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Perception of Paddy and Wheat Growers towards Climate Change in Punjab Agriculture

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Abstract

This paper assesses how farmer perceive climate change and its effects and consequences on Punjab agriculture. The primary data was collected from 200 farmers for the year 2016-17 from different agro-climatic zones of Punjab. The results revealed that more than three-fourth (83.5 % in Kharif and 93 % in Rabi) of the respondents perceived that temperature is higher than in the past and 77 per cent farmers perceived decrease in seasonal rainfall. The quality of grain of paddy and wheat as been affected by of climate change was perceived by 61.50 per cent of the respondents and a meager number (1.50 %) disagreed with the statement. To study the reasons and consequences of climate change, Garrett ranking method was applied which revealed that deforestation was the major reason with top rank with 7.01 Garrett's score followed by more use of fossil fuel (6.17 Garrett's score). Among various implications of climate change, the human health being affected got the top rank with 6.82 Garrett's score.

Keywords: *Perception, Garrett ranking, Climate change, Punjab*

JEL Classification: *Q15, Q54*

Introduction

The impacts of climate change accelerate the hydrological cycle resulting in changes in precipitation, evapotranspiration and in the intensity and frequency of floods and droughts, which eventually affect crop growth and development (IPCC, 2007). Equal distribution of rainfall all over the country is considered as boon, while the extreme events such as drought and flood constitutes natural hazard. Moreover, it has been noticed that the temperature in India has increased by 0.6º C over the past century, whereas the number of wet days and relative humidity has decreased (Rupa *et al.,* 2006). Similarly, the years 1972, 1979, 1987, 2002 and 2009 were recognized as the severe drought years (Rao, 2010). In the last four decades (1969-2005), in India for every decade, there was 0.3 °C increase in surface temperature, which along with climate change increased incidence of natural calamities such as floods, droughts, heat waves

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and cyclones (Goswami *et al*., 2006). The growing incidence and severity of droughts, floods, hailstorms and other extreme weather events severely affect the livelihood options for small-scale farmers (Swaminathan and Rengalakshmi 2016). Aggarwal (2009) revealed that a 1.0°C ascent in mean temperature would diminish the yields of wheat, mustard, soybean, potato and groundnut by three to seven per cent. By 2099, if the temperature would rise by 2.5° to 4.9°C, the damage to these crops will increase to 10 to 40 per cent. Kumar and Parikh (2001) and Sanghi and Mendelsohn (2008) predicted that by year 2099, there would be a 2.0°C rise in annual temperature and seven per cent decrease in annual rainfall. Venkateswarlu and Shanker (2012) have also indicated that water requirement is estimated to increase by 10 per cent for every 1°C rise in temperature which has serious implications on productivity and water use efficiency in several crops.

Climate in the Punjab state is undergoing change and experiencing greater variability in recent times. Climate change trends and projections suggest that rice and wheat yield, water level and energy use and consequently national food security and individual livelihood security are negatively impacted. Perceiving climate change is the foremost step in the process of adapting agriculture to climate change (Deressa *et al.,* 2011). A better understanding of farmers' concerns and the manner in which they perceive climate change is crucial to design effective policies for supporting successful adaptation of the agricultural sector. This knowledge will ultimately increase the trustworthiness of policies and their strength to deal with the challenges being imposed by climate change on farmers (Deressa *et al.,* 2009). Thus, it is important to know the perceptions of the farmers about climate change.

Data Sources and Methodology

Primary data source

To investigate the farmers perceptions towards climate change, a selection of the study districts were based on different agro-climatic zones of Punjab namely, semi-hilly i.e. kandi zone, central zone and south-western zone. For the selection of the sample farmers' multi-stage sampling technique was followed. In the first stage two districts viz., Gurdaspur and SBS Nagar from semi-hilly, Ludhiana from central and Faridkot from south-western zone were selected, respectively. Further, one block from each district and two villages from each block was selected randomly. Doraha, Balachaur, Dhariwal and Faridkot blocks were selected from Ludhiana, SBS Nagar, Gurdaspur and Faridkot districts, respectively. From each village, 25 farmers were selected randomly making a total sample of 200 farmers. The primary data were collected from the farmers through interview method. All the information were collected regarding cropping pattern, inputs used, output obtained and their current and past knowledge of climate change. The primary data collected from the farmers pertained to the crop year 2016-17 which was a normal year from the agricultural point of view.

Secondary data source

To fulfill the first two objectives, the secondary data on monthly temperature (maximum and minimum both) and rainfall was collected from five weather stations of Punjab namely Bathinda, Faridkot, Ludhiana, SBS Nagar (Ballowal Saunkhri) and Patiala for period of 30 years (1986 to 2015). In addition, information on yield and net irrigated area has been obtained from Statistical Abstracts of Punjab.

Garrett ranking method

This technique was used to evaluate the reasons and consequences of climate change. The farmers were asked to rank the given problem according to the magnitude of the problem. The orders of merit given by the respondents were converted into ranks by using the following formula:

$$\text{Percentage Position} = \frac{100\,(R_{ij} - 0.5)}{N}$$

Where,

R_{ij}= Rank given for the i^{th} item by the j^{th} individual

N_j = Number of items ranked by the j^{th} individual

The percentage position of each rank thus obtained was converted into scores by referring to the table given by Garrett and Woodworth (1971). Then for each factor the scores of individual sample farmers were added together and divided by the total respondents for whom scores were added. Thus, mean score for each problem was ranked by arranging them in the descending order.

Results and Discussion

The socio-economic characteristics such as age, education, family size, years of farming experience, size of holding, etc are expected to be the important determinants of adoption of any technology or practice. These characteristics always have direct or indirect bearing on the decision-making process of the sample farmers. Therefore, an overview of the socio-economic characteristics of the sample farmers under study has been presented.

The data given in Table 1 shows the descriptive statistics of the respondent farmers and revealed that about 52 per cent of respondents were in the age group of 35 to 55 years, which showed that the majority of them

Table 1. Descriptive statistics of sample farmers, 2016-17

Age of respondent (years)	**Number**	**Per cent**
25-35	53	26.50
36-45	60	30.00
46-55	44	22.00
More than 55	43	21.50
Educational status	**Number**	**Per cent**
Illiterate	13	6.50
Up to primary	24	12.00
Middle	35	17.50
Matric	52	26.00
Senior Secondary	50	25.00
Graduate	22	11.00
Post graduate	4	2.00
Family size	**Number**	**Per cent**
3-5	93	46.50
6-8	92	46.00
8 and above	15	7.50
Total sample size	200	100.00
Farming experience	**Number**	**Per cent**
Up to 10	44	22.00
11-20	48	24.00
21-30	55	27.50
31-40	29	14.50
41-50	20	10.00
50 and above	4	2.00
Total sample size	200	100.00
Particulars	**Average area**	**Per cent**
Owned land	2.97	70.38
Leased-in	1.25	29.62
Leased-out	0.00	0.00
Average operational holding	4.22	100.00
Particulars	**Average area**	**Per cent**
Tubewell	2.50	59.23
Tubewell + Canal	1.72	40.77
Total	4.22	100.00

were in the middle age group. The analysis revealed that the highest proportion (26 %) of the sample farmers had passed matric, followed by 25 per cent who had passed senior secondary, whereas 11 per cent were graduate and only two per cent were post graduate. It was evident from the results that the largest proportion (46.50 %) of the sample farmers belonged to the small sized families having three to five members followed by 46 per cent families having six to eight members. More than 50 per cent of the sample respondents had experience of more than 20 years in agriculture, which clearly revealed that most of the sample consisted of middle age group.

The overall average operational holding was 4.22 hectares in which 70.38 per cent had their own land and 29.62 per cent was leased in. None of the sample farmers leased out his land in the study area. All the area under sample study was 100 per cent irrigated through the tube wells and combination of tube well and canal.

Cropping pattern

Besides agro-climatic conditions, the resource endowment and the relative profitability of different enterprises also play a dominant role in determining the cropping pattern of an area. The Paddy and *kharif* ,wheat *rabi*were the major and crops grown respectively in the area under study on about 78 and 85 per cent of the total *kharif* and *rabi* cropped area respectively (Table 2). Maize was the next important crop in *kharif* season. It occupied 6.55 per cent area in the *kharif* season

Table 2. Cropping pattern among the sample farmers, Punjab, 2016-17

(In Hectares)

Crop	Average area	Per cent
Kharif		
Paddy	3.29	77.99
Cotton	0.10	2.41
Maize	0.28	6.55
Moong	0.09	2.23
Sugarcane	0.12	2.86
Fodder	0.21	5.01
Others*	0.13	2.95
Total *Kharif* cropped area	**4.22**	**100.00**
Rabi		
Wheat	3.57	84.60
Potato	0.21	4.98
Fodder	0.19	4.50
Sugarcane	0.12	2.84
Others*	0.13	3.08
Total *Rabi* cropped area	**4.22**	**100.00**

**Others include area under poplar in kharif season and in rabi season, it also includes vegetables like tomato and beans*

on the other hand in *rabi* season, Potato was another important crop in *rabi* season which was grown on about five per cent area.

Fodder occupied 5.01 and 4.50 per cent area in *kharif* and *rabi* season, respectively. It indicates the relative importance of dairying in farm structure. Hence, it can be inferred that the cropping pattern was dominated by wheat in *rabi* and paddy in *kharif* season.

Farm level perception of climate change and its related issues

The adoption and successful implementation of new technology by farmers in their ecosystems depend on their tendency to perceive and react favorably towards changes in climate. Hence, all of the respondents were asked a dichotomous ("yes/no" response) question about whether or not they had experienced changes in regional climate. Findings on farmer's perception regarding change in climate and their related issues have been presented in Table 3. The results revealed that majority of the sample farmers in this area experienced changes in the climate as they have been farming there for many years. Most of the sample farmers (77 %) perceived decrease in seasonal rainfall while 53 per cent of them perceived there was decrease in rainfall in *rabi* season. Further, the analysis revealed that the majority of the farmers (83.5 % in *kharif* and 93 % in *rabi*) perceived that temperature is higher than before (Figure 1).

Almost all the farmers perceived that there is an increase in temperature in both summer and winter seasons. These perceptions are matching with the results of trend analysis (Fig. 1a and 1b in Annexure I). According to, the mean temperature in *kharif* and *rabi* season shows a significant increase over the period of 1986 to 2015, while depicts a decrease in *kharif* and *rabi* rainfall over the same period. The uncertainty of the climate makes farming a risky operation, limiting farmers' willingness to invest in it. The riskiness will probably increase with climate change. Careful analysis of these changes and related risks can reveal viable options for farmers.

The respondents were further requried on other important climate related issues, which include changes in drought, floods and ground water availability. Almost 39 per cent of the farmers perceived an increased in frequency of drought in *kharif* season, while only five per cent of them were contrary to this opinion, which may be attributed to the high rate of desertification in the area. Whereas in *rabi* season, 36 per cent farmers perceived there are more drought than in the past. Similarly, the result indicates that there is a reduction in floods in both the seasons of the study area. All the farmers perceived that there was decrease in ground water availability in both the seasons.

Perception of the farmers regarding reasons and consequences of climate change

To find out the reasons and consequences of climate change, Garrett ranking technique was used. As per this method, respondents have been asked to assign the rank for all the problems and the outcome of such ranking has been converted into score value. First rank was given to the problem with the highest mean score and the lowest rank given to the minimum mean score (Table 4).

The study found that among various reasons of climate change, deforestation was the major reason with top rank with 7.01 Garrett's score. The sample farmers gave second rank to the more use of fossil fuel (6.17 Garrett's score). More use of chemical

Table 3. Perception of the sample farmers regarding the weather and its related issues, Punjab, 2016-17

(Frequency)

Parameters	*Kharif*		*Rabi*	
	Number of response	Per cent	Number of response	Per cent
Rainfall				
Increasing	0	0.00	0	0.00
Decreasing	154	77.00	106	53.00
Stayed the same	41	20.50	64	32.00
Don't know	5	2.50	30	15.00
Temperature				
Increasing	171	85.50	186	93.00
Decreasing	0	0.00	0	0.00
Stayed the same	13	6.50	6	3.00
Don't know	16	8.00	8	4.00
Droughts				
Increasing	77	38.50	72	36.00
Decreasing	10	5.00	0	0.00
Stayed the same	44	22.00	89	44.50
Don't know	69	34.50	39	19.50
Floods				
Increasing	0	0.00	0	0.00
Decreasing	78	39.00	67	33.50
Stayed the same	77	38.50	117	58.50
Don't know	69	34.50	16	8.00
Ground Water Availability				
Increasing	0	0.00	0	0.00
Decreasing	100	100.00	100	100.00
Stayed the same	0	0	0	0
Don't know	0	0.00	0	0.00

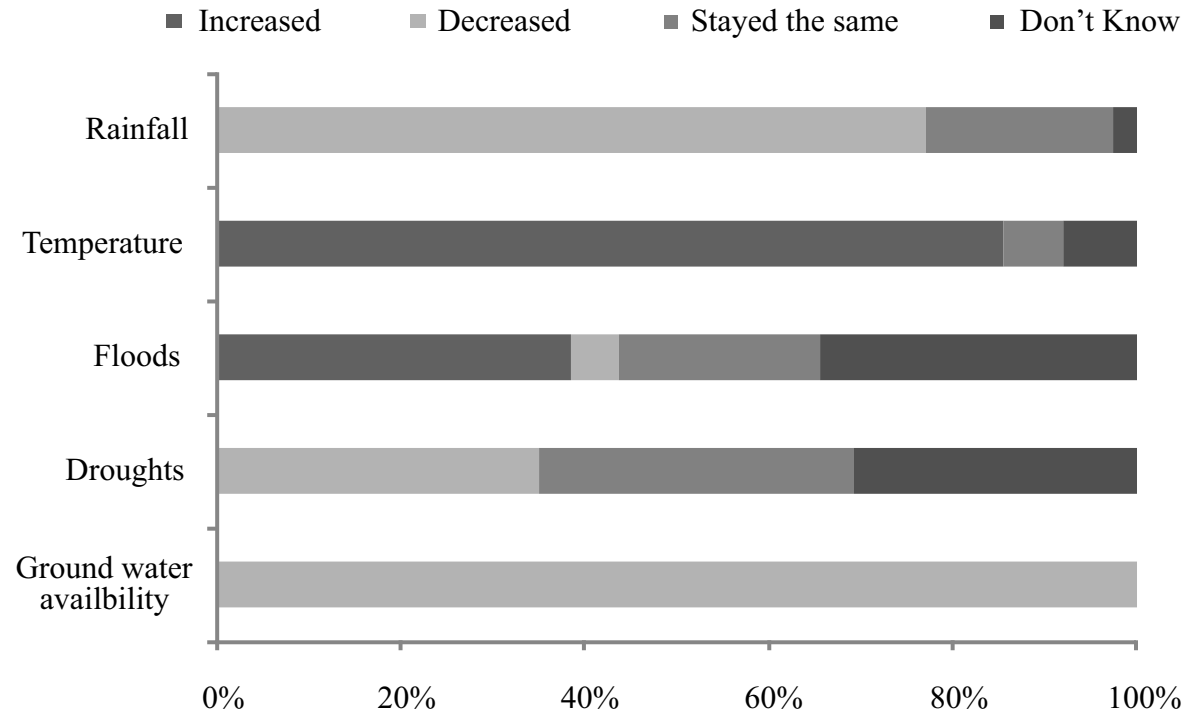

Figure 1. Perception of the sample farmers regarding weather and its related issues

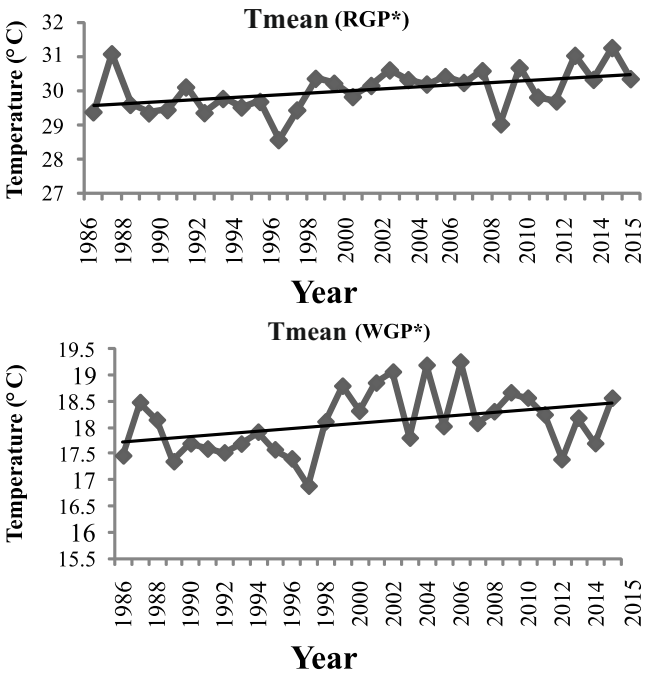

Fig. 1a: Trend in average mean temperature during rice and wheat growing period in Punjab, 1986 to 2015

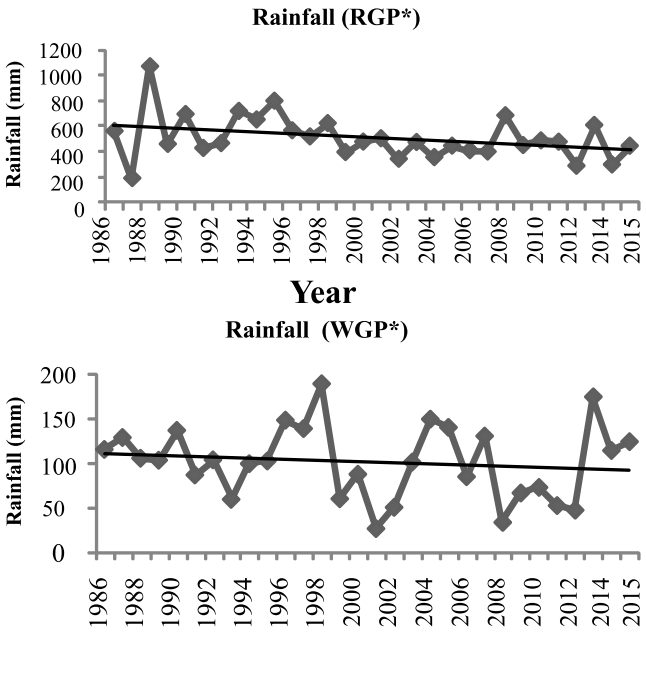

Fig. 1b: Trend in rainfall during rice and wheat growing period in Punjab, 1986 to 2015

**RGP and *WGP stands for rice growing period and wheat growing period, respectively*

Tmean stands for mean temperature

Table 4. Distribution of sample respondents according to their perceived reasons and consequences for climate change, Punjab, 2016-17

Reasons	Per cent Position	Garrett's Score	Rank
Deforestation	17.57	7.01	I
More use of fossil fuel	32.57	6.17	II
More use of chemical fertilizer	36.43	5.95	III
Over exploitation of natural resources	46.5	5.41	IV
Standing water in paddy cultivation	65.71	4.19	V
Lack of appropriate machinery (i.e straw baler and combine harvest with SMS attachment)	69.93	3.91	VI
Consequences			
Human health affected	21.64	6.82	I
Decline in crop yield (i.e foodgrains and vegetables)	27.74	6.45	II
Decreased drinking water availability	48.93	5.27	III
Increase in the number of diseases to the livestock	69.14	4.95	IV
Frequent occurring of natural calamities	54.93	4.81	V
Extinction of predatory birds (i.e owls, falcons, hawks, eagles	61.57	4.38	VI

fertilizer by the sample farmers having 5.95 Garrett's score got the third rank.

Further, among various consequences of climate change, human health being affected got the top rank with 6.82 Garrett's score. The second rank was given to the decline in yield of food grains and vegetable crops due to climate change (6.45 Garrett's score). The other consequences which resulted due to climate variability as perceived by the sample farmers were decreased drinking water availability, increase in the number of diseases to the livestock, frequent occurring of natural calamities, etc. in succession.

Perception of farmers towards impact of climate change on paddy and wheat production

Paddy and wheat dominated the cropping pattern of the respondents, therefore, only these two crops were studied in detail. The perceptions of farmers regarding effect of climate change on paddy and wheat production have been presented in Fig 2. The study revealed that more than fifty per cent of these respondents agreed with the statement that climate change has affected the date of transplantation of the non-basmati and led to delay in crop maturity. Slightly less than sixty five per cent agreed and only a few disagreed with the statement that climate change affects the number of irrigations.

The statement that climate change led to increased use of fertilizer application was agreed by 63.50 per cent of the respondents and disagreed by 10.50 per cent of the respondents. The quality of grain of these cereals crops was affected because of climate

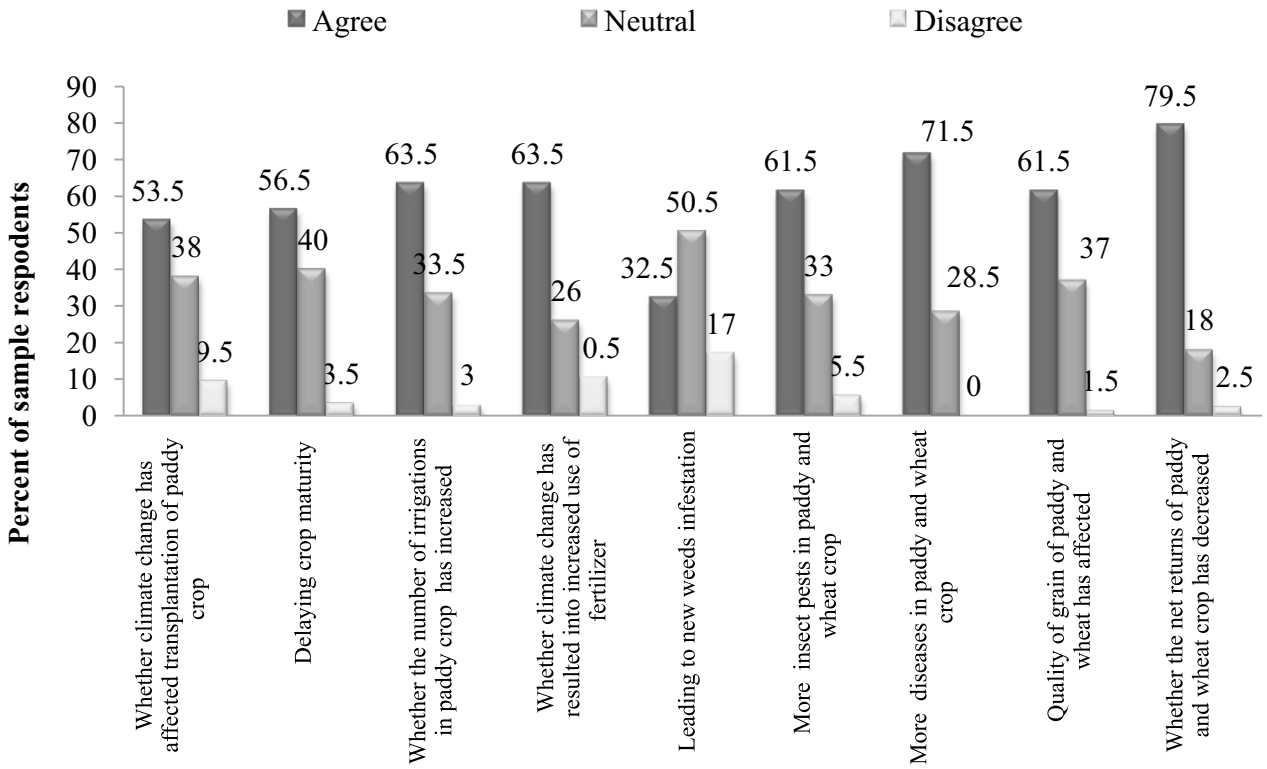

Figure 2. Perception of farmers towards impact of climate change on paddy and wheat production

change was perceived by 61.50 per cent of the respondents and a meager number (1.50 %) disagree with the statement. The whole effect of climate change is on the net returns from paddy and wheat as such, 79.50 per cent agreed and near about one fifth of the respondents had neutral response towards the statement that weather variability affects the net returns of these two crops.

Conclusion and Policy Implications

This study provides insights into the climate-related perceptions of farmers and concerns regarding negative impacts of climate change on agriculture at farm level. Identifying individual farmers' perception is important as it determines their responses and helps in designing a context-specific policy. The results revealed that, climate change would be an even greater threat to agriculture. Therefore, building capacity of the farmers and facilitating effective adaptations are important. The future policies need to address barriers to the adoption of advanced adaptation techniques at the farm level. There is a dire need for research on identifying locally specific adaptation of agriculture to climate change so that farmers can decide the most suitable adaptation measure to apply. The support from agricultural extension agencies, research institutions, policy makers and NGOs is also needed to mitigate these problems.

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