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Impact of rice-based cropping sequence at adopted village under NICRA-TDC in Nalbari district of Assam

[1]Dhyan Jyoti Bora, [2]M Neog, [3]Nilotpal Das, [4]AC Sarma, [5]Homeswar Mazumdar, [6]Ankur Rajbongshi and [7]BK Baishya

[1]SRF, KVK, Nalbari, Assam, India

[2]Director of Extension Education, AAU, Jorhat, Assam, India

[3-7]SMS, KVK, Nalbari, Assam, India

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Corresponding Author: Dhyan Jyoti Bora

Abstract

The present study examines the economic performance of rice-based cropping sequences in a NICRA (National Innovations on Climate Resilient Agriculture) adopted village of Nalbari district, Assam. Climate variability and change have increasingly disrupted traditional agricultural practices in the region, posing serious challenges to crop productivity, food security, and farm livelihoods. To address these challenges, NICRA promotes climate-resilient agricultural interventions, including improved cropping sequences tailored to local agro-climatic conditions. This study assesses the economic viability and sustainability of selected rice-based cropping systems under changing climatic conditions, with the objective of identifying profitable and resilient cropping sequences that can enhance farm income and contribute to long-term agricultural sustainability.

Keywords: Rice-based cropping sequence, NICRA, Climate-resilient agriculture

Introduction

Agriculture in Assam is predominantly centered around rice cultivation, which forms the backbone of the state's agrarian economy. As the primary food crop, rice sustains the livelihoods of a large portion of the population, particularly smallholder farmers. However, the reliance on a traditional rice mono-cropping system—where rice is grown year after year on the same land—has led to significant agronomic and economic challenges. These include declining soil fertility, increased vulnerability to pests and diseases and heightened exposure to the impacts of climate change. Erratic rainfall, rising temperatures and frequent occurrences of floods and droughts further disrupt farming practices, threaten crop yields, and jeopardize the livelihoods of many farmers in the region (Baruah *et al.*, 2020; Verma *et al.*, 2016) [2, 14]. Given these challenges, there is an urgent need to explore alternative cropping systems that not only improve agricultural productivity but also enhance economic resilience and adaptability to climate fluctuations.

To address these challenges, the Indian Council of Agricultural Research (ICAR) launched the National Innovations on Climate Resilient Agriculture (NICRA) initiative. This program aims to promote climate-resilient agricultural practices across India, with a focus on enhancing farmers' capacity to adapt to the impacts of climate change while improving productivity and sustainability.

NICRA employs a comprehensive strategy to promote climate-smart agriculture, focusing on practices such as using drought-resistant crop varieties, adopting water-saving irrigation methods and diversifying cropping patterns. A core element of this approach is the promotion of rice-based cropping sequences—integrated planting systems that combine rice with additional crops (Bhuiyan *et al.*, 2017) [3]. Among the major recommendations is the diversification of cropping systems by pairing rice with pulses, oilseeds, and other complementary crops. This integrated approach is considered beneficial for improving soil fertility, enhancing resource efficiency, and generating higher economic returns compared to conventional monocropping systems (Das *et al.*, 2018) [5].

The Nalbari district of Assam, characterized by its largely agricultural economy and vulnerability to climatic fluctuations, provides an important context for examining the effectiveness of rice-based cropping sequences within the NICRA framework. Historically, farmers in this area have depended on rice monocropping, a practice that has become less viable over time due to falling yields and reduced profitability. Introducing diversified cropping sequences—where multiple crops are cultivated either in rotation or alongside one another on the same land—offers a promising alternative. Such systems can help improve soil fertility, lower the incidence of pests and diseases, and enhance overall farm income (Hazarika and Bora, 2019) [8].

Crop diversification has been widely studied and promoted as an effective strategy for improving agricultural sustainability and profitability. Numerous studies have highlighted the advantages of integrating pulses, oilseeds, and other crops with rice-based systems. For example, Hazarika and Bora (2019) [8] reported that diversified cropping sequences not only enhance overall productivity but also increase farm income by generating multiple revenue streams. Similarly, Sharma *et al*. (2017) [12] emphasized that diversified cropping systems play a vital role in maintaining soil fertility, reducing reliance on chemical fertilizers, and minimizing risks associated with market fluctuations and climate variability.

Among various diversification options, the inclusion of toria (*Brassica campestris* L.) in rice-based sequences has gained particular importance. Toria—an early-maturing oilseed crop—fits well into the rice fallow period and offers several agronomic and ecological benefits. Its cultivation improves soil fertility, supports better nutrient cycling, and aids in pest and disease management, making the rice-toria sequence a promising approach for enhancing agricultural productivity, profitability, and resilience to climate variability.

Despite the well-recognized benefits of crop diversification, there remains a scarcity of empirical research evaluating the economic performance of rice-based cropping sequences in NICRA-adopted villages. This study seeks to address this gap by conducting a comprehensive economic analysis of various rice-based cropping patterns in a NICRA-adopted village in the Nalbari district. By examining key economic indicators—including cost of cultivation, gross returns, net returns, and benefit-cost ratios—the research aims to generate actionable insights for policymakers, researchers, and farmers.

The relevance of this study extends beyond the immediate context of Nalbari district, offering lessons applicable to other regions facing comparable agronomic and economic challenges. By demonstrating the potential economic advantages of diversified cropping sequences, the findings can encourage policymakers to promote sustainable agricultural practices that enhance climate resilience. Additionally, the results can support researchers and extension personnel in designing targeted interventions and recommendations for farmers, ultimately contributing to improved agricultural productivity, income stability, and long-term resilience in the region.

Materials and Methods

The present study aimed to assess the costs and returns associated with rice-based farming systems adopted by farmers in the NICRA village of Nadala in the Nalbari district of Assam. Under the project, the beneficiary farmers cultivated the rice variety *Ranjit Sub-1*, followed by the toria variety *TS-38*. For the study, 25 beneficiaries of the NICRA project and an additional 25 randomly selected villagers practicing sole rice cropping were included. Thus, a total of 50 households were selected for the collection of relevant data and information pertaining to rice-based cropping systems.

To assess the economic viability of NICRA-promoted rice-based cropping sequences, this study employed a multi-pronged data collection approach. A purposive sampling technique was used to identify villagers actively participating in NICRA interventions in the Nalbari district. From this group, a random sample of farmers adopting rice-based cropping sequences was selected for detailed investigation. Primary data were collected through structured field surveys designed to capture information on the specific cropping sequences practiced, land allocation patterns, production costs for each crop, average yields under local conditions, and prevailing market prices for harvested produce (Dillman, 2007) [6].

In addition to the primary data, secondary information from NICRA project reports, government agricultural statistics, and relevant academic literature was incorporated to strengthen the analysis. The data were analyzed using descriptive statistics to outline the economic landscape, cost-benefit analysis to assess the profitability of each cropping sequence, and comparative analysis to evaluate NICRA-promoted sequences against traditional practices. Rigorous data management procedures were followed to maintain confidentiality and ensure the obscurity of all respondents.

The sample households were stratified into three size categories based on their operational farm holdings. Since only a few farmers possessed more than 3 hectares of land, the stratification was carried out as follows:

Category I: Less than 1 ha

Category II: Between 1 - 2 ha

Category III: Above 2 ha

Table 1: Distribution of Sample Households According to Farm-Size Stratification

Sl. No	Distribution of Sample Households According to Farm-Size Stratification							
	Cropping sequence		No. of respondents/group			Total	System duration (Days)	No. of households under different farming systems
	Kharif	Rabi	I	II	III			
1	Rice	Fallow	12	10	3	25	150	62.16
2	Rice	Toria	10	13	2	25	240	37.84
Total			22	23	5	50		

Different cost concepts were employed to estimate the expenses associated with the rice-based cropping system using the data collected. To analyze the returns from these cropping sequences, various measures of farm income were calculated, including net returns and benefit-cost ratios. Additionally, Relative Economic Efficiency (REE) was computed to determine the percentage change in net returns of different cropping sequences compared to the existing cropping pattern, thereby providing a comparative assessment of their economic performance.

Cost concept: The various cost components considered in the analysis were as follows:

- **Variable cost:** These included labour, seed, machinery, fertilizer, insecticide, herbicide, irrigation costs, interest on working capital, and other miscellaneous cost.
- **Fixed cost:** These included interest on fixed capital, land revenue and other taxes, rental value of owned land, and depreciation on farm implements and farm buildings.

Cost A1= It included Total Variable Cost + Depreciation on farm implements + Land revenue

Cost A2 = Cost A1+ Rent paid for leased in land
Cost B = Cost A2+ interest on value of owned fixed capital (excluding land) + imputed rental value of owned land
Cost C = Cost B + imputed value of family labour

Return analysis

To evaluate the economic performance of the rice-based cropping systems, the study incorporated the following components of farm income."
Gross income (GI) = Quantity of total product X price of main product)
Farm business income = GI - Cost A1
Family labour income = GI - Cost B
Net income = GI- Cost C
Farm investment income = Farm business income -imputed value of family labour
Net return over variable cost = Gross income- total variable cost
Benefit-Cost Ratio: Gross farm Income/Total cost

Relative Economic Efficiency (REE)

The relative economic efficiency (REE) of the system was computed and the resulting values were expressed in percentage terms (Samanta T.K, 2015) [10].
REE% = (B− A)/A × 100 Where, A = Net return of existing system & B = Net return of diversified cropping system.
The economics were computed based on the prevailing market prices during the crop season.
To ensure both reliability and validity, rigorous procedures were applied in data collection and analysis, following methodological standards used in similar agricultural economics research. (Singh and Sharma, 2017) [13]

Results and Discussion

The economic analysis of the Rice-Toria (*Brassica campestris* L.) cropping sequence compared with sole rice cultivation in NICRA (National Innovations on Climate Resilient Agriculture)-adopted villages of Nalbari district, Assam, provides valuable insights into their relative economic performance. The study, based on detailed field data, revealed that the Rice-Toria sequence generated substantially higher average net returns per hectare compared to sole rice cultivation. Farmers adopting the Rice-Toria sequence earned an average net return of Rs. 75,843.13 per hectare, whereas those practicing sole rice cultivation earned Rs. 30,547.61 per hectare.
Table 2 presents the per-hectare cost structure of the rice-based farming systems under study. The total cost of cultivation for the rice-fallow and rice-toria systems amounted to Rs. 50,720.68 and Rs. 62,899.71 per hectare, respectively. In both systems, hired and family labor constituted the largest share of total production costs, highlighting the labor-intensive nature of these cropping practices.

Table 2: Cost of Rice-toria farming system adopted (Rs/ha)

Particulars	Farming systems	
	Rice- fallow	Rice- Toria
Seed	1312.50	2531.25
Manures, fertilizers, plant protection chemicals	6780.42	7910.84
Labour cost (hired)	7710.34	11312.62
Other cost (including oil & machinery charge)	3590.16	4675.25
Interest on working capital	2500	3200
Total Variable Cost(TVC)	21893.42	29629.96
Imputed value of family labour	9870.17	13454.25
Depreciation on farm implements & farm buildings	1642.10	1755.42
Land revenue	92.24	98.75
Rental value of owned land	13550.25	13875.75
Interest on fixed capital	3672.50	4085.58
Total Fixed Capital(TFC)	28827.26	33269.75
Total cost (TVC+TFC)	50720.68	62899.71
Cost A_1	23627.76	31484.13
Cost A_2	23627.76	31484.13
Cost B	40850.51	49445.46
Cost C	50720.68	62899.71

The analysis of cost components revealed that the variable costs incurred under the rice-fallow (Rs. 21,893.42) and rice-toria (Rs. 29629.96) cropping sequences were lower than the corresponding total fixed costs. The absence of leased-in or leased-out land was evident from the equality of Cost A1 and Cost A2 in both cropping sequences. Accordingly, the values of Cost A1 and Cost A2 were estimated at Rs. 23,627.76 for the rice-fallow system and Rs. 31,484.13 for the rice-toria system. Furthermore, Cost B amounted to Rs. 40,850.51 and Rs. 49445.46 for rice-fallow and rice-toria, respectively, while the corresponding Cost C values were Rs. 50,720.68 and Rs. 62,899.71.

Table 3: Farm income of Rice-Toria farming system

Particulars	Farming System	
	Rice-fallow	Rice-Toria
Gross farm income (GI)	81268.29	138742.84
Net farm income	30547.61	75843.13
Family labour income	40417.78	89297.38
Farm business income	57640.53	107258.71
Farm investment income	47770.36	93804.46
Net returns over variable cost	59374.87	109112.88
Benefit-Cost ratio	1.60	2.20
REE(%)	-	148.27

The returns over cost for the different cropping sequences are presented in Table 3. The return analysis indicated that net returns were higher under the rice-toria cropping sequence compared to rice-fallow, owing to the inclusion of a high-value crop such as toria, which contributed to higher net income. Similarly, gross returns were substantially greater in the rice-toria system (Rs. 1,38,742.84) than in sole rice cultivation (Rs. 81,268.29). The results further revealed that the rice-toria cropping sequence achieved a higher benefit-cost ratio (2.20) in comparison to the rice-fallow system (1.60), indicating superior economic efficiency.

Paired *t*-test analysis demonstrated a statistically significant difference ($p < 0.05$) in mean net returns between the Rice-Toria cropping sequence and sole rice cultivation, indicating a clear economic advantage of the diversified system. The inclusion of toria enhanced overall system profitability, underscoring the role of crop diversification in improving farm income. Qualitative evidence derived from structured farmer interviews further corroborated these findings, revealing greater resilience of the Rice-Toria sequence to climatic variability. In particular, under conditions of excessive rainfall, toria cultivation acted as an effective risk-buffering component, thereby reducing production uncertainty and enhancing system stability.

The findings of the study underscore the superior economic returns and resilience-enhancing potential of the Rice-Toria cropping sequence compared to sole rice cultivation in NICRA-adopted villages of Nalbari district. Crop diversification through the integration of toria not only augments farm income and strengthens rural livelihoods but also reduces the inherent risks associated with mono-cropping systems (Singh and Sharma, 2017) [13]. Furthermore, the rotational advantages of toria cultivation—such as improvements in soil fertility, disruption of pest and disease cycles, and better resource use efficiency—play a crucial role in enhancing overall profitability and ensuring the long-term sustainability of the production system.

A comparative assessment of cropping systems revealed that the Rice-Toria sequence outperformed sole rice cultivation in terms of economic returns, thereby underscoring the significance of crop diversification for enhancing farm profitability and agricultural resilience. The findings corroborate earlier studies by Sharma *et al*. (2019) [11], which documented the agronomic and economic advantages of integrating oilseed crops into rice-based cropping systems. Importantly, the benefits of adopting the Rice-Toria sequence extend beyond economic gains, encompassing broader socio-economic dimensions such as improved food security, generation of on-farm employment, and enhanced environmental sustainability through diversified production practices.

Furthermore, the adoption of the rice-toria cropping sequence is consistent with the objectives of the National Innovations in Climate Resilient Agriculture (NICRA) programme, which emphasizes the development of climate-resilient farming systems. The incorporation of crop diversification through this sequence reduces farmers' exposure to climate-induced stresses such as droughts, floods, and pest and disease outbreaks, thereby enhancing the resilience and stability of the agricultural production system.

Conclusion

This study elucidates the economic performance of rice-based cropping sequences in NICRA (National Innovations on Climate Resilient Agriculture)-adopted villages of Nalbari district, Assam. The results, derived from systematic data collection and rigorous comparative analysis, indicate that crop diversification significantly enhances farm profitability. In particular, the inclusion of toria (*Brassica campestris* L.) in rice-based systems was found to generate higher economic returns compared to sole rice cultivation, underscoring the economic viability of diversified cropping systems in the region.

The study reveals that cropping sequences incorporating toria cultivation, particularly the Rice-Toria system, yield significantly higher average net returns per hectare compared to sole rice cropping. The enhanced profitability of the Rice-Toria sequence is further supported by its relatively lower input costs, underscoring its economic efficiency. These findings emphasize the role of diversified cropping systems in improving farm income while reducing vulnerability to risks inherent in mono-cropping practices.

Moreover, the adoption of rice-based diversified cropping sequences is consistent with the objectives of the National Innovations on Climate Resilient Agriculture (NICRA) programme, which advocates climate-resilient and resource-efficient agricultural practices. The integration of toria into rice-dominated systems strengthens farmers' adaptive capacity to climate variability and contributes to improved livelihood security. Additionally, the rotational benefits associated with toria cultivation—such as enhancement of soil fertility and suppression of pests and diseases—support the long-term sustainability of agricultural production systems in the study region.

The findings of this study have important implications for agricultural policy and practice in Assam and similar agro-ecological regions. The promotion of crop diversification and the adoption of climate-resilient agricultural practices can strengthen the resilience of farming systems, enhance food security, and sustain rural livelihoods under increasing climate variability and change. These insights provide a strong rationale for policymakers and development stakeholders to support diversified, resource-efficient and climate-adaptive cropping systems as a pathway toward sustainable agricultural development.

Future research should prioritize a comprehensive assessment of the environmental impacts of diversified cropping sequences, with particular emphasis on soil health, biodiversity, and ecosystem services. Additionally, further studies are needed to explore innovative agronomic and management strategies that can enhance both the economic viability and ecological sustainability of agricultural systems in the region.

Conflicts of Interest

The authors have no conflicts of interest.

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References

1. Agricultural Census of India. Nalbari district profile: Agricultural statistics and indicators. 2018.
2. Baruah S, Sharma S, Saikia J. Climate change and agriculture in Assam: Challenges and opportunities. Agric Res J. 2020;57(2):123-132.
3. Bhuiyan MIH, Islam MJ, Khan BM, Sattar MA. An economic analysis of rice-based cropping patterns in some selected areas of Bangladesh. J Bangladesh Agric Univ. 2017;15(2):205-212.
4. Bryman A. Social research methods. 5th ed. Oxford: Oxford University Press; 2016.
5. Das A, Roy A, Bhattacharyya R. Enhancing resilience of agriculture through crop diversification: A study in eastern India. J Agron Crop Sci. 2018;204(4):341-352.
6. Dillman DA. How to write a survey questionnaire. Thousand Oaks, CA: SAGE Publications; 2007.
7. Government of India. National innovations on climate resilient agriculture (NICRA): Progress report. 2020.
8. Hazarika P, Bora P. Economic analysis of crop diversification in Assam. Indian J Agric Econ. 2019;74(3):317-332.
9. Indian Council of Agricultural Research (ICAR). National innovations on climate resilient agriculture (NICRA). ICAR Annual Report. 2015.
10. Samanta TK. System productivity, profitability, sustainability, and soil health as influenced by rice-based cropping systems under mid-central table land zone of Odisha. Int J Agric Sci. 2015;7(11):975-9107.
11. Sharma A, *et al*. Agronomic and economic evaluation of rice-based cropping systems in Assam. J Sustain Agric. 2019;67(3):215-230.
12. Sharma R, Singh S, Verma R. Crop diversification for sustainable agriculture in India. Sustain Agric Rev. 2017;22:45-67.
13. Singh R, Sharma P. Profitability and sustainability of rice-based cropping systems. Agric Res J. 2017;54(4):567-580.
14. Verma M, Baruah K, Das P. Impact of changing climate on agriculture of Assam, India. Int J Agric Sci Res. 2016;6(6):181-188.