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Sustainable Food Systems in India: A Pathway to Overcoming Food Insecurity

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ABSTRACT

With a population of 1.43 billion, India surpassed China in 2023 to become the most populous country, accounting for nearly 18% of the world's total population. This surge has raised major concerns, including increased pressure on natural resources, rising unemployment, strain on healthcare and education systems, urban overcrowding and environmental degradation. One of the most pressing challenges is ensuring sustainable food systems that can meet the nutritional needs of this vast population without compromising the environment. Despite major advancements in India's agricultural sector and a rise in food crop production, the nation continues to face challenges in ensuring a sufficient food supply for its entire population. Many Indians continue to experience food insecurity and hunger, contributing to the double burden of malnutrition, marked by a high prevalence of undernutrition alongside a growing incidence of obesity, largely driven by poor dietary quality. Given these challenges, transitioning to a sustainable food system is not just desirable but essential for India. A sustainable food system has the potential to simultaneously improve nutrition, protect the environment, support livelihoods and ensure equitable access to food. However, achieving this requires addressing systemic obstacles while leveraging the opportunities offered by innovation, traditional knowledge and policy reform. This review aims to explore the current status of India's food system, examine the opportunities for promoting sustainability and identify key barriers that hinder progress.

INTRODUCTION

Recent years have marked a substantial growth in the production and consumption of food. The increasing population and changing dietary patterns have posed a serious threat to the availability of natural resources. With a global population of 8.2 billion, which is estimated to reach nearly 10 billion by 2050, meeting the rising demands is a tough challenge for both the present and future generations (Lindgren *et al*., 2018).

With a population of 1.43 billion, India surpassed China in 2023 to become the most populous country, accounting for nearly 18% of the world's total population. This surge has raised major concerns, including increased pressure on natural resources, rising unemployment, strain

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on healthcare and education systems, urban overcrowding and environmental degradation. One of the most pressing challenges is ensuring sustainable food systems that can meet the nutritional needs of this vast population without compromising the environment. Despite major advancements in India's agricultural sector and a rise in food crop production, the nation continues to face challenges in ensuring sufficient food supply for its entire population. Many Indians continue to experience food insecurity and hunger, contributing to the double burden of malnutrition, marked by a high prevalence of undernutrition alongside a growing incidence of obesity, largely driven by poor dietary quality (George and McKay, 2019).

The food system of a country operates across various sectors, from production to consumption and disposal. On one hand, these can contribute to inequalities in food security, while on the other hand can prove to be a solution to global food security (Friel and Ford, 2015). Quantification of food system sustainability across various dimensions, like nutrition, environment and economy has been made possible through various research. As for India, the indicators suggest that the food system fails to achieve its target across these dimensions (Chaudhary, 2023).

Given these challenges, transitioning to a sustainable food system is not just desirable but essential for India. A sustainable food system has the potential to simultaneously improve nutrition, protect the environment, support livelihoods and ensure equitable access to food. However, achieving this requires addressing systemic obstacles while leveraging the opportunities offered by innovation, traditional knowledge and policy reform. This review aims to explore the current status of India's food system, examine the opportunities for promoting sustainability and identify key barriers that hinder progress.

Understanding Sustainable Food Systems: Global Context

Food systems encompass all activities along the food chain—from agricultural production to consumption and waste disposal—as well as the governance structures and outcomes associated with these processes. Globally, food systems are undergoing constant change due to shifting patterns of both demand and supply. Other contributing factors include evolving international trade policies, increasing market penetration by transnational food companies, the rise of supermarket-based retail and food industry marketing, all of which significantly influence consumer choices and attitudes toward food. As a result, there is no single, unified global food system. Current food systems often fall short in ensuring food security, delivering adequate nutrition and preventing widespread malnutrition (Vermeulen *et al.*, 2012).

Thus, traditional food systems need refinements to minimize environmental burden and improve economic profitability, in addition to reducing the problem of food insecurity. One potential solution is the adoption of sustainable food systems (Lindgren *et al.*, 2018). According to the Food and Agriculture Organization (FAO), a sustainable food system ensures food security and adequate nutrition for everyone, while safeguarding the economic, social and environmental resources needed to maintain this for future generations (Nguyen, 2018). Similarly, the American Public Health Association (2007) defines a sustainable food system as one that addresses food insecurity by providing affordable, healthy and sufficient food to all, encourages local production and distribution and minimizes negative environmental impacts.

To overcome the shortcomings of conventional systems, sustainable food system practices are being implemented worldwide to ensure the adequate availability of nutritious food and to safeguard the environment. These systems also advocate for the interests of the local farmers and producers.

A food system is considered sustainable when it generates positive outcomes across three key dimensions: economic, social and environmental (Fig. 1). The economic dimension pertains to the profits for stakeholders, government revenues and employment opportunities created by the system. The sustainability of a food system on a social dimension is reflected by the fair distribution of economic benefits among all participants, with special attention to marginalized or vulnerable groups. It also involves promoting positive socio-cultural outcomes like better nutrition, public health, cultural traditions, fair labor practices and animal welfare. The environmental dimension includes activities that have a neutral or positive impact on the natural ecosystem (Nguyen, 2018).

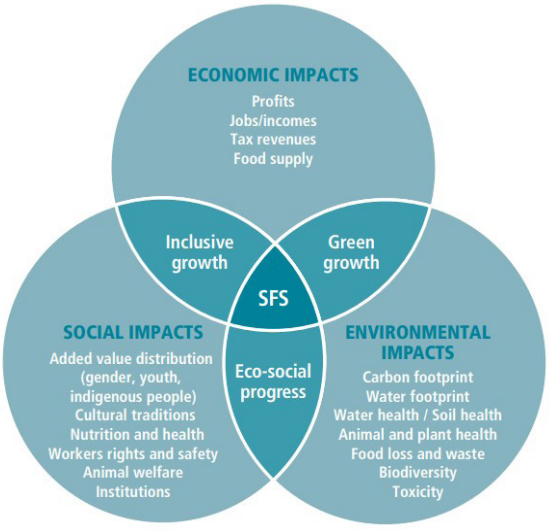

Figure 1. Three dimensions of a sustainable food system
Source: Nguyen (2018)

Food Security Scenario in India

Despite being an agriculture-dominated country, food security has consistently remained a concern for India. The Green Revolution led to a substantial increase in food production, significantly reducing the threat of acute food shortages. Today, India ranks among the top food-producing nations globally. According to the Department of Agriculture and Farmers Welfare, the country achieved a record food grain production of 3,539.59 Lakh Metric Tonnes (LMT) in 2024–25, marking an increase of 216.61 LMT over the previous year (2023–24). Horticultural production has also seen a rise, with an estimated output of 3,677.24 LMT. Likewise, the production of other food items such as milk, poultry, meat, nuts and oilseeds has grown significantly during the same period (PIB, 2024).

Following this increased production, the net per capita availability has also improved as compared to the last few decades. According to data from the Ministry of Statistics and Programme Implementation (MoSPI), per capita monthly availability of food grains increased from approximately 13.5 kg in the 1970s to around 15.8 kg in recent years (MoSPI, 2023). However, this data is a national average and does not account for distribution inequalities. The actual consumption patterns vary widely among different classes of Indian society.

Apart from food availability, food security is also influenced by other factors such as affordability, accessibility, utilization and stability over time. As per the data given by Global Food Security Index, 2022 (Table 1.1), the food security situation in India remains complex (The Economist Impact, 2022).

Table 1.1. India's scores and rankings across various GFSI dimensions

Dimensions	India's Score (out of 100)	India's Rank (out of 113)
Overall Food Security Index	58.9	68
Affordability	59.3	80
Availability	62.3	40
Quality and Safety	62.1	67
Sustainability and Adaptation	51.2	71

(Source: The Economist Impact, 2022)

The Global Hunger Index places India in a serious position regarding hunger, ranking it 105th out of 127 countries, with a score of 27.3. Notably, the percentage of undernourished individuals has increased from 11.5% in 2016 to 13.7% in 2024, indicating a worrying trend (GHI, 2024). In addition to persistent undernutrition, India now faces a double burden of malnutrition characterized by rising overweight/obesity prevalence, anaemia (predominantly among women) and disparities in access to nutritious food, especially among rural and marginalized populations.

The data from the National Family Health Survey (NFHS-5) reveal that overweight/obesity among adults has nearly doubled over 15 years. Alarmingly, one in five Indian households now has all adults either overweight or obese. The percentage of the population suffering from other non-communicable disorders has also seen a sharp rise over the recent years. Deficiencies of nutrients like Iron (manifested as Anaemia), Vitamin A, Vitamin B12, Vitamin D, Iodine, Folate, Zinc, etc., are also widespread in both rural and urban areas of India. For instance, 57% of women aged 15-49 years and 67.1% of children aged 6-59 months are anaemic. Deficiency of iron and folate are especially prevalent among adolescents and pregnant women. Studies indicate that over 60% of India's population may be Vitamin D deficient, particularly in urban areas (NIN, 2020; IIPS and ICF, 2021).

Therefore, India's food security landscape is marked by a paradox of abundance and deprivation—ample food supply coexisting with widespread nutritional deficiencies. Addressing this complex issue calls for systems that not only enhance food production but also promote equity, nutrition and environmental sustainability. Sustainable food systems that ensure access to adequate and nutritious food for all citizens while preserving natural resources can be a potent solution to overcome these challenges prevalent in developing countries like India. Implementing such systems requires coordinated efforts across sectors, informed policies and active community participation.

Existing Food Systems in India: Major Concerns

India stands at a critical juncture in terms of food security and according to current estimates, the situation is expected to worsen in the coming years due to a continuous rise in population, declining natural resources, increasing poverty and growing inequality. It is important to analyze the relationship between India's economic growth, agricultural output and nutritional outcomes using a food systems framework (Gulati *et al*., 2023).

India's food system, responsible for ensuring healthy diets for a population of 1.4 billion, is highly complex. It also plays a vital role in livelihoods, with the agricultural sector employing approximately 46% of the country's workforce—making it the largest source of employment, especially in rural areas. However, the system faces multiple challenges, including food and nutritional insecurity, widespread rural poverty, difficulties faced by smallholder farmers in adapting

to climate change and environmental degradation such as excessive water extraction, soil depletion and chemical runoff (Food System Economics Commission, 2024). India, despite being the world's second-largest producer of fresh agro produce, faces massive post-harvest losses—especially in fruits and vegetables—due to inadequate cold storage and inefficiencies in the supply chain. This food wastage not only leads to significant nutritional and economic losses but also hinders timely access to quality food for its population (Negi and Anand, 2017).

India witnessed a remarkable transformation in food production following a series of agricultural reforms and revolutions. The Green Revolution, driven by high-yielding varieties, irrigation, fertilisers and institutional support, played a crucial role, followed by the White Revolution in dairy and rapid growth in poultry and cotton through technological advancements like Bt cotton. Smallholders were central to these successes, aided by cooperative models, private investment and supportive policies. These achievements underscore the power of innovation, value chains and institutional reforms in transforming a food-insecure nation into a globally competitive agricultural economy (Gulati *et al*., 2023; Singh, 2025).

However, the growing challenges highlight the urgent need for a more integrated and sustainable food systems approach—one that addresses environmental limits, ensures equitable livelihoods and secures access to nutritious food for all. In order to achieve a refined food system, several reforms have been made in the country. These include policy interventions to improve agricultural marketing, expand access to technology, promote sustainable farming practices and strengthen food safety and nutrition programs.

India's Approach Towards Sustainability

As the Indian government strives to meet the Sustainable Development Goals (SDGs) by 2030, hunger and undernutrition remain critical challenges. To address this issue, several proactive measures have been implemented in the form of programs and policy initiatives, technological interventions, traditional practices and adherence to international commitments. These efforts aim to improve agricultural resilience, promote climate-resilient farming, enhance food production, ensure food security, improve livelihoods, promote environmental stewardship and ensure long-term sustainability in agricultural productivity (Mahali *et al*., 2024).

Advancing Sustainable Agricultural Practices

1. Zero Budget Natural Farming (ZBNF): This method of farming was first created and promoted in the mid-1990s by an Indian Agriculturist, Subhash Palekar, to provide a chemical-free alternative to input-intensive methods introduced during the Green Revolution. This farming technique implements traditional methods of farming by ditching the costly chemical fertilizers and pesticides and cuts down the input cost of farming. Its efficiency has gained international recognition and according to the Food and Agriculture Organization (FAO), such agroecological approaches can alleviate the economic burdens on farmers globally (Shyam *et al*., 2020; Choudhary *et al*., 2023).

2. National Mission for Sustainable Agriculture (NMSA): As a part of the National Action Plan on Climate Change (NAPCC), the Indian Government in 2014 launched the National Mission for Sustainable Agriculture (NMSA). This mission aims to mitigate the adverse effects of climate change on agriculture by enhancing soil health, conserving resources, optimizing water-use efficiency and promoting the adoption of climate-resilient farming technologies among farmers (Kumar and Shobana, 2024).

3. Paramparagat Krishi Vikas Yojana (PKVY): Launched in 2015 as a centrally sponsored scheme, PKVY aims at improving the soil health by promoting organic farming through the development of sustainable models and reducing dependence on chemicals used in farming. It is a component of NMSA- National Mission on Sustainable Agriculture. This scheme encourages farmers to opt for organic farming and provides financial and other assistance to them (Ghildiyal and Mallaiah, 2024).

4. Pradhan Mantri Krishi Sinchayee Yojana (PMKSY): In 2015, the Ministry of Agriculture and Farmers Welfare launched PMKSY in order to provide irrigation to all agricultural farms (Har Khet Ko Pani), boost irrigation efficiency (Per Drop More Crop) as well as income. To ensure sufficient water for irrigation and other agricultural activities, the scheme promotes the creation of water sources, restoration of traditional water bodies and adoption of micro-irrigation techniques such as drip and sprinkler systems (Wani *et al*., 2016; Tripathy *et al*., 2023).

5. Soil Health Card Scheme: The scheme was launched by the Government of India in 2015 to promote the use of fertilizers in a balanced

amount in the soil to reduce the input cost and boost productivity. Under this scheme, the soil samples are collected and tested across various laboratories and analysed by the experts for the nutrient levels and Soil Health Cards (SHCs) are issued. Accordingly, suitable crops and the fertilizer levels are recommended (Reddy, 2019).

Enabling Healthy and Sustainable Diets

1. National Food Security Act (NFSA): The NFSA is an Indian Act of Parliament that came into force in 2013. This act aimed to ensure an adequate amount of quality food for all at an affordable price. NFSA focuses on ensuring food and nutritional security for the citizens of India. Under this Act, 50% urban population and 75% of the rural population are covered and provided with subsidised foodgrains under the government scheme of TPDS- Targeted Public Distribution System (Puri, 2022).

2. Mid-Day Meal Scheme: The main purpose of the Mid-Day Meal Scheme, now renamed as PM-POSHAN (Pradhan Mantri Poshan Shakti Nirman), is to enhance the nutritional status of school-age children and improve school enrollment, attendance and retention. This scheme targets particularly the disadvantaged sections of the society and has emerged as one of India's most important school-based welfare programs (Sahai, 2014).

3. Integrated Child Development Services (ICDS): ICDS was launched in 1975 and is regarded as one of the largest programs globally focused on early childhood care, maternal health and nutrition. ICDS is implemented by the Ministry of Women and Child Development, Government of India. The beneficiaries include children (up to 6 years), pregnant and lactating mothers, women (15-44 years) and adolescent girls (up to 18 years, only for training and non-formal education in health and nutrition). ICDS aims to support better nutrition and health among vulnerable groups by implementing direct intervention strategies through Anganwadi Centres (Kapil, 2002).

4. Eat Right India: Launched by FSSAI in 2018, the Eat Right India initiative promotes the consumption of safe, healthy and sustainable food. It addresses challenges such as lifestyle diseases, nutritional deficiencies and food-related environmental concerns. Flagship programs like Eat Right Campus and Eat Right School promote dietary awareness across various groups through a multi-stakeholder, systems-based approach (Kathuria *et al.*, 2020; FSSAI, 2020).

Strengthening Inclusive Food Supply Chains

1. Electronic National Agriculture Market (e-NAM): Launched in April 2016, the e-NAM portal is a technology-driven initiative with over 1.78 crore farmers and 1389 mandis registered. It aims to create a unified national agricultural market by digitally interconnecting mandis, streamlining the marketing process and transforming traditional buyer-seller relationships. e-NAM is seen as a policy-backed innovation driving social change in agricultural marketing (Gupta and Badal, 2018).

2. Farmer Producer Organizations (FPOs): Farmer Producer Organizations (FPOs), promoted by the Government of India under the Companies Act, 1956, are collective entities formed to empower small and marginal farmers. These organizations aim to eliminate intermediaries, ensuring farmers receive fair prices directly from consumers, thereby improving their livelihoods. In the Indian context, FPOs serve as a vital tool for addressing challenges faced by fragmented farming communities and are seen as a strategic means to drive sustainable economic development and lift rural farmers out of poverty (Adhikari *et al.*, 2021).

3. PM Formalisation of Micro Food Processing Enterprises Scheme (PM-FME): Launched on June 29, 2020, under the Aatmanirbhar Bharat Abhiyan, the Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PM-FME) Scheme aims to enhance the competitiveness and formalization of micro food units. It provides financial, technical and business support to up to 2 lakh units, including FPOs, SHGs and cooperatives (PIB, 2022).

4. Operation Greens – This scheme was launched by Government of India (GOI) in 2018-19 to address issues like price instability, perishability of crops and post-harvest losses. The scheme is run by the Ministry of Food Processing Indus-

tries (MoFPI) with the objectives of enhancing the value realization of TOP (Tomatoes, Onions and Potatoes) crops, increasing food processing capacity and price stabilisation (Praveen, 2023).

Tackling Environmental and Climate Challenges

1. National Action Plan on Climate Change (NAPCC): India launched the National Action Plan on Climate Change (NAPCC) on June 30, 2008, marking its first comprehensive policy initiative to tackle climate-related challenges. Recognizing the potential threats of climate change to vital sectors such as agriculture, water, health and biodiversity, the government aligned the plan with broader development goals like poverty alleviation and economic growth. The NAPCC comprises eight core missions focused on key areas of environmental sustainability and climate resilience. It also plays a pivotal role in shaping India's stance in international climate negotiations (Pandve, 2009; Deshpande *et al.*, 2025).

2. National Adaptation Fund for Climate Change (NAFCC): NAFCC was adopted in July 2015, as an initiative for climate change. This scheme is implemented by the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India (Prasad and Sud, 2019). NAFCC provides central grants to states for climate adaptation projects, emphasizing a structured, project-based approach to domestic climate finance (Mandal, 2019).

3. State Action Plans on Climate Change (SAPCCs): The State Action Plans on Climate Change (SAPCCs) mark India's first major sub-national effort to integrate climate concerns into governance. Initiated after a national consultation in 2010, SAPCCs guide states and union territories in developing adaptation-focused strategies aligned with local priorities. They involve key development sectors such as agriculture, water, health and disaster management, with emphasis on community participation, cost-effectiveness and ease of implementation. The SAPCCs aim to mainstream climate considerations into existing policies and programmes (Kumar, 2018).

The initiatives discussed above are part of a broader framework through which India has sought to transition towards sustainability. While not exhaustive, these programs have shown measurable success in key areas. For instance, under the Soil Health Card Scheme, over 22 crore cards were distributed by 2023, helping improve fertilizer use efficiency and crop productivity (MoA&FW, 2023). The PM-Krishi Sinchayee Yojana has expanded micro-irrigation coverage to over 1.3 crore hectares, significantly enhancing water-use efficiency. Similarly, the e-NAM platform has connected more than 1,300 mandis and 1.78 crore farmers, contributing to transparent and fair market access. Programs like Zero Budget Natural Farming and Paramparagat Krishi Vikas Yojana have promoted chemical-free farming across several states, reducing environmental impact and input costs. Though challenges remain, these efforts collectively indicate progress towards improved agricultural resilience, enhanced food access and more environmentally responsible practices. However, continuous monitoring, capacity building and policy coherence are essential to scale up these outcomes and ensure long-term sustainability.

Conclusion and Pathways Forward

India's journey towards building sustainable food systems is marked by significant progress, yet persistent challenges demand continued and coordinated action. While the country has achieved commendable gains in agricultural productivity, food production and the implementation of various policy initiatives, food insecurity, malnutrition and environmental degradation continue to pose serious threats. The paradox of food surplus coexisting with widespread nutritional deficiencies underlines the need for a more integrated, inclusive and resilient food system.

The initiatives undertaken—ranging from sustainable agricultural practices and nutrition-based interventions to digital innovations and climate resilience strategies—demonstrate India's commitment to transforming its food systems. Programs such as the Soil Health Card Scheme, PM-Krishi Sinchayee Yojana, National Food Security Act and Eat Right India, among others, have played pivotal roles in improving productivity, promoting healthy diets and supporting environmental sustainability. However, gaps remain in implementation, regional disparities and equitable access to resources and benefits.

Looking ahead, the future of sustainable food systems in India hinges on several critical actions. First, there is a need for greater investment in research, innovation and climate-smart agriculture to increase productivity without depleting natural resources. Strengthening farmer collectives, such as Farmer Producer Organizations (FPOs) and expanding access to markets and credit for smallholders will be essential to ensure inclusive growth. Additionally, nutrition-sensitive agriculture must be promoted to tackle the double burden of malnutrition. Greater emphasis on circular economy principles—such as reducing food waste, improving supply

chains and promoting resource-efficient practices—can enhance sustainability.

Policy coherence, inter-sectoral coordination and participatory governance involving communities, especially women and marginalized groups, will be vital. Finally, the integration of traditional knowledge with modern technologies, continuous capacity building and robust data systems will support evidence-based decision-making and targeted interventions.

India stands at a crucial point where it has both the opportunity and responsibility to lead by example in building sustainable, equitable and resilient food systems. By aligning economic growth with ecological integrity and social well-being, India can not only ensure food and nutrition security for its population but also contribute meaningfully to global sustainability goals.

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