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Factors Influencing the Adaptation Behaviour of Rice Growers to Climate Change in Andhra Pradesh, India

G. Ravindra Babu[1], P.V.K. Sasidhar[2]* and Nisha Varghese[3]

[1]Ph.D. Scholar & Deputy Director of Agriculture, Department of Agriculture, Guntur, Andhra Pradesh, India
[2]Professor, [3]Associate Professor, School of Extension and Development Studies, IGNOU, New Delhi, India
*Corresponding author email id: pvksasidhar@ignou.ac.in

HIGHLIGHTS

- Deep summer ploughing and the use of suitable high-yielding varieties were adopted by all the farmers.
- Education, farm income, and information-seeking behaviour had a positive effect on the adaptation behaviour of rice cultivators, whereas farm size, farmer-to-farmer information exchange, and change resistance were found to have a negative influence on the adaptive behaviour of farmers to climate change.
- Lack of suitable varieties and quality seeds, price fluctuation in the market, low technical knowledge on climate-resilient rice cultivation, and lack of availability of weather-based insurance for rice were the most important problems in adaptation to climate change.

ARTICLE INFO

Keywords: Climate change, Adaptation practices, Rice growers, India.

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ABSTRACT

The rice producers of Andhra Pradesh face the problem of declining productivity due to climate change factors. Climate change has hit the paddy growers of Andhra Pradesh hard and they need to adopt adaptation practices to counter the effects of changing climate. The study has identified and ranked the adaptation techniques followed by 240 paddy growers on the basis of extent of adoption. Multiple regression analysis was done to identify the factors influencing climate change adaptation behaviour of the rice cultivators. It was observed that education, farm income and information seeking behaviour have a positive effect on the adaptation behaviour, whereas farm size, farmer to farmer information exchange and change resistance were found to influence negatively the adaptive behaviour of farmers to climate change. The problems faced by the farmers in adaptation to climate change have also been identified and ranked. Lack of suitable varieties and quality seeds, price fluctuation in the market, low technical knowledge on climate resilient rice cultivation and lack of weather based insurance for rice cultivation were the most important problems that the rice cultivators faced in adaptation to climate change.

INTRODUCTION

Andhra Pradesh (commonly known as rice bowl of India) is the eighth largest in India covering an area of 1,60,205 km^2. There are two regions in the state namely Coastal Andhra and Rayalaseema and hence, the two regions are more often referred as *Seemandhra*. There are 13 districts, nine (9) in Coastal Andhra and four (4) in Rayalaseema. The rice productivity in Andhra Pradesh varies across districts and ecosystems, with an average yield of 3,333 kg/ha. The state contributed 7.89 million tonnes of rice in 2024-25 from 2.16 million hectares of land that was put to rice cultivation (Khokhar, 2025). Due to rapid climate change, many abiotic factors such as rainfall, drought, flooding, temperature, and solar radiation are severely affecting the production of rice at various growth stages. It is predicted that almost 51 per cent of rice cultivation and production would be reduced during the next century due to global climate change (Hussain et al., 2020). *Basmati* and *Sona Masoori* are popular rice varieties cultivated in Andhra Pradesh using a blend

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of traditional and modern knowledge. There has been a marked decline in the production of rice owing to the adverse effects of climate change on rice cultivation in the state.

Rice cultivation is heavily dependent on climatic factors, particularly rainfall and temperature, making these variables crucial for understanding seasonal crop dynamics (Kumar et al., 2025). Any fluctuations in rainfall and temperature can have a significant impact on rice productivity, resulting in yield variability. Similarly, greater maximum and minimum temperatures which imply a cloud-free atmosphere, more sunshine hours, and warmer night temperatures, all of which stimulate photosynthetic activity and assimilation, resulting in higher rice yields. The shortened growth period, combined with reduced biomass production, ultimately results in a significant reduction in crop yield (Blum, 2005; Kamoshita et al., 2008). The decline in area and production has been attributed to drought like conditions and adverse weather patterns such as cyclones during the previous season (Rao, 2024).

By taking appropriate steps towards adaptation, it is possible to change the climate challenges into opportunities to increase crop yields. These actions mainly include changes and adjustments in the farming systems, such as soil and water management practices and shifting of crop cultivation dates. Studies show that farmers' adaptive capacity and adaptation behaviours are largely shaped by factors associated with the nature of the farming household (Khan et al., 2022). So, adaptation which is identified as one of the measures to reduce the negative impact of climate change in agriculture is needed urgently to reduce the adverse impacts of climate change in the state. Considering the importance of adaptation to climate change so as to reduce the adverse effect of climate change on rice cultivation in Andhra Pradesh state, this study was taken up to study the adaptation behaviour of rice cultivators to climate change, to identify the factors that influence the adaptation behaviour of rice growers, and important problems that the rice cultivators faced in adaptation to climate change in Andhra Pradesh.

METHODOLOGY

Out of 13 districts of the state, three districts viz East Godavari, West Godavari and Krishna were selected purposively for the study as they are the highest rice producing districts under Godavari and Krishna Delta regions with fertile soil and full irrigation facilities. Out of these three districts, two mandals from each district were selected using simple random sampling technique. The selected mandals were Samalkot and Kajuluru (East Godavari), Unguturu and T.P. Gudem (West Godavari), Mudenepalli and Movva (Krishna). From each mandal, two villages were selected using simple random sampling technique. Thus a total of twelve villages were selected for the study. Twenty, respondents from each village were selected, thus making a total of 240 respondents. Data were collected from the selected respondents by using the interview schedule developed for the study.

Based on review of literature and expert consultation, 13 profile characteristics of rice growers were selected and included in the study. They include gender, age, education, size of household, farm size, farm income, farming experience in rice cultivation, farmer to farmer information exchange, knowledge about local agro-climate, credit and subsidy orientation, information seeking behavior, preparedness for adaptation and change resistance.

Adaptation to climate change was operationalized as the capacity of the rice growers to adapt themselves against the adverse effects of climate change by adopting the adaptation practices (both traditional and scientific practices) in terms of total number of adaptation practices and total score of adoption of the adaptation practices. Twelve climate resilient adaptation practices which were followed by most of the farmers and endorsed by state department of agriculture were considered in the present study. A score of one (1) is assigned to each of the 12 practices, if the farmer follows the practice. The total score was then obtained by summation of only those adaptation practices that were followed by the farmers. Secondly, the same farmers were asked about the level of adoption of the 12 practices on three-point continuum, viz., full adoption, partial adoption and non-adoption with assigned score of two (2), one (1) and zero (0) respectively. Thus the total score of adaptation of every farmer to climate change was obtained as follows:

Total score of adaptation to climate change = Total number of adaptation practices followed by the farmers + total score of adoption to adaptation practices.

Multiple Regression Analysis was further used to identify the most significant factors which influence the climate change adaptation behaviour of the farmers.

RESULTS

Level of adoption of the adaptation practices

The level of adoption of 12 adaptation practices by the farmers was analyzed and ranked (Table 1). It was observed that there was 100 per cent adoption in adaptation practices like deep summer ploughing and the use of suitable high-yielding varieties. These were fully adopted by all the farmers and ranked first. These were followed by use of well decomposed FYM (rank II) which was fully adopted by 81.25 per cent of the farmers, risk management through crop insurance (rank III) was fully adopted by 81.66 per cent of the farmers, rearing of livestock/mixed crop-livestock systems (rank IV) was fully adopted by 76.25 per cent, and adoption of Direct Sown Rice (DSR) (rank V) was fully adopted by 27.91 per cent of the farmers.

Factors influencing climate change adaptation behaviour of farmers

Multiple regression analysis was done to identify the factors influencing climate change adaptation behaviour of rice cultivators. The regression analysis (Table 2) shows that education, farm income, and information-seeking behaviour have a positive effect on the adaptation behaviour of rice cultivators. Farm size, farmer-to-farmer information exchange, and change resistance were found to negatively influence the adaptive behaviour of farmers to climate change.

The model summary for the regression model used to study the factors influencing climate change adaptation behaviour of farmers is given in Table 3. The R^2 value of 0.945 shows that more than 94 percent variation in the dependent variable is explained by the independent variables included in the model. Durbin Watson

Table 1. Distribution of the respondents according to their level of adoption of adaptation practices (N=240)

S.No.	Adaptationpractices	Level of adoption			Score	Rank
		FA %	PA %	NA %		
1.	Deep summer ploughing	100	0.00	0.00	720	I
2.	Use of well decomposed FYM	81.25	18.75	0.00	675	II
3.	Green manuring	32.50	27.08	40.41	364	VII
4.	Use of suitable high-yielding variety	100.00	0.00	0.00	720	I
5.	Early sowing/planting	11.25	20.00	68.75	177	IX
6.	Adoption of Direct Sown Rice	27.91	42.50	29.58	405	V
7.	Maintenance of adequate and uniform plant stand	26.66	44.58	28.75	406	VI
8.	Rearing of livestock / mixed crop-livestock systems	76.25	0.00	23.75	549	IV
9.	Risk management through crop insurance	81.66	0.00	18.33	588	III
10.	Change in irrigation systems to manage specific stresses during crop season	10.83	19.58	69.58	172	X
11.	Use of bio-fertilizers / botanical pesticides	15.83	11.25	72.91	168	VIII
12.	Off-farm diversification	0.00	17.91	82.08	86	XI

Note: FA = Full Adoption; PA= Partial Adoption; NA= No Adoption

Table 2. Multiple linear regression analysis of the independent variables with adaptation

Independent Variables	Coefficients[a]				
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	22.811	2.979		7.657	.000
Age	-.002	.022	-.005	-.088	.930
Education	1.495	.319	.474	4.688	.000***
Size household	.122	.152	.022	.801	.424
Farm size	-.406	.178	-.083	-2.282	.023**
Farm-income	.409	.160	.086	2.562	.011**
Farming experience in rice cultivation	-.001	.022	-.002	-.036	.971
Farmer to farmer information exchange	-.061	.033	-.063	-1.839	.067*
Knowledge about local agro climate	.070	.079	.044	.882	.379
Credit and subsidy orientation	.066	.069	.043	.962	.337
Information seeking behaviour	.126	.051	.188	2.498	.013**
Preparedness for adaptation	.031	.039	.039	.796	.427
Change resistance	-.208	.066	-.152	-3.155	.002***

Table 3. Model summary for multiple regression

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.972[a]	.945	.942	1.190	2.153

a. Predictors: (Constant), Change resistance, Farm-income, Farming experience in rice cultivation, Size household, Farmer to Farmer Information exchange, Credit and subsidy orientation, Farm size, Knowledge about local agro climate, Preparedness for adaptation, Age, Information seeking behaviour, Education

b. Dependent Variable: Adaptation

test value of 2.153 shows that there is no autocorrelation between the variables.

Problems faced by the rice growers due to climate change and its implication on adaptation to climate change

The problems experienced by farmers were categorized into four groups and are presented in Table 4. In production-related problems, lack of quality seeds and suitable varieties to sustain the climate change was the most important problem mentioned by 86.25 per cent of the respondents. This was followed by high cost of cultivation (77.91%), crop failure due to frequent cyclones and high incidence of pests (77.08%), and rainfed farming (74.16%).

In socio-economic problems, price fluctuation in the market was considered as the main problem by 89.58 per cent of the respondents, followed by requirement of money ahead of season for preparedness (76.66%), higher cost of labour (72.08%), preference for traditional practices of rice cultivation (70.00%), and lack of suitable farm machinery and farmers inclination to use it (64.16%). Technology can potentially play an important role in adapting to climate change. The most important problem was less

Table 4. Problems faced by the rice growers

Problems	Percentage	Rank
Production related problems		
Lack of suitable varieties and quality seeds	86.25	I
Crop failure due to frequent cyclones and high incidence of pests	77.08	III
Rainfed condition	74.16	IV
High cost of cultivation	77.91	II
Socio-economic problems		
Price fluctuation in the market	89.58	I
High cost of labour	72.08	III
Requirement of money ahead of season for preparedness	76.66	II
Lack of suitable farm machinery and farmers' inclination	64.16	V
Preference for traditional practices of rice cultivation	70.00	IV
Technology-related problems		
Lack of information concerning adaptation options	60.41	IV
Lack of information about the weather and climate	70.41	II
Lack of proper knowledge on alternative cropping systems	65.83	III
Low technical knowledge on climate resilient rice cultivation	74.16	I
Institutional problems		
Improper management of the drainage system and late release of canal water	88.33	II
Lack of proper storage capacity	74.16	V
Ineffective procurement system in the village	80.83	III
Non-availability of credit and subsidy facilities in the locality	77.50	IV
No weather-related insurance facility for rice	90.00	I

technical knowledge of climate resilient rice cultivation, which was mentioned by 74.16 per cent of the respondents, followed by lack of information about weather (70.41%), lack of proper knowledge on alternative cropping systems (65.83%) and lack of information concerning adaptation options (60.41%). Among institutional problems, no weather-related insurance option for paddy crop was considered as the major problem by 90.00 per cent of the respondents, followed by improper management of drainage system and late release of canal water (88.33%), ineffective procurement system (80.83%), non-availability of credit and subsidy facilities (77.50%) and lack of proper storage capacity (74.16%).

DISCUSSION

Irrigation management as an adaptation strategy to rice production at the farm level help offset negative impacts of climate change was also recommended by Ansari et al., (2021), in their study on adaptation to climate change in rice production in Central Java. They also observed that shifting the planting date is important for avoiding crop failure under spatially and temporally variable rainfall patterns. The other adaptation measures include maintenance of adequate and uniform plant stand, green manuring, use of bio-fertilizers/botanical pesticides to minimize chemical consumption, early sowing/planting, and change in irrigation systems to manage specific stresses during crop season.

Education enhances the adaptive capacity of the farmers by increasing awareness, knowledge, and skills. Education empowers individuals to make informed decisions, change behaviours, and develop innovative solutions to mitigate and adapt to the impacts of a changing climate. Those with higher levels of education have a higher capacity to adapt to climate change and a lower chance of suffering from its impact (O'Neill et al., 2020; Pathak et al., 2024). Similarly, high farm income also has a positive influence on the adaptation behaviour of farmers as it offers the financial means to invest in adaptive strategies such as drought-resistant crops, irrigation infrastructure, and soil conservation methods, thereby enhancing resilience to climate variability. The information-seeking behaviour of the farmers also positively influence adaptation to climate change. The individual's intention to actively seek information about climate change would determine their knowledge and attitude towards climate change, and this would in turn influence how they act or change their behaviours in response to that risk (Choo, 2023).

Human adaptation has been defined by IPCC (Intergovernmental Panel on Climate Change) as "the process of adjusting to actual or expected climate variability and its effects to moderate harm or exploit beneficial opportunities" (Field et al., 2025). Researchers, policy makers and practitioners together agree that the adaptation to climate change is not happening at the desired pace (Salami et al., 2010; Raghuvanshi & Ansari, 2022). Farmers exhibit varying degrees of resistance to adopting new practices in response to climate change, influenced by factors like access to information, financial resources, and the perceived risks and benefits of change. Around the world, urban farmers adjust to climate change based on the support they get from local institutions and personal and environmental factors (Mensah, 2025).

Most of the farmers had small and marginal holdings. As the size of the holdings of majority of the farmers was very small, they were limited by resources and access to information on climate change adaptation. This finding aligns with a study by Daberkow & McBride (2003) in the United States, which demonstrated that due to uncertainty and fixed production and information costs, there exists a critical farm size threshold below which smallholder farmers are unable to adopt newly introduced farming technologies.

Due to lack of quality seeds in the market and non-availability of rice varieties which can withstand the adverse climatic conditions, the farmers were unable to procure seeds on time. Farmers' access to quality seed of a diverse range of adapted cultivars is still impeded by insufficient and inefficient seed production and distribution systems, poor seed quality assurance, inadequate seed policies, and seed price (Hampton et al., 2016). Increased cost of chemicals like fertilizers, fungicides, insecticides and other production inputs is also a factor. Though the use of adaptive measures can reduce the impact of extreme weather, the cost of implementation depends on the seed price and additional inputs needed. Strong cyclonic storm poses a threat to coastal agriculture in Andhra Pradesh due to heavy rainfall and high wind speed associated with the storms, leading to considerable economic losses to farmers (Ponnurangam et al., 2019). The climate in Andhra Pradesh also favours many diseases in rice, especially sheath blight. Cultivation of varieties that are susceptible to diseases is an important reason for this problem. Rising temperatures and changes in rainfall patterns have direct effects on crop yields, as well as indirect effects through changes in irrigation water availability (Nelson et al., 2009; Mishra et al., 2024). Farmers adjust to the adverse effects of climate change based on the institutional and non-institutional support they receive. While agricultural research plays an important role in developing resistant varieties, agricultural insurance takes care of farmer's fear of crop loss due to adverse weather conditions.

The defunct market committees in the state are contributing to the price fluctuation in the market. The adaptation strategy also requires some capital for preparedness to combat climate change or reduce the impacts of climate change. No adaptation strategy can be successful without ensuring that the high-vulnerability populations have the financial, technical, and institutional resources they need to adapt (World Bank, 2020). High cost of labour discourages low-income farmers from hiring necessary farm labour for adaptation to climate change. Farmers still believed that using their own traditional practices would keep the cost of cultivation lower, and traditional practices were easy to follow. For instance, Direct Seeding of Rice is a very viable alternative to traditional transplanting, offering benefits like reduced water and labour requirements. However, only 28 per cent of the sampled farmers have fully adopted this practice in the study area. Selection of appropriate machinery is important to minimize detrimental effects or to correct existing anomalies (Sundaram et al., 2019).

Even though the farmers wanted to adapt to climate change, but lack of knowledge about adaptation practices hindered their adaptation to climate change. Climate information services help farmers in finding coping strategies for managing short-term climate risks (Singh et al., 2018). Thus, a lack of such knowledge would reduce the adaptive capacity of farmers. Knowledge about plant protection is very important for a farmer in Andhra Pradesh as the climate in the state favours many diseases. Lack of such knowledge would reduce the adaptive capacity of farmers.

Crop insurance is one of the important inputs for adaptation to climate change for the farmers in the state where the adverse impact of climate change reduced the production and also sometimes resulted in total loss of the crops. Adopting insurance can affect farmers' expected utility under risk. Insurance can indeed affect the skewness of the distribution of revenues, making farmers less prone to downside risk (Falco et al., 2014). Lack of transportation for marketing increases the transportation cost and thereby reduces the net profit of the farmers. This hinders farmers from accessing the much-needed production inputs for adaptation to climate change. Another problem faced by the farmers is the lack of efficient marketing facilities initiated by the state government in the rural areas. Farmers need money for the cultivation of crops in the next season. So, they need an efficient marketing facility for reducing transportation costs, reasonable market price of the produce, direct marketing with less involvement of middlemen, etc. Credit is an important factor in adaptation to climate change, and it should be readily available whenever needed by the farmers. The climate of Andhra Pradesh, with its varied relative humidity, is very favourable for the spoilage of rice in storage. Proper storage facilities are needed for the storage of seeds, which are to be used for sowing in the next season, and also for marketing at a later stage when the prices are favourable.

CONCLUSION

It was observed that deep summer ploughing and use of suitable high-yielding varieties were adopted by all the farmers; on the other hand, practices to minimize chemical consumption of pesticides and fertilizers, and early sowing were adopted by very few farmers. Regression analysis employed to identify the factors influencing farmers' behaviour towards adoption of adaptation practices shows that education, farm income, and information-seeking behaviour have a positive effect on the adaptation behaviour of rice cultivators in Andhra Pradesh, whereas farm size, farmer-to-farmer information exchange, and change resistance were found to negatively influence the adaptive behaviour of farmers to climate change. Various problems faced by the rice cultivators of Andhra Pradesh and their significance in the context of climate change adaptation were also discussed. It is important that the rice growers of the state adapt themselves to the changing climate so as to build resilience to extreme events.

DECLARATIONS

Ethics approval and informed consent: Informed consent was sought from the farmers during the course of the research.

Conflict of interest: The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors declare that during the preparation of this work, thoroughly reviewed, revised, and edited the content as needed. The authors take full responsibility for the final content of this publication.

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