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Impact of Climate Change on Agriculture : Experiences from Rural Haryana, India

Climate is one of the main determinants of agricultural production. Since climatic factors serve as direct inputs to agriculture, any change in climatic factors is bound to have a significant impact on crop yields and production. This present study is an effort to highlight the challenges faced by rural farmers in Haryana due to the changes in climatic conditions in recent past. The study results revealed that the climatic variations such as occurrence of drought and heavy rainfall have high level of impact on the crop production. The farmers' perception on the impact of climate change on the agriculture was recorded as reduction in crop production and net income. The farmers in Haryana have already acted to the changes in the climatic changes both by adopting the technological coping mechanisms on the positive side and negatively through shifting to other professions. The study concludes that the small farmers were highly vulnerable to climate change and to a larger extent the small farmers adopted coping mechanisms for climate change compared to large farmers. The study suggests that as the impact of climate change is intensifying day by day it should be addressed through policy perspective at the earliest to avoid short term effect such as yield and income loss and long-term effects such as quitting agricultural profession by the farming communities.
Key Words : Climate Change, Agriculture, Crop Production, Farmers, Pest.

DR. SUBHASH

I. Introduction :

Climate and agriculture are intensely interrelated global processes and therefore a change in climate affects agricultural production (IPCC, 2007). One such change is global warming which is projected to have significant impacts on environment affecting agriculture, including higher carbon dioxide emission, rise in atmospheric temperature, higher glacial run-off, changed precipitation and the interaction of these elements. These conditions determine the carrying capacity of the biosphere to produce enough food for the human population and domesticated animals. The overall effect of climate change on agriculture will depend on the balance of these effects. Assessment of the effects of global climate changes on sustainable agriculture might help to anticipate and adapt farming to maximize agricultural production (Fraser, 2008).

Global climatic changes can affect agriculture through their direct and indirect effects on the crops, soils, livestock and pests. An increase in atmospheric carbon dioxide level will have a fertilization effect on crops and thus will promote their growth and productivity. The increase in temperature, depending upon the current ambient temperature, can reduce crop duration, increase crop respiration rates, alter photosynthetic partitioning to economic products, affect the survival and distribution of pest populations, hasten nutrient mineralization in soils, decrease fertilizer-use efficiencies, and increase evapo-transpiration rate. Studies have shown a significant effect of change in climatic factors on the average crop yield (Dinar et al.1998; Seo and Mendelsohn. 2008; Mall et al. 2006 and Cline. 2007). Climate change projections made up to 2100 for India indicate an overall increase in temperature by 2-4degree C with no substantial change in precipitation quantity (Kavikumar, 2010). Many studies (Parry et al., 1999; Darwin, 2004; Olesen and Bindi, 2002; Adams et al., 2003 and Tsvetsinskaya et al., 2003) find that region-specific analysis is required to evaluate the agronomic and economic impact of weather changes in more detail.

(II) Impacts of Climate Change on Agriculture :

Reduction in Crop Yield and Net Income :

Rise in the mean temperature above a threshold level will cause a reduction in agricultural yields. A change in the minimum temperature is more crucial than a change in the maximum temperature. Grain yield of rice, for example, declined by 10% for each 1 °C increase in the growing

Department of Economics, Dronacharya Govt. College, Gurgaon (Haryana)

season minimum temperature above 32 °C (Pathak et al., 2003).

Shortage of Water :

The increased temperature would result in more water shortages and the demand for irrigation water would rise. Increase in air temperature will lead to more potential evapo-transpiration in the areas south of 40º N. Likewise, water shortage due to climate change would result in about 20% net decline in the rice yields in India.

Irregularities in Onset of Monsoon, Drought, Flood and Cyclone :

Climate modelers and IPCC documents have projected possibilities of increasing variability in Asian Monsoon circulation in a warmer world. Despite expansion of area under irrigation, droughts, caused by inadequate and uneven distribution of rainfall, continue to be the most important climatic aberrations, which influence the agricultural production in India.

Decline in Soil Fertility :

Soil temperature affects the rates of organic matter decomposition and release of nutrients. At high temperatures, though nutrient availability will increase in the short-term, in the long-run organic matter content will diminish, resulting in a decline in soil fertility.

Loss of Biodiversity :

Species of animals and plants are estimated to disappear at a rate which would be about 100-times faster than the historical record, largely as a result of human activities. A detailed assessment of the 394 species of primates from South America to Indonesia has indicated that 29% are in danger of disappearing due to hunting, habitat loss and climate change.

Pests, Weeds and Diseases :

As temperature increases, the insect-pests will become more abundant through a number of inter-related processes, including range extensions and phonological changes, as well as increased rates of population development, growth, migration and over-wintering. The climate change is likely to alter the balance between insect pests, their natural enemies and their hosts.

(III) Agricultural Profile of Haryana :

Major land use in Haryana is agriculture (85%), Forest (2.4 %), about 7.2 % fallow and 5% waste land. The state has about 33000 ha under protected area network, which consists of 2 national parks, 8 wildlife sanctuaries and 2 conservation reserves. Over 500 bird species have been recorded in the State, which is almost 40 percent of total bird species in the country. Haryana is self-sufficient in food production and the second largest contributor to India's central pool of food grains. The main crops of Haryana are Wheat, Rice, Sugarcane, Cotton, Oilseeds, Gram, Barley, Pearl Millet, Green Gram etc. There are two main types of crops in Haryana: Rabi and Kharif. Agriculture contributes 17% of the state's GDP and employs 65% of the total workforce. The net sown area is 85% of the total geographic area as compared to the national average of 46%, the gross cropped area is 65 lakh Hac with a cropping intensity of 180%.

(IV) Methodology :

Mewat district of Haryana was selected to assess the impact of climate change, where the small farmers are highly vulnerable to frequent droughts as well as other climate factors. The normal rainfall is 440mm in the district. In order to assess the impact of climate change a multi-stage random sampling design was employed for the selection of the sample respondents. The total sample constitutes 100 sample respondents including 70 small and 30 large farmers and the needed information for the study was collected using pre tested questionnaire. A farmer having less than two acre of land was considered as small farmer and those who had more than two acre of land were considered as large farmers. Survey was done in the month of Jan-Feb 2016. Primary as well as secondary data were used for the present study. The analytical tools such as compound growth rate, average and percentage were employed to analyse the data collected direct from the farmers.

(V) Farmers' Experiences and Perceptions on the Impact of Climate Change :

The farmers' perception on the climate change was assessed using yes or no type questions and the results are presented in Table 1. About 86.67 per cent of the sample respondents expressed that their net income was reduced over the years, 83.33 per cent of the farmers expressed that there was change in climate and rainfall patterns, 90 per cent small farmers expressed reduction in yield, 78 per cent expressed that there was fast evaporation of soil moisture, 64.44 per cent farmers expressed that due to soil erosion and other factors day by day the land was degrading and it becomes unsuitable for cultivation, 84 per cent of the respondents expressed that the seasonal pattern is changing and 05 percent of the respondents expressed that they have no idea on the changes in climate. From the table it is clear that the level of farmers' perception on the climate change was good.

Table 1 : Farmers' Perceptions on the Impact of Climate Change (in per cent)

Factors	Small Farmers (below 2 acre land)	Large farmers (Above 2 acre land)
Reduction in yield	90	60
Reduction in net income	100	84
Pest and disease outbreak	82	80
Fast evaporation of soil moisture	78	72
Erratic rainfall	95	78
Crop failure	92	66
Shifting of seasons	84	70
Other factors/ no idea	05	52

From the personal experiences of the farmers noted in the fields in rural Haryana it can be concluded that the small farmers effected very badly due to the climate change in recent years. Agriculture has become a business of loss and farmers have started to sell their land and livestock. Large number of farmers has migrated in the cities of Gurugram, Faridabad, Delhi and other cities.

(VI) Coping Strategies by the Farmers :

The coping mechanism was followed to mitigate the climate change through technologies as well as through the socio economic aspect. There are many coping mechanisms which were followed by the farmers in the rural Haryana. The mixed and intercropping was the major coping mechanism of the large farmers which was adopted by 80 per cent, followed by integrated and mixed farming which was adopted by 76 per cent and change in cropping pattern to the extent of 42 percent.

To mitigate the reduction in the net income, the farmers in the district have to adopt some socio-economic strategies to sustain their life. The major socio-economic coping is shifting the profession which is observed to the extent of 60 per cent by the small farmers followed by borrowing for consumption from private money lenders was 48 per cent, reduction in consumption expenditure was observed in small and marginal farmers and not in the case of large farmers.

Conclusion :

To conclude, the resource conserving technologies have potential to improve the use-efficiency of natural resources such as water, air, fossil fuel and soil. The technologies can improve the sustainability of agriculture by mitigating GHG emissions and adapting to climate changes. A pragmatic roadmap to sustainable agriculture requires integrated emphasis on adoption of resource-conserving technologies, participation of farmers and their collectives, and partnership and support of political and service organizations. Besides these elements, the value orientation and perception of practitioners towards climate-friendly sustainable agriculture are of paramount importance.

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