
Awareness on Impact of Climate Change on Dryland Agriculture and Coping Mechanisms of Dryland Farmers

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I

INTRODUCTION

The climate change is any change in climate over time that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere in addition to natural climate variability observed over comparable time periods (IPCC, 2007). In course of time where the industrial revolution occurred in western countries and usage of the fossil fuels increased rapidly, on the other side the natural buffering system for climate change forests, were destroyed indiscriminately for want of fuel, fodder and timbers in the developing countries. These factors were intensified by the human activities in the past 250 years, which had tremendous impact on the climate system. According to the IPCC the green house gas emission could cause the mean global temperature to rise by another 1.4 °C to 5.8 °C. Already the symptoms of climate change were observed at a faster rate in the artic and under artic regions through melting of the frozen ice which have danger of submergence of the coastal zones. In the case of the inland water source, there is tremendous change in both surface as well as ground water due to erratic rainfall and occurrence of frequent droughts.

II

SCENARIO OF DRYLAND AGRICULTURE

Globally 80 per cent of the agricultural land area is rainfed which generate 65 to 70 per cent staple foods but 70 per cent of the population inhabiting in these areas are poor due to low and variable productivity. India ranks first among the rainfed agricultural countries of the world in terms of both extent and value of produce. Rainfed agriculture is practiced in two-thirds of the total cropped area of 162 million hectares (66 per cent). Rainfed agriculture supports 40 per cent of the India's population and contributes 44 per cent to the national food basket. The importance of rainfed agriculture is obvious from the fact that 55 per cent of rice, 91 per cent coarse grains, 90 per cent pulses, 85 per cent oilseeds and 65 per cent cotton are grown in

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rainfed areas (Yadav, 2009). These areas receive an annual rainfall between 400 mm to 1000 mm, which is unevenly distributed, highly uncertain and erratic. In certain areas, the total annual rainfall does not exceed 500 mm. As a result of low and erratic rainfall, a significant fall in food production is often noticed. As far as Tamil Nadu state is concerned 41.9 per cent of the net sown area was under rainfed condition during 2008-09.

There are a number of studies which assessed the impact of climate change on Indian agriculture and vulnerability of the small and medium dryland farmers in different aspects. But the perception on the climate change and the factors which drive the farmers to adopt or to follow coping mechanisms have not been studied in detail. The present study is a modest attempt to assess the perception of the dryland farmers on climate change along with the coping mechanisms followed to mitigate the climate change impacts and factors which drive the dryland farmers to adopt the coping mechanisms. The specific objectives of the study are to assess the impact of drought on the yield of dryland crops; to identify the level of awareness on the climate change; to define coping mechanisms followed by the dryland farmers to climate change and to identify the factors influencing in decision making on the coping mechanism to mitigate the impact of climate change.

III

METHODOLOGY

Dharmapuri district in Tamil Nadu was selected to assess the impact of climate change, where the dryland farmers are highly vulnerable to frequent droughts as well as other climatic factors. The normal rainfall is 853.1 mm 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 constitute 90 sample respondents and the needed information for the study was collected using pre tested questionnaire. The analytical tools such as compound growth rate, instability index and Logit model were employed to analyse the factors influencing the adoption of coping mechanisms among dryland farmers.

Impact of Climate Change on Agriculture

The climate is being modified at a faster rate due to mushrooming of industries and high cattle population along with exploding human population. To meet the demand of the growing population, the natural resources such as forests are also being exploited at a faster rate. In spite of the rising demand for food and fodder, the climate change will further worsen the condition by reduction in the yield of dry land crops. Most of the studies projected that the decreased yield in rainfed and dry land wheat and rice and loss in farm net revenue between 9 to 25 per cent for a temperature increase of 2 to 3.5 °C (Senthilnathan, 2008). For the temperature rise of

2 °C in mean temperature and a 7 per cent increase in the mean precipitation would create a 12 per cent reduction in net revenues for the country as a whole (Dinar *et al.*, 1998).

Growth and Instability in the Yields of Major Rainfed Crops

Compound growth rates and instability index for yield of major dryland crops such as sorghum, ragi, small millet, groundnut, horsegram, gingelly and cotton that are grown under rainfed condition in Dharmapuri district were worked out. The analysis was carried out during 1990-91 to 2008-09. The results of growth and instability in yield of the crops are presented in Table 1. The results revealed that for the study period the major crops such as sorghum, ragi, gingelly and cotton registered negative growth in spite of the technologies such as new variety, fertilisers etc., and other crops had not registered a significant growth in spite of the initiatives made by the government to boost the dryland agriculture, the yield could not be increased at significant level due to the vagaries in the monsoon and temperature in the district. The major factor which influence the yield of dryland crop is the rainfall, the yield will vary according to rainfall level. The instability index revealed that the variation was very high for gingelly, sorghum, horsegram and cotton compared to ragi and groundnut.

TABLE 1. GROWTH AND INSTABILITY IN THE YIELDS OF MAJOR DRYLAND CROPS

| Crop (1) | Compound Growth rate (per cent) (2) | Instability index (3) |
|--------------|--|--------------------------|
| Sorghum | -1.78 | 0.43 |
| Ragi | -0.35 | 0.19 |
| Horsegram | 1.20 | 0.31 |
| Groundnut | 1.45 | 0.19 |
| Small millet | 0.47 | 0.33 |
| Gingelly | -0.15 | 0.88 |
| Cotton | -0.58 | 0.35 |

Drought and Its Impact on Dryland Crop Yields

In Dharmapuri district out of the 10 years (1999 to 2008) there were three drought years which occurred during 2001, 2002 and 2006, two of them were slight drought and remaining one year 2002 was a moderate drought year. During the moderate drought year, the shortfall in rainfall was 37.57 per cent as compared to normal year in the district.

The major effect of the drought reflected in the yield of the dryland crops due to inadequate and poorly distributed rainfall. The drought need not be a lengthier one even a dry spell during the critical growth period as short drought can cause significant damage and harm the local economy. Production loss which is often used

as a measure of the cost of drought is only a part of the overall economic cost (Meenakshi, 2010). The effect of drought on dryland crop yield in Dharmapuri district is presented in Table 2. In small millet only 11.35 per cent of yield reduction was registered. In all other dryland crops the yield reduction was very high in the range of 28.68 to 59.96 per cent. The yield reduction was very high to the extent of 59.96 per cent in cotton crop since it is a sensitive crop to drought, followed by horsegram, sorghum, ragi, groundnut and gingelly to the extent of 48.23 per cent, 43.03 per cent, 34.09 per cent, 29.23 per cent and 28.68 per cent yield loss respectively. It is evident from Table 2 that if there was moderate deviation in precipitation there will be high reduction in the yield of dryland crops.

TABLE 2. EFFECT OF DROUGHT ON DRYLAND CROP YIELD IN DHARMAPURI DISTRICT

| Crop (1) | (kg/ha) | | | |
|--------------|--|---|----------------------------|---|
| | Average yield (1999-00 to 2008-09) (2) | Yield in drought year 2002-03 (3) | Total yield loss (4) | Per cent loss of normal yield (5) |
| Sorghum | 1133.90 | 646.00 | - 487.90 | 43.03 |
| Ragi | 1647.80 | 1086.00 | - 561.80 | 34.09 |
| Horsegram | 513.80 | 266.00 | - 247.80 | 48.23 |
| Groundnut | 1612.30 | 1141.00 | - 471.30 | 29.23 |
| Small millet | 860.70 | 763.00 | - 97.70 | 11.35 |
| Gingelly | 262.20 | 187.00 | - 75.20 | 28.68 |
| Cotton | 289.70 | 116.00 | - 173.70 | 59.96 |

Farmers' Perception 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 3. Most of the farmers were not able to express their perception on climate change directly but they expressed through the effects or the changes that occurred compared to the earlier years or based on their elder's experiences. 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 climatic and rainfall patterns, 76.67 per cent farmers expressed reduction in yield, 74.44 per cent of respondents expressed that there was heavy pest and disease outbreak, 71.11 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, 54.44 per cent of the respondents expressed that the seasonal pattern is changing and 7.78 per cent 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 3. FARMERS PERCEPTION ON THE IMPACT OF CLIMATE CHANGE

| Factors (1) | <i>(per cent)</i> | | | |
|---|-------------------------|--------------------------|-------------------------|----------------------|
| | Small farmers (2) | Medium farmers (3) | Large farmers (4) | Total farmers (5) |
| Reduction in yield | 90.00 | 80.00 | 60.00 | 76.67 |
| Reduction in net income | 93.33 | 86.67 | 80.00 | 86.67 |
| Pest and disease outbreak | 73.33 | 76.67 | 73.33 | 74.44 |
| Fast evaporation of soil moisture | 86.67 | 73.33 | 53.33 | 71.11 |
| Erratic rainfall | 100.00 | 80.00 | 80.00 | 86.67 |
| Crop failure | 96.67 | 96.67 | 66.67 | 86.67 |
| Shifting of seasons | 60.00 | 50.00 | 53.33 | 54.44 |
| Land is becoming unsuitable for cultivation | 76.67 | 63.33 | 53.33 | 64.44 |
| Change in climatic and rainfall patterns | 86.67 | 83.33 | 80.00 | 83.33 |
| Other factors / no idea | 0.00 | 3.33 | 20.00 | 7.78 |

Reason for Reduction in Yield and Net Revenue

The sample farmers were highly concerned about the reducing yield rate and net farm income since their livelihood and socio-economic status is determined by the net income. Almost 100 per cent of the small farmers and 92.22 per cent of the sample farmers reported that the reduction in the rainfall was the major reason for reduction in the yield levels over the period followed by the pest and disease to the extent of 72.22 per cent and changes in temperature and seasonal patterns were quoted as the reason for the reduction in the yield by 42.22 per cent of the sample respondents. About 46.67 per cent of the farmers expressed that the soil lost its vigour due to factors such as erosion, lack of organic manures etc., and 7.78 per cent expressed that they do not have any idea for the reduction in yield over the years. It is clear that the farmers know that the yield reduction occurring continuously and to some extent they have knowledge on the reason for yield reduction also.

TABLE 4. REASON FOR REDUCTION IN YIELD AND NET REVENUE

| Factors (1) | <i>(per cent)</i> | | | |
|--|-------------------------|--------------------------|-------------------------|-------------------------|
| | Small farmers (2) | Medium farmers (3) | Large farmers (4) | Total farmers (5) |
| Changes in temperature and seasonal patterns | 53.33 | 40.00 | 33.33 | 42.22 |
| Rainfall | 100.00 | 93.33 | 83.33 | 92.22 |
| Soil fertility and erosion | 60.00 | 53.33 | 26.67 | 46.67 |
| Pest and disease | 83.33 | 73.33 | 60.00 | 72.22 |
| Other factors/ no idea | 0.00 | 6.67 | 16.67 | 7.78 |

Coping Mechanisms of Dryland Farmers to Mitigate the Impact of Climate Change

The coping mechanism was followed to mitigate the climate change through technologies as well as through the socio economic aspect and the results are presented in Table. 5. There are many coping mechanisms which were followed by

the dryland farmers of Dharmapuri district. The major coping mechanisms followed in the district are presented in Table 5. The mixed and intercropping was the major coping mechanism which was adopted by 75.56 per cent, followed by integrated and mixed farming which was adopted by 71.11 per cent and change in cropping pattern to the extent of 42.22 per cent.

When there is change in the climate in either rainfall or temperature from the normal condition, there would be reduction in yield and net income of the farmers. 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 mechanism is shifting the profession which is observed to the extent of 50 per cent followed by borrowing for consumption from private money lenders was 48.89 per cent, reduction in consumption expenditure was observed in small and marginal farmers and not in the case of large farmers. Nearly 12 per cent of the sample farmers sold land and livestock, where as 11.11 per cent of the respondents adopted crop insurance as a coping mechanism.

TABLE 5. MAJOR COPING MECHANISM ADOPTED BY DRYLAND FARMERS TO MITIGATE THE IMPACT OF CLIMATE CHANGE

| Coping mechanisms (1) | <i>(per cent)</i> | | | |
|----------------------------------|-------------------------|--------------------------|-------------------------|-------------------------|
| | Small farmers (2) | Medium farmers (3) | Large farmers (4) | Total farmers (5) |
| Technological mitigation | | | | |
| Change in cropping pattern | 60.00 | 40.00 | 26.67 | 42.22 |
| Mixed / Intercropping | 93.33 | 76.67 | 56.67 | 75.56 |
| Cultivating tree crops | 0.00 | 10.00 | 76.67 | 28.89 |
| Soil organic matter enhancement | 46.67 | 46.67 | 16.67 | 36.67 |
| Drought resistant/tolerant crops | 13.33 | 43.33 | 20.00 | 25.56 |
| Integrated/Mixed farming system | 93.33 | 76.67 | 43.33 | 71.11 |
| Socio-economic factors | | | | |
| Reduced consumption expenditure | 60.00 | 50.00 | 0.00 | 36.67 |
| Shifting to other professions | 80.00 | 50.00 | 20.00 | 50.00 |
| Borrowing | 86.67 | 50.00 | 10.00 | 48.89 |
| Crop insurance | 6.67 | 16.67 | 10.00 | 11.11 |
| Selling of land and livestock | 26.67 | 6.67 | 3.33 | 12.22 |
| No response | 6.67 | 23.33 | 23.33 | 17.78 |

Factors Influencing the Adoption of Coping Mechanisms Among Dry land Farmers

The factors determining the adoption of technological coping mechanisms among dryland farmers for mitigating the climate change were analysed using Logit model and the results are presented in Table 6.

TABLE 6. FACTORS INFLUENCING ADOPTION OF COPING MECHANISMS

| Variable (1) | Coefficient (2) | 't' value (3) |
|----------------------------------|--------------------|------------------|
| Age | -0.14 | 1.59 |
| Education | 0.07*** | 7.51 |
| Gender | 0.10 | 1.02 |
| Income | 0.03*** | 5.74 |
| Household size | -0.03 | 0.71 |
| Experience | 0.14*** | 2.95 |
| Financial accessibility | 0.09 | 0.84 |
| Contact with extension personnel | 0.10 | 1.05 |
| Membership | 0.08*** | 2.93 |
| Size of holding | -0.34*** | 3.58 |
| Risk taking character | 0.13*** | 2.68 |

*** denotes significance at 1 per cent level..

The results of the logit model revealed that education, income, experience, membership of farmers association, size of holding, and risk taking character were the significant factors influencing the adoption of technological coping mechanisms for the impact of climate change. The factors such as age, gender, household size, financial accessibility and contact with extension personnel does not have significant impact on the adoption of coping mechanisms for climate change.

IV

CONCLUSION

The impact of climate change is studied in many aspects in different locations in the country and it is concluded that there is high impact on agriculture compared to any other sector in the country. The study results revealed that the climatic variation such as occurrence of drought have high level of impact on the yield of dryland crops. The farmers perception on the impact of climate change on the crops grown in dryland condition, such as yield reduction and reduction in net revenue. The farmers already act 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. It is concluded that the small and medium dryland farmers were highly vulnerable to climate change and to a larger extent the small and medium dryland farmers adopted coping mechanisms for climate change compared to larger 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 dryland farmers.

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