

Factors Affecting the Farmer-To-Farmer Spread of Selected Climate Resilient Technologies

Boppana Jagadeeswari¹, Priyanka K², Saikiran Ch³, Balasubramani N⁴ and Sreelakshmi C⁵

ABSTRACT

Climate change has significantly altered the priorities of the agriculture research, experiencing the impacts of climate change, the focus of agriculture research has shifted from yield intensification to climate adaptation and mitigation through climate resilient agriculture. Effective adaptation to climate change requires efficient technology dissemination system. Understanding technology spread pathways, factors influencing spread of the technologies is very important for the efficient spread of climate resilient technologies. The present study was conducted to find out the factors affecting the farmer-to-farmer spread of climate resilient technologies in the state of Telangana. Ex-post facto research design was used. Khammam district was selected purposively. Enkoor mandal was selected purposively as the spread of climate resilient technologies is observed in the mandal. Two NICRA villages and two NON-NICRA villages were selected from the mandal randomly. 30 farmers were selected at random from each village to create a sample of 120 respondents. The relationship analysis between factors affecting farmer to farmer spread of climate resilient technologies regarding NICRA farmers out of 18 variables 9 variables namely farm size, annual income, irrigation, information seeking behaviour, extension contact, participation in extension activities and relative advantage, trialability and access to technology showed significant correlation at 1% and 5% level of probability with technology spread. Where as in Non-NICRA respondents out of 18 variables 2 variables namely irrigation, access to technology were positively correlated at 0.05 level of significance.

Keywords: NICRA, technology spread. Climate resilience, Access to technology

1. Consultant, MANAGE, Rajendranagar, Hyderabad
2. Consultant, MANAGE, Rajendranagar, Hyderabad
3. M.Sc. Scholar, Department of Extension Education, Rajendranagar, Hyderabad
4. Director (Climate Change and Adaptation – CCA), National Institute of Agricultural Extension Management (MANAGE), Hyderabad, India
5. Academic Associate, CCA, MANAGE, Hyderabad, India

Corresponding author: jagadeeswari317@gmail.com

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1. Introduction

Crops are vulnerable to extreme temperature events, changes in historical average temperatures, increased seasonal variability of precipitation, declining soil quality, and increasing pest and disease occurrences. Climatic uncertainties can significantly affect water availability and, consequently, agricultural productivity (Dhungana et al. 2020 and Xu et al. 2019)) and Rainfall and temperature are the most critical climate variables for agricultural production (Fahad et al. 2019 and Fahad et al. 2018). Loss of crop yields increases food prices, and also can have an absurd effect on agriculture welfare globally. Increasing crop resilience (ability to withstand these stressors) will be fundamentally important as it will reduce the farmers' vulnerability to crop loss and a country's ability to sustain its food security. "A rise in the average seasonal temperature can shorten the growing season for many crops, lowering their final yield. Warming will have an immediate impact on yields in locations where temperatures are already close to the physiological maximum for crops" (IPCC, 2007). The goal of climate resilient agriculture (CRA) is to increase long term farm incomes and productivity by sustainably utilizing the natural resources already available through crop and livestock production systems. Climate resilience can be enhanced by implementing short and long-term climate mitigation and adaptation strategies, as well as ensuring transparent and inclusive participation of multiple actors and stakeholders in decision-making and management processes. Practices like the use of improved seeds, rainwater harvesting, crop/livestock insurances, and ICT based agro advisories etc. can also help farmers to minimize the effect of climate change and variability (Mittal, 2012).

In order to minimize the detrimental effects of climate change on Indian Agriculture, Climate Resilient Agricultural (CRA) technologies were introduced and being promoted through ICAR- NICRA in the selected vulnerable districts across the country started on 2nd February 2011(Pabba et al. 2021). The NICRA project has substantially improved the income and employment levels of participating farmers compared to non-NICRA areas, highlighting its role in livelihood enhancement (Lenka et al. 2022). NICRA project in Telangana, empowered the rainfed farmers to adopt integrated farming systems, improved water management practices and drought-tolerant crops, for better adaptation to climatic risks (Naik et al. 2024). Adoption of climate resilient technologies under NICRA such as improved crop varieties, water management, and livestock practices has led to notable increases in crop yields and productivity (Choudhary et al. 2025). Education, annual income, land holding, individual and mass media exposure, economic motivation, risk taking ability, and innovative proneness showed positive and significant relation with the overall

adoption of CRA technologies at a 5 per cent level of significance in Khammam and Suryapet districts of Telangana (Naik et al. 2023). Although numerous studies conducted under NICRA have evaluated technology adoption, crop productivity, livelihood improvement, resilience enhancement and climate adaptation, very limited attention has been devoted to understanding the pathways through which climate-resilient technologies spread among farming communities. Existing studies primarily assess programme impacts, whereas evidence on farmer-to-farmer dissemination mechanisms, institutional interactions, communication pathways, technology attributes governing diffusion and comparative roles of public and private extension systems remains scarce. The present investigation addresses this knowledge gap by delineating determinants influencing technology spread and analysing farmer-to-farmer diffusion networks. Therefore, it is crucial to understand the factors influencing the adoption of these climate-resilient technologies to ensure their wider spread and long-term sustainability among farming communities.

2. Objective of the study

To study the factors affecting the farmer-to-farmer spread of climate resilient technologies

3. Methodology

The study was conducted in the state of Telangana. Study, employed an ex-post facto research design. As described by Kerlinger (1973), Ex post facto research refers to a systematic empirical investigation wherein the researcher lacks direct control over the independent variables, as they have already occurred or are intrinsically non-manipulable in nature.

Khammam district was purposively selected because it is one of the NICRA intervention districts in Telangana where climate-resilient technologies have been implemented continuously through ICAR since 2011. The district represents a climate-vulnerable region frequently affected by drought and rainfall variability, making it suitable for studying climate-resilient technology dissemination. Enkoor Mandal was selected because it exhibited objective selection criteria (e.g., documented horizontal diffusion, comparable agro-ecology, and spillover of technologies). In addition, the presence of both NICRA-adopted and neighbouring non-NICRA villages with comparable agro-ecological and farming conditions provided a suitable framework for examining and comparing the factors influencing farmer-to-farmer dissemination of climate-resilient technologies. Two NICRA villages (Nacharam and Colony Nacharam) and two neighbouring non-NICRA villages (Rangapuram and Nemalipuram) were purposively selected as they possess comparable agro-

climatic conditions, cropping systems, soil characteristics, rainfall pattern and socio-economic characteristics, enabling meaningful comparison between NICRA and Non-NICRA villages while differing mainly in exposure to climate-resilient interventions.

Thirty farmers were randomly selected from each village; thus, 60 respondents were drawn from NICRA-adopted villages and 60 from non-NICRA villages, yielding a total sample of 120 respondents. As two technologies were considered in the study, the factors influencing their adoption were examined separately for each technology. Data collected through interview schedule was coded tabulated and analysed. Pearson's correlation coefficient was employed to examine the relationship between independent variables and technology spread separately for NICRA and Non-NICRA farmers.

The conceptual framework of the study grouped the determinants influencing technology dissemination into four major dimensions, namely socio-economic, technological, institutional and extension-related factors. These determinants were identified through an extensive review of literature and validated during the field investigation. Their influence on farmer-to-farmer dissemination was examined separately for WGL-44 saline-tolerant rice variety and CRT-Farm Pond technology.

Dimension	Variables
Socio-economic	Age, education, farm size, annual income, farming experience, irrigation
Extension	Information seeking behaviour, extension contact, participation in KVK activities
Technology attributes	Relative advantage, trialability, compatibility, complexity, affordability, need, access
Institutional	Availability of infrastructure, NICRA support, demonstrations, KVK interventions

4. Results and Discussion

Relationship between factors affecting farmer to farmer spread of climate resilient technologies.

WGL-44 saline-tolerant rice variety and CRT-Farm Pond were selected because these were the most widely disseminated climate-resilient technologies under NICRA in the study area, exhibiting substantial farmer-to-farmer diffusion compared with other interventions. In order to study the nature of relationship between the factors affecting farmer to farmer spread of climate resilient technologies, correlation co-efficient (r) were computed and the values were

presented in Table 1.

Table 1 Correlation analysis of factors affecting farmer to farmer spread of climate resilient technology – Wgl-44 saline tolerant variety.

S. No	Variables	NICRA Farmers (n=30)	NON-NICRA Farmers (n=30)
		Correlation coefficient	Correlation coefficient
1	Age	0.0343	0.025
2	Education	0.046	0.037
3	Family type	0.155	0.116
4	Farm size	0.355*	0.119
5	Farming experience	0.412	0.040
6	Irrigation	0.254**	0.129*
7	Annual income	0.412*	0.028
8	Information seeking Behaviour	0.233*	0.034
9	Extension contacts	0.211**	0.046
10	Participation in KVK Activities	0.346**	0.064
11	Affordability	0.131	0.092
12	Relative advantage	0.152*	0.017
13	Trail ability	0.249*	0.067*
14	Compatibility	0.219	0.022
15	Need for technology	0.004	0.020
16	Complexity	0.377	0.110
17	Availability of Infrastructure	0.236	0.226
18	Access to technology	0.165*	0.115*

** . Correlation is significant at the 0.01 level (2-tailed). * . Correlation is significant at the 0.05 level (2-tailed).

From the table 1, regarding NICRA farmers out of 18 variables 9 variables namely farm size, annual income, irrigation, information seeking behaviour, extension contact, participation in extension activities and relative advantage, trialability and access to technology showed significant correlation at 1% and 5% level of probability with technology spread. And 8 out of 18 variables namely education, family type, farming experience, compatibility, complexity, availability of infrastructure, affordability and need for technology are positively correlated with technology spread but not significant. The variable age is negatively related to technology spread.

As a result, it can be inferred that farm size ($r=0.355^*$) had positive and significant effect on technology spread among the farming communities, as it will enable the farmer to trial and observe the result of climate resilient technologies in a part of the farm. Farmers with higher incomes ($r= 0.412^*$) can practice climate resilient technologies such as farm pond construction, micro irrigation techniques, intercropping, and diversifying activities for a longer period of time, resulting in long-term profits with visible impact. This result is consistent with the findings of Pise et al. (2018) and Neelima et al. (2024).

It was perceived from the above table that irrigation ($r=0.254^{**}$) had positive and highly significant relationship with the technology spread. From this it can be comprehend that the farmers with available water resources are willing to experiment and spread the climate resilient technologies. Information seeking behaviour ($r= 0.233^*$) was positive and significantly correlated to Technology spread. It was also observed the extension contact ($r= 0.211^{**}$) of the farmers has direct and positively significant effect on technology spread.

It was perceived from the above table that there was positive and highly significant relationship between the farmers' participation in KVK activities ($r= 0.346^{**}$) and technology spread. Technology factors have direct and positive significant influence on the spread of technology. The technology factors like relative advantage ($r= 0.152^*$), trialability ($r=0.249^*$) had positive and significant effect on technology spread as these factors help the farmers to analyse and realize the importance and need of climate resilient technologies. Access to technology ($r= 0.165^*$) positive and significant relation with the technology spread.

 CRT-Farm Pond

Table 2: Correlation analysis of factors affecting farmer to farmer spread of climate resilient technology – farm pond

S. No	Variables	NICRA Farmers (30)	NON-NICRA Farmers (30)
		Correlation coefficient	Correlation coefficient
1	Age	0.0223	0.015
2	Education	0.035	0.026
3	Family type	0.135	0.122
4	Farm size	0.277*	0.119
5	Farming experience	0.376	0.101
6	Irrigation	0.233**	0.110*
7	Annual income	0.312	0.024
8	Information seeking Behaviour	0.243*	0.036
9	Extension contacts	0.219**	0.023
10	Participation in KVK activities	0.325**	0.055
11	Affordability	0.122	0.082
12	Relative advantage	0.111*	0.011
13	Trail ability	0.121	0.054
14	Compatibility	0.118	0.023
15	Need for technology	0.023	0.018
16	Complexity	0.383	0.131
17	Availability of infrastructure	0.244	0.221
18	Access to technology	0.122*	0.115

** . Correlation is significant at the 0.01 level (2-tailed). * . Correlation is significant at the 0.05 level (2-tailed).

From the table 2, regarding NICRA farmers out of 18 variables 7 variables namely farm size, irrigation, information seeking behaviour, extension contact, participation in extension activities and relative advantage and access to technology showed significant correlation at 1% and 5% level of probability with technology spread. And 11 out of 18 variables namely age, education, family type, farming experience, compatibility, complexity, availability of infrastructure, affordability and need for technology are positively correlated with technology spread but not significant.

Farm size ($r=0.277^*$) had positive and significant relation with the technology spread. As a result, it can be inferred that greater the farm size greater will be the technology spread among the farming communities. Large farms provide opportunities for experimentation, visibility and observation by neighbouring farmers, thereby facilitating horizontal diffusion.

There was a positive and highly significant correlation between irrigation ($r=0.233^{**}$) and technology spread. Extension contacts ($r=0.219^{**}$) and participation in KVK activities (0.325^{**}) had positive and highly significant correlation with the technology spread. Training and demonstrations improve observability and trialability. Seeking technical advices regarding climate resilient technologies from various sources, such as KVK scientists, mass media, and fellow farmers, and make decisions accordingly. Similar findings were reported by Dhanalakshmi et al. (2025) and Neelima et al. (2024). Relative advantage ($r=0.111^*$) of the technology and Access to technology ($r=0.122^*$) had positive and significant relation with the technology spread. Farmers spread technologies only after observing visible economic benefits.

Although the magnitude of correlation varied across the two climate-resilient technologies, the findings consistently demonstrated that farm size, irrigation, extension contact, participation in extension activities, information-seeking behaviour, relative advantage and access to technology emerged as the most influential determinants of farmer-to-farmer dissemination among NICRA farmers. These determinants collectively indicate that technology diffusion depends not only on farmers' socio-economic capacity but also on the strength of extension support and perceived technological benefits.

Conclusion

The present study revealed that the farmer-to-farmer spread of climate-resilient technologies is influenced by the combined effects of socio-economic, technological and institutional factors. Among NICRA farmers, farm size, annual income, irrigation access, information-seeking behaviour, extension contact, participation in Krishi Vigyan Kendra (KVK) activities, access to technology,

and the perceived relative advantage of the technologies exhibited significant positive relationships with technology dissemination. In contrast, comparatively weaker associations observed among non-NICRA farmers indicate disparities in access to extension services, institutional support and technology dissemination opportunities.

The findings demonstrate that successful farmer-to-farmer dissemination depends not only on the availability of climate-resilient technologies but also on enabling conditions that promote awareness, experimentation, confidence and knowledge sharing among farmers. Socio-economic resources such as farm size and irrigation facilitate experimentation, while extension interventions through KVKs and regular extension contacts strengthen farmers' capacity to adopt and disseminate technologies. Furthermore, technologies possessing greater relative advantage and easier accessibility are more readily accepted and diffused within farming communities. Therefore, strengthening extension systems, improving farmers' access to climate-resilient technologies, and promoting participatory learning approaches are essential for accelerating the horizontal spread and wider adoption of climate-resilient technologies.

Policy Implications

Policy efforts should strengthen the ecosystem in which the farmers operate by scaling up the field demonstration and capacity building programmes through KVKs and ICAR institutes, given the strong influence of extension contacts and participation in KVK activities. Participatory approaches like farmers groups, innovative farmers networks and peer learning can accelerate technology diffusion and adoption. Investments in resource infrastructure are essential for farmers experimentation of new practices. Additionally, policymakers should design targeted outreach for non-NICRA areas to bridge dissemination gaps and ensure inclusive scaling of climate-resilient agriculture.

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