

## Effect of Climate Change on Tomato Production in District Nowshera

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### Abstract

All economic sectors worldwide are facing significant threats due to climate change, but the agricultural sector is more vulnerable due to its high level of dependency of livelihood in the community. The study was designed with the objectives to analyze the factors that affect tomato productivity due to climate change and role of extension field in tackling these challenges. The sample of 135 respondents was selected from total of 450 farmers in the study area for conducting and executing this study. It was found that 46.0% of the respondents laid the in the age group of 18-35 years old, while 20.7% respondents had age of above 50 years, 30.4% of the respondents claimed drought condition affect their productivity of tomato crop, while 16.3% of the respondents claimed floods in the area hardly affect their tomato crop. Majority (77.0 %) of the respondents were agreed that there was an increase in temperature and number of sunny days, while 6.7% of the respondents was disagreeing with this. Majority (61.5%) of the respondents were agreed with frequency of heavy rains increased due to climate change, while 13.3% of the respondents disagreed with this. Study found that 68.9% of the respondents were agreed with fluctuation in rain patterns while 10.4% of the respondents were disagreed with this. most (55.6%) of the respondents cultivated tomato on up to 2 acres of land, while 6.7% of the respondents cultivated on more than 4 acres in 2024. most (57.0%) of the respondents cultivate tomato on up to 2 acres of land while 6.7% cultivate tomato crop on above 4 acres of land in 2025. Based on the conclusion it is recommended that Agricultural extension services should be strengthened to provide farmers with regular, practical training on tomato production and climate adaptation. Further recommended that Access to timely and accurate weather information should be improved through mobile alerts, radio, and local advisory services, enabling farmers to make informed decisions about irrigation, sowing, and pest control.

**Key Words:** Tomato Production, Climate Change, Extension Services, Climate Adaptation,

### Introduction

All economic sectors worldwide are facing significant threats from climate change, but the agricultural sector is especially vulnerable due to its high level of dependency (Vaghefi *et al.*, 2019). It is anticipated that agricultural food output and quality will alter as a result of the climate's periodic shifts (Ahmed *et al.*, 2013). Furthermore, the strain on the world's food supply network is increased by the population's rapid growth. Because climate change factors and the agriculture

sector have a strong interrelationship that encompasses both metrology variables, such as temperature and rainfall patterns, favorable weather conditions may be crucial in improving overall food crop production in such situations (Akram and Hamid *et al.*, 2015). With rising temperatures, changing precipitation patterns, and an increase in the frequency of extreme weather events endangering global food security, it is one of the biggest issues facing agriculture today (Amir *et al.*, 2020). The agriculture industry is particularly susceptible to these changes since it depends on stable environmental conditions. The tomato (*Solanum lycopersicum*), a widely grown and economically significant vegetable that is especially susceptible to climate fluctuations, is one of the most impacted crops (Abou-Sheel and El-Shirbeny, 2014). Tomatoes generally prefer temperatures between 20°C and 25°C; any variation from this range may result in reduced yields (Biratu, 2018). But as global temperatures continue to rise, heat stress is becoming more prevalent, which can result in smaller fruit, less fruit set, and in extreme situations, crop loss (Bhandari *et al.*, 2021). Tomato production have been directly impacted by the climatic anomalies that Pakistan has seen recently, including extended heat waves and changing monsoon patterns. Tomato plants experience decreased pollination effectiveness, flower loss, and fruit deformity during intense heat waves. Furthermore, because of glacial melting and changed precipitation cycles, the nation's irrigation systems which rely heavily on rivers fed by glaciers are becoming more and more unreliable. Tomato producers are facing difficulties as a result of this water availability uncertainty, especially those who rely on regular irrigation (Qadir *et al.*, 2020).

The agricultural sector in Khyber Pakhtunkhwa is now more susceptible to flooding due to the monsoon season's increased severity and unpredictability. In addition to destroying crops, these floods cause soil erosion and nutrient loss, which worsens the condition of the ground for future tomato farming (Ashraf and Routray, 2013). Additionally, the province experiences droughts, especially in the southern parts, which have an impact on the amount of water available for irrigation. Due to these difficulties, farmers in Khyber Pakhtunkhwa have been compelled to modify their methods, which include modifying planting dates, looking for tomato cultivars that are more drought-resistant, and putting improved water management strategies into place. One of the main agricultural pursuits of Nowshera is the production of tomatoes, especially in the rich riverbank regions. However, growers are finding it more challenging to maintain steady tomato yields as a result of the combination of rising temperatures and erratic rainfall patterns. Tomato plant development and productivity are significantly impacted by root diseases like bacterial wilt, which are brought on by waterlogged soils during periods of heavy rainfall. On the other hand, farmers have water shortages during droughts, which impede irrigation efforts and result in tomatoes that are smaller and of lesser quality (Khan *et al.*, 2020). The farming community in Nowshera is significantly impacted socioeconomically by climate change. The lack of funding prevents many smallholder farmers from implementing contemporary farming practices that could lessen the effects of climate change. These farmers are more susceptible to crop failures, which impacts their income and food security, since they lack access to effective irrigation systems or drought-resistant tomato varieties (Ahmed *et al.*, 2013). One of the most extensively grown horticulture crops in the world, tomatoes (*Solanum lycopersicum*) provide millions of people with a substantial source of sustenance and revenue. Because of its economic significance and role in ensuring food security, tomato production is essential in Pakistan. Nonetheless, climate change is a serious danger to agricultural output, and creating sustainable farming methods requires an awareness of how it affects tomato crops in this area. This study is essential to comprehending how tomato farming is affected by climate change. It will seek to enable stakeholders, such as farmers, agricultural researchers, and policymakers, to make well-informed decisions that guarantee sustainable tomato production in a time of changing climatic circumstances by offering thorough data and analysis.

## Materials and Methods

### Experimental Site and Design

The universe of the study was District Nowshera Khyber Pakhtunkhwa, Pakistan. This location is usually ideal for tomato cultivation. Several crops, including fodder crops, cash crops, grains, beat root crops, and vegetables are grown in district Nowhera. With the help of concerned area's extension field staff, a list of all those farmers who practiced vertical and traditional tomato cultivation was prepared. Keeping this in mind, for the current study, 30 % of the total tomato growers were selected randomly as sampled respondents for data collection. For sample size selection at the village level, proportional allocation sampling technique was employed. Total sample size was 135 tomato growers. An interview schedule was used as a tool for primary data collection, developed with the study's objectives in view and the goal of collecting accurate and relevant information. A well-structured interview schedule was designed for data collection. The research study was focused on primary data obtained via face-to-face interviews with tomato growers. The interview schedule was pre-tested in the field and any amendments needed, was made. To get authenticated information, the key informant strategy was also used secondary data, from various published and unpublished sources. Data were analyzed using the Statistical Software for Social Sciences (SPSS version 21). The results of this study were presented using frequency distribution tables and percentages. In addition, Chi square test was performed to analyze the relationship of various categorical variables. Paired sample t-test was also applied to compare tomato production of 2024 and 2025.

## Results and Discussion

### Age of the Respondents

Age is a significant factor for the diffusion and adoption of new technology, especially improved crop varieties, effective fertilizer application and advanced agriculture practices. It also significantly affects innovation diffusion within the farming community (Agwu *et al.*, 2008). Respondents were asked about their age and the categorized in three groups: 18-35 years, 36-50 years and above 50 years, responses of them are presented in **Fig 1**.

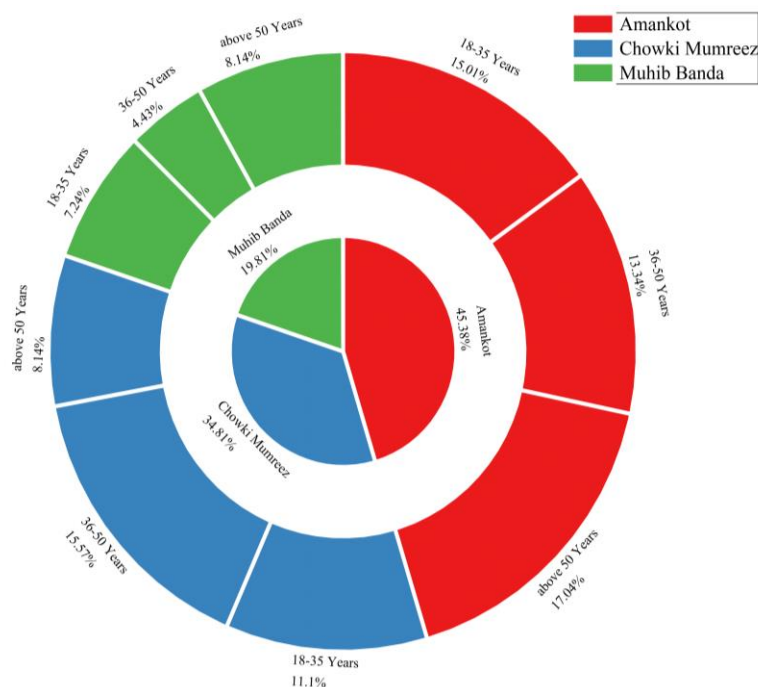


Fig. 1: Distribution of the respondents regarding area and age (Years)

The results of the study presented in **Fig. 1** disclosed that majority (46.0%) of the respondents laid in the age group of 18-35 years old while one-fifth (20.7%) of the respondents had age of above 50 years. It is also clear from data that one-third (33.3%) of the respondents laid in the age group of 36-50 years. Results of the study closely aligns with Demenongu *et al.* (2015), who reported that 30% of the respondents were belonged to age group of 40-50 years.

### Educational Level of the Respondents

Education is an essential aspect that promotes the desired change in behavior. It mainly acts as a tool in disseminating new technologies, adopting improved agricultural practices, and using innovative techniques (Buhari *et al.*, 2021). Respondents of the study were asked about their education status and responses are presented in **Fig. 2**.

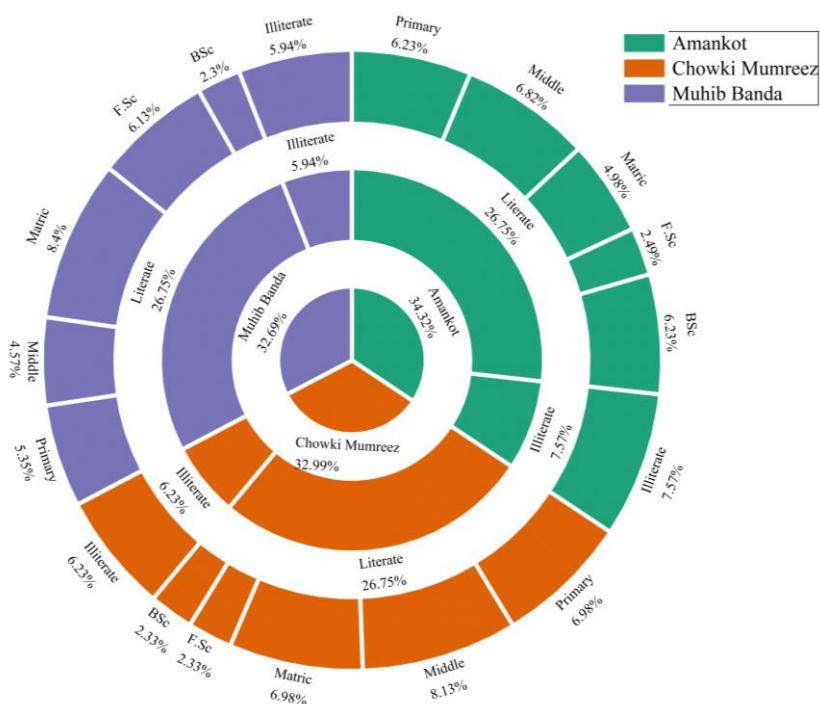


Fig. 2: Distribution of respondents regarding educational level

Results of the study presented in **Fig.2** depicted that one-fourth (25.2%) of the respondents were illiterate, they had no formal education; while majority (74.8%) of the respondents were literate. Among the literate, 24.6% of the respondents got education till matric level. Study found that 23.5% of the respondents got education up to middle level, while 22.5% of the respondents had primary level of education. The higher level of education possessed by respondents was BSc 14.7% of the respondents. Results of the study were contradictory with Pervaiz *et al.*, (2013) who reported that vast majority (90.0%) of the respondents were illiterate. This contradiction in the results is due to difference in study area.

### Factors of Climate Mostly Affect Tomato

Respondents of the study were asked about the factors that mostly affect their productivity of tomato crop and their responses are recorded in **Fig. 3**



*Fig.3: Distribution of respondents regarding climate factors most affect tomato production*

Results of the study presented in **Fig.3** highlights that 30.4% of the respondents claimed drought condition affect their productivity of tomato crop, while 16.3% of the respondents claimed floods in the area hardly affect their tomato crop. Study further explores that irregular rainfall (28.1%) and rising temperature (25.2%) are factor affecting the productivity of tomato crop. In village Muhib Banda, the 35.6% of the respondents claimed drought condition affect their crop while in Chowki Mumreez, 33.3% of the respondents claimed it. In Amankot, 31.7% of the respondents claimed that irregular rainfall affects the productivity of their tomato crop while in Muhib Banda 26.7% reported irregular rainfall affect their crop productivity.

### **Farmers Perception about Climate Change**

Assessing the understanding of farming community regarding climate change is crucial in designing effective awareness and training programs. It helps in recognizing misconceptions, knowledge gaps and willingness to adopt climate resilient practices. This insight allows specific interventions, ensuring that trainings provided are relevant and impactful (Moser and Dilling, 2011). In light of importance of this specific factor respondents were asked about their perception about climate change occurring and responses of them are presented in **Fig.4**

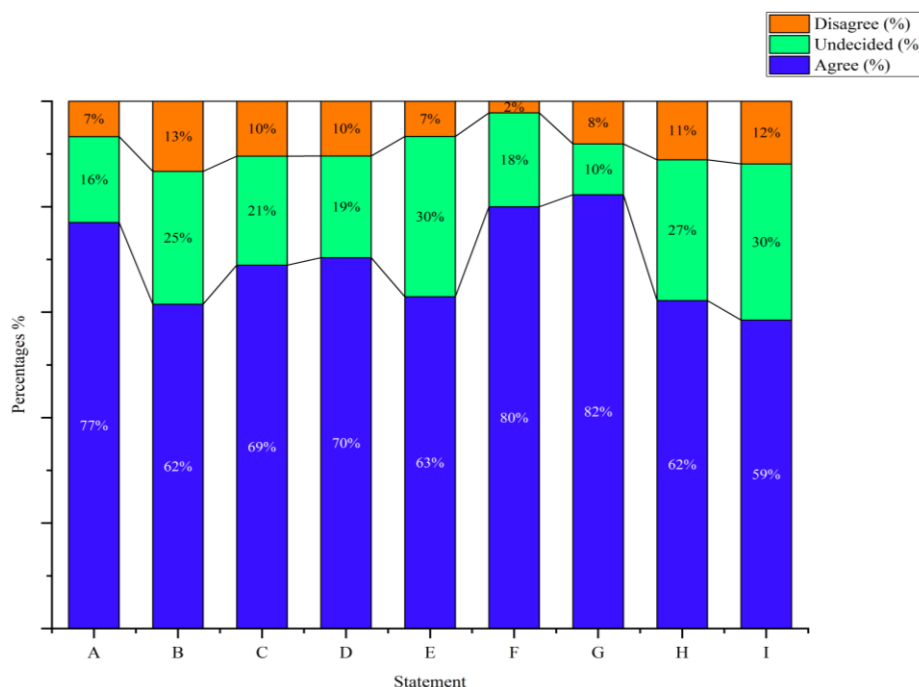


Fig. 4: Distribution of respondents regarding perceptions about climate change. (A) Increase in temperature and number of sunny days, (B) Increase in frequency of heavy rains, (C) Rains are occurring either earlier or later than the expected rainy season, (D) Total rainy days have decreased, (E) Intensity of hail storm and wind storm increased, (F) Intensity of heat during summer has increased, (G) Bitterness of cold during winter has increased, (H) Intensity of frost and crop injury increased, (I) Winter duration (days/year) has decreased.

Data presented in **Fig. 4** show that majority (77.0 %) of the respondents were agreed that there was an increase in temperature and number of sunny days, while 6.7% of the respondents was disagreeing with this. Majority (61.5%) of the respondents were agreed with frequency of heavy rains increased due to climate change, while 13.3% of the respondents disagreed with this. Study found that 68.9% of the respondents were agreed with fluctuation in rains patterns while 10.4% of the respondents were disagreed with this. Two third (70.4%) of the respondents were agreed with the statement that total rainy days decreased and 80.0% of the respondents had argument that due to climate change intensity of heat during summer has increased. Furthermore, study found that 82.2% of the respondents argued that bitterness of cold during winter has increased while 58.5% of the respondents had argument that average winter duration has decreased. Results of the study are Ashraf *et al.* (2020) who claimed in their study that variation in the rainfall pattern and temperature were the major effects of the climate change.

#### Area and Production of Tomato Crop (2024 and 2025)

Average yield of agricultural commodities affected by the climate variability, sometimes it may be positive effect and sometime has negative effects. The effect of climate on agricultural productivity varies from region to region (Afsar, 2020). So, for assessing the effect of climate change on productivity it is important to check the production of tomato crop in study area. Responses of particular variable are shown in Table 5.

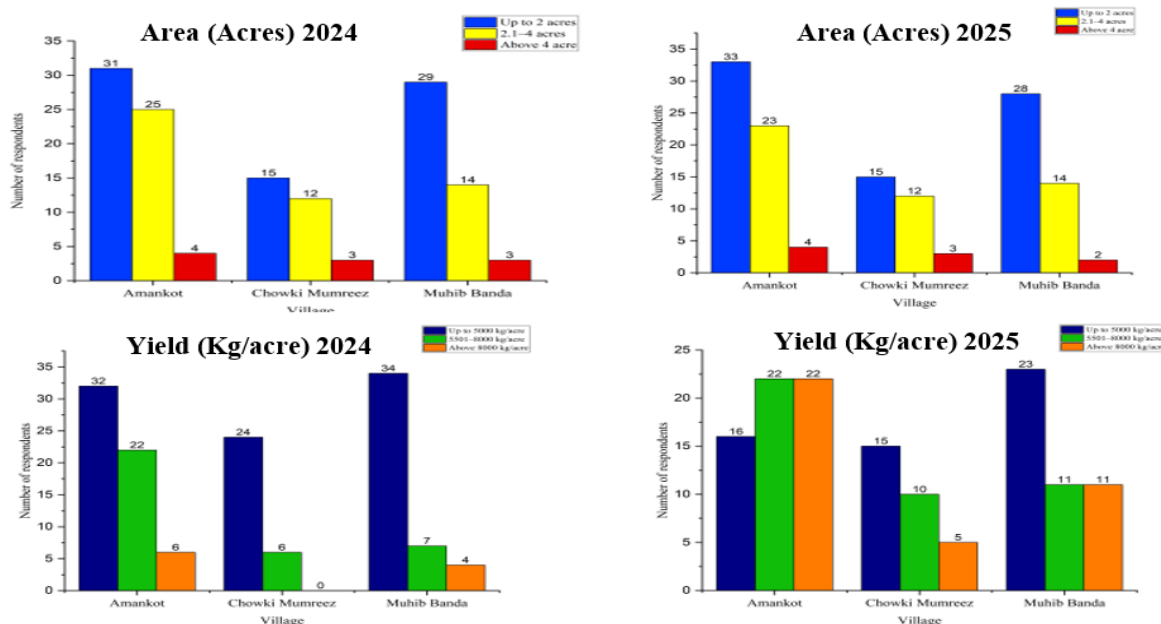


Fig.5: Distribution of respondents regarding area and production of tomato crop in last two seasons 2024 and 2025

Results of the study presented in **Fig 5** identified that most (55.6%) of the respondents cultivated tomato on up to 2 acres of land, while 7.4% of the respondents cultivated on more than 4 acres in 2024. Study also found that 37.7% of the respondents cultivate tomato between 2.1 to 4 acres of land. Study found that most (66.7%) of the respondents got yield up to 5000 Kg/acre, while 7.4% of the respondents got above 8000 Kg/acre yield of the tomato 2024. Study further disclosed that most (56.7%) of the respondents cultivate tomato on up to 2 acres of land, while 6.7% cultivate tomato crop on above 4 acres of land in 2025. Study found that 36.6% of the respondents cultivate tomato crop between 2.1 to 4 acres of land. Out of the total respondents 40% of the respondents got yield up to 5000 Kg/acre of tomato crop, while 31.9% of the respondents got yield between 5001 to 8,000 Kg/acre from tomato cultivation. It is concluded from the result that yield of 2025 was better than the previous year. Our results were also in line with GoP (2025) as government statistics disclosed that in 2025 yield of tomato crop increased up to 8.8%.

### Paired Sample T-Statistics

A paired- samples t-test was performed to evaluate the impact of trainings regarding climate adaptation between last two years of tomato yield. The results of study revealed significant increase in yield of tomato crop ( $M= 6700.54$ ,  $SD= 3596.172$ ) and yield of 2024 ( $M= 4386.57$ ,  $SD= 2273.445$ ),  $t (-11.6)$ ,  $p = 0.000$  (two tailed). The mean increase in the test score was 2313.97 with a 95% confidence interval (Table 6). These results are supported by GoP (2025) statistical report on agricultural productivity which claimed that 8.8% of the yield of tomato increase in current year compared to previous.

**Table 1: Paired sample t-test comparison of tomato yield and area (2024- 2025)**

Variable	2024		2025		Mean difference	t- Value	P. Value
	Mean	SD.	Mean	SD.			
Yield (Kg/Acre)	438657	2273.445	6700.54	3596.172	-2313.97	11.66	0.000***
Area under Tomato Cultivated (acres)	2.306	1.1665	2.344	1.1977	-0.0389	0.577	0.565 <sup>NS</sup>

It is clear from the data that there was not significant increase in the area under tomato in 2025, but yield was increased due to climate change adaptation practices adopted by respondents in the study area.

### Conclusions and Recommendations

The present study provides important insights into the socio-economic and environmental dimensions of tomato cultivation under changing climatic conditions. It is concluded that tomato farming is practiced by growers with varying levels of age and farming experience, though younger and middle-aged groups dominate. While practical farming knowledge is present, Irrigation remains heavily dependent on canal water, supplemented by tube wells in some cases, yet irregular water supply and recurring droughts pose serious challenges to production stability. It is concluded that despite their reliance on traditional farming methods, tomato growers were increasingly exposed to environmental risks that demand adaptive measures. The study further revealed that farmers were not only aware of climate change but also directly experiencing its effects in the form of extreme heat, irregular rainfall patterns, pest outbreaks, and occasional floods. Respondents reported noticeable shifts in temperature and precipitation trends over the last decade, with significant consequences for productivity. However, while awareness is high, the ability to adapt effectively remains limited due to financial barriers, high input costs, inadequate institutional support, and weak extension services. This gap between knowledge and practice reflects the structural challenges faced by smallholder farmers, who recognize the risks but lack the means to invest in climate-smart practices. Addressing these barriers is therefore essential to ensure that awareness translates into action. The role of extension services and training emerged as highly significant in shaping farmers' knowledge and adoption behavior. Extension field staff visits and training programs on tomato production and climate adaptation were associated with improvements in farming practices and productivity. Based on the conclusions it is recommended that Agricultural extension services should be strengthened to provide farmers with regular, practical training on tomato production and climate adaptation. Further recommended that Access to timely and accurate weather information should be improved through mobile alerts, radio, and local advisory services, enabling farmers to make informed decisions about irrigation, sowing, and pest control.

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