Foresight4Food
International Collaborative Initiative

Background Brief

The Future of the Food System in the Bangladesh Delta through the Lens of Land, Water, and Climate

The Center for Environmental and Geographic Information Services (CEGIS)

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Authors

Dr. Farhana Ahmed; Abdul Halim Farhad Sikder; Anindya Banik; Md. Zahidul Haque, PhD and Tasfia Dooti

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Key Messages

01 Agricultural land is shrinking due to urbanization and industrial expansion, leading to reduced crop production capacity.

02 Rising temperatures and erratic precipitation are threatening major crops such as rice and wheat, which are crucial for national food security.

03 The reliance on groundwater for irrigation is unsustainable. Alternative water sources and efficient irrigation techniques are needed.

04 By 2050, Bangladesh could face significant food shortages across key crops – including rice, pulses, and wheat – if no action is taken.

05 An integrated approach, focusing on land management, water use, and climate adaptation, is essential to secure the future of Bangladesh's food system.

1 Introduction

Bangladesh's food system is increasingly vulnerable due to a combination of population growth, rapid urbanization, technological shifts, and climate variability, all of which pose serious challenges to food and nutrition security. This paper provides an in-depth analysis of the implications for land use, water resources, and agricultural production, projecting future scenarios and offering key recommendations to safeguard food security.

The main objective of this study was to assess the future implications of changes in land use, climate variability, water availability, and dietary patterns for food security in Bangladesh. The research questions that guided this objective were:

- What are the recent trends in the impacts of climate change and changing diets?
- What are different scenarios for climate and diet related land use change in Bangladesh?
- What are the implications of climate change on land use changes in Bangladesh?
- What are the implications of changing diets for land use change in Bangladesh?

2 Methodology

The following quantitative and qualitative approaches were used to prepare this background policy paper and provide insights into the water-food-energy nexus in Bangladesh:

Scoping – Relevant policies, plans, and programs were reviewed to provide an overview of the food production landscape.

Mapping the system – A decadal (2010-2020) land use change analysis was conducted across the categories of cropland, forest land, grassland, aquaculture, settlements, water bodies, rivers, and canals.

Assessing trends and uncertainties – Historical and projected trends in temperature and precipitation, both key factors in crop production, were analyzed.

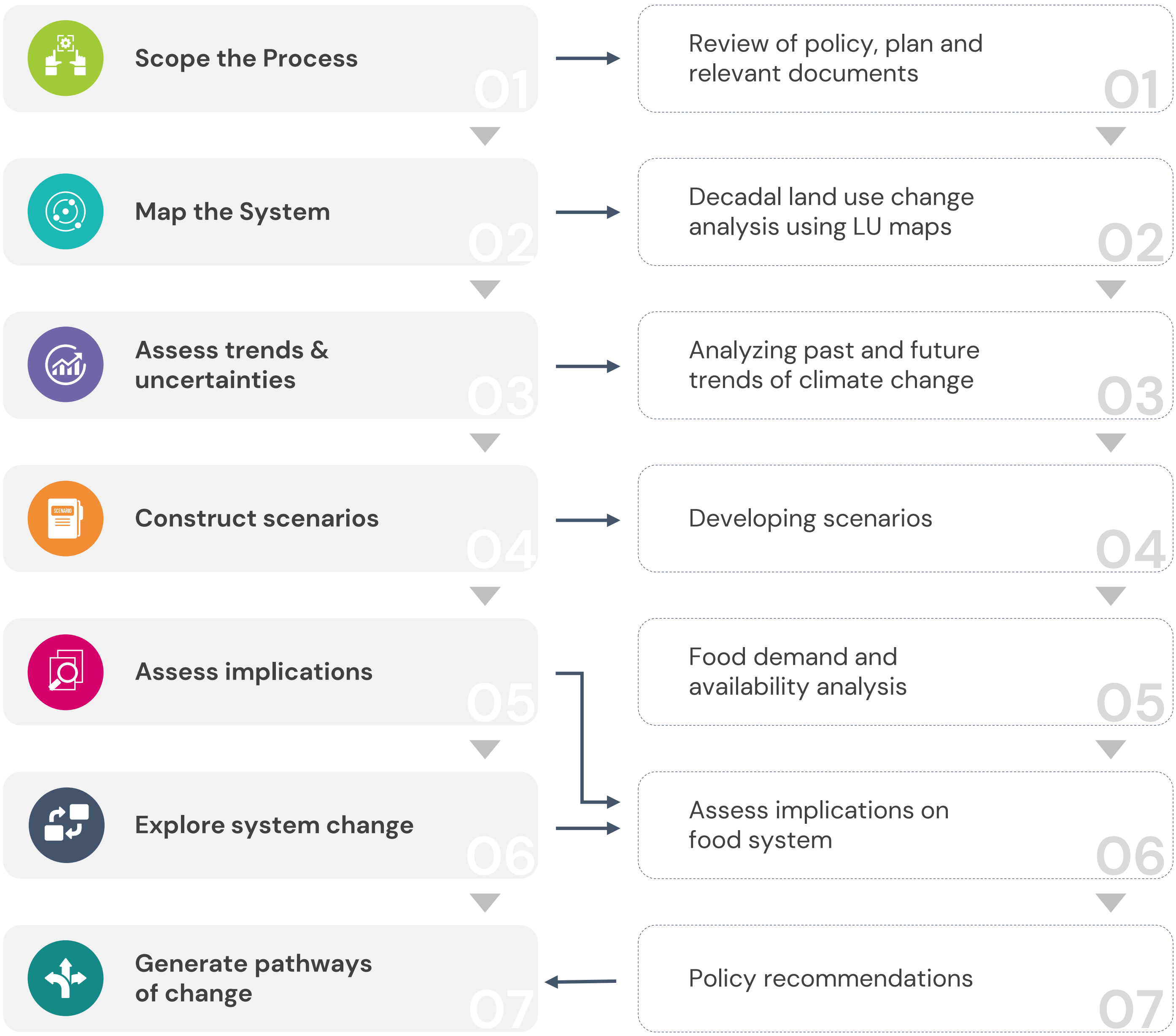
Constructing scenarios – Three scenarios were developed to project future trends for rice, pulses, wheat, and potato, based on food demand and availability.

Assessing implications – Changes in precipitation and water availability were evaluated for their effects on crop production and food security. Concerns were also raised around the impact of reduced water availability on the country's rice-dominated food system, as well as the fact that overemphasis on this crop may hinder production of other staple crops.

Exploring system changes – Recent trends in wheat production, imports, and consumption were analyzed, particularly the rise in processed wheat-based foods due to urbanization.

Generating pathways of change – These analyses were used to inform recommendations to guide policymakers in creating pathways for a resilient food system.

Figure 1.1: Approach for developing the background policy paper



3 Policy review

Bangladesh's four primary national agricultural and food security policies prioritize not only food security and productivity, but also farmer income, crop diversity, and sustainable resource management. To address key challenges, these policies also emphasize climate change adaptation, sustainable agriculture, and infrastructure development, along with improved marketing strategies, climate-resilient agriculture, and food self-sufficiency.

Image credits: IFAD/GMB Akash

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The National Agriculture Policy (NAPo, 2018) aims to ensure food security, enhance socioeconomic conditions, and improve crop productivity. It emphasizes climate change adaptation and the development of climate stress-tolerant crops. **The National Food Policy** (NFPo, 2006) targets poverty reduction and food security through agricultural diversification and the use of flood- and salinity-resistant seeds, especially in disaster-prone areas. **The National Food and Nutrition Security Policy** (NFNSPo, 2021-2030) aligns with the Sustainable Development Goals (SDGs) and promotes climate-smart agriculture, resilient food systems, and the adoption of stress-tolerant crops. **The National Water Policy** (NWPo, 1999) focuses on crop diversification, water quality management, and disaster preparedness for droughts and floods.

Several short- and long-term plans complement these policies:

- **The 8th Five-Year Plan** (8FYP, 2021-2025) guides the country's development toward high-income status by addressing climate change through nanotechnology in agriculture, science-led technology systems, and modern agricultural practices.
- **The Bangladesh Climate Change Strategy and Action Plan** (BCCSAP, 2009) promotes climate-resilient agriculture, research on stress-tolerant crops, and climate-proofing initiatives.
- **The Bangladesh Delta Plan 2100** (BDP 2100) integrates long-term water, ecology, and land management goals with economic growth and poverty elimination. It includes recommendations for climate-smart agriculture, waste management, and community-level training in alternative livelihoods.
- **The National Adaptation Plan of Bangladesh** (NAPB, 2023-2050) focuses on climate-smart agriculture, sustainable fisheries, and community adaptation practices.

Specific strategies outlined in these policies and complementary plans are detailed below:

- Develop and promote resilient agricultural systems, including cropping, fisheries, and livestock, to ensure local and national food security (BCCSAP, 2009; NFNSPo, 2021-2030; BDP 2100).
- Encourage climate-smart technologies and practices, such as conservation agriculture, alternate wetting and drying (AWD), agroforestry, smart irrigation, floating bed cultivation, and biodegradable products like jute in dry land, wetland, hills and coastal areas including use of environment friendly green technologies e.g. IPM & INM (NAPB, 2023-2050; NFNSPo, 2021-2030).
- Adopt stress-tolerant crop varieties, particularly flood, drought, and salinity-resistant seeds, for disaster-prone areas (NFPo, 2006).
- Strengthen diversification programs in agriculture and livelihoods (NWPo, 1999; NFNSPo, 2021-2030; BDP 2100).
- Introduce nanotechnology and promote science-led agricultural practices for drought, submergence, and saline-prone areas (8FYP, 2021-2025).
- Implement good agricultural, animal husbandry, and fisheries practices to produce healthy, nutrient-rich foods (NFNSPo, 2021-2030).
- Invest in climate adaptation for agriculture and climate-proofing the country to support economic growth and poverty reduction (BCCSAP, 2009).
- Strengthen research into low greenhouse gas-emission crops, innovative technologies, and profitable farming systems for adverse environments (8FYP, 2021-2025; NAPo, 2018).

4 Land use change trends and food system forecasts in Bangladesh

Land use change analysis was a key foundation of this study and revealed patterns of land use in Bangladesh. National land use maps from 2010 and 2020 were compared to illustrate the extent of changes over the last decade. Using remote sensing-based analysis, particularly LANDSAT satellite imagery, eight land use categories – including agricultural land, urban areas, and natural reserves – were identified.

Since 2010, significant shifts in land use have been observed. Urban expansion, fueled by population growth and economic development, has increasingly encroached on agricultural land and natural habitats. According to area statistics (Table 1.1), forest land decreased by approximately 0.07% between 2010 and 2020, and cropland declined by 1.51%. Conversely, grassland expanded by around 1,402 ha (0.01%), while rivers and khals (canals) grew by 0.25% (DoE & CEGIS, 2023).

Overall, forest land, cropland, and waterbodies demonstrated a downward trend, while grassland, rivers and khals, settlements, aquaculture, orchards, and other plantation areas exhibited growth.

Table 1.1: Area statistics of land use change map (2010 and 2020) of Bangladesh

Class name	Area in 2010 (ha)	Area in 2010 (% of total)	Area in 2020 (ha)	Area in 2020 (% of total)	Land use changes (ha)	Land use changes (%)
Forest land	20,03,242	13.41%	19,92,103	13.34%	-11139	-0.56%
Cropland	74,30,127	49.74%	72,04,586	48.23%	-225541	-3.04%
Grassland	68,207	0.46%	69,609	0.47%	+1402	2.06%
Rivers and khals	13,30,021	8.90%	13,67,884	9.16%	+37863	2.85%
Other waterbodies	1,36,374	0.91%	1,25,464	0.84%	-10910	-8.00%
Settlements	32,41,673	21.70%	33,05,370	22.13%	+63697	1.96%
Aquaculture	2,92,949	1.96%	3,58,396	2.40%	+65447	22.34%
Orchards and other plantations	98,376	0.66%	1,77,519	1.19%	+79143	80.45%
Other land	3,35,730	2.25%	3,35,768	2.25%	+38	0.01%
Total	1,49,36,699	100%	1,49,36,699	100%		

Source: (DoE & CEGIS, 2023)

5 Climate change: trends and forecasts

Bangladesh's geographical location and climatic conditions have historically been favorable for crop production. However, increasing food demand and the impacts of climate change necessitate an assessment of future climatic conditions to understand their implications for the food system. Two key variables – annual maximum temperature and annual average precipitation – were analyzed, with the 1981-2010 period used as a baseline. Projections for the 2050s (based on the long-term average from 2035 to 2065) used the International Panel on Climate Change's (IPCC) SSP1-2.6 scenario, which represents a best-case, low-emission future, and SSP5-8.5, which represents a worst-case, high-emission future.

5.1. Projected annual maximum temperature change by the 2050s

Temperature is a critical factor in crop physiology, influencing various processes and growth stages. Rising temperatures in Bangladesh are proving increasingly challenging for crops like wheat, which require more moderate conditions for germination and growth. Understanding how temperature projections vary across IPCC scenarios is essential for informed crop production policymaking.

During the baseline period, the western half of the country experienced higher annual maximum temperatures. This spatial variation may be influenced by the depression basins (Haors) and hilly forests in the northeast, as well as the topography and forest cover of the Eastern Hills (EH). Coastal districts in the southwest, part of the Extended Coastal (EC) Region, also exhibited the highest temperatures.

Under the SSP1-2.6 scenario, the northwest is projected to see the greatest temperature increase (1.4-1.5°C), while the EH region is expected to experience a smaller rise (1.1-1.2°C). However, the SSP5-8.5 scenario predicts alarming temperature increases across the country, with North Central (NC) and Northeast (NE) regions seeing the largest rise (1.8-1.9°C), and the EC Region the smallest (1.6-1.7°C).

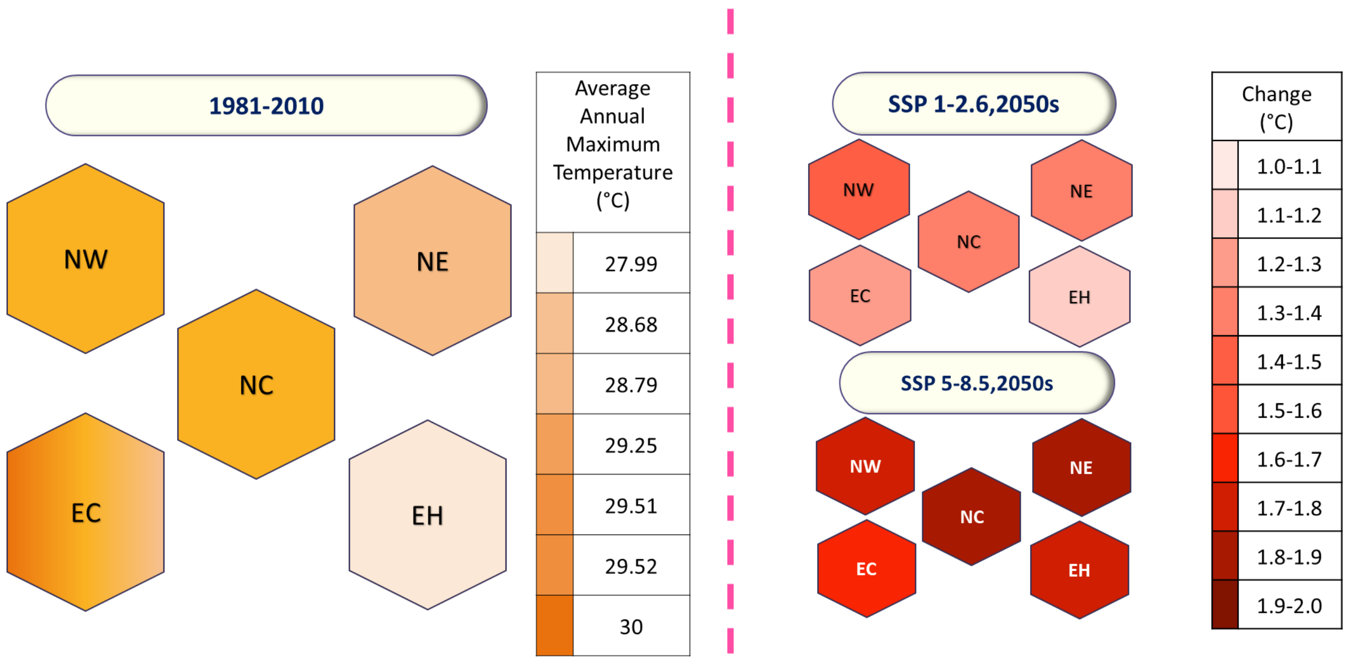

Figure 1.2: Projected change (°C) in annual maximum temperature in different regions of Bangladesh by the 2050s

5.2. Projected change in annual precipitation by the 2050s

Precipitation is vital for crop production, with monsoon rains traditionally supporting rainfed agriculture. However, rising food demand has increased farmers' reliance on groundwater irrigation, especially in the dry season, leading to rapid depletion. Such impact underscores the need to prioritize the use of surface water from the Ganges-Brahmaputra-Meghna basin, for which rainfall is crucial. Understanding future precipitation patterns is essential for water management in agriculture.

Higher rainfall was observed during the baseline period in the eastern and coastal areas, particularly in the NE and EH, due to their hilly topography.

The SSP1-2.6 scenario projects a slight decrease in precipitation in the NE by the 2050s, while the Northwest (NW) and Southwest (SW) areas may see increases of 3-4% – potentially altering the hydrological system and affecting crop production.

Under the SSP5-8.5 scenario, the NE may experience a minor precipitation increase (0-1%), with the NW and SW likely seeing the largest increases. These changes could significantly impact the hydrological regime and food production.

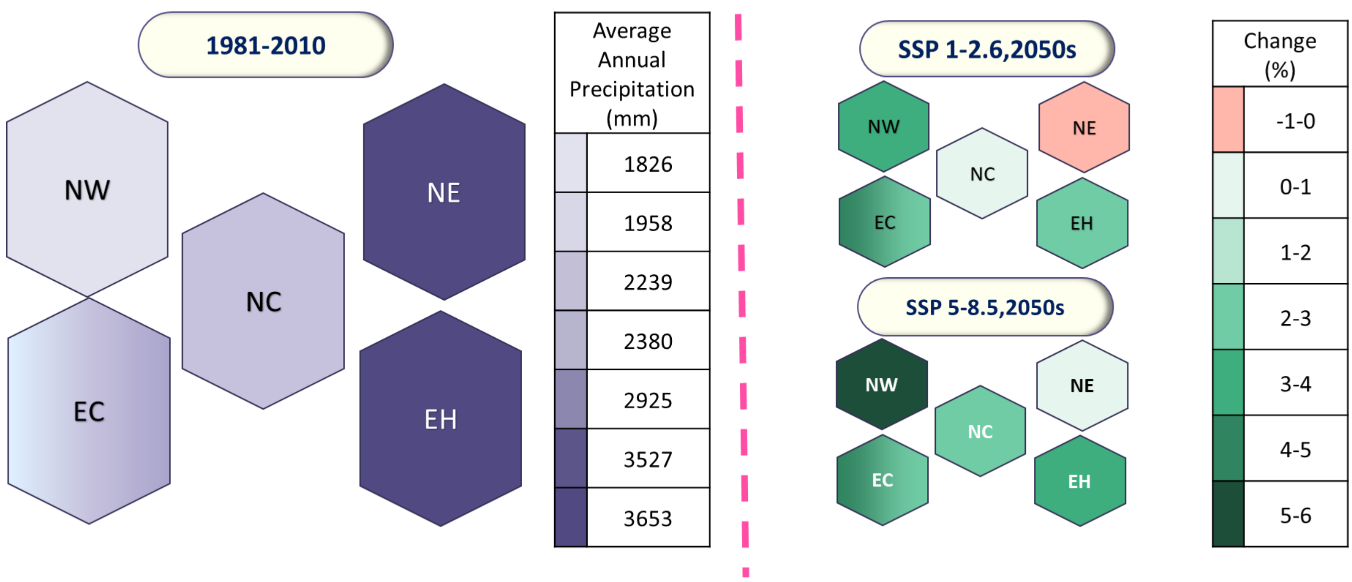

Figure 1.3: Projected change (°C) in annual precipitation in different regions of Bangladesh by the 2050s

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6 Exploring food status in 2050: through scenario analysis

For this scenario analysis, key parameters – food demand and food availability – were identified and quantified. Rice, as the primary food staple, was the main variable for food demand. Based on available data on land use, water resources, and dietary patterns, three scenarios were developed in line with BDP 2100: the **Moderate** scenario reflects a business-as-usual trend; the **Productive** scenario assumes favorable climate conditions and socioeconomic growth; and the **Active** scenario anticipates an unfavourable future with significant challenges.

These scenarios provide a framework for understanding future food security in Bangladesh by 2050, reflecting different potential outcomes for food demand and availability.

Scenario 1: Moderate

Food demand was projected based on the current dietary pattern and following recent trends, multiplying per capita demand by the projected population. Food availability and crop production were also projected using a business-as-usual approach.

Scenario 2: Productive

This scenario used a desired dietary pattern for food demand calculations, while crop production followed recent trends. The combination of improved diet and steady growth leads to an optimal future.

Scenario 3: Active

Food demand was calculated using the desired dietary pattern, while crop production was adjusted for changes in land use (declining cropland), climate changes (temperature and precipitation shifts), and water availability (adjusted crop-water demand). Increased demand and reduced food availability result in a challenging future.

Figure 1.4 shows the main factors and data sources used for the analysis.

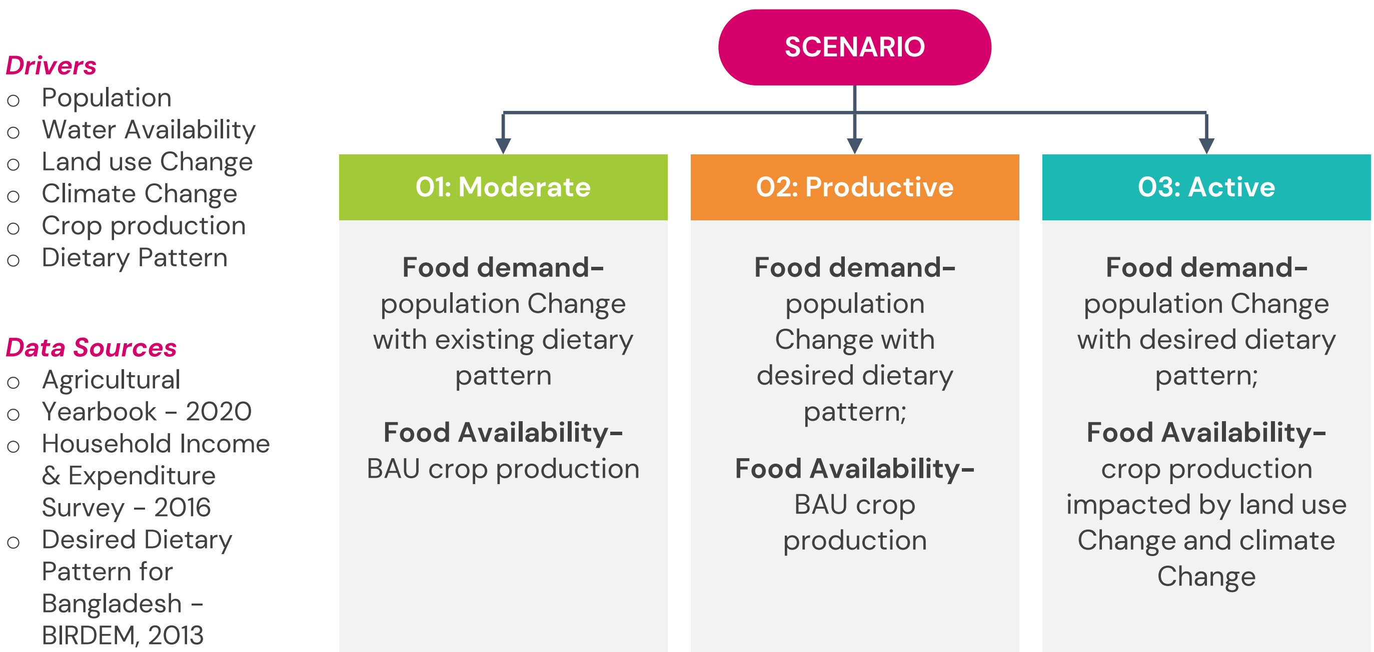


Figure 1.4: Scenario analysis schematic

Figure 1.5 illustrates the projected balance between demand and availability for major crops in Bangladesh by 2050 across the three scenarios. In the third scenario, all major crops are projected to experience deficits by 2050, with rice having the smallest shortfall at nearly 16%. Pulses will face the largest deficit, meeting only 9% of demand, followed by wheat (29%) and potatoes (85%) (Deltares, CEGIS, IWM, WUR, 2022).

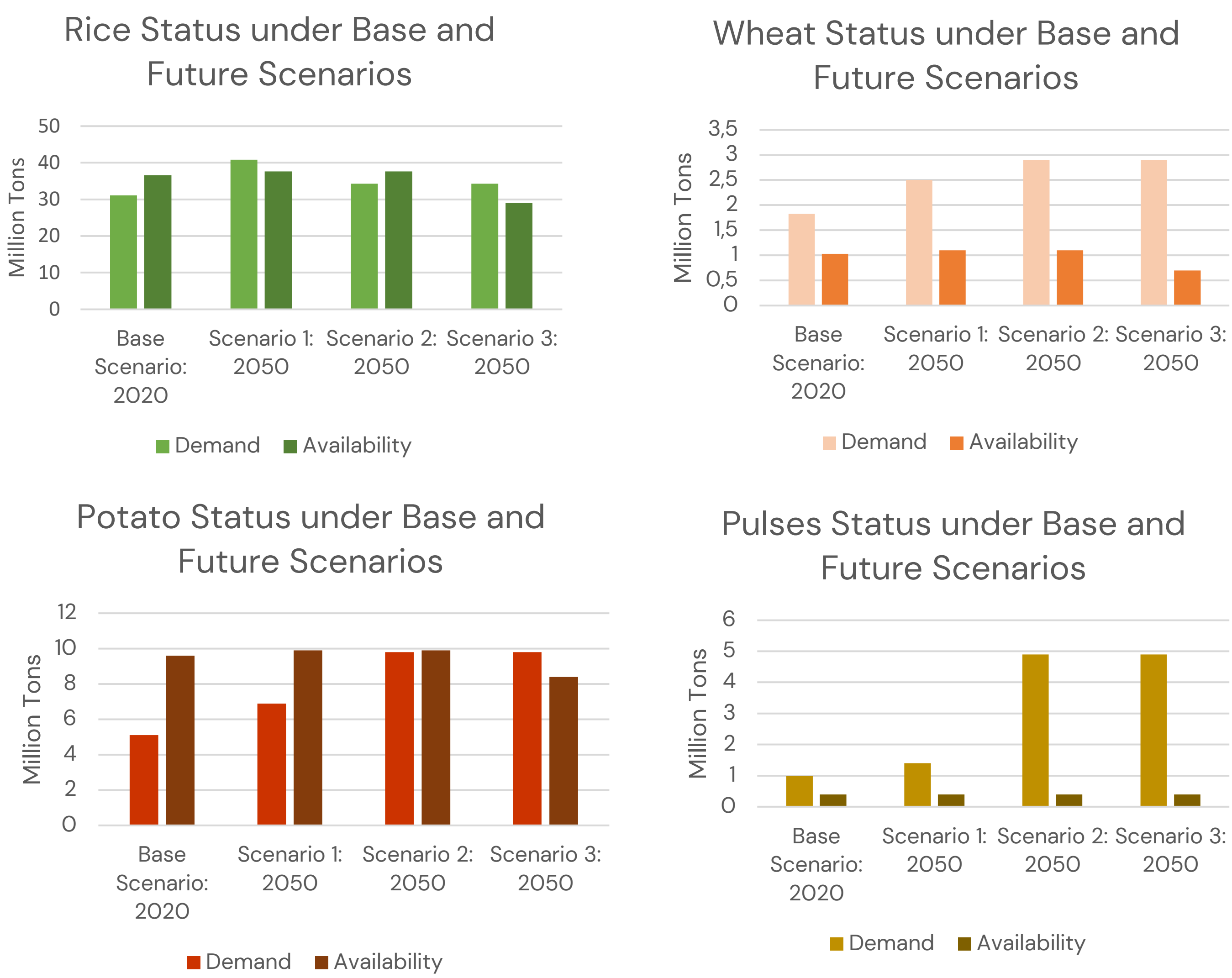


Figure 1.5: Projected demand vs. availability of major crops in Bangladesh by 2050 across three scenarios

Data source: (Deltares, CEGIS, IWM, WUR, 2022)

7 Results and discussion

7.1. Impact of growing Food Consumption on Different Ecosystems in Bangladesh

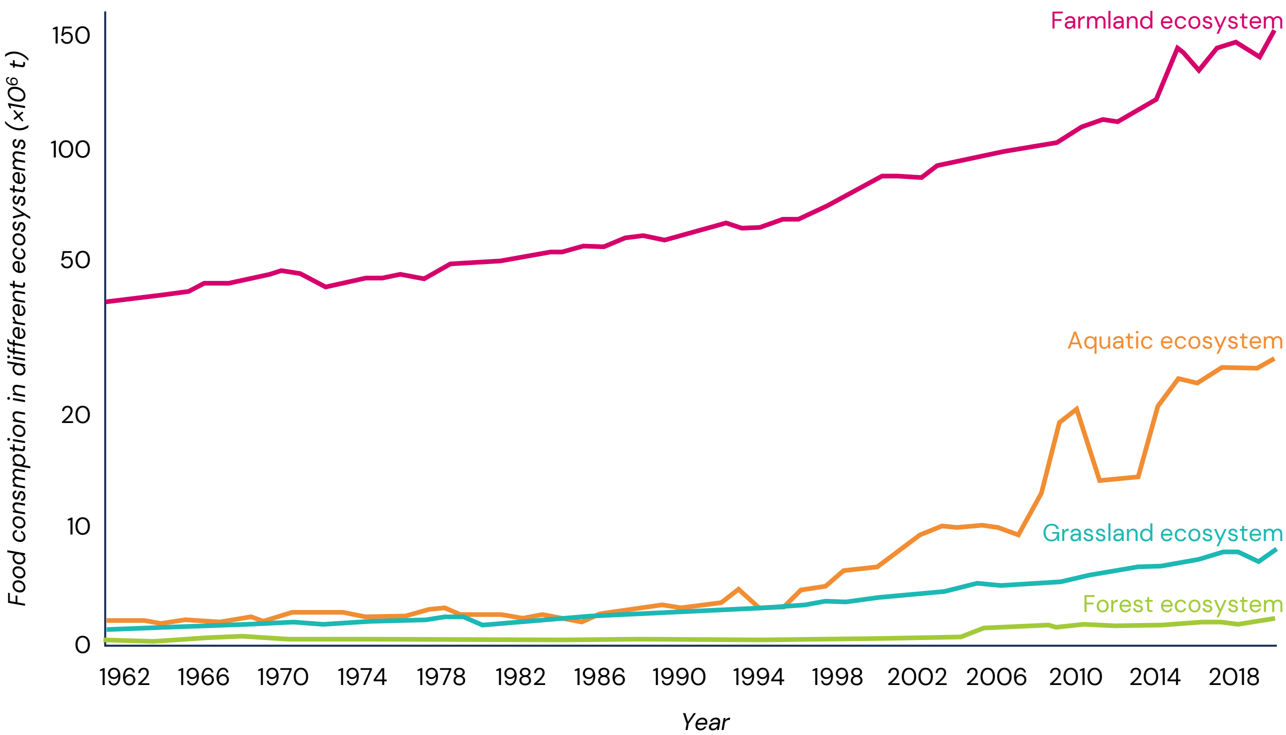
Jia, Zhen, & Wang (2023) examined shifting food consumption patterns in Bangladesh and their influencing factors, categorizing food products across four ecosystem types, table 1.2.

In Bangladesh, over 80% of food consumption relies on the farmland ecosystem due to agricultural practices, with consumption rising from 3.1 × 107 tons in 1961 to 15.52 × 107 tons in 2020. Aquatic ecosystem consumption, initially low, increased significantly post-1997, reaching 2.45 × 107 tons in 2017, largely due to expanded fisheries, especially shrimp farming. Forest and grassland-based food products have shown minimal changes; forest product consumption stayed below 2 × 10^6 tons until 2019, while grassland products peaked at 7.91 × 106 tons, a 5.45-fold increase.

Table 1.2: : Different Ecosystems as Food Sources in Bangladesh

Ecosystem Type	Food Item
Farmland ecosystem	Cereal (rice, wheat, barley, maize, millet, and sorghum) Nut
	Tuber (cassava, potatoes, and sweet potatoes)
	Bean (bean, pea, pulse, and soyabean)
	Sugar
	Oil (sesame, cotton, sunflower, groundnut, rapeseed, and mustard)
	Vegetable (tomato, onion, broccoli, pepper, and other vegetables)
Grassland ecosystem	Beef, mutton, and chicken
	Milk, Egg
Forest ecosystem	Fruit (orange, lemon, lime, apple, banana, mongo, pineapple, and grapefruit)
Aquatic ecosystem	Fish (freshwater fish, demersal fish, pelagic fish, and marine fish)
	Shrimp (shrimp, brown shrimp, and lobster) Crustacean

Figure 1.6: Changes of total and per capita food consumption in Bangladesh.



Source: (Jia, Zhen, & Wang, 2023)

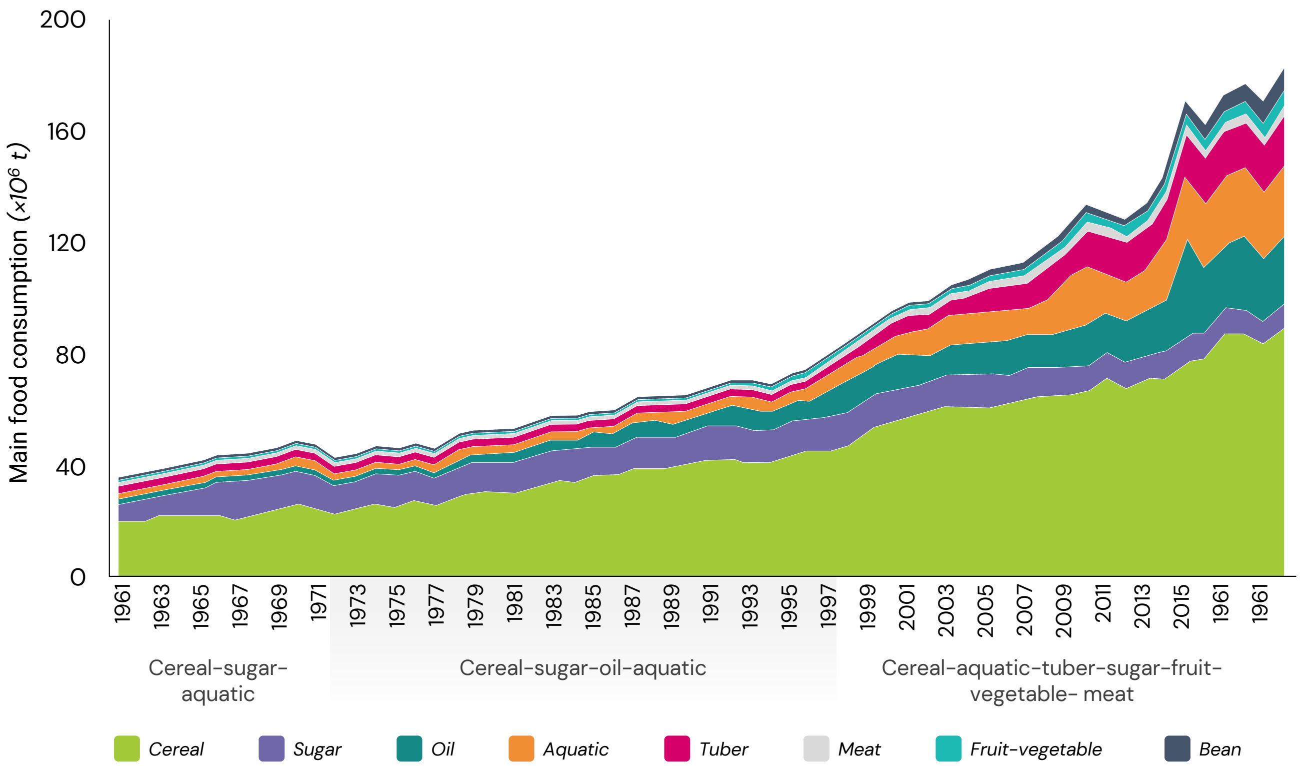
7.2. Changes in Food Consumption Patterns

According to the data gained and related consumption quantity, food consumption patterns had different characteristics in different periods. Considering the change in time, a division is made into three periods for the food consumption pattern:

First period (1961 to 1971)	Second period (1972 to 1997)	Third period (1998 to 2020)
mainly a cereal–sugar–aquatic consumption pattern was seen	food consumption focused on the cereal–sugar–aquatic–oil pattern	The main pattern of food consumption was the cereal–aquatic–tuber–sugar–fruit–vegetable–meat pattern

On the whole, food consumption in Bangladesh increased significantly. There was an increase in cereal consumption in quantity but a decrease in share to total consumption from the peak of 60.16% in 1990 to 43.48% in 2015, remaining below 50% afterwards. Sugar was also an important dietary component, with consumption having more than doubled from 6.56 × 10^6 tons in 1961 to 12.65 × 10^6 tons in 1971, reaching a high of almost 30% of total food consumption in 1967. In addition, aquatic food consumption increased steadily within the cereal-sugar-aquatic diet pattern from 1.87 × 10^6 tons in 1961 to 2.74 × 10^6 tons, growing at an average annual rate of 4.24%.

Figure 1.7: Change in Consumption of Major Food Items



Source: (Jia, Zhen, & Wang, 2023)

7.2. Implications of land use change on food consumption

The analysis of food consumption trends highlights how consumer preferences for a balanced diet have evolved over the past decade. Using data from the Household Income and Expenditure Survey (HIES), published in 2010, 2016, and 2022, the analysis reveals significant shifts.

Figure 1.8 demonstrates that rice consumption has dominated over the last decade. However, per capita rice consumption is steadily decreasing, likely driven by globalization and greater awareness of balanced diets. Wheat and potato consumption fell between 2010 and 2016 but rebounded between 2016 and 2022. Pulses consumption, though modest, steadily increased between 2010 and 2022.

Consumption per capita, g/day

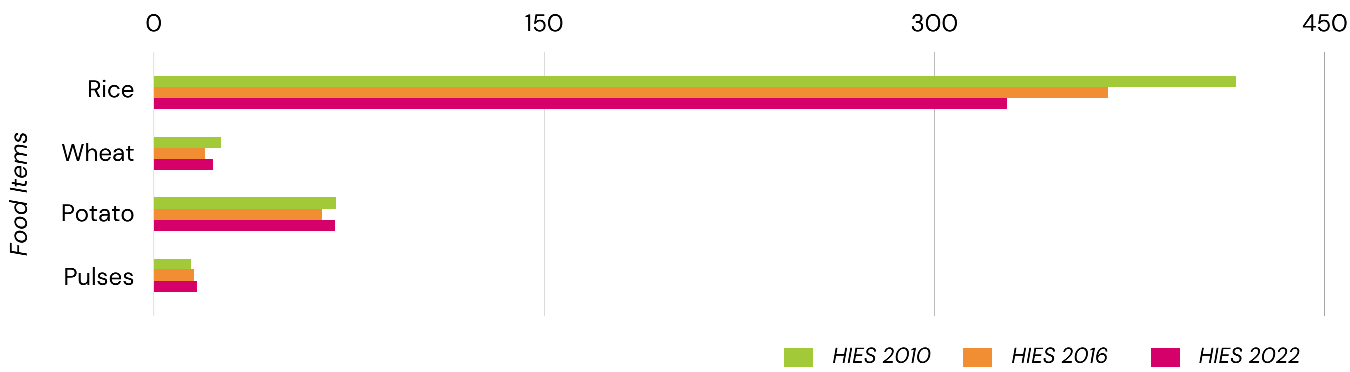


Figure 1.8: Food consumption trends, 2010–2022

Data Source: (BBS, 2023)

Land use changes from 2010 to 2020 reflect the shifts in food consumption patterns. Crops like rice, wheat, potato, and pulses rely on cropland, but increasing demand for housing, infrastructure, and industrial development has seen portions of this land converted into settlements and built-up areas. To compensate, many cropland areas have adopted multiple cropping seasons – which has allowed the total production of rice, wheat, potato, and pulses to rise, despite the shrinking cropland.

Table 1.3: Changes in food consumption by land use class

Food items	Change 2010-22	Relevant land use class	Change 2010-20
Rice	↓	Cropland	↓
Wheat	↓		
Potato	↓		
Pulses	↑		

Data Source: (BBS, 2023), (DoE & CEGIS, 2023)

Image credits: IFAD/Fahad Kaizer

7.3. Implications of climate change on dietary patterns and the food system

Impacts of climate change on agriculture, fisheries, and livestock

Climate-related factors pose a serious threat to a significant portion of the food production system. Rising temperatures alter plant growth cycles and, when combined with unpredictable rainfall, such changes can disrupt plant development and reduce crop yields (Baker, Allen, & Boote, 1990). Higher temperatures beyond certain thresholds have severe effects on crops – such as spikelet sterility in rice, reversal of vernalization in wheat, reduced tuber formation in potatoes, and loss of pollen viability in maize. Even brief periods of elevated temperatures during flowering can significantly reduce yields, while increased heat accelerates plant development, shortening the grain-filling stage and lowering output. Additionally, rising temperatures are expected to exacerbate pest and disease outbreaks.

Recent studies suggest that leaf folder infestations in rice fields could increase by 80-136% across various regions of Bangladesh by 2050, particularly in the NW, NC, and NE areas (Salam et al., 2019). Other crops and vegetables may face similar threats, potentially leading to major production losses. Meanwhile, coastal flooding – due to sea-level rises and cyclonic storm surges – could reduce rice production by 7.4% to 10.1%, depending on sea-level rises of 0.62 meters and 0.92 meters, respectively, under the IPCC RCP8.5 scenario (DoE, 2020). The potential impacts and risks to crops and fisheries are detailed in Tables 1.4 and 1.5, respectively.

Table 1.4: Potential impacts and risks for crops

Climate signal and hazards	Potential impacts	Risk level	
		SSP 1-2.6	SSP 5-8.5
Excessive rainfall	o Crop damage o Cultivation becomes less suitable due to waterlogged conditions o Loss of cultivable lands o Changed cropping patterns	Medium	High
Extreme heat	o Crop yield change/reduction o Pest infestations and disease outbreaks o Changes in flowering patterns and phenological changes	Medium	High
Cold spells	o Crop damages o Phenological changes o Pest and diseases	High	High
Frequent river floods	o Crop damages o Loss of livelihoods	Low	Medium
Early or frequent flash floods	o Dry season (Boro) crop damages o Harvesting and storage problems o Changed cropping patterns o Seasonal migration o Shifting occupations	Medium	High
Severe droughts/water scarcity	o Irrigation water crisis o Less yield o Food crisis o Pest and diseases	Medium	Medium
Frequent lightning	o Death of farmers	Medium	Medium
Increased salinity	o Crop damages among traditional varieties o Low yields o Less suitable irrigation water o Cropping pattern change o Limited scope for agricultural production o Loss of livelihoods o Internal displacement	Medium	High
Frequent cyclones/ tornados and storm surges	o Crop damages o Loss of livelihoods o Human death o Food and medicine crisis	High	High
Sea-level rise	o Less avilability of cultivable lands o Low crop yields o Hampered food security	Medium	High

Source: (MoEFCC, 2022)

Table 1.5: Potential impacts and risks for fisheries and aquaculture

Climate signal and hazards	Potential impacts	Risk level	
		SSP 1-2.6	SSP 5-8.5
Excessive rainfall	o Increased natural mortality due to lower pH o Decreased fish catchability o Problems in dry fish processing o Breaching of shrimp farm/fishpond dikes o Overtopping of cultured fish from shrimp farms/fishponds	Low	Medium
Extreme heat	o Increased natural mortality due to thermal shock, depletion of o Dissolved oxygen and bacterial decomposition o Decreased pond water availability period due to high evaporative loss o Decrease in productivity	Low	Medium
Cold spells	o Abnormal behavior in spawners o Less food intake	Low	Low
Frequent river floods	o Overtopping of ponds or shrimp/prawn farms, with fish escaping o Breaching of shrimp/prawn/fish farm dikes o Disruption to fish harvesting, storage, and processing	Medium	High
Early or frequent flash floods	o Wash out and/or overflow of fishponds, causing fish escaping o Degradation of habitat quality	Medium	High
Severe droughts/water scarcity	o Declining water area and loss of connectivity o Increase in fish mortality and loss of fish diversity and o composition o Reduction of pond water availability period and extended days of levels under thresholds o Disease outbreaks and loss of fish production	Low	Medium
Frequent lightning	o Risk of life to fishing people	Low	Low
Increased salinity	o Unfavorable habitat conditions for freshwater fish o Appearance of marine fish in the intersaline convergent zone, threatening freshwater fish	Medium	High
Frequent cyclones/ tornados and storm surges	o Overtopping of ponds or shrimp/prawn farms, with fish escaping o Degradation of the aquatic conditions of fishponds/shrimp farms o Decline of fishing days and reduction of fish caught	Medium	High
Sea-level rise	o Prevalence of marine fisheries in places with freshwater fisheries	Medium	High

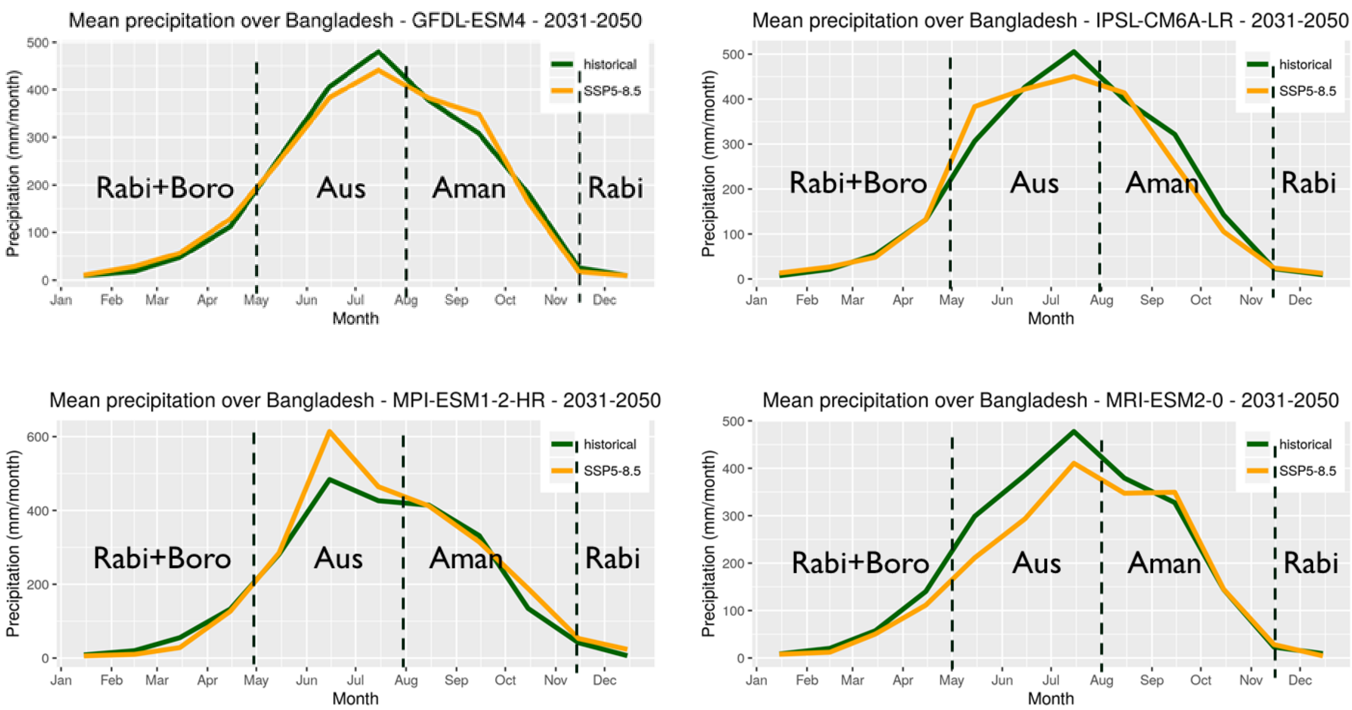
The impact of climate change on malnutrition

Climate change directly impacts crop yields, fisheries, and livestock, contributing to food insecurity. For example, shifts in precipitation and temperature patterns can reduce staple crop production, potentially leading to malnutrition. A study using national data from the 2017-2018 Bangladesh Demographic and Health Survey (Khan, Bakar, & Hossain, 2023) assessed the relationship between undernutrition and climatic variables, such as rainfall and temperature, through a spatial logistic regression model. The findings indicated that increased rainfall correlates with higher odds of undernutrition.

The connection between increased rainfall and underage malnutrition likely stems from potential flood events (Cooper, Brown, Azzarri, & Meinzen-Dick, 2019). Flooding disrupts food supplies, causes crop loss, and leads to sudden spikes in food prices (Rodriguez-Llanes, Dash, Mukhopadhyay, & Guha-Sapir, 2016). These events exacerbate social disparities in lower-middle-income countries like Bangladesh, limiting access to diverse diets and heightening the risk of malnutrition.

7.4 Scenarios projecting the impact of climate change on food production in 2050

The decline in food production is driven not only by population growth and reduced agricultural land but also significantly by lower crop yields due to climate change. The LPJML model shows declining yields for wheat, potatoes, and pulses, with only a modest increase in rice yield. Climate change impacts, such as water scarcity and erratic rainfall, intensify these declines, as not all crop yield translates to actual production. While rice production may see slight gains, expanding rice cultivation could reduce land available for pulses and wheat, further risking shortages in these crops (see Fig. 1.7).



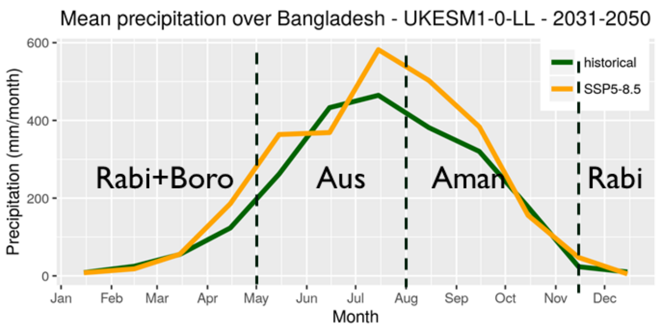


Figure 1.9: Shifting of rainfall events with amount and cropping season in future

Source: (Deltares, CEGIS, IWM, WUR, 2022)

8 Wheat status in Bangladesh

Wheat is the second largest staple food in Bangladesh, following rice. Local production of wheat meets approximately 15% of total demand. Wheat-based foods, such as bread and biscuits, are essential components of the Bangladeshi diet. Wheat products account for over two-thirds of the country's processed foods, and consumption of roti-parota (local flatbreads) has also increased significantly in recent years.

Farmers plant wheat in November and December, harvesting it in March and April. However, due to a lack of improved varieties, both wheat acreage and production are gradually declining. Despite wheat demand in Bangladesh doubling in the last decade, domestic wheat production has not kept pace, declining by about 20% over this period. Simultaneously, wheat imports have risen sharply, peaking in 2020, after which it started declining. This raises concerns over overall import costs and food security.

Wheat (Production, Import and Consumption)

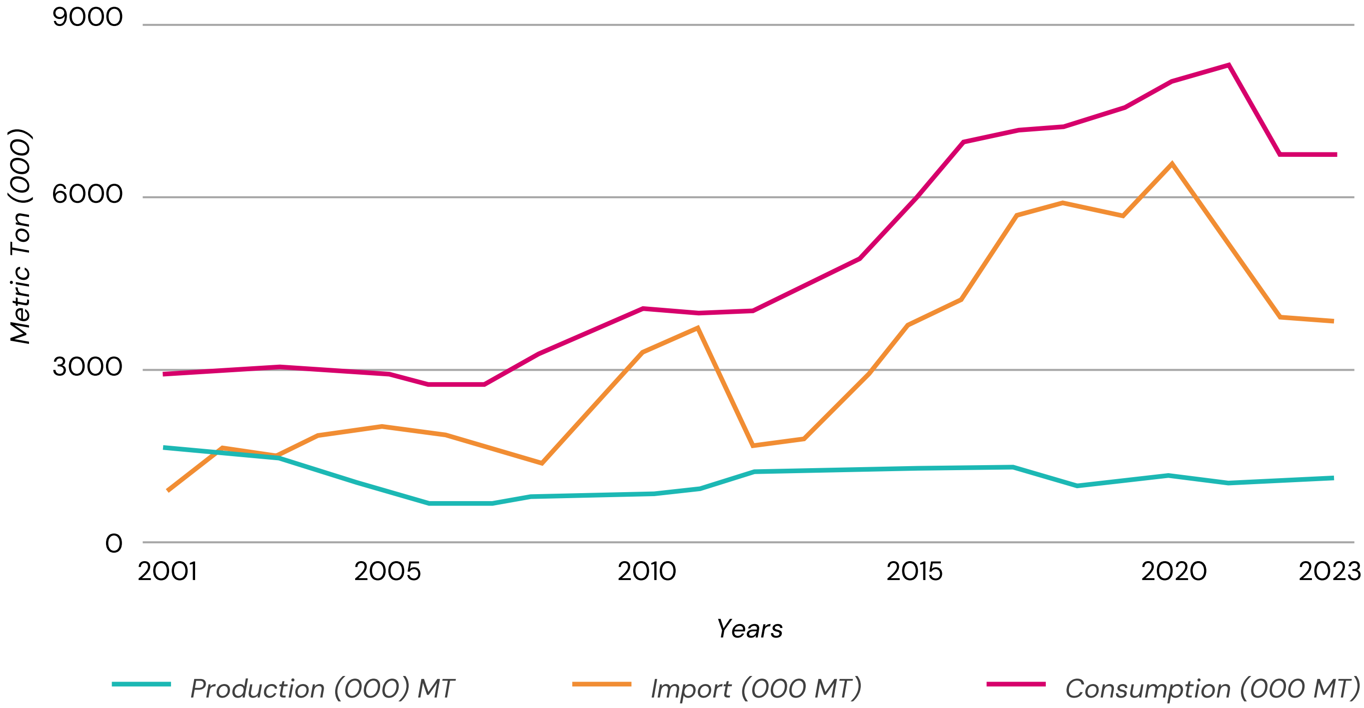


Figure 10: Wheat production, import, and consumption (2001-2023)

Data Sources: (FPMU, 2024) (BBS, 2024)

9 Key policy recommendations

9.1. Climate adaptation and resilience

- Develop and adopt climate-adaptive, resilient, and stress-tolerant crop varieties for flood, saline, and drought-prone areas.
- Implement climate-proofing and climate adaptation measures in agricultural planning.
- Strengthen research to innovate cost-effective, resilient agricultural practices and introduce modern technologies like nanotechnology.

9.2. Sustainable production and land use planning

- Enhance agricultural, fisheries, and livestock production.
- Adopt strategies for optimal land and water use, recognizing the water–food nexus to support crop production.
- Provide necessary agricultural inputs, services, and facilities to sustain production.
- Develop a sustainable agriculture action plan aligned with national policies and promote diversified production.

9.3. Promote food and nutrition security

- Raise awareness about balanced diets, including vegetables, fruits, fish, and meat.
- Ensure access to healthy and nutritious foods to meet dietary needs.
- Accommodate land use changes to match evolving dietary preferences and food demands..

9.4. Reducing Import Dependency and Economic Resilience

- Discourage reliance on imports by boosting local production.
- Set priorities to establish a sustainable and balanced food system, reducing vulnerability to external shocks.

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