Socio-economic Impact of Climate Change, Adaptation and Determinants of Willingness to Pay for Crop Insurance in Central Agro-climatic Zone of Afghanistan

Meraj Sarwary[1,2], S. Senthilnathan[1*], A. Vidhyavathi[1] and S. Kokilavani[3]

[1]*Department of Agricultural Economics, Tamil Nadu Agricultural University, Coimbatore, India.*
[2]*Department of Agricultural Economics & Extension, Nangarhar University, Nangarhar, Afghanistan.*
[3]*Department of Agricultural Meteorology, Tamil Nadu Agricultural University, Coimbatore, India.*

Authors' contributions

This work was carried out by author MS under the guidance and supervision of author SS. Authors MS and SS designed the study, performed the statistical analysis and wrote the first draft of the manuscript. Authors AV and SK managed the literature searches and checked the first draft. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Afghanistan is frequently affected by drought and other climate change related hazards due to increased temperature and reduced precipitation over most parts of the country. The present study was undertaken to analyze the climate change preparedness measures for adaptation and willingness to pay for crop insurance to mitigate the climate change impacts. This study was conducted in central agro-climatic zone of Afghanistan to collect the primary data through the random sampling technique with a total sample of 105 respondents from the seven provinces located in this zone. Likert type responses were used to assess the climate change adaptation and binary log it regression model was used to identify the factors affecting the willingness to pay for crop insurance to mitigate the climate change impacts on agriculture. The results of the study indicated that changing cropping pattern (74%) followed by receiving technical information from

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Corresponding author: E-mail: senthilnathanagri@gmail.com;

experts (70%) and keeping the land as fallow (60%) were rated as very high to high preparedness measures to mitigate the climate change impacts. Logit regression model revealed that the education and technical information received from experts were positively significant and their marginal effects implied that the probabilities of willing to pay for crop insurance were increased by 1.3 and 15.9 percent, respectively. The establishment of crop insurance agencies at province level may help reducing the impact of climate change and increasing the income and livelihood of the farmers.

1. INTRODUCTION

Intergovernmental Panel on Climate Change (IPCC), referred the climate change is attributed to any change in climate variables over time, whether due to natural climate variability or as a result of human activity [1,2]. On the other hand, the United Nations Framework Convention on Climate Change (UNFCC), referred climate change as any change in climate that is related directly or indirectly to the human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods [1]. Climate change is a change in "average weather" in a given region experiences which includes all the features associated with the weather such as temperature, wind patterns and precipitation [3].

Climate change have direct and indirect impact on agriculture and food security, water resources, environment, infrastructure and livelihood of the people [4,5,6]. The farmers in the least developing countries such as Afghanistan are relatively more affected by the climate change and limited resources for adaptation leads to high vulnerability of farmers [7]. Afghanistan is a mountainous country exhibits the characteristics of arid and semi-arid continental climate which is located in the arid sub-tropics at 37° north of the equator [8].

Afghanistan climatic changes were mainly characterized by a mean temperature increase above global level of 1.8°C from 1950 to 2010 leads the situation will be aggravated in the future, particularly in regard to water management and agriculture [9]. Also, the temperature increased up to 5°C in several provinces in the country impacted on the productivity of irrigated and rainfed wheat [10]. Matthew et al. [8] found that the ecosystem services, soil water content, water from irrigation, firewood and grazing are most affected by the climatic hazards in Afghanistan. Agricultural related activities in mountain valleys were affected due to less irrigable water associated with increasing spring temperatures. Further, irrigated agriculture, livestock herders and dry land farmers were most susceptible to the impacts of the various climatic risks. Climate change leads to drought has serious economic impacts viz., loss of employment, reduction in crop yield and livestock production, migration, conflicts over water, health problems, malnutrition and limited food options. Environmental impacts of drought such as increase in temperature, pasture and forest degradation, deterioration of water quality, damage to fish and wildlife habitats and groundwater depletion were also significantly affected [11].

Afghanistan is frequently affected by drought and other climate change related hazards. The trend analysis indicated that precipitation was decreased over most parts of the country [12] and mean annual rainfall decreased at 2 per cent per decade and temperature increased by 0.13°C during the period from 1960 to 2008 [8]. Climate change and their related hazards affects human health, agriculture, water resources, ecosystem and damage household economic conditions [13,14]. For these unexpected climate events, one of the important adaptation strategy is crop insurance to protect farmers from shocks [15,16]. Insurance is an adaptive mechanism to protect farmers from losses caused by drought, flood, pest and disease infestation, all of which can be closely linked to climate change related factors. Insurance remains one of the practical pathways to future action on climate change adaptation [13]. Crop insurance is an important risk management tool for producers [17,18] and it has a crucial role in risk mitigation for both government and farmers' [16]. However, the studies related to climate change impact on agriculture were limited, hence the present study identifies the socio-economic impacts of climate change and the farmers' willingness to participate in the crop insurance as adaptation strategies to combat the climate change impact in the country.

2. STUDY AREA, DATA AND SAMPLING PROCEDURE

Afghanistan is landlocked multiethnic country located in the heart of South-Central Asia between 33° 56' 2.54" N Latitude and 67° 42' 12.35" E longitude [19]. Afghanistan has classified into seven agro-climatic zones covering all the 34 provinces of Afghanistan as Central, Eastern, Northern, North-Eastern, Southern, South-Western and Western agro-climatic zones shown in Fig. 1(a). The present study was conducted in central agro-climatic zone of Afghanistan consisting of the seven provinces (Fig.1b). Central agro-climatic zone is located in between 32°4'30" N to35°53'33" N and 66°16'55" E to 70°17'9" E. This zone bounded from north east side to north east zone, from north side to northern zone, west side to western zone, southwest side to southwest zone and from south & southeast to southern and eastern agro-climatic has border [12].

Central agro-climatic zone is the most populous region consisting of 28.76 percent of the Afghanistan population [19]. It is a mountainous area occupying 6676 thousand hectares from a total 65286 thousand hectares in the country and highly suitable for producing cereals, fruits and vegetables.

Central agro-climatic zone (CACZ) was purposively selected to collect the primary data through personal interview method. There are seven provinces in this zone and 15 samples were collected from each of the provinces with the total of 105 respondents located in this zone. The data was collected on a mixed approach to integrate quantitative and qualitative data to capture the perception of sample farmers about socio-economic impacts of climate change [20] and willingness to pay for crop insurance. Responses to an open ended question were coded with 1 for "Yes" and 0 for "No" and five point Likert scale were also used to code the farmers' response [11,21].

3. METHODOLOGY

3.1 Likert Scaling Method

Likert-type scaling was widely used in the field of social science studies. In a Likert-type scaling, respondents were asked to indicate degree of each statement in terms of several degrees about some events or attitude. This study was used five degrees of agreement or disagreement and coded the scaling as very high (5), high (4), medium (3), less (2) and very less (1) [22,23,24]. The data was collected for the nine statements which were relevant to this study. Each statement followed the procedure to express definite favourableness or unfavourableness by the respondents to a particular point of their view or attitude. After gathered the statements, sample respondents were asked for a five point scale to indicate their response to each statement by checking one of the categories of agreement or disagreement. The response to various statements was scored
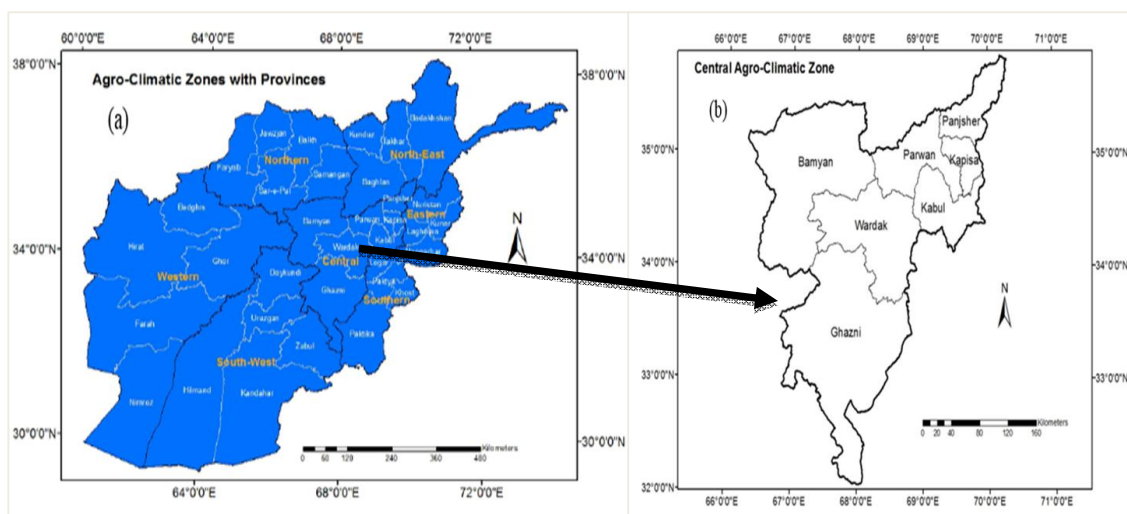

Fig. 1(a). Seven Agro-Climatic Zones with provinces and 1(b). Selected study area with provinces

and indicated that the most favourable attitude is given the highest score of (5) and that the most unfavorable attitude is given the lowest score (1). The total score of the respondent were obtained by adding the score that received from the separate statement and then the scaling is to array the total score and find out that statement which has a high discriminatory power [23,22].

3.2 Binary Logistic Regression Model

Logistic regression model has been used to investigate the relationship between binary or ordinal response probability and explanatory variables [25]. Since this model has been widely adopted from 1960s due to advantage in dealing with discrete variable outcome [26]. The general form of the a binary logit model is as follows

$$P_i(Y_i = 1)\frac{e^{X\beta}}{1 + e^{X\beta}}$$

Where,

P_i is the probability of Y equals to 1 if the sample respondents' willingness to pay for crop insurance, and 0 if otherwise; [25,26,27,28,29, 30,31].

Where;

$$X\beta = \beta_0 + \sum_{i=1}^{n} \beta_i X_{ki}$$

$$\frac{p}{1 - p} = e^{X\beta}$$

Moreover, the ultimate form of the Logit model is provided as follows:

$$ln\frac{p}{1 - p} = X\beta$$

Where $ln\frac{p}{1-p}$ is denoted as Logit (p), i.e.:

$$Logit\ (p) = X\beta = \ \beta_0 + \beta_1 X_1 + \ \beta_2 X_2 + \cdots + \ \beta_k X_k$$

In this model, each β indicated log odds ratio. In order to get the odds ratios results of the model, we can write the exponential of the βs, i.e.

Odds ratio = Exp (β).

An odds ratio represents how much likely Y= 1 is, as compared to Y= 0, corresponding to a given explanatory variable X. In other word, we can say that the odd ratio determines the likelihood of the sample respondents willingness to pay for crop insurance compared to non-willingness to pay for crop insurance, corresponding to a set of the socio-economic characteristics of the sample farmers [26,27, 30,31]. Coefficients of marginal effect are determined through the following formula:

$$ME = \frac{\partial \Lambda\ (X'\beta)}{\partial X} = \ \Lambda\ (X'\beta)[1 - \Lambda((X'\beta)]\beta$$

In this model, X denotes independent variables matrix in binary logit model, β is a matrix of parameters [26].

The binary logit regression model used to analyze the various factors responsible for willingness to pay crop insurance by the sample farmers to cope with extreme climate change impacts on agriculture. The sample farmers were enquired about whether they aware or do not have any idea about crop insurance. The farmers' those who aware of crop insurance was questioned about their willingness to participate and those who do not aware explained the importance of crop insurance and to make their choice of participation to protect the crop from vagaries of weather conditions [32]. Farmers' willingness to pay for crop insurance is of a discrete choice form (Y=1 if farmers willingness to pay for crop insurance and Y=0 if farmers not willingness to pay for crop insurance). The model was analyzed through STATA 14.1 version software. Explanatory variables used in the binary logit model and their expected sign [27] on farmer's willingness to pay for crop insurance were given in Table 1.

Age of the sample respondent's was measured in years and it is hypothesized that the increase in age, the respondents were less likely to explore willingness to pay for crop insurance compared with the young farmers. Education is one of the most important variables that influence the farmer's decision to participate in the crop insurance programme to bear the risks associated with climate change. Farmers with better education are earlier adopters of climate adaptation strategies and more willing to pay for crop insurance. The farmer having more experience, higher land holding size, access to technical information from experts and access to informal credit will be expected to positively associate with willingness to pay for crop insurance.

4. RESULTS AND DISCUSSION

4.1 Socio-economic Characteristics of Sample Farmers

A total of 105 households were interviewed from central agro-climatic zone of Afghanistan. The average age and farming experience of the respondents was about 43 and 26 years respectively. The major source of income was from agriculture followed by livestock were 41 and 33 percent respectively due to the farmers are mainly dependent on agriculture and related activities (Table 2). CACZ has two main agricultural seasons viz., summer and winter. Rice and corn were the major cereal crops cultivated during summer season and wheat and barley were cultivated during winter season. Wheat is the staple crop of CACZ covering 348208 ha followed by grapes (28770 ha), apple (14623 ha), maize (13989 ha), barley, almond, pomegranate, peach, rice, cotton, and saffron in this zone [19].

Climate related risks increases due to variation in rainfall and increase in temperature which affects the water resources lead to drought in the country. Similarly, the sample respondents also indicated that more area was irrigated through canals (40%) followed by springs (31%) and karizes (26%) during the normal year (Table 3). However during the drought year major source of irrigation was from bore wells (45%) followed by springs (33%).

The animal husbandry sector assumes greater relevance for contributing to the income in the central agro-climatic zone. The details of livestock possession of the sample respondents were shown in (Table 4). Climate change poses serious threats to livestock due to increased heat stress, reduced water availability, pronounced diseases associated to soil, water, humidity and transmission of animal pathogens are expected to adversely affect the livestock production and productivity around the world [27,33,34]. However, the farmer manage to safeguard the livestock for their livelihoods and the income generated from sheep, goat and cow were highly helpful during the year affected by climate related risks such as drought even if crop failures.

Table 1. Explanatory variables used in the binary logistic regression approach

Variables	Measurement	Expected Sign
Household Age	Continuous (year)	+/-
Respondents Education	Continuous (Years of schooling)	+
Farming Experience	Continuous (Years)	+/-
Farming Size	Continuous (Ha)	+/-
Household Income	Continuous (USD)	+
Technical guidance from experts	Binary (=1 if Yes 0 otherwise)	+
Informal Credit	Binary (=1 if Yes 0 otherwise)	+

Table 2. Sources of income by sample farmers

S. No	Income sources	Percentage
1	Agriculture	40.89
2	Livestock	32.79
3	Agricultural Labor	5.67
4	Small Business	13.36
5	Other	7.29
	Total	**100**

Table 3. Sources of irrigation by the sample farmers

Irrigation sources	Percentage of area irrigated	
	Normal year	**Drought year**
Canals	39.92	16.10
Springs	30.63	33.48
Karizes	25.89	5.93
Bore wells	3.56	44.49
Total	**100.00**	**100.00**

4.2 Climate Change Preparedness and Adaptation Measures

Climate change adaptation measures have two step procedure, the first one is climate change preparedness which is expected to occurring and the other one is responding to its various adaptation and mitigation measures such as willingness to pay for crop insurance to minimize the climate change impacts. The major climate change preparedness measures followed by sample respondents and their ratings were given in (Table 5). Based on the past experience, farmers have identified the variety of climate change preparedness measures to mitigate its impacts on agriculture. The rate of response given by the respondents as high and very high for receiving technical guidance from experts (70%), changing cropping pattern (74%), keeping the land as fallow (60%), reduction of water usage (47%) and diversifying crops (47%) were the major preparedness measures to mitigate the climate change impact in CACZ of Afghanistan.

4.3 Results of the Binary Logit Model for Willingness to Pay Crop Insurance

The result of the response on willingness to pay for crop insurance by the sample respondents was given in Table 6. It is indicated that 74 percent of the farmers' were willing to pay for the crop insurance scheme and 26 percent of the farmers' were not interested to participate in the scheme. Results of the binary logit model found that the LR χ2 is significant at 1 percent level (P=0.0001) indicated that the overall relationship between the explanatory variables and the probability of willingness to pay for crop insurance to combat the climate change impact was highly significant. The value of Pseudo R^2 was 0.253 revealed that all the explanatory factors explained 25 percent of the probability that farmers would willingness to pay crop insurance for climate change adaptive mechanism (Table 7).

From the results of binary logit model, age of the sample household was negative and significant at 5 percent implied that the age increasing by one year the probability of willingness to pay for crop insurance was decreasing at -1.3 percent since the elder farmers were less interested to pay for the crop insurance. As expected, the coefficient of education was positive and significant association with willingness to pay for crop insurance to mitigate climate change impacts. The marginal effect of education indicated that the probability of willingness to pay for crop insurance by sample farmers was increased by 1.3 percent compared since the educated farmers' were well aware of crop insurance to avoid the risk. The results also showed that the information received from the agricultural experts related to weather information were positively significant and its marginal effects implied that the probability of willingness to pay for crop insurance by those farmers were increased by 15.9 percent similar to the study conducted by [26]. Over all, the marginal effects indicated that the probability of prediction was 83.4 percent for willingness to pay crop insurance to mitigate the climate change impacts on agriculture similar to the findings by Jan [27]. Others variables did not show any significance on willingness to pay for crop insurance to climate change coping strategies.

The results of odds ratio for those variables which have one or more than one indicates that the probability of happening the event on willingness to pay for crop insurance will be more than the non-happening of event. The variables which are having more than one odds ratio were education (1.09), farming size (1.07), household income (1.00), and technical guidance from experts (2.74) will increases the chances of probability of sample respondents for willingness to pay for crop insurance as climate change adaptive mechanism similar to the findings by Jan [27].

Table 4. Livestock possession of sample households

Types of animal	No. of respondents	Livestock population (Nos)	Percentage
Cow	79	150	24.39
Bullocks	68	163	26.50
Sheep	44	210	34.15
Goat	30	92	14.96
Total	**221**	**615**	**100.00**

Table 5. Climate change preparedness measures adapted in CACZ of Afghanistan

Preparedness measures	Rate of response (%)						
	Very high	High	Medium	Less	Very less	Mean	SD*
Changing crop calendar/ cropping date	10.48	12.38	23.81	32.38	20.95	2.59	1.25
Cultivating low water consuming crops	10.48	20.00	47.62	17.14	4.76	3.14	0.98
Keeping the land as fallow	31.43	28.57	20.95	17.14	1.90	3.70	1.14
Changing traditional irrigation system into modern irrigation system	0.00	0.00	0.95	0.95	98.10	1.03	0.22
Water harvesting practices	12.38	24.76	24.76	22.86	15.24	2.96	1.26
Reduction of water usage	20.00	26.67	33.33	15.24	4.76	3.42	1.12
Diversifying the crops	17.14	29.52	31.43	18.10	3.81	3.38	1.09
Changing cropping pattern	36.19	38.10	16.19	7.62	1.90	3.99	1.00
Receiving the technical guidance from experts	45.71	23.81	16.19	8.57	5.71	3.95	1.22

SD denotes standard deviation

Table 6. Response on willingness to pay to crop for crop insurance

Willingness to pay to crop for crop insurance	Frequency (Numbers)	Percentage
Willing to participate (Yes = 1)	78	74.29
Do not willing to participate (No = 0)	27	25.71
Total	105	100.00

Table 7. Estimated results of the binary logit model on wiliness to pay for crop insurance

Indicator	Coefficients	P-value	Marginal effects (ME)	Odds ratio
Age	-0.093**	0.025	-0.013	0.911
Education	0.094*	0.085	0.013	1.099
Farming Experience	-0.005	0.885	-0.001	0.995
Farming Size	0.073	0.755	0.010	1.076
Household Income	0.000	0.838	0.000	1.000
Technical guidance from experts	1.007*	0.087	0.159	2.736
Informal Credit	-0.005	0.995	-0.001	0.995
Constant	4.320	0.014	-	-
Log likelihood	-44.700	-	-	-
LR χ2	30.310	-	-	-
Prob > χ2	0.0001	-	-	-
Pseudo R^2	0.253	-	-	-
Overall ME	-	-	0.834	-

***, **, * are significant at 1%, 5%, and 10%, respectively

5. CONCLUSION AND POLICY RECOMMENDATIONS

This study analyzed the climate change adaption measures and willingness to pay for crop insurance to mitigate climate change impacts. The major preparedness measures followed by sample respondents were changing cropping pattern followed by receiving technical information from experts, keeping the land as fallow, reduction of water usage and crop diversification to adapt the climate related risks in central agro-climatic zone of Afghanistan. The results of binary logit model revealed that education and technical information from experts were positively and significantly influencing the willingness to pay for crop insurance to mitigate climate change impacts. The marginal effect indicated that if education is increased by one year the probability of willing to pay for crop insurance by sample farmers was increased by 1.3 percent. Also, the information received from the technical experts will increase the probability of willingness to pay for crop insurance by 15.9 percent. Overall, the results of the study envisaged that the farmers were willing to participate in the crop insurance scheme as climate change adaptive mechanism. For this reason, government of Afghanistan may be considered to establish the crop insurance agencies at province level. Further, weather based crop insurance schemes, developing new varieties for rising temperature and increasing water use efficiency may be implemented to protect the farmers' from climate related hazards like drought and floods in the country.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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