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ASSOCIATION BETWEEN SOCIO-DEMOGRAPHIC CHARACTERISTICS OF WHEAT GROWERS AND THEIR AWARENESS TO CLIMATE-RESILIENT AGRICULTURAL PRACTICES IN PUNJAB, PAKISTAN

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Abstract
Objectives: Farmers' awareness of innovative technologies is a critical catalyst for transforming agricultural systems towards sustainability and enhanced productivity in the face of escalating climate challenges. While numerous studies have explored how socio-demographic characteristics influence the adoption of new technologies, less attention has been paid to the factors shaping farmers' foundational awareness of Climate-Resilient Agricultural Practices (CRAPs). To address this gap, this study was conducted in six of the largest wheat-producing districts of Punjab, Pakistan.
Materials and Methods: Data were collected from 384 wheat growers using a semi-structured questionnaire and a multistage sampling technique. Analysis involved frequency counts, percentages, weighted means, and chi-square tests.
Results: The results reveal a significant positive association ($P < 0.05$) between farmers' awareness of CRAPs and their age, education level, farming experience, farm size, and annual income. In contrast, land tenancy status showed no significant relationship with awareness levels.
Conclusions: These findings underscore that key socio-demographic profiles are strong predictors of awareness, suggesting that targeted extension programs and communication strategies are essential for improving the reach and effectiveness of climate-resilient agriculture initiatives.
Keywords: Wheat growers, climate resilience agricultural practices, Awareness, regression analysis,

INTRODUCTION

Climate change poses a significant threat to global agriculture, with vulnerable regions like Punjab, Pakistan a cornerstone of the nation's food security and rural livelihoods being particularly at risk (Usman et al., 2025). Rising temperatures, erratic rainfall, and extreme weather events threaten wheat yields, necessitating the widespread adoption of Climate-Resilient Practices (CRPs) to enhance adaptive capacity (Ali et al., 2023). However, the adoption of these practices is inherently dependent on farmers first being aware of them. The extent of this awareness is often influenced by socio-demographic characteristics such as age, education, landholding size, and access to extension services (Hussain et al., 2024). Understanding these associations is therefore critical for designing targeted interventions to improve resilience among wheat growers.

Awareness is the first essential step in the technology adoption process. Studies across various agricultural contexts reveal a strong positive correlation between farmers' awareness of improved technologies and their subsequent adoption (Barnes et al., 2019; Xie and Huang, 2021). For instance, initiatives in Ethiopia and Nigeria demonstrated that awareness campaigns led to significant increases in the adoption of improved seeds and techniques, boosting yields by 14% and adoption rates by over 50%, respectively (Abate et al., 2018; Hassan, 2018). This underscores the critical role of awareness as a precursor to adoption.

The need for such strategies is acute in South Asia. Pakistan is among the most climate-vulnerable countries in the region, facing economic challenges and a high dependence on agriculture. Recent data indicate a severe climatic shift, with Pakistan experiencing 40% less rainfall than its 30-year average. Between September 2024 and January 2025, key agricultural provinces like Punjab received only 42% of normal rainfall (Down, 2025). These changes deplete soil nutrients and degrade the agro environment, further threatening food security (Fahad and Wang, 2020). Smallholder farmers, with limited resources to cushion these impacts, are disproportionately affected.

Despite the increasing emphasis on CRPs, disparities in awareness and adoption persist, often shaped by farmers' socioeconomic backgrounds (Ashraf et al., 2025). While previous studies highlight that education level and farming experience influence the adoption of new practices (Raza et al., 2025), region-specific insights into the factors affecting awareness of CRPs remain limited, particularly in Punjab, Pakistan's agricultural heartland.

Therefore, this study aims to determine the association between the socio-demographic characteristics of wheat growers and their awareness of CRPs in Punjab, Pakistan. The study tests the following hypotheses:

Ho1: There is a positive and significant Association between the farmers' age and their awareness of climate-resilient agricultural practices.

Ho2: There is positive and significant Association between level of education of the farmers and their awareness of climate resilient agricultural practices.

Ho3: There is positive and significant Association between farmers' experience in wheat production and their awareness of climate-resilient agricultural practices.

Ho4: There is a positive and significant Association between farm size in wheat production and their awareness of climate resilient agricultural practices.

Ho5: There is a positive and significant Association between income of the farmers and their awareness of climate-resilient agricultural practices.

Ho6: There is positive and significant Association between land holding of the farmers and their awareness of climate-resilient agricultural practices.

Ho7: There is positive and significant Association between tenancy of the farmers and their awareness of climate-resilient agricultural practices.

Ho8: There is positive and significant Association between yield obtained and farmers awareness to climate-resilient agricultural practices

METHODOLOGY

Study area

Punjab province is located between latitudes 30°00 N and 70°00 E (Hussain et al., 2024). The province has the most fertile agricultural land and accounts for 70% of the cereal production in the country. Punjab province contributes more than 50% of the agricultural GDP of Pakistan (Qazi et la., 2021). More than 60 percent of total cereal production in the country is from Punjab (Hussain et al., 2012). The province also has a total arable land area of more than 7.9 million hectares, out of which, 60% is under cultivation. Punjab is in the semi-arid lowland region of Pakistan (Gulani et al., 2021). Because of the substantial contribution the province has in maintaining the country's food security. Punjab, Pakistan, is divided into 10 agro-ecological zones based on differences in climate, soil types, water availability, and cropping patterns. These divisions help in agricultural planning, resource management, and policymaking. The classification was established by Punjab's Agriculture Department and PARC (Pakistan Agricultural Research Council) to optimize farming practices according to regional conditions

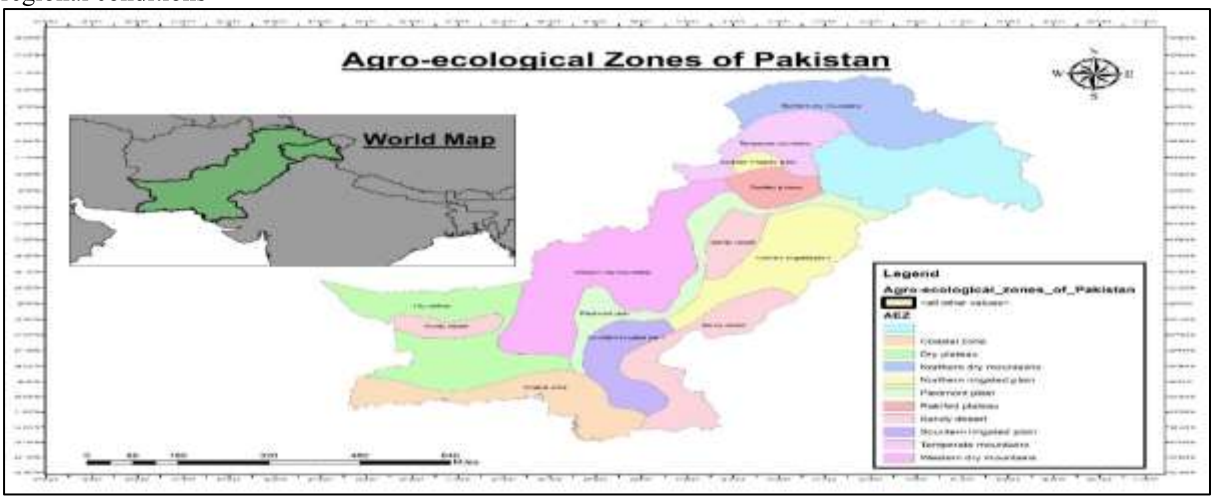


Figure 1 Study Area

Sampling procedure

Multistage sampling procedure was used for the study. In the first stage, three ecological zones were purposively selected on the basis of land topography, area and having highest wheat production. From the 3 agro-ecological zones selected, six (06) districts were purposively selected due to high wheat production (02 from each Zone), this is followed by purposive selection of twelve (12) Tehsils (02 from each district). The largest wheat producing tehsils were selected from each district and followed by selection of 2 area council from each tehsil making 24 area councils. In addition, 2 village were randomly selected from each area council thus 48 villages were selected. At the final stage 8 respondents were selected randomly through lottery from each village, thus a total of 384 respondents forms the sampling frame. This number was obtained from the table of sampling by (Chuan, and Penyelidikan, 2006).

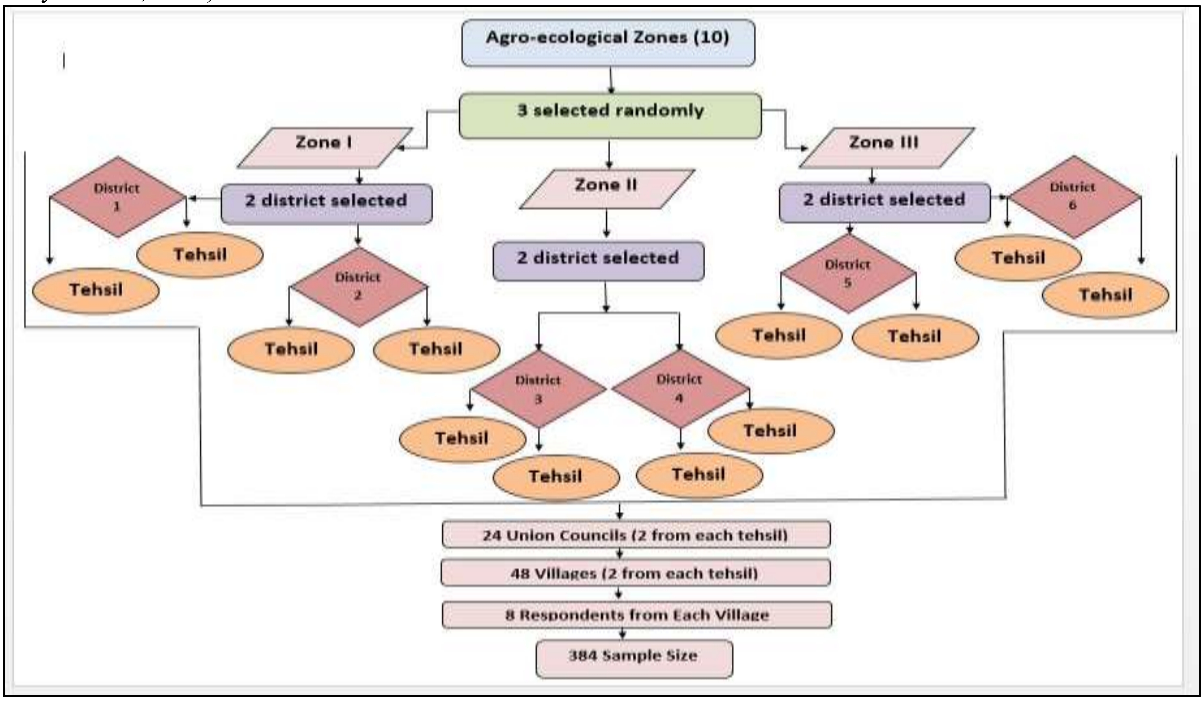


Figure 2 Overall Methodology Flowchart

METHOD OF DATA COLLECTION

A semi-structured questionnaire was used as the means of data collection. Those who could read and write the questionnaire was given to them and filled by themselves. However, those who cannot read and write the contents of the questionnaire were interpreted to them and their responses were recorded. The researchers were able to accomplish this with the help of professional enumerators. The questionnaire contains several sections including socioeconomic variables, production and awareness level of CRAPs. likert scale format was used to classify the awareness level in to (not aware, slightly aware, somewhat aware, moderately aware and fully aware). All information was entered into a spreadsheet made with Microsoft Excel 2016, and then analyzed with SPSS 24

Method of data analysis

The socioeconomic characteristics of the respondents were analyzed using descriptive statistics as frequencies and percentages. The awareness level was analyzed using weighed mean. Finally, chi square analysis was used to assess the association between the sociodemographic variables of the respondents and their awareness about CRAPs

Chi-square analysis

The chi-square test, which is a statistical method used to analyze categorical data was used to determine the association between the socio-demographic features and framers' awareness of the use of CRAPs. To conform with the condition of usage, all the data were transformed into categorical groups

$$\chi 2 = \sum \left(\frac{\mathbf{O_{ij}} - \mathbf{E_{ij}}}{\mathbf{E_{ij}}} \right)^2$$

Where;

$$\mathrm{o} = \text{observed frequency}, \mathrm{E} = \text{expected frequency}$$

Goodness of fit: df = K-1

Test of independence: df = (r-1) (c-1)

Validity and Reliability

The instrument was presented to a panel of experts from the Department of Agricultural Sciences, Faculty of Sciences at Allam Iqbal Open University Islamabad, Pakistan to assess the face and content validity of the tool. Following minor modifications to the sequence of questions, the experts endorsed the instrument. Additionally, the instrument underwent validation by two Agriculture Officers (AOs) employed in the Government sector. They meticulously reviewed the instrument and confirmed the appropriateness of its contents. To determine the reliability of the instruments, Cronbach's alpha was calculated and were found to have an acceptable value of greater than 0.7 as reported by (Taber, 2018).

RESULTS AND DISCUSSION

Socio-demographic characteristics

Result in Table 1, indicates that the age distribution of the respondents reveals that some of farmers (38.8%) fall within the 41–50 age group, followed by 51–60 (29.2%), indicating an a relatively aging farming population. Younger farmers (21–30 years) represent only 6%. The mean age of the farmers was found to be 49.09 years. Farming experience is notably high, with 43.2% having 21–30 years of experience and 12% exceeding 30 years. The mean year of experience was 21.32 years, this suggests that most farmers are experienced. A significant proportion of farmers have low formal education, 14.8% are illiterate, and 32.8% have only primary-level schooling. Only 4.4% have graduation or higher education, which may limit their access to and comprehension of modern agronomic practices. This underscores the need for visual, hands-on, and local-language extension methods rather than text-heavy materials.

In relation to annual income, the result shows that 34.9% earn PKR 500,001–1,000,000 annually, while 24.7% earn below PKR 500,000, indicating modest incomes that may restrict investment in advanced farming technologies. Only 13.5% earn above PKR 2,000,000. The income source revealed that 58.1% rely on crop cultivation + livestock, highlighting mixed farming probably as a risk-mitigation strategy. Some 25.3% depend solely on crops, making them more vulnerable to climate and market shocks. Concerning land holding the result indicates that nearly 50% cultivate <5 acres, indicating smallholder dominance, which aligns with Pakistan's agrarian structure.

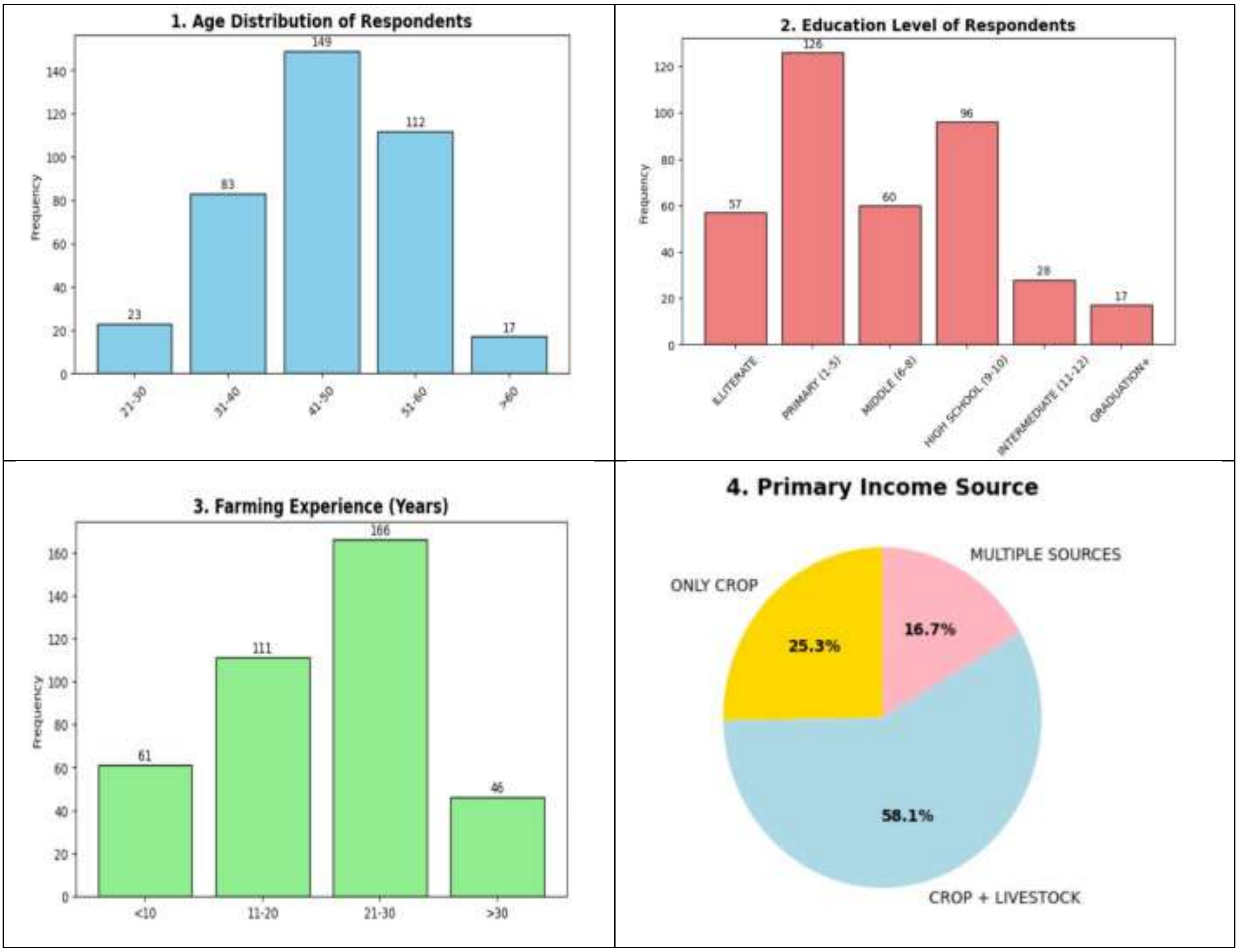
Moreover, the result indicates that Wheat yields are moderate, with 47.7% achieving 31–40 maunds/acre and only 7.6% exceeding 50 maunds/acre. This suggests room for improvement through better seeds, precision farming, and nutrient management. These findings highlight the need for demographic-sensitive, economically viable, and education-appropriate agricultural policies to enhance productivity and sustainability.

Table 1: Socio-demographic characteristics (N = 384)

AGE CATEGORIES	FREQUENCY	PERCENTAGES	MEAN
21-30	23	6.0	
31-40	83	21.6	
41-50	149	38.8	
51-60	112	29.2	
>60	17	4.4	49.09
EDUCATION			
ILLITERATE	57	14.8	
1-5 (PRIMARY)	126	32.8	
6-8 (MIDDLE)	60	15.7	
9-10 (HIGH SCHOOL)	96	25	
11-12 (INTERMEDIATE)	28	7.3	
(14 AND >14) GRADUATION AND ABOVE	17	4.4	8.91
FARMING EXPERIENCE			
<10	61	15.90	
11-20	111	28.91	
21-30	166	43.23	
>30	46	11.98	21.32
INCOME OF THE RESPONDENTS			
<500,000	95	24.7	
500,001 - 1,000,000	134	34.9	
1,000,001 – 2,000,000	103	26.9	
> 2,000,000	52	13.5	1,257,682.29

INCOME SOURCE			
ONLY CROP CULTIVATION	97	25.26	
CROP CULTIVATION PLUS LIVESTOCK	223	58.07	
MULTIPLE SOURCES	64	16.67	
AREA CULTIVATED UNDER WHEAT			
<5	190	49.48	
6-10	116	30.21	
> 10	78	20.31	6.42
YIELD PER ACRE			
<30	88	22.92	
31 – 40	183	47.66	
41 – 50	84	21.88	
> 50	29	7.55	32.54

Source: Field survey, 2025



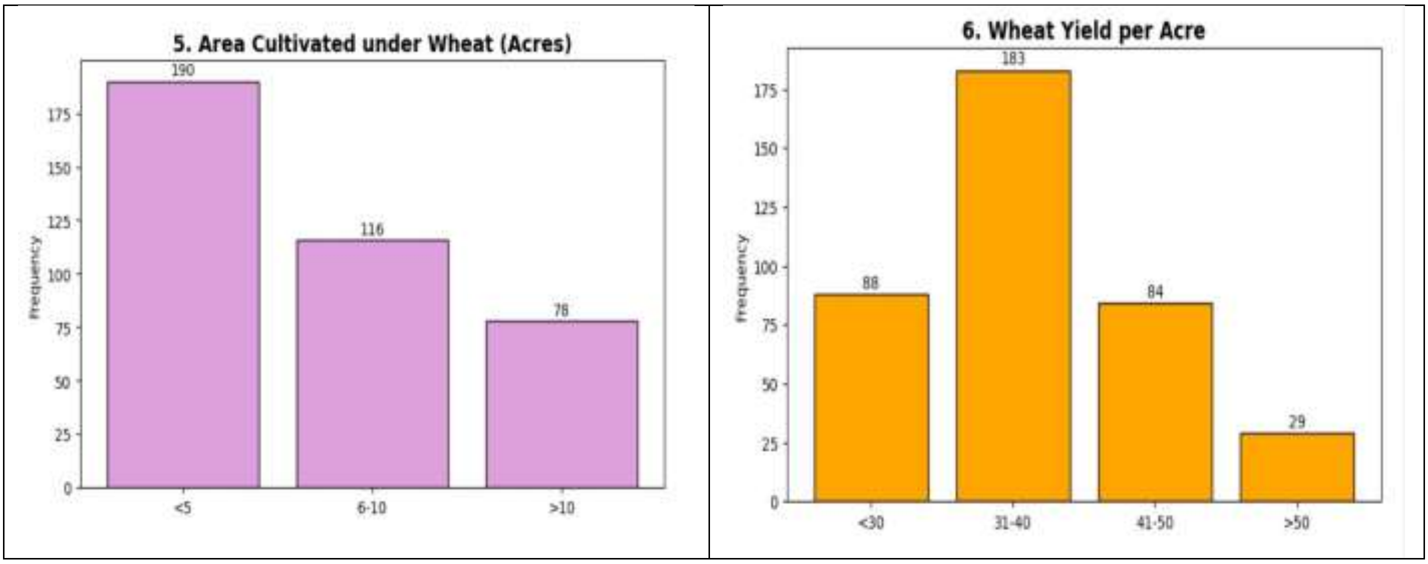


Figure 3-8: Age distribution of Respondents, Education Level of Respondents, Farming Experience, Primary Income Source, Cultivated areas under wheat, wheat yield per acre respectively

Awareness level of the respondents

From Table 2, the result shows that growers show highest awareness of ridge sowing (4.41), seed priming/Inoculation (mean score: 4.22), use of compost (4.15) raised bed technology (4.02), drill sowing method (4.00) and use of farmyard manure (4.00). studies by (Olesen et al., 2012; Zimmermann et al., 2017) outline that adjusting sowing dates is key for climate adaptation. Other practices like seed priming (38.5% fully aware), raised beds (37.8%), and drill sowing (31.3%) also had notable awareness. Irrigation management had 32.6% full awareness. Sowing data and irrigation management also has high awareness rate with mean value of 3.96, and 3.92 respectively.

Moderate awareness was reported for reduced tillage wheat sowing (3.89)**,** zero tillage wheat sowing (3.73), spinning method (3.78). Others are drifting varieties of crop duration (3.69), use of resilience varieties (3.55), Nutrients Spray/Hormones Spray (3.54) and use of inorganic fertilizer (3.52). Relatively low awareness was reported for Improved Post-harvest Management Techniques (3.44) and integrated pest management with mean score of 3.27. Although post-harvest loss led to significant loss the awareness level is relatively low. The lowest mean score was farmers awareness about the importance of intercropping with mean value of 2.52.

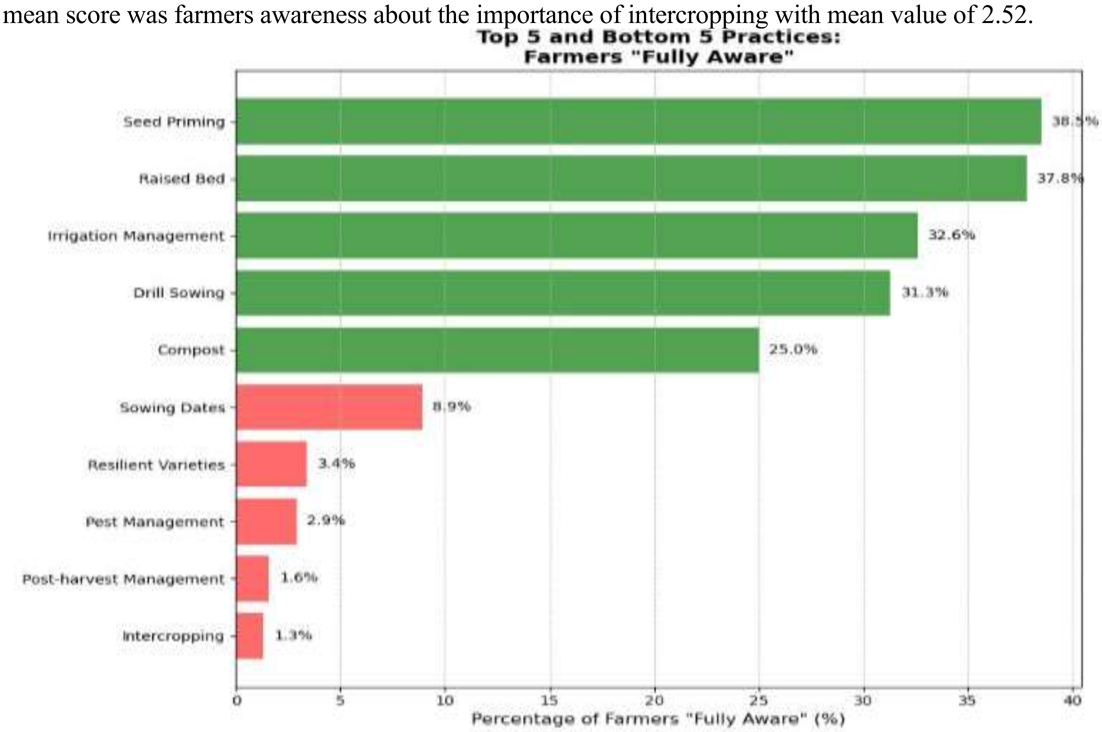


Figure 9: Top 5 and bottom 5 Practices Fully Aware

Table 2: Farmers awareness of climate resilient agricultural practices
Source: Field survey, 2025

Sr. No	CRAPs	Not at all aware (F %)	Slightly Aware (F %)	Somewhat Aware (F %)	Moderately Aware (F %)	Fully Aware (F %)	Mean	S.D
01.	Sowing Dates	0.000	3 (0.8)	43 (11.2)	304 (79.2)	34 (8.9)	3.96	.480
02.	Use of Resilient Varieties	0.000	53 (13.8)	80 (20.8)	238 (62.0)	13 (3.4)	3.55	.770
03.	Drifting Varieties of Crop Duration	5 (1.3)	60 (15.6)	68 (17.7)	167 (43.5)	84 (21.9)	3.69	1.022
04.	Zero Tillage Wheat Sowing	0.000	29 (7.6)	81 (21.1)	221 (57.6)	53 (13.8)	3.78	0.776
05.	Reduce Tillage Wheat Sowing	0.000	5 (1.3)	123 (32.0)	166 (43.2)	90 (23.4)	3.89	.772
06.	Seed Priming/Inoculation	5 (1.3)	3 (0.8)	44 (11.5)	184 (47.9)	148 (38.5)	4.22	.777
07.	Raised Bed Technology	0.000	13 (3.4)	111 (28.9)	115 (29.9)	145 (37.8)	4.02	.897
08.	Drill Sowing Methods	0.000	4 (1.0)	112 (29.2)	148 (38.5)	120 (31.3)	4.00	.805
09.	Spinning Method	0.000	39 (10.2)	69 (18.0)	214 (55.7)	62 (16.1)	3.78	.837
10.	Ridge Sowing	22 (5.7)	23 (6.0)	97 (25.3)	168 (43.8)	74 (19.3)	4.41	5.354
11.	Nutrients Spray/Hormones Spray	13 (13.4)	55 (14.3)	73 (19.0)	196 (51.0)	47 (12.2)	3.54	.992
12.	Irrigation Management	0.000	25 (6.5)	105 (27.3)	129 (33.6)	125 (32.6)	3.92	.925
13.	Fertilizers Application	0.000	19 (4.9)	114 (29.7)	201 (52.3)	50 (13.0)	3.73	.746
14.	Use of Inorganic Fertilizers	22 (5.7)	33 (8.6)	91 (23.7)	201 (52.3)	37 (9.6)	3.52	.980
15.	Intercropping	58 (15.1)	121 (31.5)	157 (40.9)	43 (11.2)	5 (1.3)	2.52	.925
16.	Use of Farm Yard Manure	0.000	2 (0.5)	58 (15.1)	261 (68.0)	63 (16.4)	4.00	.580
17.	Use of Compost	0.000	3 (0.8)	34 (8.9)	251 (65.4)	96 (25.0)	4.15	.591
18.	Integrated Pest Management Practices	11 (2.9)	36 (9.4)	185 (48.2)	141 (36.7)	11 (2.9)	3.27	.785
19.	Improved Post-harvest Management Techniques	11 (2.9)	50 (13.0)	89 (23.2)	228 (59.4)	6 (1.6)	3.44	.843

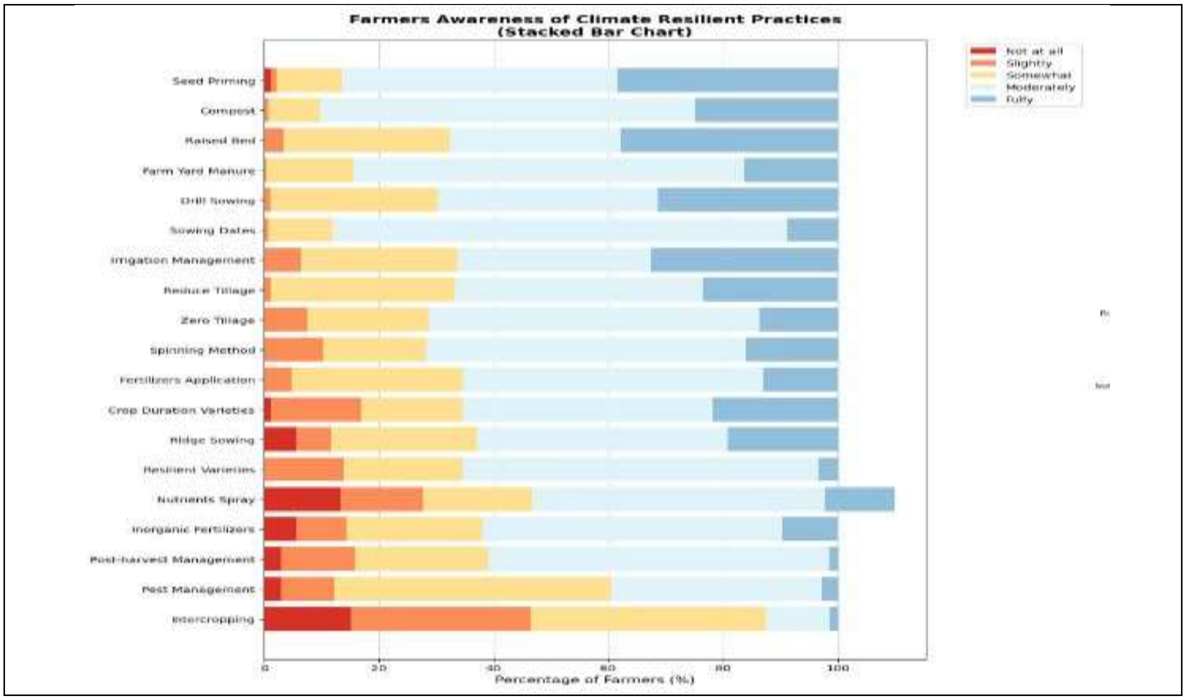


Figure 10: Farmers Awareness of Climate Resilient Practices

Association between socio-demographic characteristics and wheat farmers awareness to use of CRAPs for agricultural productivity

The study examined the relationship between socio-demographic characteristics and wheat farmers' awareness of resilience agricultural practices (CRAPs). Factors like age, education, experience, land holdings, farm size, income, tenancy, yield, and annual income were considered as independent variables, while awareness was considered as a dependent variable in table 3. Based on the results, all the tested variables (age, education, farming experience, yield obtained, land ownership, farm size and respondent annual income) with exception of tenancy are found to be significantly associated with farmers awareness to the use of CRAPs. According to Adam et al. (2021), the socio-economic profile of the farmers plays important role in the use and adoption of new technology, but the users might not get equal benefits due to different capabilities and implementation. For example, Mallappa, et al., (2023) outlined that there is a positive correlation between education of farmers and their awareness and adoption of climate smart agricultural practices. They, however, posited that the association may vary from area to area due to nature and perceived use of technology and even the level of competency and education.

From the result (Table 3), age ($\chi^2 = 418.923$, $*p* < 0.001$) is found to be significantly associated with the awareness of the use of CRAPs. Study by Asravor, (2019) indicated that older farmers often exhibit higher awareness but lower adoption due to risk aversion and reliance on traditional methods. The result of the current study resonates with the study of Adhikari et al. (2022) who had found positive and significant association between farmers age and their awareness to climate smart agricultural practices in Nepal. The study supports Moyo and Salawu's (2019) finding that farmers' age is linked to their preference for communication media in Zimbabwe, contradicting Ali's (2019) findings that there is no association between farmers' age and their awareness and adoption of ICT in Malaysia. Education plays a crucial role in technology awareness and adoption, with educated farmers more likely to adopt CRAPs due to improved access to information and technical knowledge. Increased educational levels could positively affect farmers' intentions to use or adopt more technologies for better farming practices. Onoja et al. (2019) conducted a study in Nigeria and found that urban farmers with formal education demonstrated higher awareness of CSAPs practices such as drought-resistant crops and soil conservation. (Yagah, 2019) claimed that Illiteracy and low education hinder CRAPs. So, the results of this study also support that there is a positive association between educational level and farmers awareness about CRAPs in Punjab, Pakistan. Another socio-demographic factor which exhibits significant association is farm size. From the result, farm size ($\chi^2 = 181.668$, $*p* < 0.001$) is critical and significant. This means that farmers with larger holding are more likely to have awareness and adopt CRAPs than their counterparts. Study by Muriithi et al. (2023) showed that larger landholdings (>2ha) correlate with CRAPS adoption due to economies of scale and ability to experiment with new practices. Study by (Thierfelder et al., 2017; Agholor et al., 2023) claimed that in South Africa, farmers with fertile and larger plots were more likely to adopt conservation agriculture and crop rotation. The study further observed that smallholders often struggle with CRAPS adoption due to limited resources and fragmented plots. Farming Experience ($\chi^2 = 445.822$, *p* < 0.001) this shows a significant association between farmers experience in wheat production and their awareness about the use of CRAPs. While experienced farmers in Northern Ethiopia accurately identified climate shifts (e.g., declining rainfall), their reliance on traditional methods sometimes limited adoption of new techniques. Conversely, Tanzanian farmers leveraged indigenous knowledge to complement modern adaptations, suggesting awareness does not always translate to practice without institutional support. Higher income farmers are more aware of using CRAPs, according to studies by Hassan et al. (2019) and Cui et al. (2022). This association is crucial as increased income levels make information access easier, leading to more appropriate agricultural decisions. Studies reliably demonstrate that farmer awareness serves as a critical gateway to technology adoption, which in turn can significantly impact agricultural productivity (Rusmayadi et al., 2024). This assertion is in line with the finding of the present study $\chi^2 = 36.348$, *p* < 0.005, which demonstrates a positive and significant relationship between farmers awareness for the use of CRAPs and yield obtained.

Tables 3: Result of Association between Socio-demographic characteristics and Awareness of Wheat farmers to use CRAPs for crop productivity

Sociodemographic characteristics	**Chi-square**	**DF**	**Significant**	**Decision**
Age	418.923	52	.000	Reject H_0
Education	328.888	26	.000	Reject H_0
Farming experience	445.822	39	.000	Reject H_0
Land holding	30.872	13	.004	Reject H_0
Farm size	181.668	26	.000	Reject H_0
Income	323.109	26	.000	Reject H_0
Tenancy	05.068	13	.011	Fail to reject H_0
Yield obtained	36.348	52	.005	Reject H_0

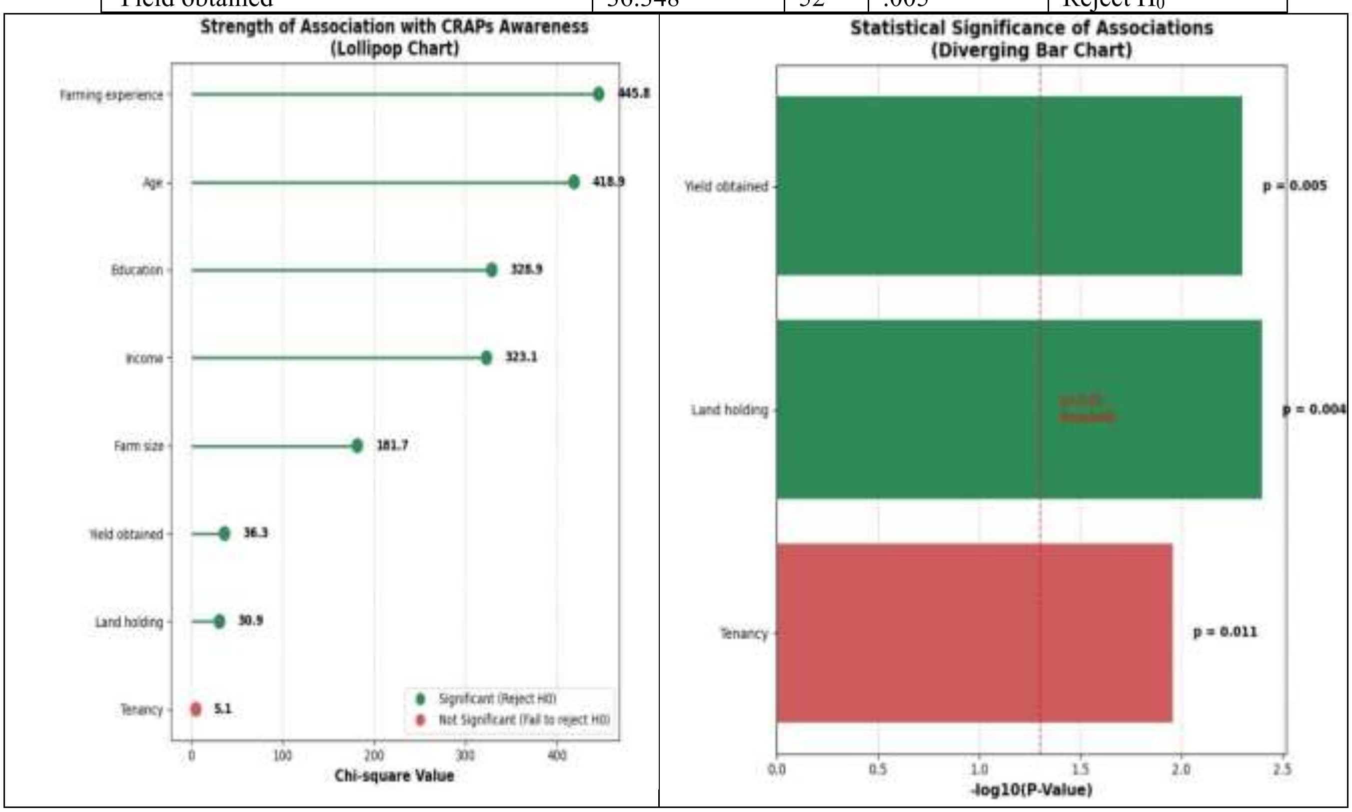


Figure 11 and 12: Strength of Association with CRAPs Awareness and Statistical Significance of Associations

CONCLUSION AND RECOMMENDATIONS

Farmers in developing countries, including Africa, are increasingly adopting Agricultural Risk Assessment Practices (CRAPs) to address climate change and environmental degradation in their agricultural sectors. Wheat farmers are particularly aware of ridge planting, seed priming, and compost use, which are crucial for crop production, agro-forestry, and livestock sub-sectors. The adoption of CRAPs is expected to intensify in the future. While post-harvest management and intercropping received the lowest scores, indicating significant gaps despite their benefits for climate resilience. Moreover, reduced tillage and robust cultivars received moderate awareness. The chi-square result shows a significant associated between farmers awareness about CRAPs and socio-demographic characteristics, namely age, education, experience, farm size, and income level. However, tenancy, could not reveal association with the awareness of farmers to the use of CRAPs in the Punjab, Pakistan.

The study suggests further research in other provinces to understand socio-demographic factors influencing wheat farmers' awareness of CRAPs for crop productivity and recommends extension service providers to promote farmers' use of CRAPs amid climate change and environmental challenges. In line with this, it is necessary for the authorities to prioritize smallholders and scale up farmer training programs through expanded extension services, this will increase awareness and, ultimately, acceptance. The study recommended to enhance understanding of farmers' awareness and usage of Climate Resilient Agriculture Practices (CRAPs) and their socio-demographic characteristics, which are crucial for increasing productivity. Despite public and private sectors promoting transformative practices, there is a need for more focus on CRAPs to address climate change and environmental degradation issues.

Conflict of interest: The authors hereby declare that there is no conflict of interest

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Authors' contributions:

HMMR: Conception/design, development of data collection instrument, analysis, interpretation of data, writing original draft, review, revised manuscript (50%)

SM: Conception/design, analysis, review and editing (30%).

MA: interpretation of data, review, revised manuscript (20%).

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