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Climate change adaptation through traditional knowledge and wisdom: evidence from Satna district of Madhya Pradesh

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Abstract
The present study is an attempt to understand the people's perception on effects of changes in climatic variables how and to what extent they have adjusted their farming practices to cope with the changes. A total of 150 farmers in one of such village highly vulnerable to climate change in Satna District of Madhya Pradesh were interviewed. This study reveals that villagers keenly observe the changes in climate and its impact on agricultural production and their livelihood options. Climate change is being experienced by the farmers in the form of rising temperatures, extreme climatic events, change in rainfall pattern and increase of drought like situations. Climate and weather has adversely affected the livelihood security of the farm families who rely on agriculture and animal husbandry for their subsistence. The persistent changes in the weather have resulted in the overall decrease in the quantity of available water in all the water sources of the village. The area under irrigation has gradually decreased due to lack of sufficient water for irrigation, resulting in low production of crops and fodder. Rising temperature has also led to a shift in flowering and fruiting time in forest trees. Crop productivity has been reduced because of moisture stress during critical crop growth period resulted in low absorption nutrients and water and higher incidence of pests and diseases during crops growing period. Villagers observed that the maturity period of wheat has reduced by 10-15 days due to change in climatic situation in the region. For Adapting to climate change, Krishi Vigyan Kendra (KVK) and the villager have developed a common strategies viz. cultivation of crops/varieties that required less water and tolerant to drought. There seems to be a similarity between perceptions held by the people, climate and agricultural data. People are experiencing that winters have become shorter; rainfall has become more unpredictable resulting in higher agricultural cost of production and also occurrence of new weeds flora in the last 10-15years in that area. Livestock feeding has become more difficult due to unavailability of fodder.

Keywords: agriculture, climate change, livelihood security, NICRA, rainfall, temperature, People perception

Introduction

In India, weather-related events such as prolonged dry seasons, floods, storms, landslides, extreme rainfall, and delayed/early rains have become more frequent and/or intense. This has left most of the rural poor farmers' food insecure and their livelihoods threatened. In order to understand how farmers would respond to climate change, it is essential to study people's perceptions of climate and the environment in general (Scott *et al*. 1990) [5]. Studies on the impact of climatic variability on farmers' livelihoods and their consequent responses have not been done at the micro level. Thus this study is important in a way that it takes into account farmers' awareness of weather fluctuations and aims at understanding the localized impact of the climate in this region which are not directly visible but changes, nevertheless, are happening indirectly. This kind of study can prove to be vital to arrive at an understanding of farmer responses, in the drought hit district to know- 'what one thinks' and 'how one thinks' about the changes in climatic patterns and their impacts; and to give an account of understanding and responses about the changes that they usually experience. This study is a small step towards gaining a better understanding of climate change impacts and challenges corresponding to the core objective of National Innovation on Climate Resilient Agriculture (NICRA) a project run for adaptation and mitigation of climate change funded by ICAR-CRIDA. The main objective of the present study was to identify the climatic characteristics that the farmer have observed as having undergone a change and the ways farmer are adapting to these changes and further to correlate farmers' perception with the available climatologically and production data. The survey was done with different communities in Bhargwan village in Majhgawan block of the Satna district, Madhya Pradesh (A village selected for demonstrating the site specific interventions on drought mitigation under NICRA

project) to know the farmers' perceptive about the changes in their local climate and the impact on agriculture and their livelihood.

Materials and Methods

The study was conducted in village Bhargawan, which is located in the ravines at a distance of 18 km from Majhgawan block of district Satna, in the state of Madhya Pradesh during 2011-16. The village is predominantly tribal village. During questionnaire survey we came to know about the history of village. As per village age per old perssonel, it came into existence somewhere 200 years ago. The village has a total population of about 474 people. The village has also seen considerable seasonal migration in recent years as some 16 families have migrated to other parts of the state and the country in search of employment opportunities. The overall literacy level of the village is approximately 60.55% with 67.89% males and 52.63% females being literate. There is, however, an apparent lack of technical or professional education amongst the people.

Most of the people are dependent on agriculture and animal husbandry. There are only 12 number of people employed in government and non government enterprises. 09 numbers of people are associated with the traditional skill based work such as masonry, tailoring, carpentry or engaged in metal work. The village has a total of 153.16 hectares of agricultural land and the average land holding per family is around 2.07 hectare, including the families who have migrated. This means that the villagers have small landholding with limited crop production. Of the total cultivable land, 81.18 percent is un-irrigated and merely 18.82 % land is under irrigation through local water source locally known as *"Nalas"*.

The survey of the village was done with more than 150 peoples. Mostly PRA tools were used for the study, in which primary data was collected through interviews/ discussions with individuals, focus groups (e.g. farmers, farm women etc.) and community meetings. Trend analysis was done by analyzing secondary data of temperature, rainfall and production. The central part of the PRA used was semi-structured interviewing; i.e. interview on a questionnaire on a checklist of issues. These interviews were guided informally like conversations. While sensitive topics were addressed in one-to-one interviews with individuals, other topics of general concern were more amenable to focus group discussions and community meetings. The secondary data about rainfall and production were collected from the District Agriculture and Statistical Department, while temperature and rain fall data was obtained from meteorological laboratory of Krishi Vigyan Kendra.

The issues raised in interviews/discussions were : Climate change in views of people (Understanding and perception), increase in warming period (warmer month in winters, major changes in winter season), rainfall (Change in intensity, duration, time and month compared to past years; occurrence of drought conditions), agriculture (Kharif crops as influenced by rainfall, rabi crops as influenced by terminal heat, changes in flowering, fruiting and harvesting time of crops, change in incidence of weeds, insect and diseases; local level adaptability strategy) and any other perception about the changes happening in environment.

Results and Discussions

The results of the present study reveals that farmers are already feeling and responding to the effects of climate change on agriculture and their livelihood. The following are key outcomes of the field survey which are tabulated in the form of % responses to the changes, as perceived by local peoples in different seasons:-

Table 1: People's perception and % response Perceptions

S. No.	About Winters	Percent response
1.	Understanding about the term climate change	80.67
2.	Increase in winter temperature	95.33
3.	Winter duration (changed from 4 to 2.5 months)	90.67
4.	Shivering (Intensity of cold) during winters has decreased	100.00
5.	Reduction in the fireplaces (Alaaw etc) during winters	58.00
6.	In winter season (from Nov-Mar), month of March has become warmer as compared to past years	82.00
7.	Frost (Pala) and winter rains have declined	64.67
8.	More intense sunlight during winters	72.67
B.	**About Summers**	
1.	More sweating	91.33
2.	More Intense loo (Warm wind)	98.00
3.	Humidity has increased a lot	64.67
4.	Stickiness condition of body	82.00
5.	More prickly-heat during summers	74.67
C.	**About Monsoon**	
1.	Increase in variability in on set of monsoon	86.00
	Decrease in Rainfall	100.00
2.	Decrease in intensity	95.33
3.	Decrease in durability	79.33
4.	No. of rainy days have decreased	100.00
D.	**About production**	
a.	**Chances of failure of crops (Kharif crops)**	
1.	Rice	80.60
2.	Pigeon Pea	93.10
3.	Sorghum	74.67
4.	Sesame	54.36
5.	Green gram	44.60
b.	**Chances of failure of crops (Rabi crops)**	
1.	Wheat	92.00

2.	Barley	82.67
3.	Chickpea	78.33
4.	Pea	92.00
5.	Lentil	75.33
6.	Mustard	56.34
7.	Linseed	48.67
8.	Dependency upon rainfall	100
c.	**Changes in flowering, fruiting and harvesting time of crops**	
1.	Wheat	92
2.	Rice	64.67
3.	Pigeon Pea	87.33
	Chickpea	82.67
d.	**Occurrence of weeds increased**	
1.	Weeds population during Kharif	100
	Weeds population during Rabi	79.33
2.	New weeds which were not known in past years	100

Source: Field Interview

Table 2: Traditional weather descriptions

Month	Condition Past	Condition (Present)
Magh- Jan 15 - Feb 15	Severe Cold with occasional rain	Cold with very less or no rain
Falgun -Feb 15 - Mar 15	Less cold (wheat harvest)	Very less cold, later half little warm
Chaitra -Mar 15 - Apr 15	Very less cold, later half little warm Spring with pleasant atmosphere, stormy weather	Dry and warm(wheat harvest)
Baishakh- Apr 15 - May15	First half dry, second half hot	Dry and very hot, stormy weather
Jeth May- 15 - Jun 15	Hot and dry	Very hot, loo, stormy
Aashadh- Jun 15 - Jul 15	Early Onset of monsoon, rain, humid(paddy sown)	Hot and humid, less rains, delayed monsoon
Savan -Jul 15 - Aug 15	Good Rains, Very humid	less rain(paddy sown in first half)
Bhadaun- Aug 15 - Sep 15	First half rainy, second half clear	Less or no rains
Kwar -Sep 15 - Oct 15	Clear (Sunny days and cold night) winter arrives in later half (paddy harvest)	Clear(Sunny days and less cold night)
Kartik -Oct 15 - Nov 15	Sunny days and cold night (wheat sown)	Clear (paddy harvest)
Agahan -Nov 15 - Dec 15	Winter arrives	Winter arrives in later half (wheat sown)
Paush- Dec 15 - Jan 15	First half cold, second half very cold,	Less cold, occasional frost (wheat sown)

People's perception about changes in Climate

It has been observed by the village people that rainfall has become uncertain and erratic with the decrease in the overall rainfall in the last 15 to 20 years. Earlier people used to consider it as an act of God and there was popular cultural practice of conducting *"Yagya*" (sacred ritual) and worshipping the local God. Now this practice has gradually disappeared, as people have lost faith in such rituals and they now understand it as a problem caused by the changes in climatic patterns. Most of the older women consider this phenomenon as a problem generated due to the increasing sins committed by their ancestors. They call it *Kalyug*, which means that people have become too greedy, have lost faith in God and have moved towards material gains. They have also stopped worshipping their traditional Gods and Goddesses which were mainly related to the natural resources around them. They were earlier considered very sacred and were worshipped by all in the village. It has been observed by the people that they are experiencing extreme climatic events; like, the year, 2015, the village experienced very low rainfall during the year and very unusual rainfall in the month of March. There has been less or negligible winter rains in the village for the last 4 or 5 years and the rain cycle has also shifted by 20 to 30 days. These persistent changes in the weather have resulted in the overall decrease of water quantity across all the water sources. This has a bearing on their agriculture, forest etc. Some of the changes are discussed below:

Temperature

People perceived a significant change in temperature distribution and a definite reduction in the number of winter months, which now last only for only two and half months. Almost 100 percent respondents felt the changes in the winter season. Onset of winters has shifted from last week of October to last week of November now. People have not experienced severe cold for the last 5-6 years. People's perceptions on temperature can be compared to the above traditional weather descriptions (Table 3). Maximum temperature has increased in 5 months (e.g. Jan, Mar, Jun, Sep, Oct, and Dec) while minimum temperature of December and January has increased manifold as compared to 10 years back. Average maximum and average minimum temperatures of winter season also show increasing trends. People also informed that the hottest month of Jeth has increased in duration and its onset has now advanced to the month of July. The people now perceive significant warming in the months of February and March, which were previously very pleasant months. Vedwan *et al.*, (2001) [7] simply described people's perception of temperature changes as a display of slight shift of weather cycle at the local level and so is the temperature. One of the major indicators of the rise in temperature was explained by Guman Singh Gound a respondent from the village, who said - *"12-15 years earlier, wheat was sown in the village in the October month and harvested during February but now wheat is sown in the month of November and sometimes in the month of December and harvesting is done in the month of March and April'.* The villagers believe that delayed sowing of wheat is due to rise in temperature during October in the recent years. Similarly, there were dense forest around the village, but now, we find only few trees in the forest. Though villagers tried to re-plant them, the trees could not survive due to higher temperatures. These forest areas have now been replaced by Gulmehndi (*Lantana Camara*) a weed. The villagers also informed that there has been a rapid growth of termites during the last 10 years in the village, causing widespread damage to the houses and crops in the field.

Rainfall

People reported changes in intensity and duration of rainfall. The data also shows variable, but very unusual and erratic rainfall since 1993, till 2016. They also reported about the delayed and alternative rainfall, i.e. one year good and timely onset and the next year less and delayed rains. The village people also said that the in some years monsoon last till October which coincide with harvesting of Kharif season and causes huge losses to Kharif crops. Local perceptions further point out that significant decrease in the number of rainy days and increase in the number of dry spell during monsoon. Rain fall analysis of the district also revealed that the drought events in the district have increased. Five drought events of category M2 and eleven drought events of category M1 were observed in Satna district during 1993 to 2016 (Table 3). Only eight years 1994, 1998, 2001, 2003, 2005, 2012, 2013 and 2016 were observed with normal rain fall during the period under study.

Table 3: Annual drought analysis based on rainfall of district Satna (1993 – 2016).

Year	Rainfall (mm)	Departure of rainfall from normal (mm)	% Departure	Drought Intensity (Code)
1993	506.7	(-) 440.71	(-) 46.52	Moderate drought (M2)
1994	1582.8	635.39	67.07	No Drought (M0)
1995	862.5	(-) 84.91	(-) 8.96	Mild Drought (M1)
1996	903.77	(-) 43.64	(-) 4.61	Mild Drought (M1)
1997	737.2	(-) 210.21	(-) 22.19	Mild Drought (M1)
1998	1050.8	103.39	10.91	No Drought (M0)
1999	880.3	(-) 67.11	(-) 7.08	Mild Drought (M1)
2000	603.05	(-) 344.36	(-) 36.35	Moderate Drought (M2)
2001	1201.8	254.39	26.85	No Drought (M0)
2002	776.48	(-)170.93	(-) 18.04	Mild Drought (M1)
2003	1298.66	351.25	37.07	No Drought (M0)
2004	824.5	(-) 122.91	(-)12.97	Mild Drought (M1)
2005	1003.75	56.34	5.95	No Drought (M0)
2006	809.9	(-) 137.51	(-) 14.51	Mild Drought (M1)
2007	635.2	(-) 312.21	(-) 32.95	Moderate Drought (M2)
2008	751.8	(-) 195.61	(-) 20.65	Mild Drought (M1)
2009	786.6	(-) 160.81	(-) 16.97	Mild Drought (M1)
2010	928.2	(-) 19.21	(-) 2.03	Mild Drought (M1)
2011	908.75	(-) 38.66	(-) 4.08	Mild Drought (M1)
2012	1409.45	462.04	48.77	No Drought (M0)
2013	1693.5	746.09	78.75	No Drought (M0)
2014	687.29	(-) 260.12	(-) 27.46	Moderate Drought (M2)
2015	526.5	(-) 420.91	(-) 44.43	Moderate Drought (M2)
2016	1675.2	727.79	76.82	No Drought (M0)

Agriculture

The major crops being produced in the village are Rice, Pigeon pea, Sesame, Sorghum during Kharif and Wheat, Barely, Chickpea during Rabi. In addition to this they also produce crops like Green gram, Black gram, Soybean, Mustard, Lentil and Linseed. The people's perceptions on impact of climate change on agriculture were very informative. Over the years, they experienced marked influence of variability in climate on Crop production. They observed changes in the Rabi crops as well as crop of Kharif. Elder farmers of the village over the years have observed decline in yield of rain fed crops by 25-30%. They attributed such decreases in yield to due to rise in temperature, changes in precipitation patterns and the frequency of terminal drought events. The farmers observed earlier flowering and crop maturity in Rabi crops due to warmer temperatures during spring season. This perception of the farmers conforms the scientific findings of Craufurd and Wheeler (2009) [1], who also reported that the warmer temperatures during spring shorten development stages of crops and induces early flowering and maturity and hence reduce the yield of a given variety. Farmers also pointed out that the short winter duration and lesser cold have slowed down the growth of wheat and the plants failed to attain good height. This perception of the villagers further conforms the findings of Jagadish *et al*., (2008) [3] who also observed that rise in temperature during the critical period of flowering greatly reduce seed set and hence crop yield in annual crops if they coincide with a brief critical period of only 1–3 days at the time of flowering.

The people also mentioned that production of Kharif crops particularly, rice was totally dependent on rainfall and the cultivation of Kharif crops was greatly affected by change in precipitation pattern. People noted reduction in cultivation of rice in the village. They also indicated the declining trends in the production of Soybean, Pigeon pea and Chickpea crops. People also mentioned that the changes in climate were not all adverse, at least in the case of Mustard and Linseed. The elderly farmers informed that they noticed a significant shift in the sowing season of wheat. They said that between 1980 and 2000, sowing of wheat was done in the first 13 days of the Kartik month (1-15 October), which was harvested in Falgun month (15 Feb – Mar 15). After 2000 however, they found that the climate was only conducive for wheat sowing in November as well as December. The villagers also reported the problems of diseases, insects and weeds destroying large chunks of crops every year due to change in climate, like Wilt and pod borer in Chickpea and Pigeon pea, termite in wheat, blast in Rice and leaf eating caterpillars in soybean. There has been a widespread growth of wild weeds in agricultural land like- *Parthenium* and *Evolvulus*. The people perceived the frequent occurrence of *Parthenium* (Gajar Ghas), *Evolvulus* (*Patharchatta*), *Argemone mexicana* (Satyanashi) and *Trianthema* (Pathari), which were nonexistent or occurring very little in winters, before 2002. Although these weeds exist all the year round; their spread was restricted by the winter cold. But as winters are getting warmer, the spread of these

weeds has also intensified. These weeds are responsible for decreasing the productivity of crops. Villagers are also facing a continuous failure of winter crops for the last 2 years. This is happening due to absolute lack of rains during critical winter period. This is a recent phenomenon seen in the village forcing people to look for other options for their survival. There has been a positive change observed by villagers in terms of maturity period of crops. The total number of months required for the cultivation of the crops, especially wheat, has reduced by 10 to 15 days. This is happening due to the rise in temperature, which has resulted in suitable climatic conditions for the crops to mature and ripen.

Table 4: Perception on the effect of climate change

S. No	Responses	Statement		
		A (%)	UD (%)	DA (%)
1.	Due to climate change, food grain production has decreased	79.33	5.33	15.33
2.	Water bodies have dried up due to change in climate	100.00	0.00	0.00
3.	Climate change has resulted in inadequate drinking water supply for the people	82.00	0.00	18.00
4.	Climate change has increased the risk of crop failure	64.67	19.33	16.00
5.	Owing to climate change production of rice and wheat (staple foods) has adversely affected	68.67	22.00	9.33
6.	Change in climate has decrease in the frequency of rainfall	58.00	30.67	11.33
7.	Quality of food grains has been affected due to climate change	49.33	24.67	26.00
8.	Because of climate change, the incidences of untimely rainfall have increased	59.33	24.67	16.00
9.	Change in climate has resulted into deforestation in the area	52.67	28.67	18.67
10.	Climate change has decreased the availability of irrigation water	91.33	4.67	4.00
11.	Because of climate change, the incidences of untimely rainfall have increased	49.33	30.67	20.00
12.	Due to climate change, level of ground water has come down.	88.00	2.67	9.33
13.	Soil erosion has increased due to climate change.	44.67	42.00	13.33
14.	Climate change has caused scarcity of fodder in the area.	52.00	32.00	16.00
15.	Due to climate change drudgery of farm women has increased.	58.00	30.67	11.33
16.	Natural regeneration of grasses/shrubs/trees has been adversely affected due to climate change	65.33	28.67	6.00
17.	Due to climate change, cost of production in agriculture has decreased	82.00	18.00	0.00
18.	Climate change has affected the standard of living of people	26.00	32.67	41.33
19.	Climate change has made farming non viable and uneconomical	62.67	24.67	12.67
20.	Climate change has affected the Livestock production	68.00	18.00	14.00
21.	Climate change has increased stress on farm family.	67.33	25.33	7.33
22.	Climate change has declined the availability of forest produce in the area.	0.00	0.00	100.00
24.	Due to climate change flowering, fruiting and harvesting time of crops have changed	66.00	26.00	8.00
25.	Climate change has increased the weeds, insects and diseases infestation on crops	57.33	25.33	17.33

A- Agreed, UD- Undecided, DA- Disagreed

Water resources and forests

The village has seen considerable decrease in the water levels across all the water sources. According to the villagers there were some 8 wells in and around the village. All of them have dried up in recent past resulting in the reduction of irrigated agricultural land, shortage of fodder to animals and problem of drinking water supply. This has led to an increase in un-irrigated land in the village resulting in a significant drop in crop production. As per Radhey Lal, a 54 years one of the respondent farmer from the village, "All my irrigated land have become rain fed and barren due to the non availability of water in well, which was once a major source of water for my land". This has apparently increased the drudgery of women in the village, especially those who have no other source of income and depend substantially on natural resources for their survival.

The villagers are of the opinion that there has been a rapid loss of forest around the village. This has resulted in significant decrease of broad leaf species of tree like Mahua (*Madhuca indica*), Chironji (*Buchanania lanzan*) and Tendu. The decrease of forests has given way to the rapid growth of *Lantana Camara*, which has further spread to grasslands, thus decreasing the availability of grasses in the village. Now women have to walk around 5 to 10 KM to collect fodder for their livestock. Villagers have also seen some of the wild varieties of vegetables/medicinal herbs like Bittergourd, Safed Musli, Kalihari, Sarpgandha, haldi etc., becoming extinct in recent years with gradual reduction of forests. As a result of this, animals like wild pigs (wild boar) are not able to find food in the forests and head for the agricultural fields in search of food. These animals destroy crops which further reduces the total produce of the village. Perceptions were also taken from landless farm families involved in collection of forest produce related to the availability of materials. They noticed decline in the availability of forest produce. According to them, the reduction in cold during winters is responsible for such anomalies. They also noticed the alternate and sometimes irregular flowering and fruiting in Mahua (*Madhuca indica*), aonla (*Emblica officinalis*) and Chironji (*Buchanania lanzan*). Since, the last few years, Mahua flowers blossom some 20-30 days before their actual time. This has resulted in reduction of size of flowers and their number. Similarly, Aonla and Chironji trees which were available in plenty in the area earlier, have now dried due to change in climatic scenario. Thus they are now more reliant on labour. These perceptions of the farmers well support the research findings of Ravindranath *et al*., (2006) [4] according to whom even with a rise in 1 to 2 ^{o}C, most ecosystems and landscapes get impacted through changes in species composition, productivity and biodiversity which further affects the people who depend upon the forests for their livelihoods.

Table 5: Farmers traditional knowledge in weather forecast

S. No.	Weather indicator	People's version
1	Laying of eggs by rain birds	If the rain bird lays eggs in low lying areas, this is a sign of delayed monsoon. But if it lays eggs in upland areas, this means that it will rain heavily.
2	Shifting of eggs by ants	This is taken as a sign of immediate rains.
3	Sprouting of roots in banayan tree	If the new white roots starts appearing in banyan tree, this is a sign for rains in 2 to 4 days.
4	Sprouting of buds in ber and castor	When sprouting of buds starts in castor and ber is a sign for rains in 10 to 15 days.
5	Flowering in babool	It will rain within 15 days.
6	Ripening neem Kernel and start falling	Rains will commence within 10 to 15 days.
7	Easterly winds in May June (*Jeth*)	Is a sign of upcoming drought in August –September (*Bhadaun*).
8	Westerly winds /clouds	It is a sign of good rain falls.
9	North – western winds / clouds	It is a sign of hail storm/ meager rainfall.
10	Clouds running opposite to the air	It is taken as a sign of Surely Rains.
11	Humid winters, cold in summers and very heavy first rain	It is considered as the sign of upcoming drought.
12	Cloudy Friday evening and clear weather on Saturday	It is taken as a sign of Surely Rains.

Coping mechanisms developed / suggested by the people/NICRA Technologies

As people have recently started realizing these changes, there are some adaptation practices being taken up by the villagers. It seems that gradually people would come up with more such practices, as they realize the gravity of the situation, in the foreseeable future. Traditionally Farmers were extensively cultivating two varieties of paddy namely *IR-36, and IR-64* in irrigated and rain fed areas are being now gradually replaced by JR-201 and Sahbhagi which requires less water due to shorter duration (105-110 days) in comparison of traditional varieties which matured in 120-125 days there by a reduction 15-20 days, both these varieties of rice introduced under NICRA demonstration. Farmers have started growing Crop like sorghum, maize, sesame, blackgram, greengram and vegetables (Radish, spinach cauliflower, tomato, chillies, cowpea, okra, and cucurbits) in both irrigated and rain fed araes. Similarly, they have started growing wheat varieties JW-17, Amrita and Harshita (Which requires less water) which were demonstrated under NICRA activities to the villagers in comparison of traditional varieties WH-147 and GW-273 (Requires more water), says villager Lal Bahadur Singh age 49 years a respondent. Under NICRA farmers were advised to grow mustard crop as this crop is more resilient to climate change and also require less water to grow at the time low harm due to wild animals (wild boars). To generate the income of the farmers some of the cash crops like tomato, onion, potato etc also introduced under the project in place of low productive traditional crops like Rice and wheat. It was the villagers experience that Cash crops require less area and generate more output than traditionally grown crops in relatively less time and space. With the gradual decline in rainfall, the farmers are now trying out crops like ginger and kharif onion at commercial level to increase their income. People are replacing their buffaloes with cows, as buffaloes need more fodder, water and require stalled feeding. Cows can be sent off for open and free grazing and they require less fodder compared to buffaloes. And for that two bull of Sahiwal breed were provided for up gradation of local breed under the NICRA project. were Poor people have largely resorted to milk selling, as they largely own less cultivated land with limited irrigation facilities. One potential strategy to mitigate the impact of climate change is adaptation. Knowledge of people's perception of climate change can play a key role to look forward to realistic adaptive responses of farmers (Srinivasan, 2006) [6]. Similarly, Dagar *et al*., (2012) [2] also emphasized the need for using modern science combined with indigenous wisdom of the farmers to enhance the resilience of Indian agriculture to climate change. Use of multiple stress tolerant varieties, efficient cropping systems, resource conservation technologies, water harvesting and supplemental irrigation for drought proofing in rain fed areas can help in mitigating the adverse impact of climate change and variability.

Conclusion

Thus, the present studies shows that the farmers are already feeling – and responding to – the effects of climate change on agriculture. The study was successful in discovering that local people clearly understand that the climate is changing or at least they are aware of an increased variability in the weather. It is also quite interesting to note that trends of change reported by villagers were closely related to the scientifically collected climatologically and production data. Weather cycle at the local level is displaying a slight shift. The cold weather is now confined to December and January. The months of June and July now witnesses hot temperatures instead of usual rainy, warm and humid patterns. Thus the overall description of climate change includes the traditional weather description and key outcomes of interviews and their correlation with available rainfall and production data. It establishes that the people living in the study area very much observed these changes, which are happening and affecting indirectly the lives of the peoples of this region. This kind of study could prove as a model and can provide the basis for other such investigations.

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