Farmers' Perception of Climate Change and Its Impact on Tobacco Grown: A Case Study of Swabi (Khyber Pakhtunkhwa)

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Abstract

This study examined the knowledge and perceptions of small farmers in the Swabi district of Khyber Pakhtunkhwa concerning climate change and its impact on their livelihoods. In collaboration with the Community Based Organisation (CBO) Swabi, the study surveyed 30 farmers across 8 Union Councils through interviews and fieldwork. The findings revealed that while farmers are aware of different farming techniques, their awareness about the long-term effects of climate change is not up to date. Farmers identified tobacco as a profitable crop but noted its vulnerability to changing climate conditions. The study also pointed out that farmers have noticed changes in temperature and rainfall patterns over the last 5 to 10 years, including early rainy seasons, prolonged drought periods, and unusual rains. Over 70% of farmers reported lower tobacco yields and increased input costs, primarily due to increased water use and pest invasions, which they directly attributed to changing climate conditions. In comparison, 60% of respondents have reported a reduction in leaf quality, characterised by leaf yellowing, which is attributed to temperature changes in the soil. Despite their limited knowledge, farmers have implemented various strategies, including adjusting planting schedules, utilising tube wells for irrigation, and increasing pesticide application for a specified period. The report finds that although the farmers' knowledge about climate change is limited, there is a necessity for specific awareness campaigns, training of farmers, providing capacity-building programs, and developing climate-resilient crop varieties, including tobacco, to improve farmers' resilience to climate change.

Keywords: Tobacco, Farmers' Perceptions, Climate Change, Swabi, Pesticides.

Introduction

Climate change is primarily a worldwide problem resulting from human activities that release hazardous greenhouse gases, particularly into the atmosphere (Jabeen et al., 2022). In other fields, climate change and the greenhouse effect pose a serious health concern to the agriculture sector and other sectors (Israr et al., 2020). Factors of climate change, such as an increase in temperature, photochemical smog, dry periods, excessive floods and heat waves, have negatively influenced the annual productivity of crops. These listed factors were not only responsible for affecting the annual production strategy of the agricultural sector, but they also badly influence the economic growth

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of a country (Ali & Khan, 2022). According to the reports of the IPCC, we can expect extreme consequences of climate change, particularly in agriculture, where excessive flooding and water shortages can specifically put different agricultural sectors at risk. This is because farming is dependent on distinct patterns of climate and cropping systems. Hence, the vulnerability of the agriculture sector to CC is considerably higher (Khan et al., 2023). Due to environmental degradation, the estimation of the financial losses to Pakistan is up to $1 billion annually (Shah et al., 2022). It is bringing into notice that Pakistan is at greater risk to environmental changes which is alarming ranked among 29th among the Global Climate Change Vulnerability Index (CCVI) for up to 2009-10 and consequently 16th for 2010-11, ranked the Pakistan as the most vulnerable country to extreme weather change (Ali & Khan, 2022).

In the Asia region, the cultivation of the tobacco crop was usually done for the first time in 1912 (Bibi et al., 2021). Tobacco is likely to be grown as a commercial crop worldwide, with a percentage of global tobacco production coming from developing countries. Several developing countries where tobacco is grown, including Zimbabwe, India, Pakistan, and Malawi, face food shortages and are likely dependent on low-income sources (Sajjad et al., 2022). Pakistan is likely to be classified as an agricultural economy, with approximately 70 per cent of the population directly or indirectly dependent on agriculture for their livelihood (Khan et al., 2020). With the advent of environmental change, Pakistan is ranked in twelfth position by the World Bank. It is brought to notice that the agriculture sector is vulnerable to significant challenges due to distinct atmospheric conditions (Ali & Khan, 2022).

Pakistan is among the top ten raw producers of the world, with an annual tobacco yield of 1.75% (Ahmad et al., 2022). Pakistan is recognised as the world's leading producer of tobacco plants, with a yield of 3017kg per hectare, surpassing the annual yield of developed countries, which is 1900kg per hectare (Hussain & Yousafzai, 2022). In Pakistan, tobacco accounts for up to 0.25% of the total irrigated land (Ahmad et al., 2022). It is reported that the total area occupied by tobacco in Pakistan was approximately 47,000 hectares in the year 2019. In the same year, the overall tobacco production reached up to 110,000,000 tons (Saddozai et al., 2022). Annually, the tobacco industry growth rate reaches up to 22% (Bibi et al., 2021). Although Pakistan is regarded as a major contributor to tobacco production, it is not considered a significant crop, especially in Pakistan's agriculture sector, in terms of its cultivated area and production value. Currently, tobacco covers only 0.425% of the annual agricultural production value (Sajjad et al., 2022).

Punjab contributes 20% to tobacco production, while Sindh and Baluchistan contribute up to 5%. In contrast, KPK is the highest contributor, with nearly 70% of all types of tobacco produced there. Due to sustainable environmental conditions, Swabi District became famous for creating the Flue-cured Virginia tobacco variety (Ahmad et al., 2022). Due to its vast agronomy, more than 35 million people residing here in Khyber Pakhtunkhwa province are especially at higher risk and are further infuriated by widespread poverty (Shah et al., 2022). Among other provinces, Khyber Pakhtunkhwa (KP) ranks as the third province that stabilises the economy of Pakistan, contributing its share to GDP growth (Iqbal & Rauf, 2021). KP, known as the land of maize and tobacco, it,ces 95% of the country's diverse types. types75% of the country's districts, such as Mardan, Swabi, Buner, Mansehra, and Charsadda, are major producers of high-quality tobacco products (Iqbal & Rauf, 2021). Among these, Swabi District is especially famous for the cultivation of Flue Cured Virginia tobacco type variety (Bibi et al., 2021). Due to its widespread agronomy and suitable environmental conditions, the district of Swabi guarantees 30% of its area and up to 38% of the overall tobacco production (Hussain & Yousafzai, 2022).

Tobacco production requires a substantial workforce of approximately 80,000 workers across 26 tobacco industries, which typically employ 50,000 workers. Additionally, indirect marketing is estimated to involve about one million workers (Aman & Khan, 2020). The country's economic development is directly or indirectly dependent on tobacco production, particularly in the farming sector. Most farmers get a considerable benefit from this crop and earn money, which plays a massive role in their economic and social development, especially in Pakistan (Aman & Khan, 2020). Tobacco has given job opportunities to people. Virginia Tobacco has provided opportunities to employers, including about 1.13 million people, consisting of about 80,000 farmers and an industrial workforce ranging up to 50,000, along with a population of one million people, particularly involved in the final product trade. Last but not least, as a sales tax/federal tax, it has also contributed Rs. 60 billion in annual revenue for the government treasury (Khan et al., 2020).

Alternative temperature and precipitation patterns affect the plant development of the tobacco plant and its productivity (Ali et al., 2021). High temperatures abruptly cause changes in physiological processes, while less or heavy rainfall patterns affect plant growth rates respectively (Ahmad & Ma, 2020). Prolonged drought for more than 2 weeks or excessive rainfall negatively affect the development of the crop, reducing the plant yields. The greenhouse effect not only increases the chances of spreading diseases but also decreases the yield of the tobacco crop (Ali et al., 2021).

Objectives

1. Find out how many small-scale farmers in the Swabi district are aware of climate change, including what they understand about its causes, effects, and how it affects their farming techniques.
2. Look into how climate changes, like temperature fluctuations and irregular rainfall patterns, affect crop yields, especially concerning how they affect tobacco farming.
3. Explore different ways that small-scale farmers adapted to the changing climate, such as changes in planting techniques, how they use water, and the variety of crops they grow.
4. Identification of the main problems farmers came across when trying to adapt to climate change, and also, the solutions to these prevailing issues.

Materials and Methods

The research methodology generally refers to the approach a researcher will take. This includes a worldwide study, sample selection and interpretation, the respondents and their sample, data collection and presentation, and data analysis. The research analysis of this research is as follows.

Research Design

The prevailing study subsequently applies different method approaches, which include techniques such as qualitative and quantitative data collection. This method helps us in understanding the various views and experiences of small-scale farmers in Khyber Pakhtunkhwa's Swabi area on climate change.

Study Area

The study was conducted in Swabi district, a town in Khyber Pakhtunkhwa province, Pakistan, with a Latitude of 34.120155 and a Longitude of 72.470154. People here mainly belong to Pashtun tribes, and the majority of them speak Pashto as a native language. The primary source of income

in this province is Agriculture, along with trade and other public services. In agriculture, people here mostly prefer to grow essential crops such as wheat, rice, maize, sugarcane, millet, barley, and tobacco. The climate of Khyber Pakhtunkhwa (KPK) province is different in comparison to its size and contains most of the distinct climate categories found in Pakistan. Rainfall also shows inconsistency, as most of the particular areas are typically dry in this province.

In comparison, the eastern part of this province is recorded to be the wettest side of Pakistan, especially from June to mid-September (Ali et al., 2021). For this purpose, eight Union Councils in Khyber Pakhtunkhwa's Swabi area were selected as the subject of the study, which was conducted there. The main reason behind the selection of these Union Councils was to ensure that the agricultural practices of the district and various environmental experiences would be precisely represented.

Sampling Procedure

With the usage of descriptive survey research design, quantitative research was selected for this study. The study utilised a sample size of 30 smallholder farmers, chosen from a pool of 1000. This random sampling was informed by data from various departments of agriculture, land, and Environmental Affairs, as well as Rural Development. Therefore, due to limited resources and time, with the usage of simple random sampling, we only select 10% of the smallholder crop farmers from the population (Dube et al., 2025).

Sampling Unit

Stratified random sampling was applied to ensure that each Union Council was studied thoroughly and equally represented. This method is reliable and generalised. It was expected that, in each stratum, i.e., village, farm characteristics are considered homogenous. For this purpose, 30 tobacco farmers were randomly selected as a sample size (Bibi et al., 2021).

Data Collection and Analysis

For the survey, a structured questionnaire was designed to collect data for the study. With the advent of descriptive statistics, such as frequency counts, percentages, means, and ranks, using IBM SPSS version 28, the entire research data was appropriately examined.

Structured Interviews

Conducted with 30 farmers using a prepared interview guide. The subjects of the interviews included awareness of climate change, opinions regarding its effects and causes and various methods for its adaptation.

Field Observations

Field observation was based on qualitative data, examining different farming methods, their surrounding conditions, and farmers' responses to climate change. All the data were collected through direct observations.

Data Collection Tools

Interview Guide

It typically involves questions about the impact of agriculture, climate change information and observations, adaptation methods, and demographic data.

Observation Checklist
Applied to systematically gather information about the condition of the crop, different farming techniques, and various environmental changes.

Quantitative Data
Data is analysed using statistical software, such as SPSS, to explore various methods and correlations. This involves adding inferential statistics, including ANOVA, chi-square, t-test, and descriptive statistics, such as mean, median, mode, and standard deviation.

Qualitative Data
Software, such as NVivo, was utilised for the analysis of different themes and patterns in the field observations and farmer responses.

Model Specification

Inferential Statistics
To determine the different results of dependent variables that are continuously measured, the multiple linear regression model is usually put forward in the study due to its ability to utilise several independent or explanatory variables. The model was employed in the analysis of respondents' socioeconomic characteristics, which continuously affect the usage of organic farming practices. Data regarding the different responses of farmers, particularly their perceptions of the effects of organic farming practices, were analysed using a five-point Likert Perception Scale, which rates responses as strongly disagree, disagree, undecided, agree, and strongly agree. Following the Nyawo and Olorunfemi (2023), an analysis of the composite score was then employed to evaluate, for each respondent, their utilisation scores from the Likert scales. This resultant utilisation index was then regarded as a substitute for the farmers' utilisation, which is then employed in a multiple linear regression model as a dependent variable.
The expanded form of the model can thus be given as:

$$Y=\beta_0+ \beta_1X_1+ \beta_2X_2 \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ BnXn + e$$

Where:
Y is known to be the farmer's utilization score/index on different farming practices.
X is regarded as a vector of variables which included farmers' social class such as their age, gender, educational attainment, marital status, household size, other farming experience and up to so on.
β is usually known to be the parameter of unknown vector which needed to be estimated and ε is independently and normally distributed random error term.

Results and Discussion

This chapter deals with the results and discussion with respect to the "Farmers' Perceptions of Climate Change and Its Impact on Tobacco Cultivation in Swabi District" The findings on the impact of climate change are presented according to different themes arising from the discussion with farmers.

Demographic Characteristics of the Sampled Farmers
Provides an overview of the demographic characteristics of the sampled farmers in the Swabi district, detailing key factors such as age, education, farm size, income, and gender distribution.

Table 1: Demographic Characteristics of the Sampled Farmers

Demographic Variable	Category	Frequency	Percentage (%)
Gender	Male	27	90%
	Female	3	10%
Age Group	20-30	5	16.7%
	31-40	8	26.7%
	41-50	10	33.3%
	51-60	4	13.3%
	60+	3	10%
Educational level	No Formal	4	13.3%
	Primary	6	20%
	Secondary	12	40%
	Higher	8	26.7%

Figure 1: Gender ratio

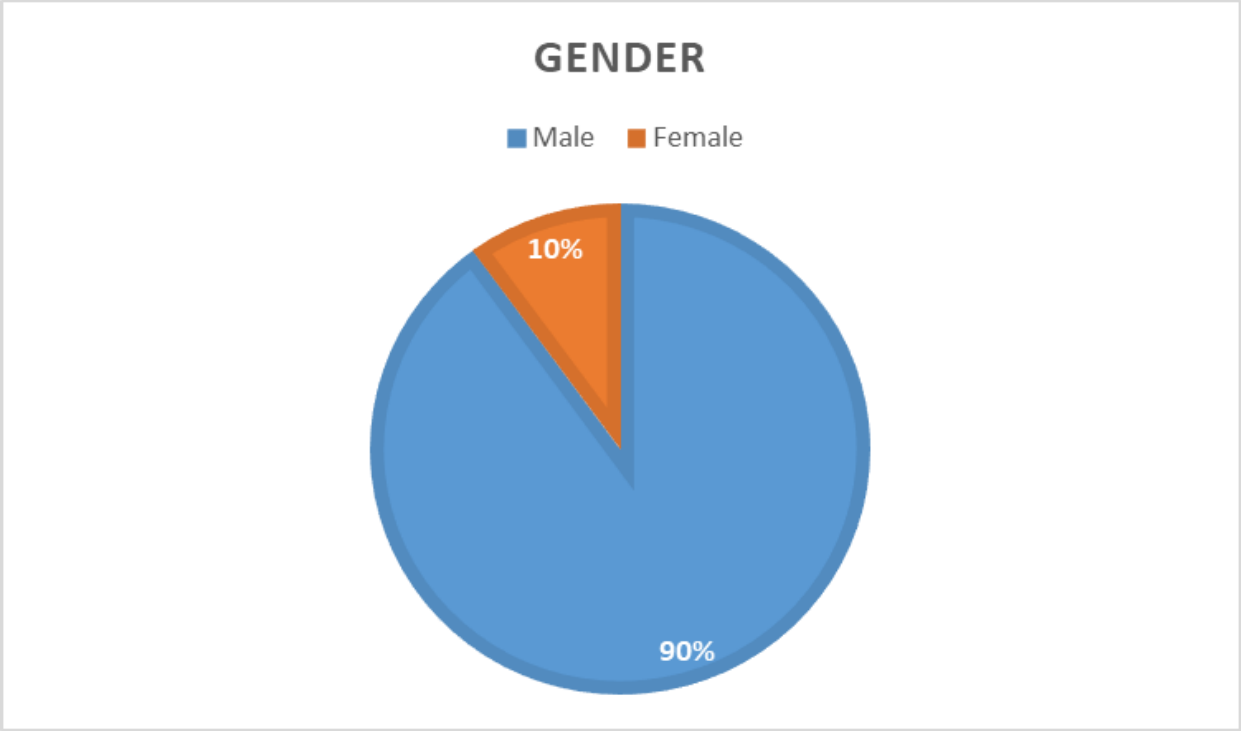


Figure 2: Age ratio

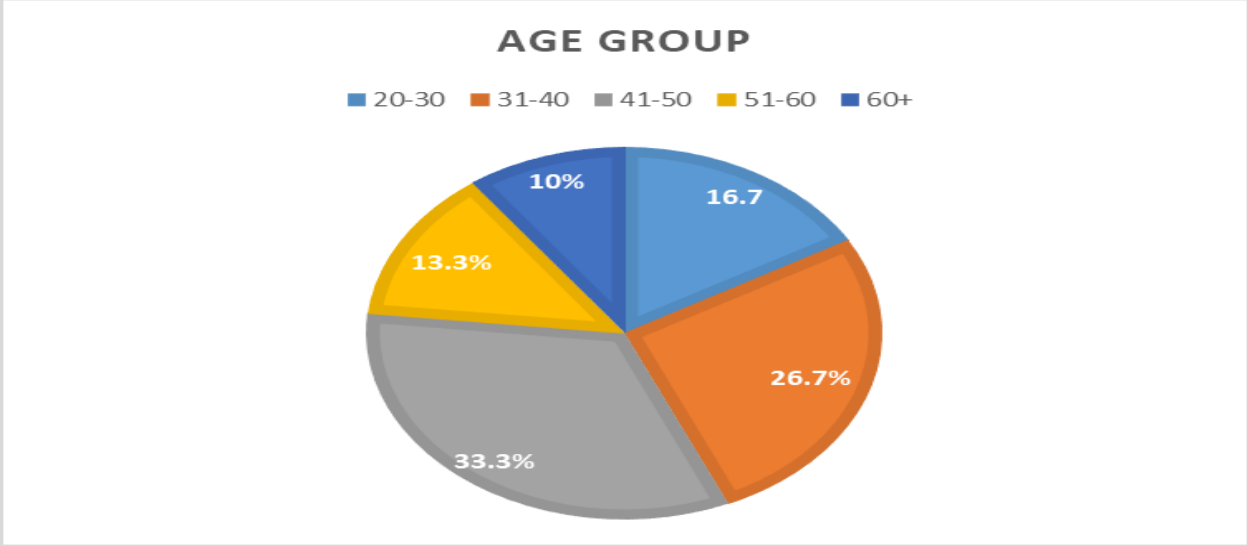
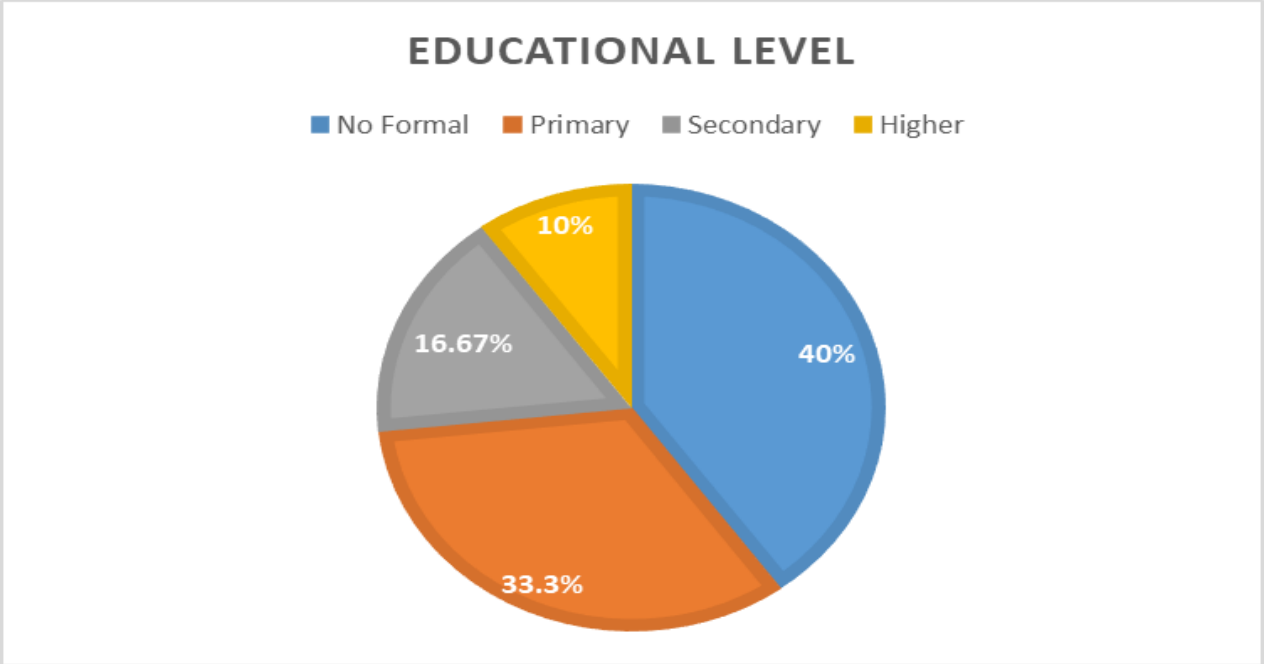


Figure 3: Education level



Age Distribution

The age distribution among 30 farmers shows that 16.7% are aged 20-30, often open to new technologies. Those aged 31-40 make up 26.7% and blend experience with innovation. The largest group, 41-50 years old (33.3%), has extensive experience and influences farming practices. The 51-60 age group (13.3%) brings valuable experience but may resist change, while those aged 61+ (10.0%) are nearing retirement and focus on maintaining traditional methods. This distribution provides insights into labor dynamics, technology adoption, and the need for targeted support and training.

Educational Background

Among the 30 farmers, 20% have primary education, potentially limiting their access to advanced farming techniques. The largest group, 40%, possesses secondary education, integrating traditional knowledge with formal training. About 26.7% have tertiary education, which supports the adoption of modern agricultural practices. Additionally, 13.3% have vocational training, providing specialized skills that enhance productivity. This educational distribution highlights its impact on farming practices and emphasizes the need for tailored training and support.

Farm Size and Ownership

Among the 30 farmers, 10 (33.3%) manage small farms (up to 5 acres), 12 (40%) operate medium-sized farms (5-15 acres), and 8 (26.7%) run large farms (15+ acres). In terms of ownership, 20 (66.7%) own their farms, 8 (26.7%) are tenants, and 2 (6.7%) are sharecroppers. This distribution illustrates how farm size and ownership influence farming practices and highlights the need for tailored support based on these factors.

Figure 4: Farm size

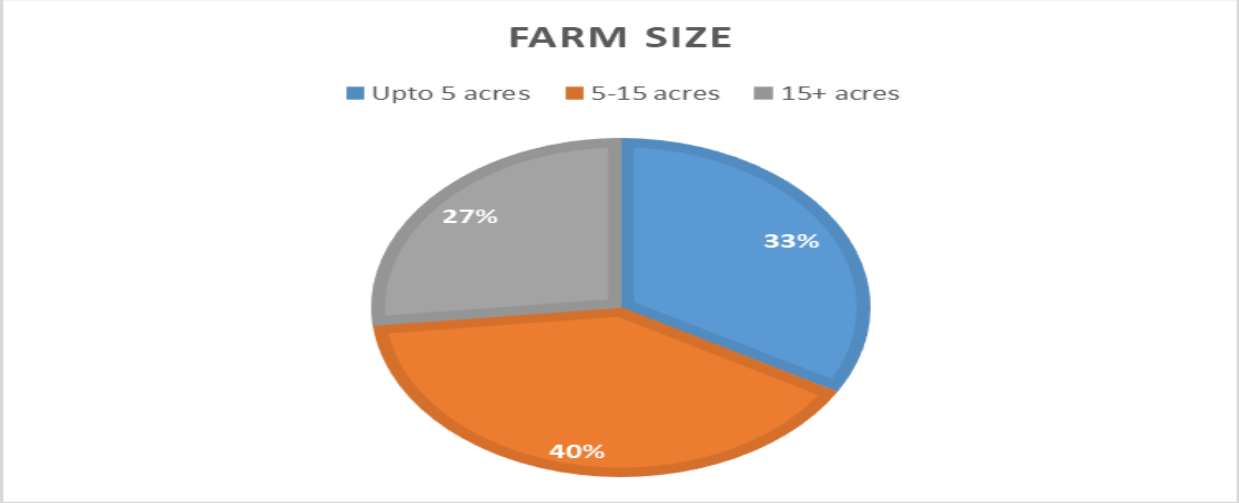
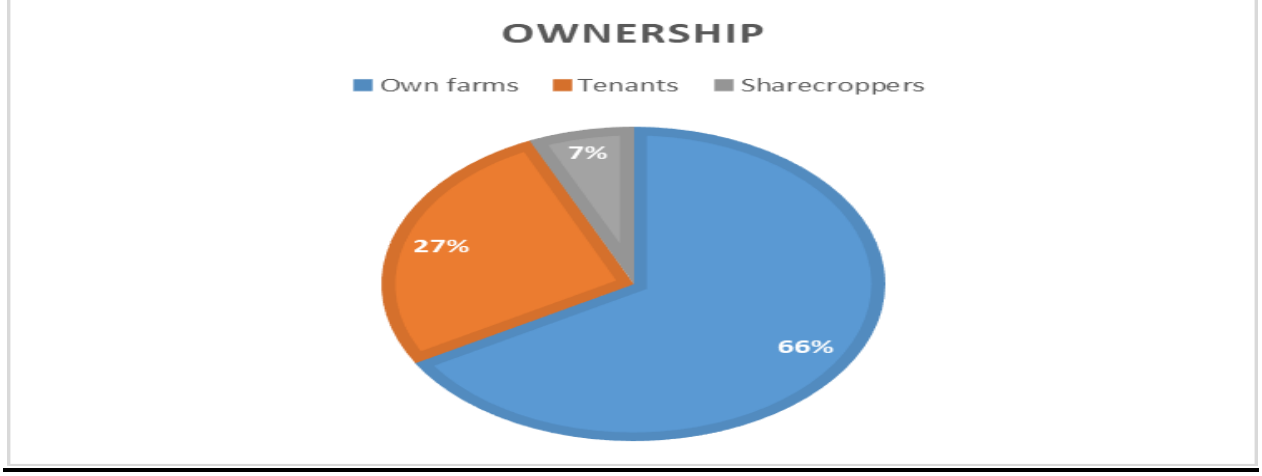


Figure 5: Ownership



Income and Livelihoods

In the sample of 30 farmers, 7 (23.3%) report a low income (below $5,000 per year), 15 (50%) have a medium income ($5,000-$10,000 per year), and 8 (26.7%) earn a high income (above $10,000 per year). Additionally, 18 (60%) rely exclusively on agriculture for their livelihood, 10 (33.3%) engage in both farming and other employment, and 2 (6.7%) work in non-agricultural sectors. This distribution underscores the influence of income levels and livelihood sources on farming practices and highlights the need for tailored support strategies.

Figure 6: Income

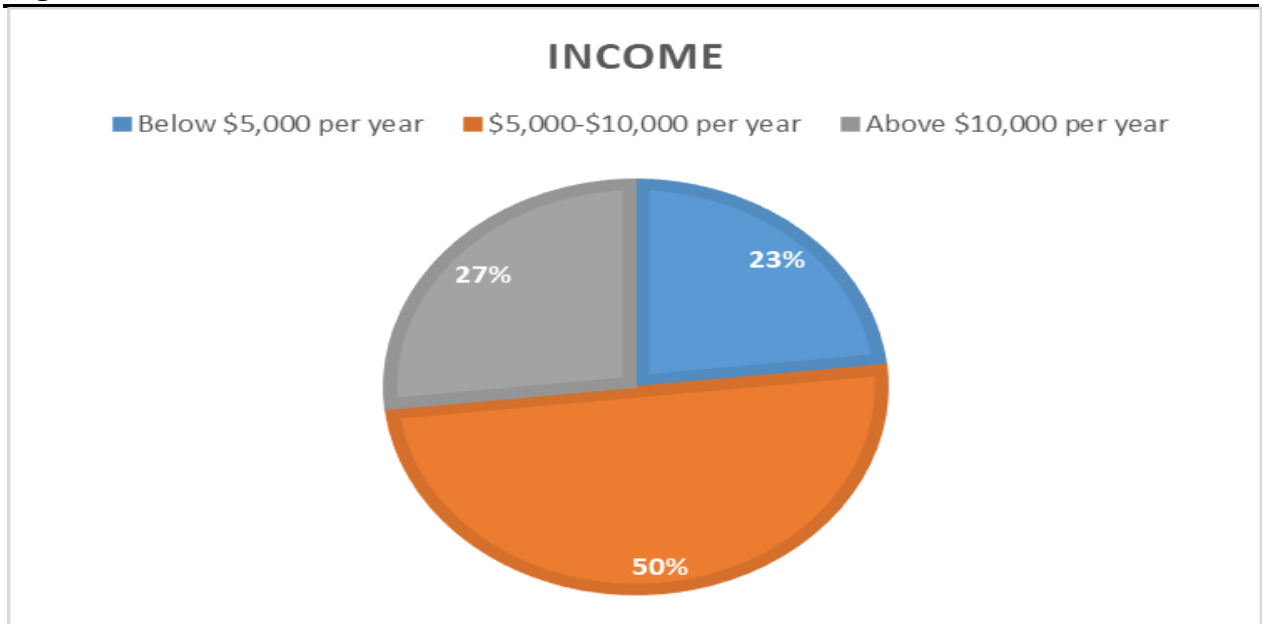
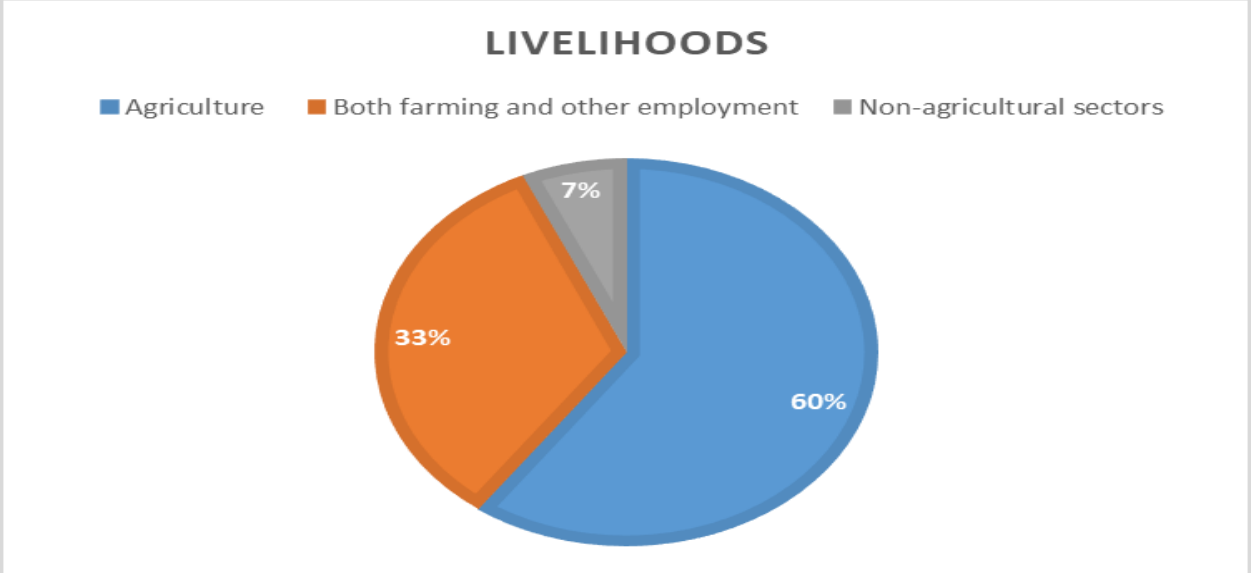


Figure 7: Livelihoods



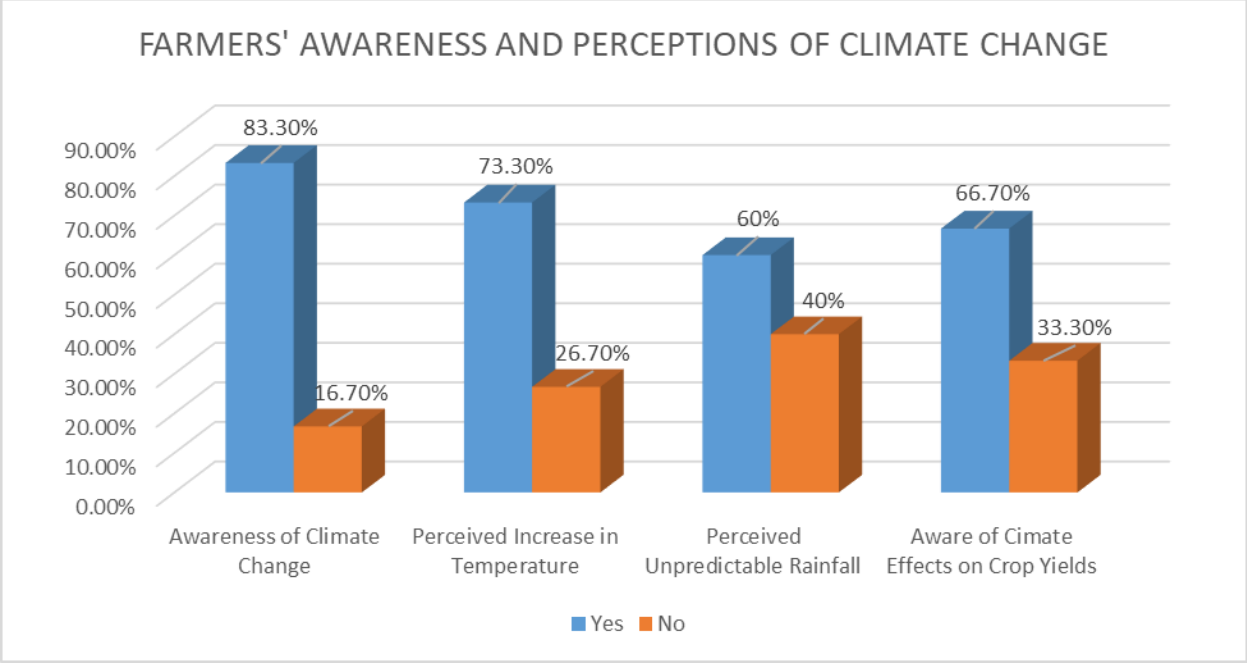
Farmers' Awareness and Perceptions of Climate Change

The findings highlight farmers' basic awareness of climate change, serious concerns about its effects on tobacco yields, observations of changing weather patterns, difficulties in adapting to these changes, and a significant need for additional support from external sources.

Table 2: Farmers basic awareness

Aspect	Yes	No
Awareness of Climate Change	25 (83.3%)	5 (16.7%)
Perceived Increase in Temperature	22 (73.3%)	8 (26.7%)
Perceived Unpredictable Rainfall	18 (60.0%)	12 (40.0%)
Aware of Climate Effects on Crop Yields	20 (66.7%)	10 (33.3%)

Figure 8: Farmers' Awareness and Perceptions of Climate Change



Awareness of Climate Change

Among the 30 farmers, 25 (83.3%) are aware of climate change, indicating a high level of recognition within the sample. Conversely, 5 farmers (16.7%) are not aware of climate change. This widespread awareness suggests that most farmers are informed about climate change, which could influence their farming practices and adaptation strategies.

Perceived Impact on Tobacco Yield

Among the 30 farmers, 20 (66.7%) see climate change as significantly affecting tobacco yields, while 18 (60.0%) associate unpredictable rainfall with reduced yields and production challenges.

Conversely, 10 farmers (33.3%) do not perceive a major impact. This range of perspectives underscores the need for targeted research and support to address these issues effectively.

Observations of Changes in Weather Patterns

Among the 30 farmers, 22 (73.3%) have noticed higher temperatures, 18 (60.0%) have experienced unpredictable rainfall, and 15 (50.0%) have encountered extreme weather events. These findings show that farmers are highly aware of changing weather patterns. The common reports of rising temperatures and irregular rainfall highlight the need for adaptive strategies and more research to mitigate these impacts on agriculture.

Challenges in Adapting to Climate Change

Among the 30 farmers, 60% encounter significant obstacles in adapting to climate change, primarily due to limited resources and knowledge. Financial constraints and inadequate access to modern agricultural tools make it challenging to address issues like rising temperatures and unpredictable rainfall effectively.

Additionally, 40% of farmers face difficulties with insufficient climate information, which impedes their ability to make informed decisions about crop management. To overcome these challenges, targeted support and resources are essential for helping farmers implement effective adaptation strategies.

Farmers' Observed Climate Changes and Adaptation Strategies

This shows how farmers are adjusting to climate change. With rising temperatures and changing rainfall patterns, they are starting to plant earlier, use more irrigation, and grow different crops. These changes help them keep their farming productive despite the shifting climate.

Table 3: Farmers' Observed Climate Changes and Adaptation Strategies

Observed Climate Change	Count	Percentage	Adaptation Strategy	Count	Percentage
Increased Temperatures	22	73.3%	New Farming Techniques	18	60.0%
Unpredictable Rainfall	18	60.0%	Adjusting Planting Dates	15	50.0%
Extreme Weather Events	15	50.0%	Improved Irrigation Methods	12	40.0%
Other Changes	10	33.3%	Other Strategies	5	16.7%

Figure 9: Farmers climate strategies towards temperature

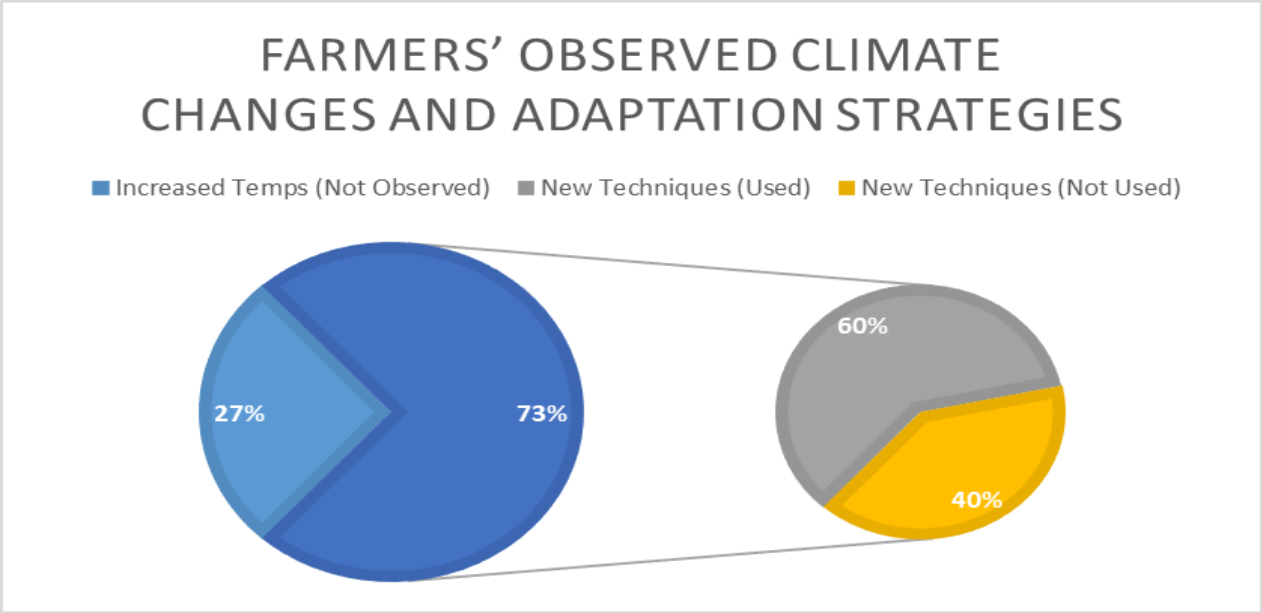


Figure 10: Farmers observed climate changes towards rain

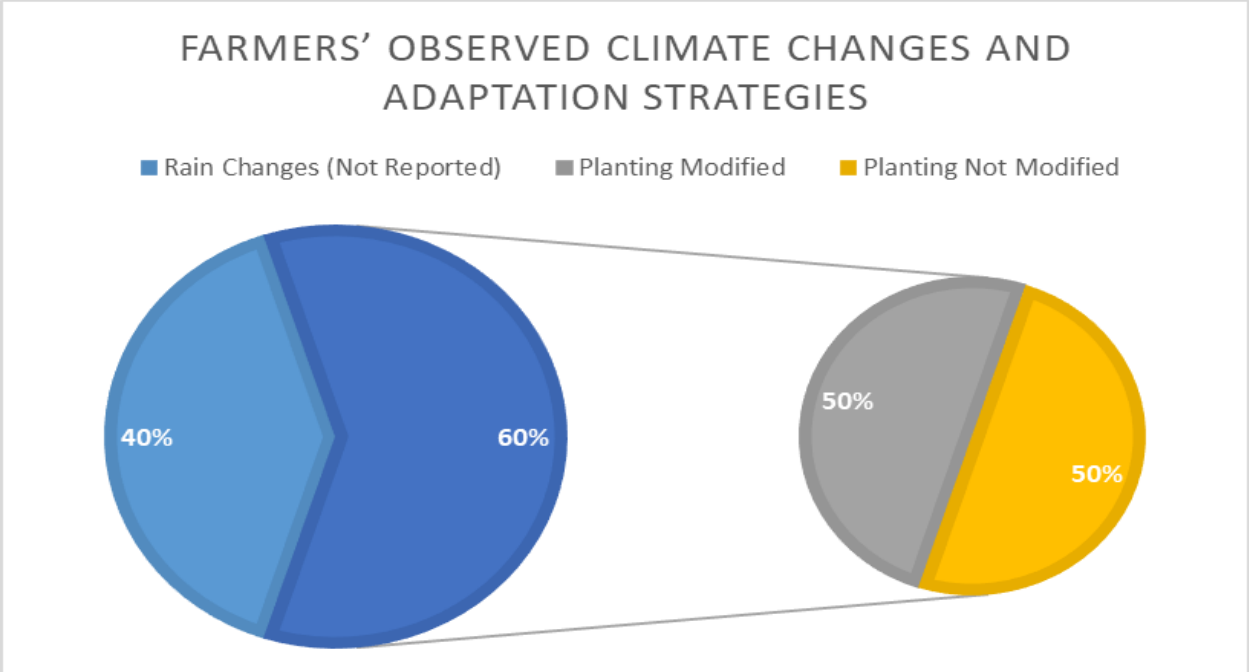


Figure 11: Farmers observed climate changes towards extreme weather

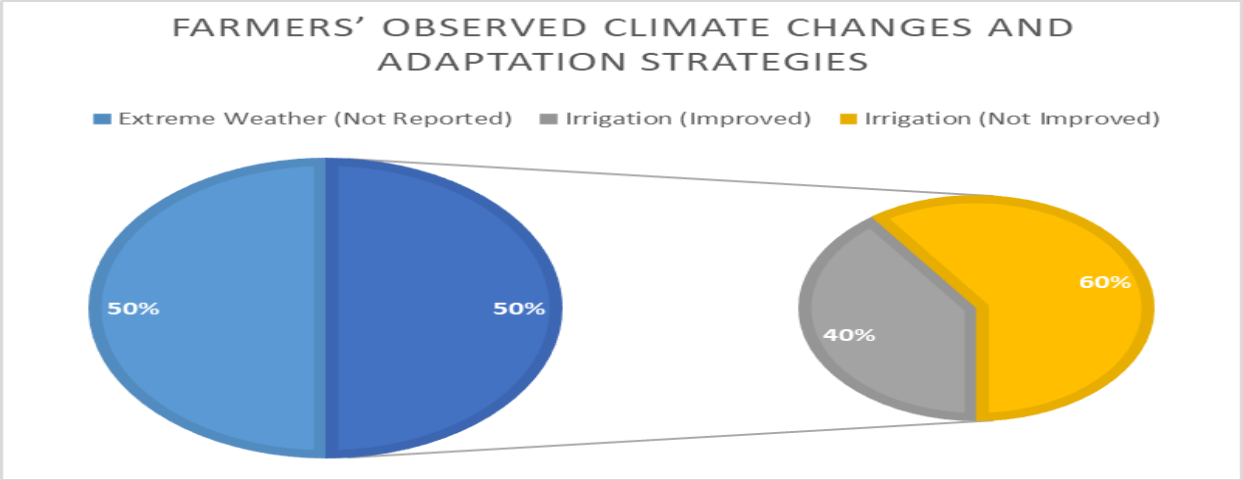
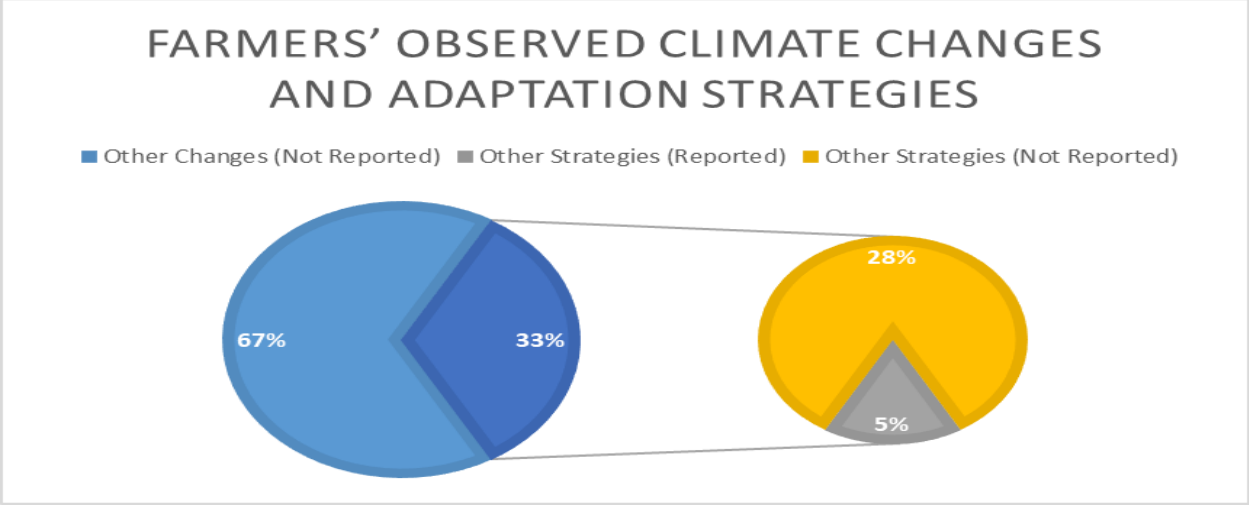


Figure 12: Farmers observed climate changes towards different changes



Observed Increase in Temperature

Out of 30 farmers, 22 (73.3%) have noticed rising temperatures. This increase impacts crop growth and farming methods, prompting 18 farmers (60.0%) to implement new farming techniques to adapt. These adjustments are vital for managing the effects of higher temperatures and sustaining agricultural output.

Observed Changes in Rainfall Patterns

Among the 30 farmers, 18 (60.0%) have reported changes in rainfall patterns, with increasing unpredictability. This variability disrupts crop planning and yields, prompting 15 farmers (50.0%) to modify their planting schedules as a response. Adapting to these irregular rainfall patterns is essential for sustaining crop production and optimizing agricultural outcomes.

Adoption of Early Planting

In response to unpredictable rainfall and rising temperatures, 15 of the 30 farmers (50.0%) have adopted early planting strategies. By shifting their planting schedules to earlier in the season, these

farmers seek to minimize the adverse effects of erratic weather and enhance crop yields. This adjustment helps them better manage climate variability and strengthen agricultural resilience.

Increased Use of Irrigation

To tackle the challenges of erratic rainfall, rising temperatures, and increased drought conditions, 12 out of 30 farmers (40.0%) have expanded their use of irrigation. This adjustment helps ensure a stable water supply for crops amidst unpredictable weather patterns and frequent droughts. By enhancing their irrigation practices, these farmers aim to maintain crop yields and improve agricultural resilience.

Diversification of Crops

Among the 30 farmers, 15 (50.0%) are diversifying their crops to reduce reliance on tobacco and address climate variability. By incorporating a variety of crops, these farmers aim to manage the impacts of erratic weather and achieve more stable income. This strategy helps them mitigate risks associated with climate change and enhances their overall agricultural resilience.

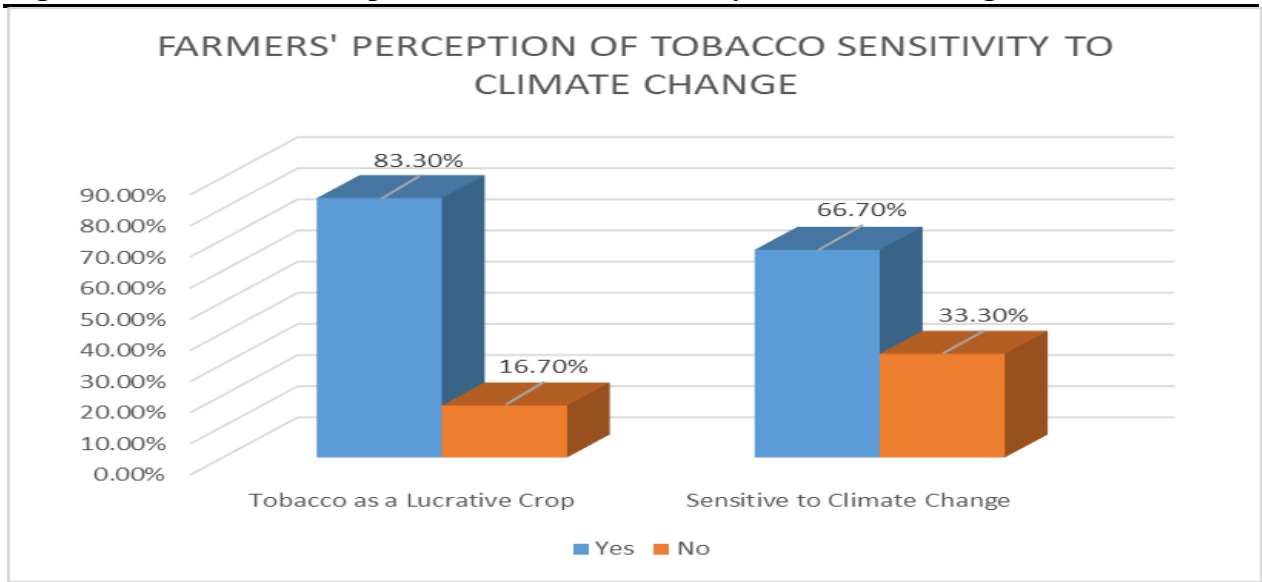
Farmers' Perception of Tobacco Sensitivity to Climate Change

It reveals that farmers are apprehensive about how climate change affects tobacco. It underscores their awareness of the need for adaptation measures to address the challenges climate change poses to both tobacco yield and quality.

Table 4: Apprehensive farmers towards climate change of tobacco

Perception	Frequency	Percentage
Tobacco as a Lucrative Crop	25	83.3%
Sensitive to Climate Change	20	66.7%

Figure 13: Farmers' Perception of Tobacco Sensitivity to Climate Change



Tobacco Sensitivity

A significant majority of the 30 farmers consider tobacco to be highly sensitive to climate change, with 20 (66.7%) recognizing its vulnerability to shifting temperatures and irregular rainfall. These climate fluctuations are seen as directly affecting tobacco growth and yield, underlining the crop's sensitivity to changing conditions.

Additionally, 18 farmers (60.0%) report an increased risk of crop failure due to climate change, linking this to unpredictable weather patterns and extreme climatic events that jeopardize tobacco production stability. Moreover, 15 farmers (50.0%) emphasize the urgent need for effective adaptation strategies to address these challenges, highlighting the necessity of adopting new practices and technologies.

Furthermore, 12 farmers (40.0%) acknowledge that climate change negatively impacts tobacco quality, with changes in temperature and humidity potentially reducing leaf quality and overall product value. This awareness underscores the importance of adaptation efforts to sustain both the productivity and quality of tobacco in the face of evolving climate conditions.

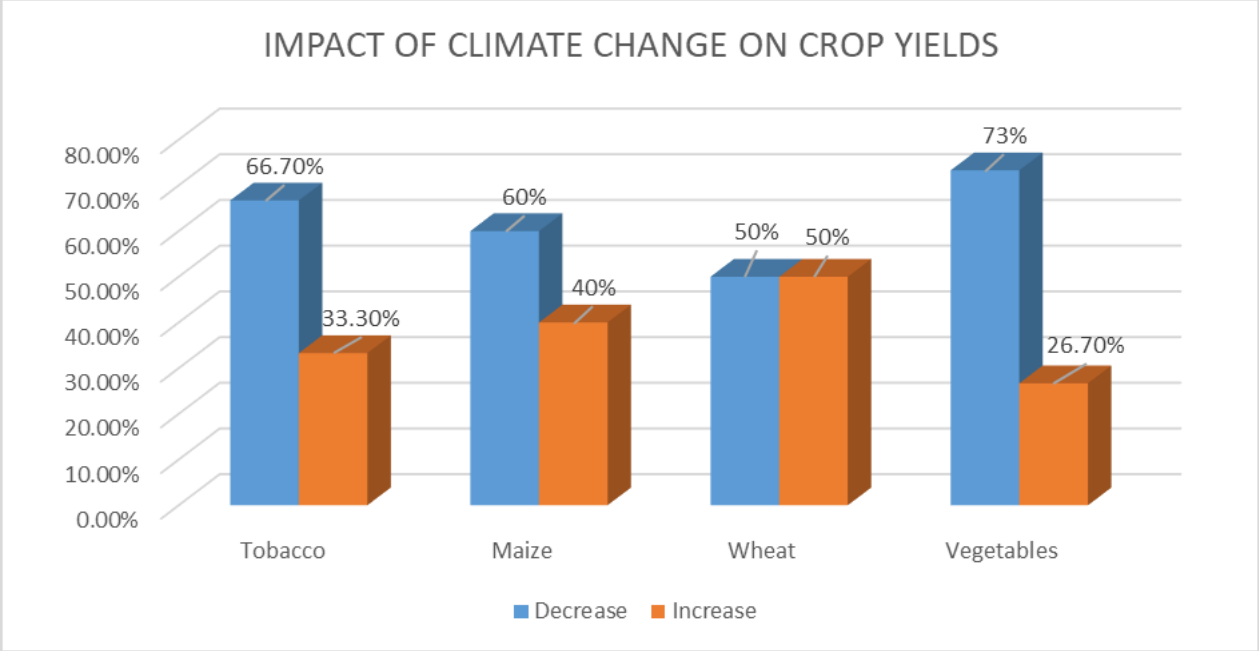
Impact of Climate Change on Crop Yields

The following illustrates the varied impacts of climate change on different crop yields, as reported by farmers. Tobacco and maize have been notably affected, with significant yield reductions. Wheat shows variable impacts, indicating some resilience or the influence of local conditions, while vegetables display mixed responses to climate changes. These observations highlight the need for tailored adaptation strategies to meet the specific requirements and vulnerabilities of each crop in the face of changing climatic conditions.

Table 5: Yield changes in different crops

Crop Type	Yields Decrease Observed	Frequency	Percentage
Tobacco	Significant	20	66.7%
Maize	Significant	18	60.0%
Wheat	Significant	15	50.0%
Vegetables	Significant	22	73.3%

Figure 14: Impact of Climate Change on Crop Yields



Tobacco

Among the 30 farmers, 20 (66.7%) have reported a decrease in tobacco yields linked to climate change. This reduction is attributed to fluctuating temperatures and irregular rainfall, which disrupt ideal growing conditions for tobacco. As a result, farmers have observed slower growth, lower leaf quality, and reduced overall yield.

Conversely, 10 farmers (33.3%) did not experience a decrease in tobacco yields, indicating that the effects of climate change can vary depending on local conditions and farming practices. The high percentage of farmers facing yield reductions highlights the urgent need for effective adaptation strategies to address these climate-related challenges and stabilize tobacco production.

Wheat

Among the 30 farmers, 15 (50.0%) have reported reduced wheat yields as a result of climate change. This decline is attributed to changing weather patterns and extreme conditions that impact crop growth. These observations underline the need for adaptation measures to manage the effects of climate change on wheat production.

Maize

Among the 30 farmers, 18 (60.0%) have observed a decline in maize yields attributed to climate change. This decrease is associated with unpredictable weather and extreme conditions. The results underscore the importance of adopting effective adaptation strategies.

Vegetables

Farmers report mixed impacts on vegetable yields, where among 30 of farmers, 22 (73.3%) have reported a decline in vegetable yields due to climate change, attributed to erratic weather and extreme conditions. Conversely, 8 farmers (26.7%) did not observe a decrease in vegetable yields, suggesting that the impact of climate change on vegetable production varies among different

farms. The significant proportion of affected farmers underscores the urgent need for effective adaptation measures to manage these challenges.

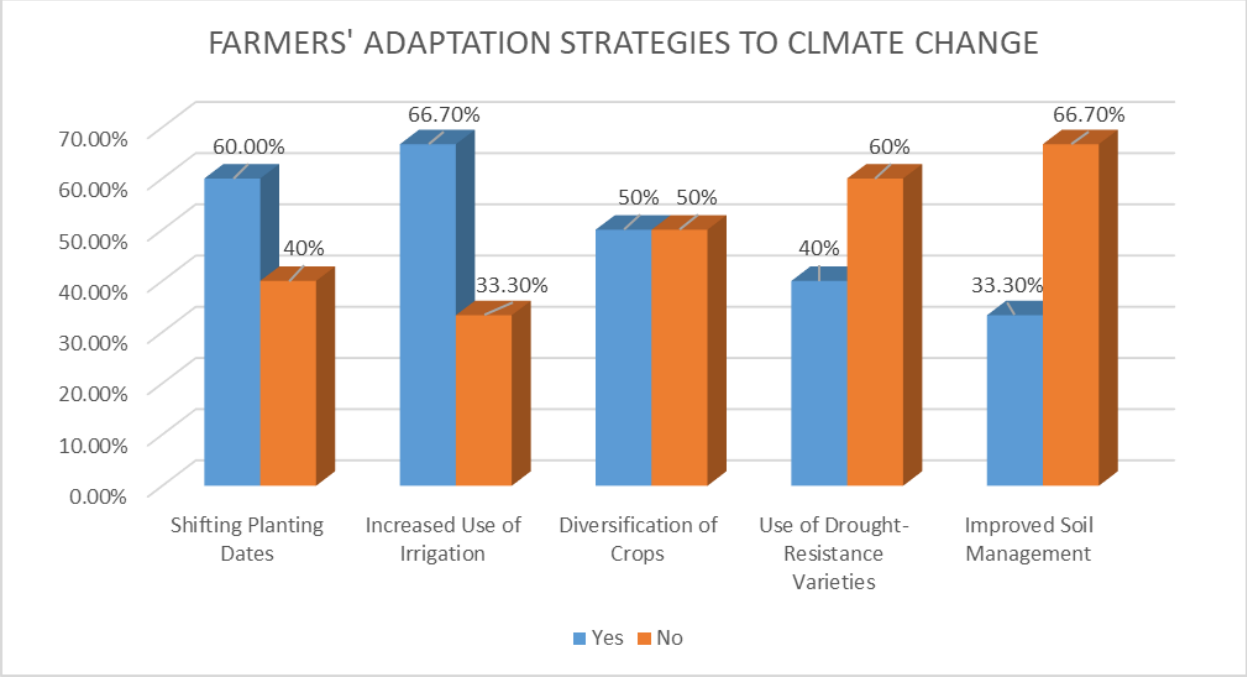
Farmers' Adaptation Strategies to Climate Change

This shows the different ways farmers in Swabi are adapting to climate change. The most common methods are changing planting dates, using more irrigation, and growing a variety of crops. Farmers are also using drought-resistant plants, practicing soil conservation, and looking for climate information to strengthen their resilience. These actions highlight how farmers are actively working to reduce the negative impacts of climate change and maintain their agricultural productivity.

Table 6: Impacts of climate change

Adaptation Strategy	Frequency	Percentage
Shifting Planting Dates	18	60.0%
Increased Use of Irrigation	20	66.7%
Diversification of Crops	15	50.0%
Use of Drought-Resistant Varieties	12	40.0%
Improved Soil Management	10	33.3%

Figure 15: Farmers' Adaptation Strategies to Climate Change



It mainly highlights the various adaptation strategies employed by farmers in Swabi to tackle the challenges of climate change.

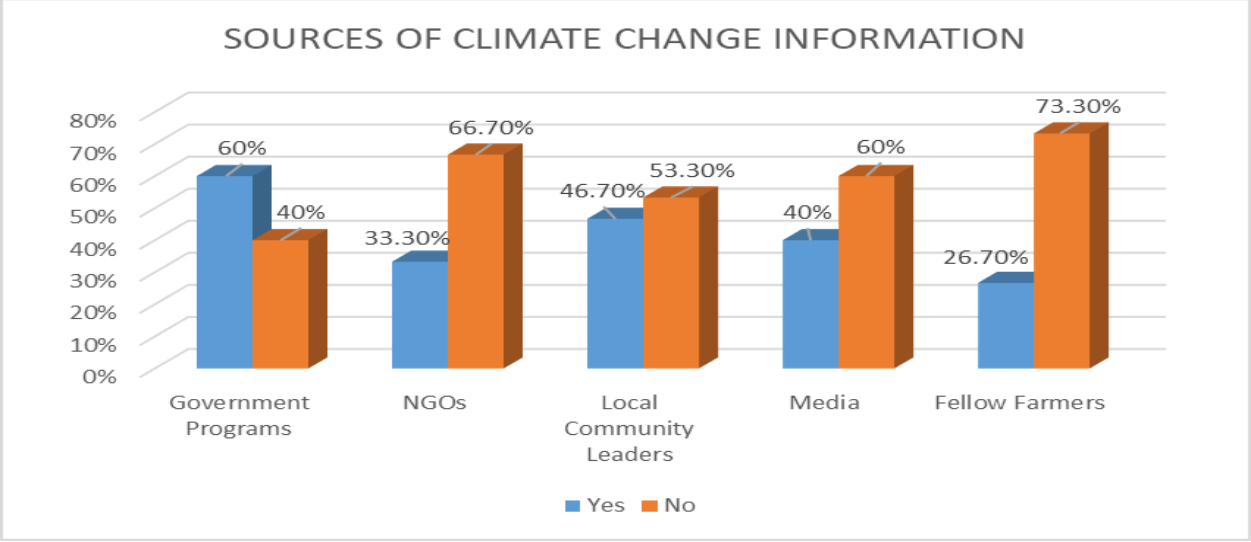
- Among the 30 farmers surveyed, 20 have adopted enhanced irrigation systems to manage the effects of climate change. This strategy is crucial for ensuring a steady water supply during periods of drought, reflecting their proactive measures to secure reliable crop yields amidst unpredictable rainfall.
- Crop rotation has been adopted by half of the farmers in the sample. This method helps maintain soil fertility and control pests, mitigating the impact of climate change on soil health and crop productivity. By varying their crop rotation practices, these farmers improve their resilience to climate-related disruptions and support sustainable farming.
- 40% of the farmers are using drought-resistant crop varieties to tackle the increasing occurrence of droughts. These specially designed crops offer a dependable solution for maintaining agricultural productivity even during extended dry spells, showcasing the farmers' commitment to adapting to the changing climate.
- Soil conservation practices, including mulching and reduced tillage, are employed by 33.3% of the farmers to enhance soil health and retain moisture. These techniques are vital for sustaining crop yields and preventing erosion in variable climate conditions, underscoring the farmers' dedication to preserving soil quality and farm resilience.
- Diversification of crops is practiced by 50% of the surveyed farmers. By growing a range of crop types, these farmers reduce the risk of complete crop failure due to adverse weather. This approach stabilizes their income and boosts overall farm resilience, allowing them to better manage the uncertainties posed by climate change.
- These strategies demonstrate the farmers' proactive efforts to mitigate the impacts of climate change and sustain their agricultural productivity.

Sources of Climate Change Information

Table 7: Sources of information

Source of Information	Frequency	Percentage
Government programs	18	60%
Non-governmental organizations (NGOs)	10	33.3%
Local community leaders	14	46.7%
Media (TV, radio, newspapers)	12	40%
Fellow farmers	8	26.7%

Figure 16: Sources of Climate Change Information



Among the 30 farmers surveyed, the sources of climate change information are varied. Government programs are the primary source for 60% of the farmers, providing essential climate data and guidance relevant to tobacco farming. NGOs inform 33.3% of the farmers through community-based initiatives focused on tobacco. Local community leaders are crucial for 46.7% of the farmers, offering localised advice on adapting tobacco cultivation. Media outlets, including TV, radio, and newspapers, reach 40% of the farmers with climate information affecting tobacco. Additionally, 26.7% rely on peer advice from fellow farmers. This diverse range of information sources highlights the different ways farmers gather and apply climate data to adapt their tobacco farming practices.

This study explores how climate change impacts tobacco farming in Swabi and aligns with global trends. The challenges, such as rising temperatures and erratic rainfall, are consistent with global predictions. These insights emphasise the need for adaptation strategies that are both tailored to local tobacco farming conditions and informed by global climate patterns, ensuring resilience against climate change.

Societal and Theoretical Reasoning's

The study focuses on how small-scale farmers in Khyber Pakhtunkhwa's Swabi area feel about the changing climate and how it affects tobacco plants. It is found that although producers have no knowledge of global warming and how it affects our way of life, they have noticed variations in the erratic patterns of precipitation, heat stress, and early seasonal beginning. All of these factors have an immediate effect on tobacco plant production, indirectly influencing the crop by affecting the nutritional value of the leaves. From a societal standpoint, these changes have an impact on rural community stability and bare subsistence in addition to the agricultural sector. In Swabi, tobacco is a major cash crop that provides income for the majority of households. Farmers struggle economically whenever productivity falls ot tobacco quality deteriorates due to climate stress, and this can result in higher debt, school dropout rates and even employee immigration to cities in search of work. This is an illustration of how warming temperatures affect households, the rural economy, and crops. This study supports the findings of (Lecours, 2014)**.** In Cambodia, farmers are typically unhappy about the amount of work involved in growing tobacco, compared to the

financial benefits it generates. They stated that, when totaling all cost associated with associated with tobacco production (such as labour and timber for draining tobacco leaves) and the increasing climate volatility that drives the selling price of tobacco on the market, the revenue derived from tobacco manufacture is less than pr Even when the farmers in swabi have implemented specific regional adaptation techniques such adjusting plant dates, increasing water supply, and changing crop arrangements, these techniques are still reactive, unofficial and limited by technical and financial constraints.

Climate vulnerability theory, which explains how individuals exposed to environmental hazards are more vulnerable when they lack the resources they need, knowledge or support from institutions, theoretically supports this. To effectively address the challenges posed by environmental shifts, it is crucial to integrate climate change awareness into practice. The adverse effects of climate change include decreased agricultural output and fewer chances of winning. Additionally, it is increasing food instability, decreasing the supply of energy sources, wool fabric, and feed, eroding biodiversity, and increasing population-out migration. Farmers also claimed that adopting climate-resilient crop types and early-maturing seed kinds was a systematic way to accomplish adaptability in agricultural utilisation (Jatav, 2024).

The extent and beneficial effects of previous crop failures on the choice of adapting demonstrate the significance of hands-on training for influencing farmers' adaptation to risk from climate change. Although farmers in Swabi have developed specific regional adaptation techniques, such as changing establishing techniques schedules, increasing water supply, and altering crop mixes, their reactions remain flexible, random, and limited by technical and economic limitations. Their farmers are likely to implement adaptation strategies for low-risk situations, having previously experienced crop failure due to severe storms or other environmental events. This is consistent with Protection Motivation Theory (PMT), which postulates that people are more likely to participate in preventive activities when they perceive a high level of threat, such as crop loss and think adaptive responses are effective. Earlier failure of crops has an advantageous effect on modification, which implies that farmers use climate-resilient seed types, better irrigation, and crop diversification as ways to make up for previous losses. However, farmers' financial capability and access to resources are also necessary for adaptation, suggesting that specific policies, such as service providers for extension, access to credit, and risk-sharing arrangements like crop insurance, could provide additional flexible responses (Wang et al., 2025).

Additionally, understanding and analysing the factors that influence environmentally conscious conduct has been made easier by the VBN's ecologically framed synthesis of several other behavioural structures, such as the theory of planned behaviour. It is important to keep in mind that perceptions of climate change danger may vary depending on one's understanding and familiarity with the phenomenon (Nurjani et al., 2020).

Conclusion

In conclusion, the prevailing study pointed out the urgent need for awareness, especially among small-scale farmers, about the carcinogenic effects of climate change and how it is affecting plant growth. Although farmers are taking proactive steps, such as applying various plant techniques, adjusting their timings, increasing irrigation chances, and practising crop rotation, their understanding of climate change and its impact on plant production remains limited. This limited knowledge poses a serious concern regarding the production of tobacco plants, which are the main crop of the Swabi district and are significant for the region's economy. The vulnerability of tobacco

crops to different climatic conditions lessens the yields and also poses a serious concern to farmers' livelihoods.

The research emphasizes that although farmers are exhibiting flexibility and adaptability but due to lack of proper education still they are under process to deal with a worldwide problem such as climate change. Alternate solutions would be the implementation of laws about the key awareness of the climate change to the farmers, development of such kind of crop varieties that could tolerate severe climatic conditions, provide the environment that could extend the agricultural services. Through the implementations of these strategies this will help the farmers to sustain such kind of climatic change and also manage the agricultural practices.

Overall, culmination of the knowledge gaps and the exaggeration of the support systems are considered crucial for enhancing the flexibility of farmers in Swabi district and ensuring the longitivity of their different agricultural activities amid the in process climatic changes.

Recommendations

- Awareness programs and seminars should be arranged monthly wise to let the farmers know about the devastative effects of climate change on tobacco farming and also on agriculture.
- Training should be provided to those agricultural sectors which are vulnerable to climate change such as setting the different timings of plant and also diversification of crop.
- Selection of crops that is strong enough to withstand the climate change with an exploration of different tobacco varieties and certain other crops.
- Improvement of the agricultural services to give timely response in case of any misery to crop and also provide support against the harsh climatic change.
- Sustainable farming practices should be given equal importance, such as soil management and its effectiveness and water usage effectively, through financial provocation and support.
- It should be bring into syllabus that farmers must have a good access to accurate and timely weather forecasts and climate data in order to timely farming decisions.
- Different opportunities should be given to farmers to share their experiences and vital strategies which they use against a climate change, encouraging a community of learning and support.
- A stronger partnerships between government agencies, local organizations and NGOs, is essential in order to provide immense support and resources to farmers.
- Establish a system to detect and assesses the effectiveness of prevailing adaptation strategies, using the results to purify and improve approaches over time.
- These recommendations sights to not only help the farmers to cope with harsh climatic conditions but it can also improve different agricultural practices, crop techniques and ensure the prolong livelihoods.

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