

GLOBAL AND BANGLADESH FOOD SECURITY OUTLOOK TO 2050: CHALLENGES, SYSTEMIC RISKS, AND STRATEGIC PATHWAY FOR SUSTAINABLE FOOD SYSTEMS

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Abstract

Bangladesh is an agricultural country. The population of this country is increasing leading to increased food demand. Besides various factors, including urbanisation, climate change, fast changing dietary habits are making feeding about ten thousand million people by 2050 as one of the biggest challenges of this time. Vulnerabilities in the global food system are highlighted by ongoing poverty, malnutrition, and rising inequality, despite the fact that global food production has increased dramatically. There are studies on Vision 2050, its goal, but no detailed identification of the problems and opportunities associated with achieving food security in the context of Bangladesh, as well as the Global world. Within the context of Vision 2050 and in accordance with Sustainable Development Goal 2 (Zero Hunger), this paper examines the opportunities and difficulties related to attaining food security. This narrative review synthesizes evidence from peer-reviewed literature, international reports, and policy documents to examine the multidimensional nature of food security-availability, access, utilization, and stability-within the framework of Vision 2050 and Sustainable Development Goal 2. The review highlights climate change and economic shocks as major risk that disrupt agricultural productivity, supply chains, and nutritional outcomes, particularly in developing countries. Bangladesh is examined as a case study, revealing notable progress in food availability alongside persistent regional disparities, climate vulnerability, land constraints, and nutritional imbalances. In Bangladesh, strengthening smallholder farmer support, integrating indigenous knowledge with climate-smart technologies, expanding climate information services, and reinforcing social safety nets are identified as key priorities. Overall, according to this review, achieving resilient and equitable food systems by 2050 will require coordinated, evidence-based strategies that balance productivity, environmental sustainability, and social equity at both global and national levels.

Keywords: Food security, Climate change, SDG-2, Vision 2050, challenges, opportunities

Introduction

One major global security challenge is feeding the world's expanding population. As of 2025, the world's population stands at 8, 231, 613, 070, rising at a pace of about 0.85% annually (down from 0.97% in 2020 and 1.25% in 2015). Moreover, an estimated 70 million

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people are added to the population each year. The more will be the world population, the demand for food will also increase. In this regard Food and Agriculture Organization (FAO) of the United Nations predicts that the world's food demand would rise by 60% caused by changes in food habits and population growth over the next twenty years (Da Silva, 2012). Besides, various factors will render feeding about ten thousand million people by 2050 as one of the biggest challenges. These factors include urbanization, climate change, fast changing dietary habits etc. Particularly, higher incomes result in dietary and food consumption modifications. To tackle this situation, global food production will need to produce 47% more crop calories than it did in 2011. Population growth centers of the world like Asia, the Middle East, and Africa will need increase in production in this regard (Sands *et al.*, 2023).

To meet the world's food demand, current technology must be adopted in order to continuously boost yields. Such as plant genomics and technology present promising production opportunities in this field, but the benefits to the food supply will not materialize without adequate investment in biosecurity and research (Grafton *et al.*, 2015). The significant effects of plant diseases and other epidemics on agricultural output and livelihoods necessitate investments also (Avelino *et al.*, 2015). Even though feeding over 9 billion people by 2050 is a huge challenge, increasing food availability is insufficient because food must be produced in ways that allow for a sustained supply, do not negatively impact our ability to produce food in the future, and do not seriously jeopardize critically important ecosystem services. (McKenzie and Williams, 2015). Global food insecurity is mostly caused by population growth, climate change, and geopolitical instability and such issues. There are study on Vision 2050, its goal, but no detailed identification of the problems and opportunities associated with achieving food security in the context of Bangladesh, as well as the Global world. This study is focused on finding out those issues.

Materials and Methods

The secondary data used in the present study came from published sources. Systematic Google Scholar searches were used to find relevant information. Research papers, reports, peer-reviewed journal articles, and other academic works relevant to the study's goals were chosen for review. The gathered sources were examined for scientific quality, dependability, and applicability. To guarantee accuracy and coherence, important data and conclusions were gathered, arranged, and synthesized. Formative recommendations and expert advice were included to enhance the manuscript's organization and readability. Ultimately, the collected data followed comprehensive analysis and was presented in a systematic and scientifically sound manner (Fig. 1). This study has followed a narrative review category.



Fig. 1. Procedure of collecting the data.

Food security

Food security is a complex problem that cannot be adequately explained by factors like money, education, geography, or demographics. One billion people, or 16% of the world's population, suffer from chronic hunger even though there is enough food to feed everyone (McCarthy *et al.*, 2018). Resolving interrelated issues such as population increase, resource constraint, climate change, and socioeconomic inequality is essential to achieve food security by 2050. On the other hand, innovation in technology, sustainable intensification, and legislative changes are necessary to transform the food system. We have to keep in mind that when we want to ensure global food security, cooperation between governments, academic institutions, commercial sectors, and communities is also necessary. According to FAO/UNICEF, four components of food security comprises of food availability, food access, food utilization, and food stability. These pillars are depicted in Fig. 2 (McCarthy *et al.*, 2018).

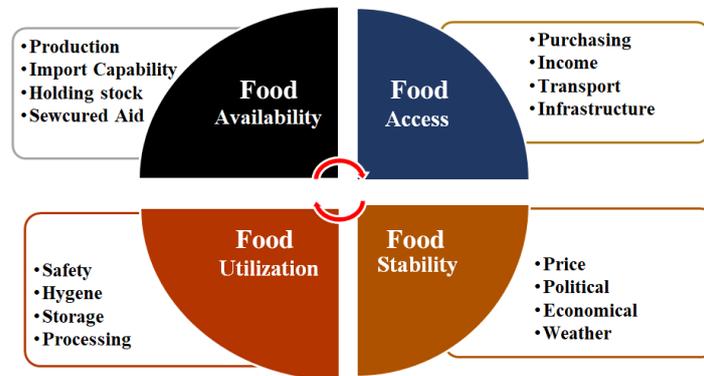


Fig. 2. Pillars of food security.

- **Food Availability:** This is the first aspect or pillar of food security. It alludes to the concept of "sufficient" in the World Food Summit definition (WFS) (Simon, 2012). Having a sufficient amount of food on hand at short notice is the responsibility of this pillar. This pillar takes into account food that is either imported using the region's importing capacity or produced locally by food business operators (FAO, 2015).
- **Food Access:** Access is defined as "having physical, economical, and social access" in the WFS. In 2009/10, about 325 kg of grain were produced annually per capita, which is significantly more than the 219 kg of grain required annually to meet the basic caloric requirements of 2100 calories per day per person (USDA-FAS, 2010; Gregory *et al.*, 2002 and Palm *et al.*, 2010).
- **Food Utilization:** "Safe and nutritious food which meets their dietary needs" is what the WFS definition calls it. The availability and accessibility of food in families is insufficient to guarantee that people will eat a "safe and nutritious" diet. Numerous factors come into play here, including nutritional absorption, food commodity selection, preservation, and cooking. Food must be safe and of high quality (Simon, 2012).
- **Food Stability:** According to the WFS definition, stability means "at all times." In the first case, this stability pertains to the three aspects of food security that were previously discussed. According to Simon (2012), food security is "a situation" that can exist permanently with sustainability rather than only for a single day, season, or moment.

Interactions of the pillars under future scenarios

Food insecurity is a great concern for the future generations as the cycle of climate change, population dynamics, economic shocks has been going on. A study showed that impacts of climate change on household food security are in diverse directions, all of the four pillars of food security is affected. Climate change driven reduced crop productivity, effects on livestock, and disruptions in food supply chains influence food availability. Accessibility is hindered by reduced income and climate-driven price hikes. Utilization suffers from water and sanitation challenges, increased pests, and reduced food quality while stability is compromised by extreme events, migration, and human-wildlife conflicts (Chettri *et al.*, 2024).

Population dynamics and economic shocks (recessions, price shocks, trade disruption, pandemics) also alter pillar functioning and generate cascading effects on food security. Increase in aggregate food demand and shift in diets, raising pressure on availability and raising reliance on markets and complex supply chains, all are seen as a result of population increase (Chakrabarty, 2022 and Onyeaka *et al.*, 2024). Another study showed that COVID-19 pandemic strained food systems and exacerbated food insecurity through income

losses and supply-chain interruptions, with policy and system resilience determining outcomes (Özkaya and Özkaya, 2022). So it is important to take appropriate steps to save our people from the future challenges of food security to ensure better health and social condition.

A global perspective on Vision 2050

Vision 2050 and global food security research has become crucial because it keeps getting challenging to make food for everyone because of climate change, resource shortages, and population growth (Alexandratos and Bruinsma, 2012; Loboguerrero *et al.*, 2019). Over the last few decades, studies have changed from mostly looking at how food is made and how available it is to people, to looking at how to make food production more environmentally friendly and how to make sure people stay healthy through food security frameworks (Godfray *et al.*, 2010 and Mora *et al.*, 2020). The World Bank, the Organisation for Economic Co-operation and Development (OECD), the World Business Council for Sustainable Development (WBCSD), the Intergovernmental Panel on Climate Change (IPCC), and the Food and Agriculture Organization (FAO) have all stressed how important it is to quickly deal with these connected problems. For example, almost 700 million people still don't get enough food, and food demand may go up by 35% to 60% by 2050 (Dijk *et al.*, 2021) (Andree and Dearborn, 2024). This stresses the need for socially and practically important work on durable, long-lasting food systems that are in line with the Sustainable Development Goals (SDGs) (Shebanina *et al.*, 2024 and Townsend, 2015).

When we go for the multi-model comparisons of food security, we find a lot of uncertainty, but they usually show that undernourishment might go down if productivity increases and policies are put in place. Involvement in scenario development makes the validity and applicability of projections used to guide policy and study stronger (Alexandratos and Bruinsma, 2012 and Weindl *et al.*, 2024). Another study says that Vision 2050's three main parts are doubling the use of green energy, tripling energy efficiency, and moving to a system of recycling materials (Komiya and Kraines 2008). Thus, maintaining food security will be a greater challenge in upcoming years.

Vision 2050: Food Security in relation to Goal 2 of the Sustainable Development Goal (SDG)

The second Sustainable Development Goal aims to eradicate hunger worldwide by 2030. Since 2015, there has been a startling rise in hunger and food insecurity, which has been made worse by a number of reasons such as the pandemic, conflict, climate change, and growing inequality. Vision 2050 aims to ensure food security in line with SDG Target 2. Analyzing the state and trend of food security globally, as well as in Bangladesh, reveals numerous obstacles (United Nations, 2025).

Despite global efforts to address the issue of food security, 2 billion people lack regular access to enough food that is safe, nourishing, and sufficient. 45 million children under the age of five suffered from wasting in 2022, while 148 million children had stunted growth. Furthermore, a startling increase from 2019 to 2022 saw about 735 million people, or 9.2% of the global population, living under chronic hunger. This data highlights the gravity of the problem and shows that the crisis is becoming worse. Severe malnutrition and hunger continue to impede sustainable development and create a trap that is difficult for people to escape. People who suffer from hunger and malnutrition are less productive, more likely to get sick, and frequently unable to increase their income and standard of living (United Nations, 2025).

Compared to many of its Asian counterparts, Bangladesh has made notable strides in recent years in addressing food security issues. Approximately 70 million people, or 43% of the total population, are classified as having IPC Level 1 (No Chronic Food Insecurity), and over 58.5 million people, or 36% of the total population, are classified as having Mild Chronic Food Insecurity (IPC Level 2) (Integrated Food Security, 2025).

11.7 million people, or 7% of the total population, experience Severe Chronic Food Insecurity (IPC Level 4), and 23.2 million people, or 14% of the total population, experience Moderate Chronic Food Insecurity (IPC CFI Level 3). Additionally, nearly 35 million people, or 21% of Bangladesh's total population, experience Moderate and Severe Chronic Food Insecurity (IPC Levels 3 and 4) (Integrated Food Security, 2025).

The lowest percentages of Moderate and Severe Chronic Food Insecurity (CFI) individuals are found in the divisions of Chattogram and Dhaka (19% and 16%, respectively) out of Bangladesh's eight divisions. The largest percentage of people with Moderate and Severe CFI (31%) is found in Rangpur division, which is followed by Mymensingh division (26%) and Barishal division (24%). (Integrated Food Security, 2025.).

The sector's risks and challenges must be addressed if the food security goals of Vision 2050 are to be met.

Challenges in the path to food security

Globally, the way we produce and eat food is altering cultures and environments. Recent decades have seen a sharp rise in agricultural intensification, which has surpassed rates of agricultural expansion (Foley *et al.*, 2011). In order to ensure food security, agricultural food production and related phenomena must overcome a number of obstacles, including.

- **Dietary Demand and Population Growth:** It is predicted that by 2050, there will be more than 9.7 billion people on the planet, which would result in a 50–70% increase in

food demand (Godfray *et al.*, 2010; FAO, 2018). This increase in demand is made worse by shifting dietary patterns, especially in developing countries where growing incomes encourage the use of more resource-intensive foods like dairy and meat (Willett *et al.*, 2019). But because of deforestation, water resource misuse, and greenhouse gas emissions, current agricultural practices are already straining the planet's limits and seriously degrading the environment (Foley *et al.*, 2011 and Rockström *et al.*, 2017). These patterns demonstrate how important it is for agriculture to grow sustainably in order to meet future food demands while causing the least amount of harm to the environment.

- **Climate Change and Food Production:** One of the biggest threats to global food security is climate change. Crop output is expected to be impacted by rising temperatures, changing precipitation patterns, and an increase in the frequency of extreme weather events, especially in tropical and subtropical nations (IPCC, 2019). For instance, research indicates that by 2050, maize and wheat yields may decrease by as much as 25% if adaptation measures are not implemented (Ray *et al.*, 2013). Additionally, water scarcity, which presently affects over 2 billion people globally, is made worse by climate change, which limits agricultural productivity (Springmann *et al.*, 2018). These issues highlight the significance of improved water management practices, climate-resilient crops, and policies that strengthen adaptive capacity in vulnerable areas.
- **Overexploitation of Natural resources and Land Degradation:** In 33% of soils worldwide, output has already been damaged by soil degradation brought on by intensive farming practices (FAO, 2018). Similarly, 70% of global freshwater withdrawals are attributed to agriculture, making water scarcity a serious issue (Searchinger *et al.*, 2019). According to reports, humans cultivate food on around half of the planet's vegetated area (WRI, 2013). By 2050, these trends could significantly reduce the amount of food available unless significant progress is made in resource efficiency (Pretty *et al.*, 2018).
- **Food Waste and Loss:** According to a study's findings, the FAO's 2017 food losses would have been sufficient to feed almost 940 million adults, which would have satisfied the world's undernourished population (Abbade, 2020). According to FAO estimates, around one-third of the world's food production is wasted either during production or consumption (FAO, 2011; FAO, 2018). 20% of fruit and vegetables are lost during production, up to 28% are wasted by customers, and 12% are wasted during distribution, mostly due to inadequate refrigeration control, according to a study conducted in the United States, Canada, Australia, and New Zealand (Gunders, 2012).
- **Urbanization:** It is anticipated that over 65% of people would reside in cities by 2050. This urbanization tendency will mostly take place in low-income nations and will be a major factor in the development of concentrated demand areas globally, which will put more strain on food supply networks.

- **Making food systems more robust, inclusive, and efficient:** It's critical to create more resilient and inclusive food systems in order to guarantee food supply and overall food security. The poorest countries in the world are today finding it too challenging. The most vulnerable countries to benefit from these systems are developing ones. Food security would be guaranteed if we could update food systems to enable them to utilize the facilities (Fan and Swinnen, 2020).
- **Nutrient imbalance:** Numerous factors, including food production (availability), malnutrition, and dietary practices (utilisation), affect the sustainability dimension of food security on population health (García-Díez *et al.*, 2021). More than 345 million people experienced severe food insecurity in 2023, according to the World Food Programme. Furthermore, 2 billion individuals suffer from deficits in micronutrients, including iron, iodine, and vitamin A. A drastically restricted diet can eventually result in malnutrition and shorten life expectancy. Moreover, around 2 billion people globally suffer from obesity or overweight (Hussain *et al.*, 2025). Hence, we can say, food insecurity causes a nutritional imbalance, which eventually leads to several diseases.

Table 1. Key supply and demand side pressures on global food security (Misselhorn *et al.*, 2012)

Supply side pressures	Demand side pressures
Climate change	Population increases
Urbanization	Land use change
Globalization	Changing demand in food types and levels of processing
Safety and quality – including factors such as environmental pollution and pests and diseases	Disease
Land use change and competition (e.g. biofuels)	Factors linked with under-development, including poverty, gender inequity, low resource access, poor health, and lack of education

Way forward to food security

The claim that Bangladesh's agricultural industry is under threat from the effects of climate change, rapid population increase, and economic expansion as evidenced by infrastructural development is supported by scientific research and projections.

Additionally, the amount of land that is available is being reduced by infrastructural development, such as the construction of homes and roads. More rural residents are moving to metropolitan regions in pursuit of improved living conditions as a result of urban expansion. As a result, the transition from an agrarian to an industrialized economy has been revolutionary, and this tendency is probably going to continue. The nation's capacity to produce enough food to fulfill rising demand in the upcoming decades may be threatened by these changes.

Additionally, droughts, floods, and storms are challenges to crop productivity brought on by climate change (Rozario *et al.*, 2021).

In order to overcome upcoming obstacles and guarantee food security and the welfare of both urban and rural populations, comprehensive measures must be implemented at all levels. The government is collaborating with the business sector to accomplish the intended objectives by offering subsidies, advancing technologies, increasing research and introducing state-of-the-art technologies. Particular focus must to be placed on protecting and rewarding smallholder farmers, who are typically the most susceptible producers and livelihood groupings. The locals have generations of experience that fosters their creativity and conquer and adjust to the difficulties of unfavorable natural circumstances. Indigenous and local knowledge can offer both technically and socially acceptable practical ways to mitigate the effects of climate change. However, financial and technical support are required to make these adaptive measures possible (Brammer, 2017).

According to Brammer, 2020, the effects of climate change are erratic and uneven throughout the country. Therefore, before being used to guide decision-making, climate estimates and trends should be validated using historical, local, and contextual data. In order to lessen agricultural damage and increase productivity, the nation can also create comprehensive, nationwide climate information and services for farmers. These programmes must to be based on thorough data and research and customized to satisfy user requirements. In order to lower greenhouse gas emissions from the agriculture sector, big data can help embrace climate-smart livestock management and crop production.

In order to tackle the nation's problems with food security and climate change, legislative support and requirements can encourage climate-resilience initiatives and innovative agricultural techniques. Agricultural growth can also be improved through institutional and community capacity building. The creation of "farmers' schools" and "farmer support centers" can give farmers the information, tools, and assistance they need to boost crop productivity. Limiting urbanization and improving farmers' well-being can be achieved by creating health and educational facilities as well as job possibilities in rural and suburban areas. Farmers' markets in urban areas might encourage nearby farmers to sell their produce directly to customers in order to give the farmers a fair price. Therefore, despite the difficulties posed by climate change, a resilient and flourishing agricultural sector in Bangladesh may ensure food security and safety for the country's expanding population through a combination of proactive efforts, activities, and strategies (Rozario *et al.*, 2021).

In the context of the world, way forwarding to food security can include the following:

- **Sustainable Intensification and Technological Innovations:** Digital techniques like biotechnology, and precision agriculture can all increase productivity while reducing

their negative effects on the environment (Herrero *et al.*, 2020). For instance, farmers can adjust to climate change by using genetically modified crops that are resistant to pests and drought (Ray *et al.*, 2013). Lab-grown meat and vertical farming are also creative ways to save water and land (Searchinger *et al.*, 2019). However, especially in low-income nations, the adoption of these technologies necessitates large investments, capacity building, and supportive legislation.

- **Policy and Governance Frameworks:** To guarantee global food security by 2050, robust national and international governance and policy frameworks are required. Multilateral agreements such as the Sustainable Development Goals (SDGs) and the Paris Agreement enable coordinated action (FAO, 2018) are required to create an environment that supports food security, national and international policy initiatives.
- **Automated manufacturing system:** At the consumer level, more industrialized nations are typically able to provide goods in attractively designed packaging that includes marketing and nutritional data and also helps to prolong the food's shelf life. According to some reports, developing nations could save about 200 million tons, or 14% of their total consumption, if they implemented the same degree of refrigeration as rich nations (Mercier *et al.*, 2017).
- **Communication:** According to Mulyasara (2025), food security programmes are greatly aided by both formal and informal communication since they improve group cohesion, cooperation, and transparency. Ensuring the availability of safe and high-quality food to feed the expanding population is a crucial area where ICTs play a key role. A viable and sustainable "farm to fork" model of food distribution can be ensured by integrating intelligent, IT/Telecom-driven technology into the current Food Supply Chain (FSC) (Gupta, 2016).
- **Putting monitoring technology and methods into practice:** Securing a complete product chain-of-custody is a fundamental prerequisite for addressing the food security dilemma. The monitoring capabilities of sensors have expanded recently, particularly with regard to the assessment of gas concentrations, pathogen presence, leaf freshness, and mineral deficiencies, all of which work together to forecast the product's remaining shelf life. While many of these sensor technologies are still in their early stages of development, a sizable portion are already being used in commercial settings (Mahajan *et al.*, 2014).
- **Social safety Net:** In developing countries, ensuring food security is crucial, especially given the ongoing social and economic inequalities. A study showed that a sizable portion of the impoverished population-roughly 11 million farming families in a developing country-are landless and unable to fulfill the daily need of 2,122 kilocalories, despite steady GDP development since 1990. Ineffective entitlement arrangements are the main cause of this problem. The government must establish effective social safety net programmes (SSNPs), including as credit and insurance plans (Siddique, 2017).

Achieving the vision of a resilient and equitable food system

At many temporal and spatial levels, a resilient food system can tolerate environmental and economic shocks and pressures. In the context of climate change, a resilient food system foresees climate change risks and incorporates redundancy (an efficient method for storing sufficient amounts of food and distributing them during emergencies) (Misselhorn *et al.*, 2012). Using a resilient food systems approach to address food security can:

- Assist in making sure the relevant topics are covered in discussions meant to improve food security (particularly in relation to other objectives) and can help determine the variety of actors and other interested parties who ought to be involved.
- Offer a structure for addressing various vulnerabilities in the midst of socioeconomic pressures.
- Help identify action points to improve food security by identifying the primary limiting factors that contribute to food insecurity (Misselhorn *et al.*, 2012).

Besides, efficient and sustainable use and management of natural resources, such as the conservation and sustainable use of biodiversity, the prevention of soil depletion, water pollution, and environmental degradation, should be incorporated by the multi-functionality of farmers in relation to their roles within the community and as environmental caregivers. Additionally, it will encourage the provision of ecosystem services, landscape management, social inclusion and equity, and the transmission and preservation of knowledge and culture. Moreover, our society's environmental, social, and economic problems must be simultaneously addressed by appropriate, interrelated policies and initiatives for a resilient system of food security (FAO and IFAD, 2019).

Conclusion

Global food security by 2050 is a complicated and important issue that goes beyond food production. This study shows that population growth, climate change, resource depletion, urbanization, dietary changes, and socioeconomic inequality threaten global food systems. Food security-availability, access, consumption, and stability-is interconnected and impacted by environmental, economic, and political factors. Climate extremes, pandemics, and economic shocks increase vulnerability, especially in developing nations. Vision 2050 emphasizes the need for sustainable intensification, technological innovation, climate-smart agriculture, better governance, and food waste reduction as key solutions.

Bangladesh has made progress in reducing food insecurity, but regional inequalities and climatic challenges remain. Resilience requires improving smallholder farmers, integrating indigenous knowledge with modern technologies, improving climate information services, and increasing institutional and policy assistance. Overall, aligning national

strategies with global Vision 2050 and SDG 2 objectives will require coordinated, evidence-based policies that balance productivity, resilience, and equity to ensure long-term food security without compromising environmental integrity.

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