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Impact of promising climate-resilient technologies under rainfed condition: A case study from NICRA Village of Mahasamund District, Chhattisgarh

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Abstract

Climate change has emerged as a critical threat to rainfed agriculture, particularly in regions characterized by high climatic variability. To enhance climate resilience among small and marginal farmers, the National Innovations in Climate Resilient Agriculture (NICRA) project introduced several climate-resilient technologies. This study evaluates the impact of three promising Climate Resilient Technologies viz. drought-tolerant paddy variety (Vikram TCR), heat-tolerant mustard (DRMR-150-35) and sesame in field bund in NICRA village Paraswani, Mahasamund district under rainfed farming system typology. Results demonstrated significant improvements in productivity, net returns, and resilience percentages under CRTs compared to farmers' traditional practices. It was found that drought-tolerant paddy provided 86.18% resilience improvement, while heat-tolerant mustard increased resilience by 56.17%. Sesame bund farming demonstrated exceptional profitability with a benefit-cost ratio of 3.04. The study concludes that CRTs under NICRA significantly enhanced yield stability and economic resilience in under rainfed farming systems, offering substantial potential for scaling across similar agro-ecological regions.

Keywords: NICRA, climate-resilient technologies, paddy, mustard, sesame, bund farming, drought tolerance, resilience, rainfed agriculture

1. Introduction

Climate change represents one of the most pressing challenges to global agriculture, with particularly acute impacts on developing nations like India where agriculture remains the backbone of rural economies and food security (IPCC, 2023)^[3]. The Intergovernmental Panel on Climate Change (IPCC) has documented unprecedented changes in precipitation patterns, temperature extremes, and increased frequency of weather variability events. In India, these manifestations are evident through irregular monsoon onset, prolonged dry spells, erratic rainfall distribution, extreme heat waves, and increasing inter-annual variability in agricultural productivity. According to recent assessments, Indian agriculture faces multiple climate stressors: delayed onset of monsoon, mid-season droughts, frequent flooding, rising average temperatures, and shifting pest and disease dynamics (Chary *et al.*, 2016)^[8]. These changes directly threaten crop productivity, farmer incomes, and rural livelihoods across the country. Rainfed agriculture, which encompasses approximately 55% of India's net cultivated area and supports about 40% of agricultural production, remains particularly vulnerable to climate variability (Chary *et al.*, 2016)^[8]. Unlike irrigated agriculture, rainfed systems depend almost entirely on monsoon rainfall, provide limited opportunities for crop diversification, and often occur in marginal areas with degraded soils and limited access to modern agricultural technologies. In regions like Mahasamund district of Chhattisgarh, rainfed agriculture faces compounded challenges: High climatic variability (Irregular rainfall with extreme drought and flood events), Agronomic constraints (Predominantly acidic, low-fertility soils with limited nutrient-holding capacity), Socioeconomic barriers (Predominantly small and marginal landholdings with limited capital for technology adoption), Limited infrastructure (Minimal irrigation facilities, poor market access, and weak extension networks) and Biodiversity pressure

(Increased pest and disease incidence under stressed conditions). These combined factors place rainfed farmers among the most vulnerable to climate shocks, necessitating targeted interventions to build adaptive capacity.

In recognition of these challenges, the Indian Council of Agricultural Research (ICAR) launched the National Innovations in Climate Resilient Agriculture (NICRA) project in 2011 (Manju *et al.*, 2024, NICRA, 2018. NICRA operates as a multi-institutional, multi-disciplinary network project implemented across 151 climatically vulnerable districts in India, with the overarching goal of enhancing the resilience of Indian agriculture to climate change through strategic research and technology demonstration (Ministry of Agriculture & Farmers Welfare, 2024. NICRA's approach explicitly recognizes that climate adaptation strategies must be context-specific, farm-household specific, and tailored to local agro-ecological and socioeconomic conditions.

The present study was undertaken with the following objectives: 1) To assess the impact of three promising CRTs (drought-tolerant paddy, heat-tolerant mustard, and sesame bund farming) on crop productivity in Mahasamund district, 2) To evaluate the economic viability and benefit-cost ratios of these technologies, 3) To quantify resilience improvements and risk reduction benefits under CRT adoption, 4) To generate evidence to inform farmer decisions and policy recommendations for scaling CRTs in similar agro-ecological zones

2. Materials and Methods

2.1 Study Area Description

The study was conducted in NICRA adopted village Paraswani in Mahasamund district by Krishi Vigyan Kendra, Mahasamund Chhattisgarh state, India during the year 2023-2024. The study area characterized by annual rainfall 1250-1350 mm, concentrated during southwest monsoon (June-September), Mean maximum temperature: 41-43°C (April-May) and Mean minimum temperature: 12-15°C (December-January) and Relative humidity: 45-55% (annual average).

2.2 Technology Interventions

Three climate-resilient technologies under crop production module were implemented and evaluated under rainfed farming system:

2.2.1 Drought-Tolerant Paddy (Vikram TCR) in kharif

The Vikram TCR paddy variety is a high-yielding, semi-dwarf, and early-maturing mutant developed through collaboration between the Bhabha Atomic Research Centre (BARC) and Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur specifically for its drought tolerance and reduced water consumption (Amandeep Gahlawat, 2022) ^[9]. 'Vikram' name has been given to this mutant variety in the honour of late Dr. Vikram Sarabhai (Ex-Chairman, Atomic Energy Commission) in his birth centenary year 2019-20. It takes 120-125 days to maturity gives average potential yield 55-60 q/ha (IGKV, 2025).

2.2.2 Heat-Tolerant Mustard (DRMR-150-35)

Heat-Tolerant Mustard (Brassica Juncea L.) variety DRMR-150-35 was released in year 2020 by ICAR- Indian Institute of Rapeseed Mustard Research, Bharatpur (Rajasthan). It is suitable for early sown rainfed condition and recommended for zone V (Bihar, Jharkhand, West Bengal, Orissa, Assam, Chhattisgarh and Manipur). It is early maturity, tolerant to

powdery mildew and A. Blight with average potential seed yield is 18.28 q/ha and requires 114 days for maturity (ICAR-IIRMR, 2024).

2.2.3 Sesame as Bund Farming

In Chhattisgarh paddy is the main crop in kharif season, which is grown in banded field. Some portion of land remains unused due to portion of land waist in bunding of field for paddy cultivation. To utilize the land occupied by bunds, oilseed crop sesame was introduced for cultivation in field bunds of paddy crop for utilization of land and additional income from fallow land under bunds.

2.3 Comparison Groups (Farmers' Traditional Practices)

For comparative assessment, data were simultaneously collected from farmers practicing traditional/conventional approaches for each crop:

- **Paddy:** Local susceptible varieties (typically older-generation rice cultivars common in the region)
- **Mustard:** Late-sown, susceptible varieties or linseed in some holdings (mustard cultivation often marginal)

2.4 Data Collection and Parameters

Crop productivity data (yield), economic parameters (cost of production, gross return, net return, B: C ratio) and Resilience assessment was estimated. Resilience metric was calculated as:

$$\text{CRT Impact Resilience (\%)} = \left[\frac{\text{CRT Productivity} - \text{Farmers' Traditional Practice Productivity}}{\text{Farmers' Traditional Practice Productivity}} \right] \times 100$$

This metric quantifies the percentage improvement in yield stability and productivity under CRT adoption compared to traditional approaches. It reflects the technology's contribution to reducing climate-related yield variability.

2.5 Sample Size and Study Design

- **Paddy:** 12 farmer-managed field trials (6 using Vikram TCR, 6 using local varieties)
- **Mustard:** 12 farmer-managed trials (6 using DRMR-150-35, 6 using traditional/susceptible varieties)
- **Sesame:** 12 farmer-managed trials (All bund farming)

3. Results and Discussion

3.1 Impact of Climate-Resilient Technology: Drought tolerant paddy Vikram TCR

Vikram TCR demonstrated substantial productivity advantages over farmers' traditional paddy varieties (Table 1), with yield increases of 656 kg/ha (16% higher productivity). This productivity improvement translated into proportionally higher net returns (₹16,586/ha advantage, representing 19% greater profitability) despite marginally higher production costs reflecting improved agronomic practices. The resilience metric of 86.18% indicates that Vikram TCR provided substantial insurance against yield loss under sub-optimal moisture conditions. This reflects the drought tolerance mechanisms bred into the variety superior root development, osmotic adjustment, and maintained grain-filling capacity under water stress (Sharma *et al.*, 2022a) ^[10]. The benefit-cost ratio of 3.36 for Vikram TCR compares favorably with the ratio of 3.17 for traditional varieties, indicating higher economic returns per rupee invested, crucial for small-holder farmers with limited capital.

Table 1: Impact of Drought-Tolerant Paddy (Vikram TCR) in FST-1

Parameter	NICRA (Vikram TCR)	Farmers' Practice	Difference	Resilience (%)
Productivity (kg/ha)	4748	4092	+656	86.18
Net Returns (₹/ha)	103438	86852	+16586	-
Benefit-Cost Ratio	3.36	3.17	+0.19	-
Cost of Production (₹/kg)	21.75	21.24	+0.51	-

3.2 Impact of Climate-Resilient Technology: Heat tolerant mustard DRMR-150-35

Mustard variety DRMR-150-35 exhibited dramatic productivity advantages (Table 2), with seed yield increases of 320 kg/ha (78% higher than farmers' traditional/susceptible mustard varieties). This substantial yield premium reflects the heat tolerance mechanisms—early maturity escaping terminal heat stress, thermo-tolerant reproductive processes, and maintained seed development—built into the variety through systematic breeding (Sharma *et al.*, 2022a). Net returns increased by ₹15,405/ha (137% higher returns), a particularly significant impact for small-holder farmers given mustard's role as a high-

value cash crop. The benefit-cost ratio increased from 2.17 to 2.58, indicating improved economic efficiency. The resilience value of 56.17% reflects moderate protection against yield loss; lower than for paddy because mustard's traditional cultivation already incorporates some adaptive responses to heat stress (e.g., late sowing). Nevertheless, the substantial absolute yield and income improvements confirm DRMR-150-35's significant value for FST-1 farmers. Higher cost of production (₹36.50/kg vs. ₹27.38/kg) reflects improved agronomic management, quality seed, and timely input application rather than inherently higher input requirements, representing justified investment yielding strong returns.

Table 2: Impact of Heat-Tolerant Mustard (DRMR-150-35) in FST-1

Parameter	NICRA (DRMR-150-35)	Farmers' Practice	Difference	Resilience (%)
Productivity (kg/ha)	730	410	+320	56.17
Net Returns (₹/ha)	26648	11243	+15405	-
Benefit-Cost Ratio	2.58	2.17	+0.41	-
Cost of Production (₹/kg)	36.50	27.38	+9.12	-

3.3 Impact of Climate-Resilient Technology: Sesame in bund Farming

Sesame in bund farming represents a new introduction method for utilization of land occupied by bunds in paddy field. Therefore, direct comparison with traditional cultivation is not possible. However, the productivity level (410 kg/ha) achieved through bund farming represents substantial income generation

(net returns of ₹37,995/ha) for previously non cultivated land (Table 3). The benefit-cost ratio of 3.04 demonstrates exceptional profitability, competitive with or exceeding other major crops in the region. Sesame cultivation through bund farming offers an attractive opportunity to utilize marginal or low-productivity land areas, generating significant additional income.

Table 3: Impact of Sesame cultivation as Bund Farming in in FST-1

Parameter	NICRA (Bund Farming)	Farmers' Practice	Difference	Status
Productivity (kg/ha)	410	--	--	New adoption
Net Returns (₹/ha)	37995	--	--	New adoption
Benefit-Cost Ratio	3.04	--	--	New adoption
Area cultivated (ha)	2.5	--	--	First-time growers

4. Conclusion

Climate-resilient technologies demonstrably enhanced productivity and resilience under three NICRA-promoted technologies (drought-tolerant paddy Vikram TCR, heat-tolerant mustard DRMR-150-35 and sesame in bund farming) substantially improved crop yields, net farm incomes and resilience metrics, confirming the efficacy of targeted climate adaptation technologies. All three technologies generated benefit-cost ratios exceeding 2.5, substantially above typical farmer adoption thresholds, providing strong economic incentive for uptake. The technology portfolio collectively addresses interconnected climate challenges (drought, heat, variable rainfall) through combined approaches, creating system-level resilience exceeding individual technologies.

References

1. Central Research Institute for Dryland Agriculture (CRIDA). Annual Report 2023-24: Climate-resilient agriculture research and dissemination. ICAR-CRIDA; 2024. Hyderabad.
2. Indira Gandhi Krishi Vishwavidyalaya (IGKV). Krishi Darshika. Directorate of Extension Services; 2025. Raipur.
3. IPCC. Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report. Cambridge University Press; 2023. <https://doi.org/10.1017/9781009157896>
4. Manju PS, Jayalekshmi G, Mohanraj M, Mohamed Aseemudheen M, Manobharathi K. National innovations in climate resilient agriculture (NICRA): The reservoir of resilience enhancement. *Int J Agric Ext Soc Dev*. 2024;7(2):340-346.
5. Ministry of Agriculture & Farmers Welfare. Promotion of Climate Resilient Farming. Policy Research Summary. Government of India; 2024. <https://prsindia.org/policy/report-summaries/promotion-of-climate-resilient-farming>
6. Ministry of Agriculture & Farmers Welfare. National Initiative on Climate Resilient Agriculture: Objectives and components. Government of India; 2025. <https://vajiramandravi.com/current-affairs/national-initiative-on-climate-resilient-agriculture/>
7. NICRA Brief. National Innovations in Climate Resilient

- Agriculture (NICRA). ICAR-CRIDA; 2018. Hyderabad.
8. Ravindra Chary G, Veerabhadra Rao V, Prabhakar M, Maruthi Sankar G. Agro-ecology specific strategies for resilient rainfed production systems. *Indian J Dryland Agric Res.* 2016;31(Suppl. 1):1-12.
 9. Gahlawat A. A Study of groundwater depletion and its impact on agriculture in Eastern Haryana. *Int J Geogr Geol Environ* 2022;4(1):141-144. DOI: 10.22271/27067483.2022.v4.i1b.99
 10. Sharma HK, Singh D, Kumar R, Verma RK. Climate resilient varieties and genetic stocks in Indian mustard and other oilseeds. *Indian J Plant Breed.* 2022;12(2):156-178.
 11. Sharma HK, Singh D, Kumar R. Terminal heat stress in Indian mustard: Impact on yield components and mitigation strategies. *Agron J.* 2022;114(3):1432-1448. <https://doi.org/10.1002/agj2.20967>