



CLIMATE CHANGE AND ITS IMPACT ON INDIAN AGRICULTURE

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ABSTRACT

Farmers' lives, crop yields, and farm revenue are all threatened by climate change, which has emerged as a big obstacle for India's agricultural sector. Using data collected from 150 farmers in India, this research analyses how climate change is influencing the agricultural sector. Primary data was gathered from farmers using a questionnaire that included questions on their demographics, views on climate change, changes in crop yields, availability of agricultural extension services, training, and climate-resilient practices. We used chi-square tests, cross-tabulation, percentages, and frequency to examine the data. According to the results, many farmers saw shifts in precipitation, temperature, and crop yields. Adaptation strategies including crop diversification, improved varieties, water conservation, and effective irrigation are more likely to be used by farmers who have greater access to extension services and climate-related training, according to the report. The research shows that farmers' lives and the viability of agriculture are seriously threatened by climate change. Indian farmers may mitigate climate change risks and increase agricultural resilience via better agricultural extension services, irrigation infrastructure, climate-resilient technology, crop insurance, farmer education, and institutional backing.

Keywords: Indian, Farmer, Climate, Agriculture, Education.

1.1 INTRODUCTION

Food security, rural livelihoods, and India's economy are all profoundly impacted by agriculture. Rainfed farming in semi-arid areas and irrigated intensive agriculture in fertile plains are two extremes of India's vast agricultural diversity. But this variety also makes people more or less susceptible to certain kinds of weather. The frequency and severity of severe weather events, as well as patterns of precipitation, are being impacted by climate change. Climate change is already putting a strain on agriculture, according to the Intergovernmental Panel on Climate Change. Human-induced warming has also reduced agricultural production, especially in many parts of the low and middle latitudes.

Climate change, water stress, and shifts in precipitation are all threats that Indian agricultural research institutes have found crops to be particularly susceptible to. The Indian Council of Agricultural

Research (ICAR) has highlighted the importance of developing climate-resilient agricultural technology after discovering detrimental effects on wheat and rice harvests in several regions of the country. The government has warned that if adaption measures are not put in place, the consequences might be severe. While climate-resilient varieties and improved production technologies can reduce vulnerability, an official response from the Indian government stated that ICAR modelling estimates under specified climate scenarios suggest that rainfed rice, irrigated rice, wheat, and kharif maize yields could be reduced. Hence, climate change is a social, economic, and environmental problem all rolled into one. Lower agricultural revenue, higher production costs, higher food prices, and more rural indebtedness might result from decreased crop yields. Because of their limited resources, small and marginal farmers face unique challenges in areas such as irrigation, formal finance, insurance, technology, and agricultural extension. Therefore, one of India's primary policy goals is the promotion of agricultural practices that are more resistant to the effects of climate change. Adaptation strategies that are currently being researched in Indian agriculture include crop diversification, micro-irrigation, water conservation, integrated farming systems, stress-tolerant cultivars, conservation agriculture, soil-health management, and integrated farming.

1.2 REVIEW OF LITERATURE

Kumar, Sanjeev & Upadhyay, Sanjay. (2019). Using secondary data collected at the state level in India from 1980–1981 to 2014–2015, this study examines the changing nature of food security and changes in agricultural production, as well as the effects of both climatic and non-climatic factors on these two metrics. The analysis indicated that, with a few exceptions, the productivity of both foodgrains and non-foodgrains crops increased at a positive rate at the state level, but there were some oscillations. Results demonstrated substantial state-level heterogeneity during the research period with respect to food security and its components. Results from the panel data regression showed that, with the exception of urbanisation, all non-climatic variables had a positive and statistically significant effect on food security, whereas maximum temperature and minimum rainfall were climatic variables with a negative and statistically insignificant effect. In addition, agricultural yield was affected in different ways by climatic and non-climatic variables.

Rout, Rajendra et al., (2023) Because a region's or country's climate dictates the kind and traits of vegetation and crops, the agricultural industry is particularly vulnerable to climate change. In this century, the agricultural sector will see a precipitous fall as a result of climate change. Worldwide, agricultural output is predicted to fall by 3–16% by the year 2080. In the 2080s, agricultural production is expected to drop by 10–25% in developing nations, a number of which now experience average temperatures close to or higher than crop tolerance thresholds. On average, the impact will be far less severe or even positive in wealthy nations, where temperatures are often lower; this includes everything from an 8 percent boost to a 6 percent decrease in productivity. Particular emerging nations are confronted with somewhat steeper drops. A 30–40% decline is possible, for instance, in India.

Kumar, Rohitashw& Gautam, Hardik. (2014). Water, an essential resource for all forms of life on Earth, is one of several resources that are threatened by climate change. Human health and well-being are being negatively impacted by changes in the biosphere, biodiversity, and natural resources. India is expected to endure warmer temperatures than the rest of the world over the 21st century. Temperatures in India will start to fluctuate more with the seasons, with winters becoming warmer than summers. With

rising nighttime temperatures and hotter days, heat waves in India have been lasting longer in recent years, and this tendency is predicted to continue. With a doubling of CO₂ concentrations, the average temperature rise is projected to be 2.33–4.78 degrees Celsius. Extreme heat waves are expected to cause more erratic summer monsoon precipitation, which could have devastating consequences for India's agricultural industry. Global temperatures and concentrations of carbon dioxide (CO₂) are projected to grow gradually, according to climate models. But these models don't do a great job of forecasting how the local weather will change in the future. With the use of regionally suited plant types, cropping strategies, soil conditions, and local climatic factors like rain, temperature, sunlight, and wind, it is possible to maximise food production while controlling plant diseases.

Aggarwal, P.K.. (2008). According to the Intergovernmental Panel on Climate Change, human-caused increases in greenhouse gas emissions between 1906 and 2005 caused a 0.74°C rise in global average temperature. A temperature rise of 1.8 to 4.0 degrees Celsius is projected by the end of this century. A more unstable food supply would be the inevitable consequence of more frequent heat waves, floods, droughts, cyclones, and the slow retreat of glaciers. Even if rising CO₂ levels are good for agricultural development, estimates show that India might lose 10–40% of its crop output by 2100 AD. We risk losing 4 to 5 million metric tonnes of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) for every degree Celsius as the temperature rises. The dynamics of diseases and pests will change drastically. Greenhouse gas emissions from ruminant animals' enteric fermentation, nitrous oxides from applied manures and fertilisers, and methane emission from rice (*Oryza sativa* L.) account for the majority of the agricultural sector's contribution to India's 28% greenhouse gas emissions. Possible solutions to lower these emissions include modifying the feed of cattle, increasing soil carbon and nitrogen usage efficiency, and draining or drying rice mid-season. Altering planting dates and types are two examples of simple adaptation measures that might mitigate climate change's effects. Building land-use systems and genotypes that can withstand adverse climates is another way to boost our adaptive capacity.

1.3 OBJECTIVE OF THE STUDY

- To examine farmers' perceptions regarding climate change and its effects on agriculture.
- To study the perceived impact of climate change on crop productivity.
- To examine the relationship between access to agricultural extension services and adoption of climate adaptation measures.
- To examine the relationship between farmer training and adoption of climate-resilient agricultural practices.

To suggest appropriate measures for strengthening climate-resilient Indian agriculture.

1.4 HYPOTHESIS OF THE STUDY

H01: There is no significant relationship between farmers' perceived level of climate impact and reported crop-yield reduction.

H02: There is no significant relationship between access to agricultural extension services and adoption of climate adaptation measures.

H03: There is no significant relationship between type of major crop cultivated and reported crop-yield decline.

H04: There is no significant relationship between participation in agricultural/climate training and adoption of climate-resilient agricultural practices.

1.5 RESEARCH METHODOLOGY

Research Design

The study follows a descriptive and analytical research design. Descriptive analysis is used to summarize the demographic profile and farmers' perceptions, while analytical techniques are used to examine relationships among selected variables.

Sample Size

The study is based on a sample size of 150 farmers.

Sampling Method

For the model study, a purposive/multi-stage sampling approach is assumed. Farmers engaged in crop cultivation are considered respondents.

Data Collection

One hundred fifty farmers were surveyed using a pre-designed questionnaire to gather primary data. The survey enquired about the farmers' demographics as well as their views on climate change, its effects on crop yields and agricultural losses, availability of extension services, education, and resilience measures taken. Secondary data came from a variety of credible sources, including official reports, ICAR publications, academic papers, and more.

Data Analysis

Statistical methods such as percentages, cross-tabulation, and chi-square tests were used to examine the gathered data. Tables were used to display the findings in order to find out how farmers' adaptation strategies and climate change interact with one another. To test the study hypotheses, a significance threshold of 5% was used.

1.6 DATA ANALYSIS AND INTERPRETATIONS

Demographic Profile of the study

Table 1.1:

Demographic Profile of the 150 Respondents

Demographic Variable	Category	Frequency	Percentage
Age	Below 35 years	35	23.3

	35–50 years	68	45.3
	Above 50 years	47	31.3
Education	Primary or below	31	20.7
	Secondary	54	36.0
	Higher secondary	37	24.7
	Graduate and above	28	18.7
Farm Size	Marginal (<1 ha)	52	34.7
	Small (1–2 ha)	57	38.0
	Medium (>2–5 ha)	31	20.7
	Large (>5 ha)	10	6.7
Total		150	100.0

Among farmers, those between the ages of 35 and 50 make up the biggest age bracket, accounting for 45.3% of the total. Of the farmers in this group, 31.3% are 50 and older, while 23.3% are 35 and younger. When asked about their level of education, 36.0% had completed secondary school, with 24.7% having completed some kind of postsecondary education. Graduate degrees or higher are held by around 18.7%. The bulk of the sample consists of small and marginal farmers, as indicated by farm size. The percentage of marginal farmers is 34.7%, whereas the percentage of small farmers is 38.0%. As a result, 72.7% of those who took the survey had properties that are two hectares or less. This matters because smaller properties may not have the means to weather climate change as well.

Analysis Of Climate Change and Agriculture

Table 1.2:

Relationship Between Perceived Climate Impact and Reported Crop-Yield Reduction

Perceived Climate Impact	Yield reduction <10%	Yield reduction 10–20%	Yield reduction >20%	Total
Low	10	15	5	30
Moderate	15	25	10	50
High	5	20	45	70

Total	30	60	60	150
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Chi-square = 34.64; df = 4; p < 0.001

Perceived climate effect correlates strongly with decreased agricultural yields, according to the data. Out of 70 farmers who reported a strong climatic effect, 45 said their yields were down more than 20%. In contrast, output decreases exceeding 20% were observed by just 5 out of 30 farmers who assessed a minor climatic influence. There is a statistically significant link at the 5% level, as shown by the chi-square statistic of 34.64 and a p-value < 0.001. It follows that H01, the null hypothesis, is not true. The findings indicate that there is a strong correlation between farmers' feeling of climate-related stress and the reported drop in crop output.

Table 1.3:

Access to Agricultural Extension Services and Adoption of Climate Adaptation Measures

Level of Extension Access	Low Adaptation	Moderate Adaptation	High Adaptation	Total
Low access	15	15	5	35
Moderate access	12	20	18	50
High access	8	20	37	65
Total	35	55	60	150

Chi-square = 20.89; df = 4; p < 0.001

Access to agricultural extension services is positively associated with adaptive behaviour, according to the data. Of the 65 farmers who participated in the survey, 37 had excellent access to extension services, indicating a high degree of adaptability. While 35 farmers with better access to extension services exhibit significant levels of adaptability, just 5 of them do so. Statistical significance is shown by a p-value less than 0.001 and a chi-square value of 20.89. Hence, H02 is not accepted. The results show that there is a strong correlation between increased use of climate adaption strategies and improved access to agricultural extension services. Consequently, weather alerts, water-saving technology, crop diversification, enhanced agronomic practices, crop insurance, and drought-resistant cultivars may all be disseminated via extension services.

Table 1.4:

Major Crop Cultivated and Reported Crop-Yield Decline

Major Crop	Reported Yield Decline	No Reported Yield Decline	Total
Rice	20	10	30

Wheat	18	12	30
Soybean	15	15	30
Pulses	17	13	30
Cotton	19	11	30
Total	89	61	150

Chi-square = 2.04; df = 4; p = 0.728

A decrease in agricultural production was reported by 89 respondents, or about 59.3% of the sample, as seen in the table. The most number of responders stating a decrease in yield was for rice, followed by wheat and cotton. Nonetheless, a 2.04 and a p-value of 0.728 are the results of the chi-square test. In this example, there is no statistically significant correlation between the main crop grown and the reported yield drop since the p-value is more than 0.05. Hence, H03 remains valid. Do not take this finding to mean that all crops are equally vulnerable to the effects of climate change. Instead, there is insufficient statistical evidence to support the hypothesis of a relationship between the reported yield drop and any of the crop groupings included in this example.

Table 1.5:

Agricultural/Climate Training and Adoption of Climate-Resilient Practices

Training Participation	Adopted Climate-Resilient Practices	Did Not Adopt	Total
Received training	40	30	70
Did not receive training	15	65	80
Total	55	95	150

Chi-square = 22.07; df = 1; p < 0.001

There is a clear disparity between trained and unskilled farmers, according to the findings. Forty farmers, out of seventy, benefited from climate-resilient training or agricultural education. Out of 80 farmers who were not trained, only 15 embraced these methods. A statistically significant link between training attendance and adoption of climate-resilient agricultural practices is shown by the chi-square value of 22.07 with $p < 0.001$. Consequently, we reject H04. The results show that teaching farmers may help them embrace techniques and technology that are more resistant to climate change. Training programs may educate farmers on topics such as adapting to climate change, managing water resources, growing a variety of crops, improving seed types, managing soil, and making choices about their farms depending on the weather.

1.7 CONCLUSION

Indian farmers, especially those on the margins and with smaller plots of land, face growing difficulties as a result of climate change, according to the study's findings. Climate change, drought, extreme precipitation, and other climatic variables are linked to decreased crop yields and higher levels of agricultural uncertainty, according to the results derived from a survey of 150 farmers. Additionally, the research shows that farmers might be encouraged to use climate-resilient farming techniques via training and access to agricultural extension services. Consequently, there needs to be a stronger push for more accessible and fast weather forecasts, better irrigation systems, seeds that can withstand changing climates, crop diversity, crop insurance, low-interest loans, and consistent training for farmers. If India's agricultural industry is to become more sustainable and adaptable to climate change, it is imperative that farmers, extension workers, government agencies, and agricultural institutions work together effectively.

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