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Organic Farming Towards Healthy Food and Safe Environment: A Review

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ABSTRACT

Organic Agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and good quality of life for all involved. The practices followed in organic farming are not new to the "Ancient Indian farming" which focuses on green manuring, cattle manures and traditional varieties for getting better harvest. Due to the Famines occurred in India during the course of the 18th, 19th and early 20th centuries which resulted in massive deaths there needs a shift towards yield oriented industrial based green revolution based agriculture practices. But these newly learnt yield oriented farming techniques and the irrational use of chemical inputs have caused many hazards, including soil erosion, groundwater level decline, soil salinization, pollution from fertilisers and pesticides, genetic erosion, negative effects on the environment, decreased food quality and increased cultivation costs, making farmers poorer year by year. Furthermore, the use of pesticides and fertilisers increased the amount of heavy metals in the soil, particularly cadmium (Cd), lead (Pb) and arsenic (As). As we almost reached the state of food security by increased production, we need to shift our perspectives towards healthy food production by organic farming for a safer food and environment.

Key words: Biostimulants, Healthy foods and environment, Organic manure.

India, predominantly an agricultural country, has most of its population living in regions that directly or indirectly depend on the agricultural sector for their livelihood (Yadav and Anand, 2019). Agriculture is not only the backbone of India's economy (Gugalia, 2021) but also a vital contributor to employment and rural development. However, famines that occurred in India during the 18th, 19th and early 20th centuries resulted in more than 30 million deaths, leaving a long-term impact on the population dynamics of the Indian peninsula (Famine in India, 2023). To address the critical need for increasing food production, the Indian Green Revolution was introduced in the 1960s.

The Green Revolution marked a transformation in agricultural practices, leading to significant increases in crop yields. It achieved this through various measures, including expanding the area under cultivation, practicing double-cropping (growing two crops annually), adopting high-yielding seed varieties (HYVs), extensively using inorganic fertilizers and pesticides, enhancing irrigation facilities and improving farm equipment and crop protection techniques (John and Babu, 2021). As per the Annual Report of Agriculture, 2021-2022, India was estimated to produce 308.65 million tons of food grains from 1293.43 lakh hectares.

However, the Green Revolution's increased production came with the extensive use of synthetic inputs such as pesticides, herbicides and fungicides, which often ended up in food grains. Gupta (2004) reported that 51% of food commodities in India are contaminated with pesticide residues, with 20% exceeding maximum residue level values globally. Long-term, low-dose exposure to such pesticide-contaminated foods is associated with serious human health effects, including immune suppression, hormone disruption, diminished intelligence, reproductive abnormalities and cancer. The use of inorganic fertilizers has also been criticized for its detrimental effects on human health and the environment, such as groundwater contamination and lack of eco-friendliness (Agbede, 2010; Kakar *et al.*, 2020). Moreover, since the onset of the Green Revolution, the cultivation of indigenous varieties of rice, millets, lentils and other traditional crops has significantly declined, being replaced by faster-growing hybrid crops. This shift led to the loss of nearly 100,000 indigenous rice varieties in India alone (Prasad, 2016).

In contrast, organic agriculture offers a sustainable and safe crop production system that promotes soil health, ecosystem balance and human well-being (Kavitha and Chandran, 2017). It relies on ecological processes, biodiversity and cycles adapted to local conditions rather than harmful and toxic inputs. Organic agriculture combines tradition, innovation and science to benefit the shared environment and foster fair relationships and a good quality

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of life for all stakeholders. The organic farming method strongly emphasizes crop rotation, natural pest management, crop and livestock diversification and improving soil health through compost additions and animal and green manures (Reganold and Watcher, 2016).

The practices followed in organic farming are not new to India. "Ancient Indian farming" has long focused on techniques such as green manuring, cattle manure and traditional crop varieties to achieve better harvests. These practices reflect a holistic approach to farming that harmonizes with nature. By rethinking our priorities and transitioning from Green Revolution-based conventional agricultural practices to organic farming-based traditional practices, we can address the challenges posed by synthetic inputs and ensure sustainable agricultural growth.

In this review, we aim to substantiate the benefits of organic farming practices, providing valuable evidence to demonstrate their advantages for human health, the environment and long-term agricultural sustainability.

Need for organic farming

Green Revolution technologies, supported by policies and fuelled by agrochemicals, machinery and irrigation, have enhanced agricultural production and productivity (Reddy, 2010). By this point, food security is almost a reality, but the use and manufacture of pesticides and fertilizers have long since caused significant environmental and health problems (Kaswan *et al.*, 2012). Over the past 40 years, modern agricultural farming techniques and the irrational use of chemical inputs have caused many hazards, including soil erosion, groundwater level decline, soil salinization, pollution from fertilizers and pesticides, genetic erosion, negative effects on the environment, decreased food quality and increased cultivation costs, making farmers poorer year by year. Additionally, there are cases of chlorinated pesticide contamination in broken milk due to using pesticides exclusively to increase output (Al antary *et al.,* 2015). According to scientific surveys and sampling, hazardous residues left by pesticides sprayed on crops are passed to people and other living things *via* grains, vegetables, fruits and grasses, leading to a variety of diseases, disorders and negative impacts on our health (Bhattacharyya, 2004). Due to constant exposure from numerous sources, the amount of pesticide in the human body might occasionally rise over the capacity of the detoxifying system (Xavier *et al.*, 2004). The use of pesticides and fertilizers increased the amount of heavy metals in the soil, particularly cadmium (Cd), lead (Pb) and arsenic (As). Other than that, following green revolutionary practices like Intensive tillage with heavy machinery and equipment, the tendency of growing monocultures, overexploitation of soil, abusive use of chemical fertilizers and pesticides that destroy soil microbes and other organisms, alter the structure of the soil and destroy its flora and fauna which results in turning fertile land into unproductive desert. The cultivation of native varieties of rice, millets, lentils and other crops has decreased since the green revolution and the acreage under hybrid crop cultivation has started increasing because of their huge yield potential and faster growth rate. Traditionally grown and consumed crops, such as millets, grow easily in arid and semi-arid conditions because they have low water requirements and are largely neglected in cropping systems because of the low yield potential and unavailability of hybrids and high-yielding varieties (John and Babu, 2021). Because of these aforementioned issues, there is said to be a burgeoning deterioration of the agro-ecosystem as well as human health inevitably due to the yield-oriented faulty agricultural practices and its recovery is only possible with organic agriculture.

Safer food

The growing demand for organic food is largely driven by consumer perceptions of its superior quality and safety, as well as the environmental benefits of organic farming practices (Pell, 1997; Singh *et al.*, 2022). While organic farming tends to yield lower quantities than conventional methods, it significantly reduces or eliminates the use of synthetic pesticides. Research has shown that children consuming conventionally produced foods have higher levels of organophosphate pesticide metabolites in their urine compared to those who eat organic produce (Curl *et al.*, 2003; Lu *et al.*, 2006). To qualify as organic, food producers must adhere to stringent regulations that ensure their products provide additional health benefits (Teixeira *et al.*, 2022). Organic certification requires compliance with standards that limit or prohibit synthetic fertilizers and agrochemicals, which appeals to consumers seeking cleaner, safer food options (FAO, 2021).

In India, organic food is regulated by the Food Safety and Standards Authority of India (FSSAI) under the Food Safety and Standard*s* (Organic Foods) Regulations, 2017, which allows up to 5% of contaminants, toxins and residues, while ensuring that the buildup of harmful substances in food is minimized (Food Safety and Standards Authority of India, 2017). These regulations have led consumers to pay a premium for organic products, driven by concerns about health, environmental sustainability and animal welfare, as organic foods are perceived as healthier and of higher quality than their conventional counterparts (Chandrakala *et al.*, 2024).

Studies support the health benefits of organic diets. For example, a study by Oates *et al.* (2014) found that just one week of consuming an organic diet significantly reduced organophosphate pesticide exposure in adults, with pesticide metabolite levels dropping by up to 96%. Similarly, Bradman *et al.* (2015) demonstrated that children who ate organic food showed a 40% reduction in total dialkylphosphates and a 49% reduction in dimethyl dialkylphosphates in their urine, compared to those on conventional diets. These findings highlight the significant health advantages of organic food, particularly in reducing harmful pesticide exposure.

Food quality of organic food

Despite the potential importance of this topic for human well-being, only a limited number of studies have been specifically carried out previously. 21% more iron and 29% more magnesium content are noticed in organically produced crops (Rembialkowska, 2007). Saha *et al.* (2007) reported higher iron content of 52.2 µg g^{-1}, was present with grains of organically grown aromatic rice crops. Mäder *et al.* (2007) reported that there is no significant difference in protein content, amino acid composition, mineral, trace element contents and baking quality of wheat grown in organic and conventional techniques. However, Cioel *et al.* (2012) reported that wheat grain from organic farming was characterized by a higher content of Mn and significantly higher content of Fe, Zn, Ca and Mg when compared to conventionally produced grains. Moreover, reports by Wolfson and Shearer (1981); Brandt *et al.* (2000) register that organically cultivated wheat has 25-30% increased lysine content when analysed. The effect of the cropping system(conventional and organic cultivation) was insignificant in analyzing the fatty acid profile of oat cultivars (Capouchová *et al*., 2021). Vitamin C (Ascorbic acid) plays an inevitable role in protecting the body cells from the harmful effects of free radicals and organically grown crops have higher levels of vitamin C especially potatoes (Fischer and Richter, 1986; Kolbe *et al*., 1995). Sunflower seed oil produced from organic cultivation had a higher total antioxidant activity compared with the conventional cultivated samples (Perretti *et al*., 2004). Based on these, there are some nutritional quality differences between products from organic and conventional methods and they highly differ among crops there is a need for detailed studies to be conducted to analyze the nutritional quality differences produced among various crops.

Safer environment

Organic farming is considered less harmful to the environment than conventional farming because it avoids synthetic pesticides, many of which can contaminate water and soil and adversely affect local terrestrial and aquatic fauna (Oquist *et al*., 2007). In addition to minimizing pesticide-related risks, organic farming promotes healthier soils with improved water retention capabilities, which can lead to higher yields, even during droughts (Pimentel *et al*., 2005). Organic farms tend to exhibit greater biodiversity, supporting a wider range of plants, insects, soil fauna, microbes and birds. This diversity, coupled with increased habitat and landscape variety, enhances the resilience of organic farms, helping them mitigate the potentially catastrophic impacts of climate change (Lynch *et al*., 2012). Furthermore, because organic farming uses little to no synthetic pesticides, the risk of pesticide contamination in ground and surface waters is almost nonexistent (Alföldi *et al*., 2002).

One of the key ecological advantages of organic farming is the return of carbon to the soil, particularly through the use of perennial crops and green manures. This practice contributes to maintaining soil health and biodiversity while mitigating the negative effects of intensive cropping systems typically seen in conventional farming (Chappell *et al*., 2011). According to Griffiths *et al.* (2010), organic farming's use of complex crop rotations, biological nitrogen fixation through legumes and organic matter inputs are all linked to environmental benefits, such as reduced off-farm nutrient runoff. A meta-analysis by Mondelaers *et al.* (2009) further supports these findings, showing that organic systems generally result in lower nitrate and phosphorus losses due to leaching compared to conventional farming. Additionally, organic farming practices have been shown to reduce energy consumption by 10-70%, greenhouse gas emissions by 39%, nitrate leaching by 30-31% and ammonia emissions by 18%, while also improving soil organic matter by 6-7%, species richness by 30-34% and organism abundance and species evenness (Meemken and Qaim, 2018).

Scientific evidence strongly supports the environmental benefits of organic farming in promoting a safer agro-ecosystem. For instance, Yadav *et al.* (2009) found that applying organic manure, including wheat residues, farmyard manure (FYM) and neem cake, in a rice-wheat cropping system resulted in the highest levels of soil organic carbon (0.64%). Similarly, a long-term study by Singh *et al.* (2019) showed that the application of FYM as the sole organic fertilizer over 20 years significantly improved soil organic carbon levels (6.6 g/kg) in the topsoil compared to inorganic nutrient treatments. Panwar *et al.* (2022) also reported that long-term organic fertilizer applications, including FYM, vermicompost and neem cake, improved soil quality and nutrient availability, with increases in soil organic carbon (3.7%), available nitrogen (33.3%), phosphorus (16.4%) and potassium (37.8%). Furthermore, microbial biomass carbon (0.45 mg g^{-1}), bacterial (40.6×10^6 CFU), fungal (36.2×10^4 CFU) and actinomycetes populations (17.5×10^6 CFU) and the soil quality index (0.60) were all higher under organic management practices, highlighting the overall improvement in soil health. These findings underline the critical role organic farming plays in building a more sustainable and ecologically balanced agricultural system, benefiting both the environment and soil health over the long term.

CONCLUSION

In response to the significant challenges posed by conventional agricultural practices-particularly the excessive use of chemical inputs and the resulting degradation of soil and environmental health-organic farming presents itself as a viable and sustainable alternative. The shift from industrial, yield-focused farming systems, as exemplified by the Green Revolution, to organic farming methods holds considerable promise for improving food quality, enhancing environmental health and ensuring long-term agricultural sustainability. Organic farming

emphasizes ecological balance, biodiversity and soil health, which directly address the negative impacts associated with the use of synthetic fertilizers and pesticides-issues that have been linked to both environmental degradation and adverse human health outcomes. By eliminating or minimizing these harmful chemicals, organic farming supports the production of cleaner, safer food, contributing to the well-being of both humans and ecosystems. Scientific research consistently highlights the multiple advantages of organic farming practices, including reduced pesticide exposure, improved soil quality, enhanced biodiversity and increased carbon sequestration. Furthermore, organic farming has been shown to mitigate several environmental issues, such as soil erosion, water contamination and greenhouse gas emissions, while simultaneously fostering resilience to climate change. Organic agriculture thus offers a critical pathway for reconciling the need for food security with the imperative to protect human health and the environment. In conclusion, transitioning to organic farming is not merely a response to contemporary agricultural challenges but a crucial investment in the ecological and nutritional health of our planet. This shift represents a long-term solution that ensures the sustainability of both agricultural systems and the global environment for future generations.

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Conflict of interest

There is no conflict of interest among all authors. All have contributed as per the role in research work.

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