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Achieving Zero Hunger under Sustainable Development Goals Concerning Organic Agriculture

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Abstract

Sustainable Development Goals (SDGs) were formulated to accomplish highly required overall human development without depleting the environment for future generations. Sustainable Development Goal 2 (SDG2) aims for "Zero Hunger" with eight associated targets. These associated targets set in motion the overall development of agriculture that provides healthy food and raises the living standard of smallholder farmers while maintaining the natural base. SDG2 and other SDGs are intertwined, and achieving SDG2 targets will help accomplish other goals that have been weakening due to climate change, carbon emission, excessive use of chemicals, droughts, locust attacks, and pandemics. The essence of achieving SDG2 is directly linked to food production and access. The current food production based on conventional farming harms the environment and is unsustainable in the long run. Thus, the need for an alternative food production system that ensures sustainable development is emphasized. Organic farming is a food production system based on agroecological principles and promotes sustainable development. We reviewed the role of the present organic farming as a food production system to achieve SDG2. We analyzed the four targets of SDG2 and assessed whether organic farming can achieve the sub-targets of SDG2. Besides food security, organic farming ensures economic viability for small farmers, provides nutritious food and promotes biodiversity. Innovative research, practices, stakeholder partnerships, and a comprehensive framework are recommended.

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Introduction

Before the advent of modern agriculture, organic farming constituted a prevalent global practice.[1] The modern organic farming movement was started by Sir Albert Howard and Lady Eve Balfour in the U.K. and Jerome Rodale in the U.S. and

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can be traced back to the 1940s.[2,3] Howard firmly advocated the “The Law of Return”, which states that recycling waste material and giving back to farms is necessary for soil fertility and humus.[2] Collecting all his experience with native farmers in India, he made a pivotal contribution by popularizing and studying the Indore composting process , a method for recycling waste products as a source of fertility. His research rests on a concrete scientific basis and elucidates intricate interdependencies among human, soil, plant, and animal health.[4] Organic practices mirror the environmental dynamics of forests, always giving back more than it takes, ensuring long-term soil fertility.[5] The fundamental doctrines guiding organic practices align with the imperatives of sustainable development, emphasizing its harmonious synchronicity with natural systems to protect both agricultural and environmental well-being over the long term. The emergence of the notion of sustainable development took place while environmental degradation peaked due to industrialization.

The end of the 18th century was the advent of the First Industrial Revolution in Britain, followed by Europe and the USA.[6] However, historians emphasise that the period after 1870 is the era of the Second Industrial Revolution, which fuelled the growth engine and brought radical changes in human history.[7] The same paradigm shift was observed when the green revolution started in agriculture. It was the need of the hour, as food insecurity severely affected developing countries. The Green Revolution brought significant changes in agricultural practices. It was the package of High Yielding Varieties (HYV) seeds, fertilizers and pesticides, and the use of machinery. This increased food production (especially wheat and rice) exponentially in African and Asian regions.[8] The Green Revolution's tremendous achievement helped developing countries secure food for everyone. For say, India could not feed its growing population from 1947 to 1960, and food availability was only 417 grams per day per person.[9,10] Calorie intake will decline further if the green revolution is not introduced.[11] Contrary to the post-independence situation, India feeds the world's largest population today and is among the most significant agricultural product exporters.

However, the developmental pursuits led to a significant apprehension: the threat of environmental degradation. Rising sea levels, flooding and droughts, and the spread of deadly diseases are the significant environmental consequences believed to originate from the expanding industrial and agricultural activities.[12,13] Eventually, a scenario developed wherein human actions jeopardized their habitat by securing their homes.

These events catalyzed the inception of a concept named sustainable development. There are many definitions of sustainable development, but the Brundtland Commission Report (WCED, 1987) gave the most widely accepted definition. The report defines sustainable development as "meeting the current generation's needs without compromising the ability of future generations to meet their own needs." Sustainable development consists of two words: "sustainable" and "development".[14] Together, a sustainable development approach for long-term economic growth while maintaining natural capital.[15,16] Moreover, the concept of sustainable development rests on three pillars: environmental sustainability, Economic sustainability, and social sustainability. These pillars are interrelated and interlinked[17] and must be aligned inclusively. Within the purview of sustainable development, the SDGs are formulated, and to achieve SDGs, these three pillars must be ensured.

From MDGs to SDGs: Common Future for all

In the 2000s, World leaders from 189 countries unified to constitute Millennium Development Goals (MDGs) from 2000 to 2015. These MDGs were formulated to achieve its eight goals focused only on developing countries. Among the eight goals, the topmost priority of the world is to eradicate poverty and hunger. Efforts of MDGs dragged one billion people out of extreme poverty, 90% coverage of primary child education, and reduction in hunger and malnutrition.[18,19] Despite these efforts, the MDGs were criticised for limited coverage (only made for developing countries) with narrow concepts (economic and social dimensions) built into them. In contrast to the MDGs, the sustainable development goals were built universally. These SDGs are more comprehensive and concentrate on all dimensions of sustainability.[20,21] Thus, economic growth, social progress, and environmental equilibrium are the mechanisms of sustainable development,[14] and SDGs incorporate these mechanisms at the center. There are 17 ambitious goals with 169 associated targets to be achieved by 2030. These related goals and targets laid the blueprint or road map for the countries to achieve a sustainable future for everyone.

Out of these 17 goals, Sustainable Development Goal 2 aims for "Zero Hunger" and is crucial for achieving other goals. SDG2 aims to ensure food security, eradicate malnutrition, and promote sustainable agriculture. Moreover, all SDGs are interlinked, any action towards one target affects the progress of others. SDG2 strongly synergies with SDG 1, "No poverty", and SDG 3 ", Good health and well-being", and is directly associated with SDG 6, 11, 13, and 15.[22] Mollier[23] showed how SDG2 works in synchronicity with other goals. For say, food and nutrition are inseparable from poverty reduction. Similarly, the increased income of farmers will further reduce poverty because most people experiencing poverty belong to rural areas. Again, access to healthy and nutritious food leads to reduced mortality rates and disease reduction.

To achieve zero hunger, the goal comprises eight targets divided into two groups. The targets from 2.1 to 2.5 focused on food security and sustainable agriculture measures, and the remaining three targets from the 2A-2C aim for market-related measures on agriculture.[24]

Table. 1

Food security and sustainable agriculture	Target 2.1: End hunger and ensure access to food for everyone
	Target 2.2: Eradicate all forms of malnutrition
	Target 2.3: Doubling productivity and income of small farmers
	Target 2.4: Sustainable agriculture
	Target 2.5: Maintain genetic diversity of seeds, plants, and animals
Market-related measures	Target 2A: International corporation for investment in agriculture
	Target 2B: Free trade and low distortions in the world agricultural market
	Target 2C: Proper Functioning of Food commodity and derivatives

Source: Otekunrin[25]

Alternative Food Production System

In 2019, the agriculture sector produced 9.4 billion tons of primary crops.[26] The massive agricultural production is the result of the "Green Revolution". The package includes high-yielding varieties of seeds (HYV) that are highly responsive to fertilizers, improved irrigation techniques, and modern machinery. These HYV seeds were developed by the Rockefeller Foundation's Mexican Agriculture Program (MAP) in the 1950s. The success of the green revolution soon reached other parts of the world, especially in Developing countries like India, Indonesia, and the Philippines. Subsequently, cereal production tripled, and a significant impact was observed in lower food prices and poverty.[11] In late 1967, the Green Revolution was introduced in India in three heartland states: Haryana, Punjab, and Western Uttar Pradesh (U.P).[29] Afterwards, the production increased from 72.35 million tonnes in 1965-66 to 173 million tonnes in 1989-90.[27] Contrary to the belief of increased foodgrain production, scholars Stone,[28] Kumar,[29] and Chaudhary[30] hold the opposite views and highlight new facts on the green revolution. For say, Kumar[29] showed that from from1950 to 1964, Punjab's agriculture was growing at a healthy rate of 4.6%, while yields were increased by 45% and food availability per capita increased from 144.1 kg per annum to 171.1 kg per annum. Meanwhile, Stone[28] reported that the success of the green revolution was the outcome of irrigation, financial support, and returns of the rains, not the other way around. Apart from these views, many studies reported environmental, public health and economic concerns due to the green revolution originator of chemical farming.

Costs of Chemical Farming that no One Pays: Negative Externalities

Despite the tremendous growth in food production, the Green Revolution was criticised on environmental grounds. Pimentel[31] showed that extensive pesticides harm soil quality and fertility, leading to soil erosion. Apart from soil fertility, water exploitation and water pollution are other major concerns of using chemicals in agriculture.[32] Using fertilizers and pesticides harms both consumers and producers. Rising cases of farmers unintentionally consuming pesticides lead to severe disease or even death.[33] Moreover, consuming chemical-ingested food also puts public health at risk.[31,34] The heartland of the green revolution, Punjab and Haryana met the same fate of environmental crisis.[27,35,36]

Apart from concerns originating from man-made interference, agriculture is drastically affected by climate and extreme phenomena such as rising global temperatures, droughts, heatwaves, and locust assaults.[37] With the current food production facing multifaceted constraints and rapidly changing climate change, it is not able to meet the 2030 deadline of SDG2. The urgency to shift toward sustainable alternative food production is the utmost priority for the world.

Organic farming is an alternative production system with ecology, care, and fairness fundamentals. Organic farming practices incorporate agroecological practices based on circular systems using residual and organic manure instead of external chemical inputs. By refraining from chemical fertilizers on farms, organic farming produces positive spillovers, such as no risk of water contamination, a premium price of organic products, healthy and nutritious food, increased soil fertility, and promoted biodiversity.[38] These positive impacts of Organic farming qualify as a feasible alternative in the long run since it is economically viable and environmentally sustainable.[38] Moreover, Torres *et al.*[40] and Bandanaa *et al.*[39] analyzed the sustainability performance of organic farming. Organic farming ensures environmental, social, and economic sustainability. Šeremešić *et al*[40] and Setboonsarng and Gregorio[18] examined the role of organic farming in achieving SDGs and found that organic farming aligns with every SDG goal and contributes significantly.

Although organic farming significantly contributes towards sustainability and sustainable development goals, many concerns remain. One such problem is whether converting a hundred per cent towards organic farms is possible. And if possible, how will developed and developing countries perform towards conversion? Muller[41] analyzed the former part of the question by employing the model that estimated converting 100 % into organic production leads to more accumulation of land under cultivation to compensate for the lower yield. However, converting to 100% organic has the potential to provide sufficient food in addition to the reduction in adverse environmental impacts by agriculture. Similarly, Kirchmann[42] showed to fill the 35% yield gap, 50% extra land will required to produce the exact yield. The latter part of the question has diverging views. Developed and developing countries have different economic characteristics and dependencies on agriculture. With an extensive resource base and higher per capita income, developed countries respond differently towards adopting and converting organic farming than developing countries.

Schader[43] investigated the adoption of organic farming in Sub-Saharan Africa (SSA). The study's outcome revealed heterogeneity in the uptake of organic farming among farmers despite having higher profits (144%). Factors such as limited capacities, market access, and lack of inputs were hindering the uptake of organic farming. Similarly, Blockeel[44] reported that sharing activities were constraints for the uptake of organic farming. Considering these constraints of organic farming, achieving SDG2 seems ambitious. However, if food production is not the way forward, the alternative must be scaled up to ensure sustainable development. Thus, we reviewed this crucial question: Can the current shape of organic farming help to achieve SDG2 by 2030?

The paper starts with the introduction in section 1, with two sub-sections on common future and alternative agriculture. In section 2, the study laid out the material and methods used. In section 3, the paper showed the status of the targets of SDG2. Section four of the paper reviewed the achievement of SDG2 targets concerning organic farming.

Materials and Methods

The study reviews the objective, and to narrow down the area, the study is confined to only the first four targets: 1) Ensuring food security and 2) eradication of malnutrition, 3) increasing productivity and income of smallholder farmers, and 4) sustainable agriculture. We used the keywords "ORGANIC FARMING", "ZERO HUNGER", "SUSTAINABLE DEVELOPMENT GOAL 2", and "ORGANIC FARMING AND FOOD SECURITY" to explore the open database of Google Scholar. Further reports from the Food and Agriculture Organization (FAO), Sustainable Development Goals (SDGs), and World Bank were reviewed. The list of papers and reports was added to the annexure.

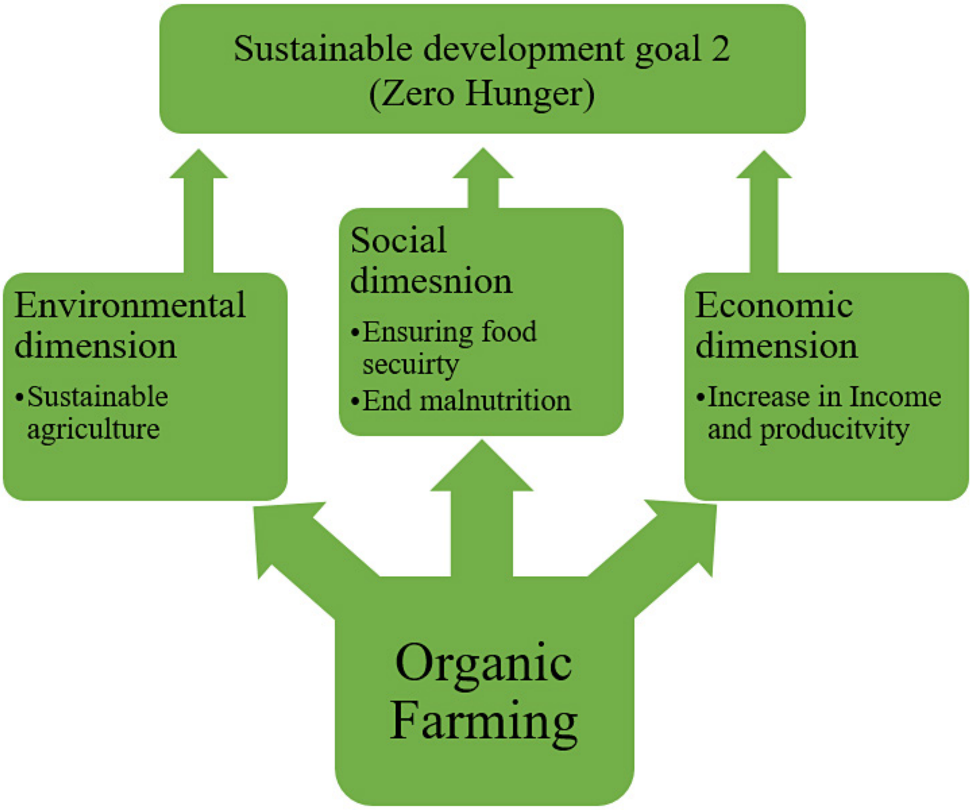

Fig. 1: Dimensions of Organic Agriculture

Source: Author's creation

Status of SDG2 targets

Although the world has improved over time to achieve SDG2, recent pandemics, climate change, economic slowdown, conflict, and war have dragged back this progress[37,45] With the current state of targets, SDG2 is unlikely to be achieved by 2030.[24,25]

As per the estimate of FAO (2021), food insecurity worldwide has increased recently after consistent declines. About 118 million people worldwide fall in the category of undernourishment, and a total estimated 768 million (9.9 %) people were facing hunger. However, the rising trend of PoU started in 2014, and COVID-19 amplified the movement to its new peak. Further, the estimated number of moderate and severe food insecurity increased to 2.37 billion in 2020, which means nearly one in three people worldwide have no or inadequate access to food. Of 768 million hungry people, 418 million belong to Asia, 281.6 million, and 59.7 million to Africa, Latin America and Caribbean, respectively. Otekunrin *et al.*[25] used Global Hunger Index (GHI) scores to show the hunger situation in Africa. The study reported that the Central African Republic (CAR), Chad, Madagascar, Zambia, Sierra Leone, and Sudan were among the countries with severe hunger.

Past studies have also demonstrated that countries that do not guarantee food intake for their residents have a more significant population of malnourished citizens. Globally, malnutrition and its dimensions share a substantial portion of the disease burden, including 13 major risk factors and life-long and irreversible conditions 23. FAO (2021) reported that in 2020, 149.2 (22 %) million and 45.4 (6.7 %) million children who were under the age of five were reported stunted and wasted. Of these, three-quarters of stunted children reside in Asia and Africa, while more than half a quarter and one-quarter of wasted children are in Asia and Africa, respectively. One in three women is still affected by anaemia. The condition of malnourished children suffers both physically and mentally.[46] Food insecurity and malnutrition are not the only situations where people suffer. The farmers (especially small farmers) are worst affected due to the economic unfeasibility.

Smallholder farmers operate on farms of less than 2 hectares, comprising 3 billion people out of 475 million households in developing economies. An estimated 50 to 70% of world food was grown by smallholder farmers, but the absurdity is that they were food insecure.[47] According to the Sustainable Development Goals Report (2021) by UN DESA,[45] a survey of 37 countries, most farmers fall into the smallholder category. In some countries, they constitute 90 % of farmers. However, the study found that small-scale farmers' labour productivity and income are lower than large farmers. The report also claimed that female farmers constitute the majority of small farmers but earn two to three times less than men. FAO[48] survey of 9 developing countries in Africa and Asia reported that many poor are concentrated in rural areas, and poverty among smallholder farmers was higher than the national poverty headcount. For example, in Sub-Saharan Africa, smallholder farmers earn over one dollar a day (p. 25). The situation is further aggravated due to the rapidly changing environment worldwide.

Sustainable agriculture is the ideal growth in agriculture without depleting the natural capital.[49,50] However, the agriculture sector spreads negative externalities which harm human health and the environment. Food systems are hurting the environment by utilizing 70 % of the water withdrawal, contributing to 60 % of biodiversity loss.[51] According to the World Bank research titled "Addressing Food Loss and Waste," consumers or merchants waste one-third or nearly 1.3 billion tons of food produced globally during the supply chain. The concern further intensifies due to climate change. Globally, climate change has adverse effects on agriculture and food security. According to Lesk *et al.*,[52] droughts and extreme heat significantly impact cereal production, resulting in a 9-10 % reduction in production. The most consumed cereal wheat and rice crops are vulnerable to temperature increases.[53] The increasing temperature has recently directly affected crops and food security. All the concerns require a food production system that is climate resilient and economically viable.

Can Organic Farming Secure Food and Eradicate Malnourishment?

Food production is the base for food security and becomes more critical when farmers live there, and environmental concerns are attached to it. The fragile food security situation in developing countries of African and Asian regions makes them vulnerable to economic shocks and climatic events. Can organic farming as a primary food production system ensure food security? Schoonbeek *et al.*[38] indicated that two sides exist and are divided on this matter; optimism says that, in the long run, organic farming can meet food security; conversely, pessimists hold the opposite view. However, Globally, current organic farming produces 10% less yields when compared to conventional farming.[54] According to Seufert,[55] a meta-analysis study comparing the yield of organic and conventional farming. The study revealed that organic farming grows lower yield, ranging from 5% in rain-fed regions. Whereas yields are 13% less when best practices are used in organic farming and 34% less when both techniques are comparable. Similar results were found in Forster,[56] Singh &

Grover,[57] and Manjunathan and Puttaswamahia[58] studies that showed a more significant yield gap between organic and conventional farming.

Contrary to these studies, many scholars[59–63] have a positive approach to feeding the world through organic farming. Chaudhary[63] analyzed the yield performance of organic farming in Haryana, India (the heartland of the green revolution). The result indicates that 98 farmers out of 218 (44%) organic farmers in 2020 produced a yield above the state average. The author further strengthened the argument with the support of many ICAR studies that reported organic yields are similar and higher than conventional farming. Similarly, a 12-year long-term Farming System trial by Pearsons[64] at Rodale Institute showed that manure-based organic farming (MNR) yield is higher than the state average of Pennsylvania, USA. Ehyhorn *et al.*[65] showed a comparable yield in organic and conventional farming. However, it can be argued that organic farming is still in its early stages and only available for niche markets. The long-run perspective of organic farming is that it has the potential to meet the challenge of food security within the framework of sustainability.[18,38,59,61,66]

In the long run, organic farming is a practical approach to fighting undernourishment in developing countries. Organically produced products are healthy and safe and have massive demands in developed and developing countries. Das *et al.*[67] and Schoonbeek *et al.*[38] reviewed several reports and papers concluding that organically produced food contains various nutrients, minerals, and vitamins compared to conventional food. Organic farming provides nutritious food, but there is still a matter of debate on its nutritional aspects and doubtful potential to secure enough food. However, there is no doubt that organic farming has the potential to provide consumers with safer food and more sustainable production, which contributes significantly to reducing malnutrition.

Organic Farming can Ensure Increased Income for Farmers.

Organic farming may not produce yield comparable to conventional farming, but economically, it provides better opportunities to farmers, especially smallholder farmers. Organic farming is cost-effective and compensates for lower yield through the premium produce price. Perasons[68] analyzed the long-term profitability under three farming systems: Conventional, legume-based, and manure-based organic. The author reported that organic under legume and manure-based have higher gross revenues of 21% and 47 % compared to conventional management when the premium price is attached. Even excluding the premium price, organic forage and grain sold at the conventional produce rate can generate 45% higher returns than the conventional system. The meta-analysis by Crowder and Reganold[69] revealed that organic farming is 22 to 35 % more profitable and has a higher benefit-cost ratio. Similarly, Heena *et al.*,[70] Singh and Grover,[57] and Manjunatha and Puttaswamaiah[58] showed a higher benefit-cost ratio in organic farming. One of the most consumable crops is basmati rice, studied by Eyhorn *et al.*[65] found that organic smallholder farmers earn higher profits. Similarly, Forster *et al*,[56] Bachmann,[71] Eyhorn *et al.*,[60] and Mishra *et al.*[72] revealed that small-scale producers profit more from organic farming. Ayuya *et al.*[73] linked certified organic producers to multidimensional poverty, showing that licensed organic producers are less likely to be poor than those not participating in organic farming certification. Being economically viable is not the only sufficient condition for achieving SDG2, organic farming must also be sustainable.

Organic Farming as a Sustainable Agriculture

Changing climate and increasing global disasters require a resilient and sustainable food production system.[74] Organic farming proactively protects the environment and provides disaster resilience. Organic farming performs better than conventional farming in agrarian distress like drought or crop failure. Lotter *et al.*[75] reported comparing organic and conventional methods of a 21-year Rodale Farming System trial. The trial showed significantly better yields in organic farming than conventional farming, even in the severe drought years of 1999. This is because organically managed soils have better water retention capacity and good soil health, yielding better even in drought conditions.[75,76] Pearsons,[64] in a decade-long study, showed that organic-managed farms have better soil health, higher soil organic matter (SOM), higher total carbon (C), and higher respiration rates in soil. Similarly, Patil *et al.*[77] showed that crop failure was 40 % lower in the case of organic agriculture. Organic farming is based on agroecological principles and promotes biodiversity. The meta-analysis by Rahmann (2011) of 396 studies from 327 case studies revealed higher biodiversity around organic farms. Promoting the ecosystem of birds, predatory insects, and soil organisms helps reduce pests. Moreover, agriculture is susceptible to climate change. Organic farming is resilient and emits low greenhouse gasses.[66,78,79] Patil *et al.*[77] claimed that organic farming maintained nitrogen in the soil and reduced nitrogen loss, positively impacting the environment and ensuring environmental sustainability. Das *et al.*[67] and Reganold and Watcher[79] maintained that organic farming promotes soil fertility and is eco-friendly. Moreover, when positive environmental externalities are converted into monetary value, organic farming becomes more profitable than conventional farming.[69] The farmers recognize the benefits of using organic farming. Manjunathan and Puttaswamaiah[58] revealed that farmers opt for organic farming as the primary food production method because of its environmental benefits.

Conclusion

The Industrial Revolution and the Green Revolution were paradigm shifts in human history. Nevertheless, the paradigm shift was the cause of the environmental crisis. To respond to these concerns, sustainable development was invented, which rests on three dimensions, i.e., economic, social, and environmental. These concepts were incorporated into Sustainable Development Goals (SDGs), which ensure human development without harming nature. SDG2 aims for Zero Hunger, which ensures that the food production system provides food security and nutrition with sustainable food production. Eventually, the negative externalities fused with the current food production system do not align with sustainable development. The world's utmost priority is the alternative measure that feeds the world without harming nature. Organic farming meets the dimensions of sustainable development, ensures its three pillars, and becomes more critical for achieving SDG2 targets. The analysis of organic farming on the first four targets of SDG2 showed that organic farming can be managed well in many aspects, but there are still various challenges to cope with. With the current state and patterns of organic farming, the objective of food availability for everyone is still challenging to achieve. However, in the long run, organic farming does ensure food security and provides higher income and better employment opportunities to smallholder farmers. Even farmers favour organic farming because its eco-friendly influence promotes soil fertility, biodiversity, and resistance to droughts and climate change.

Consequently, organic farming becomes a mandate for policymakers to implement as the primary food system. But to shift toward organic farming as a direct food production system, policymakers and institutions must frame and enforce robust policies. The study suggests innovative research and practices to respond to the yield gap and private and public partnerships to promote organic as the primary food production to promote organic farming, especially in developing countries. Moreover, a larger framework will help developing countries smooth the transition toward ecological farming. Additionally, access and availability of food for everyone, which leads to public health, must be ensured through inclusive policies. In conclusion, organic farming can be the key to meeting the demand of an ever-growing population with safe and nutritious food and help to save our mother earth.

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Conflict of Interest

We, Vikas Batra, Avinash, Ashish Kumar and Nupur Soti, the authors of this paper, hereby declare that we do not have any conflict of interest.

Data Availability Statement

Not Applicable

Ethical Approval Statement

As this is a review paper and does not involve any experiments on humans or animals, no specific ethics approval was required for this study.

Authors' Contribution

The review paper was a collaborative effort involving contributions from several authors. Dr Vikas Batra played a key role in conceptualising, supervision, providing structure of the paper, and finalising the manuscript. Whereas Avinash has contributed on preparing original draft of the paper, finding & selecting quality papers, and finalising manuscript. Ashish Kumar contributed in providing critical inputs, reviewing and conceptualisation. Nupur Soti played a pivotal role in editing process and review process.

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