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Adaptation to Climate Change: A Case Study of Farmers in The Krishna River Basin of Andhra Pradesh

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ABSTRACT

This study employed the binary logit model to analyze the adaptation to climate change, which initially assesses a farmer's perception that climate is changing, followed by an examination of the response to this perception in the form of adaptation. The analysis of factors affecting adaptation to climate change indicates that farm size, farming experience, access to credit and access to extension services are significant and positively effecting the adaptations of the farmers towards climate change.

Key words: *Adaptation, Climate Change, Nagarjuna Sagar Right Canal.*

Adaptation is identified as one of the policy options to reduce the negative impact of climate change (Adger,2006; Kurukulasuriya and Mendelsohn, 2006). Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2007). Common adaptation methods in agriculture include: use of new crop varieties and livestock species that are more suited to drier conditions, irrigation, crop diversification, mixed crop livestock farming systems and changing planting dates (Bradshaw *et al*,2004; Kurukulasuriya and Mendelsohn, 2006; Nhemachena and Hassan, 2007). Agriculture is the main sector of the Indian economy, despite of its high contribution to the overall economy, this sector is challenged by multitudes of factors of which climate related disasters like drought and flood, which often causes famine, are the major ones. The knowledge of the adaptation methods and factors affecting the perceptions to climate change enhance policy towards tackling the challenges that climate change is imposing on farmers of the basin.

MATERIAL AND METHODS

The study was conducted under Krishna river basin. Multistage random sampling technique was used to select the respondents covering three mandals,two villages from each mandal were selected. Thus the total sample of the study was 240 farmers.The surveyed farmers are spread over three different locations of the Nagarjuna Sagar Project, viz, Canal Head, Canal middle and Canal Tail . To study the factors influencing adaptations of farmers to climate change a simple tabular and logistic regression model was employed.

The logit model assumes that the underlying stimulus is a random variable which predicts the probability of adoption of new strategies for adaptation.

Conceptually, the behaviour model used to examine factors influencing adoption of new adaptations/technologies is given by

$$Y_i = g(I_i) \ldots\ldots\ldots\ldots\ldots 1$$

$$I_i = b_o + b_j X_{ji} \ldots\ldots\ldots\ldots 2$$

Where, Y_i is the observed response for the ith observation (i.e. the binary variable, $Y_i = 1$ for an adopter, $Y_i = 0$ for non adopter.)

g is the functional relationship between the field observation (Y_i) and the stimulus index (I_i).

I = 1, 2,..........m are observation on variables for the adoption model.

m = is the sample size

X_{ji} is the jth explanatory variables for the ith observation j= 1, 2, 3,............n

b_j is an unknown parameter ,where j=0,1,2,.....n. where n is the number of explanatory variables.

The logit model assumes that the underlying stimulus index (I_i) is an random variable which predicts the probability of new technologies adoption.

$$P_i = \frac{e^{Ii}}{1+e^{Ii}} \quad ....3$$

Therefore for the i[th] observation (an individual farmer)

$$I_i = \ln P_i/(1-p_i) = b_o +\text{”}\, b_j X_{ji} \quad ....4$$

The relative effect of each explanatory variable (X_{ji}) on the probability of new technology adoption was measured by differentiating with respect to X_{ji} i.e

$\frac{\partial Pi}{\partial Xji}$ Using the quotient rule

= [ ][ ].................5

The probability of adoption of new technologies (CA) is specified as a function of economic and social factors. It is represented as follows

CA = f(X1, X2 ...X9) + i 6

The attributes in equation 6 was specified in the empirical model to include the following variables: age, educational level, farm size, farm experience, access to credit, frequency of extension contact with farmers, house hold size etc.

RESULTS AND DISCUSSION

The variables hypothesised as affecting perceptions and adaptations to changes in climatic conditions along with their respective dependent variables as indicated below (Table 1).

Farmers' adaptation strategies to climate change:

The adaptation methods for this study are considered based on farmers' perceptions on climate change and the actions they have taken to counteract the negative impact of climate change. From the above table.1, it was shown that about 59.17% of the farmers in the study area reported to have adapted to climate change.

Farmers adaptation stralegies were depictied in Fig.1. As indicated on figure.1 above, use of water saving technologies was the most commonly used method which contributes to 29.19% of the total adaptation followed by crop diversification to extent of 13.3%, change to livestock up to 9.16% and off farm activities to an extent of 7.52%, where off-farm activities was the least adaptation practiced among the major adaptation methods identified in the Krishna river basin. Moreover, about 42.83 percent of the surveyed farmers reported not to have any adaptation method as indicated in the figure above due to many reasons.

Barriers of adaptation:

The analysis of barriers to adaptation to climate change in the study area indicates that there were five major constraints to adaptation. These were lack of information, lack of money, shortage of labour, shortage of land and poor potential for irrigation. Lack of information to adaptation options could be attributed to the fact that research on climate change and adaptation options have not been strengthened in the country and thus, information was lacking in this area. Lack of money hinders farmers from getting the necessary resources and technologies. Adaptation to climate change was costly, and this cost could be revealed through the need for intensive labour use. Thus, if farmers do not have sufficient family labour or the financial means to higher labour, they cannot adapt. Poor irrigation potential can most probably be associated with the inability of farmers to use the already existing water due to technological incapability. It can be seen in the fig.2, that the lack of information was the major constraint contributing to about 42.86%, followed by shortage of labour with 24.49%, lack of money with 18.37%, poor potential of irrigation with8.16% and shortage of land contributing to 6.12%.

Logistic regression model:

Quite a large number of studies have investigated the influence of various socio economic and cultural factors on the willingness of farmers going for new adaptation strategies. In many of the adoption behaviour; the dependent variable is constrained to lie between 0 and 1. In this study, the responses recorded are discrete (mutually exclusive and exhaustive) and therefore a univariate logit model was used to analyze the adoption behaviour of farmers to new adaptations to overcome the changing climate under NSP of Krishna River Basin. The logit model, which is based on cumulative logistic probability functions it is computationally easier to use than other types of model and it also has the advantage to predict the probability of farmers adapting to new technologies.

Table 1. Description of dependent of variable in the model.

Description	Dependent variable			
Adaptation to Climate Change	Farmers reported to have adapted	Percentage	Farmers reported to have not adapted	Percentage
	142	59.17	98	40.83

Table 2. Results of the logistic regression model.

Variables	B	S.E
Age (years)	0.232	0.218
Education (years)	-0.001	0.044
Farm size(ha)	0.074**	0.065
Farm experience (years)	0.232**	0.219
Size of the Household (number)	0.052	0.176
Access to credit (dummy-0,1)	0.602**	0.686
Access to extension services(dummy-0,1)	0.433**	0.350
Dummy_head (adapted-1,no adaptation-0)	0.108*	4.529
Dummy_middle (adapted-1,no adaptation-0)	5.085***	1.047
Constant	5.119***	1.066

***, **, * = Significant at 1%, 5% and 10% probability level, respectively

Fig 1. Farmers adapting to climate change (N=240).

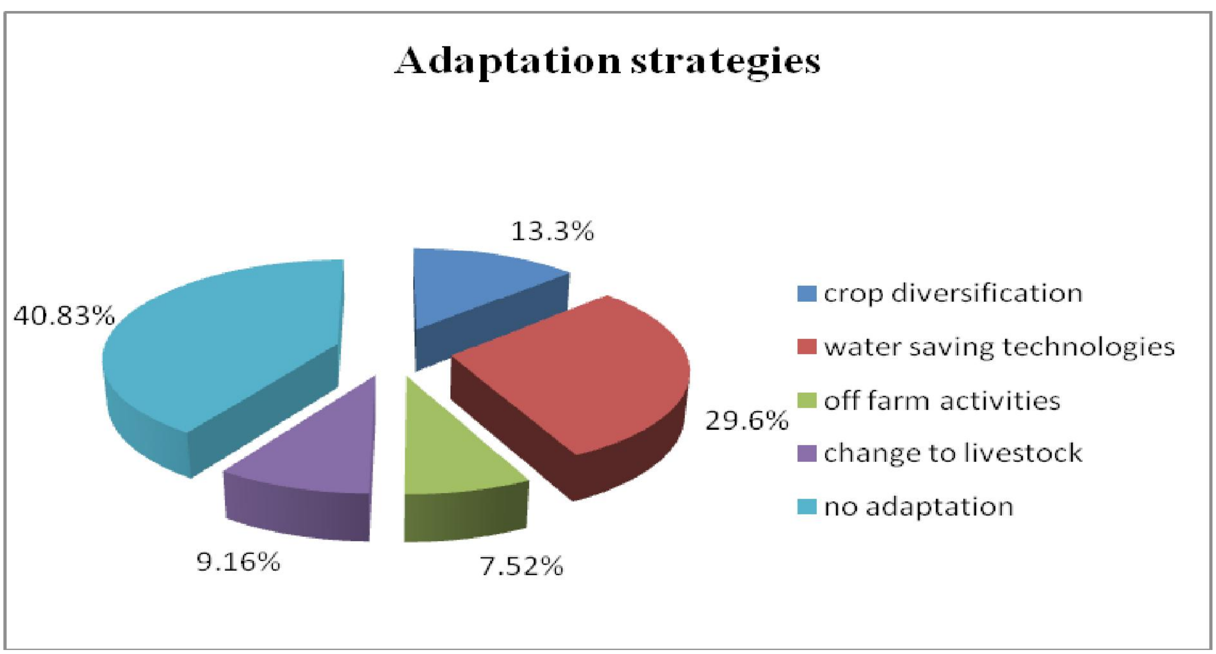
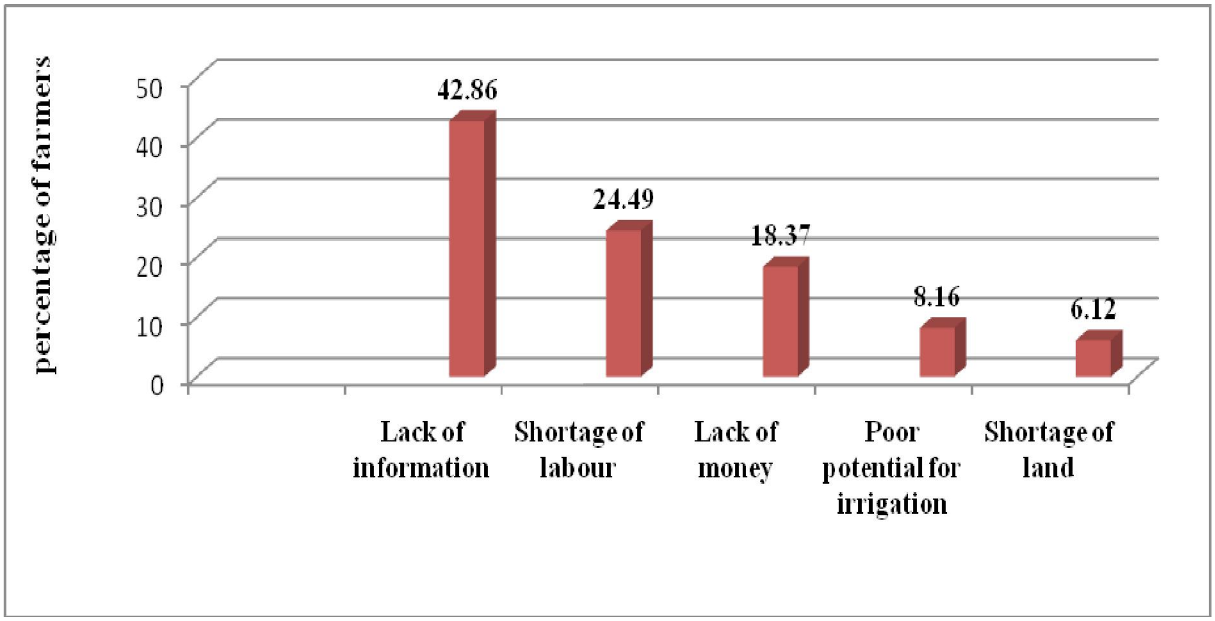


Fig 2. Barriers of adaptation.



The results from logit regression presented in Table 2 indicated that most of the explanatory variables affected the adaptation as expected, except age, education and size of the household. Variables that positively and significantly influenced adaptation to climate change include farm size, farming experience, and access to credit and extension services at 5% level of probability.

From the table 2, the results showed that unit increase in the farm size increase the log odds of adaptation to climate change by 0.074. Farm size was associated with greater wealth and it increases adaptation to climate change (Bradshaw *et al.,* 2004).

Similarly, increasing the farming experience by one unit increases the log odds of adaptation to climate change by 0.232. Studies indicate that experienced farmers have a higher chance of adapting to climate change (Maddison, 2006; Ishaya and Abaje, 2008). Likewise, increasing access to credit and increasing access to extension services by one unit increases the log odds of adaptation to climate change by 0.602 and 0.433 respectively. The results were in line with the findings of Deressa *et al*., (2009) that institutional support in terms of the provision of credit was an important factor in promoting adaptation options to reduce the negative effects of climate change. The results of the present study were in line with the findings of Maddison (2006) and Nhemachena and Hassan (2007) that access to extension services increase the chance of adapting to climate change.

The head, middle and tail regions had shown to have significance to adaptation to climate change. The three regions showed significance but tail and middle regions were significant at 1% level and head region showed significance at 10% level.

Differences in three regions had positive influence on adaptation decisions of farmers. Empirical studies on climate change and adaptation of farmers in Africa have shown that climate attributes in 15 different agricultural zones significantly affected adaptation (Kurukulasuriya and Mendelsohn, 2006).

Conclusions:

The analysis of factors affecting adaptation to climate change indicates that farm size, farming experience, access to credit and access to extension services are significant and positively effecting the adaptations of the farmers towards climate change.Based on the analysis of constraints to adaptation, factors that dictate adaptation to climate change of farmers to climate change in the Krishna river basin of Andhra pradesh, different policy options could be suggested. These policy options include, awareness creation on climate change and adaptation methods, facilitating the availability of credit, investment on yield increasing technology packages to increase farm income, creating opportunities for off- farm employment, research on use of new crop varieties and livestock species that are more suited to drier conditions, encourage informal social net works and investment on irrigation.

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