The Pharma Innovation Journal 2021; SP-10(12): 1465-1469

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(12): 1465-1469
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www.thepharmajournal.com
Received: 23-10-2021
Accepted: 25-11-2021

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# Coping mechanism to climate change among paddy growing farmers of Chhattisgarh Plains

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**Abstract**
The present investigation was an attempt to understand and document the coping mechanism to minimize the adverse effect of climate change among paddy growing farmers of Chhattisgarh Plains and to know what are the constraints being faced by them to adapt against these changes. This study was carried out in four randomly selected districts of Plain Zone of Chhattisgarh State. A total of 240 farmers from twenty four villages of eight blocks were considered as respondents. The findings of the study revealed that as a coping mechanism to excess rainfall at the time of sowing the majority of farmers delayed sowing dates and used short duration variety of paddy. On other hand they were opted late harvesting in case of excess rainfall at the time of maturity of crop. Majority of the farmers delayed sowing dates and increased seed rate of paddy as an adaptation/coping mechanism to deficit rainfall at the time of sowing. The major constraints to adapting to climate change faced by the respondents were lack of information about accurate weather forecast, irregularity of extension services and lack of knowledge about need based improved agriculture technologies with rank of I, II and III, respectively. To overcome the above constraints, the majority of the respondents suggested that weather forecast should be more accurate and timely, whereas, another suggestion were effective extension services should be available to the farmers and proper information should be provided about climate change which might be enable them to adapt against climate change.

**Keywords:** Climate change, coping mechanism, adaptation, deficit & excess rainfall

## Introduction
Agriculture is the most important sector of the economy in India provides food and livelihood security to much of the Indian population. It plays a crucial role in the country's development contributing 16 per cent of India's Gross Domestic Product (GDP). Climate is one of the key components influencing agricultural production and has large-scale impacts on food production and overall economy. Agriculture in India suffers a lot from erratic weather patterns such as heat stress, longer dry seasons and uncertain rainfall, since about 65 per cent of the cultivated area fully depends on monsoon rainfall. Declined yield due to unfavorable weather and climate will lead to vulnerability in the form of food insecurity, hunger and shorter life expectancies. There are some impacts for which adaptation is the only available and appropriate response.

With regards to Chhattisgarh, the state is major producer of paddy and is mainly dependent on monsoon rainfall as the irrigation facilities are limited to very small part of the region. The water supply for domestic purpose, water storage in dams, ground water table, Hydro-electric generation, planning of government policies and schemes etc. are also dependent on monsoon rainfall. Recent studies in climate change in Chhattisgarh indicated that the rainfall pattern has changed during 20$^{th}$ century, fluctuations in the onset and offset of monsoon rainfall, decreasing pattern of rainfall in many districts and also the deficit rainfall years increased during the global worming period. Climate is getting hotter in the state due to increasing trend for both maximum and minimum temperature, which, has been showed by many of the studies. With this climatic variability, farmers in the state are vulnerable because their livelihood is totally dependent on agriculture.

Chhattisgarh plain zone comprising 15 districts out of 28 districts in the state. It has a tropical wet and dry climate, temperature remain moderate throughout the year, except from march to June. It has a mixed climate which is more towards hotter side, summer are extremely hot and at times the mercury may rise up to 47 ˚C. The zone receives about 1250-1300 mm of annual rainfall, in which, share of monsoon rainfall from June to September is about 85-90 per cent. As for as agriculture is concerned, out of total cultivated area in the state, 65 per cent is shared

by the plain zone. Paddy is the principle crop of the zone and about 75 per cent of the total production of paddy in the state is produced by this zone.

Coping mechanism 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 takes advantage of any positive opportunities that 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. The process of adaptation includes learning about risks, evaluating response options, creating the conditions that enable adaptation, mobilizing resources, implementing adaptations, and revising choices with new learning. 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. This study therefore examined how rural smallholder farmers in different selected study area perceive the effects of changes in climatic variables, and how they have adjusted their farming practices to cope with the changes in climate.

## Research Methodology

The present study was carried out in Plain Zone of Chhattisgarh state. The state is divided in to 28 districts and 3 agro climatic zones namely Bastar Plateau, Chhattisgarh Plains and Northern Hills in which four districts of Chhattisgarh Plains namely Raipur, Durg, Balodabazar-Bhatapara and Bemetara were selected for present study. Two blocks from each selected district were selected for the selection of villages. From each selected block, 3 villages (Total 3 X 8 = 24) were selected randomly for the selection of respondents. From each selected village, 10 farmers were selected randomly, who had more than 15 years of farming experience. In this way, a total of 240 farmers (Total 24 X 10 = 240) were considered as respondent for the present study. These selections were done by using simple random sampling method for the purpose of the study.

Adaptation or coping mechanism refers to the measures employed by the farmers to curb the immediate-term and long-term negative effects of climate change on agriculture and allied activities. Understanding the existing coping and adaptive strategies of farmers in specific crop context is a first step toward the identification of appropriate options to increase the potential for adaptation of vulnerable section of farmer. In this regard farmers were interviewed for their responses towards adaptation measures taken by them in case of deficit and excess rainfall during paddy cultivation, as paddy was the main crop of study area. Afterwards, for presentation of data frequency and percentage were calculated for each adaptation measures. The constraint refers to the hurdles or obstacles faced by farmers in adaptation to climate change. The open-ended questions were used to collect responses on constraints faced by them in adaptation. Furthermore, frequency and percentage were calculated and accordingly ranks were assigned for presentation of data. To overcome the constraints in adaptation to climate change, respondents were asked to indicate possible suggestions by using open-ended questions. Frequency and percentage were calculated for each suggestion and ranks were provided accordingly.

## Result and Discussion

### Coping mechanism/adaptation to climate change

The research revealed that, the coping strategies (adaptation options) adopted by farmers to sustain adverse effect imposed on paddy production by climate change can be categorized into crop management strategy, soil fertility strategy, land preparation strategy and farm size strategy or diversification of crop. Further, we collected data from the farmers and investigated actual farm-level coping strategies and documented how paddy farmers cop with extreme conditions generated by excess or deficit/no rainfall during various stages of crop. The specific methods embedded in each of these strategies are elaborated below.

### 1. Coping mechanism in paddy against excess rainfall

Table 1 illustrates farmers coping mechanism in paddy, as an adaptation to excess rainfall the majority of respondents delayed sowing dates. This change in sowing date was adopted by 68.33 per cent of the farmers in study area. The majority of farmers (67.91%) were opted late harvesting in case of excess rainfall at the time of maturity of crop. According to data in Table 1, majority of the informants (62.08%) believed that use of short duration varieties might be beneficial if there was excess rainfall at the time of sowing of paddy. Sowing by lehi method, put harvested paddy (*Karpa*) on bunds for drying, turn harvested paddy (*Karpa palatna*) several times for drying, double sowing and gap filling were cited by 55.00, 53.33, 41.25, 22.08 and 19.17 per cent of the respondents as a core strategy to deal with excess rainfall during various stages of crop period, respectively. Other coping mechanisms were mentioned by some of the farmers to deal with excess rainfall which may be profitable to the whole farming community if successful. A quite number of farmers believed in preparation of channels inside the field to drain excess water, keeping harvested paddy (*Karpa*) on big size of stubbles and prepare more seedlings than required. The disparity of adoption of these strategies clearly indicates the need to test their effectiveness of their efforts and available resource with them to cop against these circumstances.

### 2. Coping mechanism in paddy against deficit rainfall

No rainfall 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 low productivity of crop.

Table 2 presents coping mechanisms actually adopted by the respondents against deficit rainfall during various stages of paddy cultivation. As an adaptation to deficit rainfall at the time of sowing majority of the farmers (70.41%) delayed sowing dates, whereas, 54.58, 49.17 and 24.17 per cent of the respondents cited that they increase seed rate, use short duration varieties and use different varieties for sowing, respectively. Use dry seeding method (30.41%), crop diversification (15.83%), increase broadcasting method of sowing (12.92%), use of line sowing method (10.83%), and transplanting of young aged seedlings (3.75%) were the main coping strategies used by the respondents in study area to reduce the risk of crop failure. Soil water management and arrangement of irrigation is very crucial in case of deficit rainfall. Furthermore in Table 2, it was mentioned by 42.50

per cent of the farmers that they were dependent on canal for irrigation, while, 31.25 percent of them arranged irrigation water from storage water tank by using diesel pump. However, 18.75 per cent of the respondents used to weeding without biasi or delayed biasi, 5.42 per cent believed in application of FYM to increase water holding capacity, while, equal number of farmers (2.92%) change dose of Nitrogenous (N) and Phosphoric (P) fertilizers to accelerate vegetative growth of crop and to increase water holding capacity of soil, respectively.

**3. Constraints in coping/adaptation to climate change**

The present study also assessed farmers' perception on constraints experienced by them in using various coping mechanisms to mitigate adverse effect of climate change on agriculture and allied activities. The information received by the farmers on constraints was further ranked as per maximum number of responses obtained and presented in Table 3. Analysis of the data collected from respondent's shows that the major constraints to coping to climate change faced by farmers in the study area included lack of information about accurate weather forecast (68.33%), irregularity of extension services (66.25%) and lack of knowledge about need based improved agriculture technologies (64.58%) with rank of I, II and III, respectively. Moreover, findings of the study indicate that other major constraints reported by respondents were lack of information about climate change (61.67%), lack of resources (48.33%), unavailability of inputs on proper time (46.67%), lack of believe on current weather forecast system (43.75%) and inadequate supply of irrigation water in canal (42.50%). The result further showed that lacking of training programmes on disaster management, less/no subsidies on desired agricultural inputs, irregularity in electricity supply and lack of government policies to combat against natural calamities were other constraining factors reported by respondents for their better coping to climate change. These findings are similar with findings reported by Nhemachena and Hassan (2007) [6], Ishaya and Abaje (2008) [5], Bryan *et al.* (2009) [2], Deressa *et al*. (2009) [2, 3], Pande and Akermann (2010) [8] and Nzeadibe *et al.* (2011) [7].

**4. Suggestions given by farmers to overcome the constraints**

The farmers of the study area were also asked about their suggestions to overcome constrains faced by them in coping to climate change and presented in Table 4. Majority (65.83%) of the respondents suggested that weather forecast should be more accurate and timely, whereas, 63.33 and 57.91 per cent of them said that effective extension services should be available to the farmers and proper information should be provided about climate change which might be enable them to adapt against climate change. The other suggestions given by respondents were efforts should be made to create awareness among the people about the effect of climate change and its consequences (53.33%), training should be imparted to build the capacity for better adaptation (42.50%) and government policies should be made to support the farmers during natural calamities. Furthermore, farmers suggested that availability of agricultural inputs at village level on time should be ensured, need based water supply in canal should be ensured and good quality of agricultural inputs should be available on subsidized rate in proper time. According to the farmers of study area above arrangements may help them to overcome constraints in coping against climate change. Above findings are in line with the findings of Pande and Akermann (2010) [8] and Pettengell (2010) [9].

**Table 1:** Distribution of respondents according to their coping mechanism against excess rainfall

(n=240)

| Coping mechanism | Frequency | Percentage |
|---|---|---|
| • Late sowing | 164 | 68.33 |
| • Double sowing | 53 | 22.08 |
| • Use of short duration varieties | 149 | 62.08 |
| • Sowing by lehi method | 132 | 55.00 |
| • Increase broadcasting method of sowing | 09 | 3.75 |
| • Prepare more seedlings than required | 23 | 9.58 |
| • Sowing without ploughing | 8 | 3.33 |
| • Increase seed rate | 28 | 11.67 |
| • Purchasing of seedlings | 12 | 5.00 |
| • Transplanting by thinning dense field | 08 | 3.33 |
| • Gap filling | 46 | 19.17 |
| • Prepare channels inside the field to drain excess water | 38 | 15.83 |
| • Application of potash | 06 | 2.50 |
| • Late harvesting | 163 | 67.91 |
| • Put harvested paddy (*Karpa*) on bunds for drying | 128 | 53.33 |
| • Turn harvested paddy (*Karpa Palatna*) several times for drying | 99 | 41.25 |
| • Keep harvested paddy (*Karpa*) on big size of stubbles | 28 | 11.67 |
| • Trailing of harvested paddy (*Karpa katar*) to save from excess water | 18 | 7.50 |

**Table 2:** Distribution respondents according to their coping mechanism against deficit rainfall

(n=240)

| Coping mechanism | Frequency | Percentage |
|---|---|---|
| • Late sowing | 169 | 70.41 |
| • Sowing of different varieties | 58 | 24.17 |
| • Use dry seeding method | 73 | 30.41 |
| • Increase seed rate | 131 | 54.58 |
| • Transplanting of young aged seedlings | 09 | 3.75 |
| • Use of short duration varieties | 118 | 49.17 |
| • Increase broadcasting method of sowing | 31 | 12.92 |
| • Use of line sowing method | 26 | 10.83 |
| • Crop diversification | 38 | 15.83 |
| • Change the dose of N & P | 07 | 2.92 |
| • Application of FYM to increase water holding capacity | 13 | 5.42 |
| • Purchasing of water for irrigation | 08 | 3.33 |
| • Dependent on canal for irrigation | 102 | 42.50 |
| • Irrigation from storage water tank by diesel pump | 75 | 31.25 |
| • Weeding without biasi/Delayed biasi | 45 | 18.75 |
| • Use crop insurance | 11 | 4.58 |
| • Late harvesting | 08 | 3.33 |

**Table 3:** Distribution of respondents according to constraints faced by them in coping to climate change

(n=240)

| Constraints | F | P | Rank |
|---|---|---|---|
| Lack of information about accurate weather forecast | 164 | 68.33 | I |
| Lack of information about climate change | 148 | 61.67 | IV |
| Lack of knowledge about need based improved agriculture technologies | 155 | 64.58 | III |
| Lack of resources | 116 | 48.33 | V |
| Unavailability of inputs on proper time | 112 | 46.67 | VI |
| Irregularity of extension services | 159 | 66.25 | II |
| Less/no subsidies on desired agricultural inputs | 82 | 34.17 | X |
| Lack of government policies to combat against natural calamities | 27 | 11.25 | XII |
| Lack of believe on current weather forecast system | 105 | 43.75 | VII |
| Irregularity in electricity supply | 49 | 20.41 | XI |
| Lacking of training programmes on disaster management | 94 | 39.17 | IX |
| Inadequate supply of irrigation water in canal | 102 | 42.50 | VIII |

**Table 4:** Distribution of respondents according to their suggestions to minimize the constraints in coping to climate change

(n=240)

| Suggestions | F | P | Rank |
|---|---|---|---|
| Weather forecast should be more accurate and timely | 158 | 65.83 | I |
| Proper information should be provided about climate change | 139 | 57.91 | III |
| Regular training programme should be organised on disaster management | 102 | 42.50 | V |
| Good quality of agricultural inputs should be available on subsidized rate in proper time | 88 | 36.67 | X |
| Availability of agricultural inputs at village level on time | 97 | 40.41 | VI |
| Efforts should be made to create awareness among the people about the effect of climate change and its consequences | 128 | 53.33 | IV |
| Effective extension services should be available to the farmers | 152 | 63.33 | II |
| Need based water supply in canal should be ensured | 91 | 37.91 | VIII |
| Government policies should be made to support the farmers during natural calamities | 95 | 39.58 | VII |
| Location specific water storage structure should be developed for effective utilization of rainwater | 76 | 31.67 | IX |
| Electricity supply should be proper | 18 | 7.50 | XI |

## Conclusion

Coping strategies and adaptation mechanism were limited at the study site. So, to solve the problem of climate change at first we have to create awareness among the farmers by using mass media followed by individual contact method through trained extension agents. In addition, empowerment is crucial in enhancing farmers' awareness. This is vital for adaptation decision making and planning. Agriculture was the main source of livelihood of the farmers in study area and that was most vulnerable section due to climate change because majority of the farmers in the study area were relied on rainfed agriculture, while considering risky, mono-cropping practicing under dry land. Government policies should therefore ensure that farmers have access to affordable credit to increase their ability and flexibility to change production strategies in response to the forecasted climate conditions. Because access to water for irrigation increases the resilience of farmers to climate variability, irrigation investment needs should be reconsidered to allow farmers increased water control to counteract adverse impacts from climate variability and change.

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