Exploring Farmers Attitudes towards Climate Resilient Agricultural Technologies in Telangana State, India

ABSTRACT

Since the start of this century, there has been significant attention placed on climate change, largely due to its direct impact on ecosystems and agriculture, particularly affecting farmers in vulnerable regions. A descriptive research study was undertaken to explore the attitude of farmers towards climate resilient agricultural technologies in the National Innovations on Climate Resilient Agriculture (NICRA) projectimplementedvillages of Suryapetand Khammam districts of Telangana state, India. The *ex-postfacto* research design was used in this study. A sample of 200 respondents from the two districts*i.e.* Suryapet and Khammam were randomly selected to assess the attitude of farmers towards these CRA technologies and also employed Z test to evaluatesignificant difference between the attitude of farmers in Suryapet and Khammam districts towards climate resilient technologies. The findings of the study revealed that the majority of the Suryapet and Khammam (62.67% and 72.00%) farmers had highly favourable attitude towards CRA technologies which was followed by moderately favourable (35.33% and 28.00%) and less favourable (2.00% and 0.00%). On the whole, nearly two third (65.00%) of the respondents had highly favourable attitude towards CRA technologies which is considered as a precursor for adoption of these technologies by the farming community. By employing the Z-test it was observed that there was a difference between farmers' attitude inthe Suryapet and Khammam districts where Khammam farmers were having slightly more favourable attitude when compared toSuryapet farmers.Therefore, the outcomes of this research study could assist extension organizations in effectively training and implementing climate-resilient technologies under the National Innovations on Climate Resilient Agriculture (NICRA) initiative in the other villages.

Keywords: Agriculture, Attitude, Climate change, Resilient technologies.

INTRODUCTION

An enduring challenge of the 21st century is the persistent threat posed by climate change to the global food security infrastructure (FAO, 2019). In today's era of climate change, it is evident that densely populated countries like India are particularly susceptible to the adverse impacts of climate change (Pabba *et al*. 2021).The Indian environment faces susceptibility to the impacts of climate change, with farmers bearing the effect, particularly those in dryland areas. The relationship between agriculture and climate is profound. Any alteration in climatic conditions, whether beneficial or detrimental, significantly impacts agricultural output, thus affecting the food security of the nation (Jasna *et al*. 2016). In Asia, agricultural crop yields are projected to decrease by 5 to 30% by the 2050s as a result of increasing temperatures. This decline in agricultural productivity will result in food insecurity, posing one of the most critical challenges for humanity to address in the future(Raghuvanshi and Ansari, 2016).Research indicates that Indian agriculture will also suffer adverse consequences due to climate change. It is anticipated that for every one-degree rise in temperature, crop yields may decline by 3-7% (Shelar *et al*. 2022; Agarwal *et al*. 2009)]. Out of India's total cultivated land area of 141 million hectares, 80 million hectares rely on rainfed conditions, constituting 40% of food grain production and two-thirds of livestock forage production (CRIDA, 2011). The aforementioned facts vividly illustrate the reliance and significance of dryland agriculture in the Indian economy. Global food security is seriously affected by climate change with rising temperatures, changing rainfall patterns, and more frequent extreme weather events (Mbow *et al*. 2019; FAO, 2018).While certain regions may experience marginal benefits from altered temperature and precipitation patterns, agricultural experts concur that the overall shift in climatic patterns will lead to a global decrease in agricultural production(Kucharik and Serbin, 2008; CCSP, 2008).In previous years, predictions have indicated that with temperature increases ranging from 2.5°C to 4.9°C, rice and wheat yields could decline by 32% to 40% and 41% to 52%, respectively(Shelar *et al*. 2022; Choukse*yet al*. 2021).Climate change effects are categorized into environmental, economic, and social impacts (ILO, 2011). Within the environmental domain, significant effects include rising sea levels, cyclones, floods, heatwaves, droughts, biodiversity loss, forest fires, erratic rainfall, and escalating surface temperatures. The impacts on production, productivity, livestock diseases,

income, and employment result in economic losses for farmers. Social effects encompass public health, food security, employment, income, livelihoods, gender dynamics, education, housing, poverty, and migration, which were previously less acknowledged but are now subjects of increased research regarding the societal impacts of climate change (Jena and Acharya, 2016; Kothari and Garg, 2014; Rakibal*et al*. 2015; Rao *et al*, 2011; Ravi Shankar, 2013; Ravi Shankar *et al*. 2013; Ravi Shankar *et al*. 2014; Venkateswarlu*et al*. 2012).For a nation such as India, ensuring food and nutrition security for its growing population necessitates the establishment of a self-sustaining agriculture sector(Chauhan and Vinaya Kumar, 2016).While the impacts of climate fluctuations are felt globally, nations like India are particularly vulnerable due to a significant portion of the population relying on agriculture for their livelihoods. Consequently, India has prioritized research and development efforts to address climate variations overall, with a specific focus on agricultural adaptation (Harikrishna and Naberia, 2021).To address these diverse effects of climate variability, the Indian Council of Agricultural Research (ICAR) initiated the National Innovation on Climate Resilient Agriculture (NICRA) project in February 2011. This project aims to conduct long-term strategic research focusing on adapting crops, livestock, and natural resource management, as well as exploring potential institutional interventions to alleviate the impacts of climate change (NICRA, 2018). Natural resource management involves the organized handling of resources such as land, water, and soil. Climate-resilient practices highlighted by NICRA include in-situ moisture conservation, water harvesting, and recycling for additional irrigation, enhanced drainage in flood-prone regions, conservation tillage where suitable, artificial groundwater replenishment, and water-efficient irrigation techniques.Climate-resilient crop production practices entail the introduction of drought/flood tolerant varieties, adjusting planting dates for rabi crops in regions experiencing terminal heat stress, establishing water-saving community nurseries for delayed monsoons, facilitating custom hiring centers for timely planting, and implementing location-specific intercropping systems with a high sustainable yield index. The climate-resilient livestock management practices identified by NICRA include utilizing community lands for fodder production during droughts or floods, enhancing methods for fodder and feed storage, administering preventive vaccinations, upgrading shelters to mitigate heat stress in livestock, and implementing strategies for managing fish ponds and tanks during periods of water scarcity or excess. Actions such as establishing seed banks, fodder banks, commodity groups, custom hiring centers, collective marketing initiatives,

and implementing weather index-based insurance, alongside promoting climate literacy through village-level weather stations, are recognized as climate-resilient institutional interventions (Venkateswarlu*et al*, 2012).In light of current circumstances, it's imperative to actively promote the adoption of Climate-Resilient Agricultural (CRA) technologies among farmers. This will empower them to better navigate and mitigate the adverse impacts of climatic variability and change (Thatikonda, 2017). Given the pivotal role of the adoption of these climate resilient technologies in this distressed climate change, examining farmers' attitudes towards these technologies has a direct and profound influence on their adoption levels of these technologies. The success of the adoption of these CRA technologies in agriculture hinges on the willingness and enthusiasm of key stakeholders to embrace and integrate these technologies into their daily practices. Hence the current study focused on the exploration of farmers' attitudes towards CRA technologies.

MATERIALS AND METHODS

The current research was purposively carried out in Suryapet and Khammam districts of Telangana state, India. These districts were purposively chosen because the NICRA has been implemented there since its inception. Specifically, Nandhyalagudem, Kotha Thanda, and Boring Thanda from Suryapet district, and Nacharam village from Khammam district were selected for the study due to the implementation of the NICRA project under these villages.Using a simple random sampling method, 50 respondents were selected from each of the four villages spanning two districts. This resulted in a comprehensive sample of 200 respondents. The current investigation used an *ex-post facto* research design. In this study, the attitude was operationally defined as the level of farmers' feelings toward CRA and particular CRA technologies in the Suryapet and Khammam districts.

To evaluate the attitude, a scale (Thurston) developed by (Thatikonda, 2017) was used with suitable modifications. Using Cronbach's alpha method, the reliability of the attitude scale toward CRA was calculated in this study. The scale was given to a set of 40 responders who were not part of the sample. The reliability coefficient (rff) of the test calculated was 0.93, which indicates that there was an internal consistency. The final scale, which was comprised of 18 statements (9 positives and 9 negatives) was divided into two categories, general attitude toward the concept of CRA, and specific attitude towards CRA technologies. Respondents were

instructed to indicate their agreement on one of three continuums, ‘agree’ (AG), ‘undecided’ (UD), and ‘disagree’ (DA), depending on which statements they agreed with.

The attitude score of each responder is determined by adding the scores on all attitude statements, with the weighting of 2, 1, and 0 for positive statements and vice versa for negative statements. Based on the overall attitude score obtained, farmers were then grouped into three categories as shown below using the Cumulative Square Root Frequency method(CSRF). Apart from Cumulative Square Root Frequency method, appropriate statistical tool likeZ test was employed to find whether there is any significance difference in attitude of farmers between two districts.

RESULTS AND DISCUSSION

This part of the paper discusses the results that arrive from the analysis of the data.

Table 1.Statement wise Attitudeofrespondentstowardsgeneral concept of Climate Resilient Agricultural technologies

S. No	Attitude of respondents toward the general concept of ClimateResilientAgriculturaltechnologies	Suryapet			Khammam		
		NICRA farmers (n_1=150)			NICRA farmers (n_2=50)		
		AG	UD	DA	AG	UD	DA
		f(%)	f(%)	f(%)	f(%)	f(%)	f(%)
1	In my view drought is not a doomed fate but there are strategies tominimizeitseffects.	124 (82.66)	16 (10.67)	10 (6.67)	35 (70.00)	12 (24.00)	3 (6.00)
2*	Inmyview,thereisnoneedtospendmoneyonCRAtechnologies	0 (0.00)	23 (15.33)	127 (84.67)	0 (0.00)	17 (34.00)	33 (66.00)
3*	I observed that small farmers are not able to receive the full benefit of improved CRAtechnologies	89 (59.33)	21 (14.00)	40 (26.67)	23 (46.00)	20 (40.00)	7 (14.00)
4	Due to the adoption of CRA technologies, there is a substantialimprovementincropyieldsin myareaduringadverse drought situations.	150 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)
5	Istronglyfeelthatfoodsecuritycanbeachievedbyadoptingclimate-resilient technologies	131 (87.33)	19 (12.67)	0 (0.00)	35 (70.00)	15 (30.00)	0 (0.00)

6	CRAtechnologies havecomeasarealboonforthefarmersinmanagingdrought conditions.	150 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)
7*	Inmyview,itissimply a wasteoftimetopractice climateresilienttechnologies	0 (0.00)	24 (16.00)	126 (84.00))	0 (0.00)	8 (16.00)	42 (84.00)
8	CRAtechnologydevelopsself–relianceamongdrylandfarmers	146 (97.33)	4 (2.67)	0 (0.00)	46 (92.00)	4 (8.00)	0 (0.00)
9*	The use of CRA technology is less profitable with the cost involved	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)

***Negative statements**

It could be noticed from Table 1 that in Suryapet and Khammam majority (82.66% and 70.00%) of the respondents agreed that drought is not a doomed fate but there are strategies to minimize its effects, followed by 100.00 per cent of the respondents who agreed that due to the adoption of CRA technologies there is a substantialimprovementofcropyieldsin theirareaduringadverse drought situation and CRAtechnologies havecomeasarealboonforthem formanagingdrought conditions. The further majority (97.33% and 92.00%), (87.33% and 70.00%) of the respondents agreed that CRAtechnologydevelopsself–relianceamongdrylandfarmers and they stronglyfeelthatfoodsecuritycanbeachievedbyadoptingclimateresilient technologies. Moreover, most (59.33% and 46.00%) of the respondents agreed that small farmers are not able to receive the full benefit of improved CRAtechnologies. On the other hand, 100.00 per cent of the respondents disagreed that the use of CRA technology is less profitable about the cost involved. It was further found that the majority (84.67% and 66.00%) and (84.00% and 84.00%) disagreed that intheirviewthereisnoneedtospendmoneyonCRAtechnologies and itwassimply a wasteoftimetopractice climateresilient technologies.

Table 2.Distribution of respondents according to their attitude towards general concept of ClimateResilient Agricultural technologies

S. No	Categories	Suryapet NICRA farmers (n_1=150)		Khammam NICRA farmers (n_2=50)		Overall NICRA farmers (n=200)	
		f	%	f	%	f	%

1	Less favourable (Up to 7)	3	2.00	1	2.00	4	2.00
2	Moderately favourable (8 to 15)	67	44.67	17	34.00	84	42.00
3	Highly Favourable (16 and above)	80	53.33	32	64.00	112	56.00
	Total	150	100	50	100	200	100

Finding from the Table 2 shown that in Suryapet and Khammam majority (53.33% and 64.00%) of the respondents had highly favourable attitude followed by moderately favourable attitude (44.67% and 34.00%) and low favourable attitude (2.00% and 2.00%). On the whole more than half (56.00%) of the respondents had highly favourable followed by moderately favourable (42.00%) and less favourable (2.00%).

From the above findings it was noticed that the maximum number of the NICRA farmers had highly favourable attitude towards CRA technologies this might be due to the benefits obtained by the farmers from CRA technologies during uncertain climatic conditions. The findings are in agreement with (Thatikonda, 2017) who reported that majority (71.76%) of the NICRA farmers had highly favourable attitude towards general concept of CRA technologies.

Table 3.Statement wise Attitudeofrespondentstowardsspecific Climate Resilient Agricultural technologies

B.	**AttitudeofrespondentstowardsspecificClimateResilientAgriculturaltechnologies**	**Suryapet**			**Khammam**		
		NICRA farmers (n_1=150)			**NICRA farmers (n_2=50)**		
		AG	**UD**	**DA**	**AG**	**UD**	**DA**
		f(%)	**f(%)**	**f(%)**	**f(%)**	**f(%)**	**f(%)**
1*	There is no improvement in soil moisture retention levels byadoptingmoistureconservationmethods(deadfurrows,mulch,covercrops,etc.)	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)
2	Irrigationwithsprinkler/driphadhelpedmycropinmitigatingthe soilmoisturestress	150 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)

3 *	In my view, the construction of rainwater harvesting structures isverycostlyandrisky	150 (0.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)
4	I observed that the Performance of contingent crops under delayedmonsoonisgood	130 (86.67)	9 (6.00)	11 (7.33)	44 (88.00)	6 (12.00)	0 (0.00)
5	IobservedthatthePerformanceofclimateresilientvarietieswas goodindrought areas	150 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)
6	In my view, composting organic waste would upgrade soilquality	150 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)	0 (0.00)	0 (0.00)
7 *	Ifeelthatthereisnoimprovement incropyieldduetocropdiversification	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)
8 *	Inmyview,farmoperationsaredelayeddu etoimproperfunctioningof customhiringcenters	140 (93.33)	10 (6.67)	0 (0.00)	39 (78.00)	0 (0.00)	11 (22.00)
9 *	I strongly feel that there is no recharge of bore wells in the vicinity of percolation ponds	0 (0.00)	0 (0.00)	150 (100.00)	0 (0.00)	0 (0.00)	50 (100.00)

***Negative statements**

Results from the Table 3 showed that in Suryapet and Khammam 100.00 per cent of the farmers agreed that irrigationwithsprinkler/driphadhelpedtheircropinmitigatingthe soilmoisturestress, and they observedthatthePerformanceofclimateresilientvarietieswas goodindrought areas and composting of organic waste would upgrade soilquality. Further, the majority (86.67% and 88.00%) of the respondents agreed that the Performance of contingent crops under delayed monsoonisgood. Results further noted that the majority (100.00% and 100.00%) and (93.33% and 78.00%) of the respondents agreed that the construction of rainwater harvesting structures isverycostlyandrisky and farmoperationsaredelayedduetoimproper functioningof customhiringcenters. On the other hand, 100.00 per cent of the respondents from both districts disagreed that no improvement in soil moisture retention levels byadoptingthemoistureconservationmethods and thereisnoimprovement incropyieldduetocropdiversification and there is no recharge of bore wells in the vicinity of percolation ponds.

Table 4.Distribution of respondents according to their attitude towards specific ClimateResilient Agricultural technologies

S. No	Categories	Suryapet		Khammam		Overall NICRA farmers (n=200)	
		NICRA farmers (n_1=150)		NICRA farmers (n_2=50)			
		f	%	f	%	f	%
1	Less favourable (Up to 7)	0	0.00	0	0.00	0	0.00
2	Moderately favourable (8 to 15)	36	24.00	13	26.00	49	24.50
3	Highly Favourable (16 and above)	114	76.00	37	74.00	151	75.50
	Total	150	100	50	100	200	100

The distribution of respondents according to their attitude towards the specific concept of climate resilient agricultural technologies is presented in Table 4. From the Table, it is evident that in Suryapet and Khammam majority (76.00% and 74.00%) of the respondents had a highly favourable attitude towards specific CRA technologies followed by moderately favourable (24.00% and 26.00%) and less favourable (0.00% and 0.00%). on the whole, the majority (75.50%) of the respondents had a highly favourable attitude followed by moderately favourable (24.50%) and less favourable (0.00%)

It could be concluded from the above results that the majority of the NICRA farmers had favourable attitude toward specific CRA technologies. The probable reason for this might be the continuous implementation of NRM activities, it is very easy to perceive the benefits accrued through the NRM activities by way of recharging the groundwater, improvement in flora and fauna, and the micro-climate as a whole. The farmers are slowly realizing the adverse effects due to indiscriminate use of natural resources thereby they felt no one has the right to use natural resources as he/she feels. They also felt to give fresh life to the natural resources by gradual restoration and replenishment to minimize climatic aberration and also to maintain ecological balance. Farmers were practicing contingent crops (sorghum) under delayed monsoon, proper functioning of custom hiring center service, soil moisture conservation methods like dead furrows, cover crops, and getting income by practicing crop diversity. With the help of these

technologies, farmers were getting more income. They had an idea that the resources can be managed effectively through community-based organizations. IWMP, DWMA, MGNREGS, and KVKs were excavating water harvesting structures and constructing check dams. Through this, the NICRA farmers might have a favourable attitude towards CRA technologies. The results are in contrast with (Thatikonda, 2017) who found that majority (73.33%) of the beneficiaries had highly favourable attitude towards specific CRA technologies.

Table 5. Distribution of respondents according to their overall attitude towards Climate Resilient Agricultural technologies

S. No	Categories	Suryapet		Khammam		Overall NICRA farmers (n=200)	
		NICRA farmers (n_1=150)		NICRA farmers (n_2=50)			
		f	%	f	%	f	%
1	Less favourable (Up to 14)	3	2.00	0	0.00	3	2.00
2	Moderately favourable (15 to 29)	53	35.33	14	28.00	67	33.50
3	Highly Favourable (30 and above)	94	62.67	36	72.00	130	65.00
	Total	150	100	50	100	200	100

The distribution of respondents according to overall attitude is depicted in Table 5 and Figure 1. From the findings, it is evident that in Suryapet and Khammam majority (62.67% and 72.00%) of the respondents had highly favourable attitude followed by moderately favourable (35.33% and 28.00%) and less favourable (2.00% and 0.00%). On the whole, nearly two third (65.00%) of the respondents had highly favourable attitude followed by moderate (33.50%) and less (2.00%) favourable attitude respectively. The findings are in contemporary with (Thatikonda, 2017)respondents had favourable attitude towards CRA technologies.

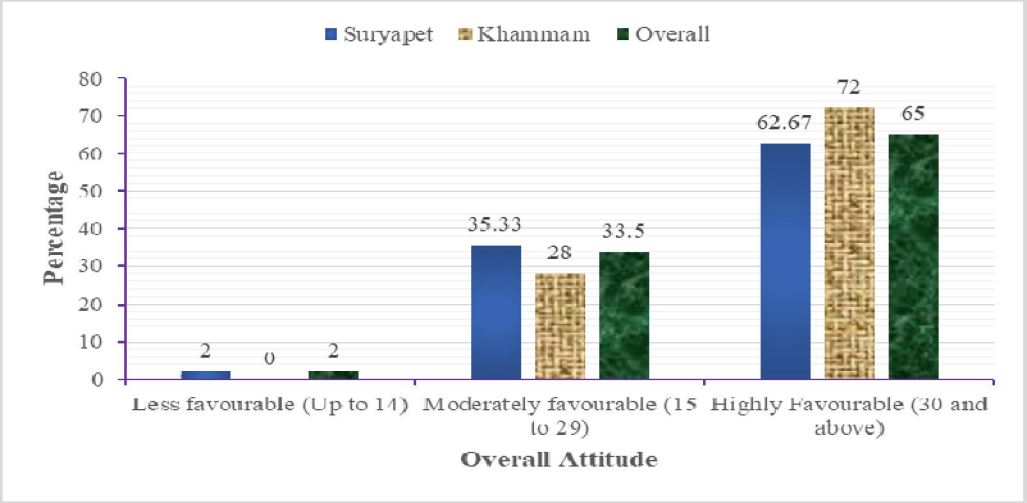

Fig. 1.Distribution of respondents according to their overall Attitude

Table 6. Comparison of attitudes between respondents of Suryapet and Khammam districts towards CRA technologies

S. No	Category (Districts)	Size of sample	Mean	S.D	'Z' Value
1.	Suryapet	150	29.77	3.03	2.98**
2.	Khammam	50	30.54	0.50	
	Total	**200**			

****Significant at 0.01 level of probability**

From the above Table 6. It can be noticed that there is significant difference with z value at 0.01 level of significance between two districts (*i.e.* Suryapet and Khammam)and it was shown that mean value of khammam is slightly greater than Suryapet which means Khammam farmers were having slightly more favourable attitude towards climate resilient agricultural technologies than Suryapet farmers. The possible reason for this was Khammam farmers are progressive in nature to recognize and adopt these resilient technologies which they come through in mitigating the climate change.

CONCLUSION

From the above results it is understandable that, majority of the farmers in Suryapet and Khammam (62.67% and 72.00%) had highly favourable attitude towards CRA technologies which was followed by moderately favourable (35.33% and 28.00%) and less favourable (2.00%

and 0.00%). It was also revealed from the above results that in Suryapet and Khammam majority (53.33% and 64.00%) of the respondents had highly favourable attitude towards general concept of climate resilient agricultural technologies and it is also evident that in Suryapet and Khammam majority (76.00% and 74.00%) of the respondents had a highly favourable attitude towards specific CRA technologies. Based on these findings, it can be concluded that individuals benefiting from the NICRA project exhibit a positive inclination towards climate-resilient technologies, which in turn influences their selection and uptake of CRA practices aimed at stabilizing yield and income. The educational initiatives undertaken by KVK have notably cultivated a more favorable disposition among beneficiary farmers towards climate-resilient technologies. Consequently, the outcomes of this research offer valuable insights for extension organizations, facilitating effective training and implementation strategies for climate-resilient technologies under the National Innovations on Climate Resilient Agriculture (NICRA) initiative in other villages.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that generative AI technologies such as OpenAI ChatGPT version 3.5 have been used during writing or editing of manuscripts for language improvement.

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