



Impact Of Climate Change On Livelihood Of Farmers In India

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ABSTRACT

Farmers in India are in grave danger due to climate change because their livelihood is so dependent on agriculture for the country's economy and food supply. In this work, we look at how recent climatic trends—like higher average temperatures, changed rainfall patterns, and more frequent extreme weather events—have affected Indian agriculture. Farmers are facing social issues, economic uncertainty, and lower crop yields as a result of these climate changes. Combining quantitative data from agricultural surveys and weather reports with qualitative insights from interviews with farmers throughout several regions of India, this study employs a mixed-methods approach. The results show that smallholder farmers, who do not have access to sophisticated tools or capital, are the ones most hit by climate change, which makes their preexisting vulnerabilities worse. Case studies show how farmers overcame obstacles and implemented successful adaptation measures, such as growing crops that are less susceptible to drought and using more efficient irrigation methods. The article stresses how important it is to invest more in sustainable farming practices, have stronger government backing, and implement strong policy initiatives. This study seeks to support the sustainability and prosperity of India's farming sector by offering thorough policy recommendations and identifying future research directions. The goal is to build agricultural systems that are resilient enough to resist the negative impacts of climate change.

Keywords: Climate Change, Livelihood of Farmers, Agricultural Productivity, Sustainable Agriculture, Adaptation Strategies, Crop Yields

Introduction

One of the most pressing issues of this century, climate change is having far-reaching consequences for agricultural practices across the globe. An important part of India's economy that provides jobs for millions of people is agriculture, which is suffering an outsized impact from climate change. Extreme weather occurrences, shifts in precipitation patterns, and changes in average temperature like droughts and floods are impacting the country's varied climatic zones. These zones extend from the tropical climes of Kerala to the driest parts of Rajasthan. The majority of farmers are smallholders, and these changes are making their already precarious situation even worse. The agricultural sector in India has always been particularly vulnerable to climatic fluctuations because of its reliance on the monsoon season. The disturbing tendency of unpredictable rainfall and extended dry spells in recent trends has a direct impact on soil fertility and crop output. Declining salaries, worsening rural poverty, and people fleeing to cities in quest of better economic opportunities are some of the serious social and economic effects. This paper seeks to offer a thorough examination of the effects of climate change on the economic and social aspects of farmers' livelihoods in India. By employing a mixed-methods strategy, it integrates numerical data derived from agricultural and meteorological reports with qualitative insights derived from interviews with farmers worldwide. Use of drought-resistant crop varieties, improved irrigation methods, and government assistance programmes are some of the adaptation tactics and coping mechanisms discussed in the study. In addition, it takes a look at the institutional solutions and regulations that have already been put in place to try to lessen the impact of climate change on farming. Improved policy interventions, more funding for sustainable farming practices, and more resilient agricultural systems are critically needed, according to the results. In light of these difficulties, the purpose of this article is to provide

some suggestions on how India's agricultural sector might adapt to climate change in a way that is both sustainable and profitable.

Review of literature

(Ahmad et al., 2011) studied "Impact of Climate Change on Agriculture and Food Security in India" and said that Greenhouse gas emissions and land use consequences are driven by climate change, according to the report, which also assesses the effects on India's agricultural sector and food security. The majority of these emissions come from agricultural activities, such as raising cattle and growing rice, which are relied upon by 55% of the population. The Intergovernmental Panel on Climate Change has recognised these as major contributors.

(Angles et al., 2011) studied "Awareness on Impact of Climate Change on Dryland Agriculture and Coping Mechanisms of Dryland Farmers" and said that Changes in the global atmosphere and the ways in which natural climatic variability are being impacted by human activities are collectively referred to as climate change. The industrialization of industrialised nations led to the growing usage of fossil fuels, which in turn caused the deforestation of developing nations. Human interference with these factors has contributed to a global temperature increase of 1.4–5.8 degrees Celsius. The Arctic and sub-Arctic regions are experiencing the most severe impacts of the changing water supplies, both above and below ground, caused by the rapid melting of glaciers and unpredictable precipitation.

(Arivudai Nambi & Sekhar Bahinipati, 2013) studied "Adaptation to Climate Change and Livelihoods: An Integrated Case Study to Assess the Vulnerability and Adaptation Options of the Fishing and Farming Communities of Selected East Coast Stretch of Tamil Nadu, India" and that In this study, we examine how vulnerable two coastal areas in the Indian state of Tamil Nadu are to the potential impacts of climate change on fishing and farming. Case study methods include in-depth interviews, focus groups, and examination of climatic data from the past. Findings provide a groundwork for understanding the scope and effectiveness of adaptation initiatives in these critical livelihood areas.

(Rautela & Karki, 2015) studied "Impact of Climate Change on Life and Livelihood of Indigenous People of Higher Himalaya in Uttarakhand, India" and said that Extreme weather events, such as heat waves, floods, and droughts, are causing widespread disruptions in the region. Even if modern life support systems are improving, there is a continued need for scientific and technological knowledge as well as additional study.

(Bhatta et al., 2015) studied "Livelihood diversification and climate change adaptation in Indo-Gangetic plains: implication of rainfall regimes" and said that Studying the Indo-Gangetic Plains allows us to learn how household food supply, adaptability to local conditions, and livelihood diversification are impacted by climatic resources like rainfall in different places. A larger proportion of the population relies on agriculture in high rainfall regimes, whereas a larger proportion relies on non-farming sources in medium rainfall regimes. The study concluded that both climatic and non-climatic aspects should be included in livelihood and adaptation measures.

(P & A, 2016) studied "Farmers' perceptions of climate change and the proposed agriculture adaptation strategies in a semi-arid region of south India" and said that For farmers in particular, climate change poses a serious threat to their livelihoods and the agricultural sector as a whole. Climate variability, including rising temperatures, delayed beginning, intermittent dry spells, and decreased soil moisture, is seen by farmers in India as a critical factor affecting their crop, according to a 2012 study. While some farmers have begun growing crops with shorter growing seasons, others have begun to leave more land fallow and have stopped producing large amounts of cereal. According to the research, site-specific policies and initiatives should take into account the unique adaptation requirements of farmers.

(Raghuvanshi, 2017) studied "A Study of Farmers' Awareness About Climate Change and Adaptation Practices in India" and said that A hundred and ten farmers in the Indian state of Uttarakhand are aware that the weather is changing; the main signs of this change are higher temperatures, decreased agricultural output, and more erratic rainfall. Among the major consequences mentioned were floods, migration, and agricultural failures. The findings can be useful for policymakers, mitigation strategy developers, and adaptation technique creators in the context of agricultural development.

(Kumar et al., 2018) studied "Climate change consequences and its impact on agriculture and food security" and said that Because of climate change and its consequences on food insecurity and malnutrition, extreme weather events make the risks of hunger even more severe. Extreme weather is becoming more often, and it is already affecting people's capacity to earn a livelihood and provide for their families. The destruction of food supply, buildings, and other communal assets by natural disasters has the ability to worsen poverty. Alterations to agricultural yields, glacier melting, and increasing sea levels are further elements influencing food security. Future climate change may cause crop prices to rise, which could lead vulnerable communities to reduce their income or resort to harmful coping techniques.

(Funk et al., 2020) studied "Changing climate - Changing livelihood: Smallholder's perceptions and adaption strategies" and said that Reduced precipitation has prompted farmers in Kerala to embrace technological solutions, crop diversity, cooperatives, and soil conservation as means of coping with climate change. Gender, age, education, farm size, and financial situation are some of the elements that influence their decisions.

(R. K. Singh et al., 2020) studied "Perceived Climate Variability and Compounding Stressors: Implications for Risks to Livelihoods of Smallholder Indian Farmers" and said that This research aims to investigate the coping

mechanisms employed by small-holder farmers in the Azamgarh area, located in the eastern Uttar Pradesh region of India, in relation to climate variability and other stresses. Information gathered from eighty-four farmers suggests that fewer regular and more erratic rainstorms are challenging their dominance. Climate variability is the most important issue since it worsens environmental, socioeconomic, and political problems. The study's authors suggest rethinking what constitutes "normal" and "drought" precipitation by reusing the idea that evenly distributed rain is essential to farmers' harvests.

(S. Singh, 2020) studied "Farmers' perception of climate change and adaptation decisions: A micro-level evidence from Bundelkhand Region, India" and said that Findings from this study provide light on why farmers in India's arid Bundelkhand region are looking for affordable ways to adapt to climate change. The research indicates that farmers' livelihoods are greatly affected by changes in rainfall and temperature. Their low livelihood status, limited irrigation area, and lack of employment possibilities all contribute to their precarious financial situation. Positive factors include insurance and financing, and profitable crop varieties that mature early and use less water.

(Das & Ansari, 2021) studied "The nexus of climate change, sustainable agriculture and farm livelihood: contextualizing climate smart agriculture" and said that In order to mitigate the effects of climate change on agricultural livelihoods and food security, this article lays out a thorough plan for Climate Smart Agriculture (CSA) that combines scientific approaches with conventional agricultural knowledge and new institutional frameworks.

(Venus et al., 2022) studied "Livelihood vulnerability and climate change: a comparative analysis of smallholders in the Indo-Gangetic plains" and said that According to the Livelihood Vulnerability Index, which compares the two Indian districts of Vaishali and Karnal, the former is at more risk from the consequences of global warming. The sensitive decision-makers among us should put conservation agriculture, information and communication technology (ICT) training, and livelihood diversification at the top of our list of priorities when allocating funds for infrastructure projects. Sustainable growth and mitigating climate change are both aided by this.

Importance of Agriculture in India

India's agricultural sector is crucial for its economy, employing over half of its workforce and contributing significantly to GDP. It provides food security and raw materials, supporting millions of smallholder farmers. India's diverse agricultural landscape impacts rural life, celebrations, and traditions. However, challenges like landholding dispersion, inadequate infrastructure, and climate change threaten productivity and sustainability. Addressing these issues through sustainable practices, technological innovations, and supportive policies is essential for enhancing agricultural resilience and driving economic growth.

Vulnerability of Indian Agriculture to Climate Change

Climate change is posing a significant threat to India's agricultural sector due to its reliance on smallholder farmers and monsoon rains. Frequent and severe weather events, such as floods, droughts, and cyclones, negatively impact crop yields, soil fertility, and water availability, putting millions of farmers' livelihoods and food security at risk. Smallholder farmers, who often lack access to advanced technology, financial resources, and insurance programs, are particularly vulnerable. Climate change also leads to reduced revenues, increased rural poverty, and migration, affecting traditional farming practices. To address these vulnerabilities, India needs to adopt climate-resilient crop varieties, improve irrigation methods, and strengthen agricultural extension services.

Impact on Crop Yields and Agricultural Output

Climate change is significantly impacting India's agricultural production and crop yields, threatening the country's food supply and economy. Global warming has increased variability in crop yields, leading to increased frequency of severe weather events like floods, droughts, and cyclones. Rising temperatures can decrease harvest yields, disrupting planting and harvesting schedules. Unpredictable rainfall patterns can cause waterlogging or drought, affecting crops like rice and lentils. Extreme weather events also cause physical crop damage, soil erosion, and fertility loss.

Adaptation plans must be tailored to regional differences to mitigate the long-term effects of climate change. Improving irrigation methods, spreading climate-resilient crop types, and implementing sustainable farming practices are urgently needed. Governments should prioritize infrastructural improvements, financial aid, and comprehensive insurance coverage to help farmers weather climate-related storms.

Climate Change and Agriculture in India

The agricultural industry, which provides food and income for millions of people in India, is facing increasing pressure from climate change. Climate change is threatening agricultural sustainability and productivity due to rising temperatures, changing precipitation patterns, and more frequent extreme weather events.

Rising Temperatures: Climate change's rise in average temperatures can accelerate crop maturation, reduce growing period duration, and negatively impact yields, particularly in wheat, which can be significantly reduced by up to 10%.

Altered Precipitation Patterns: India's agriculture relies heavily on monsoon rains, which are becoming increasingly erratic due to climate change. However, these rains can alter planting and harvesting schedules, leading to severe droughts or floods.

Extreme Weather Events: Extreme weather events are causing crop failure, soil erosion, and farmland loss, causing water shortages and impacting crop irrigation during droughts.

Regional Variations: Climate change impacts agriculture differently across India, necessitating region-specific adaptation strategies. Northern India faces rising winter temperatures, while southern India faces heat stress and water scarcity.

Socio-Economic Impacts: Climate change significantly impacts agriculture, leading to reduced crop yields, increased rural poverty, and migration to urban areas. Smallholder farmers, particularly those without advanced technologies or financial resources, are particularly vulnerable.

Pest and Disease Dynamics: Climate change impacts agricultural output by promoting pest and disease proliferation, necessitating pest control measures, and potentially reducing crop quality and quantity.

Adaptation and Mitigation Strategies: Climate change requires a comprehensive strategy, including crop varieties, irrigation, and sustainable farming practices. Government should prioritize infrastructure improvements, financial aid, and insurance coverage. Funding studies on climate change's impact on agriculture is crucial for Indian farmers' livelihoods.

Livelihood of Farmers

The livelihood of farmers in India is intricately tied to the agricultural sector, which forms the backbone of the rural economy and sustains a significant portion of the population. However, the changing climate poses serious threats to the sustainability of farming livelihoods, exacerbating existing vulnerabilities and creating new challenges.

Economic Impact: Climate change is affecting agricultural production, causing crop failures and decreased output due to unpredictable weather patterns. This instability leads to economic hardship for farmers, perpetuating poverty and indebtedness, especially for smallholders.

Social Impact: Climate change causes economic instability, forcing farmers to migrate to urban areas for employment, disrupting communities, separating families, and causing loss of traditional farming knowledge and skills.

Health and Well-being: Climate change and farming stress negatively impact farmers' health, leading to financial insecurity, anxiety, depression, and physical health problems, reducing their ability to work and earn a living.

Coping Mechanisms: Farmers face challenges in farming, adopting coping strategies like resilient crop varieties, improved irrigation, and income diversification. Government schemes support resilience, but limited awareness in remote areas.

Government and Institutional Support: India's government has implemented climate change adaptation programs, including crop insurance, sustainable farming practices, and financial subsidies, such as PMFBY and NMSA, to support farmers and promote resilience in agriculture.

Technological Innovations: Farmers must adopt new technology like mobile-based advisory services, weather forecasting systems, and precision farming to make better decisions, use resources, and mitigate climate variability risks, despite high prices, technical understanding, and limited access in rural areas.

Policy and Institutional Responses

The Indian government, along with various institutions, has recognized the urgent need to address the impacts of climate change on agriculture and the livelihoods of farmers. Several policy measures and institutional initiatives have been implemented to enhance the resilience of the agricultural sector and support farmers in adapting to changing climatic conditions.

National Action Plan on Climate Change (NAPCC): The National Action Plan on Climate Change (NAPCC) in India, launched in 2008, outlines eight national missions, with the National Mission for Sustainable Agriculture (NMSA) focusing on climate-resilient farming practices.

Pradhan Mantri Fasal Bima Yojana (PMFBY): PMFBY, introduced in 2016, offers crop insurance to farmers, providing financial support in case of crop failure, promoting innovative farming practices, and ensuring stability.

Soil Health Card Scheme: The 2015 initiative offers farmers soil health cards with nutrient status information and fertilizer dosage recommendations, aiming to improve soil fertility, crop yields, and reduce farming practices' environmental impact.

Paramparagat Krishi Vikas Yojana (PKVY): This program promotes organic farming through the adoption of traditional agricultural practices and the use of organic inputs. PKVY aims to improve soil health, reduce farmers' dependence on chemical fertilizers and pesticides, and enhance the resilience of farming systems to climate variability.

National Adaptation Fund for Climate Change (NAFCC): NAFCC, established in 2015, funds state-level climate resilience projects, focusing on water management, climate-resilient crops, and infrastructure strengthening, ensuring widespread benefits through scalable and replicable initiatives.

Krishi Vigyan Kendras (KVKs): KVKs are agricultural extension centers that provide training, demonstrations, and advisory services on climate-smart practices, pest management, and resource efficiency, bridging the gap between research institutions and farmers.

Collaborative Research and Development: The Indian government collaborates with international organizations and research institutions to advance climate-resilient agriculture, focusing on developing and disseminating climate-resilient crop varieties, improving water management, and enhancing agricultural productivity.

Methodology

The effects of climate change on Indian farmers' incomes are examined in this study using a quantitative strategy. Quantitative data were gathered from meteorological records and agricultural reports to analyze trends in temperature, precipitation, and crop yields.

For collection of data, a self-administered questionnaire is used, having demographic questions and questions based upon 5 Likert Scale. Additionally, for determining the impact of climate change on livelihood of farmers, we have used regression analysis using SPSS V27.

Data analysis

Age					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Under 20	68	27.2	27.2	27.2
	20-29	52	20.8	20.8	48.0
	30-39	39	15.6	15.6	63.6
	40-49	26	10.4	10.4	74.0
	50-59	26	10.4	10.4	84.4
	60 and above	39	15.6	15.6	100.0
Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	166	66.4	66.4	66.4
	Female	84	33.6	33.6	100.0

The demographic analysis of the survey respondents reveals a diverse age range, with the largest group being under 20 years old, accounting for 27.2% of the sample, followed by the 20-29 age group at 20.8%. The age groups of 30-39 and 60 and above each constitute 15.6%, while the 40-49 and 50-59 categories both represent 10.4%. This distribution suggests a relatively young sample with significant representation from older age groups as well. Gender distribution shows a predominance of male respondents, who make up 66.4% of the sample, compared to 33.6% female respondents. This demographic profile indicates a gender imbalance and highlights the importance of considering age and gender differences in understanding the impacts of climate change on the farming community.

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Climate change has significantly reduced my crop yields	66 (26.4%)	68 (27.2%)	54 (21.6%)	38 (15.2%)	24 (9.6%)
I face financial instability because of climate-related crop failures	42 (16.8%)	52 (20.8%)	42 (16.8%)	90 (36.0%)	24 (9.6%)
The cost of farming inputs (seeds, fertilizers, etc.) has increased due to climate change	24 (9.6%)	49 (19.6%)	12 (4.8%)	111 (44.4%)	54 (21.6%)
Climate change has made it difficult to secure loans for farming	25 (10.0%)	50 (20.0%)	41 (16.4%)	84 (33.6%)	50 (20.0%)
I have started using drought-resistant crop varieties	42 (16.8%)	28 (11.2%)	42 (16.8%)	100 (40.0%)	38 (15.2%)

The survey responses indicate a mixed impact of climate change on various aspects of farming. A notable portion of farmers (53.6%) disagree or strongly disagree that climate change has significantly reduced their crop yields, though 24.8% agree or strongly agree with this statement. Financial instability due to climate-related crop failures is a significant issue, with 45.6% of farmers agreeing or strongly agreeing, while 37.6% disagree or strongly disagree. The majority (66%) of respondents agree or strongly agree that the cost of farming inputs has increased due to climate change, highlighting a widespread concern. Securing loans has also been challenging, with 53.6% agreeing or strongly agreeing that climate change has made it difficult,

though 30% disagree. On a positive note, 55.2% of farmers have started using drought-resistant crop varieties, indicating a proactive adaptation strategy, while 28% disagree or remain neutral.

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I have adopted advanced irrigation techniques to cope with water scarcity	42 (16.8%)	52 (20.8%)	42 (16.8%)	90 (36.0%)	24 (9.6%)
I have diversified my farming practices to reduce climate risks	24 (9.6%)	49 (19.6%)	12 (4.8%)	111 (44.4%)	54 (21.6%)
Government insurance schemes like PMFBY have been helpful in mitigating losses	25 (10.0%)	50 (20.0%)	41 (16.4%)	84 (33.6%)	50 (20.0%)
I am aware of government initiatives promoting sustainable agriculture	42 (16.8%)	28 (11.2%)	42 (16.8%)	100 (40.0%)	38 (15.2%)
I have received adequate support from local agricultural extension services	25 (10.0%)	50 (20.0%)	41 (16.4%)	84 (33.6%)	50 (20.0%)

The survey responses reveal various adaptive measures and perceptions among farmers regarding climate change and institutional support. A significant number of farmers (45.6%) have adopted advanced irrigation techniques to cope with water scarcity, while 37.6% have not. Diversifying farming practices to reduce climate risks is common, with 66% agreeing or strongly agreeing to this approach, whereas 29.2% disagree or remain neutral. Government insurance schemes like PMFBY are seen as helpful by 53.6% of respondents, but 30% disagree or strongly disagree. Awareness of government initiatives promoting sustainable agriculture is relatively high, with 55.2% agreeing or strongly agreeing, while 28% are unaware or neutral. Adequate support from local agricultural extension services is acknowledged by 53.6% of farmers, though 30% feel they do not receive sufficient support.

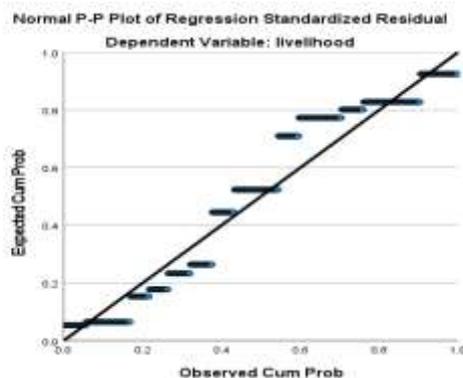
Regression Analysis:

Model Summary ^b				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.884 ^a	.781	.780	.42315
a. Predictors: (Constant), Climate change				
b. Dependent Variable: livelihood				

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	158.527	1	158.527	885.342	.000 ^b
	Residual	44.406	248	.179		
	Total	202.933	249			
a. Dependent Variable: livelihood						
b. Predictors: (Constant), Climate change						

The model summary provided illustrates a regression analysis examining the relationship between climate change and livelihood. With an R-square value of .781, indicating a strong correlation, the model suggests that approximately 78.1% of the variability in livelihood can be explained by changes in climate.

The ANOVA table presented summarizes the analysis of variance for the regression model, focusing on the impact of climate change on livelihood. The table indicates that the regression model is highly significant ($p < .000$), as evidenced by the F-statistic of 885.342, with one degree of freedom for the predictor variable "Climate change." This suggests that the variability in the dependent variable, livelihood, is largely explained by the predictor variable, supporting the notion that climate change significantly influences livelihood outcomes. The sum of squares for regression (158.527) compared to the residual sum of squares (44.406) further emphasizes the substantial contribution of the predictor variable in explaining the variance in livelihood.



Conclusion

Reduced agricultural production and crop yields are two ways in which climate change is negatively affecting the livelihoods of farmers in India, according to the report. As a result, there is now economic uncertainty, widespread poverty in rural areas, and a surge in forced migration. Efforts such as cultivating crops that are resistant to drought and implementing new irrigation systems are impeded by a lack of funding and technical expertise. To lessen the impact of climate change on India's agricultural sector, a well-rounded strategy is required, including strong legislative interventions, more funding for sustainable practices, and improved support networks.

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