magnusson, M.K., Arvola, A., Hursti, U.K.K., Åberg, L. and Sjoden, P.O. 2003. Choice of organic foods is related to perceived consequences for human health and to environmentally friendly behaviour. *Appetite*. 40(2): 109-117.
- Meemken, E.M. and Qaim, M. 2018. Organic agriculture, food security, and the environment. *Annual Review of Resource Economics*. 10: 39-63.
- Mercati, V. 2016. Organic agriculture as a paradigm of sustainability: Italian food and its progression in the global market. *Agriculture and Agricultural Science Procedia*. 8: 798-802.
- Mikkelsen, R.L. 2000. Nutrient management for organic farming: A case study. *Journal of Natural Resources*



- and Life Sciences Education. 29(1): 88-92.
- Peigne, J., Ball, B.C., Roger Estrade, J. and David, C.J.S.U. 2007. Is conservation tillage suitable for organic farming? A review. *Soil Use and Management*. 23(2): 129-144.
- Perera, W.P.R.T., Dayananda, M.D.N.R., Dissanayake, D.M.U.C., Rathnasekara, R.A.S.D., Botheju, W.S.M., Liyanage, J.A. and Kularathne, K.A.M. 2021. Risk assessment of trace element contamination in drinking water and agricultural soil: a study in selected chronic kidney disease of unknown etiology (CKDu) endemic areas in Sri Lanka. *Journal of Chemistry*. 1-10.
- Ponisio, L.C., M'Gonigle, L.K., Mace, K.C., Palomino, J., De Valpine, P. and Kremen, C. 2015. Diversification practices reduce organic to conventional yield gap. Proceedings of the Royal Society. *Biological Sciences*. 282(1799): 20141396.
- Probst, L., Houedjofonon, E., Ayerakwa, H.M. and Haas, R. 2012. Will they buy it? The potential for marketing organic vegetables in the food vending sector to strengthen vegetable safety: A choice experiment study in three West African cities. *Food Policy*. 37(3): 296-308.
- Ramesh, P., Panwar, N. R., Singh, A. B., Ramana, S., Yadav, S. K., Shrivastava, R. and Rao, A. S. 2010. Status of organic farming in India. *Current Science*. 98(9): 1190-1194.
- Reganold, J.P. and Wachter, J.M. 2016. Organic agriculture in the twenty-first century. *Nature Plants*. 2(2): 1-8.
- Rex Dufour, 2015. Tipsheet: Organic pest management, NCAT Sustainable agriculture.
- Scialabba, N. and Muller-Lindenlauf, M. 2010. Organic agriculture and climate change. *Renewable Agriculture and Food Systems*. 25(2): 158-169.
- Seufert, V., Ramankutty, N. and Foley, J.A. 2012. Comparing the yields of organic and conventional agriculture. *Nature*. 485(7397): 229-232.
- Seufert, V., Ramankutty, N. and Mayerhofer, T. 2017. What is this thing called organic?—How organic farming is codified in regulations. *Food Policy*. 68: 10-20.
- Sharma, K. and Pradhan, S. 2011. Organic Farming: Problems and Prospects. *Yojana*. 55: 68-70.
- Sharma, P. and Pandey, R. 2009. Biological control of root-knot nematode; *Meloidogyne incognita* in the medicinal plant; *Withaniasomnifera* and the effect of biocontrol agents on plant growth. *African Journal of Agricultural Research*. 4: 564-567.
- Singh, S. 2003. Marketing of Organic Produce and Minor Forest Produce", Chairman's Report on Theme 1 of the 17th Annual Conference of the Indian Society of Agricultural Marketing (ISAM). *Indian Journal of Agricultural Marketing*. 17(3): 77-83.
- Tscharntke, T., Clough, Y., Wanger, T. C., Jackson, L., Motzke, I., Perfecto, I. and Whitbread, A. 2012. Global food security, biodiversity conservation and the future of agricultural intensification. *Biological Conservation*. 151(1): 53-59.
- UNEP, 2008. Organic Agriculture and Food Security in Africa. United Nations Publication
- Vasilikiotis, C. 2000. Can organic farming "Feed the World". University of California, Berkeley ESPM-Division of Insect Biology, 201.
- Venkatesh, M.S., Hazra, K.K., Ghosh, P. K., Khuswah, B.L., Ganeshamurthy, A.N., Ali, M. and Mathur, R.S. 2017. Long-term effect of crop rotation and nutrient management on soil-plant nutrient cycling and nutrient budgeting in Indo-Gangetic plains of India. *Archives of Agronomy and Soil Science*. 63(14): 2007-2022.
- Wani, S.A., Wani, M.A., Mehraj, S., Padder, B.A and, Chand, S. 2017. Organic farming: Present status, scope and prospects in northern India. *Journal of Applied and Natural Science*. 9(4): 2272-2279.
- Woese, K., Lange, D., Boess, C. and Bogl, K.W. 1997. A comparison of organically and conventionally grown foods—results of a review of the relevant literature. *Journal of the Science of Food and Agriculture*. 74(3): 281-293.
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