Original Paper

A multidimensional analysis of food security for sustainable development

Evidence from India

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Received: 5 August 2024 | **Accepted:** 7 September 2024 | **Published:** 21 September 2024

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Keywords: food security; India; policy evaluation; Sustainable Development Goals (SDGs).

Abstract. *Ensuring access to sufficient and nutritious food is a vital component in attaining sustainable development, especially in developing nations like India. This study aims to comprehend the importance of food security measures in relation to Sustainable Development. We performed an analysis employing data obtained from the official Food and Agriculture Organisation databases and the National Family and Health Survey of India. This study utilises a comprehensive quantitative approach, employing graph analysis, trend analysis, and literature reviews to examine the several dimensions of food security in India. These dimensions include availability, access, utilisation, stability, agency, and sustainability. The results emphasise the importance of policy in improving food security and encouraging healthy diets, while considering the current state of affairs. This paper argues that achieving sustainable development in India requires not just increasing food production but also adopting responsible food consumption practices and optimal utilization the use of current resources.*

1. Introduction

Food aid which includes variety of programs and initiatives designed to provide food security and nutritional support to vulnerable populations, has both positive and negative effects on food security. It facilitates food security through improving production and consumption choices, but also hinders it through labor supply disincentives and dependence syndrome. Further, the impact of food security is multifaceted, influenced by food aid, environmental factors, food processing technologies, and dietary habits. Therefore, researchers are of the opinion that comprehensive studies are needed to determine the net effect of food aid on food security, incorporating multi-country and multi-program factors (Garbero & Jäckering, 2021).

The economic and social transformation after the dissolution of the USSR, changing agricultural policies, and climate change have shaped the state and changing trends of food security in Asia. Asia is the largest producer of rice, with China and India being the leading producers, and the region also produces a significant amount of vegetable oil (Iqbal et al., 2022). More than half the world's population lives in Asia, making food security a matter of paramount

importance. Even though, the region has made impressive achievements in reducing poverty and hunger, driven by economic growth and rising incomes, progress has been uneven, with over 60% of undernourished people in the world residing in Asia. Similarly, in India, the issues of food security and food consumption are critical, yet they have not been thoroughly assessed. More than 40% of the population lives below the poverty line, earning less than $3.20 per day, according to the World Bank Poverty and Inequality Platform (2021). This lack of adequate nutrition and sanitation facilities contributes to high morbidity rates among this group. The demand for food in India has surged over the last decade, driven by population growth. As one of the world's most populous countries, India is expected to surpass all others by 2027. Being a major agriculture player, India is also home to 25% of the world's hungry population.

India's food security situation has been a major concern, with the country ranking 76th among 113 countries in the Global Food Security Index 2018 and 103rd out of 119 countries in the Global Hunger Index 2018. Further, India, ranks 102nd out of 119 countries on the 2019 Global Hunger Index (GHI) with a score of 30.5, indicating a serious hunger problem. The GHI score is determined by four factors: undernourishment, child wasting, child stunting, and child mortality. India's high GHI score is partly due to the prevalence of child wasting (children under five who are too thin for their height) and child stunting (children under five who are too short for their age). Although India has made some strides in reducing hunger and malnutrition, substantial work remains. With 113 other nations, India ranks 68th on the 2022 Global Food Security Index. Its performance is generally consistent throughout all four dimensions, with a peak of 62.3 in the availability dimension. The Sustainability and Adaptation pillar is where the nation really falls short, earning a score of 51.2. According to the results, India's food security is especially at risk from the effects of climate change. The root causes of food insecurity in India are diverse, including poverty, low agricultural productivity, inefficient supply chains, and inadequate infrastructure. Natural disasters like floods and droughts exacerbate the problem.

In recent years, the number of people living in poverty and hunger has increased, and food costs have risen significantly. With this backdrop, this article aims to provide a comprehensive overview of food security interventions in India, emphasizing their multidimensional nature, which is crucial for understanding the unique challenges the country faces in this area.

1.1 Food Policy Interventions in India

Government interventions in foodgrains markets in India have been in place for several decades, aiming to ensure remunerative prices to farmers, improve access to food for economically vulnerable people, and stabilize foodgrains prices and availability in the country. Moreover, studies have shown that food security interventions, such as the Public Distribution System (PDS) and the Mid Day Meal Scheme (MDM), have significantly contributed to poverty reduction and improved calorie intake in India. Major food policy intervention are listed in below Table 1.

Table 1. Major Food Policy Interventions in India

Year	Scheme/Programs	Objective/(s)
1940	Public Distribution System (PDS)	Launched as general entitlement scheme
1960s	Green Revolution	Self – sufficiency in Food grains (Macro level food security)
1975	Integrated Child Development Services	Includes a package of integrated services consisting of supply of nutrition, immunisation, health check-up, referral and educational services (up to 6 years through Anganwadi)
1995	Mid-day Meal	Aims at enhancing retention, attendance and improvement in nutritional levels in government schools and aided schools.
1997	Targeted Public Distribution System (TPDS)	PDS was revamped to target poor households.
2000	Antyodaya Anna Yojana	Poorest among Below Poverty Line identified for TPDS. 25kgs of food grains made available to eligible family (revised to 35kgs) at subsidized rate of 3 per kg for rice and 2 per kg for wheat.
2010-11	Rajiv Gandhi Scheme for Empowerment of Adolescent Girls (RGSEAG)	Empowerment Adolescent Girls (11-18 years) through nutrition, healthcare and life skills education
2013	National Food Security Act (NFSI)	Aim of increasing rice, wheat, and pulses output through expanding land and increasing productivity, as well as offering job possibilities and initiatives to help farmers regain confidence
2017	Zero Hunger Program	To make India free from malnutrition by 2022 and attaining "Zero Hunger"
2018	National Nutrition Mission (POSHAN)	Improvement in nutritional status of children from (0-6 years) through different target aims at reducing levels of stunting, under-nutrition, anaemia and low birth weight babies.

Source: Authors compilation from various Government database.

The PDS was introduced in the 1940s to ensure food security in urban areas and continued after independence to address food security during droughts, famines, and wars. The PDS was later expanded to include other items such as cooking oil, sugar, and wheat. Additionally, the Green Revolution in the 1960s, which introduced high-yielding varieties of crops, had significant impacts on agricultural production, biodiversity, and environmental sustainability. It led to a significant

increase in food production and helped to improve the food security situation in the country. Further, food policy interventions in India such as mid-day meal scheme, TPDS, Antyodana Anna Yojana have shown positive economic implications through improved food security, potential public health benefits through poverty reduction and calorie intake. The TPDS Act also contains a number of provisions aimed at improving the efficiency of the distribution system, including the use of electronic ration cards and the establishment of a grievance redressal mechanism.

Apart from the above-mentioned interventions, Government also introduced the Pradhan Mantri Fasal Bima Yojana (PMFBY), a crop insurance scheme that provides insurance cover to farmers in the event of crop loss. The scheme has been operational since 2016, and it is currently the largest crop insurance scheme in the world. The Pradhan Mantri Krishi Sinchai Yojana (PMKSY) is a scheme that was launched in 2015 with the aim of improving irrigation infrastructure in the country. The scheme has been successful in increasing the area under irrigation and in reducing the state of waterlogging and salinity in the country. The government of India has put in place several food policy interventions in an effort to address the challenge of food insecurity in the country. However, the government's efforts to improve agricultural productivity and infrastructure have not yielded the desired results.

2. Methodology

This study is comprised of two stages. The prevalence of various food insecurity challenges, in Asia and India was compared using statistics from the World Food and Agriculture Yearbook 2023, the Food and Agriculture Organisation of the United Nations (FAO), and the National Family and Health Survey of India. This analysis examines the consumption of certain sector outputs, with a specific emphasis on food security and nutrition. Secondly, based on the output of the relevant data of food security, current scenarios are discussed in Indian context on the basis of pillars of food security namely, availability, access, utilization, stability, agency and sustainability to assess sustainable development.

3. Results

According to the National Family Health Survey (NFHS - V) data, 33.4% of women and 28.5% of men are undernourished in India. This means that nearly one-third of the population is not getting the minimum amount of food required

for a healthy and active life. In comparison to the global and Asian averages, Indians have the highest proportion of undernourishment (15.3%), which is a cause for alarm.

The main reasons for high levels of undernourishment encompass a complex interplay of poverty, inadequate food security, unhealthy diets, and disruptions in the food supply chain. Millions of people in India do not have access to adequate nutritious foods, especially those rich in essential vitamins and minerals, leading to malnutrition due to low income and affordability issues. This leads to serious health related consequences, including weakened immunity, increased susceptibility to illness, and stunted growth (Tharumakunarajah et al., 2024). Furthermore, as mentioned in Figure 2, undernourishment is a significant contributor to high levels of child mortality in India, with nearly half of all child deaths in the country attributed to malnutrition. The prevalence of underweight, stunting, and wasting among children under five is alarmingly high, with rates of 32.1%, %, and 24.5% respectively

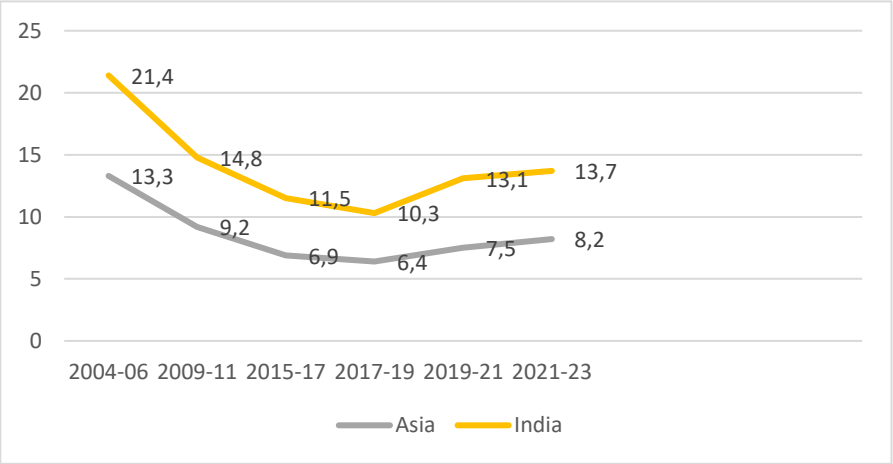

Figure 1. Prevalence of Undernourishment (in %). Source: World Food and Agriculture Yearbook, 2023.

Figure 1 demonstrates that both Asia and India made a significant reduction in undernourishment in terms of population % from the year 2004-06 to 2021-23. However, the uptrend from 2017-19 for both regions suggests that external factors such as COVID-19 may have adversely impacted the increase of food insecurity and nutritional diets. Furthermore, the prevalence of

undernourishment in India is much higher compared to overall average of Asia, which highlights severe concern.

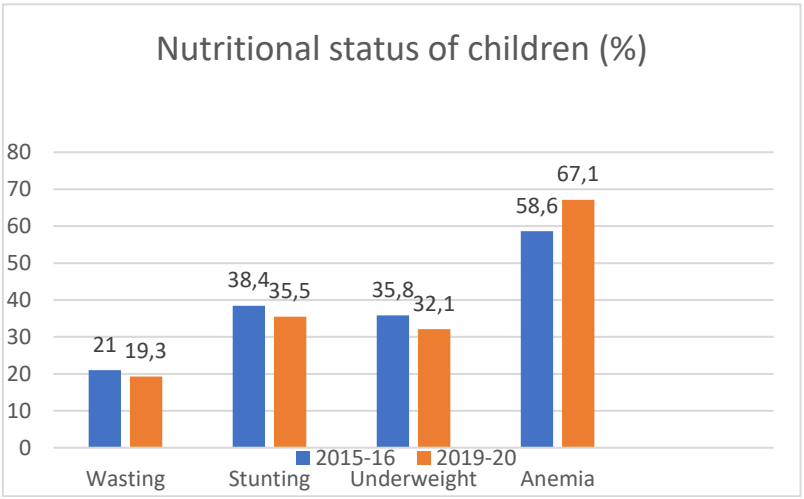

Figure 2. Nutritional status of children in India. Source: NFHS V; Wasted, Stunting, Underweight, Anaemia.

Figure 2 shows how India has reduced the percentage of wasted, stunted, and underweight children (0-5 yrs) during the last five years. However, the proportion of children who are anaemic has recently increased (9%). This is a concerning development for the country, which is due in part to the fact that anaemia affects more than half of women of reproductive age.

4. Discussions

Adopting the four pillars of food security framework namely, availability, access, stability, and utilization can lead to a more holistic understanding of food security, guiding the development of effective interventions at the national, community, or household level (Okpala et al., 2024). Further, research suggests a need for a more efficient approach which shall include agency and sustainability to dealing with the multifaceted nature of food insecurity (Clapp et al., 2022).

4.1 Availability

The definition of availability in food security encompasses the concept of ensuring that all people have physical, social, and economic access to sufficient, safe, and nutritious food to meet their dietary needs for an active and healthy life (Barrett, 2010). Cereals are the most important staple food crop globally, contributing substantially to more than 50% of daily caloric and nutrient intake across the globe (Anjali et al., 2023).

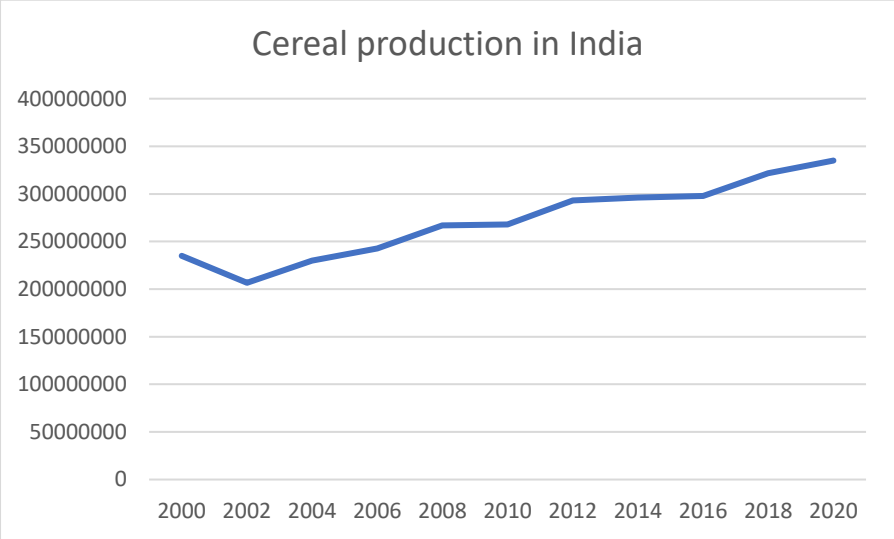

Figure 3. Cereal Production in India. Source: Food and Agriculture Organization of the United Nations (FAO, 2023).

As per data suggests from the Figure 3, , the cereal production in India is on the increasing rate. Further, the average Indian adult requires around 1798 kilocalories (kcal) per day to maintain their body weight, according to the National Institute of Nutrition (NIN).

We live in a more equal world today than we did in the previous century when it comes to food availability (Balogh & Hall, 2016). According to the data presented in Table 2, it is clear that the availability of nutrient-rich diets is steadily growing each year.

Table 2. Supply of dietary per capita in India

Year	Per capita fat Supply (in gms)	Per Capita Protein Supply	Per Capita Kilo Calorie Supply
2010	49.29	60.46	2378.80
2012	50.85	60.85	2407.44
2014	53.91	63.78	2457.91
2016	54.66	65.19	2489.46
2018	59.97	66.35	2539.40
2019	59.06	67.83	2549.85
2020	60.14	70.07	2550.00
2021	60.36	70.52	2569.00

Source: Food and Agriculture Organization of the United Nations (FAO, 2023).

4.2 Access

A fivefold strategy incorporating a life-cycle approach, reproductive health, citizen participation in national programs, women's empowerment, agricultural advancement, and better monitoring of the Public Distribution System is proposed to tackle the various factors affecting food and nutrition security in India. Moreover, The Government's National Food Security Mission has helped to improve food security for millions of people across the country. The Mission has helped to increase production of food grains, improve access to food grains, and reduce wastage.

However, there are still challenges in terms of affordability of food security. While the Government has increased production of food grains and improved access to food, the prices of food grains have also increased. Moreover, according to NFHS-V, 23% of reproductive-age women have no formal education. Furthermore, despite continuing to spend up to 28.3% of their total private final consumption budget on food and non-alcoholic beverages in FY19, many people have poor dietary practises. Their diets are severely lacking in healthy and nutritional foods such as fruits, vegetables, legumes, nuts, and whole grains.

Figure 4 shows that 70% of Indians did not have access to a healthy diet in 2020. This figure has not decreased considerably since 2017. When this figure is compared to the cost of a nutritious diet, the outcome is surprising. For example, 75% of Indians could not afford a nutritious meal in 2017, the year with the lowest cost, the highest percentage in the previous four years. Compared to the previous three years, the expense of a healthy diet was relatively modest. Due to

the higher expense of a nutritious food, it comes to reason that a substantial percentage of individuals cannot afford it. As per the Centre for Science and Environment's (CSE) State of India's Environment 2022 report, consumer food price index inflation has increased by more than 300% over the past year, making a balanced diet unaffordable for even more people. This is a significant problem because a lack of access to healthy food can lead to a number of health problems.

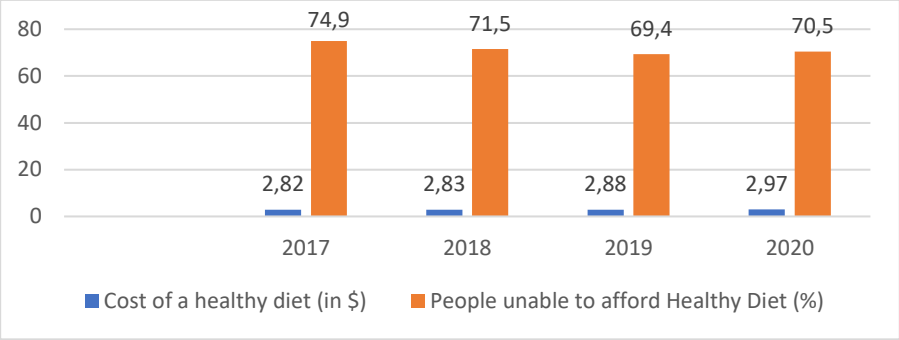

Figure 4. Affordability of healthy diet in India. Source: State of Food Security and Nutrition in the World, UN-FAO, 2022.

4.3 Utilization

Although adequate nutrition has always been a presumption of food security, the broader context that determines the nutrients in food, especially micronutrients and high-quality protein, and the ability to use that nutrient content, an additional pillar of the concept known as "utilisation" as indicated by Clap (2021). A study found that the NFSA has led to improvements in employment, calorie intake, and children's enrolment in schools among beneficiary households after three years of implementation (Satapathy et al., 2020). In addition, the Public Distribution System (PDS) has been an increasingly important tool in the fight against poverty and for better food security in India. Nevertheless, challenges in the implementation of food security programs include errors in the beneficiary list, broken delivery mechanisms, and financing costs for program implementation. The need for repairing the broken delivery mechanism and financing the program aiming to provide subsidized food to a large portion of the population are significant challenges.

4.4 Stability

The challenges to sustain food security in India are primarily due to rapidly increasing population, changing dietary patterns, decreasing productive land area, and the impact of climatic changes on sustainable crop production. The country's agricultural achievements have transformed it from a food importer to a potential exporter, but failure to improve agricultural practices may nullify these prospects.

Every year, millions of tonnes of food are wasted in India. According to the Food Waste Index Report, 2021, by UNEP and The Waste and Resources Action Programme (WRAP), 931 million tonnes of food waste were generated globally in 2019, with households contributing 61%, food services 26%, and retail 13%. The report estimates that Indian households alone generate 50 kg of food waste per capita per year, amounting to a total of 68,760,163 tonnes annually (UNEP, 2021). Additionally, it is noted that only 2% of the total food produced in India is processed, leading to a large portion being wasted without being consumed. The large generation of food waste (FW) is having a severe impact on the environment due to the emission of greenhouse gases (GHG) (Gustavsson et al., 2011; Venkata Mohan et al., 2017). This has exacerbated the issue of food security stability in India.

4.5 Agency

The purpose of agency is to end hunger and its harmful impacts by promoting process variables that enable individuals and communities to make their own decisions regarding food systems.(Clapp et al., 2022) An emphasis on agency also acknowledges that gender, racial, literacy, and other societal power disparities may hinder people's ability to have their voices heard and to take part in community and individual decisions regarding food systems. When people are unable to influence the production, distribution, and consumption of their food, food security suffers (Rocha, 2009).

The Food Corporation of India (FCI) is a crucial entity in ensuring food security in India, established in 1964 with the objective of managing minimum support price (MSP)-based public procurement operations and maintaining buffer stocks for food security. It plays a crucial role in procuring, storing, and transporting food grains on behalf of the Government of India, as well as managing the public distribution system. The FCI has a network of over 5,000 godowns across the country with a storage capacity of over 18 million tonnes. Under this system, the FCI supplies food grains to the state governments at subsidised prices. The state governments then distribute the food grains to the eligible households through

the Fair Price Shops. It procures and stores food grains to safeguard against any shortfall in production.

4.6 Sustainability

The concepts of food security and food sustainability are interrelated, and a comprehensive analysis of sustainability transitions is essential to address the issues arising from conventional food systems. Govindan (2018) found that globalization and the growing world population have a significant impact on the sustainability of food production. As the world's population is expected to grow by 30%–35% over the next 60 years, with India being one of the most populous countries. This will require a 50%–75% increase in food production, particularly protein and dairy products, to meet the growing demand (Basso et al., 2024). Hence, it is essential to have a sustainable approach to food supply chains in order to limit the amount of carbon emissions produced.

5. Policy implications

Effective food security policy implementation is crucial in moving India forward with a nutritionally sensitive population. As the world population continues to grow, the demand for food will also increase. Ensuring food security for all is therefore a key challenge for policymakers. While there are many different ways to approach this challenge, one key policy implication is the need for greater investment in agriculture. This can help to increase food production and ensure that everyone has access to the food they need. In order to implement effective food security policies, it is also important to consider the social and economic factors that can influence food access and availability

5.1 Policy on health diets

If food prices continue to increase without a relative rise in wages, it will become increasingly difficult for people to afford a nutritious diet (Jha & Srinivasan, 2014; Reeves et al., 2017). If earnings drop at the same time that food prices increase, healthy diets may become unattainable for even more people (Clapp, 2014). A shift in India's agricultural policies and incentives towards investments and policies that are more nutrition-sensitive is necessary if the country is to cut down on food waste and increase efficiency across all regions. If we want those who are most vulnerable to be able to purchase healthy food, we need social protection measures that are nutrition-sensitive. It will also be necessary to

implement policies that encourage people to alter their eating habits for the better (Barnhill & Bonotti, 2023).

5.2 Action on climate change

Unsustainable food production techniques contribute to climate change, which in turn threatens the long-term viability of food systems. Greenhouse gas emissions from the food industry, comprising all stages of production and consumption, account for 21–37% of global emissions, according to the IPCC (Calvin et al., 2023). Fossil fuel usage has led to a tremendous increase in worldwide energy demand and carbon dioxide emissions, contributing to climate change (Gollakota & Shu, 2023). Moreover, Climate change, characterized by rising temperatures, shifting rainfall patterns, and extreme weather events, poses a significant threat to agricultural and horticultural crop production. Additionally, increased frequency of extreme weather events, such as droughts, floods, and storms, has made agriculture more susceptible to climatic risks, leading to decreased crop productivity (Mall et al., 2017). Research indicates that climate change affects the nutritional content of foods, potentially leading to malnutrition globally. (Giulia et al., 2020). Hence, the government of India should implement measures to mitigate the impact of climate change on farming and to strengthen the agricultural sector's ability to withstand it.

5.3 Consideration of density of population

The impact of population density on the effectiveness of food security policies and programs in India is underscored by the need for a portfolio of strategies, rather than a single grand strategy, to address multiple tradeoffs at different scales. Additionally, few studies highlighted the importance of understanding interventions or environmental shocks that might affect farmers' food security status differentially, emphasizing the need for informed and equitable development (Lopez-Ridaura et al., 2018; Patel et al., 2015) . The strategies for addressing food security in densely populated regions of India should focus on crop diversification, wild fruit domestication, aquaculture, and animal foods to improve access to food, diet diversity, and nutritional security, especially for vulnerable sections of the population. Further, multisectoral interventions are required to tackle the problem of urban food insecurity in densely populated areas, including nutritional interventions combined with appropriate education, income support programs, and employment generation schemes.

5.4 Evaluation system

Food systems interventions are complex and dynamic, posing challenges for evaluation due to their multifaceted nature and lack of fit with standard evaluation methods. However, areas for future research include the evaluation of national-level policies, efforts to support women's empowerment within the food system, and the synthesis of dietary quality. The development and implementation of a holistic evaluation system should consider the ethical implications of interventions. It can be prioritized by ensuring equitable resource distribution, particularly to marginalized groups, assessing potential unintended consequences, and respecting the autonomy of local communities. This approach ensures that interventions are not only effective but also socially just, safeguarding human rights and dignity. Moreover, as researchers pointed out, multi-stakeholder engagement is critical in addressing wicked problems in agri-food businesses and public policy development (Dentoni & Bitzer, 2015). It is particularly useful in providing diverse perspectives and improving policymaking in food security. This approach would help to ensure that food policy interventions are more effective and lead to positive outcomes for all those involved.

6 Conclusions

This study laid emphasis on understanding the link between food security and Sustainable development through multidimensional analysis. It reveals a complex picture with a range of successes and failures. Further, this study asserts that attaining sustainable development in India necessitates not just augmenting food production, but also practicing responsible food consumption and optimising the utilisation of existing resources. Researchers noted that there are several ways in which food security policies can contribute to the SDGs. For example, current trends suggest that achieving zero hunger by 2030 may not be feasible without significant efforts to address food security challenges (Marcolin & Cadel, 2024). They are also integral to reducing food waste and promoting sustainable agriculture, aligning with Goal 12 of the SDGs (Responsible Consumption and Production) (Zisopoulos et al., 2017) . Furthermore, food security policies can contribute to the SDGs is by promoting sustainable agriculture practices, which can help to reduce greenhouse gas emissions and increase the resilience of local communities to climate change.

Governance plays a crucial role in conjunction with the SDGs, emphasizing the need for clear and universally applicable targets and indicators to support sustainable agriculture and food security. In order to be effective, food security

policies need to be tailored to the specific needs and context of each country. They also need to be well-coordinated between different government agencies and sectors. By taking these steps, food security policies can play a vital role in achieving the SDGs and creating a more sustainable future for all.

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Funds

This study did not receive any external funding.

Competing Interests

The authors declare that they have no conflict of interest concerning the topic covered in this publication.

Citation

Hiranya, J. & Joshi, H.G. (2024). A multidimensional analysis of food security for sustainable development. Evidence from India. *Visions for Sustainability*, 22, 10891, 1-18. http://dx.doi.org/10.13135/2384-8677/10891