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Sustaining the farm incomes through adoption of climate resilient technologies in scarce rainfall zone of Andhra Pradesh

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Abstract
National initiative on climate resilient Agriculture (NICRA) was being implemented by ICAR since 2010-11 through 100 kvks to built capacities of the farmers and to demonstrate the climate resilient technologies in climatic vulnerable districts of the country. The study was conducted in Kurnool district with drought as climate vulnerability in Yagantipalle and Meerapuram villages to study the impact of the Project on Knowledge, adoption and economic benefits of climate resilient technologies. Data was collected from hundred respondents. The study revealed that seventy five per cent of the respondents have good knowledge on climate resiliency. Under NRM practice 84 per cent were adopting insitu moisture conservation practices. Under crop production 92 per cent of the farmers were adopting drought tolerant varieties followed by adoption of alternate crops and inter cropping system. In animal husbandry component 81 percent of the respondents adopted calf registration practice followed by adoption of green fodder cultivation. All the respondents were economically benefited through the intervention of climate resilient technologies like percolation tanks, adoption of drought tolerant varieties of Seteria, red gram and Bengal gram. Intercropping of red gram and millets, management of sucking pest. Education has highest correlation with the knowledge of climate resilient technologies followed by mass media exposure. But in case of adoption of technologies mass media exposure was highly correlated with adoption of climate resilient technology followed by age and farming experience.

Keywords: Climate resilient technologies, NICRA

Introduction

Climate change is a significant and lasting change in the statistical distribution of Weather patterns over periods ranging from decades to millions of years. The fact that climate affects development and development affects the climate has come to be known widely during recent times. The problem of human induced climate change first came into force and drew the attention of the scientists and policy makers when Inter Governmental Panel on Climate Change (IPCC) was established. The Inter-governmental Panel on Climate Change (IPCC) defined climate in a narrow sense as the average weather, or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO).

In India, significant negative impacts have been implied with medium-term (2010-2039) climate change, predicted to reduce yields by 4.5 to 9 per cent, depending on the Magnitude and distribution of warming. Since agriculture makes up roughly 16 percent of India's GDP, a 4.5 to 9% negative impact on production implies a cost of climate change to be roughly up to 1.5 per cent of GDP per year (Venkateswarlu *et al.*, 2013) [6].

The decreased yield in rainfed and dry land wheat and rice and loss in farm net revenue between 9 to 25 per cent for a temperature increase of 2 to 3.5 ^{O}c. It is evident that increase in atmospheric temperature could decrease in crop yield and net income (Sinha and Swaminathan 1991, Saseendran *et al* 2000, Dinar *et al.*, 1998) [5, 4].

Need for Planned adaptation

In the absence of planned adaptation, the consequences of long term climate change could be severe on the livelihood security of the poor. Therefore, it is of utmost importance to enhance the resilience of Indian agriculture to climate change. Planned adaptation is essential to increase the resilience of agricultural production to climate change. The potential adaptation strategies are: developing cultivars tolerant to heat and salinity stress and resistant to flood and drought, modifying crop management practices, Improving water management, adopting new farm techniques such as resource conserving technologies (RCTs), crop diversification, improving pest management, better weather forecasting and crop insurance and harnessing the indigenous technical knowledge of farmers.

The Prime Minister's National Action Plan on climate change has identified Agriculture as one of the eight national missions. With this background, The Indian Council of Agricultural Research (ICAR), New Delhi has launched a major network project entitled, National Initiative on Climate Resilient Agriculture (NICRA) during 2010-11, focusing on the process of developing district level contingency plans for all the rural districts of country with Central Research Institute for Dry land Agriculture (CRIDA), Hyderabad as the nodal agency in the XI Plan. The project was implemented by Krishi Vigyan Kendras (KVKs) at district level, regionally coordinated by the Zonal Project Directorates (ZPDs) with overall planning, monitoring and coordination by CRIDA and is being implemented at large number of Research Institutes of ICAR, State Agricultural Universities and 100 KVKs.

NICRA has the major objectives, to enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies; to demonstrate site specific technology packages on farmers' fields for adapting to current climate risks; and to enhance the capacity building of scientists and other stakeholders in climate resilient agricultural research and its application. Both short term and long terms outputs are expected from the project in terms of new and improved varieties of crops, livestock breeds, management practices that help in adaptation and mitigation and inputs for policy making to mainstream climate resilient agriculture in the developmental planning. The overall expected outcome is enhanced resilience of agricultural production to climate variability in vulnerable regions.

All the four modules were implemented in the NICRA village. Selected technologies based on the need of the farming situation of the village were demonstrated. Keeping these factors in view, the present field investigation entitled " Sustaining the farm incomes through adoption of Climate Resilient Technologies in Scarce Rainfall zone of Andhra Pradesh was under taken with general objective of analyzing the climate resilient technologies in rainfed agriculture under NICRA project in Yagantipalle and Meerapuram villages of Banaganapalle mandal Kurnool district and specific objectives are as follows.

1. To measure the knowledge about climate resiliency among NICRA farmers.
2. To know the adoption pattern of climate resilient technologies by NICRA farmers.
3. To study the economic impact of climate resilient technologies.

Methodology
The study was conducted in Kurnool district of Andhra Pradesh. The research locales were selected purposively, as the NICRA has been implemented in this districts since its inception. The selected study locale is vulnerable to climatic Vulnerability of drought. Recently the frequency of drought has increased to 5-6 times in 10 year span.

Kurnool District is one of the 13 districts in the state of Andhra Pradesh, India. The district is located in the west-central part of the state and is bounded by Mahabubnagar district of Telangana in the north, Raichur district of Karnataka in the northwest, Bellary district of Karnataka in the west, Ananthapur district in the south, YSR Kadapa district in the South East and Prakasham district in the east. The city of Kurnool is the headquarters of the district. It has a population of 4,053,463 of which 28.35% were urban as of 2011. The district is the 10th largest district in the country and the 2nd largest district in the state [2], accounting for 17,658 square Kilometres (6,818 sq mi).

Selection of the sample
Yagantipalle and Meerapuram villages which are located at a distance of 4 km and 7 km from Yagantipalle Panchayat of Banaganapalle Mandal Kurnool district of Andhra Pradesh (the rain shadow area) were selected for the project with climate vulnerability of drought, with 70% of rainfed agriculture.

Selection of farmers
The respondents for the study were the beneficiaries and non-beneficiaries of NICRA. The list of NICRA beneficiaries was taken from KVK and 100 respondents were selected by simple random sampling technique. Thus, a total of hundred beneficiary farmers were selected.

Statistical tools
Frequency, percentages, Mean, Standard Deviation and Correlation were the statistical tools used for the study.

Results and Discussion
The results are based on analysis of the data with regard to Knowledge about climate resiliency, adoption pattern of climate resilient technologies, factors responsible for adoption and economic impact of these technologies. The results are presented, discussed and interpreted under the following rubrics:

Knowledge on climate resiliency
It was indicated that majority of the respondents (45.00 %) were having medium knowledge on climate resilient technologies followed by high (30.00 %) and low (25.00 %) categories respectively.

It can be concluded that seventy five per cent of the respondents have good knowledge on climate resiliency. The reason behind their knowledge levels on climate resiliency is attributed for their participation in the different activities such as taking up demonstrations on climate resiliency and capacity building programmes under NICRA project**.** The results are in concurrent to Jasna (2015)

Table 1: Distribution of respondents according to their Knowledge on Climate Resiliency

Sl.no	Category	Frequency	Percentage
1	Low (<15.79)	25	25.00
2	Medium (15.79 – 19.30)	45	45.00
3	High (>19.30)	30	30.00

Mean: 17.55 SD: 3.50

Relationship between independent variables with Knowledge

From the table (2) it was analyzed that all the independent variables like Age, education, land Holding, Farm experience, Mass media exposure and extension contact are highly correlated with the knowledge of farmers on climate resiliency at 5 per cent level of significance.

Table 2: Correlation coefficient between Knowledge and independent variables

S. No.	Independent variables	Correlation Coefficients('r' value)
1.	Age	0.60**
2.	Education	0.90**
3.	Land holding	0.51**
4.	Farming experience	0.58**
5.	Mass media exposure	0.76**
6.	Extension contact	0.36**

Adoption of climate resilient technologies

Distribution of respondents according to their Adoption of Climate of climate resilient technologies

It was recorded (table 3) that majority of the respondents (60.00 %) were adopting climate resilient technologies in their farms.It can be concluded that majority of the farmers were adopting climate resilient technologies due to their increased levels of knowledge and availability and feasibility of the resilient technologies.

Table 3: Distribution of respondents according to their Adoption of Climate Resilient Practices

sl.no	Category	Frequency	Percentage
1	Low (< 4.81)	25	25.00
2	Medium (4.81 – 9.81)	60	60.00
3	High (>9.81)	15	15.00

Mean: 7.00 SD: 4.36

Relationship between independent variables with Adoption

From the table (4) it was analysed that the independent variables like Age, Education, Farming experience, and Mass media exposure are highly correlated at 5 per cent level of significance. Whereas land holding and Extension contact are significant at 1 per cent level of significance.

Table 4: Correlation Coefficient between adoption and independent variables

S. No.	Independent variables	Correlation Coefficients('r' value)
1.	Age	0.70**
2.	Education	0.69**
3.	Land holding	0.23*
4.	Farming experience	0.70**
5.	Mass media exposure	0.76**
6.	Extension contact	0.27*

Adoption pattern of climate resilient technologies by NICRA farmers In NRM (Natural Resource management)

From the table (5) it was found that under Natural resource management majority of the farmers (84.00 %) are adopting the practice of ridges and furrows to conserve moisture at 30 to 35 DAS in all rainfed crops like red gram, Bengal gram, jowar etc. Thirty seven per cent of the farmers have adopted drip irrigation method to irrigate their fields. Thirty per cent of the farmers reclaimed their saline soils with the application of recommended dose of gypsum. It can be concluded that the importance of conserving moisture in rainfed crops was well taken by the farmers of the Project village. Drip irrigation method was practiced by the horticulture farmers. The adoption farm pond technology was meager because the technology was adopted by only big farmers.

Reclamation of soils was taken up by the farmers whose soils are saline in nature. Traditional compost pits are existing in the village for every farmer. The farmers who had gone for modernized compost pits are young educated and economically better

Table 5: Adoption pattern of climate resilient technologies by NICRA farmers in NRM

Technology		Adoption	
		F	%
Natural Resource Management	Farm Ponds	11	11.00
	Compost pits	10	10.00
	Insitu moisture conservation measures like Formation of ridges furrow between crop rows at 30-35 DAS	84	84.00
	Resource conservation measures like introduction of drip irrigation	37	37.00
	Reclamation of sodic soils with gypsum as per pH	30	30.00

Adoption of climate resilient technologies by NICRA Farmers in Crop Production

In crop production (table 6) majority of the farmers (92%) are adopting drought tolerant varieties of rainfed crops like, red gram, Seteria, Yellow jowar and Bengal gram. Seventy two per cent of the farmers are going for alternate crops like Seteria in place of cotton and maize. Likewise intercropping system with Seteria and Red gram (68%) was also being widely practiced by the farmers.

It can be concluded that the majority of the farmers practicing of sowing drought tolerant varieties can be attributed to the availability of seed at kvk, seed bank of the village and the increased knowledge of the farmers on climate resilient agriculture. Alternate crop taken up by farmers can be attributed for their past experience (failure of long duration crops like cotton and maize) and increased knowledge level through project. Intercropping of Red gram and Seteria was widely accepted because of the several demonstrations organized in the village and visualization of the economic benefits of bimodal distribution of rainfall.

Table 6: Adoption of climate resilient technologies by NICRA Farmers in Crop Production

Technology		Adoption	
		F	%
Crop production	Alternate cropping pattern like fox tail millet - Suryanandi and SIA-3085	72	72.00
	Drought tolerant varieties of red gram Seteira, & Bengal gram	92	92.00
	Intercropping systems like Seteria + Redgram (5:1)	68	68.00

Economic impact of the climate resilient technologies

Cropping intensity with intervention of percolation tank

From the table 7 it was understood that the copping intensity was increased by 70 percent with the cultivation of crops in rabi season also. Likewise the income from the cultivation of crops increased nearly three folds.

It can be concluded that the de silting of the percolation tanks helped to raise the water levels of the bore wells surrounding the tank. Due to the availability of water in the bore wells helped to provide protective irrigation in Kharif and additional area of cultivation in rabi lead to increase in cropping intensity.

Table 7: Cropping intensity in NICRA village with intervention of percolation tank

Cropping intensity		Income in lakh rupees	
Before	**After**	**Before**	**After**
100 (80 ha)	170 (136 ha)	12.5	32.5

Inter cropping of foxtail millet (*Seteria*) + Red gram (5:1)

It was evident from the table (6) that intercropping of red gram with Seteria (5:1 ratio) proved economical over the farmers practice. With the practice of intercropping there is addition net income of Rs 15,620/ha.

It can be concluded that intercropping system is more economical in scarce rainfall zone of Andhra Pradesh. The bimodal distribution of rainfall helped to give better economic returns in intercropping system with different crop durations.

Table 8: Inter Cropping of Foxtail millet (*Seteria*) + Red gram (5:1)

Crop/Cropping System	Seed yield (kg/ha)	Fodder (kg/ha)	Cost of cultivation (ha/ac	Gross income (Rs/ac)	Net income (Rs/ac)	B:C ratio
Farmers' Practice Setaria (Sole)	1400	1588	14070	21000	6930	1:1.49
Demo Seteria + Redgram	919 (S) 394 (R)	1470	15228	38080	22852	1:2.5

Economic benefit short duration cultivar of Red gram

The results (table 9) indicated that Red gram variety PRG-176 with Improved production technologies gave higher yield (926 kg/ha), which was 6.2 per cent than that of farmers practice (864 kg/ha) in medium black soils.

The Economic Viability of improved technology over farmers practice was calculated depending on prevailing prices of input and output costs. The improved technologies resulted increased income with cost benefit ratio of 1:2.11/1.90.

Table 9: Economic benefit of short term cultivar of Red gram

Comparison of Treatments	Seed yield (kg/ha)	Percentage In Crese	Gross cost (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	Percentage increase	BC
Treatment / Demo PRG-176	926	14.3	23655	50004	26349	27.00	2.11
Farmers practice –Asha	810	-	24530	43,740	19,210	-	1.78

Economic benefit of drought tolerant Bengal gram Cultivar

From the table (7) it was recorded that the variety NBeG-1 performed well with 22 per cent enhanced yield over the farmers practice. In terms of the income the variety gave 21.9 per cent more than the farmer's variety.

It can be concluded that the varierty NBeG-1suited well to scarce rainfall zone. The additional yield obtained by this variety is due to its heavy rooting traits and tolerance to heat.

Table 10: Economic benefit of drought tolerant Bengal gram cultivar

Treatments	Seed yield (kg/ha)	% Increase	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	% Increase	B:C ratio
Farmers practice JG-11	1035	-	30150	39330	9180	21.9	1:1.3
Improved varieties (NBeG-1)	1262	22.0	27954	47956	20002		1:1.7

Conclusion

From the findings of present study it can be concluded that, as an instrument for inducing resilience to agricultural system, climate resilient technologies had managed to imprint its positive and intended consequences on various dimensions affecting human being and his surroundings. The interventions were able to make NICRA beneficiary farmers to stand a step forward towards achieving climate resilience. Apart from technological implications, the interventions put in enhancement in economic sectors.

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