Original Research Article

Climate Change Adaptation and Mitigation Measures Initiated by Farmers in Aravalli Hill Zone of Rajasthan

ABSTRACT

Aims: To study about the adaptation and mitigation measures initiated by the farmers against climate change in local conditions.

Study Design: Ex-post-facto research design was followed.

Place and Duration of Study: The study was conducted at department of agricultural extension and communication, Bhagwant University, Ajmer during 2019-2022.

Methodology: study was conducted in Aravalli Hill Zone of Rajasthan to understand adaptation & mitigation measures employed by farmers to the adverse effects of climate change. In the investigation region, 240 farmers were randomly considered for the study purpose.

Results: In the region 95.83 per cent of the farmers pursued that soil and water conservation was the most widely practiced strategy. Whereas, almost three fourths of the respondents were practices adoption of drought tolerant and early maturing crop varieties (75%), use of small-scale irrigation (73.75%), enhancing participatory forest management (73.33%) and afforestation/ reforestation (72.91%), while (70. 83%) practiced diversification of small ruminant animals and changing cropping calendar of agricultural activities. In the constants of the maize crop adaptation measures against excess rainfall was 70.83 per cent of delayed sowing dates; this change in sowing date was adopted by the farmers and adaptation measures in maize crop against deficit rainfall observed by the investigator of 69.58 per cent of the farmers found that delayed sowing dates.

Conclusion: The local people employed different strategies to adapt the adverse effects of climate change, there were constraints that limit the farmer's adaptation strategies e.i. lack of financial support, lack of climate information and lack of technical skills. Therefore, the local decision makers such as agricultural sector, microfinance sector, and meteorological agency should provide farmers credit access and climate information to reduce shortage of finance and lack of climate information. There is also need of providing training to the farmers on improved agricultural technology and market access to enhance their climate resilience conditions.

Keywords: *Climate Change, Adaptation and Mitigation Measures, Agriculture.*

1. INTRODUCTION

Towdays, climate change is acknowledged as one of the most challenging and complex problem confronting the agricultural development worldwide [1]. Changing climatic conditions are causing significant impacts on livelihoods, food security, health, economic opportunities and the survival of humanity, especially in developing countries like that India. Climate change is likely to intensify high temperature and low precipitation [2]. Recent studies showed a significant increase in temperature, frequent heat waves, droughts, extreme precipitation events, and intense cyclonic activities are the important resion of climate change [3]. The average annual temperature of the earth's surface has risen over the last century, [4]. At the rate of 0.15–0.20 °C per decade average global temperature has increased since 1975 The [5] and is expected to increase by 1.4–5.8 °C by 2021. Increase in the mean seasonal temperature can reduce the duration of many crops and therefore reduce the final yield of the crops. In areas where temperatures are already close to the physiological maxima for the crops, warming will impact yields more immediately, [6]. These conditions present serious environmental, economic and social impacts on the agricultural community in India. In India two-thirds of the population depends on agriculture directly or indirectly. From the ancient periods India's agriculture is more dependent on monsoon. India has an annual precipitation of 1170 mm and about 80 per cent of the total area of nation experience annual rainfall of 750 mm or more. For most parts of India's the rainfall occurs under the influence of the south west monsoon between June to September. Southern coastal area near the east coast is influence by the north east monsoon during October and November. The river flow occurs during the four to five months of the south west monsoon season is 80 per cent, [7]. India has achieved self-sufficiency in food grains production by Green

Revolution, it brought a most of environmental challenges (e.g., loss of soil fertility, intensified pests, and diseases, waterlogging, ground water and surface water pollution) and socioeconomic problems (e.g., increased farm input prices, regional disparity) [8]. In additional to all these climatic changes have added a new dimension to the existing problems by posing a significant threats to Indian agriculture in general and food security in particular [9].

In India, Rajasthan is the largest state of country and entire state receives scanty rainfall. In more recent times, has experienced severe and frequent spells of droughts than any other region of the India. The region's climate is projected to become harsher with increased average temperatures, intensity of rainfall events, and increased variability in space and time of monsoon rains being consistently. Aravalli hill zone of Rajasthan served its area and the people as a rich resource area providing forest products, fodder, timber, fuel wood, water through springs, and rivers, minerals, safe and secured locations to their public. Aravalli region of Rajasthan and depletion of environmental resources particularly, vegetation, soil resources have led to decline to water-table, high air and soil temperature, intense solar radiation and high wind velocity was the major cause of climate change. There is a need of understanding location-specific opportunities, challenges and the key drivers behind adaptation. Now climate change adaptation strategies are a matter of urgency [10]. Therefore in order to help communities adapt to the impact of climate change it is necessary to adopt effective adaptation strategies. The adaptation strategies must be environmentally friendly, sustainable, and easy for farmers to adopt and economically viable. Adaptation can be affected at different scales individual, farm-level, national level and international level. Although there is some autonomous of adaptation at farm-level is usually inadequate and requires the intervention of different institutions [11]. Adaptation at national or international level entails an understanding of the process of location-specific autonomous adaptation at farm-level and to make stronger adaptation policies by the government on impact of climate change in India as well as Rajasthan [12]. At present some parts of sub humid southern plain and Aravalli hill zone facing rapid climate impact on agriculture and allied activities. Impact of climate change is not directly visible in the hilly regions, but there is no doubt that there are some potential impacts that are still unknown. It can be adversely affect the Aravalli regions as well.

2. MATERIALS AND METHODS

2.1 Location of the study area

The study was carried out in Aravalli hill zone of Rajasthan state (Agro-ecologically the district has been part of Zone-IVA). This region has Sub-humid climate and have the soils; grey, brown loam, medium black, moderately deep with medium to heavy in texture. Average annual rainfall of the region is 852 mm. and majority of it received during mid-June to end of September. From the region four districts were selected for study purpose.

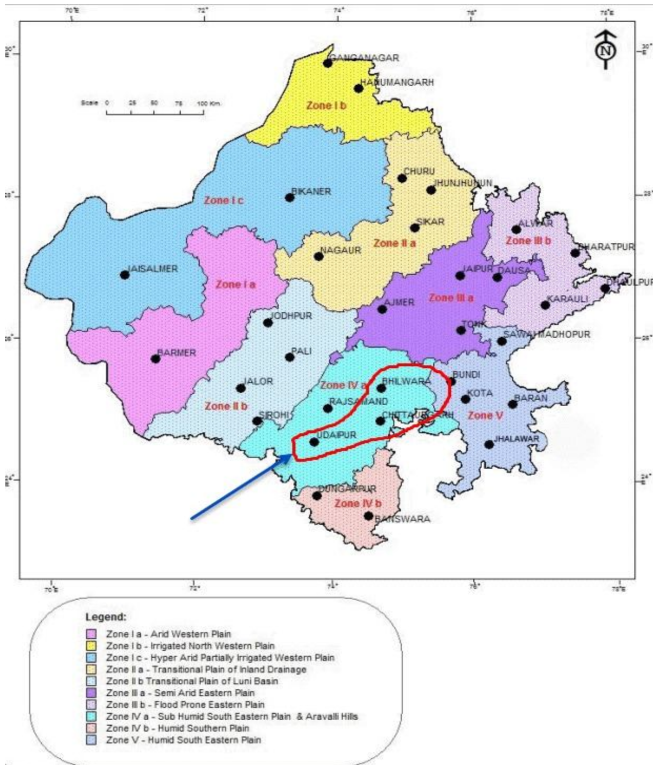

Fig. 1: Location map of the study area

2.2 Research design and data collection

The study was carried out in four randomly selected districts of Sub-humid southern plain & Aravali hill zone, (Agro-ecologically the district has been part of Zone-IVA), namely of Udaipur, Bhilwara, Chittorgarh and Rajsamand districs of Rajasthan. Two blocks from each selected districts were selected for the selection of villages. Total of 240, farmers was selected randomly from the eight administrative blocks. The interview schedule was used for the data collection. Data was collected personally by the investigator himself. The respondents were select who have more than 10 years of farming experience. Ex-post-facto research design was followed in investigation. The data collected from the selected farmers was tabulated in the excel worksheet and then appropriate analysis of data was made accordingly to the objectives formulated for the investigation.

2.3 Statistical Analysis The statistical techniques were applied to analyze the data like frequency, percentage; means and standard deviation were followed in data analysis. The details of statistical techniques and tests used are given in below.

$$\text{MPS} = \frac{\text{Sum of scores obtained by respondents}}{\text{Maximum obtainable scores}} \times 100$$

The responses obtained from the respondents were counted and converted into mean; S.D. (standard deviation) and M.P.S. (mean per cent score).

3. RESULTS AND DISCUSSION

Climate change adaptation and mitigation measures

Adaptation and mitigation is the ability of farmers to respond and adjust against actual or potential impacts of changing climate conditions on crop in ways that cause moderate harm or any positive opportunities of the climate may afford. It includes policies and measures to reduce expected harmful impacts of climate variability and extremes, and the strengthening of adaptive capacity. They should include local actions taken by the farmers themselves in response to changing market or environmental conditions.

Most studies assessing the potential effects of climate change on agriculture are regional or national and yet adaptation is place-based and needs the use of place-specific strategies.

Table 1. Distribution of respondents according to their views about adaptation and mitigation to climate changes

(N=240)

S.No.	Adaptation measures	Response	Frequency	Percent
1.	Increased use of small-scale irrigation	Yes	177	73.75
		No	63	26.25
2.	Changing cropping calendar of agricultural activities	Yes	170	70.83
		No	70	29.16
3.	Adoption of drought tolerant and early maturing crop varieties	Yes	210	87.50
		No	30	12.50
4.	Increased use of soil and water conservation (terracing, water harvesting, area closure) technologies	Yes	230	95.83
		No	10	4.16
5.	Diversification of off-farm (trade, daily	Yes	80	33.33

	labor, migrate to urban) activities	No	160	66.66
Mitigation measures				
6.	Reducing expansion of agricultural land through agricultural intensification (conservation agriculture, compost usage, using productivity enhancement technologies)	Yes	192	80.00
		No	48	20.00
7.	Afforestation/ Reforestation (planting trees on communal and farm land)	Yes	225	93.75
		No	15	6.25
8.	Expansion of agro-forestry (mango, avocado, apple) development	Yes	125	86.25
		No	25	10.41
9.	Improving animal productivity through breeding (reducing number of local cattle population)	Yes	150	62.50
		No	90	37.50
10.	Diversification of small ruminant (sheep, goat, poultry) animals	Yes	170	70.83
		No	70	29.16
11.	Increased use of fuel wood conservation (stove, solar panel and bio-gas) technologies	Yes	100	41.66
		No	140	58.33
12.	Enhancing Participatory forest management (using forest products efficiently and expansion of economic activities in the forest)	Yes	180	75.00
		No	60	25.00

The adaptation and mitigation measures initiated by farmers in response to climate change furnished in Table 1. The finding shows that soil and water conservation was the most widely practiced strategy pursued by 95.83 per cent of farmers. On the other hand, fuel wood conservation (stove, solar panel, and biogas) technologies were found to be pursued by the smaller proportion of respondents 41.66 per cent. Moreover, the farmers were observed to adopt agricultural intensification (such as conservation agriculture, compost usage, and increasing use of productivity enhancement technologies). About 86.25 per cent of the respondents reported to undertake agro-forestry like planting aonla, mango, custard apple, guava, papaya, sapota and pomegranate fruits in addition to annual crops as principal mitigation strategies.

Table 1. further shows that almost three fourths of the respondents were practices adoption of drought tolerant and early maturing crop varieties (75%), use of small-scale irrigation (73.75%), enhancing participatory forest management (73.33%) and afforestation/ reforestation (planting trees on communal and farmland) (72.91%), while (70. 83%) practiced diversification of small ruminant (sheep, goat, poultry) animals and changing cropping calendar of agricultural activities. On average, 62.50 per cent of respondents show that the improving animal productivity through breeding (reducing number of local cattle population), whereas only 33.33 per cent of the respondents diversification of off-farm (trade, daily labor, migrate to urban) activities. The findings are in agreement with the findings of Asrat & Simane [13].

Adaptation measures in maize crop against excess rainfall

The adaptation measures by the farmers to excess rainfall in maize crop were furnished in Table 2. It was observed from Table that the majority of respondents delayed sowing dates; this change in sowing date was adopted by 70.83 per cent of the farmers in study area. The majority of farmers 69.58 per cent were opted late harvesting in case of excess rainfall at the time of crop maturity.

Table 2. Distribution of respondents according to their adaptation measures in maize crop against excess rainfall

(N=240)

S. No	Adaptation measures	Frequency	Percent
1.	Late sowing	170	70.83
2.	Double sowing	90	37.50
3.	Use of short duration varieties	160	66.66
4.	Increase seed rate	105	43.75
5.	Gap filling	55	22.91
6.	Prepare channels inside the field to drain excess water	52	21.66
7.	Late harvesting	167	69.58
8.	Application of potash	10	4.16

According to data illustrates in Table 2, majority of the farmers 66.66 per cent believed that use of short duration varieties might be beneficial if there was excess rainfall at the time of sowing of maize, whereas, increase seed rate, double sowing, gap filling and prepare channels inside the field to drain excess water were followed by the respondents (43.75%), (37.50%), (22.91%) and (21.66%), respectively. Other adaptation measures were mentioned by some of the farmers to deal with excess rainfall which may be profitable to the whole farming community if successful. The disparity of adoption of these measures clearly indicates the need to test their effectiveness of their efforts and available resource with them to cop against these circumstances.

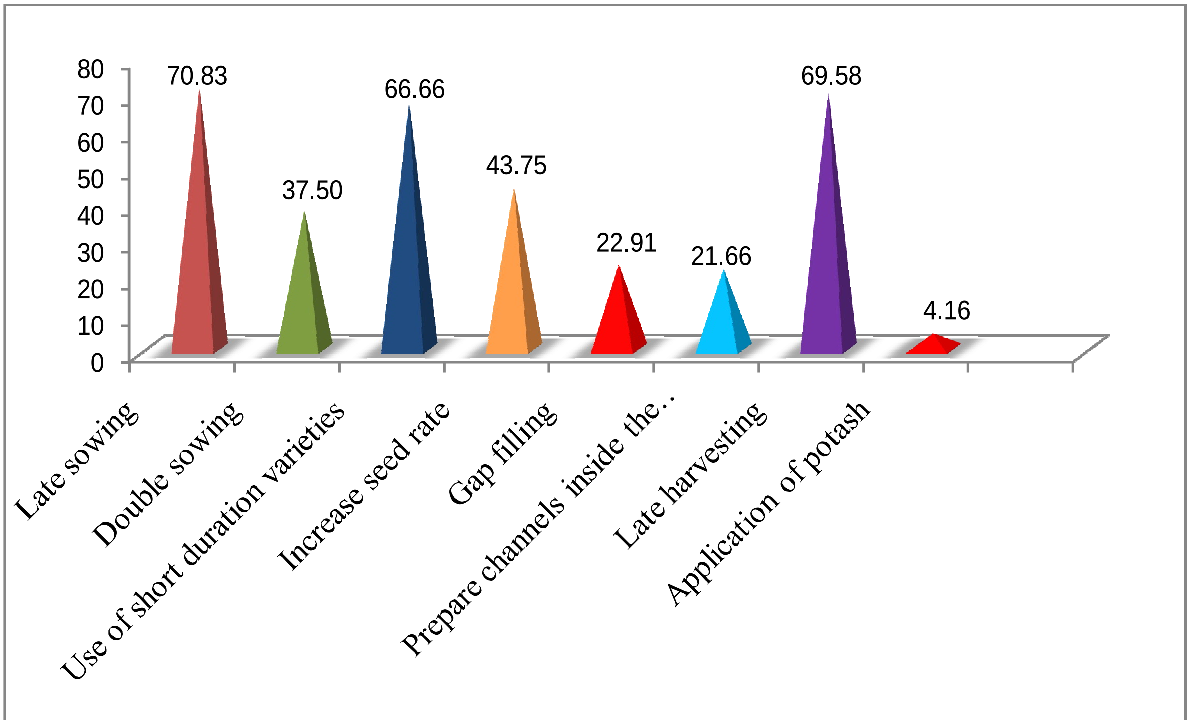

Fig. 2. Distribution of respondents according to their adaptation measures in maize crop against excess rainfall

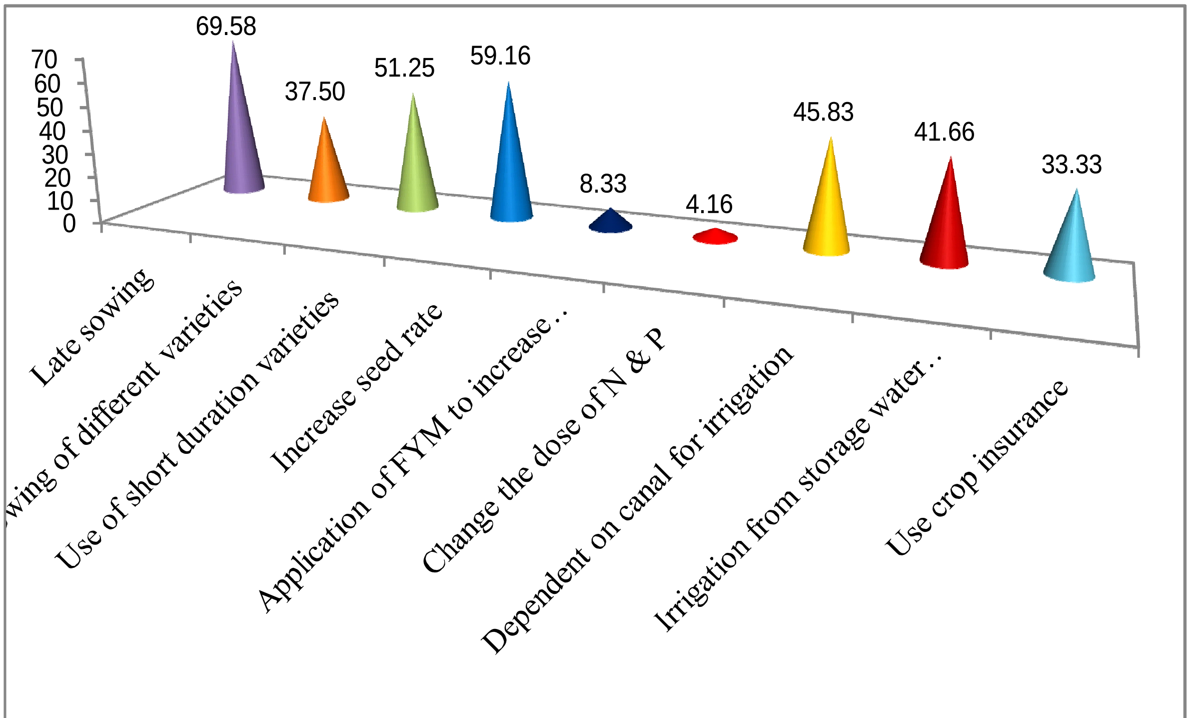

Fig. 3. Distribution of respondents according to their adaptation measures in maize crop against deficit rainfall

Adaptation measures in maize crop against deficit rainfall

No rainfall is the major problem of during sowing of crop land becomes dry and difficult to plough, and lack of precipitation hinders seed cultivation and germination of cultivated seeds. Even weeks delay in the onset of rain and long dry spells in between the various stages of crop cultivation was found to have significant difference on the harvest and has deprivation of households' livelihood due to low productivity of crop. The results in Table 3 mentioned that the adaptation measures actually adopted by the respondents against deficit rainfall during various stages of maize cultivation. As an adaptation to deficit rainfall at the time of sowing majority of the farmers 69.58 per cent delayed sowing dates, whereas, 59.16, 51.25, 49.17 and 37.50 per cent of the respondents say that they increase seed rate, use short duration varieties, and use different varieties for sowing, respectively.

Table 3. Distribution of respondents according to their adaptation measures in maize crop against deficit rainfall

(N=240)

S. No	Adaptation measures	Frequency	Percent
1.	Late sowing	167	69.58

2.	Sowing of different varieties	90	37.50
3.	Use of short duration varieties	123	51.25
4.	Increase seed rate	142	59.16
5.	Application of FYM to increase water holding capacity	20	8.33
6.	Change the dose of N & P	10	4.16
7.	Dependent on canal for irrigation	110	45.83
8.	Irrigation from storage water tank/pond by diesel pump	100	41.66
9.	Use crop insurance	80	33.33

Soil water management and arrangement of irrigation is very crucial in case of deficit rainfall. Furthermore in Table 3, it was showed that by the respondents 45.83 per cent of the farmers that they were dependent on canal for irrigation, while, 41.6 6 per cent of them arranged irrigation water from storage water tank by using diesel pump and only 33.33 per cent of the farmers followed the crop insurance. However, 8.33 per cent believed in application of FYM to increase water holding capacity, while, 4.16 per cent of the farmers change dose of Nitrogenous (N) and Phosphoric (P) fertilizers to accelerate vegetative growth of crop and to increase water holding capacity of soil, respectively. The present results were supported by the findings of Parganiha [14].

4. CONCLUSION

Adaptation strategies become indispensable in order to minimize the effects of climate change and in preparing the nation for climate change. The result of the study indicate that majority of the farmers employed different adaptation strategies to adapt adverse effects of climate change and variability, including soil and water conservation, agro-forestry like planting aonla, mango, custard apple, guava, papaya, sapota and pomegranate, adoption of drought tolerant and early maturing crop varieties, use of small-scale irrigation and changing cropping calendar of agricultural activities. The adaptation measures expressed by the farmers to excess rainfall in maize crop were observed that the majority of the farmers delayed sowing dates was adopted. More than two third per cent of the respondents believed that use of short duration varieties might be beneficial if there was excess rainfall at the time of sowing of maize. The results further revealed that although the local people employed different strategies to adapt the adverse effects of climate change, there were constraints that limit the farmer's adaptation strategies e.i. lack of financial support, lack of climate information and lack of technical skills. Therefore, the local decision makers such as agricultural sector, microfinance sector, and meteorological agency should provide farmers credit access and climate information to reduce shortage of finance and lack of climate information. There is also need of providing training to the farmers on improved agricultural technology and market access to enhance their climate resilience conditions.

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