



## A Study on Effects of Climate Change in Indian Agriculture

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### Abstract

Climate change has emerged as a critical challenge for Indian agriculture, significantly influencing crop productivity, food security, and rural livelihoods. Rising temperatures, prolonged droughts, and increasing frequency of floods have disrupted traditional farming cycles, leading to reduced yields of staple crops such as rice, wheat, and pulses. Shifts in monsoon behavior affect irrigation availability, while soil degradation and pest outbreaks further compound the risks. Small and marginal farmers, who form the backbone of Indian agriculture, are particularly vulnerable due to limited adaptive capacity and dependence on rain-fed cultivation. Addressing these challenges requires integrated strategies such as climate-resilient crop varieties, improved water management, sustainable farming practices, and policy support to safeguard farmers and ensure long-term food security in India.

**Keywords:** Adoption strategies, Climate change, Crop productivity, Food security, Indian agriculture, Livelihood vulnerabilities, Monsoon variability, Policy intervention, Rain-fed-farming, Sustainable agriculture.

### 1. Introduction

Agriculture has long been regarded as the backbone of the Indian economy, employing nearly 58 percentage of the population and contributing around 18 percentage to the national GDP. However, this vital sector is increasingly vulnerable to the adverse impacts of climate change. Rising temperatures, erratic rainfall, shifting monsoon patterns, and frequent extreme weather events such as floods and droughts have disrupted traditional farming practices. These changes not only reduce crop productivity but also threaten food security and rural livelihoods across the country. India's dependence on monsoon rains makes its agricultural system particularly sensitive to climatic fluctuations.

Variability in rainfall affects irrigation, soil fertility, and crop cycles, leading to reduced yields of staple crops such as rice, wheat, and pulses. Moreover, climate change exacerbates pest infestations and plant diseases, further undermining agricultural sustainability. These multidimensional challenges highlight the urgent need for adaptation strategies, including climate-resilient crop varieties, improved water management, and sustainable farming practices. Beyond crop production, climate change also impacts allied sectors such as livestock, fisheries, and horticulture.

Heat stress reduces livestock productivity, while rising sea levels and changing water temperatures affect coastal

fisheries. Government policies and institutional support play a crucial role in mitigating risks and ensuring long-term food security. Thus, the effect of climate change on Indian agriculture is not merely an environmental issue but a socio-economic challenge that demands integrated solutions. Addressing it requires a combination of scientific innovation, policy intervention, and grassroots resilience to safeguard the livelihoods of millions and secure India's agricultural future.

### 2. Statement of the Problem

Indian agriculture, which sustains the majority of the population and contributes significantly to the national economy, is facing unprecedented challenges due to climate change. The increasing variability of monsoon rains, rising temperatures, frequent droughts, floods, and extreme weather events have disrupted traditional farming practices and reduced crop productivity. These climatic shifts not only threaten food security but also intensify the vulnerability of small and marginal farmers who depend largely on rain-fed cultivation. The problem is compounded by inadequate adaptation measures, limited access to technology, and insufficient policy implementation, leaving farmers ill-equipped to cope with changing conditions. The central problem, therefore, lies in the urgent need to understand the multidimensional impacts of climate change on Indian

agriculture and to develop sustainable, resilient strategies that can safeguard both productivity and the socio-economic well-being of farming communities.

### 3. Review of Literature

Aggarwal, P.K. (2008) in his work underscores the systemic risks posed by climate change to food security. He discusses simulation models predicting yield declines in rice and wheat, and stresses the importance of integrated adaptation strategies including crop diversification and water-use efficiency<sup>[1]</sup>.

Mall, R.K.; Gupta, A.; Singh, R.; Singh, R.S.; Rathore, L.S. (2006) in the authors analyze regional climate projections and their implications for agriculture. They conclude that extreme weather events, particularly droughts and floods, will intensify, thereby affecting both productivity and farmer livelihoods. They advocate for early warning systems and climate-resilient infrastructure<sup>[3]</sup>.

Sinha, S.K.; Swaminathan, M.S. (1991) in his work was among the earliest to warn about the vulnerability of Indian agriculture to global warming. The authors predicted yield reductions in wheat and rice due to temperature rise and highlighted the need for long-term policy frameworks to safeguard food security<sup>[2]</sup>.

### 4. Research Gap of Study

Although numerous studies have examined the impact of climate change on Indian agriculture, most existing research has focused either on broad climatic trends or on specific crop yield simulations. Much of the literature emphasizes rice and wheat productivity, while less attention has been given to diverse crops, regional variations, and allied sectors like livestock and fisheries. Furthermore, while adaptation strategies such as climate-resilient seeds and water management have been discussed, there is insufficient empirical evaluation of their effectiveness at the grassroots level. This gap highlights the need for a comprehensive study that bridges legal analysis with field-based evidence, thereby offering a holistic understanding of how climate change affects Indian agriculture and what sustainable interventions can be implemented to protect farmer livelihoods and national food security.

### 5. Objective of the Study

- i). To find out the socio-economic vulnerabilities of small and marginal farmers arising from climatic variations, and sustainable adaptation strategies and policy interventions that can safeguard agriculture and rural livelihoods.
- ii). Analysis of the impact of climate change on crop productivity and food security in India and policy interventions that can safeguard agriculture and rural livelihoods.
- iii). To examine impact of climate change on Indian agriculture, including its effects on crop productivity, farmer livelihoods, and the effectiveness of adaptation strategies.
- iv). To evaluate climate change influences agricultural systems in India by examining its effects on crop productivity, rural livelihoods, and the resilience of farming practices.
- v). To understand the multifaceted impact of climate change on Indian agriculture by exploring its influence on crop productivity, farmer livelihoods, and rural sustainability, while also examining the effectiveness of policy measures designed to safeguard food security.

- vi). To suggest practical measures for addressing the impact of climate change on Indian agriculture by identifying its effects on crop productivity and ensure long-term food security.

### 6. Methodology

This research is based on both doctrinal and non-doctrinal research. The sources of data collected from different newspaper, journals, magazines, AIR and e-sources. This research is used to stratified random sampling. There are 160 sample size of the respondent is used. In this research adopted some of the statistical tool such as percentage and average method. The duration of research is three months.

### 7. Significance of the Study:

The study is significant for the government as it provides a comprehensive understanding of how climate change directly affects agricultural productivity, food security, and rural livelihoods in India. By analyzing both scientific data and socio-economic realities, the research highlights the urgent need for policy interventions that address regional disparities in climate vulnerability. This helps the government prioritize resources and design location-specific strategies that can strengthen resilience in the agricultural sector. Insights from the research can guide the government in expanding crop insurance schemes, improving access to credit, and promoting climate-resilient seeds and farming practices.

Ultimately, the study serves as a valuable tool for the government to strengthen agricultural resilience, safeguard food security, and promote sustainable rural development. It bridges the gap between scientific research and practical policymaking, enabling the government to take informed decisions that benefit both farmers and the nation as a whole.

This study is significant for you as it deepens your understanding of how climate change affects Indian agriculture, enabling you to connect theoretical knowledge with practical realities. By engaging with both doctrinal sources such as laws, policies, and institutional frameworks, and non-doctrinal evidence like farmer experiences and field data, you strengthen your analytical and comparative skills. The research process enhances your ability to synthesize complex information into clear, exam-ready notes and structured arguments, which directly supports your academic preparation.

### 8. Hypothesis of the Study

- H1:** Climate change is affecting productivity of agriculture.  
**H2:** Climate change is a serious threat to India's food security.

### 9. Limitation of the Study

The present study is limited by its reliance on secondary data sources such as government reports, meteorological records, and published literature, which may not fully capture the most recent or localized impacts of climate change on agriculture. Field surveys and farmer interviews, though valuable, are restricted to selected regions and therefore may not represent the diverse agricultural practices and climatic variations across the entire country. In addition, the study focuses primarily on crop productivity and farmer livelihoods, leaving out allied sectors such as fisheries and livestock that are also affected by climate change. Finally, the study does not account for long-term projections beyond the available data, which limits its ability to predict future scenarios with complete accuracy.

## 10. Result and Discussion

### Part-I: Doctrinal Research

Climate change has emerged as one of the most pressing global challenges, with agriculture being among the most vulnerable sectors. Agriculture in India is highly climate-sensitive, as it depends on monsoons, seasonal rainfall, and temperature stability for crop productivity. Over the past century, India has experienced a rise in average surface temperature of about 0.51°C, with projections suggesting accelerated warming in the coming decades. This warming trend, coupled with erratic rainfall and increasing frequency of extreme weather events, poses serious risks to food security and rural livelihoods.

The agricultural sector contributes significantly to India's economy and employs nearly half of the population, making it central to socio-economic stability. However, climate change disrupts traditional farming cycles, reduces soil fertility, and increases water stress, leading to declining yields in staple crops such as rice and wheat.

Beyond crop productivity, climate change also affects farmer livelihoods, rural employment, and the broader agrarian economy. Small and marginal farmers, who form the majority in India, face heightened risks due to limited access to irrigation, credit, and modern technology. The government has recognized these challenges through initiatives like the National Action Plan on Climate Change (NAPCC) and its agricultural missions, which aim to promote climate-resilient practices and sustainable resource management.

Thus, the intersection of climate change and agriculture is not merely an environmental issue but a socio-economic and legal concern. It requires doctrinal analysis of policies, laws, and institutional frameworks, alongside empirical evidence, to understand how India can safeguard food security and rural livelihoods in the face of climatic uncertainty<sup>[4]</sup>.

**Concept and Scope:** The scope of doctrinal research is broad, as it allows the researcher to explore legal frameworks, policy documents, and institutional mechanisms that govern agricultural resilience in India. It involves studying the National Action Plan on Climate Change (NAPCC), state-level agricultural missions, and judicial pronouncements that interpret environmental rights under Article 21 of the Constitution. Doctrinal research also extends to comparative analysis, enabling scholars to evaluate how international conventions such as the Paris Agreement and global best practices influence Indian agricultural policies.

By synthesizing these sources, doctrinal research provides a structured and authoritative foundation for understanding the legal dimensions of climate change in agriculture. Its scope is not limited to identifying gaps in law but also includes suggesting reforms, clarifying ambiguities, and strengthening the coherence between environmental sustainability and agricultural development. Thus, doctrinal research serves as the backbone of this study, offering a rigorous legal perspective that complements empirical findings and ensures that recommendations are firmly grounded in established legal principles<sup>[5]</sup>.

#### Impact of Climate Change on Crop Productivity:

Agriculture in India is highly climate-sensitive, and crop productivity is directly influenced by variations in temperature, rainfall, and extreme weather events. Climate change has already begun to alter traditional farming cycles, leading to reduced yields in several staple crops. Rising average temperatures shorten crop growing periods, particularly affecting Rabi crops such as wheat, which require cooler conditions. Studies indicate that a 1°C increase in

temperature may reduce wheat yields by 4–5 percentage, posing a serious threat to food security.

Rainfall variability is another critical factor. The Indian monsoon, which sustains nearly 60 percentage of agricultural activity, has become increasingly erratic, with delayed onset, uneven distribution, and frequent droughts or floods. These changes disrupt sowing patterns, damage standing crops, and reduce soil moisture, thereby lowering productivity. Crops such as rice, pulses, and oilseeds are particularly vulnerable to irregular rainfall and water stress.

Extreme weather events such as cyclones, heatwaves, and unseasonal rains further compound the problem. For instance, unseasonal rainfall during harvest periods often leads to crop losses, while prolonged droughts reduce yields and force farmers to abandon cultivation. Small and marginal farmers, who lack irrigation facilities and depend on rain-fed agriculture, are disproportionately affected.

Climate change also impacts soil fertility and pest prevalence. Rising temperatures and altered humidity levels create favorable conditions for pests and diseases, increasing crop damage. In addition, excessive use of chemical fertilizers to compensate for declining yields contributes to soil degradation, creating a vicious cycle of reduced productivity.

The cumulative effect of these factors is a decline in agricultural output, threatening India's food security and rural economy. Legal and policy frameworks such as the National Mission on Sustainable Agriculture (NMSA) under the National Action Plan on Climate Change (NAPCC) aim to promote climate-resilient practices, including drought-resistant crop varieties, improved irrigation, and integrated pest management. However, the effectiveness of these measures depends on their proper implementation and accessibility to vulnerable farming communities.

Thus, the impact of climate change on crop productivity is not only an environmental concern but also a socio-economic and legal issue, requiring doctrinal analysis of policies and judicial interventions to safeguard agriculture and ensure sustainable development<sup>[6]</sup>.

**Socio-Economic Vulnerabilities of Farmers:** Farmers in India, particularly small and marginal cultivators, face significant socio-economic vulnerabilities that are aggravated by climate change. With nearly 85% of Indian farmers owning less than two hectares of land, their dependence on rain-fed agriculture makes them highly susceptible to erratic monsoons, droughts, and floods. Limited access to irrigation facilities, modern technology, and crop insurance further deepens their vulnerability, leaving them exposed to crop failures and income instability.

Economic insecurity is compounded by rising input costs for seeds, fertilizers, and pesticides, which often force farmers into debt. The lack of institutional credit pushes many towards informal moneylenders, creating cycles of indebtedness and poverty. Climate-induced crop losses intensify this burden, leading to distress migration and, in extreme cases, farmer suicides. These vulnerabilities highlight the intersection of environmental stress with socio-economic fragility.

The legal and policy framework attempts to address these vulnerabilities through initiatives such as the Pradhan Mantri Fasal Bima Yojana (PMFBY), rural employment schemes, and subsidies for climate-resilient technologies. Judicial interventions have occasionally emphasized the need for farmer protection, linking agricultural distress to the constitutional right to livelihood under Article 21.

**Legal Policy:** India has developed a multi-layered legal and policy framework to address the challenges posed by climate

change, particularly its impact on agriculture and rural livelihoods. At the constitutional level, Article 21 guarantees the right to life, which the Supreme Court has interpreted to include the right to a clean and healthy environment. Article 48A (Directive Principles of State Policy) directs the State to protect and improve the environment, while Article 51A(g) imposes a duty on citizens to safeguard natural resources. These constitutional provisions form the foundation for India’s climate-related legal measures.

The Environment Protection Act, 1986 serves as the umbrella legislation empowering the central government to take measures for environmental protection and climate resilience. Complementary laws such as the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981.

- i). Institutionalize climate-smart standards within existing schemes (NMSA, PMKSY) using measurable indicators—soil organic carbon, water-use efficiency, and yield stability.
- ii). Align incentives with resilience outcomes link subsidies and credit to practices like diversified rotations, micro-irrigation, and agroforestry rather than inputs alone.

**Case Laws:**

**i). T.N. Godavarman Thirumulpad v. Union of India (1995):** T.N. Godavarman, a former zamindar from Tamil Nadu, filed a PIL highlighting large-scale deforestation and illegal timber felling in the Nilgiris. He argued that forests across India were being destroyed due to weak enforcement of laws. Whether the term “forest” should be interpreted broadly to include all areas that fit the dictionary meaning of forest, not just those officially notified under the Forest Act?. The Supreme Court gave a continuing mandamus (an ongoing order) and held that The term “forest” must be understood in its dictionary sense, covering all forest-like areas. Strict restrictions were imposed on deforestation, tree felling, and use of forest land for non-forest purposes. The Court expanded the scope of forest conservation under the Forest (Conservation) Act, 1980 [7].

**ii). Delhi Air Pollution & Stubble Burning PILs (2015):** Several PILs were filed in the Supreme Court and National Green Tribunal (NGT) highlighting severe air pollution in Delhi NCR. A major cause identified was stubble burning by farmers in Punjab and Haryana after harvesting paddy, which released massive smoke and worsened smog conditions. Whether the government and states were failing in their duty to control air pollution and crop residue burning, thereby violating citizens’ right to clean air under Article 21?. The Supreme Court and NGT directed Punjab, Haryana, Uttar Pradesh, and Delhi governments to take strict measures against stubble burning. Ordered promotion of alternatives like Happy Seeder machines and subsidies for eco-friendly farming practices. Recognized that unchecked stubble burning contributes to climate change, soil degradation, and health hazards, making it a violation of fundamental rights [8].

**iii). Ridhima Pandey v. Union of India (2017):** Ridhima Pandey, a 9-year-old girl from Uttarakhand, filed a PIL in the Supreme Court (with NGO support) arguing that the government was failing to take adequate steps against climate change. She pointed out that deforestation, pollution, and greenhouse gas emissions were worsening

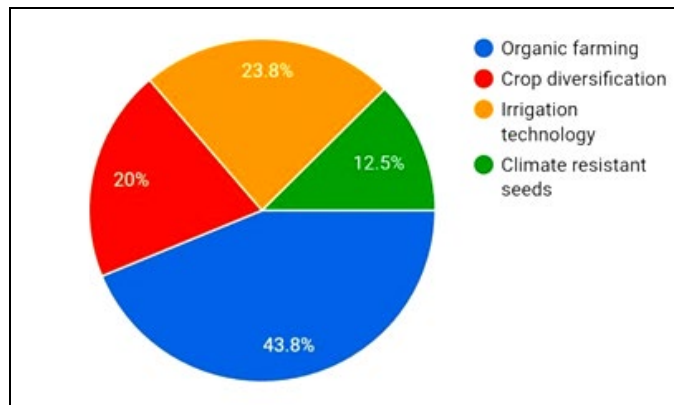
floods and droughts, directly harming communities and agriculture. whether the government’s inaction on climate change violated citizens’ fundamental right to life under Article 21, especially for vulnerable groups like children and farmers?. The Supreme Court admitted the petition but did not pass a detailed ruling. Instead, it directed the government to strengthen climate policies and submit reports on compliance with environmental laws and international commitments (like the Paris Agreement). The case highlighted that climate change is a rights issue in India [9].

**Part-II: Non-Doctrinal Research**

**Table1:** Adopted methods using Agriculture

Particulars	Male	Female	Transgender	Total
Organic farming	28(17.5)	42(26.25)	0(0.00)	70(43.75)
Crop Diversification	20(12.5)	12(7.5)	0(0.00)	32(20.00)
Irrigation Technology	21(13.13)	17(10.63)	0(0.00)	38(23.75)
Climate Resistant Seeds	10(6.25)	10(6.25)	0(0.00)	20(12.5)
Total	79(49.38)	81(50.63)	0(0.00)	160(100)

*Source: Primary data*

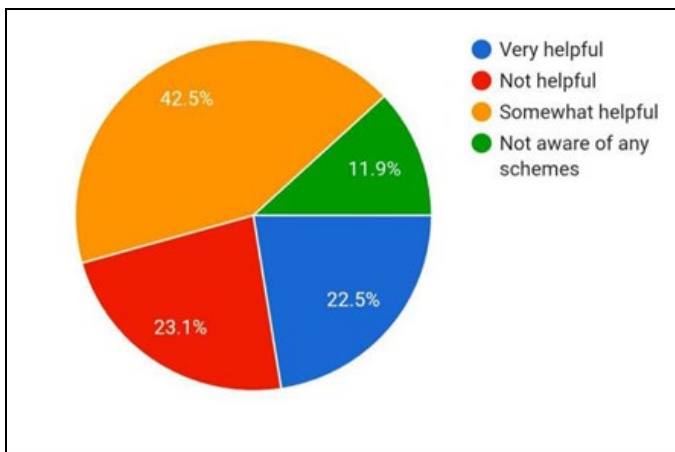


The data shows that organic farming is the most widely adopted climate adaptation method, accounting for 43.75 percentage of the sample, with female respondents 26.25 percentage showing stronger participation than males (17.5%). Irrigation technology ranks second at 23.75 percentage of the respondent, reflecting investments in water management, while crop diversification follows at 20 percentage, highlighting efforts to reduce risks and enhance resilience. Climate-resistant seeds are used by only 12.5 percentage of respondents, equally split between males and females, indicating limited adoption despite their importance. Overall, the gender distribution is nearly balanced, with 49.38 percentage of the male respondent and 50.63 percentage of the female respondents, suggesting both groups are actively engaged in sustainable agricultural practices.

**Table 2:** Government schemes are helpful in dealing with climate change

Particulars	Male	Female	Transgender	Total
Very helpful	19(11.87)	17(10.63)	0(0.00)	36(22.5)
Not Helpful	24(15.00)	13(8.13)	0(0.00)	37(23.13)
Somewhat Helpful	31(19.37)	37(23.13)	0(0.00)	68(42.5)
Not aware of any schemes	5(3.13)	14(8.75)	0(0.00)	19(11.87)
Total	79(49.38)	81(50.63)	0(0.00)	160(100)

*Source: Primary data*

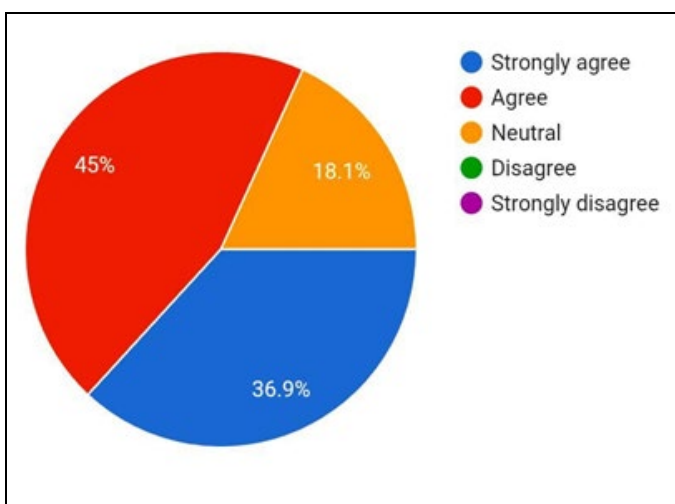


Among the respondents, 42.5 percentage of the respondent feel government schemes are somewhat helpful, showing moderate confidence in climate programs. A smaller group, 22.5 percentage of the respondent, finds them very helpful, reflecting positive perceptions among some. Meanwhile, 23.13 percentage of the respondent consider schemes not helpful, indicating skepticism or dissatisfaction. Notably, 11.87 percentage of the respondent are unaware of such schemes, especially females 8.75 percentage of the respondent, pointing to communication gaps.

**Table 3:** Climate Change is Affecting Productivity of Indian Agriculture

Particulars	Male	Female	Transgender	Total
Strongly Agree	29(18.13)	30(18.75)	0(0.00)	59(36.87)
Agree	34(21.25)	38(23.75)	0(0.00)	72(45.00)
Neutral	16(10.00)	13(8.13)	0(0.00)	29(18.13)
Disagree	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Strongly Disagree	0(0.00)	0(0.00)	0(0.00)	0(0.00)

Source: Primary data

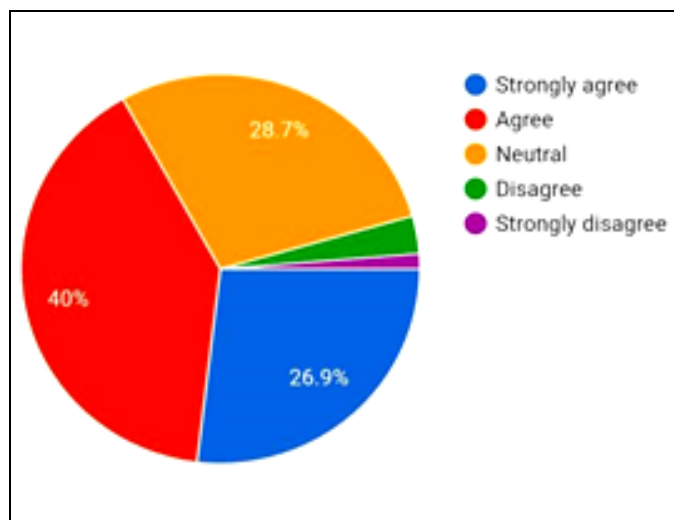


The table shows that most respondents believe climate change is affecting Indian agriculture. A majority, 81.87 percentage of the respondent, either strongly agree 36.87 percentage of the respondent or agree 45 percentage of the respondent, indicating widespread recognition of its impact. About 18.13 percentage of the respondent remain neutral, reflecting some uncertainty or lack of awareness.

**Table 4:** Climate Change is a Serious Threat to India's Food Security

Particulars	Male	Female	Transgender	Total
Strongly Agree	25(15.63)	18(11.25)	0(0.00)	43(26.8)
Agree	28(17.5)	36(22.5)	0(0.00)	64(40.00)
Neutral	23(14.37)	23(14.37)	0(0.00)	46(28.75)
Disagree	3(1.87)	2(1.25)	0(0.00)	5(3.13)
Strongly Disagree	0(0.00)	2(1.25)	0(0.00)	2(1.25)
Total	79(49.38)	81(50.63)	0(0.00)	160(100)

Source: Primary data



Among the respondents, 40 percentage of the respondent agree that climate change poses a serious threat to food security, 28 males of 17.5 percentage and 36 females 22.5 percentage. Another 26.87 percentage of the respondent strongly agree, including 25 males 15.63 percentage and 18 females 11.25 percentage, indicating that over two-thirds of the sample recognize the severity of the issue. 28.75 percentage of respondents remain neutral, equally split between males and females 23 each, suggesting uncertainty or lack of sufficient information. A small minority 3.13 percentage of the respondent are disagree and 1.25 percentage of the respondent are strongly disagree, with slightly more males expressing disagreement.

**Hypothesis Testing:**

**H1:** Climate change is affecting productivity of Indian agriculture

Table No.3 shows that A combined 81.87 percentage (Strongly Agree + Agree) of the respondents believe that climate change significantly affects Indian agriculture and that the legal framework is relevant to addressing these challenges. About 18.13 percentage of respondents remain undecided, indicating a need for greater awareness or clarity on the legal aspects of climate change in agriculture. Notably, 0 percentage disagreed or strongly disagreed, showing that there is no outright rejection of the idea among participants.

**H2:** Climate change is a serious threat to India's food security  
Table No.4 shows that Climate change undeniably threatens India's food security, but there is a positive perception of the legal framework as a necessary tool to mitigate these risks. However, the presence of neutral responses highlights the need for:

- i). Better communication and awareness of policies among farmers.
- ii). Inclusive legal reforms that address local realities.

16. *T.N. Godavarman thirumulpad v. Union of India*. 1995.
17. *Delhi Air Pollution & Stubble Burning PILs*. 2015.
18. *Ridhima Pandey v. Union of India*. 2017.

### Conclusion

The research underscores that adaptive strategies—such as climate-resilient crop varieties, improved irrigation techniques, crop diversification, and sustainable farming practices—can mitigate adverse impacts. Policy interventions, including investment in rural infrastructure, crop insurance, and farmer education, are equally critical to strengthen resilience. These changes not only threaten food security but also deepen socio-economic vulnerabilities among small and marginal farmers who form the backbone of Indian agriculture.

### Suggestions

Hereby, the research carried on some suggestions are laid down,

- i). To emphasize how climate change directly impacts rural livelihoods, crop yields, and food security.
- ii). Rural perspectives can be contrasted with urban and semi-urban responses to highlight differences in awareness and adaptation.
- iii). You can recommend policy-driven awareness campaigns targeting less educated farmers to bridge the knowledge gap.
- iv). To indicate the need for greater promotion of scientific innovations and subsidies to encourage their use.
- v). To suggest gender-sensitive policies and training programs to ensure women farmers are equally empowered in climate adaptation.

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