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Climate change scenario: A study on perception, adaptation and mitigation strategies in reference to Indian farmers

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ABSTRACT

The issue of impact of climate change on agriculture has emerged in recent decades and it is necessary to evaluate its impact on agriculture. It is resulting in problems with food security and may threaten the livelihood activities upon which much of the population depends. However it may affect crop yields both positively and negatively, as well as the types of crops that can be grown in certain areas, by impacting agricultural inputs such as water for irrigation, amounts of solar radiation that affect plant growth, as well as the prevalence of pests. Keeping in mind the importance of the issue a study was conducted in two villages of Haryana state. The objective of the study was to determine the perception of farmers on issue of climate change. A sample of 300 respondents (40 %) was randomly selected from a total population of 800 farmers. Data were collected from the sampled respondents in 2013 and 2014. Most of the farmers (69.3 %) perceived that climate change started between last 5 to15 years. Almost half of the farmers (48.0%) believe that environmental factor is responsible for climate change and felt that both rainy season and cold season start late and are of shorter duration. Hot season shows opposite scenario as it starts early but is prolonged. Mean duration of hot season has significantly increased in recent past compared to last decade. Similarly, they perceived that hotness has increased (88.7%) and coldness has reduced (60.0%). Farmers observed a reduction in overall rainfall (83.3%) as well as variation in the speed and duration of strong wind. They felt that incidence of drought has increased (73.3 %). However the educational status of the farmers and access to extension services had significant association with their perceived cause towards climate change.

Key words: climate change, mitigation, adaptation, agriculture

INTRODUCTION

Agriculture is a major economic, social, and cultural activity, and it provides a wide range of ecosystem services. Importantly, agriculture in its many different forms and locations remains highly sensitive to climate variations, the dominant source of the overall interannual variability of production in many regions and a continuing source of disruption to ecosystem services. For example the El Niño Southern Oscillation phenomenon, with its associated cycles of droughts and flooding events, explains between 15 percent and 35percent of global yield variation in wheat, oilseeds, and coarse grains (Ferris, 1999).

India, being a country of diversified climatic variation and farming systems, has high dependency of agriculture on the monsoon rains and a close link exists between climate and water resources. Two thirds of the area in India is rainfed. Climate change can affect crop yields (both positively and negatively), as well as the types of crops that can be grown in certain areas, by impacting agricultural inputs such as water for irrigation, amounts of solar radiation that affect plant growth, as well as the prevalence of pests (Kumar, 2014). Agriculture represents a core part of the Indian economy and provides food and livelihood activities to much of the Indian population. It represents 35 percent of India's Gross National Product (GNP) and as such plays a crucial role in the country's development (Singh and Nautiyal, 2011). However it is greatly dependent on climatic conditions and impact of climate change on agriculture could result in problems with food security thus threatening the livelihood activities upon which much of the population depends. There will be increased frequency of floods during the monsoon and a decrease in winter precipitation with a lower number of rainy days. With a 0.68 degrees Celsius increase

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in temperature so far in India, it is expected that there will be pronounced warming in future, particularly during the post monsoon period and winter (Pathak *et al*., 2012).

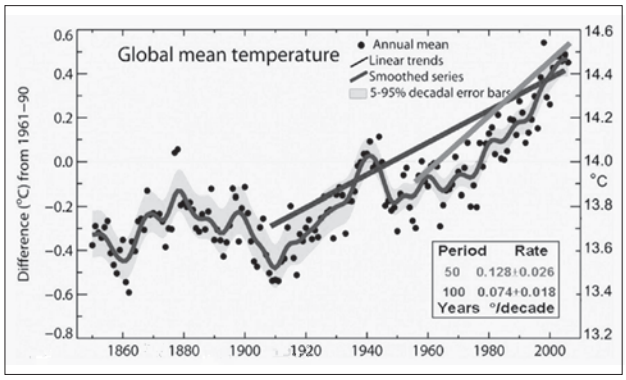

Fig. 1. Trends in global temperature over the years (*Source*: IPCC, 2007)

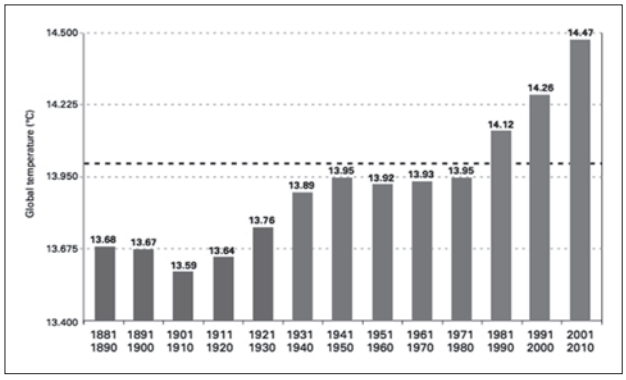

Fig. 2. Trends in global temperature over the years (*Source*: NASA, 2012)

According to Pratheep (2015), amongst the key impacts will be the faster retreat of Himalayan glaciers, frequent floods and decrease in crop yields, yield reductions in wheat and rice due to temperature rise in key growing regions The potential impacts on Indian agriculture would look like this: the productivity of most cereals would decrease due to increase in temperature and CO_2, and the decrease in water availability. There will be a projected loss of 10-40% in crop production by 2100 if no adaptation measures are taken. Global temperature shows the increasing trend (Fig 1, 2) that affects agriculture crops. Every one degree Celsius increase in temperature may reduce yields of major food crops by 3-7%. The length of the growing period in rain-fed areas is likely to decrease, especially in peninsular regions. An increase in climatic extremes such as heat and cold waves will likely to increase production variability (Hijioka *et al*., 2014). Keeping in the mind the importance of the issue in reference to cropping system and farmers it is inevitable to identify the status of agri-workers in reference to their knowledge status. A study was conducted with the objectives (a) to determine the perception of farmers on the issue of climate change, (b) to determine barriers felt by farmers in adopting climate resilient technologies and (c) to find out the Important Farm-level adaptation strategy to combat climate change.

METHODOLOGY

The present study focuses on agri-workers in the northern area of country where the climatic conditions have great variations throughout the year. The study was conducted in a survey approach through a Performa to be filled during the interaction with each worker for identifying their perception towards the issue.

For this purpose ten variables were selected and these were further categorized under four standards *viz.* confirm (positively sure with understanding the reasons behind the fact), agree (sure without knowing the reasons behind the fact), neutral and disagree with the fact. Sample size for farmers was 300 from the two villages of Faridabad namely *Badarpur Said* and *Jasana.* The selection of the respondents was done randomly however keeping in the mind the close participation of fair gender in the agriculture works; women farmers were also included in the study. The study also included identification of the barriers responsible for inhibiting the adoption of climate combat strategies in the cropping system. Some adaptation and mitigation strategies based upon the climate and cropping system of the area were advocated to the farmers for adoption. The mitigation strategies were based upon the variability in the climatic conditions since the last two decades however the cropping system of the area is replicated by the farmers in the same way as their ancestor were practicing while it is not appropriate according to current scenario.

RESULTS AND DISCUSSION

Perception of farmers towards climate change

As revealed by the Table 1, that more than two third respondents (69%) were of the opinion that change in climate has started more voraciously during last fifteen years. Another twenty five percent of the respondents have also showed the agreement with the similar views. However respondents who were of different opinion and did not coincide with the statement were only few ie less than 4 percent. Less than half (48%) had the opinion that climatic conditions are due to environmental factors which are basically causing

Table 1. Perception of farmer towards climate change under different variables (n=300)

Perception	Confirm		Agree		Uncertain/Neutral		Disagree	
	(f)	(%)	(f)	(%)	(f)	(%)	(f)	(%)
Climate change started between last 5 to15 years	207	69.0	80	26.6	03	1.0	10	3.3
Environmental factor is responsible for climate change	144	48.0	106	35.3	40	13.0	10	3.3
Rainy season and cold season are delayed and of shorter duration	185	61.0	65	21.6	35	11.6	15	5.0
Increase in temperature	266	88.0	14	4.66	20	66.0	0	0
Temperature in winters is moderate	180	60.0	20	6.66	80	26.6	20.0	6.6
Reduction in overall rainfall	249	83.0	11	3.6	25	8.3	15.0	5.0
Change in timing of rains	85	28.3	65	21.6	35	11.6	15.0	5.0
Sporadic rains	15	5.0	20	6.6	80	26.6	85.0	28.3
Water table decreasing sharply	219	73.0	40	13.3	20	6.6	11.0	3.6
Need to change cropping system	135	45.0	65	21.6	35	11.6	65.0	21.6

the change in climatic conditions. Nearly 35 percent were also having the same views but were not capable to connect the both, the environmental factors and the changing climatic scenario. However, only a few respondents expressed their opinion that both the concepts have no dependency at all.

Keeping in mind the dependency of Indian agriculture on rains, the study included different variables related to weather conditions. Nearly 61 percent respondents expressed their perception that both rainy and winter seasons are commencing delayed and also experiencing shorter duration. However, only 5 percent of the respondents did not coincide with their opinion. The study also revealed that a considerable number of respondents (11.6%) were having no idea about the change in duration and commencement of rainy and winter seasons.

The increase in temperature during the last few years was experienced by 88 percent of the respondents and more than half of the respondents experienced the similar views about the critical coldness levels in winters too. These respondents felt that critical minimum temperature was not experienced by northern Indian Plains as it was experienced a few decades ago. However a few (26%) of respondents did not perceive this change in the temperature during winters.

The survey also covered the important aspects of climate change like scanty rainfall, change in timing of rains, sporadic rains, and water table decreasing sharply. A major portion (83%) perceived that there is a considerable decrease in the rain fall during the last decade as a consequence of the changing climatic scenario. While very few also experienced that rains perceived by the land is same as it was earlier.

The study also tried to judge the mind set of respondents regarding the mitigation strategies like change in cropping system and revealed that nearly half of the respondents (45%) advocated the demand of change in cropping system from conventional to climatic savvy cropping system, while only 20 percent also agreed with statement.

Important farm-level adaptation strategy to combat climate change

The top three ranked adaptation strategies adopted by farmers were increased use of irrigation, moved to non-farm activities and practicing crop diversification was observed by 80, 65 and 40 percent. However, the important climate combat strategies like agro forestry, soil conservations techniques, zero tillage, use of drought tolerant varieties and use of salinity tolerant varieties were found completely missing from the cropping system of the area (Table 2).

The other important strategies like cultivating short duration crops, practicing intercropping and practicing crop rotation were also found in very less percent (less than 10).

Important Barriers felt by farmers to Combat Climate Change strategies

The very less adoption of climate combat strategies in the cropping system led authors to identify the barrier responsible for non-adoption of the strategies. In this reference some barriers were identified and ranked as perceived by the respondents. The top most barriers perceived by farmers are lack of information about weather, lack of Information about climate resilient varieties and lack of information about climate change. Lack of knowledge about adaptations and lack of credit or savings were also observed by the respondents as

Table 2. Adoption percentage of Important Farm-level adaptation strategy to combat climate change

S. No.	Adaptation Strategy	Percent Farmers	Rank
a.	Increased use of irrigation	80.0	I
b.	Moved to Non-farm activities	65.0	II
c.	Practicing crop diversification	40.0	III
d.	Change in crop variety	35.0	IV
e.	Integrated farming system	34.0	V
f.	Buy insurance	15.0	VI
g.	Build a water-harvesting structure	14.0	VII
h.	Crop insurance	9.0	VIII
i.	Cultivating short duration crops	9.0	IX
j.	Practicing intercropping	7.0	X
k.	Practicing crop rotation	5.0	XI
l.	Agro forestry	0	XII
m.	Soil conservations techniques	0	XIII
n.	Zero tillage	0	XIV
o.	Use of drought tolerant varieties	0	XV
p.	Use of salinity tolerant varieties	0	XVI

a major barrier in way to adoption the strategies. However, the less ranked barriers were lack of appropriate seed, adaptation not cost effective and lack of market access or transport problems were also observed by a moderate number of respondents (Table 3).

Table 3. Important barriers felt by farmers to combat climate change strategies

S. No.	Barrier	Rank
a.	Lack of information about weather	I
b.	Lack of Information about climate resilient varieties	II
c.	Lack of information about climate change	III
d.	Lack of knowledge about adaptations	IV
e.	Lack of credit or savings	V
f.	Lack of appropriate seed	VI
g.	Adaptation not cost effective	VII
h.	Lack of market access or transport problems	VIII

Adaptation and mitigation strategies

The area of north India just like other part of the world is experiencing variability in temperature which was not seen earlier so there is an urgent need to review the protocol and colander of cropping system accordingly. Since the issue of climate change is very complex to tackle by researchers any how some mitigation strategies that are must to follow in current scenario are prescribed to farmers. These are as follows.

(a) Farmers need crops and varieties that fit into new cropping systems and seasons.
(b) Researchers need to develop varieties with changed duration and varieties for high temperature, drought, inland salinity and submergence tolerance.
(c) Agri-workers need crops varieties that may tolerate coastal salinity and seawater inundation and may respond to high CO_2.
(d) Quality research is required to make germplasm climate resilient.
(e) Wild and extinct varieties have traits tolerant to high temperature, elevated CO_2 etc.
(f) Wild and extinct varieties might have been discarded in the past due to low yield potential but can be made use of today as parents for the breeding of tolerant varieties to climate change.
(g) There is a need to revisit gene banks with a view to searching for unique traits required for climate change. In this search, indigenous knowledge and farmer's wisdom have immense value.
(h) Efficient and wise management practices hold the key to adaptation and mitigation.
(i) Better water management and nutrient management.
(j) Lastly, agriculture needs varieties with high radiation use efficiency.

CONCLUSIONS

Most of the farmers (69.3%) perceived that climate change started between last 5 to15 years. Almost half of the farmers (48.0%) believe that environmental factor is responsible for climate change felt that both rainy season and cold season delays to start but ends early. Mean duration of both seasons has been significantly reduced in recent past than long time ago. Hot season shows opposite scenario as it starts early but delays to end. Mean duration of hot season has been significantly increased in recent past compared to long time ago. Similarly, they believe that hotness has increased (88.7%) and coldness has reduced (60.0 %). Farmers found a reduction in overall rainfall (83.3%) and variation in wind speed, duration of strong wind. They felt the incidence of drought has been increased (73.3%) and flood has been decreased (66%). Level of education and access to extension services had significant association with their perceived cause of climate change. Science, too, has to adapt. Multi-disciplinary problems require multi-disciplinary solutions, *i.e.* a focus on integrated rather than disciplinary science and a strengthening of the

interface with decision makers. The barriers lack of information about weather, lack of Information about climate resilient varieties were ranked first and second respectively.

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