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## Bhabhar region farmer's perception towards climate change: An exploratory research

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**Abstract**

The present study has been conducted in different agro-climatic regions of Uttarakhand, to explore the perception of Bhabhar region farmers regarding impact of climate change on their livelihood. A total of 60 Bhabhar farm households from Nainital and Dehradun 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 Bhabhar 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.

**Keywords:** Brinjal, production. nursery, demonstration etc.

**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 2<sup>nd</sup> 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 bhabhar 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 Bhabhar 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 Bhabhar region farmers regarding impact of climate change on their livelihood. A total of 60 Bhabhar farm households from Nainital and Dehradun 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.

### Results and Discussion

#### Farmer's perception about climate change in bhabhar zone of Uttarakhand

The bhabhar region of Garhwal division taken for the study (Nenital and Dehradun) has emerged as an important educational business, and cultural hub in north India after being named the capital of newly carved out Uttarakhand state since the year 2000. Table 1 depicts the perception of bhabhar farm households on climate change (general). It can be deduced from table that 100 per cent farm households agreed that increase in pollution, pollution and increasing deforestation are some of the main causes of climate change. The farm households are found to be well aware of the changing weather cause and effects.

**Table 1:** The general perception of farm households of Bhabhar zone about climate change (Percentage)

S.NO	Perceptions	Farm size group			
		Marginal	Small	Medium	Large
1	Understanding about the term climate (A1)	38	42	46	46
<b>Causes of climate change</b>					
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
<b>Effects of climate change</b>					
5	Glaciers are melting (A5)	38	30	30	60
6	Increase in sea level (A6)	18	25	40	40
7	Weather has become unpredictable (A7)	82	94	94	96
8	Decrease in ground water level (A8)	52	64	44	56
9	Extreme weather events (A9)	100	100	100	100

It was observed during the household survey that farmers of bhabhar have very clear views and responses about different questions asked about the changing climate and its possible effects. Several industries namely, pharmaceutical and chemicals, electronic and electrical engineering, food processing and glassware were established in the region in the last few years causing alarming increase in pollution. The major conversion into built up area in the city took place from agricultural land, forest areas and open spaces, resulted into loss in agricultural lands and deforestation. Alarming increase in vehicular traffic has been observed in the city after the formation of the state and initiation of growth in population, urbanization and industrialization process. All the farm households (100 per cent) were of the view that increase in population, deforestation along with pollution are some of the major factors responsible for change of climate. While only 18 to 60 per cent of respondents related to the fact that changing climate is causing melting of glaciers and increase in sea level. Most of the farmers' were found unaware about an ice glacier. Sarkar *et al.* (2012) [8] 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, Shashidhra and Reddy (2012) [10] 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. Mishra and Sahu (2014) [3] also reported the farmers perception and their adaptability strategies to climate change. He revealed that there are various factors those are responsible for influencing behavior of farmers to adapt climate change and major of them were annual income, access to irrigation, access to credit facility and landholding size of the farming households. In a study conducted by Rana *et al.* (2013) [7] in Himachal Pradesh 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) 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.

#### Perception of farm households about change in winters in bhabar zone

All the farm household across size group responded the fact that winter duration is decreased and there is more intense sunlight and strong heat during day time in winters. Table 2 gives the idea about the perception of farm households of bhabar region about change in winter season.

**Table 2:** Perception of farm households of Bhabar region about winter season (Percentage)

S. No	Perceptions	Farm size group			
		Marginal	Small	Medium	Large
1	Extreme winter duration reduced from 4 to 3 months (B1)	100	100	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	96	94
3	Hoarfrost and winter rain has declined (B3)	94	88	88	85
4	More intense sun light during winters (B4)	100	100	100	100
5	High variation in temperature throughout the days (colder morning and night and hotter afternoon) (B5)	96	90	88	84

Bhabar region comes under the maximum rained zones of Uttarakhand. Also the physical make up of the region makes it a good rainfall receiver both in summers and winters, however 85 to 94 per cent of farm households have observed a decreasing trend in winter rainfall from the past few years which is causing crop loss. Variability in winters along the days as well months is increased as, 84 to 100 per cent farm households of all categories realized this and also supports the facts pointed out by the farmers. Farm households also informed that as compare to previous years in every coming years January is getting colder and March hotter. Some studies also revealed the same as perceived by the farmers, the maximum and minimum temperature in winter season (November to March) is increasing in Nanital and Dehradun. The change in temperature is affecting the intensity of winter and also resulted in the decreased duration of extremely cold winter months. In a study conducted by Rana *et al.* (2013) [7], 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.

#### Perception of farm households about change in summers in bhabar region

In past few years temperature of the region is crossing the marks of 50 degree Celsius in summers in the hottest days. Farm households felt significant change in summer season temperature and other factors. Table 3 shows the perception of farm households of different farm size group of bhabar region about summer and fig 4 explains it diagrammatically. All farm households were of the opinion that now there are more intense heat waves in summers and heat is also more prickly. The respondent felt the change in duration of summer (100 per cent) and opined that it's more humid and harsh now as compared to the previous years.

**Table 3:** Perception of farm households of bhabar region about summer season (Percentage)

S. No	Perceptions	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

It is further revealed from the table that the difference in the perception of farm households is almost negligible as everyone felt the changes in the same way irrespective of being poor or rich. The perception of farm household can be verified with the results depicted in Table 3 and 5 from the trend analysis of minimum and maximum temperature of past 40 years. Tables revealed that temperature is increasing in summer season each year leading to more prickly heat, increasing in humidity etc. In a study conducted by Rana *et al.* (2013) [7], 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.

#### Perception of farm households about change in rainfall in bhabar region:

Table 4 depict the perception of farm households of bhabar region about rainfall pattern

**Table 4:** Perception of farm households of bhavar region about rainfall pattern (Percentage)

S.no	Perceptions	Farm size group			
		Marginal	Small	Medium	Large
1	Increase frequency of intense and erratic rainfall events (D1)	86	72	84	82
2	Increase in events of flood and climate climates due to rain fall (D2)	100	100	100	100
3	Uneven distribution of rainfall (D3)	74	67	82	84
4	Variation in amount of rainfall over the year (D4)	84	95	96	94
5	Drying of water bodies (D5)	94	86	96	94

Weather predictions and disaster response have become issues fuelling the blame game between state officials in Uttarakhand after the 2013 Kedarnath floods. As temperature rises and the air becomes warmer, more moisture evaporates from land and water into the atmosphere. More moisture in the air generally means more rain and snow (called precipitation) and more heavy downpours. Rainfall in winter is decreasing significantly, where as in, monsoon season there is an increase in the frequency and amount of rainfall observed in the trend analysis and supports the farmers perception about the rainfall patterns. A high variability was recorded in the rainfall throughout the years and it is recorded highest in winter season. Farm households of bhavar region, were most worried about the changing rainfall patterns in the zone. In last few years farm households observed heavy rainfall, seventy two per cent of marginal and small households and 86 per cent of medium and large farm households informed that frequency of intense rainfall has increase in past few years. The climatic calamities from the past few years made people aware about the consequences of climate change on rainfall. Sixty seven to 84 per cent opined that the behavior of rainfall pattern and monsoons is very irregular and uneven from the past few years. Vedwan and Rhoades (2001) [11] 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) [9] 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.

#### Perception of farm households about effect of climate change on agriculture and livestock in bhavar zone

Effect of climate change in crop production, observed by farm households is shown in table 5. Farm households strongly opinioned that there is a change in flowering and harvesting period of wheat. According 82 to 96 per cent of marginal, small, medium, and large farm households climate is effecting wheat production in a negative way. Wheat plays an important role in feeding the world, but climate change threatens its future harvest. Without adaptation, global aggregate wheat production is projected to decline on average by six per cent for each additional degree Celsius increase (IARI).

**Table 5:** Perception of farm households of bhavar region about agriculture and livestock (Percentage)

S. No	Perception	Farm size group			
		Marginal	Small	Medium	Large
1	Decrease in the production of crops (E)				
i	Wheat (E1)	55	63	42	42
ii	Barley (E2)	100	100	94	94
iii	Gram (E3)	94	82	78	72
iv	Mustard (E4)	72	72	64	68
v	Rice (E5)	52	68	48	36
2	Changes in flowering, fruiting and harvesting time of wheat (E6)	82	96	84	86
3	Increase in the occurrence of weed and diseases (E7)	82	82	76	74
4	Decline in the production of milk in summers (F1)	84	82	66	60
5	Negative impacts on reproductive performance of livestock (F2)	58	44	56	48
6	Decline in feed and fodder resources are decreasing (F3)	68	64	42	38
7	Increase in livestock disease incidences (F4)	56	62	54	56
8	Decline in egg production in summers (F5)	84	82	74	78

Worldwide this would correspond to 42 million tons yield reduction for 1°C global warming as per the IPCC report. It has also experienced by 74-82 per cent of respondents from all farm size group that due to increase in temperature and humidity there is increase in the occurrence of weeds and pests. Marginal and small farm households are found to be more effected by the occurrence of weeds and pests in the crop as due to the lack of resources to deal with. Marginal and small farm households as compared to medium and large farm households opined more decline in production of crops.

Majority of marginal and small farm households (84 per cent) were of the view that due to increase in temperature in summers the production of milk decreases whereas only up to 60 per cent medium and large farm households opined the same. Most of the farmers in the region rear livestock for both commercial and household purposes. Here small and marginal farm households found to be much affected and aware of the effects of varied climate on livestock, as Maintenance and proper facilities were lacking like most of the cattle were shades were not covered and some are not ventilated which resulted in increase in diseases and adverse direct effect of heat and other factors on animals and poultry. Summer has a bad impact on both livestock and poultry. Some of the effects felt by the farm households are decrease in egg production as reported by 84 per cent of marginal and small and 78 per cent of medium and large farm households. Reduction in reproduction and increase in the outburst of disease have been also realized as informed by 44 to 58 per cent of the farm households. Severity of adverse effect has been found more pronounced as marginal and small farm household comparatively.

### Summary and Conclusion

Almost all the farm households in the Bhabar 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. Choudhary and Bawa (2011) carried out the a study to comprehend 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 (Nhemachena and Hassan 2007) <sup>[6]</sup>. 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 (Banerjee, 2015) <sup>[1]</sup>.

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