Assessing the Effectiveness of Climate-Resilient Rice Varieties in Building Adaptive Capacity for Small-Scale Farming Communities in Assam

ABSTRACT:

Rice crop in Assam constitutes a significant portion of the cultivated area, covering around sixty percent of the total area. The state, like many others, confronts the repercussions of climate change, notably evident in recurrent floods that impact agricultural lands. The shifting climate, marked by rising temperatures and increased rainy days, poses threats to crop production. Despite witnessing overall productivity growth, the state grapples with persistent challenges related to flood-induced losses. In response to this, climate-resilient rice varieties were developed to withstand submergence. This study delves into the assessment of the impact of these climate-resilient rice varieties on yield, income, and adoption among farmers. Concentrating on Golaghat and Sivasagar districts, where 106 farmers were interviewed, the research addresses the prevalent challenges in rice cultivation due to changing rainfall patterns. The introduced varieties underwent demonstration in plots, and their effects on yield, income, and adoption were comprehensively evaluated. The study additionally scrutinized the technology and extension gaps in the area, utilizing various indices such as the technology gap, extension gap, technology index, and benefit-cost ratio to measure the efficacy of the introduced varieties. The findings of the study highlight disparities between recommended agricultural practices and the actual methods employed by farmers. Despite these challenges, the introduction of climate-resilient varieties resulted in a noteworthy increase in yield. Economic analysis revealed enhanced profitability from B:C ratio of 0.43 to1.06 and positive changes in economic indicators. The adoption and horizontal spread of these varieties were substantial, with a significant rise from 106 to 378 in the number of adopters and expanded cultivation areas. Overall, the study emphasizes the success of climate-resilient rice varieties in augmenting yield, income, and adoption among farmers. The positive economic changes, coupled with heightened awareness, underscore the importance of promoting such varieties. The study advocates for sustained efforts in disseminating climate-resilient varieties, emphasizing their pivotal role in enhancing farmers' climate resilience. Addressing the identified discrepancies in agricultural practices emerges as a crucial step toward fostering sustainability and optimizing crop yield in the region.

Keywords: Assam, Rice, Climate Change, Adaptation

1. INTRODUCTION:

Rice is a staple for Assam, the crop has been a major produce for many years now. It is the most cultivated and occupies about 60 percent of the total area under cultivation. Approximately 2.35 million hectares of the 4.16 million hectares cultivated in Assam are occupied by this crop during 2021-22 [1]. Assam like many other states has also been affected by the changes in climate, the state has endured the severe impact of floods over the years. In 2022 alone, approximately 2.46 lakh hectares of land were affected, impacting a total of 33 districts, and resulting from three flashes of floods [2]. These flood events significantly affect farmers cultivating paddy, highlighting the ongoing challenges faced by the agricultural community in the region.Northeast India has witnessed a gradual rise in temperature and an increase in the number of rainy days in recent years [3]. The changing climate poses a significant risk to farmers who rely on crop production [4], [5]. Studies conducted in Assam have focused on exploring farmers' strategies to mitigate flood risk [6], [7], [8] and understanding their vulnerability to floods [9]. Various studies have documented coping and adaptation strategies employed by households affected by floods in the Brahmaputra plains, it is noteworthy that this study is criticized for lacking methodological rigor. Despite the struggles that the farmers have faced, the state has seen a rise in overall productivity, with many high-yielding varieties being introduced over the years. However, each year due to floods a great amount of the total production is destroyed. In 2018, two rice varieties Ranjit Sub 1 and Bahadur Sub 1 were developed atRegional Agricultural Research Station, Titabar, Assam Agricultural University with submergence tolerant traits, especially for the flood-affected farmers.

In the initial years of international climate change studies, the predominant focus was on mitigation efforts and understanding the impacts of climate change [10]. However, in more recent times, adaptation has gained increased attention. A growing recognition is emerging, conceptualizing climate change as a mainstream issue. This perspective suggests that vulnerabilities and adaptation strategies are intricately connected to the development of poverty reduction strategies [11]. The evolving discourse underscores the importance of integrating adaptation measures[12], [13], [14] into broader development initiatives, emphasizing the need for a holistic approach to address the multifaceted challenges posed by climate change. Similarly, to alleviate climate-adverse impacts, the Resilience project was set up in the districts of Sivasagar and Golaghat. The project implemented climate-resilient rice varieties in the region, analyzing the value of the crops and the losses experienced by farmers because of climate change. Ranjit Sub-1 and Bahadur Sub-1 varieties were introduced which are long-duration high-yielding varieties and can withstand complete submergence for 10-12 days. The idea was to enable the farmers to prepare for any changes to the crop season without affecting the cropping pattern. The present study is based on the changes in yield as an introduction of the new high-yielding climate-resilient varieties and the effects on the annual income of the farmers in the project area. The study also reveals the technology gap and the extension gap in the area.

2. MATERIALS AND METHODS

The study was carried out in the climate-affected districts of Golaghat and Sivasagar in Assam where 106 farmers were interviewed. The area grows paddy as the most important crop; its crop season in the areas has been highly affected by the changes in the rainfall pattern, and the introduced varieties are a way to mitigate those problems. Before conducting demonstrations under the project, a list of farmers was prepared from group meetings and training and improved seeds were provided to the selected farmers.

In demonstration plots,Yielding varieties of Ranjit Sub-1, Bahadur Sub-1 procured from the Regional Agricultural Research Station, Titabar were sown nursery and transplanted in raised beds using balanced fertilization and timely application of weedicide and pesticides. The locally grown varieties were taken as a local check and the yield gap was calculated. The demonstrated trials were regularly monitored, and necessary data related to all necessary traits of the new varieties were collected. In addition to this, data on traditional practices followed by the farmers were also collected. The gap, extension gap, and technology index were worked out as per the formula suggested by N.K. Singh et al., [15]. are given below:

Technology gap = Potential yield (P1) - Demonstration yield (D1)

Extension gap = Demonstration yield (D1) - Farmers yield (F1)

Technology Index $= \frac{(PI - DI)}{PI} X100$

Benefit-Cost Ratio (BCR)

$$= \frac{\text{Total cash benefit}}{\text{Total expenditu re}}$$

However, data about the adoption and horizontal spread of technologies were collected from the farmers through personal interviews. Data were subjected to suitable statistical methods. The following formulae were used to assess the impact on different parameters of rice crops [16].Impact on Yield (% increase over control) =

$$\frac{\text{Yield of Demonstrated Plot}}{\text{Yield of Control Plot}} \text{ X 100}$$

$$\text{Impact on Adoption (\% Change)} =$$

$$\frac{(\text{No of Adopters after Demo} - \text{No of Adopters before Demo})}{\text{No of Adopters before Demonstration}} X\ 100$$

$$\text{Impact on Horizontal Spread (\% Change)} =$$

$$\frac{\text{After area (ha)} - \text{Before area (ha)}}{\text{Before area (ha)}} X\ 100$$

3. RESULTS AND DISCUSSION:

The study of the data highlighted in Table 1 shows notable disparities between the recommended or enhanced agricultural practices and the methods employed by farmers across various facets of crop cultivation. Firstly, the selection of crop variety presents a complete gap, as farmers opt for local varieties instead of the recommended Ranjit Sub-1& Bahadur Sub - 1. Soil testing, a crucial component for informed farming, is conspicuously absent among farmers, signifying a full deviation from this recommended practice. Although the seed rate does not strictly adhere to the suggested 37-40 kg/ha, there is a partial gap as farmers utilize 50 kg/ha. Seed treatment, a vital measure for disease prevention, is completely overlooked, contributing to yet another full gap. While the transplanting method is partially adopted through normal transplanting practices, there remains room for improvement, resulting in a partial gap. Transplanting time and fertilizer dose also display partial gaps, with farmers deviating slightly from the recommended timelines and neglecting fertilizer application. Notably, weed management practices present a complete gap, as farmers prefer hand weeding over the recommended paddy weeder. Numerous studies, [17], [18], [19], conducted over the years on diverse crops consistently reveal a persistent gap in adoption among farmers. This recurring pattern suggests that addressing the identified discrepancies has the potential to significantly enhance agricultural practices, ultimately fostering optimal crop yield and promoting sustainability. The recognition of this ongoing gap underscores the importance of targeted interventions and initiatives to bridge the divide between recommended agricultural practices and the actual implementation by farmers, thereby contributing to a more sustainable and productive agricultural landscape.

Table 2 compares key agricultural parameters between the baseline year (2018-20) and the demonstration year (2022-23) for a sample of 106 farmers. Examining the technology gap, which represents the difference between potential and achieved yields, reveals a positive trend. In the baseline year, the achieved yield by the farmers i.e., before intervention stood at 33.98 quintals per hectare, reflecting the potential for improvement in agricultural practices. However, in the demonstration year, the production noticeably increased to 46.66 quintals per hectare. This reduction in the technology gap suggests a positive impact, potentially driven by the adoption of new technologies.

The extension gap, denoting the disparity between the attained yield and the potential yield attributed to extension efforts, stands at 12.68 quintals per hectare. This metric emphasizes the specific impact of extension activities in influencing the variance between the actual and potential yields. The technology index, indicating the percentage of the technology gap closed by extension efforts, witnessed an increase from 43.37% in the baseline year to 22.23% in the demonstration year. This suggests an improvement in the efficiency of extension efforts. Overall, these findings suggest positive outcomes from interventions, showcasing advancements in technology adoption and extension activities to optimize agricultural practices. Several findings show that with the extension services provided the extension gaps get reduced [20], [21].

To assess the economic viability of the demonstrated agricultural practices compared to conventional methods, key economic indicators such as the cost of cultivation, net return, and the benefit-cost ratio (B:C ratio) were examined. Notably, during the baseline year (2018-19), farmers sold their produce at an average rate of Rs. 1500 per quintal, and this increased to Rs. 1800 per quintal in the demonstration year (2022-23).

Table 3 provides a comprehensive analysis of critical economic metrics for rice cultivation, drawing a comparison between the baseline and demonstration years under both demonstrated and local control practices. A significant rise in yield from 33.98 quintals per hectare in the baseline year to 46.66 quintals per hectare in the demonstration year underscores the positive impact of the demonstrated agricultural practices on crop productivity. Considering the cost of cultivation, there is an increase from Rs. 35,713 per hectare in 2018-19 to Rs. 38,570 per hectare in 2022-23 under the demonstrated practices. This upward trend indicates potential investments in enhanced cultivation methods, potentially contributing to the observed increase in yield. Gross returns exhibit a noteworthy surge from Rs. 50,970 per hectare in the baseline year to Rs. 79,322 per hectare in the demonstration year. The B:C ratio improved significantly from 0.43:1 in 2018-19 to 1.06:1 in 2022-23, indicating the enhanced profitability associated with both the extension services and the adopted crop variety.

The findings suggest that the demonstrated agricultural practices not only led to a substantial increase in yield but also contributed to improved economic viability, as evidenced by higher gross returns and a more favorable benefit-cost ratio. These results underscore the economic advantages associated with the implementation of demonstrated practices in rice farming, emphasizing the profitability of the extension services and the selected crop variety.

Table.1: Level of use and gap in adoption of rice technologies in study area

Crop operation	Improved package of practices	Farmers practices	Gap
Variety	Ranjit sub-1	Local variety	Full gap
Soil testing	Have done in all location	Not in practice	Full gap
Seed rate	37-40 kg/ha	50kg/ha	Partial gap
Seed treatment	Seed was treated with Captan @ 2.5g/kg seed	Not in practice	Full gap
Transplanting method	Normal transplanting	Normal transplanting	Partial gap
Transplanting time	July	July/August	Partial gap
Fertilizer dose	Fertilizer @ 132 kg/bigha Urea, 125 kg/bigha SSP, 66 kg/bigha MOP	Nil/without recommendation	Full gap
Weed management	Use of paddy weeder	Hand weeding/Rarely used	Full gap

Table.2 : Productivity, technology gap, extension gap and technology index in rice in study area

Year	No. of farmers	Grain yield(q/ha)		Technology gap(q/ha)	Extension gap(q/ha)	Technology index (%)
		Potential	Yield Achieved			
2018-20(Baseline year)	106	60	33.98	26.02	12.68	43.37
2022-23(Demonstration year)	106	60	46.66	13.34		22.23

Table 4 provides valuable insights into the impact of introducing a new climate-resilient rice variety on the adoption of rice production technology. In the demonstration, 106 farmers participated, and post-demonstration, there was a significant upswing, with the number of adopters increasing to 378. This reflects a noteworthy addition of 272 adopters within the same locality.

The impact of this introduction, expressed as a percentage change, is notably high at 256.61 percent. This remarkable figure suggests a robust positive influence, indicating a substantial surge in the adoption of rice production technology linked to the introduction of the climate-resilient variety. The considerable increase in the number of adopters underscores the success and effectiveness of the demonstration in motivating farmers to embrace innovative rice production technologies, particularly those aligned with climate resilience.

Table.3. Cost of cultivation (Rs/ha).net return (Rs/ha) and benefit cost ratio of rice as affected by demonstration and local practices control

Yield(q/ha)		Cost of Cultivation(Rs/ha)	Gross Return(Rs/ha)		Benefits-Cost ratio (B:C Ratio)	
2018-19	2019-20		2018-19	2019-20	2018-19	2019-20
33.98	44.93	35713.21	25734	55772	0.54	1.34

Table.4. Impact of Introduction of new varieties on adoption of technology in study area

Variety	No of Adopter before Demonstration	No of Adopter After Demonstration	Change in No. of Adopter	Impact(% Change)
Climate Resilient Variety	106	378	272	256.61

Table.5. Impact of Introduction of new varieties on horizontal spread of rice area in study area

Variety	**Area before Demonstration(ha)**	**Area After Demonstration**	**Change in Area(ha)**	**Impact(% Change)**
Climate Resilient Variety	133	351.54	218.54	164.32

Table 5 presents a detailed analysis of the impact resulting from the introduction of a new climate-resilient rice variety on the horizontal spread of rice hybrid cultivation. Before the demonstration, the specified variety covered an area of 133 hectares. Following the demonstration, there was a notable and positive change, with the covered area experiencing a substantial increase to 351.54 hectares. This signifies a significant change of 218.54 hectares, highlighting the considerable expansion in the cultivation area of the climate-resilient rice variety within the same locality.

The impact of this introduction, expressed as a percentage change, stands at a noteworthy 164.32%. This percentage change reflects a substantial positive influence, indicating a considerable surge in the horizontal spread of rice hybrid cultivation associated with the introduction of the climate-resilient variety. The increase in the covered area underscores the success and effectiveness of the demonstration initiative in encouraging broader adoption of innovative rice varieties, particularly those specifically designed to withstand and thrive in varying climatic conditions.

The data from Table 5 portrays a tangible and positive outcome of the demonstration, showcasing the successful horizontal spread of the introduced climate-resilient rice variety. This expansion indicates a growing acceptance and adoption of more resilient and innovative agricultural practices within the local farming community, aligning with the intended goals of the demonstration initiative.

4. CONCLUSION:

The study has yielded compelling results, demonstrating a substantial increase in the yield of selected Paddy varieties in comparison to local varieties. Additionally, there has been a notable and rapid horizontal spread of these selected varieties. Alongside these agricultural advancements, positive changes have been observed in economic factors. This collective evidence underscores the potential for enhancing climate resilience among farmers through the widespread distribution and promotion of climate-resilient varieties, supported by effective demonstrations and training programs.

The positive changes in economic factors suggest that the adoption of climate-resilient varieties not only contributes to improved agricultural productivity but also holds economic benefits for farmers. The study indicates a growing awareness among farmers regarding climate-resilient varieties, driven by their superior performance compared to local varieties. In conclusion, the findings strongly support the notion that climate-resilient varieties play a significant role in building the climate resilience of farmers. The success observed in terms of increased yields, horizontal spread, and positive economic changes emphasizes the need for continued efforts in promoting and disseminating such varieties, accompanied by awareness campaigns and training initiatives. This holistic approach can contribute significantly to building a more resilient agricultural system in the face of climate challenges.

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