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Effect of Risks on Farmers' Adaptation to Climate Change: A Structured Field Experiment

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Abstract:

This study investigates the dynamic interplay between agriculture-related risks and climate change mitigation strategies in Riverbed and Rainfed regions. India, a pivotal global food producer, grapples with the challenging paradox of diminishing agricultural GDP amid a burgeoning population reliant on agriculture. The study scrutinizes whether disparities in agriculture-related variables, spanning seasonal crop cultivation, crop selection rationale, income sources, and farming expenses, between these regions are mirrored in the adoption of climate change mitigation strategies. The analysis reveals substantial variations between these regions across multiple dimensions, underscoring the need for region-specific interventions to address their distinct imperatives. In the realm of seasonal crop cultivation, Riverbed and Rainfed regions exhibit stark differences, signaling the imperative to tailor agricultural strategies to local conditions. Crop selection rationale diverges significantly, emphasizing the necessity for adaptive measures catering to the unique challenges faced by each region. Income sources display pronounced disparities, necessitating strategies that bolster income diversification and resilience. Additionally, farming expenses vary notably, advocating for targeted cost-effective solutions tailored to each region's needs. These findings allude to the importance of aligning policy decisions with the specific needs and vulnerabilities of Riverbed and Rainfed regions. Tailored support mechanisms can enhance agricultural resilience and ensure the livelihood security of the farming populace. The nuanced understanding of the intricacies of these regions can also inform region-specific climate-resilient farming practices. These insights ultimately safeguard the livelihoods and food security of farming communities in Riverbed and Rainfed regions.

***Key words**: Climate change, Mitigation strategies, Regional disparities, Small farmers, Agriculture Resilience.*

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1. Introduction

India stands as a prominent global food producer, with a staggering 68 percent of its 1.3 billion population directly or indirectly engaged in agriculture. However, the disconnection between the agricultural sector's contribution to the Gross Domestic Product (GDP) and the sheer number of households reliant on agriculture is stark. Over the years, India has witnessed a decline in its agricultural GDP, plummeting from 51 percent in 1950-51 to 18.8 percent in 2021-22, while the count of farming households has swelled from 70 million in

1950 to 120 million in 2021 (Economic Survey, 2021-2022). This paradox reveals the over-dependence on agriculture and a limited grasp of the profound impacts of climate change, which collectively endanger farmers' livelihoods, food security, and rural well-being. Notably, India, as an emerging economy, experiences an annual loss of USD 9 to USD 10 billion due to extreme weather events alone (Economic Survey, 2018). A study by the Indian Council of Agricultural Research (ICAR) has illuminated the concerning trend of States like Andhra Pradesh, Punjab, and Rajasthan, where agriculture now demands 30 percent more water due to heightened evaporative demand and accelerated crop maturity. This excessive water usage poses grave environmental risks, leading to salinity, nutrient pollution, and wetland degradation (Dhawan, 2017). Moreover, factors like erratic rainfall patterns and severe weather events can inflict significant harm on agriculture, with a 40 percent reduction in rainfall potentially causing a drastic income decline for 14 percent of farmers along the agricultural chain (Economic Survey, 2017-18).

As climate change takes its toll, it emerges as one of the most critical threats to human survival. However, individuals' perceptions of climate change risks vary widely (Metag J et al. 2015). In the Indian context, awareness of climate change remains moderate to low among farmers in Tamil Nadu. Additionally, many agricultural communities anticipate only irregular rainfall patterns, while knowledge about issues like acid rain, wind speed fluctuations, and heat and cold waves remains notably limited (Sangeetha S et al. 2021). Consequently, there is a pressing need to disseminate knowledge about climate change among small and marginal farmers. They must not only comprehend the costs but also the nature of climate change impacts (Safdar et al. 2014). Significantly, a palpable disconnect persists between policies, passive actions, scientific findings, future projections, and the present global state (Chowdhury, 2021). This disconnect could aggravate the challenges faced by developing economies. Therefore, to pave the path towards sustainability, there is an urgent requirement to establish a robust and holistic knowledge base that empowers decision-making. This entails categorizing and integrating the diverse information on farmers' adaptive actions (Datta P et al. 2022).

In the face of these challenges, the central research question emerges: Is there a relationship between agriculture-related risk and mitigation strategies adapted to combat climate change? As India grapples with the implications of climate change and the vulnerabilities of its agricultural sector, this question becomes increasingly pertinent. In this context, this paper endeavours to explore the mitigation strategies adopted by farmers to address the impacts of climate change and the risks inherent in farming. By bridging this knowledge gap, we aim to shed light on the strategies employed by farmers in adapting to the changing climate and the potential challenges they face in ensuring food security and livelihood sustainability.

2. Methods and materials

This study adopts a qualitative research approach, relying on data collected primarily through structured interviews with respondents. The research was conducted in the Madurai region, known for experiencing high temperatures, with a maximum of 42°C observed between March and September. Madurai district is comprised of seven taluks and thirteen blocks, and for this study, we specifically focused on Usilampatti taluk (riverbed) with the largest irrigated area, covering 8,140 hectares, and Thirumangalam taluk (rainfed) with the smallest irrigated area, spanning 2,649.7 hectares, as reported in

Block "G" Return in 2020. A total of 100 farming households were randomly selected from each of these chosen taluks (n = 200). These respondents were then interviewed to gather data related to the risks they face in their farming activities and the various factors influencing their decisions to adopt adaptive strategies. The information collected from the selected informants was subjected to analysis using a simple linear regression model, allowing us to explore and quantify the relationships between different variables and factors affecting the adoption of adaptive strategies in the context of Madurai's distinct agricultural regions.

3. Results and discussion

Table 1 presents a comparison of socio-economic drivers between two distinct groups of farmers, Rainfed and Riverbed, and highlights the percentage differences in various variables and their attributes. It is evident that a higher percentage of male farmers are engaged in both Rainfed (84 percent) and Riverbed (75 percent) farming. However, there is a noteworthy gender disparity, with Riverbed female farmers comprising a larger proportion (25 percent) compared to Rainfed female farmers (16 percent). This indicates that Riverbed farming may have a relatively higher participation of female farmers. Besides, Household head, also reveals some interesting disparities, whereas the majority of households are headed by males. However, the percentage difference in Riverbed farming is significantly smaller (4.2 percent) compared to Rainfed farming (80 percent), where there is a substantial difference favoring male household heads. This suggests that the Riverbed farming community has a more balanced gender distribution among household heads. In terms of farming experience, Rainfed farmers predominantly fall in the "7 to 11 years" category, while Riverbed farmers are relatively more experienced, with a significant percentage difference of 66.7 percent. This could imply that Riverbed farming attracts more experienced farmers, possibly due to its unique challenges or opportunities. The majority of Rainfed farmers have landholdings of less than 1 hectare, with a notable 80 percent difference compared to Riverbed farmers. Conversely, the "1 to 2 hectares" category shows a higher percentage of Riverbed farmers. This suggests that landholding patterns are significantly different between the two groups, with Rainfed farmers predominantly having smaller landholdings. The data highlights a striking percentage difference of 125.9 percent, indicating that the proportion of Marginal Farmers is considerably higher among Riverbed farmers, while Small Farmers are more prevalent in the Rainfed category. This could be indicative of varying economic conditions and resource access among the two groups.

Table 1: Socio-Economic Drivers of Riverbed and Rainfed Farmers

Variables and their attributes		Rainfed	Riverbed	Percentage difference
Gender	Male	84	75	11.3
	Female	16	25	43.9
Household head	Male	93	97	04.2
	Female	07	03	80.0
Farmers experience on farming	7 to 11	01	02	66.7
	≥ 12	99	98	01.0

Landholding details	< 1 ha	28	12	80.0
	1 to 2 ha	72	88	20.0
Type of farmer	Marginal Farmer	66	15	125.9
	Small farmer	34	85	85.7

Source: Estimated from field survey data
Sample Households (N) = 200 (Rainfed – 100; Riverbed – 100)

Table 2 provides a detailed comparison of the economic capital of Riverbed and Rainfed farmers, shedding light on various key variables and their attributes. Rainfed farmers predominantly cultivate Sorghum & Green gram (64 percent) as their seasonal crops, whereas Riverbed farmers exhibit a significantly different pattern, with a majority cultivating Paddy (68 percent). This suggests that crop preferences and choices differ markedly between the two groups. Additionally, the rationale behind crop selection varies, with the majority of Rainfed farmers (82 percent) choosing crops based on considerations of less maintenance, available technology, and resource availability, whereas Riverbed farmers (47 percent) seem to prioritize crops based on suitability for weather conditions, farm-specific attributes, and their potential use as livestock fodder. Rainfed farmers exhibit a more even distribution of income levels, with 60 percent of households falling in the "Rs. 13,161 – Rs. 19,758" category. In contrast, Riverbed farmers show a broader distribution, with a substantial percentage (33 percent) in the same income range. This suggests that Riverbed farmers may have more diverse income profiles. The data indicates that a significant proportion of Rainfed farmers (38 percent) incur costs in the "Rs. 7,887 – Rs. 13,160" range, while Riverbed farmers show a relatively even distribution of costs across different ranges. This highlights a notable variation in the cost structure of farming activities between the two groups. Differences are observed in crop cultivation choices, the rationale for crop selection, household income distribution, and farming costs. These variations may be influenced by factors such as geography, resource availability, and economic conditions specific to each farming category.

Table 2: Economic Capital of Riverbed and Rainfed Farmers

Variables and their attributes		**Rainfed**		**Riverbed**	
		Frequency	**Percent**	**Frequency**	**Percent**
Seasonal crop cultivation	Sorghum & Green gram	64	64.0	12	12.0
	Sorghum, Pigeon pea & Guar	24	24.0	20	20.0
	Paddy	12	12.0	68	68.0
Rationale on crop selection	Apt to weather, Farm conditions, Location specific & For livestock fodder	18	18.0	47	47.0
	Less maintenance, Available technology & Resource availability	82	82.0	53	53.0
Household	Rs. 7,887 – Rs. 13,160	22	22.0	05	05.0