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Farmers perception to climate change under sodic environment of Uttar Pradesh

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ABSTRACT

Most of the Indian population is considered more vulnerable to climate change because of its direct or indirect dependence on agriculture. Successful adaptation to changing climate is vital for sustainable productivity. Adaptation and mitigation are two essential solutions to avoid the ill effects of climate change. Adapting to changing climate is a continuous process. Strategic planning is required to reduce the consequences of long-term climate change, which may severely affect the livelihood security of people with low incomes. Several global studies have indicated that India is particularly vulnerable to climate change, and the country will likely suffer damage to agriculture, food and water security, human health and cattle populations. When these impacts of climate change are combined with other stresses like salt stress in the sodic environment, the overall problems for practising agriculture increase manifolds. Agriculture practices in a sodic environment face different challenges, such as salt stress, poor soil structure, restricted water movement, and nutrient toxicities, which are significant constraints to plant growth. Structural degradation arises from clay dispersion, plugging of the soil pores and developing a calcareous hard layer in the sub-soil. High pH may persist throughout the soil profile, hampering essential plant nutrient availability. Overall, the situation for agriculture under a sodic environment becomes complex as several direct and indirect effects of climate change on precipitation patterns, higher atmospheric temperatures, increase in the frequency of droughts, floods and storms, and greenhouse gas emissions- would drastically limit agricultural productivity, particularly in sodic soils under arid and semi-arid regions in the country. In context to the above, it has been realized that at the farmers' level, the awareness of climatic problems in combination with existing problems due to the presence of salt is low. This may be due to a lack of knowledge about the right set of practices/technologies to adopt under these scenarios and their poor socio-economic conditions. Considering this, farmers' perceptions and their level of awareness about the changing climate in the Unnao and Hardoi districts were recorded and presented, which may help plan the appropriate strategies while sensitizing the farmers about the current scenario of climate change, providing knowledge about the required technologies and practices in hand and their capacity building.

Keywords: Climate change, farmers' perception, sodic environment

INTRODUCTION

As per estimates, over 2.1 million hectares of salt-affected land is in the country's key bread basket in the North. Uttar Pradesh alone has about 1.37 million hectares of sodic and saline soils, of which approximately 1.34 Mha area falls under alkali or sodic soil. Alkali or sodic soils in Indo-Gangetic

plains are generally light to medium textured, sandy loam on the surface and clay loam in lower depths with $CaCO_3$ concentration. Generally, Rice and Wheat are the dominant cropping practices in these areas. Significant challenges for undertaking agricultural activities are excess sodium, poor porosity, low nutrient content, and indifferent drainage. With these constraints, the sodic areas are reported for low crop productivity (Bhardwaj *et al.*, 2021), which leads to poor socio-economic conditions for the people in these areas.

On the other hand, climatic discrepancy is a new challenge to the farming communities. These discrepancies in climatic trends result in uneven distribution of rainfall, change in ground water level, solar radiation, temperature, etc. These trends are further affecting the several agricultural practices as it is well known that agriculture and climate are very closely dependent on each other. Now, it is widely discussed that the consequences of climate change have started imposing their impact on agriculture in India. Agriculture provides livelihood security to an estimated 61.5 per cent of the Indian population in general and over 85 per cent in particular to rural India. Most of the Indian population is considered more vulnerable because of its direct or indirect agricultural dependence.

Successful adaptation to changing climate is essential for sustainable productivity (Singh *et al.*, 2021). This requires ecological, social, or economic adjustments in response to actual or expected climatic stimuli and their effects or impacts. A combination of salt-related problems and changes in climatic trends has doubled the challenges for sustainable agriculture in sodic villages (Bhardwaj *et al.*, 2016). Apart from losses caused by variable climatic conditions, it also affects farmers' decision-making ability due to a lack of awareness and knowledge. Perceptions and attitudes regarding climate change affect farmers' willingness to adapt. Under these scenarios, assessing farmers' adaptation to Climate Resilient Technologies has been felt necessary.

The impacts of changing climate on agriculture have been severely felt in India. In recent years it has been projected that under the scenario of a 2.5ºC to 4.9ºC temperature rise in India, rice yields will drop by 32-40 per cent and wheat yields by 41-52 per cent. This would cause GDP to fall by 1.8-3.4 per cent (GOI, 2011). The recognition that climate change-related threats to agriculture also represent threats to the quality of life on a global scale has led to an increasing amount of attention to adaptation and mitigation strategies for agriculture by farmers (Howden *et al.*, 2007; Chejara *et al.*, 2021, Bhagat *et al.*, 2003). Researchers are very concerned with the potential damages and benefits that may arise in future from climate change impacts on agriculture since these will affect domestic and international policies, trading patterns, resource use and the average crop yield (Dinar *et al.*, 1998; Cline, 2007; Seo and Mendelsohn, 2008; Bhardwaj *et al.*, 2020).

Climate change will affect agriculture through effects on crops, soils, insects, weeds, diseases and livestock. Small changes in temperature and rainfall could significantly affect the quality of cereals, fruits, aromatic and medicinal plants and result in changes in prices and trade patterns. Pathogens and insect populations are strongly dependent upon temperature and humidity; increasing these parameters will change their population density, resulting in a loss in yield (Nguyen, 2012; Arunachalam and Sasmitha, 2020). Agriculture is subjected to various stresses, and potential yields are seldom attained with stress (Malik *et al.*, 2021, Mishra *et al.*, 2015; Malik *et al.*, 2022).

Climate change can affect the yield positively as well as negatively. The warming of the climate system is unequivocal, and since the 1950s, many of the observed changes have been unprecedented over decades to millennia (IPCC, 2013). Climate change projections for the Indian subcontinent indicate an increase in temperature by at least 3.3°C by 2080s relative to pre-industrial times (IPCC, 2007a,b). There is evidence of negative effects on yields of wheat and paddy in some parts of India due to raised temperature, moisture stress, and lessening rainy days. Under the medium-term (2020–2039) climate change scenario, crop yield is projected to reduce by 4.5 to 9 per cent, depending on the magnitude and distribution of warming (NICRA, 2013). Research evidence shows that changes in temperature and rainfall in India could reduce average rice yield by 15 to 25 per cent, average wheat yield by 30 to 35 per cent (Kavikumar and Parikh, 1998) and farm net income by 8 per cent (Mendelsohn *et al.*, 1994).

According to Nguyen (2014), rainfall pattern is a significant limiting factor for rain-fed rice production. Higher variability in distribution and a likely decrease in precipitation will adversely impact rice production, and complete crop failure is possible

if severe drought occurs during the reproductive stages. Farmers' awareness and perception of the erratic rainfall pattern would help develop appropriate extension educational strategies to manage these issues systematically. Bhatt *et al*. (2018), in their study focussing agroclimatic zones of Uttar Pradesh, also mention significant variations in maximum and minimum temperature trends and rainfall. Sharma *et al*. (2018) indicated that most farmers (57.50%) had a high level of awareness of the issues of heavy rain. The study recommends creating awareness among farmers, and extension personnel should play an essential role in educating the farmers about mitigation and adaptation strategies. Chouksey *et al*. (2021), Devi *et al*. (2021), Yadav *et al*. (2022), Shelar *et al*. (2022), and Bharat *et al*. (2022) in their study mention that farmers are unaware of the long-term impact of climate change on farming as well as on their socio-economic conditions. They further suggest that extension efforts should be intensified to increase awareness and adopt suitable practices to mitigate the harmful effects, as an adaptation to climate change may help the farming community secure their livelihood.

Overall, the situation for agriculture under a sodic environment becomes complex as several direct and indirect effects of climate change on precipitation patterns, higher atmospheric temperatures, increase in the frequency of droughts, floods and storms, and greenhouse gas emissions-would drastically limit agricultural productivity, particularly in sodic soils under arid and semi-arid regions in the country. In context to the above, it has been realized that at the farmers' level, the awareness of climatic problems in combination with existing problems due to the presence of salt is low. This may be due to a lack of knowledge about the right set of practices/technologies to adopt under these scenarios and their poor socio-economic conditions. Hence, this requires sensitizing the farmers about the current scenario, providing knowledge about the technologies and practices necessary, and building their capacity. Considering this, an attempt was made to assess the existing practices undertaken by the farmers. Need-based corrections will be incorporated in consensus and further demonstrated at farmers' fields on a pilot level for adoption.

MATERIAL AND METHODS

The study was conducted in two selected villages, one each in Unnao and Hardoi in Uttar Pradesh. The names of the villages were Ullarapur of Shankarpur Panchayat in Unnao and villages of Kasimabad-Bariya panchayat in Hardoi. The majority of the land in these villages falls under sodic land. To know the level of awareness of farmers and their best options to lower the impact of climate change in agriculture responses of 76 farmers selected randomly from villages comprising 32 from Unnao district and 44 from Hardoi district were collected. The information was collected using a pre-tested structured interview schedule during PRA activities in different villages. The farmers' responses were recorded on seven aspects. Also, farmers' responses were recorded for preferences of appropriate measures to mitigate the impact of climate change by providing seventeen options to prioritize their options. All the recorded information was further analyzed to know the level of awareness of farmers in the study area and to prioritize the interventions that are discussed further.

RESULTS AND DISCUSSION

It was observed that Kasimabad-Bariya panchayat of Hardoi district comprises eight hamlets, namely Shankar panchayat of Unnao district consists of two hamlets. The major highlights were that many of the hamlets of the identified panchayat have normal to moderate sodicity levels. Due to this, farmers can have good crop productivity in the area. Part of the area in some hamlets is moderately to severely affected by sodicity, and the productivity level is low in these areas. Hence, villages that were highly influenced by sodicity were considered in the study. Thus, this study identified Hannihya village of Kasimabad-Bariyaa (Hardoi) and Ullarapur village of Shankarpur (Unnao) as focussed villages. It is observed that farmers of focused villages having sodic land generally take rice and wheat as significant crops. In the case of fertilizer application, mainly the use of N and P is reported, which varied in the range of 120-180 Kg/ha (N) and 30 to 90 Kg/ha (P) whereas none of the farmers reported use of K. This indicated a higher nitrogen use and a less use of P and K. The average paddy productivity was reported to be in the range of 2.5 to 3.0 t/ha, whereas in the case of wheat, the productivity was 2 to 2.5 t/ha. Generally, farmers reported practising 3 to 5 irrigations in Paddy depending upon rainfall; the same in wheat was reported to be 2 to 4. As reported by the farmers, hybrid or traditional Paddy and Wheat varieties are

generally used. In Hannihya village, farmers never used gypsum for reclamation, whereas in Ullarapur, the farmers reported use of gypsum 15-20 years before. The farmers reported some of the major problems they are facing in relation to agriculture, which are as follows:

- Timely sowing/planting of crops
- Timely availability of irrigation water
- Fall of groundwater level
- Excess rainfall during particular periods
- Intermittent drought spells
- Erratic change in temperature
- Availability of quality agricultural inputs
- Rise of prices of agricultural inputs
- Lack of technical know how
- Storage and marketing of farm produce
- Production of crops not satisfactory

Farmer's Awareness Level about Changing Climate

Farmers' perceptions and their awareness level on different aspects of changing climate were recorded for the questions below.

1. Delayed onset of monsoon
2. Early retreat of monsoon
3. Change in rainfall pattern
4. Change in temperature pattern
5. Change in frequency of rainfall
6. Intermittent drought spells

Each of the above aspects of climate was explained in detail regarding their impact on agriculture. Further responses from farmers were collected for the level of awareness about these aspects and their effects on agriculture. The respondent's feedback was analyzed and presented in Tables 1 and 2.

Table 1. Level of awareness of farmers about impact of climate change in Unnao (N=32)

	Highly aware (%)	Moderately aware (%)	Low or not aware (%)
Delayed onset of monsoon	37	50	13
Early retreat of monsoon	37	47	16
Change in rainfall pattern	62	31	7
Change temperature pattern	15	31	54
Change in frequency of rainfall	25	37	38
Intermittent drought spells	28	56	16

Table 2. Level of awareness of farmers about impact of climate change in Hardoi (N=44)

	Highly aware (%)	Moderately aware (%)	Low or not aware (%)
Delayed onset of monsoon	27	45	28
Early retreat of monsoon	11	52	37
Change in rainfall pattern	59	29	12
Change temperature pattern	18	41	41
Change in frequency of rainfall	29	52	19
Intermittent drought spells	36	50	14

Table 1 and 2 reflected that most respondents are moderately aware of the impact of the changing climate on agriculture. Considering the responses, it is contemplated that change in rainfall pattern is very well experienced as about 62 per cent in Unnao and 59 per cent in Hardoi reported being highly aware of the impact of rainfall in agriculture, whereas 54 per cent of the respondents from Unnao and 41 per cent respondents from Hardoi reported low or not aware of the impact of change in the pattern of temperature. This reflects the sensitivity of respondents to the availability of agricultural water. The responses of both the villages were combined and further analyzed. The combined scenario is depicted through Figure 1 to Fig. 6.

Figures 1 and 2 reflect respondents' level of awareness about the delayed onset of monsoons and early retreat of monsoons. It is observed that most of the respondents, nearly 50 per cent, reported being moderately aware, whereas, 32 percent and 24 percent of respondents reported being highly aware of the delayed onset of monsoon and early retreat of monsoon, respectively. The remaining respondents either have low awareness or no awareness. In contrast, it is observed (Figure 3) that about 61 per

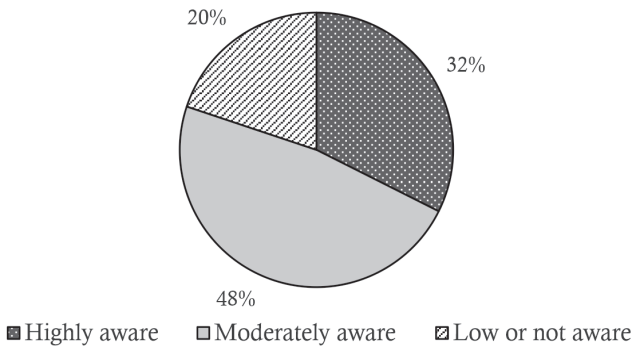

Fig. 1. Level of awareness of respondents to delayed onset of monsoon

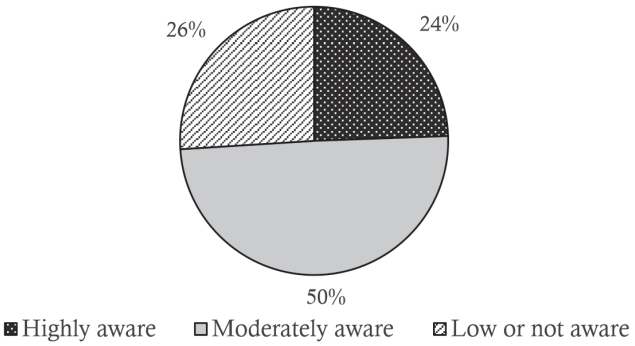

Fig. 2. Level of awareness of respondents to early retreat of monsoon

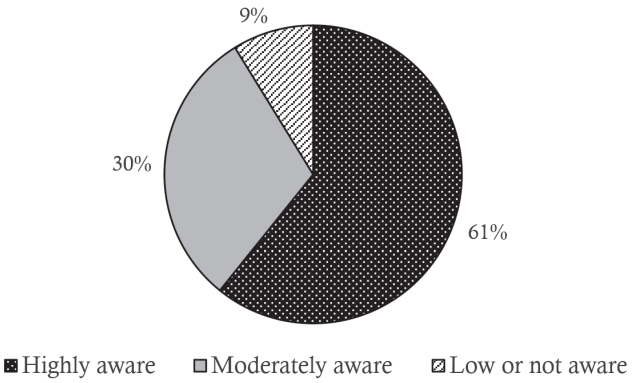

Fig. 3. Level of awareness of respondents to change in rainfall pattern

cent of respondents reported being highly aware of the impact of changing rainfall patterns, followed by 30 per cent moderately aware and 9 per cent low or not aware.

Understanding of respondents about the effect of change in temperature pattern is observed (Figure 4) least as 47 per cent of the respondents either have low awareness or no awareness about the impact of temperature change in agriculture, followed by 36 per cent moderately aware and 17 per cent highly aware. Figure 5 depicts the awareness level of respondents with respect to the change in frequency of rainfall. Regarding the interactions, it was observed that most respondents do not have clarity on this aspects. When explained in detail, it is observed that 28 per cent of respondents reported being highly aware, followed by 45 under the moderately aware category and 27 per cent either having low awareness or not being aware. Concerning this, respondents' awareness about intermittent drought spells was observed (Figure 6) much better as about 32 per cent respondents reported being highly aware followed by 53 per cent moderately aware and 15 per cent either low or not aware.

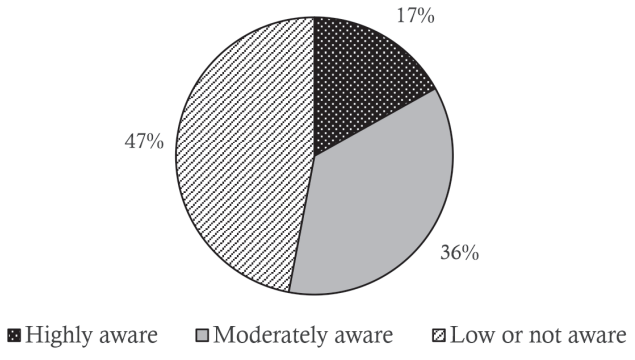

Fig. 4. Level of awareness of respondents to change in temperature pattern

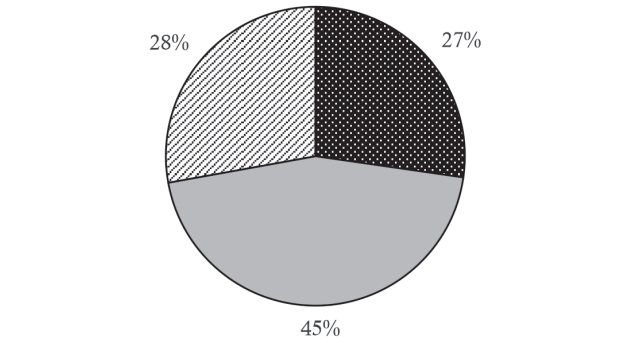

Fig. 5. Level of awareness of respondents to change in frequency of rainfall

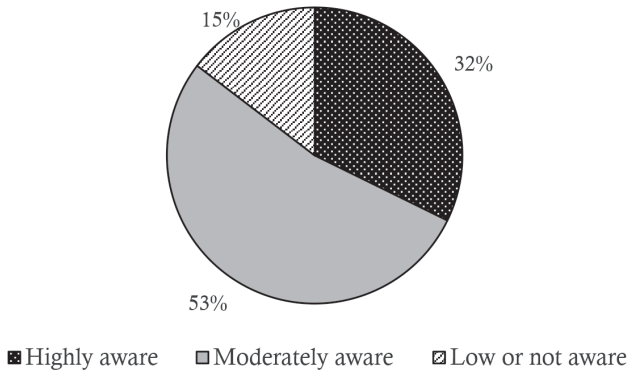

Fig. 6. Level of awareness of respondents to intermittent drought spell

CONCLUSION

Based on the farmers' feedback, timely availability of water, fall of groundwater, intermittent drought spells, availability of quality agricultural inputs, and lack of technical know-how are some of the major problems. The feedback regarding the level of awareness about changing

climate and its impact shows that most farmers are moderately aware. The awareness level was higher where the availability of water is affected, as about 61 respondents were highly aware of changing rainfall patterns, whereas understanding the impact of temperature still needs to be improved. This indicates the importance of water in practising agriculture. The responses reflect the need to enhance farmers knowledge about different aspects of changing climate and how to face the challenges of climate change.

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