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Adaptation Methods Practiced by Farmers in Response to Perceived Climate Change in Andhra Pradesh

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ABSTRACT

The study was aimed at analyzing adaptation methods practiced by farmers' and determining factors for adoption to climate change in the Andhra Pradesh (Zone-1 and Zone-6). A cross sectional household survey (by employing structured interview schedule), participant observations and focused PRA were conducted to collect the information on adaptation methods being practiced by 320 randomly selected farmers. The study employed descriptive statistics to types of adaptation measures exercised to cope up with the risk of the change in climate. The study also employed the multinomial logit regression to analyze the determinants of adaptation method extracted. Factors such as age, education, number of crops cultivated, use of new technology, extension participation, contact and farmer's commitment are the common determinants for adoption of practices.

INTRODUCTION

Climate change is affecting agricultural sector in India. The temperature will boom by means 1.7 to 4.78 °C by 2030-2080 with an increase in precipitation from 1.2 to 11.3 per cent influencing the agricultural and water sectors. Under medium-time period (2020–2039) weather alternate situation, crop yield is projected to lessen through 4.5 to 9 per cent, relying at the significance and distribution of global warming (Harikrishna et al., 2019). The solid drifts in climate change are evident, the likelihood of further changes occurring and the increasing measure of potential climate impacts give urgency to addressing agricultural adaptation practices more consistently (Chunera & Amardeep, 2018). The stable drifts in climate trade are obtrusive, the probability of further changes taking place and the growing measure of potential climate affects provide urgency to addressing agricultural adaptation practices greater continually. As agriculture zone has to face the antagonistic effects of climate change and climate variability, hence variation techniques are essential for farmers to deal with them (Chunera & Amardeep, 2018). There are various capability model options to be had for marginal trade of present agricultural practices, regularly versions of current weather chance management. The implementation of adoption methods is probable to have considerable advantages below moderate climate exchange for some cropping structures (Rakshit et al., 2016). However, there are limits to their usefulness under more intense climatic variations. Resent climatic condition there should be extra systemic changes in useful resource allocation want to be taken into consideration, consisting of targeted diversification of manufacturing structures, socio monetary circumstance and livelihoods (Dupdal et al., 2021). We say that achieving improved variation practices will require integration of weather trade-related problems with different risk factors, for example: climate variability and marketplace danger and with other coverage domains, inclusive of sustainable development. In order to support farm level decisions and minimize the loses in adverse climatic and weather conditions farmers' understanding about interaction of climate and agro-ecosystem need to be bridged through

inclusion of farmers' communication network (Ravikumar et al., 2015). In India, climate change in Andhra Pradesh was highly

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vulnerable and all the four districts of Rayalaseema area was highly vulnerable (Vincent & Balasubramani, 2021) then moderately in Krishna Godavari zone to climate change. State action plan on climate change for Andhra Pradesh was mentioned critical issues in agriculture was decrease in winter rainfall has a negative impact on winter crops (Rabi crops), especially in the rainfed areas, temperature fluctuations affect Rabi crops severely, decrease in area under crops on account of insufficient rainfall, particularly in the South- West Monsoon period, dryland areas of the state have annual rainfall less than 550 mm and farming is not viable and loss in fertility of soil in many areas due to excessive use of fertilizers and pesticides. The river basins and coastal areas are vulnerable to climate change influences due to converting precipitation and temperature styles.

In this context, in order to analyze adaptation methods practiced by farmers' and determining factors for adoption to climate change, two agro-climatic zones viz., Krishna Godavari zone-1 (Prakasam and Guntur Districts) and Scarce Rainfall zone-6 (Anantapur and Kurnool Districts) in the state of Andhra Pradesh were chosen to notice various diversification in their socio economic and agricultural practices by farmers.

METHODOLOGY

This study was undertaken within Andhra Pradesh, where farming is adversely laid low with weather variables which include rainfall and temperature. In Zone-1, two districts Guntur and Prakasam categorized as prone to climate variability were selected (Kumar et al., 2018). From every district, two mandals were selected based on 30 years' rainfall records and irrigated area of each mandal within the district. Selected two mandals were having deficit rainfall with high irrigated area (irrigated mandal) and deficit rainfall with low irrigated area (rainfed mandal). In Zone-6, districts viz., Kurnool and Anantapur, liable to climate variability (Kumar et al., 2018) were selected. One representative village from each selected mandals was selected to make a total of 8 villages. Forty farmers were selected randomly from each of the village randomly. Data collection was carried out through structured interview schedule, participant observations and focused PRA with farmers and local key informants. Adaptive measures practiced by farmers were categorized into soil and water conservation, crop cultivation, socio economic and livestock. The study employed descriptive techniques including multinomial logit regression. The MNL model was used based on the previous literature (Deressa et al., 2009 & Abid et al., 2015) on determinants of farmers' adaptation to climate change. The model is specified as follows.

$$P(-y = 1/x) = 1 - (P2 + P3 + \cdots Pj)$$

Y as dependent variables included; soil and water conservation practices, crop cultivation practices, livestock management and socio economic management practices. All were entered as individually in Stata software, whereas the X represents the factors that influence choice of the adaptation strategies and P1, P2…Pj as associated probabilities, such that P1 + P2 + … + Pj = 1. The change in X affects the response probabilities P (y = j/x), j = 1, 2 …J. The generalized form of probabilities for an outcome (dependent variable) with j categories is

$$\Pr(yi = j/x) - pr_{ij} = \frac{exp\,(X'\,\hat{a}_j)}{1 + \Sigma^{j}_{j=2} \exp(x'\,\hat{a}_j)} \quad j = 1,2, \ldots..j$$

For j>1, with respect to the explanatory variable provides the marginal effect of the independent variables which give as

$$\frac{\partial pi}{\partial xk} = p_j\,\beta_{jk} - \sum_{j=1}^{j=1} pj\beta jk$$

The marginal effects that shows the magnitude of the changes that occur on the dependent variable when there are corresponding changes in the independent variables was also estimated.

RESULTS AND DISCUSSION

Adaptation methods being practiced by farmers

The adaptation practices by farmers to cope with climate change can be used in combination. Four kinds of combination practices were identified and this section analyzes how respondents combined agronomic strategies, soil and water conservation, livestock and socio economic practices to adapt to climate change. Soil and water conservation practices comprises of maintaining of soil health, filed bunds, drainage channel and tillage operations according soil slope. Crop cultivation practices focused on farming system, selection of crops according to climate change and practices to enhance the situation in adverse condition. Livestock management practices are considering for study are rearing maintenance of livestock and their feeding pattern changes. A total 65 adoption practices considered for the study, in that 15 were soil and water, 25 crop cultivation, 10 livestock management and 15 as socio economic measures.

The detailed analysis revealed that cent per cent of farmers in the study area were found to practice laying of bunds along field boundary and deep summer ploughing shown in Table 1. But very less per cent found to practice provide stone pitching along terrace slopes (6.88%), vegetative soil coverage (17.50%), incorporating green manure crops (23.13%) and practicing digging farm pond for harvesting rain (23.75) followed by opening of trenches along field boundary (25.31%).

The results pointed out that high per cent of farmers found to adjusting sowing or planting dates based on rainfall (97.81%), cultivating drought resistant crops (85.63%) followed by crop rotation (83.75%), practicing seed treatment were followed by 80.63 per cent. Half of the sample farmers shifted mode of irrigation from flood to sprinkler/drip and taking up intercropping. 48.75 per cent of farmers following relay cropping. Nearly 30 per cent of farmers are adopting foliar spray of 2% KNO_3 or 2% urea solution and practicing broad bed furrow practices. Only 8.75 per cent of farmers are adopting reducing the quantity of use of fertilizers and pesticides followed by cultivating crops with tolerance to biotic stresses (7.5%). None of the farmers in study area are adopted agro-forestry system.

It was observed from Figure 1 that the major adaptation practices followed were feeding more concentrates to the livestock (77.78%) and change in feeding pattern to the livestock (73.91%). Less number of farmers sent some of livestock to relatives' house in other places/different village (9.66%). Least number of farmers adopted bringing fodder from government fodder depot/ cattle camps (9.18%). The results revealed that 93.75 per cent of sample

Table 1. Farmers' adaptive measures

S.No.	Adaptive measures	Practicing Farmers (%)
a)	*Through soil and water conservation practices*	
1	Practicing mulching using crop-residue	32.19
2	Laying of bunds along field boundary	100.00
3	laying of bunds across slopes	85.00
4	Optimizing drainage channels	31.56
5	Opening of trenches along field boundary	25.31
6	Vegetative soil coverage	17.50
7	digging farm pond for harvesting rain	23.75
8	Planting trees/ grasses on bunds	68.75
9	Planting trees/ grasses on slopes	27.81
10	Creating gully plugs to arrest soil erosion and free flow of water	55.00
11	Zero tillage system	35.63
12	Provide stone pitching along terrace slopes	6.88
13	Applying FYM in large quantity	77.19
14	Incorporating green manure crops	23.13
15	Deep summer ploughing	100.00
b)	*Through crop cultivation*	
1	Crop rotation	83.75
2	Cultivating new crop	46.25
3	Cultivating early maturing/short duration varieties	61.88
4	Cultivating drought resistant crops	85.63
5	Adjusting sowing or planting dates based on rainfall	97.81
6	Raising of nursery and transplant for possible crops	47.19
7	Taking up multiple crops / Diversification of crops	31.88
8	Practicing seed treatment	80.63
9	Taking up intercropping	52.19
10	Taking up mixed cropping	21.56
11	Adjusting spacing in crop cultivation	34.06
12	Making necessary changes in cropping pattern	60.31
13	Reducing the quantity of use of fertilizers & pesticides	8.75
14	Increase irrigation frequency	35.94
15	Shift mode of irrigation from flood to sprinkler/drip	55.94
16	Practice agro-forestry	0.00
17	Cultivating crops and cultivars with tolerance to biotic stresses	7.50
18	Emphasis more on livestock enterprise	40.00
19	Shift from farming to non-farming activity	24.38
20	Moving to IFS for climate resiliency	23.44
21	Foliar spray of 2% KNO_3 or 2% urea solution	31.56
22	Growing cover crops	17.81
23	Relay cropping	48.75
24	Strip cropping	9.06
25	Practicing broad bed furrow	30.94

farmers are borrowed money for farming and their needs (Figure 2). Three by forth of farmers are engage as wage labour in MGNREGA (78.13%) and wage laborers in others fields/other activities within the village (72.19%). 57.50 per cent of farmers are reduced daily expenditure on essential items like food grains, vegetables and fruits. Half of the sample farmers are migrating to cities for work, barrowing commodities and reducing their expenditure on non-essential items like clothing, phone recharge etc., It is observed that less per cent of farmers are postpone family functions like marriage, cradle ceremony etc., (11.56%).

Determinants of adaptation method

Regression analysis was employed to determine the relative influence of each independent variable considered in the study in explaining the variation in the adoption of practices of the farmer.

In adaptation of soil and water conservation factors (Table 2) of age and irrigation circumstance had negative effect on adoption, in comparison to old age farmers, young farmers were adopting greater and rather than irrigated circumstance farmers, rainfed farmers were adopting more technologies. Factors like education, wide variety of plants cultivated, material ownership, use of latest technology, extension contact and farmer's commitment are positively determining the adoption of soil and water conservation practices. Their marginal effects showed that increased the probability of adopting soil and water conservation practices by means of a component of 0.65, 0.61, 0.11, 1.02, 0.034 and 0.31, respectively.

In case of crop cultivation practices (Table 2) rainfed situation farmers were adopting more crop cultivation practices than irrigated as this variable showed negative impact and its marginal value showed that decreased the probability of adopting crop cultivation practices by a factor 0.021. Other factors of education, number of crops cultivated, annual income, livestock possession, use of new technology and farmer's commitment are positively determining and marginal effects indicate that increased the probability of adopting crop cultivation practices by a factor of 0.41, 1.04, 0.26, 0.07, 0.072 and 0.02 respectively.

With respect to livestock management adaptive measures (Table 3) factors determine are age, livestock possession, farmers' orientation, use of new technology, extension participation and trainings attended. Except age all are positively determines the adoption. The marginal effects indicate that livestock possession,

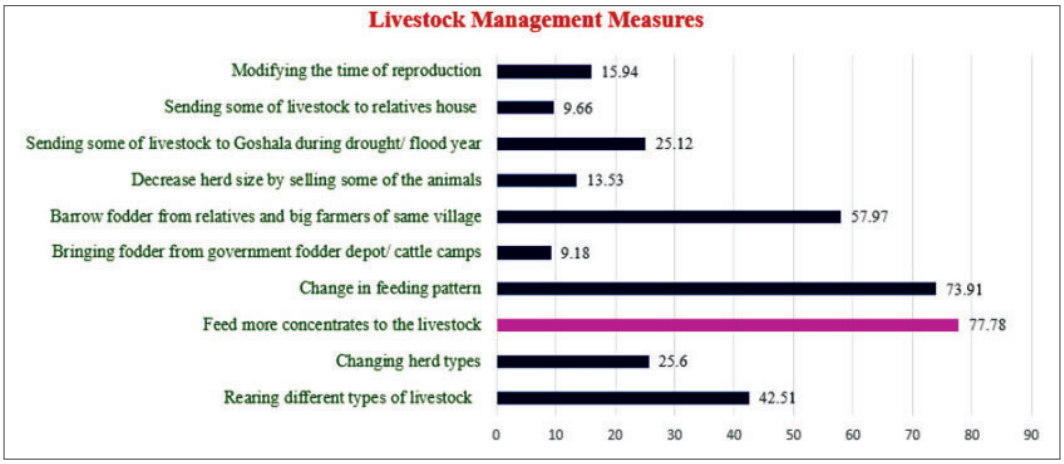

Figure 1. Livestock Management Measures

Figure 2. Socio Economic Adaptive Measures

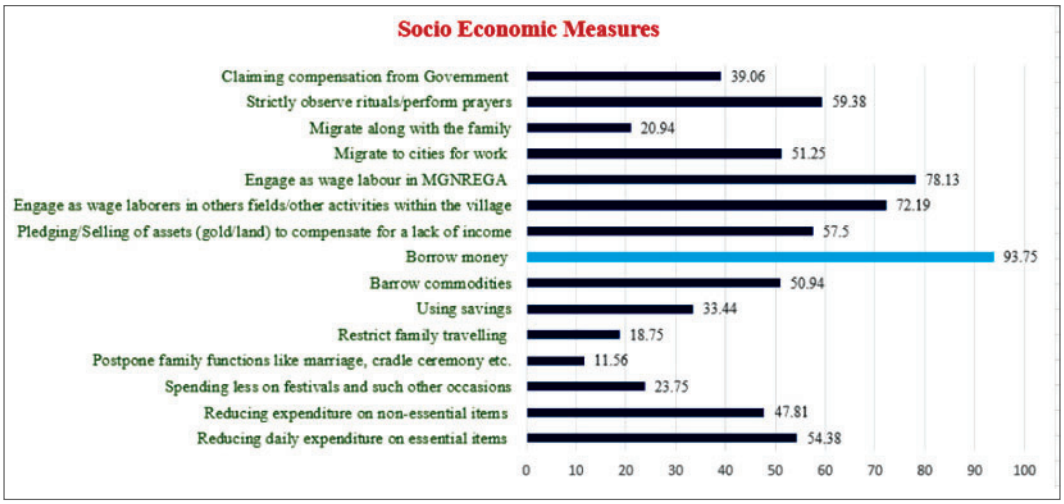

Table 2. Determining factors of farmers' adaptive measures for climate change

Variables	Soil and water conservation		Variables	Crop cultivation	
	Coefficient	Marginal effects		Coefficient	Marginal effects
Age	-1.56(2.34)	- 0.12	Education	0.14(1.81)	0.41
Education	1.23(2.01)	0.65	Rainfed/Irrigated condition	-1.71(3.01)	-0.021
Rainfed/Irrigated condition	-0.40(1.56)	- 0.34	Number of crops Cultivated	2.63(1.92)	1.04
Number of crops Cultivated	2.50(2.89)	0.61	Annual income	0.76(2.11)	0.26
Material Possession	0.57(2.64)	0.11	Livestock possession	3.03(1.27)	0.07
Use of New Technology	3.90(1.53)	1.02	Use of New Technology	0.04(2.85)	0.072
Extension contact	0.99(3.10)	0.034	Farmers commitment	1.51(2.67)	0.02
Farmers commitment	1.36(1.92)	0.31			
Prob > chi^2 0.0000			Prob > chi^2 0.0000		
Log likelihood - 359.62			Log likelihood -409.729		

Figures in parenthesis are Standard Error. Variables which are presented in table are significant at 5% level.

Table 3. Determining factors of farmers' adaptive measures for climate change

Variables	Livestock management		Variables	Socio-economic	
	Coefficient	Marginal effects		Coefficient	Marginal effects
Age	-2.02(1.60)	-0.305	Age	1.03(1.80)	1.23
Livestock possession	0.33(2.91)	0.20	Family Size	1.12(2.63)	0.96
Farmers Orientation	1.07(1.83)	1.90	Annual income	-1.35(2.34)	-0.41
Use of New Technology	0.04(1.84)	0.22	Use of New Technology	-0.32(1.68)	- 0.05
Extension participation	1.49(2.17)	1.26	Extension contact	2.12(2.13)	1.02
Trainings attended	1.10(3.11)	0.41	Trainings attended	-1.31(2.37)	-0.69
			Farmers commitment	-3.57(2.79)	-2.10
Prob > chi^2 0.0000			Prob > chi^2 0.0000		
Log likelihood -295. 93			Log likelihood -349.62		

Figures in parenthesis are Standard Error. Variables which are presented in table are significant at 5% level.

farmers' orientation, use of new technology, extension participation and trainings attended increased the probability of adopting livestock management practices by a factor of 0.2, 1.9, 0.22, 1.26 and 0.41 respectively. Age decreased the probability of adopting livestock management practices by a factor 0.305. Lastly socio-economic adaptive measures (Table 3) were determined by factors like age, family, size annual income use of new technology extension contact trainings attended farmer's commitment. Marginal effects indicate that age, family size and extension contact increased the probability of adopting by a factor of 1.23, 0.96 and 1.02 respectively. Annual income, use of new technology, trainings attended and farmers' commitment decreased the probability of adopting socio-economic management by a factor 0.41, 0.05, 0.69 and 2.10 respectively. Deressa et al., (2009); Deepthi et al., (2015); Ghanghas et al., (2015); Vanschoenwinkel & Passel (2018); Ntshangase et al., (2018) reported relationship of independent variables with adaption strategies.

CONCLUSION

This study revealed that farmers in the study area are aware of some climate change adoption practices. They have followed unique techniques encompass soil and water conservation practices,

socio economic measures and crop cultivation. There are few barriers which challenges the farmers to cope with the climate change. To increase the effectiveness in adoption of more practices by farmers, educate the farmers on impact of climate change, with respect to improve their farm income with mitigation of adverse effect of climate change (Fadina & Barjolle, 2018.). As the extension contact and participation was determining factors for adoption, through that contact informing about the risks they are exposed to climate change, knowledge on level of vulnerability, the adaptation practices, the existing capacity to adapt and the perceived barriers to adaptation may improve the situation.

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