

Climate Change and Its Implications for Agricultural Livelihoods with Reference to Assam

Sanjib Saikia, Assistant Professor, Department of Political Science, Dr. Nobin Bordoloi College, Na Ali Dhekiajuli, Jorhat, Affiliated to Dibrugarh University, Dibrugarh

Abstract

Climate change poses a significant threat to agricultural livelihoods, particularly in climate-sensitive regions like Assam, where agriculture is the main source of income for the rural population. Erratic rainfall, frequent floods, rising temperatures, and shifting crop patterns have disrupted traditional farming systems and undermined food and income security. In alignment with the Sustainable Development Goals (SDGs)—specifically zero hunger, climate action, and sustainable communities—this paper examines the implications of climate variability on agricultural livelihoods in Assam and explores community-based adaptive strategies. The objectives are to assess the extent of climate change impacts on crop productivity, identify socio-economic vulnerabilities of smallholder farmers, and evaluate local adaptation practices and institutional responses. A mixed-methods approach was used, combining meteorological data analysis with household surveys in five flood-prone districts of Assam. These were supported by focus group discussions and interviews with farmers, agricultural officers, and local NGOs. Findings reveal a clear pattern of declining yields in key crops such as rice and mustard, primarily due to increased flood frequency and shortened growing seasons. Small and marginal farmers, particularly women-headed households, are disproportionately impacted due to limited access to credit, insurance, and agricultural extension services. However, adaptive practices such as cultivating flood-resilient crop varieties, adopting integrated farming systems, and engaging in community-based disaster preparedness present viable pathways for building resilience. This paper underscores the urgency of incorporating climate adaptation into rural development strategies. It calls for enhanced community engagement, targeted policy interventions, and increased investment in climate-smart agriculture. The findings are directly relevant to the conference theme, illustrating how participatory, locally grounded solutions can address regional vulnerabilities while contributing to global sustainability efforts.

Keywords: Climate change, agricultural livelihoods, Assam, adaptation, community resilience, SDGs.

Introduction:

Agriculture remains the cornerstone of rural livelihoods in Assam, employing over half of the state's workforce. However, the growing threat of climate change has increasingly compromised the stability and productivity of this vital sector. Variability in rainfall, rising temperatures, and recurrent floods have intensified vulnerabilities among smallholder farmers, most of whom depend on monsoon-fed cultivation. These environmental changes have also led to alterations in cropping patterns, increased pest attacks, and land degradation. In this context,

understanding the implications of climate change on agricultural livelihoods becomes essential for formulating adaptive strategies that ensure food security and economic resilience. Assam's agro-ecological sensitivity and socio-economic dependence on agriculture make it an important case for examining climate impacts and community-led responses. This paper attempts to explore how climate change affects agriculture in Assam and how rural communities are adapting to these challenges in alignment with Sustainable Development Goals (SDGs).

Background of the Study-

Climate change has emerged as a defining challenge of the 21st century, with far-reaching impacts on ecosystems, food systems, and rural livelihoods globally. In India, and particularly in Northeast regions like Assam, these impacts are especially pronounced due to the region's high dependence on climate-sensitive agriculture. Studies indicate that the frequency and intensity of floods, heat waves, and unseasonal rainfall events in Assam have increased in recent decades (Das, 2021). These erratic climatic patterns have led to substantial yield losses, especially in key crops like rice and mustard, which are central to Assam's agricultural economy.

Assam's geographical location in the Brahmaputra floodplain exposes it to annual flooding, further exacerbated by climate-induced glacier melting and increased rainfall variability (Goswami et al., 2018). Small and marginal farmers, who form the backbone of the rural economy, often lack the financial resilience and institutional support to cope with such challenges. Their dependence on traditional farming methods, limited access to irrigation, and weak extension systems compound their vulnerability.

Climate change also disrupts planting cycles, increases the incidence of pests and diseases, and reduces soil fertility, all of which have cascading effects on income, food security, and migration. In this context, the state's development trajectory needs to prioritize sustainable agricultural practices and resilience-building strategies.

Moreover, as Assam contributes to the national food basket and biodiversity, any deterioration in its agricultural system poses risks not only to local communities but to broader environmental and food security objectives. This study, therefore, addresses an urgent need to assess how climate change is affecting agricultural livelihoods and to explore the adaptive responses being implemented by farmers and institutions to ensure long-term sustainability in the region.

Rationale-

Assam's agriculture is at a crossroads, with climate change increasingly altering its ecological and socio-economic foundations. The state has witnessed growing instances of climate-related disruptions such as erratic rainfall, riverine floods, and dry spells, severely affecting crop productivity and farm incomes. Despite the mounting evidence of climate-induced stress, limited region-specific studies exist that holistically examine its implications on agricultural livelihoods in Assam.

Given that a significant proportion of the rural population depends on agriculture for subsistence and employment, understanding the nature and depth of these impacts is vital for sustainable development planning. Additionally, while national policies like the National Action Plan on Climate Change (NAPCC) exist, localized insights are needed to align policy interventions with on-ground realities.

This study aims to bridge that gap by providing an empirical assessment of climate change impacts on agriculture in Assam and by identifying community-based adaptive practices. It also seeks to contribute to the discourse on how grassroots resilience can be enhanced through participatory governance and climate-smart strategies. The relevance of this research extends to multiple SDGs, particularly those addressing poverty, food security, gender equality, and climate action. Therefore, this paper is both timely and necessary for designing integrated approaches to mitigate climate risks in vulnerable agrarian communities.

Objectives-

1. To assess the extent and nature of climate change impacts on crop productivity and agricultural practices in Assam.
2. To identify the socio-economic vulnerabilities of smallholder and marginal farmers affected by climate variability.
3. To evaluate existing adaptation strategies and institutional responses at the community level.

Scope and Limitations-

This study focuses on examining the implications of climate change on agricultural livelihoods in selected flood-prone districts of Assam. The scope includes understanding both direct impacts—such as changes in crop yields, planting cycles, and soil conditions—and indirect effects like food insecurity, reduced income, and migration trends. It explores farmers' adaptive strategies, including changes in cropping patterns, adoption of resilient varieties, water management practices, and the role of community-based initiatives. The research also investigates the institutional support available to farmers, including governmental schemes, NGO interventions, and local governance.

However, the study has certain limitations. First, it is geographically limited to five districts, which may not fully represent the diversity of climatic impacts across all of Assam. Second, while efforts have been made to gather recent data, the availability of reliable long-term meteorological records at the micro-regional level remains a constraint. Third, the study relies on self-reported data from farmers, which may be influenced by recall bias or subjective perceptions. Finally, the complex interactions between socio-political factors, environmental degradation, and market dynamics are beyond the full analytical scope of this paper.

Despite these limitations, the findings offer valuable insights for policy formulation and community engagement strategies aimed at promoting sustainable agricultural livelihoods under changing climate conditions.

Study Area: Assam – An Overview-

Assam, located in the northeastern region of India, is a land of diverse topography, rich biodiversity, and vibrant cultural heritage. Spanning an area of approximately 78,438 square kilometers, the state is characterized by the Brahmaputra and Barak river valleys, hilly terrains, and forested areas. Assam's climate is predominantly humid subtropical, with high rainfall, hot summers, and mild winters. The monsoon season, stretching from June to September, brings the majority of the annual precipitation, often resulting in floods that have severe consequences for the agrarian population.

Agriculture is the backbone of Assam's economy, employing over 60% of its workforce and contributing significantly to the state's Gross Domestic Product. Major crops include rice, tea, mustard, jute, and pulses, with rice being the staple and most widely cultivated. However, the agricultural sector is largely dependent on rainfall, making it highly vulnerable to climate variability and extreme weather events such as floods and droughts.

The state's physiographic diversity and location in the Eastern Himalayan foothills make it ecologically sensitive and prone to environmental challenges. Over the past few decades, Assam has witnessed increasing instances of riverbank erosion, erratic rainfall, and rising temperatures. These climatic changes are affecting soil fertility, water availability, and overall agricultural productivity. Floods, in particular, have become more frequent and intense, displacing thousands of farming families annually and damaging standing crops and infrastructure.

The rural population, especially small and marginal farmers, faces growing livelihood insecurity due to their limited adaptive capacity and dependence on subsistence farming. Women and indigenous communities are often the most affected due to systemic socio-economic vulnerabilities.

Assam's complex agro-ecological landscape, combined with its climate sensitivity, makes it a critical region for studying the implications of climate change on agricultural livelihoods and exploring sustainable, community-driven adaptive strategies.

Research Methodology-

This study employs a mixed-methods approach to comprehensively assess the implications of climate change on agricultural livelihoods in Assam. The methodology integrates both quantitative and qualitative data to capture the multifaceted impacts of climate variability and community responses.

The research was conducted across five flood-prone districts of Assam: Dhemaji, Lakhimpur, Barpeta, Morigaon, and Dhubri. These districts were selected based on their high agricultural dependence and recurrent exposure to climate-induced hazards such as floods and erratic rainfall.

Quantitative data was collected through structured household surveys targeting 250 small and marginal farming households. The survey covered variables such as crop yield trends, income changes, incidence of crop failure, access to institutional support, and adaptation practices. Stratified random sampling was used to ensure representation across gender, landholding size, and socio-economic categories.

Qualitative data was gathered through focus group discussions (FGDs) and key informant interviews (KIIs). FGDs were conducted separately with male and female farmers to understand gendered experiences and perceptions. KIIs involved agricultural officers, village leaders, and representatives from local NGOs working on climate resilience. These interactions provided deeper insights into local knowledge systems, institutional interventions, and community-level adaptation strategies.

Secondary data, including meteorological records, flood maps, and government agricultural reports, were analyzed to identify long-term climate trends and correlate them with livelihood outcomes.

Data triangulation was employed to validate findings from different sources. Quantitative data were analyzed using statistical tools, while thematic analysis was applied to qualitative inputs. This methodological framework

enabled a holistic understanding of the vulnerabilities and adaptive capacities of farming communities in Assam amid changing climatic conditions.

Climate Change Trends in Assam:

Assam has been experiencing notable shifts in climate patterns over the past few decades, posing serious concerns for its agrarian economy and ecological balance. The state has witnessed a gradual increase in average temperatures, altered rainfall patterns, and more frequent extreme weather events, all of which directly impact agricultural livelihoods.

Temperature trends indicate a steady rise in both maximum and minimum temperatures. Studies suggest that Assam has recorded an increase of about 0.01°C to 0.03°C per year over the last century, with more significant warming trends observed in recent decades. This warming is leading to heat stress on crops, changes in crop growing seasons, and increased pest infestations.

Rainfall patterns have become increasingly erratic. While the overall annual rainfall may not have drastically decreased, its distribution has changed significantly. There are more instances of high-intensity rainfall in shorter durations, often followed by dry spells. This has disrupted sowing and harvesting cycles and reduced groundwater recharge. According to the Indian Network for Climate Change Assessment (INCCA), Assam has experienced a noticeable shift in monsoon onset and withdrawal dates, leading to an overall reduction in the length of the growing period (*INCCA Report, 2010*).

Flood frequency and severity have intensified. The Brahmaputra and its tributaries overflow almost annually, but recent years have seen multiple waves of floods within a single monsoon season. These floods are not only caused by excessive rainfall but are also exacerbated by glacial melt and deforestation in the upstream Himalayan regions.

Moreover, the state is increasingly vulnerable to drought-like conditions in the post-monsoon months. This dual risk of flood and drought within a single agricultural cycle threatens food security and rural livelihoods.

These changing climatic trends have made traditional farming practices less reliable, urging the need for climate-resilient agriculture and community-based adaptation mechanisms. Understanding these trends is crucial for developing region-specific strategies to mitigate and adapt to climate change impacts in Assam.

Impacts on Agricultural Livelihoods:

Climate change has had a profound impact on agricultural livelihoods in Assam, primarily through its effects on crop yield, income stability, and employment opportunities. Increasingly unpredictable rainfall, frequent floods, and rising temperatures have disrupted sowing and harvesting cycles, reduced agricultural productivity, and damaged vital rural infrastructure. These climatic stressors have led to growing livelihood insecurity among small and marginal farmers who depend heavily on rain-fed agriculture.

Livestock and fisheries, important supplementary sources of rural income, have also suffered due to climate-related water quality issues and fodder shortages. The shift in agro-climatic conditions has forced farmers to either abandon traditional crops or adopt risky alternatives. As a result, household food security is under threat, and seasonal migration for work has increased. These impacts have compounded existing rural poverty, emphasizing the urgent

need for climate-resilient strategies and policy interventions to protect and sustain agricultural livelihoods in the region.

Crop Yield and Productivity-

Crop yield and overall agricultural productivity in Assam have been significantly affected by climate change. Major food crops, especially rice—the state's staple—have seen noticeable reductions in yield due to altered rainfall patterns, increased frequency of floods, and rising temperatures. Traditional sowing and harvesting calendars have become unreliable, as early or delayed monsoons disrupt the kharif cropping season.

Floods often submerge fields at critical stages of crop growth, causing partial or total crop failure. Prolonged water logging in low-lying areas results in delayed replanting and soil nutrient loss, as a result further depressing yields. Additionally, erratic weather has contributed to the rise in pests and diseases, which small farmers often lack resources to combat effectively.

Mustard, jute, and pulses have also seen declining productivity, with shortened growing periods and poor flowering rates due to temperature stress. According to a study by the North Eastern Space Applications Centre (NESAC), the average yield of rice in flood-affected districts dropped by nearly 20% over the past decade (NESAC, 2018).

These yield losses directly affect household food availability and marketable surplus, putting smallholders at financial risk. With few alternative income sources and limited access to extension services or crop insurance, the declining productivity remains a critical challenge for Assam's rural farming communities.

Income and Employment-

Climate-induced disruptions in agriculture have led to declining incomes and irregular employment opportunities for rural households in Assam. For small and marginal farmers, who make up the majority of cultivators, income is highly dependent on successful crop cycles. However, erratic monsoons and frequent floods increasingly result in partial or complete crop loss, leading to reduced seasonal earnings.

As agricultural output declines, labor demand in rural areas has also diminished. Daily wage laborers, especially those engaged in land preparation, weeding, and harvesting, face reduced workdays and lower wages. Women, who traditionally supplement household income through farm labor or livestock care, are particularly affected by shrinking employment opportunities.

Non-farm employment in rural Assam remains limited, pushing many to seek seasonal or long-term migration to urban areas for unskilled labor. This migration often results in fragmented households and further weakens the social safety net.

Government schemes like MGNREGA offer some support, but inconsistent implementation and wage delays limit their effectiveness. A study by the Centre for Northeast Studies (2020) found that nearly 45% of households in flood-prone areas reported a sharp decline in annual agricultural income over the last five years (Centre for Northeast Studies, 2020).

These income shocks and employment insecurities exacerbate poverty, limit educational investment, and create long-term development challenges for rural communities.

Socio-economic Vulnerabilities-

Socio-economic vulnerabilities significantly shape the degree to which communities in Assam experience and respond to climate change impacts. Small and marginal farmers, who possess limited landholdings and financial resources, are disproportionately affected by climate variability. Their dependence on rain-fed agriculture, coupled with inadequate access to irrigation, credit, and insurance, makes them highly susceptible to climate-induced crop failures.

Women, particularly those heading households, face additional barriers due to limited ownership of land, lower literacy rates, and restricted mobility. Their voices are often excluded from decision-making processes related to agriculture or disaster preparedness, further marginalizing their adaptive capacities.

Indigenous communities and those residing in remote, flood-prone areas often lack basic infrastructure, such as embankments, storage facilities, and road connectivity. This isolation hinders timely evacuation during disasters and reduces access to markets, healthcare, and extension services.

Caste and class disparities also influence how resources are distributed during relief operations, with marginalized groups frequently receiving inadequate support. Limited awareness about climate-resilient farming practices and technological interventions further deepens these vulnerabilities.

In such a context, socio-economic disadvantages intersect with environmental risks, leading to chronic livelihood insecurity and poverty. Addressing these vulnerabilities requires a multi-dimensional approach that includes policy reform, capacity-building, and community-level empowerment for effective climate adaptation.

1. Adaptation and Coping Strategies:

Farmers in Assam have developed a range of adaptation and coping strategies in response to the growing impacts of climate change. These include both traditional knowledge systems and emerging community-based and institutional approaches. Adaptation strategies range from shifting crop calendars and using flood-resistant crop varieties to diversifying income sources through livestock and small businesses. Communities also build raised storage structures and adopt integrated farming systems to mitigate risk.

Collective efforts such as disaster preparedness training, community seed banks, and water-sharing systems further strengthen resilience. These locally grounded practices, supported by evolving policy frameworks, demonstrate the potential for sustainable adaptation when traditional knowledge, community participation, and institutional support are effectively integrated (*Taru Leading Edge, 2019*).

• Traditional Practices-

Traditional agricultural practices in Assam reflect generations of local knowledge adapted to the region's unique agro-climatic conditions. Farmers have historically cultivated flood-resilient rice varieties like "bao" rice, which can grow in standing water and withstand long submergence periods. These indigenous seeds require minimal inputs and have strong resistance to pests and diseases.

Contour farming and bamboo-based irrigation systems in hill regions help reduce soil erosion and manage water effectively. Seasonal migration of livestock to elevated areas during floods is another coping mechanism

practiced by many rural households. Farmers also construct elevated granaries (bhorals) to store food grains safely during monsoons.

Traditional weather forecasting, based on natural indicators such as bird behavior or cloud patterns, continues to guide farming decisions in remote areas. Crop diversification—such as growing mustard, pulses, or vegetables in winter—ensures food security when monsoon crops fail.

However, many of these practices are at risk of being lost due to modernization, lack of documentation, and generational shifts. Reviving and integrating traditional knowledge with modern techniques can create robust, context-specific adaptation systems. The preservation of such practices is essential for long-term sustainability and resilience against climate-induced risks (*ICIMOD, 2017*).

- **Community-Based Approaches-**

Community-based adaptation strategies have gained traction in Assam as effective responses to localized climate challenges. These approaches emphasize participation, local ownership, and collective action, enhancing both social cohesion and resilience. Villages often organize community seed banks that store and exchange climate-resilient indigenous seeds, ensuring timely sowing even after disasters.

Farmer producer groups and self-help groups play a crucial role in spreading awareness about sustainable practices and facilitating access to inputs like organic fertilizers and improved tools. In flood-prone areas, communities have developed elevated farming techniques and floating vegetable gardens, allowing cultivation even during submergence.

Local youth clubs and women's groups are also engaged in disseminating early warning systems and participating in mock drills for disaster preparedness. Community-managed irrigation systems and water harvesting structures reduce dependency on erratic monsoons.

These initiatives often draw upon both traditional knowledge and external support from NGOs or research institutions. What makes them effective is the emphasis on context-specific solutions that are low-cost and scalable.

Moreover, these approaches foster inclusive participation, especially of women and marginalized groups, ensuring that adaptation planning is equitable. Community-driven initiatives thus provide a critical foundation for building long-term resilience in the face of increasing climatic threats in rural Assam.

- **Institutional and Policy Support-**

Institutional and policy support plays a pivotal role in enabling climate adaptation among farming communities in Assam. Government schemes such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) aim to expand irrigation infrastructure, reducing reliance on erratic rainfall. The State Action Plan on Climate Change (SAPCC) for Assam also outlines targeted interventions in climate-resilient agriculture, afforestation, and water resource management.

Research institutions like Assam Agricultural University are promoting climate-smart agriculture through training and the dissemination of improved crop varieties. NGOs and international agencies partner with local governments to implement pilot projects focused on sustainable livelihoods and natural resource management.

Insurance programs such as the Pradhan Mantri Fasal Bima Yojana (PMFBY) provide risk coverage for crop loss, although challenges remain in awareness, accessibility, and claim processing. Extension services are expanding through Krishi Vigyan Kendras (KVKs), offering training on climate-resilient practices.

However, coordination gaps, limited outreach in remote areas, and bureaucratic inefficiencies reduce the effectiveness of these initiatives. There is a need for stronger institutional mechanisms that integrate local voices into policy design and ensure timely delivery of benefits.

Strengthening these frameworks can bridge the gap between policy intent and ground realities, enabling scalable, inclusive, and sustainable climate adaptation strategies in Assam (TERI, 2021).

Discussion;

The study highlights the growing vulnerability of agricultural livelihoods in Assam to climate change and underlines the urgent need for holistic adaptation strategies. Climate variability in the form of erratic rainfall, frequent floods, rising temperatures, and shortened cropping seasons has significantly altered the agrarian landscape. These changes have disrupted traditional farming practices, reduced productivity, and led to unstable income streams, especially for small and marginal farmers. The research reinforces the observation that climate change does not act in isolation but interacts with existing socio-economic disparities to deepen rural poverty and inequality.

It was found that traditional knowledge and coping strategies still hold immense value. Practices such as the use of flood-resistant rice varieties, elevated granaries, and seasonal crop diversification remain relevant and effective. However, these are gradually being overshadowed by modern technologies that are not always accessible or appropriate for all farmers, particularly in remote or under-resourced areas. The decline in use of traditional practices also reflects a disconnect between generations and a loss of locally-adapted agricultural wisdom.

Community-based approaches have shown great promise in strengthening local resilience. Collective action, such as community seed banks, disaster preparedness initiatives, and cooperative water management, fosters shared responsibility and supports adaptive capacity. Women's participation and local governance structures have been identified as key enablers of these initiatives, yet these are often under-supported by formal institutions.

Institutional support mechanisms, though expanding, still fall short in addressing on-the-ground challenges. While schemes like crop insurance and climate-resilient agriculture programs exist, they are often limited by poor implementation, lack of awareness, and inadequate infrastructure. Policies remain top-down and sometimes disconnected from local realities.

Therefore, adaptive strategies must be inclusive, locally contextualized, and supported by robust institutional mechanisms. A greater emphasis on participatory planning, capacity building, and integration of traditional knowledge with scientific inputs is essential to strengthen the resilience of agricultural livelihoods in Assam. This approach not only ensures sustainability but also promotes community empowerment and ownership of adaptation processes.

Findings and Analysis:

The findings of the study reveal a clear and adverse impact of climate change on agricultural livelihoods in Assam. Quantitative data from household surveys showed a consistent pattern of declining crop yields, particularly

in rice and mustard, attributed to irregular rainfall, increased flooding, and higher temperatures. About 68% of surveyed farmers reported yield losses over the past five years, with many attributing the damage to frequent submergence and delayed sowing periods.

Socio-economic analysis identified that small and marginal farmers were the most vulnerable, with limited financial resources to invest in adaptive technologies or recover from crop failures. Women-headed households, in particular, experienced compounded challenges due to restricted access to credit, land, and decision-making spaces. The qualitative data highlighted the importance of traditional knowledge and local practices, yet their usage was declining due to a lack of institutional support and awareness among the younger generation.

Community-based adaptation practices were found to be effective but underutilized. Groups that engaged in shared seed banks, elevated farming techniques, and disaster preparedness measures demonstrated better coping capacity. However, such initiatives were mostly seen in areas with active NGO involvement or strong local leadership.

On the institutional side, policies and schemes intended to support climate adaptation were in place but poorly implemented. Many farmers were unaware of government programs or found them difficult to access. Insurance schemes suffered from delayed payments, and extension services were either unavailable or insufficiently tailored to local needs.

The analysis indicates that while the impacts of climate change are widespread, the adaptive responses are fragmented. Strengthening local capacities, promoting equitable resource distribution, and ensuring more responsive governance are essential for addressing the growing threat to agricultural livelihoods in Assam.

Conclusion:

This study has demonstrated that climate change is a critical challenge to agricultural livelihoods in Assam, threatening both food security and rural economic stability. The increasing frequency of floods, erratic rainfall, and rising temperatures have already disrupted farming systems, reduced yields, and eroded the resilience of smallholder communities. These effects are more pronounced among marginalized groups, particularly small and marginal farmers, women, and indigenous populations.

Despite these challenges, the research also highlights the presence of effective adaptation practices rooted in both traditional knowledge and emerging community initiatives. However, these strategies remain fragmented and often unsupported by formal institutions. While policies and programs exist at the state and national levels to support climate-resilient agriculture, implementation gaps and poor outreach continue to limit their impact on the ground. The findings underscore the need for a more integrated, inclusive, and locally relevant approach to climate adaptation. Promoting traditional practices alongside modern techniques, ensuring equitable access to resources and support, and empowering communities through participatory planning and governance are key steps forward. Ultimately, sustainable agricultural livelihoods in Assam depend on collective action involving farmers, local institutions, civil society, and government agencies. A community-centric, climate-aware development strategy is

crucial for building long-term resilience and advancing the Sustainable Development Goals in vulnerable rural regions.

Recommendations-

1. **Promote Climate-Resilient Farming:** Introduce and scale up the use of flood-resistant and short-duration crop varieties through localized research and farmer training programs.
2. **Strengthen Traditional Knowledge Systems:** Document and integrate indigenous farming practices into mainstream agricultural extension services to preserve context-specific adaptation strategies.
3. **Enhance Community Engagement:** Support community-based adaptation initiatives such as seed banks, elevated farming, and cooperative water management through financial and technical assistance.
4. **Improve Access to Institutional Support:** Streamline access to crop insurance, credit, and government schemes by simplifying procedures, increasing outreach, and building trust among rural populations.
5. **Focus on Vulnerable Groups:** Prioritize the needs of women, smallholder farmers, and indigenous communities by ensuring their inclusion in decision-making and providing targeted capacity-building.
6. **Strengthen Extension Services:** Expand and equip Krishi Vigyan Kendras and local agricultural centers to provide timely, relevant, and location-specific climate advisories and training.
7. **Promote Diversification:** Encourage income diversification through livestock, fisheries, and non-farm employment to reduce dependence on climate-sensitive crops.
8. **Integrate Climate Planning into Development:** Ensure that climate adaptation is embedded within broader rural development plans to align policy, infrastructure, and funding with local needs.

Relevance to Sustainable Development Goals (SDGs)-

The findings of this study are directly aligned with several key Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 13 (Climate Action), and SDG 15 (Life on Land). By addressing the effects of climate change on agricultural livelihoods, the research contributes to poverty reduction through sustainable income generation and improved resilience among smallholder farmers.

SDG 2 is targeted through the promotion of food security by advocating for climate-resilient crop varieties and integrated farming practices that can withstand environmental shocks. Moreover, the community-based approaches and traditional knowledge systems discussed here emphasize inclusive and sustainable agricultural practices, advancing SDG 15.

SDG 13 is central to the study, which explores both the impacts of climate change and the adaptive responses needed at the grassroots level. The research underscores the importance of localized climate action and emphasizes capacity-building for vulnerable populations. Finally, the participatory and inclusive framework suggested aligns with the overarching vision of the SDGs—ensuring that no one is left behind. By strengthening institutional frameworks, promoting equity, and encouraging community engagement, the study illustrates a pathway for integrating sustainable development with practical climate resilience in Assam's rural regions.

References:

- Das, R. (2021). *Climate Variability and Agriculture in Northeast India*. Indian Journal of Agricultural Sciences.
- Goswami, B., Saikia, P., & Deka, J. (2018). *Flood Patterns and Agriculture in Assam*. Environmental Research Journal.
- Centre for Northeast Studies. (2020). *Impact of Floods on Agriculture and Livelihoods in Assam*. Guwahati: C-NES.
- ICIMOD. (2017). *Harnessing traditional knowledge for climate resilience in the Eastern Himalayas*. International Centre for Integrated Mountain Development.
- NESAC. (2018). *Assessment of agricultural vulnerability in Assam*. North Eastern Space Applications Centre.
- TERI. (2021). *Climate Resilience in Agriculture: Strengthening Adaptive Capacity in Assam*. The Energy and Resources Institute.
- Taru Leading Edge. (2019). *Community-Based Adaptation in the Brahmaputra Basin*. New Delhi: Taru.
- Assam Agricultural University. (2020). *Annual Report 2019–2020*. Jorhat: AAU.
- Government of Assam. (2021). *State Action Plan on Climate Change (Revised)*. Guwahati. India Meteorological Department. (2022). *Climate Profile of Assam*. New Delhi: IMD.
- Ministry of Agriculture & Farmers Welfare. (2020). *Statistical Handbook*. New Delhi: Government of India.
- FAO. (2021). *Climate-smart agriculture sourcebook*. Rome: Food and Agriculture Organization.
- World Bank. (2020). *South Asia Climate Change Strategy*. Washington, D.C.: World Bank Group.
- UNDP India. (2021). *Enhancing climate resilience in vulnerable communities*. New Delhi.
- National Bank for Agriculture and Rural Development. (2020). *Climate Resilient Agriculture in India*. Mumbai: NABARD.
- Choudhury, B. U., & Das, A. (2020). Climate change and agriculture in Northeast India: Adaptation strategies. *Current Science*, 118(2), 245–251.
- Saikia, D. (2019). Coping with floods: Agricultural adaptation in Assam. *Economic and Political Weekly*, 54(41), 62–68.
- Das, P. J., & Barua, P. (2021). Community-led resilience: Case studies from flood-prone Assam. *Disaster Studies Quarterly*, 12(3), 88–103.