

AGRICULTURAL SUSTAINABILITY IN THE BRAHMAPUTRA FLOODPLAINS: CHALLENGES, PRACTICES, AND POLICY PATHWAYS

BY

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Abstract

Despite the fact that agriculture is the major source of livelihood in rural areas of Brahmaputra floodplain of Assam, environmental variability, frequent floods and socio economic factors are posing serious problems for sustainability. This chapter reviews agro ecological contexts, important sustainability issues, adaptation practices that have been applied by local communities and the importance of the policy frameworks in influencing agriculture outcomes. The discussion, based on empirical studies in Assam and other parts of India and on official reports on sustainable agriculture and flood resilience, outlines some of the future avenues for increasing resilience, productivity and ecological well-being. The key strategies highlighted include implementing climate smart farming techniques, integrated watershed management, crop diversification, and providing institutional assistance to smallholder farmers, especially women farmers. The chapter provides concrete recommendations for reaching the goal of sustainable agriculture in one of the most dynamic and sensitive agro ecosystems in India, by making a connection between local knowledge systems and policy interventions and sustainable practices.

Keywords: Sustainable Agriculture; Brahmaputra Floodplain; Assam; Climate Change; Flood Resilience; Climate-Smart Agriculture; Crop Diversification; Smallholder Farmers.

1. Introduction

Agriculture forms the backbone of socio-economic fabric of Assam particularly in the fertile Brahmaputra floodplain. The area's complex geography is influenced by the alluvial dynamics of the Brahmaputra River, which nurtures several production systems for the livelihoods of millions of smallholder farmers (Mahanta, Dutta & Choudhury, 2021). But climate change effects, regular flood and soil degradation are still threats to agricultural sustainability and rural living (Baruah & Mahanta, 2024; Singh & Singh, 2015). Added to this is the socio economic factors such as poor market linkage, restricted

access to credit and land fragmentation (Deka & Das, 2023).

In this chapter, the multi dimensional challenges to sustainability in Brahmaputra floodplains are discussed, local adaptive practices are explored, and policy frameworks at national and state levels are discussed. Applying both empirical evidence and thematic analysis, it outlines pathways to achieve resilient agricultural systems that strive to reconcile productivity, ecological function and livelihood security.

2. Agro-Ecological Context of the Brahmaputra Floodplain

2.1 Geography and Climate

Much of Assam is part of the Brahmaputra floodplain which is flat and has dynamic river channels. The fertile alluvial soil has been used for intensive farming of rice and other crops for generations (Deka & Das, 2023). However, this fertility is offset by the fact that the area is vulnerable to seasonal floods, river bank erosion and deposition which are factors affecting agro ecosystems and bring risk.

The climate of the region is monsoon influenced with high annual precipitation and much year to year fluctuation. Science assessments show changing patterns of precipitation and the rise in the frequency of extreme events, which is related to climate change (Baruah & Mahanta, 2024). An increase in temperature compounds the stress on agriculture systems through changes in the phenology of crops and pest dynamics.

2.2 Dominant Cropping Patterns

The floodplain is dominated by rice, grown in several seasons (aman, boro and aus) based on the flood timing and availability of water. With improved water management technology, Boro rice, which needs irrigation, has also increased in its area under cultivation (Mahanta et al., 2021). In between rice cultivation, pulses, oilseeds, and vegetables are grown that adds some diversification to the farm income and nutrition security (Saikia & Kalita, 2020).

Ecological advantages, such as dispersing risk over seasons and cycling nutrients through the soil, can be found in traditional methods like mixed cropping and livestock integration. But for each household it differs according to access to resources and knowledge.

3. Challenges to Agricultural Sustainability

3.1 Flooding and Erosion

The main environmental problem of Brahmaputra system is recurrent floods. Floods bring nutrient rich sediments and catastrophic inundations kill standing crops, wash away productive lands and affect rural economy (Singh & Singh, 2015). In fact, almost 40% of the cropped area of Assam is defined as flood prone (Assam Agriculture Department, 2022) resulting in yield loss and insecurity of livelihood.

The riverbank erosion, which is closely associated with the monsoons, leads to an irretrievable loss of land and influx of internally displaced agricultural families, especially in Dhemaji, Majuli and Morigaon districts (Deka & Das, 2023). All these processes highlight the need for farming practices that are flood resilient and landscape management.

3.2 Soil Degradation

The soils in floodplain areas are naturally fertile, however, soil fertility has been decreasing gradually due to monocropping and imbalance use of fertilizers (Saikia & Kalita, 2020). Areas with chronic waterlogging have become salinity problem, adding to soil health issues. Smallholder farmers who lack access to inputs are using cheaper, low quality seeds, and overusing chemical fertilizers, which also degrades soil resilience.

3.3 Climate Change Impacts

Assam's floodplain experiences variations in rainfall, temperature and pest pressures due to climate change. Research indicates a rise in the variability of monsoon timing and strength, impacting planting schedules and crop yields (Baruah & Mahanta, 2024). Increased temperatures also alter the rates of evapotranspiration which also creates stress in

water resource management and crop productivity.

3.4 Socio Economic Constraints

Brahmaputra floodplain agriculture is marked by small and fragmented land holdings, limited access to formal credit, and poor of market integration, which restricts investments in sustainable technologies (Deka & Das, 2023; Saikia & Kalita, 2020). Women, who do a large share of the work in agriculture, are highly disadvantaged in land ownership, input access, and decision making (Choudhury, 2021). For sustainability to be possible, these socio-economic realities need to be addressed, too.

4. Adaptive Practices and Local Innovations

4.1 Climate-Smart Crop Varieties

Development and sharing of flood tolerant rice varieties like Swarna Sub1 are among the most important progress in flood adaptive agriculture. These varieties are able to withstand submergence for up to 2 weeks and hence crop losses are reduced in flood years (ICAR, 2020). The introduction of such seeds, along with knowledge of the timing of floods, would increase farmers' resilience to such extreme events.

4.2 Diversification and Crop Rotation

Crop diversification, such as embedding legumes, vegetables and oilseeds, diversifies risk and improves soil fertility with biological N fixation. Rice-legumes rotation helps to sustain soil organic matter and decreases the reliance on synthetic inputs (Saikia & Kalita, 2020). Mixed cropping systems also enhance household nutrition and have alternative means of livelihood.

4.3 Water management and agroforestry are combined in this section.

Water harvesting structures, small check dams and contour trenches help retain moisture during

periods of no rainfall, making them less vulnerable to the unpredictable nature of rainfall. These are complemented by agroforestry methods, where trees are integrated into agricultural landscapes, which helps to reduce erosion, enhance microclimates and biodiversity (Singh et al., 2019).

5. Policy and Institutional Frameworks

5.1 National Policy Initiatives

However, at the national level, there are frameworks like the National Mission for Sustainable Agriculture (NMSA) under the National Action Plan on Climate Change which supports climate smart agriculture, soil health management and water use efficiency (MoAFW, 2023). The Soil Health Card scheme is initiated by the Ministry of Agriculture & Farmers Welfare to achieve balanced fertilization in accordance with soil nutrient profile which is a very much essential in floodplain system.

Additionally, Indian Council of Agricultural Research (ICAR) encourages flood tolerant cultivars, context specific extension services (ICAR, 2020). There are issues coverage and timely compensation with Pradhan Mantri Fasal Bima Yojana (PMFBY) which offers cover for crop insurance to safeguard farmers from risks of natural calamities like floods.

5.2 Assam State Strategies

The Assam Agricultural Department has taken various initiatives to make agriculture more resilient and sustainable in the face of floods. These include community based watershed programs, flood forecasting systems, support to irrigation infrastructure etc. (Assam Agricultural Department, 2022). But, there are still major implementation and resource allocation challenges.

In 2021, the Government of Assam released the Strategic Development Plan 2030, which aims for sustainable agriculture and rural livelihoods, as

well as climate adaptation solutions — a testament to the government's commitment to ecological and economic resilience in the long term (Government of Assam, 2021).

5.3 Community Institutions and Cooperatives

Improving local institutions, including Farmer Producer Organizations (FPOs) and self help groups, improves collective bargaining, access to inputs and market linkages. Such structures also enable the sharing of knowledge and joint investments in infrastructure, such as storage and processing units, thus increasing the economic viability.

6. Pathways to Agricultural Sustainability

Based on the empirical study and policy outcomes, the following pathways towards achieving agricultural sustainability in Assam floodplain arises:

6.1 To scale up Climate Smart Agriculture.

Improving and expanding the adoption of climate smart technologies such as flood-tolerant varieties, precision irrigation, soil health management, etc. can have a major impact on reducing vulnerability. Participatory testing and co design of technologies with farming communities ensures relevance and adoption.

6.2 Integrated Landscape Management

With agricultural practices, watershed restoration, floodplain zoning and stabilization of riverbanks can diminish risk and improve ecological services. Landscape resilience is enhanced by combining physical interventions with agroforestry and soil conservation.

6.3 Empower Smallholders and Women Farmers.

Land, credit, training, and inputs are equitably distributed, contributing to better sustainability outcomes, particularly for women farmers. Potential of marginalised groups can be tapped through social inclusion strategies and targeted extension services.

6.4 Increase market linkages and value chains

Building successful value chains from the farm to the processor and to the market boosts farm income and minimizes post harvest losses. Market gaps can be filled with public public partnerships, cooperative models and digital platforms.

6.5 Policy Integration and Adaptive Governance

Good inter agency coordination, resource mobilization and adaptive governance mechanisms, such as climate risk information systems, are essential. Capacity building in the enabling environment through mainstreaming of sustainability objectives in agricultural, water and rural development policies.

7. Conclusion

In Assam's Brahmaputra floodplains, achieving agricultural sustainability is essential to ensure the long-term viability of the region's agricultural systems. This is crucial for ensuring the sustainability of agricultural systems in Assam's Brahmaputra floodplains. Diversified farming systems, integrated water management, and climate smart crop varieties are examples of adaptive practices, which show a way towards sustainability, while recurrent floods and climate variability present greater challenges. These, combined with enabling policy interventions at national and state levels, have the potential to improve productivity, conserve natural resources and strengthen robust rural livelihoods.

Sustainable agriculture futures in the Brahmaputra floodplain are possible by linking local knowledge systems and scientific innovation and policy interventions.

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