Research Article

Indian Journal of Extension Education
Vol. 60, No. 4 (October–December), 2024, (101-106)

ISSN 0537-1996 (Print)
ISSN 2454-552X (Online)

# Farmers' Awareness and Perception about Climate Change in the Indo-Gangetic Plain Region of India

Anuj Kumar[1]* and Swami Prasad Saxena[2]

[1]Assistant Professor, Department of Commerce, Institute of Oriental Philosophy Vrindavan, Mathura, Uttar Pradesh, India
[2]Professor, Department of Applied Business Economics, Dayalbagh Educational Institute, Dayalbagh, Agra, Uttar Pradesh, India
*Corresponding author email id: achaudhary278@gmail.com

## HIGHLIGHTS

- The survey data reveal that 48.8 per cent of farmers originally get weather-related information from television or newspapers.
- The survey data reveal that 75 per cent of the specimen farmers expressed that due to climate change, they are observing a 10 to 20 per cent reduction in farm yield.
- The results reveal that 80.25 per cent of sampled farmers are taking benefit of the Neem-coated urea (NCU) scheme for boosting the growth of crops.

ARTICLE INFO

**Keywords:** Farmers' awareness, Climate change, Farmers' perception, Indo-gangetic plain.

https://doi.org/10.48165/IJEE.2024.60418

**Conflict of Interest:** None

**Research ethics statement(s):**
Informed consent of the participants

## ABSTRACT

Climate change is negatively impacting agriculture productivity worldwide. Accordingly, it becomes necessary to know the level of farmers' awareness about climate change. The study was conducted in the year 2023 to examine farmers' awareness and perceptions about nature, and the impact of changes in climate patterns on agriculture in India's Indo-Gangetic Plain (IGP) region. The study is based on a survey of 400 farmers, selected conveniently from five districts of Uttar Pradesh, a prominent province of the IGP region. The weighted average mean and chi-square test were applied to analyze the primary data. The findings indicate that farmers of the sampled area were aware of the problem, they get weather-related information from multiple sources like television, newspapers, etc. Almost half of the respondents in the sampled area strongly consider climate change as anthropogenic as well as naturogenic. Farmers perceived that reduced crop yields as the premier ultimatum of climate change in agriculture. The results unveil that the contrasting income groups have different levels of awareness of climate change similarly youth and educated farmers rely on their specific sources of weather-related information.

## INTRODUCTION

Climate change is the long-term weather patterns during a period; it potentially affects the frequency of natural disasters, damages natural ecosystems and human-built infrastructures, and causes human health issues via food shortages, increased heat, pollution, etc. The region depends on the monsoon for the rainfall, but rainfall is changing, and monsoon rainfall is declining year on year (Kumar & Saxena, 2021). Climate change, the most threatening issue is hitting almost all spheres of life. Agriculture, being an open-field activity, is directly affected by climate change and is also the most vulnerable to this query (Saxena & Kumar, 2019).

Indo-Gangetic Plains (IGP), is the oldest plain in the extensive north-central section of the Indian subcontinent. IGP plays a vital role in the generation of supreme food crops. It dispenses 48.4 per cent of rice and 74.7 per cent of wheat in the composite production of these dual extensive food crops. The rainfall trends in the IGP region are static, but there is a shift in the term of the rainfall. The shift in the term of rainfall and significant change in average heat in the territory is a matter of colossal regard for agricultural activities

Received 11-09-2024; Accepted 29-09-2024

(New et al., 2012). IN IGP, agencies and stakeholders assisting farmers in scaling up the adoption of climate smart agricultural practices, like precision conservation agriculture (Shitu & Nain, 2024).

The awareness about a phenomenon helps in taking corrective measures to tackle the problem (Arunachalam & Sasmitha, 2020). The cultivators are aware of the shift in metrological circumstances, and they primarily get weather-related information through radio broadcasts (Ravikumar et al., 2015; Adhikari et al., 2022; Gupta et al., 2024). The farmers do not sense the jargon 'climate change' (Tripathi & Mishra, 2017) and their knowledge about the shock and threats arising due to changes in climatic settings is limited (Hundera et al., 2019). Even the capacity development of extension scientists is being advocated in major areas of knowledge (Ghanghas et al., 2015). The farmers' awareness and perceptions differ according to age, education, farming experience, and size of land holdings (Mehmood et al., 2022; Fahad et al., 2020; Matsalabi et al., 2018). Most farmers perceive that the heat in the winter season is increasing, and the incidents of droughts have increased (Paramesh et al., 2022). As adaptation practices, they are using crop diversification and new crop varieties (Reddy et al., 2022).

## METHODOLOGY

The present study is plotted on fresh details gathered through a survey of four hundred farmers, conducted in 2023, distributed among the five most productive districts (Agra, Bulandshahar, Hapur, Meerut, and Etawah) of Uttar Pradesh, the prominent provinces of the Indo-Gangetic Plain region. The survey was organized in two phases. An exploratory approach was adopted in the early phase to get some idea of the variables, and in this phase, the researcher conducted a thorough literature survey which generated many statements related to various aspects of the study. To elicit responses, an empirical study through scheduled interaction on various aspects included in a self-structured questionnaire was conducted on four hundred farmers selected randomly from the villages of identified five districts of Uttar Pradesh. The sample size of three hundred eighty-four respondents was estimated by using Cochran's (1977) sampling methodology. Accordingly, the sample size of four hundred respondents was considered for the present study. Further, the sample size of four hundred respondents was proportionally divided into the selected five districts according to the number of cultivators in each selected district. The questionnaire, mainly containing close-ended questions was validated using multiple reviews from academicians and pre-tests with respondents. The internal consistency and reliability of the questionnaire were measured through the Cronbach Alpha test (Cronbach, 1951). Since the calculated value of Cronbach alpha for the questionnaire was 0.721 (more than 0.60), the developed questionnaire was considered reliable for further study.

## RESULTS

### Farmers' awareness and perception about climate change

Information about a phenomenon determines the level of awareness and it is a necessary input for decision-making. Since people are facing drawbacks kindred with weather and changes in weather parameters, all the sampled farmers are conscious of the problem; but their level of awareness is different. Collected information shows that farmers with high, moderate, and low levels of awareness were 36 percent, 62.5 per cent, and 1.5 per cent respectively. Regarding sources of weather-related information, television and newspapers are the uttermost popular sources. The survey data reveal that 48.8 per cent of cultivators originally get weather-related information from television or newspapers; probably because all the farmers have at least a basic level of education and newspapers are conveniently available in local shops and panchayat offices. Word of mouth is the third largest source of climate change and weather-related information (chart 1). Youth of the current era use the internet and social media a lot. About 35 per cent farmers were youth (20–40 years of age); educated among them gather weather-related information through the internet, the fourth largest source of information. In contrast, people aged above 60 years (more than one-tenth of sampled farmers) seem to rely on the traditional source of information (based on wind flow and cloud colours).

The central and state ministries have taken plenty of initiatives for farmers' welfare. Krishi Vigyan Kendras (KVK) has started to disseminate weather-related information on farmer's registered mobile phones. Further, the government also launched some special agriculture shows on television to provide weather-related information for broad geographical regions and spread information about new and innovative mechanisms for agriculture. A small portion of sampled farmers (5.3%) rely on telephonic information, and 4 per cent of farmers were found to get weather-related information through television show in Figure 1.

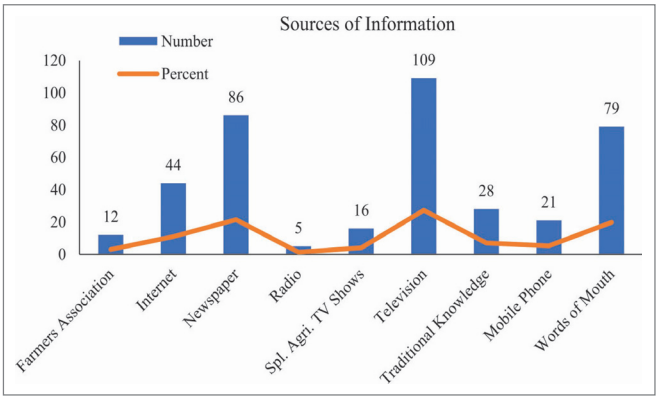


**Figure 1.** Sources of weather-related information used by farmers in the sampled area
*Source:* The Authors

In recent years, farmers' associations in western Uttar Pradesh have grown rapidly. These associations provide weather-related information, solve common problems, and motivate farmers to adopt modern technology-based agriculture practices. A few farmers (3%) were found to rely on information through these associations, and only 1.3 per cent of farmers use radio to get information about the climate and weather. In a nutshell, farmers depend on many sources to get weather-related information. These sources are unique and popular among different farmers' groups. Internet is the most preferred source of information, but some farmers still have faith

in traditional knowledge and personal experience to get weather-related information.

To analyze farmers' perception of the nature of climate change, cultivators were stated to confer their opinion by rating the statements concerned with the anthropogenic or naturogenic nature of change in weather variables on a five-point Likert scale indicating the level of understanding (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree). The results of their responses (weighted average and standard deviation for each statement) presented in Table 1 indicate that 20.25 per cent of cultivators strongly concur with the anthropogenic nature of climate change. According to them, climate change is caused by human activities. 19.75 per cent of farmers strongly suppose that climate change is natural and influenced by natural factors, such as floods, cyclones, drought, stroke incidences, airborne pollutants, etc. Almost half of the respondents (52%) in the sampled area strongly consider climate change as anthropogenic as well as naturogenic instigated by both natural factors and human actions as well. The weighted average and standard deviation of responses indicate that a greater number of cultivators sense that climate change is an anthropogenic activity. Some experimental studies also illustrate that human activeness is more guilty for changes in weather patterns.

**Farmers' views on the impact of climate change of government schemes**

To comprehend farmers' views on the impact of climate change in sampled areas, farmers were interrogated to specify the gravity of the impact of climate change on agriculture. In response, 23.8 per cent of cultivators viewed that they observe low impact, while 63.7 per cent of the farmers of the sampled area perceive moderate impact of climate change on agriculture. A few (12.5%) farmers feel that climate change has a high degree of impact on agricultural activities.

To understand the potency of the impact of climate change on agriculture, farmers were asked to rate various subjects concerned with agriculture operations and yield, such as farm yield, quality of produce, crop diseases, delay in the system of sowing seeds, and changes in cropping pattern on 5-point Likert scale expressing their level of understanding (1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, and 5 = Very High). The frequencies of their responses along with the weighted average and standard deviation of each subject are presented in Table 2. The results indicate that 54.5 per cent of sampled farmers observe a very high impact of change in weather conditions on yield; 61.75 per cent of cultivators consider thatshift in weather variables has a very high unfavourable effect on the quality of produce (Table 3). About 50 per cent of farmers feel the high effect of climate change on crop decrease in the sampled area. In comparison, 45.0 per cent and 58.75 per cent of cultivators accept that climate change (increase in temperature and/ or delay in the rainfall) has a moderate effect on the seeding process and shift in cropping pattern respectively.

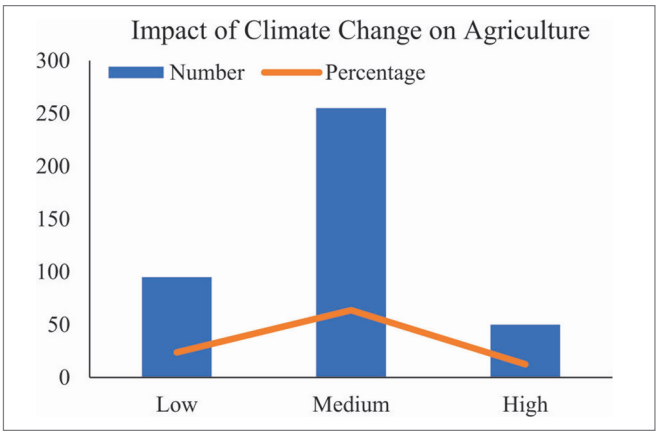


**Figure 2.** Farmer's perception about the level of impact of climate change on agriculture

The mean values indicate a strong negative impact of shift in climatic arrangement on farm yield and the quality of produce (WA = 4.48 equally), followed high impact on frequent crop diseases (WA = 3.78), and a moderate effect on the seeding process (WA = 3.52) and shift in cropping pattern (3.37). The standard deviation (SD) of these elements hints that there is not much difference in the opinion of respondents. Farmers were again asked to compute the impact of the shift in climatic arrangement on agriculture yield. In response, 75 per cent of the sampled cultivators specify that they are observing a 10 to 20 per cent reduction in farm yield, while 15 per cent of cultivators are encountering a 20 to 30 per cent fall

**Table 1.** Farmers' view on the nature of climate change

| Statement | SA | A | N | D | SD | WA | SD |
|---|---|---|---|---|---|---|---|
| Climate change is anthropogenic | 20.25 | 37.75 | 39.5 | 2.25 | 0.25 | 3.76 | 0.82 |
| Climate change is naturogenic | 19.75 | 6.25 | 41.75 | 31.0 | 1.25 | 3.12 | 1.09 |
| Climate change is both anthropogenic and naturogenic | 52.0 | 40.0 | 8.0 | 0.0 | 0.0 | 4.44 | 0.64 |

*Note:* Figures in parentheses indicate the per cent of the total.

**Table 2.** Farmers' view on the impact of climate change on agriculture

| Impact | VH | H | M | L | VL | WA | SD |
|---|---|---|---|---|---|---|---|
| Decrease in farm yield | 54.5 | 39.75 | 4.75 | 0.75 | 0.25 | 4.48 | 0.648 |
| Decrease in the quality of produce | 61.75 | 27.0 | 9.5 | 0.5 | 1.25 | 4.48 | 0.787 |
| Frequent crop diseases | 15.0 | 50.0 | 16.75 | 4.75 | 3.5 | 3.78 | 0.881 |
| Delay in the process of sowing seeds | 12.5 | 35.75 | 45.0 | 4.25 | 2.5 | 3.52 | 0.858 |
| Change in cropping pattern | 5.75 | 31.0 | 58.75 | 3.25 | 1.25 | 3.37 | 0.699 |

**Table 3.** Farmers' observations on average reduction in farm yield

| Reduction in farm yield | Number | Percentage |
|---|---|---|
| < 10 percent | 35 | 8.8 |
| 10 – 20 percent | 300 | 75.0 |
| 20 – 30 percent | 60 | 15.0 |
| > 30 percent | 5 | 1.2 |
| Total | 400 | 100.0 |

in crop yield due to injurious outcomes of changing weather conditions (Table 3). 8.8 per cent of cultivators feel less than a 10 per cent decrease in crop yield, and only a few (1.2%) cultivators claimed that they are observing more than a 30 per cent fall in the yield of dominant crops in the sample area.

To examine farmers' awareness about government programs and schemes for sustainable agriculture development supporting farmers to combat the menace of the shift in climatic patterns in agriculture, sampled farmers were asked to mention whether they are informed and taking benefit of government schemes. Their responses presented in Table 4 reveal that 80.25 per cent of sampled farmers' are taking benefit of the Neem-coated urea (NCU) scheme for boosting the growth of wheat and paddy crops. The sampled farmers taking benefit of Soil Health Card (SHC) scheme for soil health and nutritional information, *Paramparagat krishi vikas yojana* (PMKVY) for soil fertility and help farmers in production of healthy food through traditional or conventional (organic) agriculture practices without use of agrochemicals, and *Pradhan Mantri fasal bima yojana* (PMFBY) were 19.25 per cent, 10.75 per cent, and 9.25 per cent respectively.

**Table 4.** Government schemes supporting farmers to combat climate change

| Government Schemes | Aware | | Unaware |
|---|---|---|---|
| | Using (%) | Not Using (%) | (%) |
| Neem Coated Urea (NCU) Scheme | 80.25 | 5.75 | 14.0 |
| Soil Health Card (SHC) Scheme | 19.25 | 18.0 | 62.75 |
| Paramparag at Krishi Vikas Yojana (PMKVY) | 10.75 | 22.75 | 66.5 |
| Pradhan Mantri Fasal Bima Yojana (PMFBY) | 9.25 | 19.25 | 71.5 |
| Rainfed Area Development Program (RADP) | 5.75 | 13.50 | 80.75 |
| PM Krishi Sinchayee Yojana (PMKSY) | 0 | 16.0 | 84.0 |

Rainfed area development program (RADP) focuses on the unified cultivation structure for effective production and diminishes the peril identical to weather variabilities, especially in those areas that solely depend on rainfall for irrigation purposes. Under this program, the government adopts a rainfed area to develop agriculture and farming system. A very small proportion of farmers (5.75%) are earning perks from this program probably because cultivators of the IGP region are blessed with a river base. Likewise, *Pradhan Mantri Krishi Sinchayee Yojana* (PMKSY), a scheme for investment in irrigation, cultivable area expansion with assured irrigation, and efficient use of water (per drop – more crop) through rigor irrigation and micro irrigation (drip and sprinkler irrigation) is not extremely pertinent for the sampled area because of sufficiency of irrigation resources and especially for dominant crops (rice and wheat) of IGP region and likewise the alternative crops. The sample statistics imply that despite 16 per cent of farmers being familiar with the scheme; none of them are beneficiaries of the scheme.

**Relationship of demographic features and farmers' awareness and perception**

To familiarize with the nature, degree, and significance of the relationship between demographic features (personal characteristics and socio-economic conditions) of sampled farmers with the level of their awareness towards climate change, preferences towards sources of weather-related information, the magnitude of the impact of climate change on agriculture yield, and use of government schemes, the researchers applied Chi-Square test (Table 5).

The results presented in Table 5 reveal that the Chi-Square test ($\chi^2$) follows chi distribution, and sampled farmers of different demographic features (age, land-holding size, education level, and family size) except family income have similar levels of awareness about the problem of climate change. However, their awareness level towards climate change differs according to family income ($P > 0.05$). This is because farmers of high-income crowds are more exposed to information about changes in weather situations and related issues. The Chi-Square test results related to farmers' preferences toward weather-related information show that farmers of different age groups, educational levels, and family sizes prefer using different sources to get weather-related information. The results indicate that young and educated farmers use the Internet and mobile-based weather systems for weather-related information, while aged and uneducated farmers still depend on traditional sources of information. The p-value of the chi-square test of the

**Table 5**. Relationship between demographic features and farmers' awareness and preferences

| Variable | Measure | Demographic Features | | | | |
|---|---|---|---|---|---|---|
| | | Age | Land-holding | Education Level | Family Size | Family Income |
| Level of awareness towards climate change | $\chi^2$ | 19.10 | 11.00 | 3.849 | 4.930 | 29.367 |
| | Prob. | 0.086 | 0.275 | 0.921 | 0.251 | 0.003 |
| Preferences towards weather-related information | $\chi^2$ | 211.15 | 32.612 | 106.32 | 32.294 | 38.393 |
| | Prob. | 0.000 | 0.113 | 0.000 | 0.009 | 0.202 |
| Intensity of the impact of climate change on agriculture yield | $\chi^2$ | 4.971 | 5.730 | 13.381 | 2.807 | 5.570 |
| | Prob. | 0.761 | 0.454 | 0.037 | 0.591 | 0.695 |
| Preferences towards government schemes | $\chi^2$ | 31.595 | 19.569 | 12.877 | 8.175 | 20.355 |
| | Prob. | 0.011 | 0.076 | 0.377 | 0.417 | 0.205 |

other two demographic factors i.e. land-holding and family size is more than 0.05, which means that different land-holding and family sizes use similar sources of weather-related information. Results also indicate that farmers' perceptions of the intensity of the impact of climate change on agriculture yield do not differ significantly ($P > 0.05$) at different age groups, sizes of land-holding, family size, and family income further the preferences towards government schemes do not differ significantly ($P > 0.05$) at sizes of land-holding, family size, education level, and family income.

## DISCUSSION

Although, studies immersed worldwide cover various aspects linked to the causes and impact of alteration in weather patterns, farmers' awareness and perception of climate change, the impact of shifts in climatic conditions on agriculture yield, and its mitigation strategies. These studies focus on one or two facets of the issue in some developed and developing countries, and their findings are ambiguous, perhaps due to constricted area or inadequate sample size. The results of the present study are very valuable for the different stakeholders. The findings expressed in the result section described that farmers are aware of the problem of climate change and the government agencies can include these findings in policy framing. The farmers perceive that change in climatic conditions is negatively affecting the quantity of crop yield. The government should frame a sound adaptation and mitigation policy to overcome this particular issue arising due to alterations in weather patterns similarly, government agencies should promote and effectively implement their schemes supporting farmers to combat climate change. The results revealed that demographic factors affect the farmers' awareness of climate change and these findings are supported by Fahad et al., (2020), who found similar results. According to the findings, the income of the farmer is a significant demographic factor that determines the awareness of farmers about climate change, this finding aligns with the results of the study conducted by Raghuvanshi et al., (2017) in selected districts of Uttarakhand. The age and level of education of farmers along with family size are the main demographical factors that determine about the source of weather-related information of the farmers. This result aligns with the findings of the study conducted by Bharat et al., (2022). Age is a crucial factor that determines the farmers' preferences towards government schemes.

## CONCLUSION

Agriculture is a vital economic activity, especially in emerging countries like India, where almost half of the population is occupied in agriculture and allied activities. Indo-Gangetic Plains, one of the oldest plains situated in the extensive north-central segment of the Indian sub-continent is considered as the food bowl of South Asia. The shift in the timing of rainfall and significant change in average temperature in the region is a matter of great concern for agricultural activities. The results of the farmers' survey conducted in selected districts of Uttar Pradesh (the largest state of the IGP region of India) pinpoint that the majority of farmers in the IGP segment of India are familiar with the causes and effects of climate change on agriculture, but demographic features of the cultivators determine the level of their awareness about nature, causes, and impacts of climate change on agriculture.

## REFERENCES


Adhikari, S., Sara, R., & Sandesh, T. (2022). Assessment of status of climate change and determinants of people's awareness to climate-smart agriculture: a case of Sarlahi District, Nepal. *Advances in Agriculture*, *2022*(2), 1-9. https://doi.org/10.1155/2022/1556407

Arunachalam, R., & Sasmitha, R. (2020). Awareness and perception on the issues arising out of undesirable pattern of rainfall of the rice farmers. *Indian Journal of Extension Education, 56*(2), 16-20. *https://epubs.icar.org.in/index.php/IJEE/article/view/107301*

Bharat, B., Chapke, R. R., & Kammar, S. (2022). Farmers' Perception about climate change and response strategies. *Indian Journal of Extension Education, 58*(1), 7-11. https://epubs.icar.org.in/index.php/IJEE/article/view/119144

Cochran, W. G. (1977). *Sampling Techniques*. John Wiley & Sons.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*, 297-334. https://doi.org/10.1007/BF02310555

Fahad, S., Tahira, I., Jian ling, W., Li, D., Guangyin, H., Sufyanullah, K., & Aaqil, K. (2020). Farmers' awareness level and their perceptions of climate change: A case of Khyber Pakhtunkhwa Province, Pakistan. *Land Use Policy, 96*(7). 104669. https://doi.org/10.1016/j.landusepol.2020.104669

Ghanghas, B. S., Shehrawat, P. S., & Nain, M. S. (2015). Knowledge of extension professionals regarding impact of climate change in agriculture. *Indian Journal of Extension Education*, *51*(3&4), 125-129.

Gupta, R. M., Negi, A., Sharma, P., & Kaur, A. (2024). Farmer's awareness regarding climate change and its effect on ground water. *Indian Journal of Extension Education, 60*(1), 91-94. https://doi.org/10.48165/IJEE.2024.60117

Hundera, H., Mpandeli, S., & Bantider, A. (2019). Smallholder farmers' awareness and perceptions of climate change in Adama District, Central Rift Valley of Ethiopia. *Weather and Climate Extremes, 26*, 100230. https://doi.org/10.1016/j.wace.2019.100230

Kumar, A., & Swami, P. S. (2021). Climate change in South Asia: impact, adaptation and role of GI science. In: Singh, S. K., Kanga, S., Meraj, W., Farooq, F., & Sudhanshu, *Geographic information science for land resource(pp:1-18). John Wiley & Sons Inc. and Scrivener Publishing, LLC*. https://doi.org/10.1002/9781119786375.ch1

Matsalabi, A. A., Patrice, S., Kanak, P. A., & Mudimu, G. T. (2018). Farmers' perceptions and adaptation strategies to climate risks and their determinants: Insights from a farming community of Aguie district in Niger. *Geo Journal*, *85*(4), 1075–1095. 10.1007/s10708-019-10011-7

Mehmood, M. S., Gang, L., Ahsan, R. K., Badar, N. S., Waqar, U. H. T., Amara, T. K., & Muhammad, A. U. R. (2022). An evaluation of farmers' perception, awareness, and adaptation towards climate change : A study from Punjab Province Pakistan. *Ciencia Rural, 52*(3), 20201109.10.1590/0103-8478cr20201109

New, M., Muhammad, R., & Jagadishwor, K. (2012). Climate change in Indo-Gangetic agriculture: recent trends, current projections, crop-climate suitability, and prospects for improved climate model information. *CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), Copenhagen, Denmark* (3–18). https://hdl.handle.net/10568/27832

Paramesh, V., Parveen, K., Mohammad, S., Natesan, R., Vadivel, A., Arun, J. N., Trivesh, M., Raghuveer, S., Ashisa, K. P., & Racharla, S. R. (2022). Integrated farming systems as an adaptation strategy to climate change: case studies from diverse agro-climatic zones

of India. *Sustainability, 14*(18). https://doi.org/10.3390/su141811629

Raghuvanshi, R., Ansari, M. A., & Amardeep. (2017). A study of farmers' awareness About Climate Change and Adaptation Practices in India. *International Journal of Applied Agricultural Sciences, 3*(6), 154-160. doi: 10.11648/j.ijaas.20170306.13

Ravikumar, K., Nain, M. S., Singh, R., Chahal, V. P., & Bana, R. S. (2015). Analysis of farmers' communication network and factors of knowledge regarding agro metrological parameters. *Indian Journal of Agricultural Sciences*, *85*(12), 1592-1596.

Reddy, K. V., Venkatesh, P., Vadivel, A., Bappa, D. P. R., Malay, P., Shankarappa, S., Reddy, D. D., Abed, A., & Ahmed, Z. D. (2022). Farmers' perception and efficacy of adaptation decisions to climate change. *Agronomy, 12*(5), 10-23. https://doi.org/10.3390/agronomy12051023

Saxena, S. P., & Kumar, A. (2019). Economic analysis of climate change impact, adaptation, and mitigation on potato farming in India with special reference to Agra District. *Indian Journal of Economics and Development*, *7*(3), 1-7.

Shitu, A. G., & Nain, M. S. (2024). Benefits of precision conservation agriculture practices as perceived by Indo-Gangetic Plain (IGP) community for climate-smart agriculture, *SKUAST Journal of Research,* 26(2), 219-226. *https://doi.org/10.5958/2349-297X.2024.00029.2*

Tripathi, A., & Mishra, A. K. (2017). Knowledge and passive adaptation to climate change: An example from Indian farmers. *Climate Risk Management, 16*, 195–207. https://doi.org/10.1016/j.crm.2016.11.002