Farmers Perception about Impact of Long Term Climate Change on Agriculture in Plain Zone of Chhattisgarh

Abstract

This investigation was an attempt to capture the extent of local peoples' perceptions regarding impact of long term climate change on agriculture and allied activities. The study was carried out in four randomly selected districts of Plain Zone of Chhattisgarh State. A total of 240 farmers from twenty four villages of eight blocks were considered as respondents. Data were collected through the personal interview using structured interview schedule prepared in Hindi and also group discussions were conducted among the farmers in each selected village to affirm the response in group about climate change. Based on the multiple responses, out of the total, 183 respondents were growing paddy in irrigated condition and 146 of them were growing paddy in un-irrigated condition. Out of total cultivated area (583.70 ha) paddy was cultivated in 47.56 per cent of area in irrigated condition and 47.28 per cent of area in un-irrigated condition. With regards to various varieties grown by respondents there was drastic change in 15 years, local varieties like Gurmatia, Mundaria, Kanthbhulaw, Nankeshar, Bhejri, Asamchudi etc. were grown by 86.25 per cent of the respondents 15 year back which has confined to only 1.67 per cent of the respondents with varieties like Gurmatia, Nankeshar, Asamchudi etc. Almost half of the respondents believed that due to climate change area of some crops like minor millets, sesame, pigeon pea, maize, jowar etc. in *kharif* and linseed, lathyrus, lentil etc. in *rabi* has decreased. Majority of respondents (86.30%) agreed, over the past 15 years migration of birds and animals has increased due to climate change, while, 82.92 per cent believed that climate change has increased drudgery of farmers/farm women. The results indicated that nearly 37 per cent of the respondents perceived medium level of overall impact of long term climate change, while, 34.17 and 29.17 per cent of the respondents reported high to low level of overall impact of long term climate change on agriculture and allied activities.

Key Words: Farmers perception, Climate change, Impact.

Introduction

Climate change has become a major concern to society and it is one of the biggest environmental challenges because of its potentially adverse impacts worldwide. There are already increasing concerns globally regarding changes in climate that are threatening to transform the livelihoods of the vulnerable population segments. Climate change is associated with various adverse impacts on agriculture, water resources, forest and biodiversity, health, coastal management and increase in temperature. Climate change refers to any change in climate over time, whether due to natural variability or/and as a result of human activity (IPCC, 2007a). The average annual temperature of the Earth's surface has risen over the last century. Not only the temperature is rising, but the rate of warming itself is increasing too. The earth's climate has warmed on average by about 0.7^0C over the past 100 years with decades of the 1990s and 2000s being the warmest in the instrumental record (Watson, 2010).

Impacts of climate change and its associated vulnerability are particular concern to developing countries like India, where large parts of the population depend on climate sensitive sectors like agriculture and forestry for livelihood. India is considered to be especially vulnerable

to the impacts of climate change with an extraordinary variety of climatic regions, ranging from tropical in the south to temperate and alpine in the Himalayan north, where elevated regions receive sustained winter snowfall. The north of the country has a continental climate with severe summer conditions that alternates with cold winters when temperatures plunge to freezing point. Climate change is likely to affect all the natural ecosystems as well as socio-economic systems as shown by the National Communications Report of India to the UNFCCC (INC, 2004). Various studies have indicated a probability of 10 to 40 per cent loss in crop production in the country due to the anticipated rise in temperature by 2080. Agriculture places heavy burden on the environment in the process of providing humanity with food and fiber, while climate is the primary determinant of agricultural productivity. Climate change and agriculture are interrelated processes, both of which take place on a global scale (Parry *et al.*, 2007). Global warming is projected to have significant impacts on conditions affecting agriculture, including temperature, precipitation and glacial run-off (Funk *et al.*, 2008 and McCarthy *et al.*, 2001). Given the fundamental role of agriculture in human welfare, concern has been expressed by federal agencies and others regarding the potential effects of climate change on agricultural productivity. Interest in this issue has motivated a substantial body of research on climate change and agriculture over the past decade (Lobell *et al.*, 2008, Wolfe *et al.*, 2005 and Fischer *et al.*, 2002).

Agriculture is the most important sector of the economy in India provides food and livelihood security to much of the Indian population. Declined yield due to unfavorable weather and climate will lead to vulnerability in the form of food insecurity, hunger and shorter life expectancies. India demonstrates diverse geo-physical and climatic conditions within relatively small areas. It is, therefore, an ideal place to study climate change impacts on natural and socio-economic spheres. Such a study would contribute towards a better understanding of the intensity and impacts of global changes. Based on the case of the local peoples of Chhattisgarh plain zone, this investigation intends to capture the extent of local peoples' perceptions regarding impact of long term climate change on agriculture and allied activities.

Research Methodology

The present investigation was carried out in four randomly selected districts of Chhattisgarh Plains. Two blocks from each selected district were selected for the selection of villages. From each selected block, 3 villages were selected randomly for the selection of respondents. From each selected village, 10 farmers were selected randomly, who had more than 15 years of farming experience. In this way, a total of 240 farmers were considered as respondent for the present study.

Climate change has both long term and short term impact on agriculture and other events. To ascertain the impact of long term climate change on various events, respondents were asked for their general perceptions on climate change impacts using 11 statements regarding agricultural incidences as well as 11 statements regarding other incidences; whether they have expressed their agreement or disagreement on impacts of climate change. Responses were recorded on 3 point continuum scale viz. agree, can't decided and disagree by assigning scores 3, 2 & 1, respectively. Further, the overall impact of long term climate change was determined and respondents were categorized into three categories.

Result and Discussion

Season wise crops grown

Paddy is the principle crop of Chhattisgarh and contribute major share in national paddy production that's why State is popularly known as "bowl of paddy". Most of the agriculture is dependent on monsoon rainfall, which is vulnerable to changing climatic conditions and variability. Due to lacking of assured irrigation in *rabi* area under second crop is only one third of total cultivated land.

Table 1: Season wise crops grown by respondents with average area and productivity

Season/Crop	No. of Farmers		Area (ha)		% in Total cropped area		Productivity (qha^{-1})	
	I*	UI*	I	UI	I	UI	I	UI
Kharif								
Paddy	183	146	277.61	275.99	47.56	47.28	43.85	37.18
Pigeon pea	07	19	3.36	6.73	0.58	1.15	6.25	5.00
Soybean	08	11	5.68	7.40	0.97	1.27	13.45	7.20
Vegetables	08	03	2.72	0.86	0.47	0.15	-	-
Others	05	07	1.78	1.57	0.30	0.27	-	-
Rabi								
Summer Paddy	68	00	66.60	0.00	11.41	0.00	51.23	0.00
Wheat	59	26	46.40	1.60	7.95	0.27	14.93	13.75
Gram	86	26	71.86	27.06	12.31	4.64	8.90	7.30
Lathyrus	18	64	11.33	33.47	1.94	5.73	6.03	5.10
Vegetable	27	06	13.00	1.74	2.23	0.30	-	-
Others	19	08	9.82	2.51	1.68	0.43	6.05	4.18
Zaid								
Moong	06	00	4.00	0.00	0.69	0.00	5.50	2.50
Urd	02	00	0.80	0.00	0.14	0.00	5.00	2.50
Til	01	00	0.80	0.00	0.14	0.00	5.00	-
Vegetable	08	00	2.86	0.00	0.49	0.00	-	-

* Based on multiple responses **(Total cropped area = 583.70 ha)**

Season wise crops grown by respondents are given in Table 1. It can be observed that based on the multiple responses, out of total 183 respondents were growing paddy in irrigated condition and 146 of them were growing paddy in un-irrigated condition. In *rabi* season, 86, 68 and 59 respondents were growing gram, summer paddy and wheat in irrigated condition, whereas, each 26 respondents were growing gram and wheat in un-irrigated condition, respectively. Lathyrus was grown by 64 respondents in un-irrigated condition.

With regards to crop wise irrigation availability (Table 1), out of total cultivated area (583.70 ha) paddy was cultivated in 47.56 per cent of area in irrigated condition and 47.28 per cent of area in un-irrigated condition. In *rabi* season 12.31, 11.41 and 7.95 per cent of total area were cultivated under gram, summer paddy and wheat in irrigated condition, respectively. While,

5.73 and 4.64 per cent of area were cultivated by lathyrus and gram in un-irrigated condition, respectively.

As for productivity of crops, it is obvious from the data given in Table 1 that respondents produced 43.85 qha^{-1} of paddy in irrigated condition and 37.18 qha^{-1} of paddy in un-irrigated condition. However, in *rabi*, respondents produced 14.93, 8.90 and 6.03 qha^{-1} of wheat, gram and lathyrus in irrigated condition, respectively. Productivity of crops wheat, gram and lathyrus was 13.75, 7.30 and 5.10 qha^{-1} in case of un-irrigated condition, respectively.

Thus, it can be concluded from the above findings that almost all the respondents grow paddy in *kharif* season in irrigated as well in un-irrigated condition. Area of other crops like pigeon pea, soybean, vegetables etc. is nominal in *kharif* season. In *rabi* season major crops are grown in irrigated condition accept lathyrus.

Impact of long term climate change

Long term climate change has been not only affecting the growth and quality of various crops but also its effects could be clearly seen in the activities of the farmers other than agriculture. From a food security perspective, India as whole and state like Chhattisgarh particularly is arguably the most vulnerable region to many adverse effects of climate change due to a very high reliance on rainfed agriculture for basic food security and economic growth, and entrenched poverty. Climate change is certain to amplify these vulnerabilities given projections of warming temperatures. The present study was an attempt to document the farmers' perception on impact of long term climate change on agriculture and allied activities as per their farming experiences of 15 years or more.

Impact on various crops grown by respondents

Farmers are the best judge of their own concerns and they alter their farm operations to get adapted with changing climatic conditions by new technological interventions. Selection of crops and its varieties are dependent on prevailing climatic conditions and recourses available with them.

This study further assessed farmers' perception on impact of long term climate change on various crops grown by the farmers. Table 2 shows that paddy was dominant crop of study area which was grown by 100 per cent of the respondents 15 years back and unchanged at present, only per cent area covered might be differ little bit. With regards to various varieties grown by respondents there was drastic change in 15 years, local varieties like Gurmatia, Mundaria, Kanthbhulaw, Nankeshar, Bhejri, Asamchudi etc. were grown by 86.25 per cent of the respondents 15 year back which has confined to only 1.67 per cent of the respondents with varieties like Gurmatia, Nankeshar, Asamchudi etc. at present. As for improved varieties of paddy, Safari was most preferred variety 15 years back which was grown by about 89 per cent of respondents followed by Kranti (36.25%), IR-36 (30.42%) and Culture (17.50%), at present time, area of these varieties has replaced by Swarna (88.33%), MTU-1010 (70.00) and Mahamaya (55.83). Swarna has been preferably growing by farmers in low land, whereas, MTU-1010 and Mahamaya has been growing in mid land and up land as well with some extent at present time. Replacement of paddy varieties was mainly due to technological advancement with changing climatic conditions.

Table 2: Impact of long term climate change on various crops grown by respondents

15 years back	Season/Crops	At present	Change

Season/Crops	Respondents (%)	time	Respondents (%)	Direction
➢ ***Kharif***		➢ ***Kharif***		
❖ Paddy	100.00	❖ Paddy	100.00	
Local varieties (Gurmatia, Mundaria, Kanthbhulaw, Nankeshar, Bhejri, Asamchudi etc.)	86.25	**Local varieties** (Gurmatia, Nankeshar, Asamchudi etc.)	1.67	-
Scented varieties (Dubraj, Rani kajar, Luchai, Lohandi, Tulsimala etc.)	20.00	**Scented varieties** (Dubraj, Vishnu bhog, Badsah bhog, Tulsimala etc.)	5.00	-
Improved varieties		**Improved varieties**		
▪ Swarna	9.58	▪ Swarna	88.33	+
▪ Safari	89.17	▪ MTU-1010	70.00	
▪ Mahamaya	2.08	▪ Mahamaya	55.83	+
▪ Culture	17.50	▪ Hybrid	17.08	
▪ IR-64	12.08	▪ IR-64	5.83	-
▪ IR-36	30.42	▪ IR-36	13.33	-
▪ Kranti	36.25	▪ HMT	13.33	
▪ Others (Falguna, Shyamla, Masuri etc.)	4.12	▪ Others (BPT, Karma masuri, Bamleshwari, Samleshwari, 1001 etc.)	5.24	
❖ Kodo (Minor millets)	28.33	❖ Kodo (Minor millets)	0.00	-
❖ Pigeon pea	17.50	❖ Pigeon pea	10.83	-
❖ Sesame	16.25	❖ Sesame	1.67	-
❖ Soybean	4.17	❖ Soybean	7.92	+
❖ Moong/Urd	13.75	❖ Moong/Urd	2.08	-
➢ ***Rabi***		➢ ***Rabi***		
❖ Lathyrus	55.00	❖ Lathyrus	34.17	-
❖ Wheat	22.50	❖ Wheat	26.25	+
❖ Gram	41.17	❖ Gram	46.67	+
❖ Summer paddy	0.00	❖ Summer paddy	20.00	+
❖ Linseed	30.00	❖ Linseed	3.75	-
❖ Lentil	14.17	❖ Lentil	7.50	-

In *kharif* season other than paddy, crops like kodo (minor millet), pigeon pea, sesame and moong/urd were grown by 28.33, 17.50, 16.25 and 13.75 per cent of the respondents 15 years back which has reduced at present by 0.00, 10.83, 1.67 and 2.08 per cent, respectively. Only soybean growers were in increasing trend during previous 15 years. The decrement in number of growers of above mentioned crops was mainly because most of the farmers converted their suitable lands into paddy fields by making big bunds to store run off waters in fear of insufficient rainfall and to make efficient use and take full advantage of the prevailing water and temperature conditions in this changing scenario of climate.

In *rabi* season drastic change was occurred in number of lathyrus grower farmers which was reduced from 55.00 to 34.17 per cent during last 15 years. Lathyrus is cultivated by farmers as relay crop in matured paddy fields in rainfed condition. At present declining moisture content at the time of harvesting of paddy is main reason behind the decrement of lathyrus growers. These findings are in partial accordance with those reported by Bhushal *et al.* (2009), Pande and Akermann (2010), Kemausuar *et al.* (2011) and Sorhang and Kristiansen (2011).

Impact of long term climate change on agriculture

Table 3 reveals the impact of long term climate change on agriculture. As per the past experiences, majority of the respondents (86.25%) agreed that due to climate change, investment in agriculture has increased. This is mainly due to more infestation of insects & diseases on crops and more expenses on irrigation water. Moreover, 82.92, 82.08 and 79.59 per cent of them said that cropping pattern has changed, use of traditional crop varieties decreased and climate change has reduced traditional irrigation sources like pond, respectively. It might be due to fluctuations in rain onset, heat stress, longer dry seasons, uncertain rainfall and changing patterns of rainfall. A total of 75.00 per cent key informant believed that there was drastically conditions getting favorable to flourish weeds/ insects/diseases, whereas, 71.67 per cent agreed that population of rodent like rat has increased in recent past years due to climatic conditions have been supportive to its growth and 67.91 per cent of the farmers said that new species of seasonal weeds seen in recent years due to climate change.

Table 3: Perception of respondents about impact of long term climate change on agriculture

Statement	Agree (%)	Can't say (%)	Disagree (%)
• Area of some crops (like minor millets, sesame, pigeon pea, maize, jowar etc. in *kharif* and linseed, lathyrus, lentil etc. in *rabi*) has decreased	48.33	17.92	33.75
• Use of traditional crop varieties decreased	82.08	12.50	5.42
• Changes occurred in flowering and fruiting time of crops	48.33	32.50	19.17
• Cropping pattern has changed	82.92	15.83	1.25
• Population of rodent like rat has increased	71.67	22.50	5.83
• Some insects have extinct and some have been getting adapted with changing climatic condition	67.09	29.16	3.75
• New species of seasonal weeds seen in recent years	67.91	27.50	4.59
• Conditions getting favorable to flourish weeds/insects/diseases	75.00	20.00	5.00
• Investment in agriculture has increased	86.25	12.08	1.67
• Traditional irrigation sources like pond has reduced	79.59	14.16	6.25
• Level of ground water has decreased	63.75	29.16	7.09

Almost half of the respondents believed that due to climate change area of some crops like minor millets, sesame, pigeon pea, maize, jowar etc. in *kharif* and linseed, lathyrus, lentil etc. in *rabi* has decreased, on the other hand 33.75 per cent of them were disagreed with that. The results of the impact of long term climate change observed in the present study are similar to the earlier studies of Pearce *et al*. (1996), Kinuthia (1997), FAO (2005) and Bhushal *et al.* (2009).

Impact of long term climate change on allied activities

The results of analysis examining the impact of long term climate change on allied activities depicted in Table 4. The results revealed that majority of respondents (86.30%) agreed, over the past 15 years migration of birds and animals has increased due to climate change, while, 82.92 per cent believed that climate change has increased drudgery of farmers/farm women. A significant majority of respondents (82.51%) agreed that drinking water availability decreased due to climate change. Though drinking water has decreased in summer due to changing pattern of rainfall resulting more runoff, local people said that they were facing more drought periods resulting decrease in ground water level. It was also perceived by a substantial percentage of respondents that the change in climate has resulted in scarcity of fodder in the area, increased human health problems and air pollution.

Table 4: Perception of respondents about impact of long term climate change on allied activities

Statement	Agree (%)	Can't say (%)	Disagree (%)
• Species of some animal and bird has extinct	67.97	21.33	10.70
• Scarcity of fodder in the area	80.42	17.91	1.67
• Behavioral changes and adverse effect on health of livestock	60.00	29.17	10.83
• New fish species found and old species have extinct in rivers	60.42	38.33	1.25
• Investment on physical facilities increased	68.75	12.92	18.33
• Human health problems are increasing	72.92	25.41	1.67
• Migration of birds and animals has increased	86.30	9.58	4.12
• Drinking water availability decreased	82.51	10.41	7.08
• Air pollution are increasing	71.67	28.33	0.00
• Water pollution are increasing	51.66	47.92	0.42
• Drudgery of farmers/farm women has increased	82.92	7.50	9.58

However, it was surprising to note that 68.75 per cent of the respondents perceived that due to climate change investment on physical facilities increased, there life style have improved. Those who agreed that extinct of some animal and bird species has resulted due to climate change and new fish species found and old species have extinct in rivers due to climate were 67.97 and 60.42 per cent, respectively.

Similar findings were also reported by Rischkowsky *et al.* (2004), Arya (2010), Bhushal *et al.* (2009), Pettengell (2010) and Owusu-Sekyere *et al*. (2011).

Furthermore, overall impact of long term climate change was determined by summed up the scores of farmers' perception on impact of long term climate change on agriculture and allied activities. Findings of farmers' perception regarding overall impact of long term climate change are presented in Table 5. The results indicated that nearly 37 per cent of the respondents perceived medium level of overall impact of long term climate change, while, 34.17 and 29.17 per cent of the respondents reported high to low level of overall impact of long term climate change on agriculture and allied activities.

Table 5: Perception of respondents about overall impact of long term climate change

Impact of long term climate change	Frequency	Percentage

Low (Up to 22 score)	70	29.17
Medium (23-44 score)	88	36.67
High (More than 44 score)	82	34.17

Conclusion

Long term climate change has been predicted by scientists to have the main impact on agriculture, economy and livelihood of the populations of developing countries and India is one of them, where large parts of the population depend on climate sensitive sectors like agriculture and forestry for livelihood. Almost half of the respondents of study area believed that due to climate change area of some crops like minor millets, sesame, pigeon pea, maize, jowar etc. in *kharif* season and linseed, lathyrus, lentil etc. in *rabi* season has decreased. Majority of respondents (82.51%) agreed that drinking water availability decreased due to climate change. Though drinking water has decreased in summer due to changing pattern of rainfall resulting more runoff, local people said that they were facing more drought periods resulting decrease in ground water level. As per the past experiences farmers agreed that due to climate change, investment in agriculture has increased. This is mainly due to more infestation of insects & diseases on crop and more expenses on irrigation water. Agriculture was the main source of livelihood of the farmers in study area and that was most vulnerable section due to climate change because majority of the farmers in the study area were relied on rainfed agriculture, while considering risky, mono-cropping practicing under dry land.

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