Assessment of local perceptions on climate change and coping strategies in Chotanagpur Plateau of Eastern India

JAIPAL S. CHOUDHARY, GOPAL SHUKLA, C.S. PRABHAKAR, SUDARSHAN MAURYA, BIKASH DAS AND SHIVENDRA KUMAR
ICAR, Research Complex for Eastern Region, Research Centre, Ranchi, Jharkhand (India) - 834010
E-mail: choudhary.jaipal@gmail.com; gopalshukla12@gmail.com

ABSTRACT

In the era of climate change, the Chotanagpur plateau is facing extreme climate change related events and its possible impact on ecosystem, livelihood, agriculture, livestock and biodiversity. The scientific community of region yet to start examining the views of farming communities on climate change and its possible impact in Chotanagpur plateau. Keeping this view's the present study as attempted to understand the present perception's of farmers about the climate change and also try to assess the indigenous knowledge to handle the impact of climate change. The perception of 355 respondents were examined through focus group discussion and recorded the opinion on climate change and its impact on ecosystem, agriculture, livelihood, livestock, biodiversity and well beings of human. Results of the study showed that farming communities of the Chotanagpur plateau have meager knowledge about the climate related change and its possible impact. It was also recorded that the farming communities of Chotanagpur plateau have indigenous knowledge to handle possible impact of climate change.

Key words: Chotanagpur plateau, Climate change, Indigenous knowledge, Farmers perception

Climate is continually changing and with projected changes in rainfall patterns and temperature range are expected to affect many biological systems including agriculture. Climate related events such as droughts, cyclones, hailstorm, snowfall, erratic rainfall and fluctuations in temperature badly contributing to world food production and overall economy (IPCC 2007; Shukla et al. 2002; Dhaka et al. 2010). Farming communities are especially sensitive and vulnerable to adverse climate conditions, due to their strong dependence on agricultural production for their livelihood (Campbell 1999).

The Chotanagpur plateau is a known for highly diversified region of India. It has been formed by continental uplift during the Cretaceous to embark on a 50-million-year journey was violently interrupted by the northern Eurasian continent (Anon 2010_a). The region receives an annual average rainfall of around 1400 mm, which is less than the rain forested areas of India and more than 80 % (about 2, 287, 260 ha) of the arable land are rainfed (Dey and Sarkar 2011). The rainfall trend of last 10 years exhibited decreasing pattern. Drought is a recurrent phenomenon in Jharkhand and it affects the livelihoods of the majority of its people, particularly tribes and rural peoples living in this area. In today's context of population explosion coupled with pollution, environmental degradation and climate change, the main concern is increased concentration of CO_2 in the atmosphere and health of the global environment are topics of intense scientific, social and political concern (Shukla 2010). Although the pace of climate change in the Chotanagpur plateau may be fast and its impacts on nature and people are severe, the scientific community has been slow to examine the extent and consequences of climate change. Researches on climate change in this region are meager and have received scarce attention by scientific community and policy makers. Meanwhile, public perception on climate change plays an increasingly important role in shaping environmental policy and management response systems (Brody et al. 2008). Farming communities have been coping with environmental change since the time immemorial. Thus they often have large knowledge about environmental change and means to cope with its consequences (Salick and Byg 2009; Byg and Salick 2009). Such knowledge can boost scientific inquiry and at the same time help design mitigation and adaptation measures to deal with climate change. Thus documentation of local knowledge about climate change adaptation is gaining popularity (Martello 2008; King et al. 2008).

\Adaptation to climatic changes requires a combination of various individual responses at the farmer's level and assumes that farmers have access to alternative practices and technologies available in their area (Charles and Rashid 2007). Adaptation of people to different hazards vary from household to households and region to region based on existing support system to increase the resilience of affected individuals. In the Chotanagpur plateau, no studied has been previously carried out about traditional knowledge concerning the impact of climate change on agriculture, livestock, livelihood and biodiversity even though the region is rich in biodiversity and traditional knowledge systems held by various ethnic groups. The present, assessment was aimed to generate primary information on perceptions of farming community of the Chotanagpur plateau about climate change. Here we illustrate local/indigenous knowledge about changes in climate

and probable impact of such changes on ecosystems, biodiversity, agriculture and livelihoods among local communities of the Chotanagpur plateau using focus group discussion. More specifically, this research tries to develop better understanding about what local farmers' believed about climate change and would assist policy makers to decrease the vulnerability of farming communities to adverse impacts of climate change.

MATERIALS AND METHODS

Study area

The present study conducted on Chotanagpur plateau under National Initiative on Climate Resilient Agriculture (NICRA) project of Indian Council of Agricultural Research (ICAR), New Delhi. This area is situated 23° 45' N latitude and 85° 30' E longitude at an elevation of 700 m. Its mean minimum and maximum temperature varies between 10°C and 37° C, respectively. This area is highly depended on rainfed agriculture. The area also characterized by erratic rainfall from last few years (Anon 2010_b). The main rain occurs from June to September and sometimes it starts in May and stops in October and the wettest month is July/August.

Selection of respondents

Selections of respondents were done based on Simple Random Techniques across the whole region of Chotanagpur plateau. In this way, 355 respondents were sampled from population of the Chotanagpur plateau and views of respondents towards the climate change were recorded. The data were collected from each respondent through Focus Group Discussion (FGD) with the help of pre-tested questionnaire.

Focus group discussion (FGD)

Focus Group Discussion (FGD) were employed to generate information on the perception of the farmers on climate change, its related hazards and existing coping strategies according to Kumar, 1987. Twenty-one FGDs, each consisting 17 participants from different blocks, were held for climate related hazard identification, characterization, and prioritization of coping mechanisms. Tools such as hazard identification and characterization, hazard behavior story telling (time line), hazard ranking matrix and experiential stories telling on indigenous technologies and knowledge was used to acquire information on farmers' perception on climate change trends, existing hazards and their severity on the community. The different coping strategies used by the community were also identified and analyzed for their effectiveness based on their satisfactory level, which is converted into percent for further assessment.

Data management and analysis

Information was recorded using worksheets prepared for each category of discussion. Data collected on each parameter was expressed as percent of respondents. Farmers' perceptions on changes in long-term temperature and precipitation as well as various coping strategies used by farmers were analyzed and presented using simple descriptive statistics with standard error.

RESULTS AND DISCUSSION

Farmer's perception about climate change

Perception of farmer's community about weather relater parameters like temperature, rainfall and drought along with the rainfall pattern is predictable. Data on farmer's responses regarding late onset of monsoon, early withdrawal of monsoon, uneven distribution of rainfall, changing seasons and long dry spell presented in table 1. About 61.29 % local farmers have agreed that temperature is increasing followed by 32.26 % farmers were don't know anything about temperature rise whereas only 6.45 % farmer's perception was opposite to the trends of rise in temperature. Around three fourth of respondents have the idea about temperature changes. Almost, similar trends were recorded about changing rainfall pattern. Most of farmers have little bit knowledge about uneven distribution of rainfall. Similar trends were again observed about the long dry spell. Most of the farmers agreed about the changing of season. Dhaka et al. (2010) carried out a similar study and reported from Bundi District of Rajasthan that majority of the farmers agreed that the temperature increased and precipitation decreased. Similar to our study Chaudhary et al. (2011) also reported that the 84.4% of the people believe that the weather is getting warmer and nearly 78.6% believe that onset of summer and monsoon has advanced during the last 10 years. Studies from different parts of the country also indicate temperature rise, shift in seasons, reduced severity of cold during winter and changes in the number of cloudy days; changes in timing, magnitude, and intensity of both rainfall and snowfall (Joshi and Joshi 2011; Byg and Salick 2009; Salick and Byg 2009; Xu et al. 2009; Vedwan and Rhoades 2008; Goswami et al. 2006).

Last two decades temperature data received from the metrological station is (Fig. 1) revealed that this region has encountered frequent temperature extremities leading to early maturity of crops and fruits, reduction of water table, mortality of young mango plant due to unknown disease and pests.

Perception of farmer's about climate related hazards

Perception of farmer's about climate related hazards on ecosystem function and process included incidents of drought, hail storm, wind pattern is getting warmer, wind storm getting stronger, water source and soil erosion has been presented in table 2. Climate related hazards, soil erosion including the level of soil fertility status ranked 1st with 52.90 % respondents fallowed by wind pattern and wind storm with 50.97 and 50.32 % respectively whereas 32.90 % farmer's identified

water source related problem. However 37.42 % expressed that incident of drought is the major problem and 38.71 % advocated that the hail storm was the main concern. This is again justifying the increasing trends of mean temperature and rainfall which are directly or indirectly related to climate change (table 1). Similar finding were reported by authors like Chaudhary et al. (2011) and Dhaka et al (2010).

Climate change related effect on agriculture and livelihood

Impact of climate change on agriculture and livelihood included Soil fertility status, early flowering and fruiting, changes of fruit/crop ripening, status of crop production, new insect pest and diseases incidence and changing of cropping pattern (table 3). Finding related to impact of climate change on agriculture and livelihood indicated that about 40 % farmers were having the knowledge on the early flowering and fruiting along with the status of production. Similar trends were recorded as 31.02 % farmers know about the changing of cropping pattern. Above 50 % farmers are in the opinion that crops mature early, however 14.19 % had negative response regarding the crops maturity. This may be attributed to the fact that increasing temperature is responsible for the early maturity of crops. Around 40 % farmers agreed that the new species of weed, insects and disease were observed in the field, but they could not identify these. These data of low perception may be due lack of knowledge, backwardness as well as lack of extension facility and awareness program. Soil fertility is the most important parts of the agriculture production, but only 36.13 % farmers have the opinion that the fertility of soil decreases. This may be due that the majority of farmers don't have any knowledge about the status of soil fertility. A similar study was conducted by Chaudhary et al. (2011) and observed that the 56.8% of the people experienced early ripening or maturity of their crops and vegetables. The authors also reported that majority of the individuals 73.6% and 54.2%, respectively have seen new crop pests and new weeds in their fields.

Impact of climate change on livestock and fish included different parameters like behavioral changes in livestock, change in fish species in rivers, incident of mosquito, occurrence of disease and change of milk production graphically presented in table 4. Near about 50% (i.e. 50.32 %) farmers viewed that the incidents of mosquito is increasing whereas 39.35 % don't know whether the incidents of mosquito increased or decreased. Due to lack of scientific knowledge about the behavioral pattern of livestock and fish species identification it was evidence from the table 3 that majority of farmers don't know the changing trends. Similar response was recorded for change in milk production. However, 48.39 % farmers had opinion that the occurrence of disease increased, but due to lack of health facility at village level they don't know the name of disease and their occurrences.

Climate change related effect on biodiversity in forest areas

Perception of farmers about impact of climate change on early flowering, early budburst, shift in range of species, early singing of birds and deforestation has been depicted in table 5. 43.87 % farmers had positive view about the early flowering and 8.39 % farmers showed negative response about the early flowering. Due to lack of technical knowledge and experience about the shift in range of species and budburst more than 50 % don't have any knowledge about the impact of climate change. Similar trends about the early singing of birds were also recorded. Deforestation is the important part of rising of temperature, but in the Chotanagpur plateau villagers totally depend upon forest for fuel wood collection. Due to this villager have biased response about the deforestation as 46.45 % don't agreed weather the deforestation increased or decreased. However, 37.42 % farmers are concerned that the deforestation increased and 16.13% did not agree upon increasing the deforestation.

In India, Hindi months are also indicators of weather forecasting and closely associated with agricultural activity in the rural areas. During the group discussion, different types of story was observed like sound of Koyal is the indicator for mango repining where as sound of frog is the indicator for rainy season. According to these indicator farmers started different agricultural activity like nursery preparation for Cole crops and paddy. Some of local festivals are also associated weather forecasting like *Sarhul puja* is celebrated in the month of *Magh* is indicator for spring arrivals and *Karma puja* is also very common climate indicator in Eastern Plateau and Hill region (Table 6).

Existing, coping and adaptation strategies to climate change

Knowledge posses within the farmer's community since the time immemorial showing it-self capable of responding to changing influences and of implementing adaptations and innovations as circumstance. Various scientific reports showed that there are a various actions that individual farmers can implement, some of which are specific to exacting enterprises or land and resources type and other have more general application (Charles and Rashid 2007; Loe et al. 2001; Maddison 2006). Unique knowledge is available within the farmer's community in the region and farmer's community used this knowledge to combat the impact of climate change on livelihood, agriculture, livestock and biodiversity (table. 6). More than 50 % farmers used different type (straw, leaf of plant, herbaceous plant and polythene) of mulching for conserving the soil moisture and help to control the soil temperature and after the decomposition of mulch, material improved the soil fertility. Whereas, 54.84 % farmers adopted traditional agroforestry system for

controlling the microclimate of the field, temperature during the summer season and diversify the cropping system. Rain water harvesting and soil conservation techniques were also used by the farmers to avoid the scarcity of water during the summer and control soil erosion with the help of locally available mulching material. For controlling the insect, pest and diseases about 50.32 % farmers used locally available material and technique like cow urine with water for controlling insect and disease also farmers prefer to use wood ash for controlling aphid in Cole crops and mustered during winter season. Most of the farmers were not aware about the scientific approaches to combat impact of climate change as evidenced in the data on the crop rotation, change in the time of farm operation, integrated farming, zero tillage, short duration crop varieties, drought tolerant crop and crop varieties, use of organic & inorganic products to control disease, insects & pests and innovative approaches to improve yield, control insect pest and diseases (table.1). The above finding confirmed that the extension system in Chotanagpur plateau is fragile and don't have proper coordination between the scientists, extension functionary and farmers. This may be due to backwardness and lack of training program and awareness about the adoptive measure to combat impact of climate change in region. This invaluable information from local rural communities, acquired through generations of experience of working on the land, will also support policy makers and stakeholders in identifying adaptation and mitigation options.

CONCLUSION AND POLICY SUGGESTION

The farming communities of the region have noticed that their area is getting warmer, drier, increase in soil erosion and shift in the time of rains. Observed trends of climate support this perception. Hail storm, soil erosion and drought and water availability and changing wind pattern are among the major hazards related to climate change. It was concluded from the present study that the climate change in the region, evidenced from the previous temperature record (Fig. 2). However, farmers are not aware of the phenomena of climate change on livelihood, agriculture, livestock and biodiversity due to lack of awareness programme and lack of coordination between scientific community and extension agency in the region. Moreover farmer's community of the region used very innovative indigenous knowledge including various type of mulching, soil and water conservation technique along with tree based farming system to combat the impact of climate change. Due to erratic rainfall farmers are hesitated to adopt diversified farming system, however diversified farming is the best option to combat climate related hazards. Farmers also need to adjust their management practices to ensure that they make efficient use of the limited rainfall for better food production. Availability of climate information is prerequisite for mitigating the adverse effect of climate variability and capitalizing on beneficial effect, especially in the region where the agriculture and livelihood totally depend upon natural resources. Try to ensure that the farmers understand the information and can modify their agricultural activity.

Addressing these issues to improve farmer's knowledge and perception on climate related change and improve their understanding to manage their crops, livestock, fish and other resources during warmers and drier condition. It will be helpful to increase and sustain their productivity even under climate change scenario. Example of such policy measures include developing drought resistant crops, conducting awareness program and promoting farm level adaptation measures such as the use of irrigation technologies and adjusting planting dates. Such type of policy is utmost important for developing countries like India.

Table 1. Perception of farmers about climate change (N=355)

Parameters	Yes (in per cent)	No (%)	Don't No (%)
Increasing of temperature	61.29	6.45	32.26
Rainfall pattern unpredictable	54.84	13.55	31.61
Late onset of monsoon	52.26	20.00	25.16
Early withdrawal of monsoon	49.68	16.77	33.55
Uneven distribution of rainfall	43.23	13.55	43.23
Seasons are changing	52.90	5.81	41.29
Long dry spell	57.42	18.71	29.03

Table 2. Impact of climate change on ecosystem function and process(N=355)

Parameters	Yes (%)	No (%)	Don't No (%)
Incidents of drought is increasing	37.42	23.23	39.35
Hail storm occur beyond autumn and spring season	38.71	25.16	36.13
Wind pattern is getting warmer	50.97	15.48	33.55
Wind storm getting stronger	50.32	32.90	16.77
Water source and availability increasing	30.32	32.90	36.77
Soil erosion	52.90	7.10	40.00

Table 3: Impact of climate change on agriculture and livelihood(N=355)

Parameters	Yes (%)	No (%)	Don't No (%)
Soil fertility decreases	36.13	16.13	47.74
Early flowering and fruiting	43.87	16.13	60.00
Fruit/crop ripening	40.00	9.03	43.23
Early crop maturity	50.32	14.19	35.48
New insect observed	44.52	9.68	45.81
New disease observed	45.81	6.45	47.74
New weed observed	40.00	14.84	45.16
Change of cropping pattern	32.26	10.97	56.77
Impact on yield	32.90	6.45	60.65

Table 4. Impact of climate change on livestock and fish (N=355)

Parameters	Yes (%)	No (%)	Don't No (%)
Behavioural changes in livestock	38.06	12.90	49.03
Change in Fish species in rivers	38.71	9.68	51.61
Change of milk production	38.70	9.03	52.26
Occurrence of disease	48.39	9.03	42.58
Incident of mosquito	50.32	10.32	39.35

Table5. Impact of climate change on biodiversity (N=355)

Parameters	Yes (%)	No (%)	Don't No (%)
Early flowering	43.87	8.39	47.74
Early budburst	39.35	9.03	51.61
Shift in range of species	40.65	8.39	50.97
Early singing of birds	29.68	18.06	52.26
Deforestation	37.42	16.13	46.45

Table 6: Traditional weather indicators

Month	Description	
	Local Term Approximate Period Condition (Ideal)	Condition (Present)
Magh Jan 15 - Feb 15	Cold with occasional fog, very less rain, celebration of Sarhul puja, leaves fall from trees is the indication of spring season.	
Falgun Feb 15 - Mar 15	Les cold (wheat harvest start), flowering in Sal (*Shorea robusta*) plant, full boom of spring starts	
Chaitra Mar 15 - Apr 15	Spring with pleasant atmosphere, later half little warm Dry and warm (wheat harvest complete)	
Baishakh Apr 15 - May15	First half dry, second half hot dry and very hot, stormy weather	
Jeth May 15 - Jun 15	Hot Very, hot and dry, loo, stormy loo, sound of koyal is the indication of mango repining start.	
Aashadh Jun 15 - Jul 15	mango harvesting complete is the indication for staring paddy sown, Onset of monsoon, rain, dry, delayed monsoon (paddy sown), sowing of Cole crops seed in nursery	
Savan Jul 15 - Aug 15	Sound of frog is the indication of rain season, rain Very humid, less rain (late paddy sown in first half), transplanting of Cole crops in main field	
Bhadaun Aug 15 - Sep 15	Total rainy days, celebration of karma puja, humid, early harvesting of Cole crops.	
Kwar Sep 15 - Oct 15	Paddy harvest is the indicator for winter arrivals, potato sowing, field preparation for wheat sowing.	
Kartik Oct 15 - Nov 15	Mostly clear weather, wheat sown and mustard sowing, celebration of chatah puja,	
Agahan Nov 15 - Dec 15	full boom of winter, potato harvesting	
Paush Dec 15 - Jan 15	First half cold, second half very cold with fog, celebration of Makar Sankrati	

Table 7: Coping and adoptive strategies measures adopted by the farmers to combat climate change (N=355)

Adopted Measures	Yes (%)	No (%)	Don't know (%)
Pre-monsoon dry seeding	45.8	7.74	46.45
Agroforestry	36.77	8.39	54.84
Crop rotations	46.45	5.81	54.19
Change in time of farm operation	42.58	6.45	50.97
Integrated farming	35.48	7.74	56.77
Inter cropping	40.00	7.10	52.90
Mulching	30.97	12.90	56.13
Rain water harvesting	38.06	10.32	51.61
Zero tillage to conserve soil, moisture & save time	28.39	11.61	60.00
Use of short duration crop varieties	45.81	3.23	50.97
Drought tolerant crop and crop varieties	36.13	11.61	52.26
Soil conservation techniques	38.71	7.10	54.19
Use of water conservation techniques	37.42	12.26	50.32
ITK knowledge to control disease, insects & pests	40.00	9.68	50.32
Use of organic & inorganic products to control disease,	42.58	8.39	49.03
Innovative approaches to improve yield, control disease,	39.35	7.74	52.90

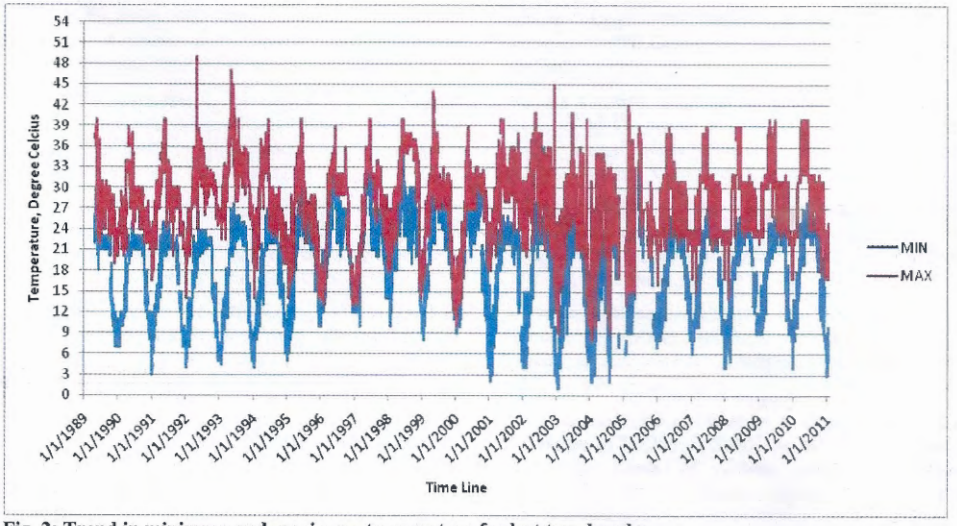

Fig. 2: Trend in minimum and maximum temperature for last two decades

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