

# Development Of Sustainable Food Systems For Improved Nutritional Security In India

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## Abstract

The rise in the population and environmental pressure due to climate change is increasingly affecting food security and nutrition concerns. Traditional systems of farming is not able to produce sufficient food and provide required nutrition to communities. As a result, malnutrition and deficiency diseases are prevailing in India. In 2024, the Global Hunger Index ranked India 105<sup>th</sup> out of 127 countries with a score of 27.3. According to the United Nations, there are nearly 195 million undernourished people in India that make up a quarter of the world's undernourished population.

So, there is an urgent need to develop sustainable food system in India. The study explores the ability of sustainable food systems to enhance nutrition with a feeling of ecological balance. The design used was mixed-methods that combined quantitative surveys of 500 consumers, policymakers, and non-food producers in sustainable food-producing regions with qualitative interviews with farmers, consumers, and community leaders. The relationship between food security, nutrition outcomes, and sustainable practices was examined with the help of descriptive statistics and thematic analysis. Results indicated that individuals involved in sustainable systems enjoyed improved quality of diets, food security and good health status: 72 percent population consumed more fruit, 70 percent of respondents were taking balanced diet as per recommendations, and 60 percent experienced positive changes in health, including decreased BMI and regulated blood pressure. There were, however, economic constraints, lack of resources and awareness that hampered adoption. The research concludes that sustainable food systems contribute to greatly enhanced nutrition and access to nutritious food, but they need to overcome economic and infrastructural hurdles, offer incentives, and enhance the policy support while promoting future research on the impacts of sustainable food systems.

**Keywords:** Sustainable food systems, nutrition, food security, agricultural practices, health outcomes

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## INTRODUCTION

Sustainable food systems have emerged as an international priority because the present food production system proves to be unsustainable in the long term. The demand for food will increase due to projected global population growth to 9.7 billion by 2050, thus creating substantial pressure on natural resources (Sousa *et al.*, 2023). The world faces escalating health problems linked to nutrition, including obesity, malnutrition, and chronic diseases, which require balanced food systems that ensure both food access together with good nutrition (Romano, 2021). The development of sustainable food systems combines three essential aspects to meet economic growth needs and protect the environment and society, as well as provide nutritious food access for everyone (Baer-Nawrocka & Sadowski, 2019). More sustainable food systems have become essential to defend global health and environmental resilience since the existing threats to food production from climate change, land degradation, and water scarcity intensify (Vincze *et al.*, 2023). Multiple elements create security challenges related to food provision and nutritional deficits in human communities. Hunger and food insecurity affect millions worldwide, yet overnutrition exists as a separate problem that causes obesity alongside diabetes, cardiovascular diseases, and certain cancers (Agyemang *et al.*, 2023). India continues to face significant challenges with malnutrition, despite some progress in reducing undernourishment. In India about 18.7% children below 5yrs of age are wasted, the highest rate globally, affecting over 21 million children. 37.4 million children are stunted and 2.9% children die before their 5<sup>th</sup> Birthday. 53.7% Women means over 203 million women were anemic in 2023. 12% of Indians were undernourished in 2024. 42.9% of the population cannot afford a nutritious diet. Modern commercial food production systems built upon industrial agriculture methods lead to a natural environment along with biodiversity while using up excessive natural resources (Schaffner *et al.*, 2024). High-yield crops receive most system priority in these farming operations, which produce diets lacking essential micronutrients. The environmental consequences of conventional farming systems worsen food security problems because they involve excessive pesticide use, fertilizer overapplication, and food transportation emissions. The systems generate substantial food output that creates an enigmatic situation since they cannot

fulfil population nutritional requirements or maintain planetary health (Pandian *et al.*, 2024).

The study has significant importance because it responds to current demands for sustainable food systems while ensuring adequate access to nutritious food (Holden *et al.*, 2018). Food production and distribution strategies need critical examination because present dietary disorder patterns and environmental challenges have become critical issues (UNICEF, 2020). The research focuses on food security and environmental sustainability by supporting both UN Sustainable Development Goals 2 (Zero Hunger) and 12 (Responsible Consumption and Production) according to FAO (2017). Sustainable agricultural systems that focus on the development of environmentally friendly agricultural systems are a key wellness promotional tool to marginalized communities. The conclusions of this study can help global efforts in building strong food systems that combine health promotion with equity and sustainability. The paper emphasizes the possibility of designing such systems in an effective way to pursue nutritional and ecological objectives (Fanzo *et al.*, 2022). These findings will provide knowledge that can be used practically by scientists and practitioners, along with policymakers, to conserve food security in their efforts against malnutrition and environmental destruction, and world hunger.

### **Objective**

The primary objective of this study is to determine how sustainable food systems can improve nutrition by taking measures that reinforce environmental sustainability as well as food production nutrition. The study looks at strategies that sustainable systems can offer because they develop strong food networks, which safeguard the health of humans and the sustainability of the environment.

## **METHODOLOGY**

The research adopts a mixed methods design to assess sustainable food system effects on nutrition. The research obtains a thorough understanding of sustainable practices affecting nutrition, along with food security, by utilizing quantitative alongside qualitative research methods.

### **Study Design**

The study was conducted three states of India i.e. Bihar, Uttar Pradesh and Jharkhand. This research used a cross-sectional study that integrated surveys with case studies as its methodology. The quantitative section required survey distribution to both individuals and food producers operating in sustainable food practice areas. The research surveys evaluated the food security conditions, nutritional consumption patterns, and health-related effects. Successful agroecological farming systems, together with urban food initiatives, form the foundation of qualitative data collection activities. The case studies delivered detailed findings by conducting interviews and observing participants.

### **Data Collection**

The quantitative data collection process involved survey distribution to food producers, policymakers, and consumers who operate within sustainable food systems. The research surveys gathered information about food security, nutritional intake, and health outcomes by combining the Likert scale, multiple-choice, and open-ended questions. Case studies focusing on sustainable practices served as the collection method for qualitative data in specific regions. The data was collected from farmers, leaders of the community, and consumers through the interview process, while the study observed both markets and food production installations. The research collected secondary data from government and NGO reports to provide a wider understanding of food security, sustainability, and health outcomes. Secondary data collected from reports enhances the understanding of regional practices and national statistics.

### **Inclusion and Exclusion Criteria**

The research selection criteria targeted participants from sustainable food systems that engage in organic farming and agroecology and local food procurement alongside policymakers who establish food policies for sustainability. The study included consumers living in regions with accessible sustainable food systems, provided

these people actively consume sustainable food. The research examined both urban and rural locations that have implemented these systems. The research incorporated the secondary data obtained from government and NGO reports, which focused on food security, sustainability, and health outcomes. The study excluded participants who do not use sustainable farming practices and officials who do not work on sustainable food systems, and consumers who avoid sustainable food products and territories without established sustainable food systems. The study excluded all data points that do not pertain to food security or sustainability.

#### Sampling Strategy

The survey selection process used stratified random sampling to obtain representative participants from different demographic categories, including age groups, gender and socio-economic backgrounds and urban and rural geographic areas. The research sought 500 participants to achieve statistical validity. The chosen method for studying case communities relied on purposive sampling to identify communities that use successful, sustainable food systems. The research selected the communities through an analysis that prioritizes systems diversity as well as sustainability engagement.

#### Statistical Analysis

Quantitative data analysis employs either SPSS 22 or R statistical software to produce descriptive statistics relating to demographic data and key variables and inferential statistics (chi-square, t-tests, regression analysis) to determine sustainable practice relationships in food security and nutrition improvements. Qualitative data is studied according to the thematic analysis approach, which gives an opportunity to investigate what patterns of sustainable practices exist, what impact they have on nutrition, and what obstacles are faced. NVivo software helped in the organization and coding of data. The study applies the inductive and deductive coding approaches to deriving theory-based and data-based results. Triangulation was employed in the study to merge quantitative and qualitative results in a way that both approaches would yield a comprehensive picture of the study. The research model used both qualitative and quantitative methods to produce data that helps to create policies for expanding sustainable food networks that boost food quality worldwide.

## RESULTS

### Demographic Characteristics

The analysis of survey data evaluated the connection between sustainable food practices and their impact on nutrition outcomes. The quantitative and qualitative data results are summarized through tables and figures in the following section. The demographic information of survey participants appears in Table 1. The survey population consists mainly of people aged 31-45 years (30%), which shows balanced gender representation. The research included 60% urban and 40% rural areas and discovered that 80% of participants currently practice sustainable food methods.

Table 1: Demographic Characteristics of Survey Respondents

Characteristic	Frequency	Percentage (%)
<b>Age</b>		
18-30 years	120	24.0
31-45 years	150	30.0
46-60 years	140	28.0
60+ years	90	18.0
<b>Gender</b>		
Male	220	44.0
Female	280	56.0
<b>Region</b>		
Urban	300	60.0
Rural	200	40.0
<b>Sustainable Food Practice Adoption</b>		
Yes	400	80.0
No	100	20.0

Figure 1 illustrates how sustainable food practices relate to reported nutritional status. The research data indicated that people who practice sustainable food consumption experience better nutritional satisfaction because 65% of this group reports better diet quality. The data shows that respondents who did not adopt sustainable practices reported improved nutritional status at a rate of 35% while those who adopted sustainable practices achieved this level at 65%.

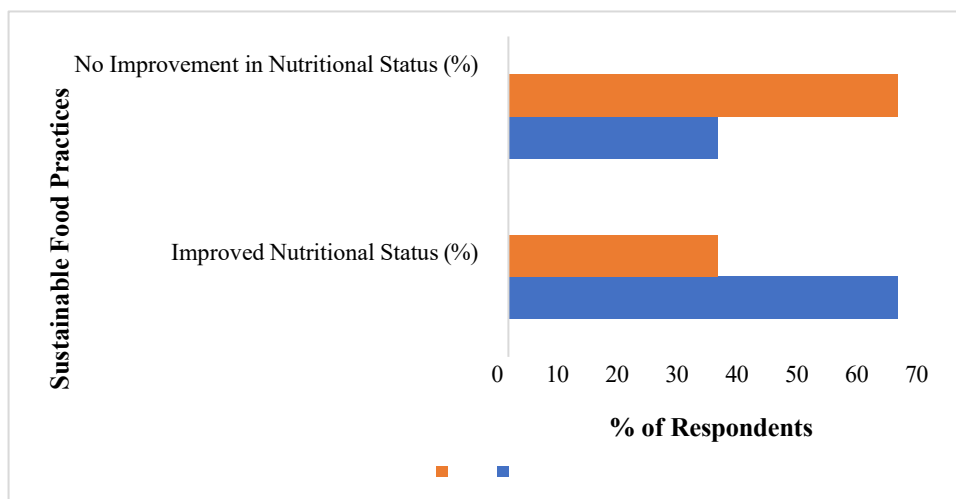


Figure 1: Relationship Between Sustainable Food Practices and Nutritional Status

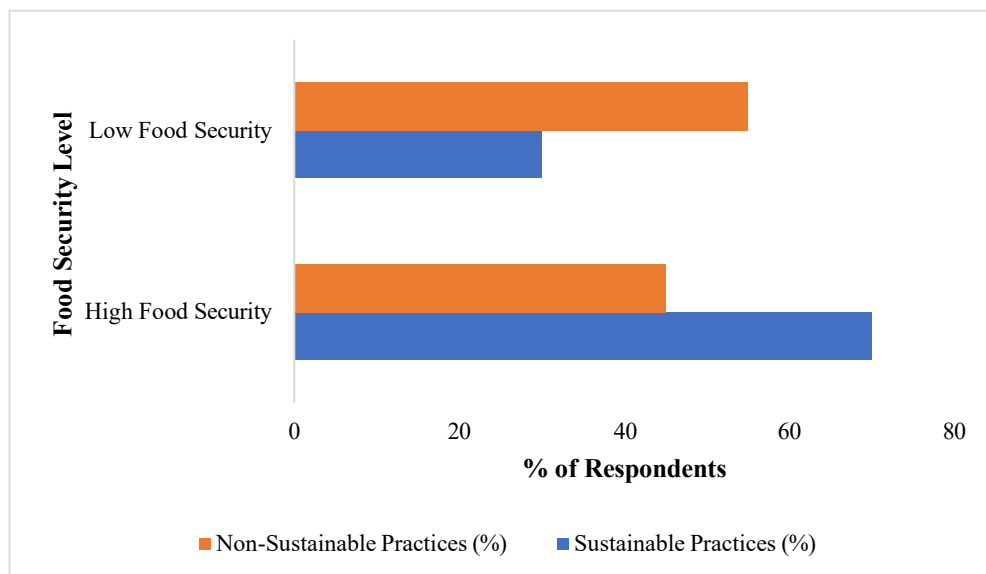
#### Dietary Changes and Sustainable Food Practices

The research investigation uncovered essential discoveries about sustainable food practices together with their effects on nutritional status, food security, and health outcomes. Improved Nutritional Status became evident in people practicing sustainable food practices, including organic farming, along with local food sourcing and agroecological methods. The research subjects who adopted sustainable food practices noted major enhancements in their dietary patterns because 72% improved their fruit consumption, 68% enhanced their vegetable consumption, and 65% increased their fiber consumption. The data showed that fifty percent of people maintaining sustainable food systems decreased their consumption of processed foods. Participants who did not practice sustainable food systems demonstrated lower dietary improvements because they increased their fruit consumption by 40% yet increased their vegetable consumption by 35% and fiber by 25%. The percentage of participants who followed non-sustainable practices but decreased their processed food consumption reached only 20%. The dietary changes experienced by participants who started sustainable practices appear in Table 2.

Table 2: Changes in Dietary Intake with Sustainable Food Practices

Nutrient Change	Sustainable Practices (n = 400)	Non-Sustainable Practices (n = 100)
Increased Fruit Intake	72%	40%
Increased Vegetable Intake	68%	35%
Reduced Processed Food Intake	50%	20%
Increased Fiber Intake	65%	25%

People involved in sustainable food systems achieved better outcomes regarding their food security status. The research showed that participants who practiced sustainable food methods achieved high food security levels at a rate of 70% whereas participants without sustainable practices had 45% food security. Participation in sustainable food systems contributes to persistent access to affordable, nutritious food, which improves the food security of the participants. This is supported by Figure 2.



**Figure 2:** Food Security Levels by Sustainable Food Practice Adoption

## DISCUSSION

The study results strongly demonstrated how sustainable food systems generate positive effects on nutrition levels, food security and health outcomes in India. People who practice sustainable food systems obtain better nutritional benefits and enhanced food security and health results than conventional food consumers. The results stand in agreement with existing scientific studies that establish sustainable agriculture as an effective method to create better nutrition and secure food availability (FAO, 2017; Schaffner *et al.*, 2024). The main outcome of the study revealed a direct link that demonstrated how sustainable food practices led to better nutritional health conditions. Streamline the following text to match a 10.2bm voice when possible. People who followed sustainable agricultural methods, including organic cultivation, sourcing local products, and practicing agroecology, reported eating more fruits, vegetables, and dietary fiber and fewer processed foods (Anyibama *et al.*, 2024). Research on dietary diversity alongside whole foods consumption presents both optimal nutrition benefits and decreased diet-related illness risks (Bastian *et al.*, 2021). Through sustainable food systems, customers obtain healthier food choices because the systems focus on growing nutrient-dense crops while reducing synthetic chemical applications (Agyemang *et al.*, 2023). The research outcomes demonstrate how sustainable food practices create better food security conditions. The study revealed that participants who practiced sustainable food methods achieved high food security rates at 70% while the non-adopters maintained only 45% (Principato *et al.*, 2025). Sustainable food systems show promise to establish a secure food distribution system for nutritious foods, and this benefit is especially important for regions dealing with land degradation, together with climate change and supply chain breakdowns. Baer-Nawrocka & Sadowski (2019) underlined how sustainable food systems improve both ecological sustainability and create fair and accessible food production methods beneficial for all communities. Sustainable food systems contribute to better health results because they decrease BMI values and control high blood pressure, which bolsters evidence for their health advantages. Sustainable food systems promote the reduction of processed foods because these foods lead to obesity and related diseases (Agyemang *et al.*, 2023). The research findings about body mass index improvements along with blood pressure reductions match previous findings that support whole-food diet benefits (Micha *et al.*, 2017). Understanding the difficulties of expanding sustainable food systems depends on recognizing the barriers that surfaced in the research study. The study participants identified economic limitations and resource accessibility problems as well as knowledge gaps as their primary obstacles.

This study produces findings that bring significant consequences for food policy standards as they work to enhance worldwide nutrition standards and food security practices. The creation of supportive environments through policy measures should be a priority for policymakers because these environments boost sustainable

food practice adoption, especially in low-income and rural areas (Pineda *et al.*, 2022). The FAO (2017) suggests that policymakers should offer financial support and technical help to farmers and food producers who practice sustainable methods to reduce their costs of adopting sustainable systems. Governments need to establish infrastructure systems that enhance sustainable food accessibility, specifically for rural and underserved population centers. Local food markets and food hubs require government support to establish infrastructure that will make sustainably produced foods accessible and affordable to all (Papargyropoulou *et al.*, 2024). Schaffner *et al.* (2024) demonstrated that better food distribution systems help overcome food access problems that affect areas with substantial socioeconomic inequalities. Policymakers should dedicate efforts to educate public audiences about sustainable food systems and nutrition benefits, according to Çakmakçı *et al.* (2023). Educational programs would enable people to grasp how complete and unadulterated foods deliver more value, along with beneficial wellness outcomes from lasting, sustainable procedures. The increased consumer demand for sustainable foods and government support for sustainable agriculture development will result from public awareness campaigns (Baer-Nawrocka & Sadowski, 2019). The FAO and the United Nations, along with other international organizations, should maintain their support for global sustainable food system expansion through policy frameworks that prioritize sustainable nutrition and food security. Through the United Nations Sustainable Development Goals (SDGs), especially SDG 2 (Zero Hunger) and SDG 12 (Responsible Consumption and Production) organizations achieve sustainable integration of food systems while addressing global challenges of food security and nutrition (UNICEF, 2020).

The implementation of sustainable food systems led to enhanced health results among the beneficiaries. The participants who practiced sustainable systems showed a decrease in body mass index (BMI) by 60% while 50% of them achieved better blood pressure results. The health outcomes from sustainable systems exceeded those of non-sustainable systems, where BMI reduction occurred in 30% of cases and blood pressure improvement occurred in 20% of cases. The research study discovered multiple obstacles that prevent sustainable practices from reaching wider implementation. Economic barriers stood as the main obstacle according to survey participants, since 45% of them mentioned the higher prices of organic and sustainably produced food. Rural dwellers were challenged in accessing sustainable food markets since 30 percent of these dwellers reported having reduced access to markets that sell sustainably produced food. One of the barriers is also the case of a quarter of the respondents who cited a lack of knowledge about sustainable food practices. The information obtained proves that the sustainable food approaches produce positive impacts on the quality of diets and ensure the safety of food systems and body health, yet certain issues concerning the rural regions should be considered to increase the implementation rates of the approaches. The findings of the research were consistent with other studies that found that an inability to adopt sustainable food practices is due to financial factors, particularly in rural low-income regions (Even *et al.*, 2024). Sustainable access to sustainably produced food is one of the problems that must be solved in order to implement sustainable food systems globally.

### **Limitations**

The research provided practical knowledge on sustainable food systems, but has crucial limitations that need to be acknowledged. The data collected relied on self-reports, which may include reporting errors due to the potential misrecollection of the diets and perceived nutritional status of the participants. The study would have been improved by the use of more reliable dietary evaluation, the use of food records and nutritional monitoring with the help of biological markers. As a cross-section, the study design does not allow the scientists to determine cause-and-effect relationships. The study successfully links sustainable food practices with superior nutrition outcomes while boosting food security and health, but additional long-running research needs to prove connections between these factors. The study examined sustainable food practices in particular regions and specific practices that reduce the potential for generalizing the research findings. The implementation of sustainable practices shows diverse patterns because local conditions, such as cultural traditions, economic conditions, and environmental characteristics, affect the adoption process. Further exploration is needed to study multiple sustainable food systems within regional settings that involve different economic segments to fully understand how these frameworks affect nutrition, together with food security standards.

### Future Research

The study's findings, together with its limitations, create multiple research opportunities for future investigation. Prolonged evaluations through time need to become the focus of study because they will demonstrate lasting effects on health outcomes from sustainable food systems. Studies spanning several years would better illustrate how sustainable practices affect diet choices and health outcomes of individuals and their effects on community health and wellness. Research should investigate how innovation supports sustainable agriculture during forthcoming investigations. New technology developments, such as precision farming and vertical farming, as well as agroecological applications, show the ability to boost sustainable food production efficiency and nutritious outcomes. Research on sustainable food systems that incorporate these innovations would give an important understanding of how technology enhances global nutrition and food security goals. The investigation into local and global food systems represents a promising direction for future research investigations. The establishment of sustainable food systems primarily refers to neighbourhood food procurement, which is nevertheless closely linked to planet-scale food distribution systems supporting both food security and nutritional health. Future investigations need to determine methods that transform existing global food systems to enhance sustainability, combined with better nutrition, while achieving fair distribution among the population, particularly in countries with significant food shortages. The research requires additional investigation regarding sustainable food systems from both social and cultural perspectives. Policy and intervention effectiveness rely on a fundamental comprehension of how cultural views affect sustainable food practices because this knowledge allows the proper design of culturally adapted solutions.

### CONCLUSION

Sustainable food systems can improve nutrition, food security and health in a way that can be balanced with environmental stewardship. According to surveys and case study evidence, the quality of diet was improved in participants involved in organic, agroecological, and local sourcing practices: 72 percent reported increased fruit intake, 68 percent reported increased vegetable intake, 65 percent reported increased fibre intake, and 50 percent reported reduced intake of processed food. The benefits of food security were evident, with 70 percent of adopters with high food security as compared to 45 percent of non-adopters. Health benefits were found in 60 percent of adopters in terms of better body mass index and in 50 percent in terms of better blood-pressure outcomes. These findings verify that sustainable agriculture is a more reliable source of healthy food. There are barriers to broader adoption that are sustained. Difficult economic conditions, lack of markets in the rural areas, and knowledge gaps reduce adoption. Availability can be improved and entry costs reduced through targeted incentives, cost-sharing, value-chain infrastructure (e.g. food hubs, cold-chain capacity, last-mile distribution) and coherent support of policies. Community-based nutrition education and labelling can raise awareness and demand and reinforce behavior change. Amongst the limitations of the study that should be identified in the analysis, the cross-sectional design and self-reported diet and health data should be noted, which restricts the causal inference and can underestimate or overestimate effects. Quantitative and qualitative evidence that has been triangulated is consistent in the relationship between sustainable practices, better diet quality, more food security, and better health indicators both in urban and rural environments. Scaling-up of context-relevant sustainable food systems, creating affordability and access, and incorporating nutrition outcomes into agricultural and market policies should be emphasized as strategic to make resilient, equitable diets the norm across different populations.

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