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An exploratory research on perception of Tarai region farmers towards climate change

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Abstract

The present study has been conducted in different agro-climatic regions of Uttarakhand, to explore the perception of Tarai region farmers regarding impact of climate change on their livelihood. A total of 60 Tarai farm households from Haridwar and Rudrapur district of Uttarakhand were drawn as sample with the help of multistage stratified random sampling technique. A farmer's perception tool- impact of climate change on livelihood was constructed to achieve research objectives. Percentage was applied as statistical tool to derive the result. Almost all the farm households in the Tarai region accepted that population growth; emissions and rising deforestation are among the key causes of climate change. It has been found that farm households are well aware of the causes and consequences of changing causes and effects of the weather. Majority of the farmers across the Tarai regions were agreed on the facts that climate is changing more dramatically now, temperatures are rising, rainfall is increasingly uneven every year and floods are becoming more frequent now.

Keywords: Exploratory, perception, climate change

Introduction

Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades to millions of years. Climate change can no longer be ignored as its consequences are becoming increasingly visible all over the world. Almost every year since 1992, is included on the list of warmest years, and according to the National Aeronautics and Space Administration (NASA) and The *National Oceanic and Atmospheric Administration* (NOAA), 2016 was the hottest year recorded and 2019 was 2nd hottest year on record for Earth. It is now perceived as the direst environmental and developmental challenge faced by humanity today. Farm families being totally dependent on agriculture, which is typically depends on climatic factors, are most vulnerable to Climate change. In research study it was found that temperature is increasing across the state. Also rainfall frequency and amount of rain are found decreasing in winters while, increasing in monsoon seasons in all selected districts. In Udham Singh Nagar, Nainital, Haridwar and Dehradun districts, climatic vulnerability was observed to be increasing over the years. Marginal and small farm households in bhabar regions are found more vulnerable. The accessibility of water is found as the major reasons behind water poverty of hills, whereas, lack of basic infrastructures like health facility, proper water supply, proper sanitation, lack of employment facilities, poor farming conditions and migration, etc. are found as the main reasons behind the high livelihood vulnerability of hill farmers. The increase in temperature mostly found to affect the crop productivity of all the selected crops negatively. Rainfall in the initial period of crop cultivation affected the yield of all selected crops positively, whereas, same downpour in the maturing and harvesting periods of crop had negative effects on productivity of crops.

The scientific data is an important tool for understanding changing weather patterns in various physiological zones of Uttarakhand. However, the experience of those who live and understand various ecosystem functions in the region is an equally critical tool to develop a complete climate change picture. With the change in lifestyles and adapting modernization how climate change is affecting the farm households this study digs deep into the perception and understanding of farm households to changing environment. Farm households of each zone are found aware of changing climate and opined that it changed significantly over the years, most importantly, that it is much less predictable than earlier. The erratic nature of the weather events and lack of predictability posed the greatest problem for the adaptation processes of the rural poor, who are lagging in basic infrastructures. A few studies refers that that farmers also opined that there is an increase in temperature in summer as well winter season, decrease in precipitation, changes in the timing of rains and increasing weather

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disparities and climate calamities, crops production, change in wheat cultivation cycles, decrease in milk and egg production in summers was also observed by the farm household. Many reviews suggested that that most of the studies related to the climate change, and livelihood vulnerability was done in abroad. There is hardly few studies have been conducted in Uttarakhand related to perception farmers regarding impact of climate change on their livelihood are yet to be explored. In light of above purview the study aims to *explore the perception of Trai region farmers regarding impact of climate change on their livelihood*. The study will is a new contribution and hence will help in addition of new knowledge about the farmer's opinion towards climate change and to establish a clear picture of affect of climate change.

Research Methodology

The present study has been conducted in different agro-climatic regions of Uttarakhand, to explore the perception of

Tarai region farmers regarding impact of climate change on their livelihood. A total of 60 Tarai farm households from Haridwar and U.S. Nagar district of Uttarakhand were drawn as sample with the help of multistage stratified random sampling technique. Purposive sampling was used to identify different categories of farmers, women and other key informants and compare their perceptions of climate change and consequent water management practices. The farmers were separated into large, medium and small on the basis of landholding size. The categorization was based on the understanding that each group might have different levels of vulnerability and adaptive capacity based on their resource base and factors affecting the same. A farmer's perception tool- impact of climate change on livelihood was constructed to achieve research objectives. Percentage was applied as statistical tool to derive the result.

Results and Discussion

Table 1: General perception of farm households about climate change in the terai region

S. No	Perception	Farm size group			
		Marginal	Small	Medium	Large
1	Understanding about the term climate (A1)	58	46	62	78
Causes of climate change					
2	Increase in pollution (A2)	100	100	100	100
3	Increase in population (A3)	100	100	100	100
4	Deforestation (A4)	100	100	100	100
Effects of climate change					
5	Glaciers are melting (A5)	70	78	72	74
6	Increase in sea level (A6)	28	25	30	30
7	Weather has become unpredictable (A7)	90	95	95	100
8	Decrease in water ground water level (A8)	75	86	72	68
9	Extreme climatic events (A9)	100	100	100	100

Availability of resource and level of education and awareness played a major role in farmers' perception on climate change and the extent to which the changing weather is affecting their livelihood. It is revealed from the table 1 that only 46 to 78 per cent of the farmers understand the term climate change across the farm size group. Most of the small and marginal farm households are aware of their changing surroundings and weather but rather unfamiliar with the term, whereas medium and large farm households are mostly well educated or well informed, they shared their insight about the causes and effects of climate change and their concern over increase in cost of production due to changing temperature and rainfall patterns. Farm households, in general opined that melting of glaciers, increase in sea level, unpredictable weather, and decrease in ground water level and extreme weather events are the climate change effects of the climate change. While the main cause of the climate change are reported as increasing population, increase in pollution and deforestation. Melting of glaciers, increase in sea level due to change in climatic make up, though they are threatening the lives of hills and coastal regions, only 25 to 78 per cent of the farmers perceived these effects of climate change across the farm size. But the most general effects like unpredictability of weather, extreme climatic events are opined by 100 per cent of farm households of all categories. All the farm households reported increase in air and water pollution. After the establishment of industries 100 per cent of marginal and small farmers reported deforestation while 100 per cent of marginal farmers and all the small, medium and large farm households opined that increase in population are main causes of climate change. Similar to above results Sarkar *et al.* (2012) [10] also examined the farmers' perception and attitude regarding climate change

in coastal ecosystem of West Bengal. His finding of the study revealed that less than one fourth of the respondents were aware about climate change. Whereas, farmers views were different and they felt climate change is real and it is already underway. Mixed type of attitude of people of Sundarbans area towards climate change were shown. Similarly, Shashidhara and Reddy (2012) [12] also conducted study to assess farmers perception towards climate change and explored the various barriers faced at the farm household level and farm-level adaptations measures and concluded that awareness of climate change is an important component of farm-level adaptation. Study reported that temperature has increased over the past few years, rainfall was very low in past three years and created drought conditions. Indeed, the study also found that perceptions on climate change were in line with the climatic data records. However, majority of farmers had adjusted their farming practices to account the impact of climate change. Lack of access to credit was cited by respondents as the main factor inhibiting adaptation.

In a study conducted by Rana *et al.* (2013) [9] with objective to examine the farmers' perceptions on climate change specially focused on locally idealized traditional weather cycles and responses were compared with climatic condition of different agro climatic zones of Himachal Pradesh. Farmers responded that climate change showed in temporal displacement of weather cycles, reflecting changes in crop enterprises and livelihood options. Climate is changing result of that temperature is increasing during summers season along with extended summers and delayed onset of winter with short winter periods. Responses of farmers clearly revealed that crop pattern and production is changing in the low and mid hill regions i.e. adopting cropping of basmati rice and

sugarcane crop who requires high moisture, instead of maize and local paddy rice crop which are sustain at lower water requirement. Similarly in study of Mertz *et al.* (2007) [4] a farmers group was interviewed and it was found that respondents were aware of climate variability and reported that most destructive climate factors were wind and occasional excess rainfall. It was concluded that awareness of climate issue among communities were high, but climatic narratives were likely to influence responses when questions mention climate.

Households perceive both positive and negative impacts of climate change on crop production and food security. Dahal

(2016) mentioned the positive impacts of climate change in the high mountains. He explained that farmers were growing vegetables, such as cauliflower, cabbages, tomato and cucumber, that were not possible a few years back. Some researchers [36–38] emphasized that some of the most profound impacts of climate change over the coming years will be on agriculture and food systems. Additionally, the extent to which households have the capacity to respond to or adapt to these changes has critical implications for human development at the household, community, national and global level.

Table 2: Perception of farm households about change in winters in tarai region (Percentage)

S. No	Perception	Farm size group			
		Marginal	Small	Medium	Large
1	Extreme winter duration reduced from 4 to 3 months (B1)	100	92	100	100
2	In winter season from (Nov-march) the month of Jan is much colder and march is hotter comparison to past years (B2)	92	94	100	96
3	Hoarfrost (Pala) and winter rain has declined (B3)	75	88	77	80
4	More intense sun light during winters (B4)	92	100	100	100
5	High variation in temperature throughout the days (colder morning and night and hotter afternoon) (B5)	100	100	100	100

Most of the farm households responded positively to the question of change in temperature, they felt that temperature in the summer and winter seasons have changed significantly with the duration of season. Table 2 presents the perception of farm households about the change in winter. It is deduced from the table as well as figure that almost all the farm households were of the view that extreme winter period

shrunk to 3 months from the usual 04 months, compared to past years whereas, intensity of sun light has increased. Cent per cent farm households across the farm size group opined that there is high variation in intraday temperature in the winters comparatively. While only 75 to 88 per cent reported that there is decline in the frost and rain in the winters.

Table 3: Perception of farm households' of tarai region about change in summer season (Percentage)

S. No	Perception	Farm size group			
		Marginal	Small	Medium	Large
1	More sweat (C1)	100	100	100	100
2	More intense heat waves (C2)	100	100	100	100
3	Humidity has increased (C3)	100	100	100	100
4	More prickly heat during summers (C4)	100	100	100	100
5	Prolonged summer season (C5)	100	100	100	100

Variations in perceptions of farm households of farm size group is almost negligible as can be observe in table, temperature change and variation there in are the physical phenomenon something a poor or a rich farmer can feel in the same way despite having the better facilities to cope with them. Summers are getting hotter and longer every year as all the farm households responded in favor of a change, viz., very hot and slowly but noticeably extending summer season. Table 3 shows the perception of farm households of tarai region about change in summer season.

Increase in temperature is a climatic factor farm households found most affected with. Farmers informed that it's getting difficult to work in fields during summers. The duration of summer was once from April to August which is now from March to October according to the respondents (100 per cent). As per the responses of farmers of all farm size groups it can

be said that increase in humidity and intense heat waves are making the physical suffering more and more severe. In a study conducted by Rana *et al.* (2013) [9], farmers responded that climate change showed in temporal displacement of weather cycles, and delayed onset of winter with short winter periods. Moreover, it was observed that temperature in winters recorded above than normal temperature during winters, snowfall during winters also decreasing and delayed in snowfall time low temperature spells at high altitudes during winters and unpredictable rainfalls. The perception of farmers are in line with the trend analysis results presented in table 3, summer season (April to October) have a rising in temperature in both minimum and maximum temperature. Also the diurnal temperature is decreasing. Hence it can be said that, farmers perceived the change in temperature in summer season correctly.

Table 4: Perception of farm households about change in rainfall in tarai region (Percentage)

S.no	Perceptions	Farm size group			
		Marginal	Small	Medium	Large
1	Increase frequency of intense and erratic rainfall events (D1)	84	92	92	96
2	Increase in events of flood and climate climates due to rain fall (D2)	100	100	100	100
3	Uneven distribution of rainfall (D3)	75	75	86	82
4	Variation in amount of rainfall over the year (D4)	72	74	76	82
5	Drying of water bodies (D5)	94	96	92	98

One of the biggest threats posed by climate change in India is water scarcity, both for agriculture as well as for domestic purposes. Climate change threatens to alter the quality and the distribution of water and with adverse effects on water-sensitive sectors like agriculture (NAPCC 2008). Using a qualitative approach, this paper looks into the perceptions of the farmers in four villages in the states of Maharashtra and Andhra Pradesh, to climate change in terms of the onset of rainfall, the distribution of rainfall, temperature along with the impact they perceive. It also looks into the accuracy of these perceptions as compared with actual available climatic data thus providing further ground in considering their importance in the adaptation process.

The Intergovernmental Panel on Climate Change (IPCC) has predicted that "rainfall patterns in peninsular India will become more and more erratic, with a possible decrease in overall rainfall, but an increase in extreme weather event and this is going to be worse in Uttarakhand". By observing the responses of farm households it can be said that the statement is now a reality for the farmers of tarai farmers. Table 4 depicts the perception of tarai farm households about climate change effect on rainfall.

The extraordinary rainfall in Uttarakhand in June in 2013 has found a place in a list of 16 extreme weather events, according to scientists this was a direct result of the climate change. Tarai region of Garhwal division is established along the Bay of Ganga River. From the last few years people of Uttarakhand has faced several adverse condition and climatic calamities. cent per cent respondents of all farm size group were of the opinion that the calamities are increasing over the years, 75 to 86 per cent farmers felt that the heavy and uneven rainfall are the reasons of such calamities most of the time.

Analysis revealed that in Haridwar (tarai) the rainfall frequency decreased in the winter season (November to march) and increased in the monsoon season (May to August). The rain in June, July and August is increased and showing a large variability in the amount and frequency over the year. Same trend was observed in the rainfall total. Farmers' perception appeared to be in accordance with the statistical data recorded.

Impact of climate variability on crop production Climate variability was perceived as presenting a risk to the farming communities amid concerns that income through agriculture had drastically reduced (Banjee, R. 2015. Monsoons are

highly varied in last few years, as opinioned by most of the farmers, one year it is weaker and causes less rain hence, loss of crops and earning of farm households while the next year due to heavy rainfall the farm households suffer from crop damage again, also the life of people are threatened due to the fear of flood and other disasters. Vedwan and Rhoades (2001) [13] also conducted study to examined the perception of apple farmers about climatic change and compared it with the locally idealized traditional weather cycle. The accuracy of perceptions was assessed through Snowfall and rainfall data collected from 1962–1996 year. Farmers expressed their views about climate change and reported that they experience climate change as the temporal displacement of the weather cycle but the changes themselves still were not perceived as altering the idealized weather calendar. Similar study was conducted by Jitendra *et al.* (2015) who explored the characteristics of monsoon rainfall and association with yield of Kharif rice. Study conducted in 55 districts spreading over five states in north Indian region and took 11 year of data. For analyzing Linear regression method of least square was used. Finding of the study revealed that monsoon rainfall was scanty in Haryana and Jammu and Kashmir state and not reliable with agriculture perspective. In Uttarakhand monsoon rainfall was quite plenty and agriculture can rely on it. Data showed that only Uttarakhand has shown a significant increase of monsoon rainfall in the last decade. Whereas, other states had shown non-significant increasing trend. Further, Yield of Kharif rice is found to be significantly influenced by rainfall climatology in August and September for all the states except Himachal Pradesh. Shankara *et al.* (2013) [11] results also concludes that as per the scientifically recorded climate data indicated that after 2000 there is gradual increase in rainfall but farmers perception not similar to recorded data they perceived decrease in the rainfall. The reason behind this perception among farmers was due to increased area under water intensive crops and short period of rainy days. Further, more than seventy-five per cent of farmers showed high level of perception about changes in temperature before 2000 while after the year 2000, almost all farmers reported high level of perception. Whereas it was found that all the farmers perceived that there was decrease in income, yield, soil nutrients and increase in pests, cost of cultivation, diseases and weed infestation due to climate change.

Table 5: Perception of farm households about effect of climate change on agriculture and livestock in tarai region (Percentage)

S. No	Perception	Farm size group			
		Marginal	Small	Medium	Large
1	Decrease in the production of crops (E)				
i	Wheat (E1)	64	56	56	52
ii	Barley (E2)	92	92	86	74
iii	Gram (E3)	94	84	84	82
iv	Mustard (E4)	76	72	88	72
v	Rice (E5)	84	78	62	65
2	Changes in flowering, fruiting and harvesting time of wheat (E6)	100	94	92	88
3	Increase in the occurrence of weed and diseases (E7)	72	76	74	74
4	Decline in the production of milk in summers (F1)	92	94	100	100
5	Negative impacts on reproductive performance of livestock (F2)	68	62	72	78
6	Decline in feed and fodder resources are decreasing (F3)	64	55	52	48
7	Increase in livestock disease incidences (F4)	66	52	54	56
8	Decline in egg production in summers (F5)	76	62	82	78

Table 5 present the perception of farm households of tarai region about agriculture and livestock. Farm households observed that there is a significant decrease in the production of barley and gram, while only 62 to 88 per cent farmers

experienced the decrease in the production of crops of mustard and paddy. Farmers strongly agreed to the fact that the changing rainfall and winter season period is affecting the wheat crop and hence it leads to the change of flowering

fruiting and harvesting pattern of wheat crop. It can be observed from the table that small and marginal farmers were more affected by the decrease in crop production. Large farmers, having better resources than small and marginal farmers, hence in case of a failed monsoon season or less winter rain, they put more irrigation into the farms to cope with. For marginal and small farmers a failed monsoon mostly means the decrease productivity of crop. Also a better technology adoption by large farmers helps them to cope with the effects of climate change and maintain the crop production levels.

Majority of farmers (92-100 per cent) opined that in summers milk production decreases. Sixty two to 78 per cent of households felt that the varied climatic conditions viz., increase in temperature and humidity are adversely affecting the reproductive performance and also the outburst of diseases in livestock. In general less than 60 per cent of farm households reported decline in feed and fodder in the summer season. Poudel *et al.* (2017) [8] attempted to find out changes in households food security and daily activities in the face of climate change for the last twenty years. Households expressed different levels of perception in terms of climate change on food security. The result shows that most of the mountainous households experienced increased temperature, less rainfall in winter, an increasing number of natural disasters and the emergence of insects for the last twenty years. They perceived the role of climate change in decreased crop production, decreased dairy products and increased household work. The situation of food security is likely to be more vulnerable to climate change in the future. It was also observed that households have been using different autonomous adaptation measures, such as high yielding crop varieties, enhanced irrigation systems and fertilizers, to cope with the changing climate.

Livestock sector plays key role on economy of rural farmers. Current trend of global greenhouse gas emission and rising temperature has greatly impacted the livestock sector in several ways. In present study medium and Large farm households, as clearly opinion about the changing effects of climate change on livestock. Small and marginal farm households usually have one or two livestock and most of them rare livestock for household needs, on the contrary medium and large farm household rare livestock for commercial purpose also, hence they were much concerned about their performance and health and have more knowledge about the effects and causes. a study conducted by Acharya *et al.* (2017) [1] that Milk yield, infertility and feed intake were major effects that farmer directly observed as climate change impact on dairy animals in study area. Farmer adapted major adaptation strategies were livestock diversification, involvement in natural resource conservation, interaction to extension personnel and involvement in cooperative. Unavailability of technology, lack of adaptation knowledge, weak government extension service and lack of credit facility were recommended area of intervention to decrease the risk of climate change among dairy farmers.

In his Study Acharya *et al.* (2017) [1] have assessed the dairy farmer's perception on climatic variation, impact on livestock health and farmer following adaptation strategies based on household survey in western Nepal. Most of farmer were aware of increasing climatic variation. Number of climatic hazards were seen, and experienced by farmers. Most of them observed sharp reduction in water level in local rivers. Reduced in milk yield was most noticed direct impact of climate change for dairy farmers in study area. Infertility and

decreased feed intake were also recognized as important climate induced impact on livestock production. Farmers had been practicing different adaptation strategies both knowingly and unknowingly. Livestock diversification, natural resources protection and approach to extension services were mostly adapted adaptation strategies. Many information regarding climate change have been disseminated in farmer level, however availability of farming technology, appropriate adaptation knowledge, ineffective extension service have created bottleneck towards increasing farmers ability to cope with climatic variation. Further, collaborative involvement of all concerned stakeholder (Dairy farmers, Agro-vet, Lab) should be placed into top priority to develop better understanding about the effect of changing climate in dairy animal.

Summary and Conclusion

It can be concluded from the above results, majority of households felt that the varying climatic conditions viz., temperature and humidity rise adversely affected reproductive output and also disease outbursts in livestock. In general, in the summer season, less than 55 percent of farm households reported declines in feed and fodder. Almost all the farm households in the Terai region accepted that population growth, emissions and rising deforestation are among the key causes of climate change. It has been found that farm households are well aware of the causes and consequences of changing causes and effects of the weather. Majority of the farmers across the Bhabhar regions were agreed on the facts that climate is changing more dramatically now, temperatures are rising, rainfall is increasingly uneven every year and floods are becoming more frequent now.

the perception of farmers about the climate change and revealed that farmers had insufficient knowledge about the climate related change and its possible impact but they had was indigenous knowledge to handle possible impact of climate change. A multivariate discrete choice model reveals that in farm-level adaptation, awareness of climate change and access to credit and extension were few important determinants and the climate change forces farmers to adopt new pattern and method to deal with climate change and there is need to enhance information about climatic and agronomic, access to credit as well as to spread knowledge about markets input and output which can significantly increase farm-level adaptation. Farmers perception play important role and understanding their perspective is helpful in developing adaptation plans to deal with changing effect of climate and shocks. Government should gather information and views of farmers regarding climate variability so gathered responses will be beneficial for policy makers.

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