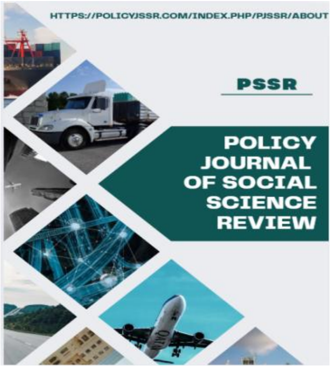
DOI: https://doi.org/10.5281/zenodo.20526156

Volume. 4, issue No. 6 (2026)



Policy Journal of Social Science Review

ISSN Online:3006-4635

ISSN Print: 3006-4627

PERCEPTION OF FARMERS ABOUT CLIMATE CHANGE AND ITS IMPACT ON CROP PRODUCTIVITY

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Article Details

Received on 12 May, 2026

Accepted on 01 June, 2026

Published on 03 June, 2026

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ABSTRACT

Climate change is a major threat to agriculture sustainability, particularly in dry and semi-arid climate like Southern Punjab, Pakistan. The purpose of this study was to assess the perceptions of farmers, climatic changes experienced by them, impacts of climatic changes on the productivity of crops, adaptation strategies adopted and constraints faced by farmers in the study area of three districts of Southern Punjab (Multan, Muzaffargarh, and Bahawalpur). The study used a quantitative cross sectional survey design and 120 farmers were sampled and primary data collected using structured questionnaire. Descriptive statistics, one-way ANOVA and Pearson correlation analysis was used. The results showed that awareness level of the farmers about climate change is high and most farmers reported an increase in summer temperature, delay in monsoon and decrease in winter temperature. The most serious threats identified are heat stress and water scarcity, and cotton is the most sensitive crop to them, followed by wheat and rice. The main adaptation options that should be considered were changing planting dates and introducing seeds with drought resistance. But there were a number of constraints that farmers experienced especially financial resources and access to information related to climate. The ANOVA result revealed that there was no significant difference in the awareness of climate change between districts, yet the perception of the impacts of climate change on productivity was significant across districts. Correlation analysis showed that education level and climate awareness were related positively while age and farming experience were related either positively or negatively with perceived yield losses. The study suggests that, while farmers are aware of climate change, and they are taking measures to cope with it, their adaptive ability is still limited due to socioeconomic and institutional factors.

Keywords: *Climate change, adaptation, farmers' perception, Southern Punjab, agriculture, Pakistan.*

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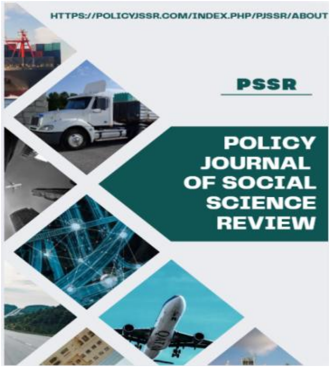

Policy Journal of Social Science Review

ISSN Online:3006-4635
ISSN Print: 3006-4627

Introduction

Climate change is one of the most pressing global challenges of the twenty first century and has significant implications for the agricultural system, rural livelihoods and food security. Global warming, changes in precipitation, more extreme weather and more climate variability, are strongly impacting crop production systems, especially in developing countries where agriculture is particularly sensitive to climate change and is resource-limited (IPCC, 2021). The region of South Asia is regarded as one of the most climate change vulnerable regions because of its large agri-dependent population, reliance on monsoon rain and low adaptive capacities (Lobell et al., 2011). In this regard, agriculture sector in Pakistan is very vulnerable to climate risks particularly in arid and semi-arid areas like Southern Punjab. In Pakistan agriculture has a key role in economy as it generates major contribution in gross domestic product (GDP), employment and food security. But the region is increasingly facing the challenges of erratic rainfall, extended droughts, heat waves, and unpredictable changes in the season. The southern part of Punjab (Multan, Muzaffargarh and Bahawalpur) is one of the key agricultural areas of the country. The area is a key cash and food crop producer of wheat, cotton, rice, maize, sugarcane, mango and date palm. Although the agriculture is important in the area, it is highly vulnerable to climate variability due to its arid climate, limited water resources, and dependence on irrigation systems that are under stress (Hussain and Mudasser, 2007). In the recent past there has been some evidence that farmers are already observing climatic changes in Pakistan such as higher temperatures, delayed monsoon rainfall and greater drought frequency. These alterations will have a direct impact on crop productivity, pest dynamics and farming decisions. Heat stress under certain critical growth phases of the crops can lead to lower wheat and cotton production, whereas water scarcity can lead to higher production and production risk and higher production costs (Ahmad et al., 2019). Likewise, shifts in temperatures and humidity contribute to the emergence and spread of new outbreaks of pests and diseases that further jeopardize agricultural productivity (Deutsch et al., 2018). Climate change has a socioeconomic dimension, as well, influencing the decisions made by farmers and their socioeconomic situation. Smallholder farmers, who make up the bulk of agricultural producers in Southern Punjab, are more susceptible because they have fewer climate information services, fewer financial resources and fewer agricultural technologies. Climate change awareness is not the only factor that influences their preparedness to respond to climate risks; they also need to be able to

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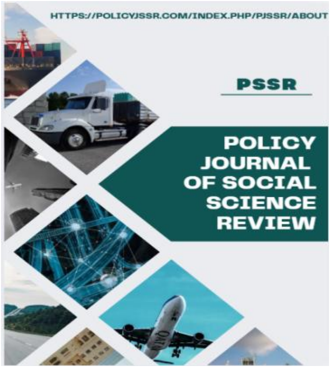

Policy Journal of Social Science Review

ISSN Online:3006-4635

ISSN Print: 3006-4627

implement effective adaptation measures, including crop diversification, adjusted planting dates, planted drought-resistant varieties, and efficient water management practices (Deressa et al., 2009). Adaptation is, however, limited by poverty, institutional weakness and poor extension service. It is important to understand the perception of farmers, as it plays a significant role in the farmer's adaptation behaviour when it comes to climate change. The recognition by farmers of the changes in weather patterns is the deciding factor on whether they are to use new technologies or traditional practices. Results indicate that farmers who find climate change a serious problem are more likely to take adaptation action than those who are less aware of the problem (Bryan et al., 2013). Thus, measuring perception is a prerequisite measure to design effective policies and interventions to adapt to climate change. Though many studies have been conducted worldwide on the impact of climate change on agriculture, there is need of empirical evidences in particular agro-ecological zones in Pakistan. The different cropping systems and different vulnerability levels in this region are worth studying, as they offer a case study for understanding farmer perceptions of climate change and how this influences farmer adaptation. Furthermore, the perception and the adaptation capacity may be significantly affected by disparities in socio-economic factors, including education level, land ownership, years of farming experience and access to information. The present study is designed to evaluate the perception of farmers on climate change, climatic changes observed by farmers, impacts of these climatic changes on crop productivity, adaptation strategies of farmers and limitations to effective adaptation in Southern Punjab. The socio-economic determinants of farmers' perception of climate change are also discussed. This research fills in the lack of empirical evidence from Multan, Muzaffargarh and Bahawalpur districts, which helps to gain knowledge about climate risk perception and adaptation practices in the agriculture sector of Pakistan.

This research will provide policy makers, extension and development service providers with benefits in the context of climate smart agriculture. Empowering farmers' adaptive capacity through specific interventions, better access to climate information, and investments in agricultural technologies that can withstand climate risks and uncertainties are key to sustaining agricultural development in the presence of climate uncertainty.

Methodology

3.1 Study Area

The present study was done in Southern Punjab region in the districts of Multan,

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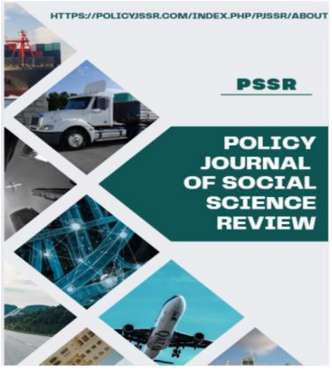

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Muzaffargarh and Bahawalpur. The selected districts were purposive as they are highly vulnerable to climate variability and crucial agricultural districts of the Punjab province. Climate conditions are dry and semi-arid with high temperature variation, frequent droughts, irregular rainfall, and the rise of extreme climates like floods and heat waves. These districts are predominantly agricultural with major crops grown including wheat, cotton, rice, maize, sugarcane, mango and date palm.

3.2 Research Design

A quantitative cross sectional survey research design was used to examine how farmers perceive climate change, its effects on crop productivity, adaptation measures and constraints. Primary data was collected from the farmers from the selected districts using a structured questionnaire.

3.3 Sampling Procedure

A multistage sampling technique was adopted for sample selection.

Stage I: Selection of Districts

Three agriculturally important districts of Southern Punjab were selected purposively:

- Multan
- Muzaffargarh
- Bahawalpur

Stage II: Selection of Respondents

From each district, 40 farmers were randomly selected, resulting in a total sample size of 120 respondents. The respondents included small, medium, and large-scale farmers involved in crop production activities.

3.4 Data Collection

Primary data were collected through face-to-face interviews using a well-structured and pre-tested interview schedule. The questionnaire was developed after reviewing relevant literature on climate change and agricultural adaptation.

The questionnaire consisted of the following sections:

1. Socio-economic characteristics of respondents
2. Farmers' awareness and perception of climate change
3. Observed changes in climatic and weather patterns
4. Perceived impacts of climate change on crop productivity
5. Pest and disease incidence due to climatic variations
6. Adaptation and coping strategies adopted by farmers
7. Constraints faced in climate change adaptation

Data collection was conducted during field visits to the selected districts.

3.5 Measurement of Variables

Dependent Variables

The major dependent variables included:

- Climate change awareness score
- Perceived crop productivity loss
- Adaptation level of farmers

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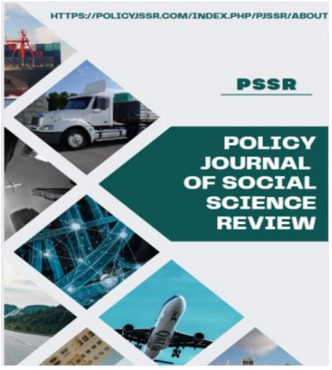

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Independent Variables

The independent variables included:

- Age
- Education level
- Farming experience
- Land holding size

The response categories were:

- Access to agricultural information

3.6 Scaling Technique

A five-point Likert scale was used to measure farmers' perceptions and awareness regarding climate change impacts.

Scale	Interpretation
1	Strongly Disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly Agree

Mean scores and standard deviations were computed to interpret respondents' opinions.

3.7 Data Analysis

The collected data were coded, entered, and analyzed using the Statistical Package for Social Sciences (SPSS).

The following statistical techniques were applied:

- Descriptive Statistics
- Frequencies
- Percentages
- Means
- Standard deviations

These were used to summarize socio-economic characteristics, adaptation strategies, and observed climatic changes.

Inferential Statistics

One-Way ANOVA

One-Way Analysis of Variance (ANOVA) was applied to compare farmers' perception scores among Multan, Muzaffargarh, and Bahawalpur districts.

The ANOVA model used was:

$$F = \frac{\text{Variance Between Groups}}{\text{Variance Within Groups}}$$

Pearson Correlation Analysis

Pearson correlation coefficients were computed to examine relationships among demographic variables and climate change perception indicators.

The Pearson correlation formula is given as:

$$r = \frac{\sum(X-\bar{X})(Y-\bar{Y})}{\sqrt{\sum(X-\bar{X})^2 \sum(Y-\bar{Y})^2}}$$

Level of Significance

The significance level for statistical tests was set at:

$p < 0.05$ = Significant

$p < 0.01$ = Highly Significant

3.8 Reliability of Instrument

To ensure reliability and consistency of the questionnaire, a pilot survey was

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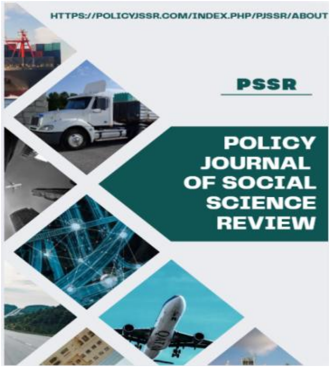

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conducted before final data collection. Cronbach's Alpha coefficient was used to assess the internal consistency of the scale items.

The reliability coefficient was found satisfactory ($\alpha > 0.70$), indicating acceptable reliability of the research instrument.

The formula is:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2}\right)$$

Results

Table 1

Demographic Characteristics of Surveyed Farmers

Demographic Variable	Multan	Muzaffargarh	Bahawalpur	Total
20-35	8 (20%)	10 (25%)	7 (17.5%)	25 (20.8%)
36-50	18 (45%)	16 (40%)	19 (47.5%)	53 (44.2%)
51-65	10 (25%)	9 (22.5%)	11 (27.5%)	30 (25.0%)
>65	4 (10%)	5 (12.5%)	3 (7.5%)	12 (10.0%)

Table 2

Farmers' Perception of Climate Change (Awareness Level)

Statement	Multan	Muzaffargarh	Bahawalpur	Overall Mean	Significance
Observed changes in the climate	4.65±0.48	4.58±0.50	4.70±0.46	4.64±0.48	0.432 NS
Summer temperatures increased	4.70±0.46	4.65±0.48	4.75±0.44	4.70±0.46	0.521 NS
Winter temperatures decreased	4.25±0.71	4.30±0.65	4.20±0.69	4.25±0.68	0.634 NS

Table 3

Observed Changes in Weather Patterns

Weather Parameter	Multan	Muzaffargarh	Bahawalpur	Overall Mean
Increase in Summer Temperature	38 (95.0%)	36 (90.0%)	39 (97.5%)	113 (94.2%)
Decrease in Winter Temperature	32 (80.0%)	34 (85.0%)	30 (75.0%)	96 (80.0%)
Delayed Monsoon Arrival	35 (87.5%)	37 (92.5%)	36 (90.0%)	108 (90.0%)

Table 4

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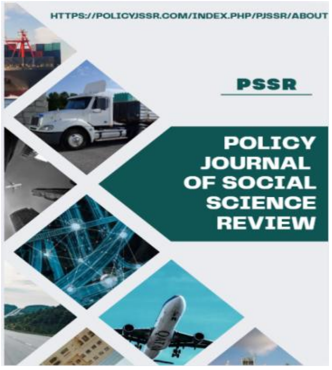

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Perceived Impact of Climate Change on Crop Productivity

Crop / Impact Parameter	Multan	Muzaffargarh	Bahawalpur	Overall Mean
Wheat Yield Decrease (%)	28.5±6.2	30.2±5.8	27.8±6.5	28.8±6.2
Cotton Yield Decrease (%)	35.2±7.1	38.5±6.9	34.5±7.3	36.1±7.1
Rice Yield Decrease (%)	25.8±5.5	27.5±5.2	26.2±5.8	26.5±5.5

Table 5

Ranking of Climate-Related Factors Affecting Crop Productivity

Climate Factor	Multan	Muzaffargarh	Bahawalpur	Overall Rank
High Temperature / Heatwaves	1.45	1.50	1.40	1st
Drought/ Water Scarcity	2.10	1.95	2.20	2nd
Unpredictable Rainfall	2.85	2.90	2.75	3rd

Table 6

Observed Changes in Pest and Disease Incidence Due to Climate Change

Pest/Disease	Multan	Muzaffargarh	Bahawalpur	Overall
Increased pest attacks on cotton	36 (90.0%)	38 (95.0%)	35 (87.5%)	109 (90.8%)
New pest species observed	28 (70.0%)	30 (75.0%)	26 (65.0%)	84 (70.0%)

Table 7

Adaptation Strategies Adopted by Farmers

Adaptation Strategy	Multan	Muzaffargarh	Bahawalpur	Overall
Changed planting dates	32 (80.0%)	35 (87.5%)	30 (75.0%)	97 (80.8%)
Shifted to drought-tolerant varieties	28 (70.0%)	30 (75.0%)	26 (65.0%)	84 (70.0%)

Table 8

Constraints Faced by Farmers in Adapting to Climate Change

Constraint	Multan	Muzaffargarh	Bahawalpur	Overall
Lack of financial resources	36 (90.0%)	38 (95.0%)	35 (87.5%)	109 (90.8%)
Lack of knowledge/information	32 (80.0%)	34 (85.0%)	30 (75.0%)	96 (80.0%)

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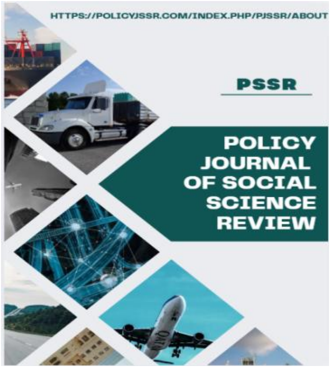

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Table 9

One-Way ANOVA Comparing Perception Scores Across Three Regions

Parameter	Sum of Squares	df	Mean Square	F-value	p-value
Climate Change Awareness	0.245	2	0.1225	1.28	0.282 NS
Perceived Impact on Productivity	1.456	2	0.728	3.45	0.035*

Table 10

Correlation Matrix (Pearson Correlation Coefficients)

Variable	Age	Education Level	Farming Experience	Land Holding Size
Climate Awareness	-0.15 NS	0.42**	0.08 NS	0.18*
Perceived Yield Loss	0.22*	-0.31**	0.25**	-0.12 NS

Discussion

The farmer demographics in Southern Punjab are important for understanding perceptions of climate change and adaptation actions. The above result indicates that most of the respondents are in the economically active age of 36-50 years (44.2%) and 51-65 years (25%). This means that in the study area farming is mainly operated by middle aged and above who have a lot of experience in the field. The younger farmers are relatively under-represented (20.8% aged 20-35), suggesting that there is limited youth participation in agriculture, which could have implications for innovation adoption and climate-smart farming practices in the longer term.

One key aspect of age structure is that younger farmers are more inclined to adopt technologies, digital information sources and modern farming practices as part of adaptation to climate change. Older farmers, on the other hand tend to be more dependent on traditional knowledge systems. These findings are echoed by Maddison (2007), who observed that age has significant effect on perception and adaptation decisions of the farmers in the developing countries. The age distribution in this study might, therefore, contribute towards the differences in adaptation strategies seen throughout the region.

The results show a very high level of awareness among farmers in the context of climate change. The means for all the items in Table 2 (all with values greater than 4.2 on a 5-point scale) indicate that the farmers strongly agree that climatic conditions have

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changed over the past few years. Respondents were very consistent in their responses of an increase in temperature in the summer (mean = 4.70) and general changes in climatic patterns (mean = 4.64). The results indicate that climate change is not a mythological phenomenon for farmers of Southern Punjab, but a phenomenon that is actually experienced.

No statistically significant difference between districts ($p>0.05$) means that the perception of climate change was same in all the districts of Multan, Muzaffargarh and Bahawalpur. The uniformity could be attributed to the similar agro-ecological conditions and exposure to extreme climatic events throughout the region. Ali and Erenstein (2017) Pakistan have also found that farmers in the arid and semi-arid regions have become more aware of the impacts of increased temperature, irregular rainfall and water scarcity from direct exposure to environmental stressors.

The perception data is also supported by this descriptive data in Table 3 where, the majority of farmers (94.2%) reported an increase in summer temperature and 90% reported a delay in the onset of the monsoon. The results point to a high degree of correspondence of indigenous farmers' knowledge with the scientific projections of climate change. The farmers' ability to be accurate in recognizing climatic trends indicates that experiential learning is one of the key factors in climate awareness.

The perceived decrease in winter temperatures (80%) is also associated with shifts in the seasonal variability, which can have significant implications for crop phenology and pest dynamics. The temperature variability and changing monsoon in South Asia have already increased and are positively impacting on agricultural productivity, according to IPCC (2021). This consistency between global climate assessments and farmer perception suggests that local observations can be considered as a good proxy of environmental change.

The findings are clear; that farmers are feeling the impacts of climate change is greatly negative on major crops. The most impacted crop was cotton, at 36.1% perceived yield reduction on average, followed by wheat (28.8%) and rice (26.5%). This ranking is based on sensitivity to heat stress and insufficient water availability, especially in the south in the irrigated areas of Southern Punjab.

This finding is similar to Ahmad et al. (2019) who found that the rise in temperature and water shortage have adversely affected the productivity of cotton in Punjab. Likewise, Lobell et al. (2011) highlighted that heat stress and rainfall fluctuations are two of the most significant factors affecting yield volatility of major staple crops in South Asia.

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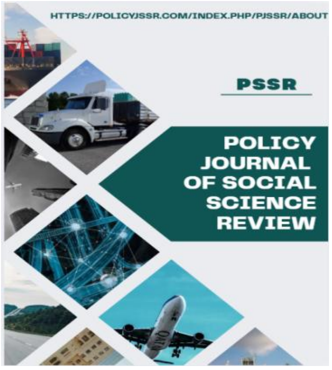

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Comparatively high losses in Muzaffargarh district as compared to others could be attributed to the higher vulnerability to drought and lower reliability of irrigation in the district.

The ranking of the climate-related constraints reveals high temperature and heat waves as well as drought and variable rainfall as the most severe constraints to agricultural productivity. This finding highlights the role of thermal stress in contrast to hydrological variability in the agriculture risk factor region. Heat waves can have a particular impact on crops sensitive to temperature such as wheat flowering and cotton boll formation. Hussain and Mudasser (2007) have reported that wheat production has already been adversely affected by the rise in temperature in the arid areas of Pakistan. The situation of drought as the second most significant factor also shows the vulnerability of both rain fed and irrigation system in Southern part of Punjab. Unpredictability of rainfall, which came in at 3rd position, is also a major concern and impacts sowing timings and establishing crops. Pest and Disease Dynamics under Climate Change Location: China, Singapore, and Malaysia One of the key observations of the study is the highly perceived rise in pest and disease levels. Over 90% of farmers reported higher infestation of cotton by pests, while 70% reported new species of pests. This is consistent with worldwide trends which show an increase in temperature and humidity has resulted in wider geographical distribution and multiple generations of agricultural pests. Deutsch et al. (2018) suggest that insect pests will adjust their metabolic and reproductive rates to a warmer climate, and therefore may cause greater crop damage. The cotton pests including whitefly and bollworm are increasingly difficult to control in Pakistan because of the variations in climatic conditions and pesticide resistance. Thus, this study underscores the need for integrated pest management (IPM) measures that are climate responsive. The farmers adopted the following adaptation strategies:The farmers used the following adaptation strategies: The study revealed that farmers are actively taking measures to adapt to climate stress by implementing various measures. The most prevalent approach is changing of planting dates (80.8%) and the next most popular is the adoption of drought-tolerant crop varieties (70%). These adaptive responses suggest that farmers are not just victims of climate change but are making efforts to adapt their practices to changes that they have noticed in the environment. The change in planting dates is a low-cost and flexible adaptation option that can help farmers avoid critical heat and/or water stress periods. The same goes for the use of drought-tolerant cultivars, which signals

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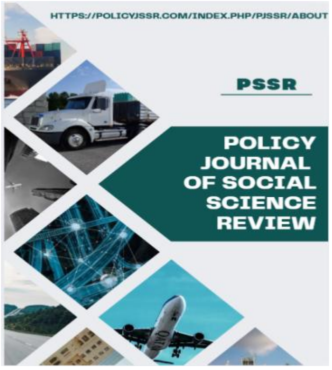

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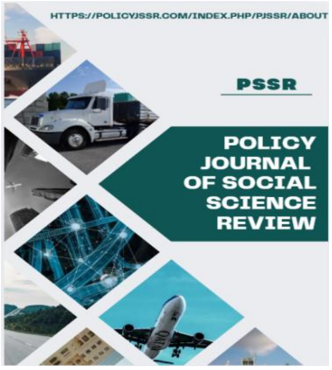
ISSN Online:3006-4635

ISSN Print: 3006-4627

growing awareness of climate-smart agriculture. The results are in line with Deressa et al. (2009) who stated that the primary adaptation strategies to climate change used by African farmers are changes in planting dates and cropping patterns. The use of these simple strategies also reflects low use of more sophisticated adaptation technologies, including precision irrigation, weather forecasting and water management mechanisms. This implies that adaptation is primarily reactive, and not transformative.

The two main challenges to adaptation identified in the study are lack of financial resources and lack of knowledge/information. Financial issues faced by more than 90% of farmers and lack of access to climate-related information by 80% of farmers. Such restrictions place a huge restriction on farmers' capacity to invest in better seeds, better irrigation systems, and modern technology. In smallholder farming systems, income is frequently unpredictable, and credit facilities are limited, making the lack of financial resources extremely important. Likewise, farmers' decision-making capacity is limited due to lack of information when deciding on crop planning and risk management. Access to Climate Information Services helps farmers in the developing world to be more adaptive, according to Bryan et al. (2013). The results of this study thus indicate the need to develop better rural financing systems and extension services. The relationship between perception and statistics, the determinants of perception. The correlation analysis is able to find meaningful correlations between socio-economic variables and the perception of climate change. Climate awareness is significantly positively correlated with education level (r = 0.42), meaning that the educated farmers are more able to understand and interpret phenomena related to climate change. This is in line with Deressa et al. (2009) who established that education is a significant factor in climate change perception and adaptation in Africa. On the other hand, the proportion of the yield loss due to the climate event is negatively related with farm education (r = -0.31), indicating that farmers with higher educational levels are better equipped to cope with climate risks and losses in productivity. Perceived yield loss is moderately weakly positively correlated with age (r = 0.22); presumably, there are physical limitations in adapting to new technology and in adaptability that explain why older farmers may perceive a higher loss in yield. In addition, there is a slight positive correlation between landholding size and climate awareness (r = 0.18) which indicates that larger farmers are more exposed to extension services and information networks. All of these relationships show that socio-economic



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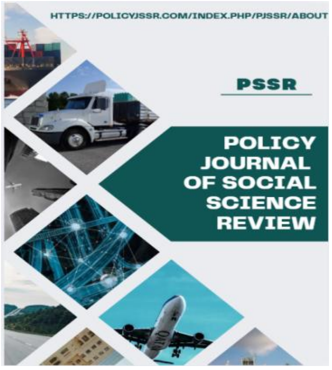
factors have a strong influence on perception and adaptive behaviour. The ANOVA results show that there were no differences found between the districts in terms of climate change awareness, which means that awareness of climate change in Southern Punjab is homogeneous. There was, however, a significant difference in perceived impacts on productivity ($p = 0.035$), suggesting that while awareness is similar; there is variation in intensity of perceived impacts on productivity by location. This variation could be explained by access to irrigation, soil quality and crop mix between districts. In the case of Muzaffargarh, it seems like the impacts are perceived slightly higher which can be attributed to the higher vulnerability of the area to drought and water scarcity. One of the key findings of the study is the high sense of increased pest and disease incidence. Over 90% of farmers reported more attacks of pests on cotton and 70% reported new species of pests. This is consistent with global examples of increased temperatures and humidity changes leading to extension of geographical distribution and reproduction of agricultural pests. Deutsch et al. (2018) suggest that insect pests can boost their metabolic and reproductive processes under warming, and thus cause more harm to the crops. The introduction of new pest species (e.g. whitefly and bollworm), pesticide resistance and the changing climatic conditions in Pakistan have made control of these pests more challenging. The results of this study thus underscore the need for climate-responsive integrated pest management (IPM) approach. The research identified a number of adaptation measures of which farmers are actively taking up. The most frequently adopted strategy is shifting planting dates (80.8%), with drought-tolerant crop varieties (70%) coming in next. The adaptive responses suggest that the farmers are not victims of climate change but are responding to the changes that they have noticed in the environment. Changing planting dates is an adaptation strategy that is simple, flexible and relatively inexpensive, enabling farmers to avoid the hottest or wettest periods of the planting season. In the same way, the use of drought-resistant varieties is indicative of awareness of climate-resilient agriculture. The results are in line with Deressa et al. (2009) who found that primary adaptation strategies used by African farmers include adjusting planting dates and crop species. The use of these simple technologies, however, also suggests that there is limited access to more complex options like precision irrigation, climate forecasting systems, and mechanized water management technologies. This implies that adaptation is taking place, but not in a transformative way. Not enough financial resources and not enough knowledge/information are

DOI: https://doi.org/10.5281/zenodo.20526156
Volume. 4, issue No. 6 (2026)



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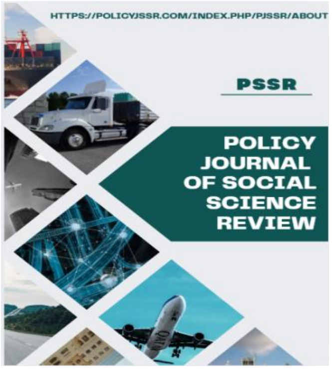
ISSN Online:3006-4635
ISSN Print: 3006-4627

the two most important barriers to adaptation identified by the study. 80% of farmers mentioned that they did not have sufficient access to climate-related information, and more than 90% of them experienced financial constraints. These restrictions seriously restrict farmers' investment in better seeds, irrigation schemes, and contemporary technologies.

In smallholder farming systems, in particular, financial constraints are crucial, as income is often volatile and credit is limited. Likewise, inadequate information hinders farmers' decision making on crop planning and in managing risks. Bryan et al. (2013) found that farmers' adaptive capacity is greatly improved when they have access to climate information services in developing countries. So the results of this study suggest a need to develop more effective mechanisms for financing in rural areas and better extension services.

Correlation analysis shows important relationships between socio-economic variables and perception of climate changes. Education levels is strongly positively correlated with climate awareness ($r = 0.42$), meaning that the more educated the farmer, the more likely he is to be able to understand and interpret the phenomena of climate change. This result agrees with the study of Africa by Deressa et al. (2009) who determined that education was among the most important factors affecting perception of, and adaptation to, climate change in Africa. On the other hand, education is negatively correlated with perceived yield loss ($r = -0.31$), indicating that more educated farmers are more capable of coping with the climate risk and mitigating losses in production. The relationship between age and vulnerability as measured in perceived yield loss is weak and positive ($r = 0.22$), suggesting that older farmers perceive higher vulnerability, possibly because they are less physically able to adapt and less able to access new technologies. There is also a positive correlation between landholding size and climate awareness ($r = 0.18$), indicating that larger farmers are more likely to receive extension services and information networks. These relationships provide overall evidence that socio-economic factors have a significant impact on perception and adaptive behavior.

From the results of ANOVA, perception of climate change among districts has not shown any significant differences, indicating that the perception of climate change is similar in the whole of the southern part of Punjab. A significant difference in perceived impacts on productivity ($p = 0.035$) was found, suggesting that perceptions of impact on productivity are comparable, but more intense in some locations. This difference could be due to variations between districts in irrigation availability, soil fertility, or crop types. For instance, the perceived



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impacts seem to be a little higher in Muzaffargarh as compared to other districts, which maybe be attributed to its vulnerability to drought and water scarcity.

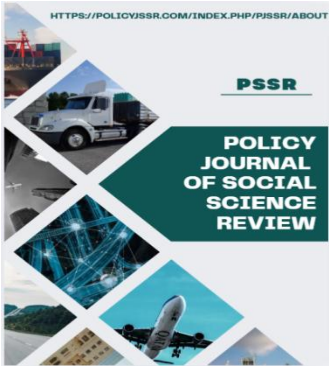
Conclusion

The study finds that farmers in Southern Punjab are very conscious about the climate change and are facing its negative effects on the agriculture production system. An increase in temperature, irregular rainfall, late monsoon onset and the increased occurrences of droughts are observed throughout all three districts. These climatic changes are felt to have adversely affected the productivity of the crops, especially cotton, wheat and rice, which are the principal crops of the area. Even though farmers are aware of the issues, they are still limited in their effective response to climate change. The results indicate that adaptation measures like plantings dates shifts and introduction of drought-tolerant varieties are frequently implemented, but most of these are not techno-adaptable and sustainable. The study also finds that farmers' perception and adaptation behavior is significantly influenced by socioeconomic factors like education, land holding size, and sources of information. Furthermore, it was found that financial limitations and access to reliable agricultural information were the most important constraints to adaptation. The study shows that the vulnerability of farmers to impact of climate change will keep rising if they are not provided with access to appropriate institutional support, extension services, and technologies that can help them adapt to climate change. Thus, more resilient to adaptation capacity building in the context of policy intervention is necessary for sustainable agriculture development in Southern Punjab.

Recommendations

The study results have led to a few policy and practice oriented recommendations for strengthening climate change resilience of farmers in Southern Punjab.

To begin with, there is a great demand to enhance the agricultural extension system with a particular emphasis on climate-smart agriculture. Farmers need to be trained regularly in good practices for climate smart agriculture such as crop diversification, water management, pest management in changing climatic conditions etc. Extension programs should also help to disseminate early warning systems and seasonal climate forecasts effectively. Second, there is a need to enhance farmer access to climate information services by governments and relevant institutions. Introducing mobile advisory systems, radio programmes, and community-level CI centres can help farmers make informed decisions on crop planning, planting dates and risk management. Third, there should be financial assistance programmes to ease



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farmers' economic difficulties. Access to credit, support for irrigation infrastructure (drip and sprinkler systems) and subsidies for drought-resistant seeds can make a huge difference in enhancing adaptive capacity, particularly for smallholder farmers. Fourth, investment in research and development is needed to enhance and promote the development of climate resistant crop varieties which are able to cope with heat stress, water scarcity, and infestation of pests. Research institutions, universities and agricultural departments must be encouraged to work together more. Fifth, Capacity-building programmes should focus more on the farmers with lower education level because education is seen to have a strong impact on climate awareness. There should be special training modules and farmer field schools introduced to improve awareness of climate risk and climate adaptation strategies. Last, but not least, integrated policy approaches are needed to tackle the challenges of climate change in agriculture. Collaboration among government departments, NGOs and private sector actors is key to create viable adaptation strategies. Looking forward, agricultural systems need to be resilient in order to adapt to the rise of climate variability and its effects in Southern Punjab.

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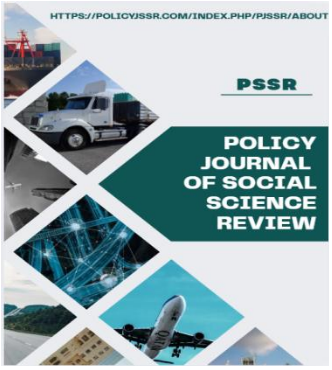

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