Farmers' Perception on Climate Change and Agricultural Adaptation Strategies

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ABSTRACT

The study analyzed farmers' perception about climate change and agricultural adaptation strategies in North-eastern Karnataka region. A multi-stage random sampling technique was employed to elicit information from 120 respondents. Data were collected through a well-structured questionnaire. Ex-post-facto research design was adopted for this study. The perception level of respondents about the climate change parameters followed the normal distribution curve with slight skewness towards low level of perception and 40.83 per cent of the respondents had low level of perception, 30.83 per cent had medium level of perception and 28.33 per cent of the respondents had high level of perception about climate change parameters and majority farmers in study area experienced climate change through increase in average temperature, occurrence of droughts, increased pest and diseases, uneven distribution of rainfall, decrease in average rainfall, decreased yield, reduction in average productivity, decrease in quality of produce, late onset of monsoon, increased crop weed competition, changing time of sowing, reduced soil fertility, reduced water holding capacity , increased water stress and terminal heavy rain. Appropriate system for weather/climate data collection, forecasting and early warning system for climatic extremities should be developed by the Department of Hydrology and Meteorology. While climate-based advisory such as insect pest and disease, weather forecasting system should be devised by Department of Agriculture.

Key words: *Farmers' Perception, Climate change, Climate parameters, Adaptation, strategy*

INTRODUCTION

Climate change refers to any change in climate over the time, either due to natural variability or as a result of human activity (IPCC, 2007; Fusel, 2007). The changes occur in different climatic parameters such as, variation in precipitation, temperature and increase in greenhouse gases (GHG's) emission through human activities. Due to global warming, climate is changing rapidly with adverse effects including excessive and uneven rainfall, floods, droughts and cyclones (Baul *et al*. 2013). The climate change is major threat to livelihood of rural people (IPCC, 2007).

In India, climate change has been experienced by the communities in the form of irregular rainfall and snowfall, increasing temperature, decreasing moisture content and delaying monsoon. Crop productivity has been also decreased because of low soil fertility and higher incidences of diseases (Rawat *et al*. 2013). The adverse effects of changing weather patterns and climate have extended beyond crop cultivation and influence livelihoods of people. Due to rising in temperature agriculture production is expected to decline by 2050 in Himalaya region and will lead food insecurity (Dahal, 2008). Changes in weather patterns also result in reduction in availability of fuel wood, fodder availability, spring water (Gene, 2012). Increasing disturbances of forests (forest fire, heavy lopping and logging, migration of wild animals towards village, *etc*.) accompanied by increased human population, increasing in number of factories and motor vehicles were some of the causes that lead to climate change (Arya, 2010a).

The perceptible change in climate due to anthropogenic activities started with industrialization in the modern era, has aggravated in recent times. The negative impacts of the climate change on human life, flora, fauna, seasons, water and air is witnessed all over the world. Lots of discussions for its controlling and combating the unabated climate change are taking place from school, village level to global level. It has been realised now that, if the climate change phenomenon is left uncontrolled, the survival of

human kind and the globe is at stake. However, before taking controlling measures, it is necessary to understand its phenomenon thoroughly. Because, people have different perceptions about the change which is happening around them and sometimes attribute the causes for change to unrelated reasons.

Perception is the ability to see, hear or become aware of something through senses. It is basically a partial understanding of a thing or phenomenon but the building block of knowledge and further wisdom. Therefore, understanding of an individual's perception about a thing is first step in the direction of encouraging, modifying and changing the behavior. Hence, it is essential to understand the farmers' perception about climate change parameters and their adaptation strategies in agriculture sector.

METHODOLOGY

The research study on farmers' perception about climate change and agricultural adaptation strategies was conducted in North-eastern Karnataka during 2018-19. Multi-stage random sampling method was used. At the first stage, all the districts of North-eastern Karnataka were selected. Based-on data pertained to drought affected blocks (taluks) provided by Karnataka State Natural Disaster Monitoring Center during 2001 to 2018. At the second stage, two talukas in each district were selected based on frequency of drought occurrence and one village in each taluk were selected, randomly. Then, 12 villages were finalized at the third stage. Total 120 respondents were selected from these villages to make out the required sample size. The districts were selected based-on data pertained to drought affected blocks (taluks) listed by Karnataka State Natural Disaster Monitoring Center during 2001 to 2018. An *ex-post facto* research design was adopted. According to Kerlinger (1964), an ex-post facto research is a systematic empirical enquiry in which the researcher does not have direct control over the variables because their manifestations have already occurred or because they are inherently not manipulable. A numerical rating scale developed by Kranti kumari (2014) in the study on "Farmers' perception and adaptability of the farmers towards climate variability in Kurnool district of Andhra Pradesh" was adopted and used to measure the perception of the respondents towards climate change parameters in the present study. Rating scale was administered to rate each statement on a three-point continuum as strongly agree, agree, disagree with weight ages of 3, 2, and 1, respectively. Equal scores were given to all the 20 statements listed and taken into consideration while scoring. The sum of all scores on all the statements formed the perception of farmer score on climate variability. The possible score varied from 20 to 60. Interview method of data collection was used with the help of semi structured interview schedule to elicit required data. It was pretested with expert committee before the final use. Descriptive statistics tools namely, mean, frequency, percentage and regression were used for data analysis.

Regression analysis was done including climate change parameters index as a dependent variable and respondents' profile as an independent variable.

RESULTS AND DISCUSSION

The analysis of the socio-demographic profile of the respondents has its crucial importance in the social science investigation. It enables us to understand the diverse factors such as age, family structure, caste, their education attainment, economic status of the family etc., that reflects perception of the respondents on any idea or innovations.

Socio-personal characteristics of respondents

Out of the respondents, majority (62%) of them were of middle age group (36 to 55 years) followed by 22 per cent were belong to young age group (<35 years). This is because of most of younger generation is not interested in farming, and therefore, more number of middle aged person were continuing the farming. With respect to education, 29 per cent of them studied up to higher primary and 22 per cent up to primary education. Less than

half of respondents (42%) belonged to medium size family, followed by large sized family (36%) comprising of 7 and above members, respectively. This shows predominance of medium size family in rural area and less of urbanization in the study area. Majority of the respondents had found to have an experience of more than 10 years (73%) followed by respondents with experience of 5-6 years of (23%) in farming. This might be because of predominant age groups of the respondents. Less than half (44.17%) of farmers owned 2 to 4 ha of land and fallen under medium farmers category followed by the respondents owning 1 to 2 ha of land (33%) under small farmer category. This might be due to splitting of joint families, the land is being fragmented and large farms are converted into small holdings.

About 50% of farmers were dependent on farming alone for their livelihood (49%) whereas, one third 30 per cent of them were engaged in agriculture related occupation like dairying, agriculture labour, poultry *etc.,* Nearly half of the respondents (48%) belonged to low income group. This is because of the study area is very much prone to low and erratic rainfall with uneven distribution pattern and frequent droughts. Above 40 per cent of farmers, (42%) practiced double cropping pattern followed by mono cropping (37%). Around 40 per cent of the respondents had no irrigation source and solely depended on rainfall for farming.

An overall view of mass media exposure revealed that above 40% of the respondents (43%) had low level of mass media exposure. This is because of, majority of the respondents were not using mass media to seek and gain the knowledge regarding climate change. While, and 48.33 per cent were of low-level extension participation category, and same were (48%) had low level of risk bearing ability. An economic motivation concern, above half of the respondents (52%) had low level of economic motivation. This is because of increased in cost of cultivation, increasing debt, and uncertainty in returns from farming due to fluctuations in the market and climate conditions like erratic distribution of rainfall and droughts. As far as participation in social organizations is concerned, 46 per cent of the farmers were members of co-operative society, youth club, farmers commodity group at present. Majority of the respondents belonged to middle age group and had big land size, their social participation was also at the expected level.

Table 1
Characteristic profile of the respondents(n=120)

Sl. No.	Variable	Frequency	Per cent
1	**Age**		
	Young (<35)	27	22.50
	Middle (36to 55 years)	78	65.00
	Old age (>55 years)	15	12.50
2	**Education**		
	Illiterate	14	11.67
	Can read and write	11	21.67
	Primary education	26	21.67
	Middle school	35	29.17
	High school	19	15.83
	PUC	12	10.00
	Graduation and above	3	2.50

3	**Family size (members)**		
	Small (<5 members)	26	21.67
	Medium (5-6 members)	51	42.50
	Big (7 and above)	43	35.83
4	**Farming experience**		
	Less (<5 years)	4	3.33
	Moderate (5-10 years)	28	23.33
	High (>10 years)	88	73.33
5	**Land holding**		
	Marginal farmers (up to 1 ha)	9	7.50
	Small farmers (1 to 2 ha)	40	33.33
	Medium farmers (2 to 4 ha)	53	44.17
	Big farmers (above 4 ha)	18	15.00
6	**Occupation**		
	Farming alone	49	48.83
	Farming +agriculture related occupation	36	30.33
	Farming + service	21	17.50
	Farming + independent profession	14	11.67
7	**Annual income**		
	Low (≤ 80383 rupees)	57	47.50
	Medium (80383-188199 rupees)	34	28.33
	High (⩾188200 rupees)	29	24.17
8	**Irrigation source**		
	Canal	17	14.17
	Open well	13	10.83
	Open well + Borewell	4	3.33
	Rainfed	47	39.17
	Other irrigation sources	39	32.50
9	**Mass media use**		
	Low (≤ 4.12)	52	43.33
	Medium (4.13-6.23)	32	26.67
	High (⩾ 6.24)	36	30.00
	Mean = 5.18, SD = 2.50		
10	**Extension participation**		
	Low (≤1.93)	58	48.33
	Medium (1.94-3.52)	46	38.33
	High (⩾3.53)	16	13.33
	Mean = 2.73, SD = 1.88		

11	**Decision making**		
	Low (≤14.20)	45	37.50
	Medium (14.21-16.89)	39	32.50
	High (⩾16.90)	36	30.00
	Mean-15.54, SD-3.15		
12	**Risk bearing ability**		
	Low (≤13.34)	58	48.33
	Medium (13.35-15.52)	41	34.17
	High (⩾15.53)	21	17.50
	Mean-14.43, SD-2.57		
13	**Economic motivation**		
	Low (≤21.30)	62	51.67
	Medium (21.31-23.09)	32	26.67
	High (⩾23.10)	26	21.67
	Mean-22.2, SD-2.12		
14	**Scientific orientation**		
	Low (≤23.04)	49	40.83
	Medium (23.05-25.23)	44	36.67
	High (⩾25.24)	27	22.50
	Mean-24.14, SD-2.59		
15	**Social participation**		
	Past member	17	14.17
	Past office bearer	2	1.67
	Present member	55	45.83
	Present office bearer	0	0.00
	No social participation	46	38.33

Table 2

Perception of farmers about different climate change parameters (n=120)

Sl. No.	Climate change parameters	Respondents categories						Totalscore	Mean score	Rank
		Strongly agree		Agree		Disagree				
		F	%	F	%	F	%			
1.	Increase in average temperature	79	65.83	41	34.17			319	2.66	I
2.	Occurrence of droughts	76	63.33	39	32.50	5	4.17	311	2.59	II
3.	Increased in pest and diseases	65	54.17	49	40.83	6	5.00	299	2.49	III
4.	Uneven distribution of rainfall	55	45.83	61	50.83	4	3.33	291	2.43	IV
5.	Decrease in average rainfall	51	42.50	68	56.67	1	0.83	290	2.42	V
6.	Prolonged dry-spell	62	51.67	46	38.33	12	10.00	290	2.42	V
7.	Decrease in number of rainy days	46	38.33	70	58.33	4	3.33	282	2.35	VI
8.	Decreased in yield	42	35.00	72	60.00	6	5.00	276	2.30	VII
9.	Reduction in average productivity	42	35.00	71	59.17	7	8.83	275	2.29	VIII
10.	Decrease in quality of produce	34	28.33	79	65.83	7	5.83	267	2.23	IX
11.	Late onset of monsoons	27	22.50	89	74.17	4	3.33	263	2.19	X
12.	Early withdrawal of monsoons	27	22.50	86	71.67	7	5.83	260	2.17	XI
13.	Increased crop weed competition	23	19.17	77	64.17	20	16.67	243	2.03	XII
14.	Changes in time of sowing	11	9.17	77	64.17	32	26.67	219	1.83	XIII
15.	Shortening lengthof crops season	16	13.33	67	55.83	37	30.83	219	1.83	XIII
16.	Reduced soil fertility	13	10.83	72	60.00	35	29.17	218	1.82	XIV
17.	Reduced water holding capacity	17	14.17	35	29.17	68	56.67	189	1.58	XV
18.	Decreased fertilizer use-efficiency	9	7.50	50	41.67	61	50.83	188	1.57	XVI
19.	Increased water stress	9	7.50	45	37.50	66	55.00	183	1.53	XVII
20.	Terminal heavy rains	11	9.17	27	22.50	82	68.83	169	1.14	XVIII

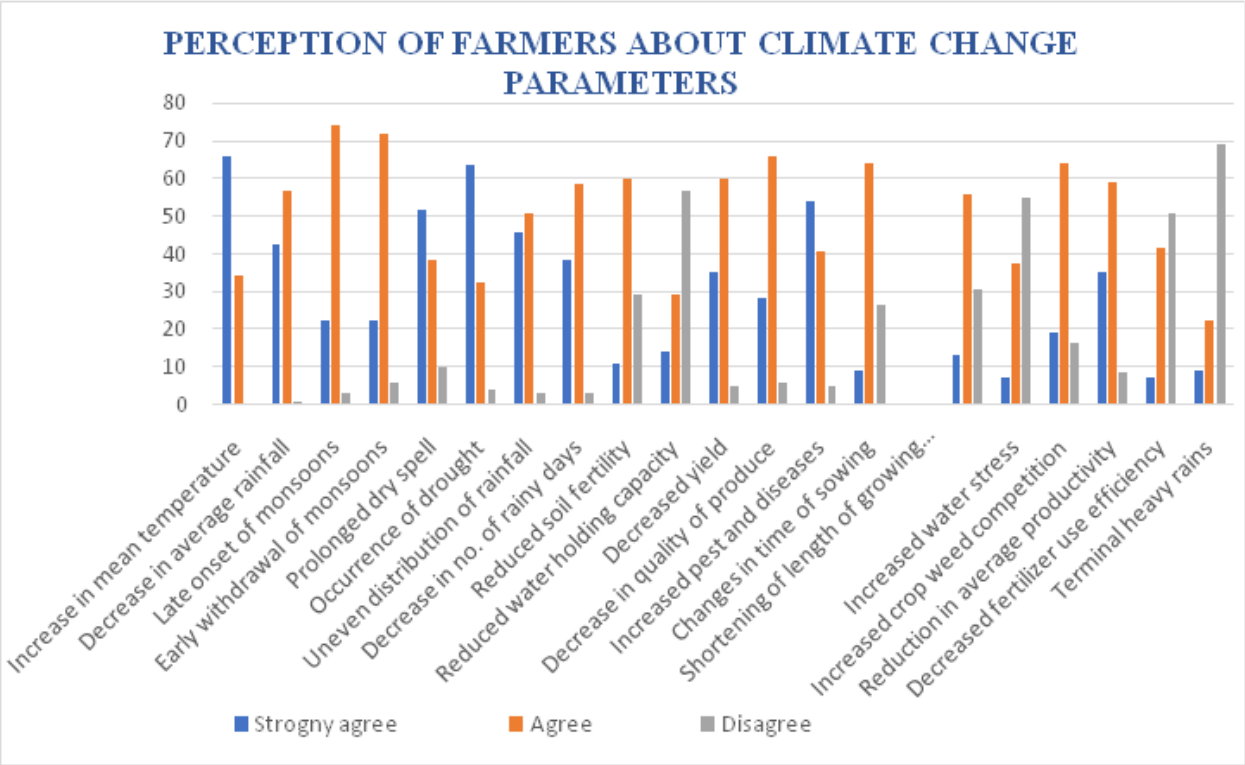

Fig. 1.

Perception of farmers about climate change parameters

It is revealed (Table 3) that, increase in average temperature was found most significant climate change parameter had first rank according to majority of the respondent farmers. The finding was supported by of Fosu *et al.* (2012) and Haque *et al*. (2012). Occurrence of drought was found to be the second most climate change parameter as ranked by the respondents. Increased in pest and disease incidence was ranked third followed by uneven distribution of rainfall, prolonged dry spell and decreased number of rainy days which were ranked four, five and six, respectively. Decrease in average rainfall was on sixth ranked along with prolonged dry spell. Decrease in the yield was ranked seven by the respondent farmers.

Increase in average temperature was found to be highest ranked parameters among the twenty. It reflected that most part of the study area was in the rain shadow region and the weather in general throughout the year is dry and temperature went up to 45˚C and sometimes upto 48˚C in some parts. Constant high temperature in the region over a period of time in most times of the year had made temperature was most significant parameter of climate change that affect agriculture to large extent. The selected districts were experienced droughts many times continuously according to Karnataka State Natural Disaster Monitoring Centre Bangalore. In the past 18 years, 11 years were drought affected period. This was proven in accordance with the farmers response as they ranked occurrence of drought as second most significant climate change parameter. Along with climatic factors, the farmer felt that increase in the attack of pest and disease incidences which was perceived to be the resultant of climate change. In study area, farmers also felt that the outbreak of pest and diseases had rapidly increased in the past few years. The major crop in the study area namely paddy, cotton, red gram, black gram, green gram and bengal gram were severely affected by pest incidence and consequently, farmers realized very low yield and income. The findings were in line with

the results reported by Arya (2010).Uneven distribution of rainfall decreases in annual rainfall, prolonged dry spell and decrease in number of rainy days were realized due to climate change in the recent years therefore, there was significant decrease in average rainfall level. The rainfall was earlier spread from June to October and used to receive in even and balanced manner. Due to severe climate change, there was shift in rainfall pattern. The monsoon rain supposed to be to be started in the month of June, is recently received in the mid and later parts of July. Due to this shift, the farmers were not able to sow their crops at the right time. Along with change in rainfall pattern, it was observed that there was rapid reduction in the average rainfall over the past few years. The farmers are not able to predict the timing and intensity of rainfall. Heavy rainfall was received in some parts during the rainy season whereas there was no rainfall in other parts. Over the past few years, there was frequent and prolonged dry spell due to decrease in average rainfall. The occurrence of drought has become common phenomenon. The farmers were suffered heavily due to crop losses and obtained low income only. The quantity and duration of rainfall were drastically reduced over the past few years, but also the number of rainy days were come down significantly. Less rainfall impacted, farmers to get low production and productivity were resulted into low income. The farmers were not able to get good and consistent yield from their fields.

Erratic rainfall, prolonged dry spell along with indiscriminate use of fertilizer and pesticides led to overall reduction in the productivity of crops. Heavy downpour resulted in soil erosion thus, the soil become less fertile. Along with this, the heavy use of fertilizers and plant protection chemicals altered the soil properties and made it less fertile. consequently, the productivity of the crop was decreased rapidly and this item was given eight rank by the farmers.

Decrease in quantity of produce was ranked ninth. This was felt by the farmers, because in earlier days the soil was very rich in organic matter and they used quality produce. Due to soil erosion, water logging and injudicious use of irrigation water along with the toxic effect of chemicals made the soil less productive.

Late onset of monsoon which was ranked tenth in the study. it was due to climate change caused shift in monsoon cycle and rains were not received at time as predicted earlier. There was gradual shift in the monsoon and rains that used to receive in the mid of June, were being postponed to late July or first week of August. Due to this late set of monsoons, the farmers were not able to plan of sowing properly as to which crop to grow. Delayed monsoon also has the risk of increased pest outbreak and disease incidence and resulted into low yield. The eleventh rank was given to early withdrawal of monsoons. The rainfall does not only start late, but also it ends soon leading to lesser number of rainy days. The rainfall season which was spread till end of October in the earlier days, has come down to mid-September. This early withdrawn of monsoon, uneven rainfall duration has led to low crop productivity and reduced income to the farmers. The weeds grow rapidly and overtake the crops leading to major crop loss was also realized in the study area.

Change in time of sowing and shortening during of the crop season was ranked thirteenth by the respondent farmer. These two factors were the direct result of uneven and decreased rainfall due to climate change since the rains were not received as predicted. Due to the delayed monsoon, the farmers had to change the time of sowing in accordance with the rainfall pattern. The farmer earlier used to go for sowing in early June but, now-a-days they were sowing in mid or late July and even up to first week of August due to delayed monsoon. The rainfall pattern had also affected the crops season due to water shortage. The plants were under stress and were forced to complete the life cycle. The farmers now-a-days are going for short duration cultivars so that the crops can be escaped from water stress at the terminal stages of their life cycle.

Reduced soil fertility was ranked fourteenth and reduced water holding capacity was ranked

fifteenth. These two soil related parameters were resultant of uneven rainfall, excessive use of fertilizer and pesticides. Decreased fertilizer use-efficiency was ranked sixteenth by the respondent farmers. This may be due to excessive irrigation, where the applied nitrogen leaches down into the soil and could not be available for plants. The soils are becoming saturated and not able to produce more yield per unit quantity of fertilizer.

Increased water stress and terminal heavy rains were ranked seventeenth and eighteenth, respectively. The prolonged dry spell due to the frequent droughts led to increased water stress in the study area.

Level of farmers' perception about climate change

The data in Table 3 depicted that 41 per cent of the respondents had low level of perception, followed by 31 per cent had medium level of perception and 28 per cent of the respondents had high level of perception about climate change parameters. Because most of the farmers they were not well aware about climate change parameters, also they were not aware about suitable latest technology (improved seed variety, short duration crops, farm machinery, latest water conservation techniques etc.) still they are following in traditional way only. The finding was similar to findings reported by Mustapha *et al.* (2012).

Table 3
Perception of farmers about climate change parameters

Sl. No.	Particulars	Criteria	Frequency	%
1.	Low level ofperception	⩽ 39.59	49	41
2.	Medium level ofperception	39.60-43.43	37	31
3.	High level ofperception	⩾ 43.44	34	28
	Total		120	100.00
	Mean = 41.52, SD = 4.54			

CONCLUSION

Farmers perceived climate change and experienced the changes in climatic pattern since many years. While studying farmers perception about climate change parameters, it was found that temperature was increasing at higher rates in the study area. A big change was noticed in total monsoon precipitation, though it was slightly increasing sometimes. Erratic rainfall was continuing in all and winter rain was decreasing. Erratic rainfall was increasing incidences of drought where flooding somewhere due to heavy terminal rains. Problems of soil fertility and irrigation availability were increased. Similarly, an erratic rainfall and increasing temperature promoted the incidence of insect-pests and diseases which directly affecting the growth and development of crops resulted into low production. If, the change continues in the same manner and timely appropriate adaptation strategies are not developed, agriculture sector will suffer at large extend in the days to come. Farmers made adjustments in agricultural practices such as varietal replacement, changes in cropping calendar, pattern, planting method, application of pesticide chemical fertilizers and resource conservation technologies such as zero-tillage, inter cropping and mulching practices s in both low and upland areas.

The perception level of respondents about the climate change parameters followed the normal distribution curve with slight skewness towards low level of perception. It means the farmers could perceive the climate change and its manifestations to some extent. Farmers are worried about the

probable negative impact of these changes in future. Thus, it implies to have more efforts to make aware the farmers about climate related parameters real time basis by the extension agencies through, weather forecasting departments, concerned government agencies using various means.

Appropriate system for weather/climate data collection, forecasting and early warning system for climatic extremities should be developed by the Department of Hydrology and Meteorology. While climate-basedadvisory such as insect pest and disease, weather forecasting system should be devised by Department of Agriculture.

Paper received on 22.10.20
Accepted on 07.10.20

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