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Adoption of institutional interventions for climate-resilient agriculture in drought-prone areas

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ABSTRACT

Farmers in drought-prone areas often face uncertainty in production because weather conditions vary from season to season. Institutional support can therefore be important for maintaining agricultural resilience. The study assessed farmers' adoption of institutional interventions related to Climate Resilient Agriculture (CRA) in NICRA and non-NICRA villages. An ex-post facto research design was adopted for the study. Nalgonda district of Telangana and Anantapur district of Andhra Pradesh were purposively selected because of their association with the National Innovations on Climate Resilient Agriculture (NICRA) programme. One mandal in each district was selected, followed by two NICRA and two non-NICRA villages in each mandal. Thirty farmers were randomly selected from every village, resulting in 240 respondents. Of the NICRA farmers, 60.83 per cent were high adopters and 39.17 per cent were medium adopters. All non-NICRA respondents (100.00%) were in the low-adoption category. The mean adoption score was 3.558 for NICRA farmers and 0.192 for non-NICRA farmers. The Z-value of 47.09 showed a significant difference between the two groups. The results show a clear association between NICRA exposure and farmers' reported adoption of the institutional interventions studied. The study design, however, does not allow the separate causal effect of individual interventions to be estimated.

Keywords: Climate resilient agriculture, Institutional interventions, NICRA, Adoption, Drought-prone areas

Introduction

Rainfed agriculture is affected by changing rainfall patterns, climatic variability and extreme weather events. Such changes may affect crop establishment, reduce the available sowing period and make farm livelihoods less stable. In agriculture, climate resilience refers to the ability of farming systems and rural communities to prepare for climatic stresses, cope with them, recover after disruptions and continue essential production and livelihood activities. The IPCC (2021) [1] has highlighted the growing importance of climate-related risks to agricultural systems, particularly in locations that are already vulnerable to climatic stress.

These concerns are particularly relevant to drought-prone areas of India, where agricultural performance is closely linked to the amount, timing and distribution of rainfall. Thus, improving resilience involves more than introducing individual technologies. Farmers also require timely machinery services, quality inputs, technical information, training, advisory support and appropriate institutional arrangements.

Against this background, the Indian Council of Agricultural Research started the National Innovations on Climate Resilient Agriculture (NICRA) programme in 2011, with ICAR-Central Research Institute for Dryland Agriculture (ICAR-CRIDA), Hyderabad, serving as a nodal institution. The programme focuses on developing and demonstrating climate-resilient technologies and on improving farmers' capacity to manage climatic risks. Its interventions cover natural resource management, climate-resilient crop production, livestock and fisheries management, and institutional mechanisms such as Custom Hiring Centres (CHCs), village seed banks, fodder banks, climate-risk management arrangements and extension activities (ICAR-CRIDA, 2016; Rao *et al.*, 2016) [2, 3]. Recent ICAR-CRIDA documentation also gives emphasis to strengthening CHCs and climate-resilient villages as mechanisms for improving adaptive capacity (ICAR-CRIDA, 2026a) [4].

Farmers' adoption decisions depend on the usefulness of a practice as well as on access to information, services, inputs and equipment. Evidence from India suggests that institutional arrangements, information and agro-meteorological advisories are associated with the uptake of climate-smart agricultural practices, although the influence differs among practices and locations (Bahinipati *et al.*, 2024) [5]. In Nalgonda district, Pabba *et al.* (2022) [6] reported medium to high adoption of climate-resilient agricultural technologies among NICRA farmers and identified information-seeking behaviour and weather-based advisories among the factors related to adoption.

Timely machinery access is particularly useful in drought-prone farming because delays in field operations can lead to missed sowing opportunities. CHCs provide an institutional route through which farmers can ob

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tain machinery without bearing the full cost of ownership. ICAR-CRIDA has identified CHCs as an important mechanism for facilitating timely farm operations in climate-vulnerable villages. Similarly, Kumar *et al.* (2024) [7] found that CHC services in Bihar improved machinery access and reduced labour requirements for farmers adopting climate-resilient practices.

Recent evidence from rainfed production systems also points to the role of institutional exposure. Naik *et al.* (2026) [8] reported higher adoption of climate-resilient technologies among intervention farmers than control farmers in rice-based systems of Odisha and emphasised institutional access and extension support. These observations provide a rationale for examining institutional interventions as a distinct component of climate-resilient agriculture.

The study was therefore undertaken to assess the adoption of institutional interventions among NICRA and non-NICRA farmers in drought-prone areas of Telangana and Andhra Pradesh.

Methodology

Sampling procedure

Locale of the study: Telangana and Andhra Pradesh were selected purposively, considering the investigators' familiarity with the local language, field conditions and feasibility of establishing rapport with respondents.

Selection of districts: Nalgonda district of Telangana and Anantapur district of Andhra Pradesh were purposively chosen because NICRA interventions and climate-resilient agricultural technologies were implemented in these areas.

Selection of mandals: One mandal was purposively selected from each district.

Selection of villages: Two NICRA villages and two non-NICRA villages were selected from each mandal. Thus, the study covered four NICRA villages and four non-NICRA villages.

Selection of respondents: Thirty farmers were randomly selected from each village. This resulted in 120 respondents from NICRA villages and 120 respondents from non-NICRA villages, making the total sample 240 farmers.

Data collection: Data were obtained through personal interviews with each selected respondent using a structured interview schedule.

Results and Discussion

Table 1 presents the respondents' distribution by adoption level of institutional interventions related to climate-resilient agriculture. In Anantapur, 63.30 per cent of NICRA farmers were classified as high adopters and 36.70 per cent as medium adopters; no respondent was placed in the low category. In Nalgonda, the corresponding figures were 58.30 per cent high adoption and 41.70 per cent medium adoption. Among non-NICRA farmers, all respondents in both districts (100.00%) were classified as low adopters.

When both districts were considered together, 60.83 per cent of NICRA farmers were high adopters and 39.17 per cent were medium

adopters. In comparison, all 120 non-NICRA farmers (100.00%) fell in the low-adoption category. The difference is consistent with the greater institutional exposure of NICRA farmers to demonstrations, training, technical guidance and project-supported services. Pabba *et al.* (2022) [6] similarly documented medium-to-high adoption of climate-resilient agricultural technologies among NICRA farmers in Nalgonda and identified information-seeking behaviour and weather-based agro-advisories as factors associated with adoption.

The results are also in line with Naik *et al.* (2026) [8], who reported higher adoption of climate-resilient technologies among intervention farmers than control farmers in a rainfed rice-based production system in Odisha. Their study highlighted institutional access, participatory processes and extension support. In the present investigation, the higher adoption observed among NICRA farmers may be related to their greater opportunities to use programme-supported facilities and interact with technical and extension personnel. Nevertheless, the present design does not permit estimation of the separate causal contribution of each institutional intervention.

The practical value of CHCs provides one possible explanation for the comparatively stronger use of institutional services. In rainfed drought-prone farming, operations such as land preparation and sowing often need to be completed within a narrow time window. Hiring machinery through a CHC can reduce the requirement for large investments in farm equipment and improve access during periods of high demand. Kumar *et al.* (2024) [7] reported that CHC services in Buxar district improved machinery access among small and marginal farmers, lowered labour requirements and supported climate-resilient practices. ICAR-CRIDA (2018) [9] has likewise documented the role of CHCs in facilitating timely farm operations in NICRA villages.

The presence of medium adoption among a sizeable share of NICRA respondents may reflect differences in the accessibility, relevance and perceived utility of particular institutional facilities. Machinery services can provide an immediate benefit, whereas the usefulness of village seed banks and fodder banks may depend on crop choice, preferred varieties, livestock ownership, availability of crop residues and seasonal needs. ICAR-CRIDA (2016) [2] documented the establishment of village seed and fodder banks under NICRA to improve access to these resources during periods of climatic stress.

The uniformly low adoption recorded among non-NICRA farmers suggests limited exposure to the institutional mechanisms assessed in this study. Differences may be associated with awareness of available facilities, frequency of farmer–scientist and farmer–extension contact, institutional linkages and physical access to services. Existing evidence indicates that institutional access, information and advisory support can affect climate-smart agriculture adoption, while the relative importance of individual institutional factors may vary across settings (Bahinipati *et al.*, 2024) [5]. Therefore, the observed difference should be interpreted as an association between programme exposure and adoption status rather than as evidence that NICRA participation alone produced the difference.

Table 1. Distribution of respondents according to their level of adoption of institutional interventions towards CRA

S. No.	Adoption level	Anantapur NICRA F (%)	Anantapur Non-NICRA F (%)	Nalgonda NICRA F (%)	Nalgonda Non-NICRA F (%)	Overall NICRA F (%)	Overall Non-NICRA F (%)
1	Low (0–1)	0 (0.00)	60 (100.00)	0 (0.00)	60 (100.00)	0 (0.00)	120 (100.00)
2	Medium (2–3)	22 (36.70)	0 (0.00)	25 (41.70)	0 (0.00)	47 (39.17)	0 (0.00)
3	High (4–5)	38 (63.30)	0 (0.00)	35 (58.30)	0 (0.00)	73 (60.83)	0 (0.00)

It could be observed from the Table 2, that there is a significant difference in the adoption level between NICRA and non-NICRA farmers in both Anantapur and Nalgonda districts. In Anantapur, NICRA farmers recorded a higher mean adoption score (3.617) compared with non-NICRA farmers (0.217), with a Z-value of 35.56. Similarly, in Nalgonda, NICRA farmers recorded a mean adoption score of 3.500, compared with 0.167 among non-NICRA farmers, with a Z-

value of 31.62. The mean adoption score was 3.558 for NICRA farmers and 0.192 for non-NICRA farmers. The Z-value of 47.09 showed a significant difference between the two groups. The higher adoption among NICRA farmers could be attributed to their greater exposure to climate-resilient technologies through demonstrations, training programmes, capacity building, technical guidance and regular interaction with scientists and extension personnel. Pabba *et al.* (2022) [6] re-

ported medium to high adoption of climate-resilient agricultural technologies among NICRA farmers in Nalgonda district and emphasized the role of extension exposure and access to technical information in promoting adoption. Similarly, Boda Mahesh Naik *et al.* (2023) [10] reported medium to high adoption of climate-resilient technologies among NICRA farmers in Telangana and found that factors such as

education, mass media exposure, economic motivation and innovativeness were positively associated with adoption. The present findings are therefore consistent with earlier studies and indicate the important role of NICRA interventions in enhancing farmers' adoption of climate-resilient agricultural practices.

Table 2. Comparison of Adoption Levels between NICRA and Non-NICRA Farmers in Anantapur and Nalgonda Districts

Variable	District	Farmers	Two Sample Z Test		
			Mean	Sample	Z Value
Adoption level	Anantapur	Anantapur NICRA	3.617	60	35.56
		Anantapur Non-NICRA	0.217	60	
	Nalgonda	Nalgonda NICRA	3.500	60	31.62
		Nalgonda Non-NICRA	0.167	60	
	Overall	NICRA	3.558	120	47.09
		Non-NICRA	0.192	120	

Conclusion

A clear difference was observed in the adoption of institutional interventions between NICRA and non-NICRA farmers. NICRA respondents were found in the medium and high categories, whereas all non-NICRA respondents were in the low category. The findings, considered alongside evidence from Telangana and other climate-vulnerable regions, point to the relevance of institutional access, technical guidance, demonstrations, advisory services and affordable mechanization in supporting farmers' responses to climatic risks.

Regular farmer–scientist contact, need-based training, easier access to CHCs and village-level facilities, and wider sharing of successful climate-resilient practices may help extend institutional support to more villages. Future research may examine each institutional intervention separately and use study designs that can distinguish programme effects from other factors affecting adoption.

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