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Assessment of Farmers' Knowledge, Perceptions, and Satisfaction with Agricultural Extension Services and Climate Change Impacts in the Merged Districts of Khyber Pakhtunkhwa.

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Abstract

Climate change is a burning issue and one of the biggest hazards to the Pakistani agriculture. Agricultural sector in Pakistan especially in the merged regions of Khyber Pakhtunkhwa, is becoming vulnerable to climate change. Agriculture is the main crop in the Merged Districts of Khyber Pakhtunkhwa in Pakistan where most of the people make their living through farming, as the main source of food and security. This paper critically analyzes the knowledge, perceptions, and satisfaction of farmers with agricultural extension services; as well as, their perception of climate change and the outcomes of climate change to agriculture. Structured interviews were used to collect data on 300 farmers in South Waziristan, Bajaur, and Khyber and were supplemented with secondary data of governmental sources. Results show that the largest source of information is the agricultural extension workers, although a considerable number of farmers are dependent on NGOs, peer networks and the electronic media. About 76 percent of the respondents had been sensitized to the issue of climate change where the most recognized threat was erratic rainfall, delayed monsoons, extended dry spells, and increased temperatures. Farmers also reported several contradicting effects such as decrease in crop production, kill of livestock, rural youth migration, soil infertility and rising costs of production. Even though 60.7 percent of the surveyed clients mentioned that they are satisfied with extension services, there are still gaps in the accessibility, technical guidance and the availability of climate adaptation strategies. The paper reveals the importance of extension services in facilitating climate-sensitive agricultural practices and recommends that science and local knowledge should be used to improve the resilience of the farmers. Results offer some actionable information to policy makers and development agencies to develop some specific interventions which would enhance adaptive capacity, enhance agricultural output as well as the welfare of rural populations in the face of the increasing challenges in climatic conditions.

Keywords: Climate change, Climate-Smart Agriculture (CSA), Agricultural extension Services, Climate Change Effect, Merged districts of Khyber Pakhtunkhwa, Pakistan.

Introduction

Agriculture is the support of human civilization and one of the key components of world economies, as it gives food, raw materials, and jobs to billions of people. It is vital in providing food security, sustaining rural livelihood, and economic growth. The Food and Agriculture Organization

estimates that agriculture yields about 4 percent of the world GDP, and a significantly greater percentage in developing nations where most people depend on agriculture as a source of livelihood and income (FAO, 2021). In addition to food production, agriculture contributes to the development of industries, including textiles, biofuels, and pharmaceuticals, so it is one of the main industrial drivers (Gonzalez et al., 2022). Besides, agriculture plays the key role in global endeavors related to fighting hunger and malnutrition, and sustainable agricultural practices are the key to protecting the environment and preserving biodiversity (Godfray et al., 2018).

Pakistan relies on Agriculture as the main source of the economy as it provides a lot of employment, food security, and livelihoods in rural areas. Agriculture in the province of Khyber Pakhtunkhwa (KP) is a significant factor in supporting the local population especially in the Merged Districts, in which most of the population relies directly on farming operations to earn their living and sustain themselves. Although it is of great significance, agricultural productivity in these regions is still limited because of the lack of access to new methods of farming and agricultural extension services, as well as the emergence of new environmental challenges, such as climate change (FAO, 2021).

The extension services of agriculture are an essential bridge between the research centers, the state organizations, and the farmers due to the spread of the essential knowledge on the better agricultural practices, the pest control methods, the crop diversification and the methods to withstand the adverse climate. Good extension services enable farmers to embrace new ways of doing things that may lead to increased levels of productivity, minimize losses and even guarantee food security. Nevertheless, the knowledge, perception, and satisfaction of the farmers with the offered support will determine the success of these services to a great extent. The perception and evaluation of the extension services as perceived by farmers is thus important to enhance the effectiveness of agricultural programs in the region (FAO, 2017).

Climate change is being considered a significant menace to the world agriculture. Khyber Pakhtunkhwa with its agro-ecological variety, reliance on rain-fed agriculture, and low adaptive capacity of farming communities is especially vulnerable to the Merged Districts. The higher temperatures, climate variation of the rainfall cycle, and the frequency of severe weather conditions like floods and droughts are already influencing the crop production, land productivity and access to water supply. The knowledge and perceptions of farmers about these climatic changes are important factors that define their capacity to adapt by changing their farming methods and Crop choice as well as effective management of resources (IPCC. 2022).

Moreover, to make informed decisions, farmers usually use a variety of agricultural information sources, such as the extension workers, the media, the local knowledge, and the community network. Availability, dependability, and applicability of these sources of information play a significant role in determining the decision-making process among the farmers, particularly in the climate variability and its effects on the agricultural production process. It is thus necessary to assess the connection between delivery of agricultural extension services and the awareness of farmers on climate change so that specific interventions can be developed to increase resilience and productivity (Imelane, & Worth, 2020).

The newly merged Districts of the Khyber Pakhtunkhwa are individually challenged when it comes to the development of agriculture in the region. These are the regions that have in the past recorded low infrastructural development, inadequate institutional support as well as access to farming education and advisory services. That is why it is essential to examine the knowledge, perceptions, and satisfaction of farmers regarding the agricultural extension service in such districts to guide on the gaps and identify the most effective outreach program and encourage climate-based agricultural activities (GoKP, 2020).

This paper will attempt to offer an empirical measurement of the knowledge and attitudes of the farmers towards climate change, their satisfaction with agricultural extension services and how these aspects influence crop production in the Merged Districts of Khyber Pakhtunkhwa. The study

aims to enhance the adaptability of the farming community in the area by research into the interaction of extension services, dissemination of information, and awareness of farmers about climatic variability to help in policy formulation, extension strategy, and eventually improve climatic variability adaptation.

Materials and methods

The research was carried out in the Khyber Pakhtunkhwa, Pakistan, in particular to the three merged districts; South Waziristan, Bajaur, and Khyber. They were intentionally chosen to be in these districts because of their agricultural significance and their vulnerability to the effects of climate change. The target population was registered farmers in these districts in both the irrigated and rain-fed agriculture. South Waziristan: It has a land area of 11,585 km 2, split into three subdivisions and eight tehsils. The agricultural industry consists of livestock, vegetables, fruits and cereals. The district is characterized by temperate and sub-tropical climate and groups of hazards to climate conditions including floods, increase in temperature, and attacks by pests. Bajaur: This is a mountainous area that is small bordering Afghanistan, where agriculture, livestock, and mining are the main sources of livelihood. The number of people is more than one million and subsistence farming is widespread. Khyber: The first one is mainly pastoral and agrarian economy, accompanied by some handicrafts. Land area is scarce and the area experiences a shortage of water and unpredictable rainfall. The sample was made up of all farmers in the sampled districts. The sampling method was a multistage. The two purposive agro-ecological areas Valley Plains and Semi-Arid Piedmont have been chosen due to their agricultural importance and susceptibility to climate. Purposive selection was done on three districts (South Waziristan, Bajaur, and Khyber). One district was selected at random and this was the tehsil. There were 3 tehsils of union councils chosen. Each union council had 30% of the registered farmers who were chosen proportionately making 300 respondents out of 1,004 farmers. The study objectives were used to formulate an interview schedule which had both open-ended and close-ended questions. The instrument was pre-tested among 20 farmers, and changes were done to make the instrument clear and reliable. The information was gathered in the form of a face-to-face interview with the farmers. Other secondary data were received through Pakistan Bureau of statistics and Directorate of Agricultural Extension, Khyber Pakhtunkhwa. A panel of experts in the field of agricultural extension and social science ensured content and face validity. Based on their suggestions, the instrument was updated, so that it could effectively measure the knowledge, perception, and satisfaction of the farmers with the extension services and the effects of climate change.

Results and discussions

Age

Age is the most important demographic factor in agriculture and helps in exploring the vision and wisdom of an individual. It is the main agent for adoption or rejection of a new idea or technology. The more aged a respondent is, the more he/she is experienced and mature enough to take an important decision of every day's life. Existing literature suggests that age can influence farmers' decision-making processes, technological adoption, and overall resilience in the face of environmental and economic uncertainties (Feder, 2013; Fernandez-Cornejo & Mishra, 2008; Thapa & Gaiha, 2019)

Table 3.1 District wise distribution of sample respondents regarding their age

District	Age (Years)				Total
	Up-to 30	31-40	41-50	above 50	
South Waziristan	18 (19.4)	26 (28.0)	18 (19.4)	31 (33.3)	93
Bajaur	10 (8.7)	37 (32.2)	28 (24.3)	40 (34.8)	115

Khyber	10 (10.9)	24 (26.1)	22 (23.9)	36 (39.1)	92
Total	38 (12.7)	87 (29.0)	68 (22.7)	107 (35.7)	300

Source: Field Data, 2024.
(Figures in parenthesis are percentages)

Table 3.1 reveals that 35.7 percent of respondents belonged to the above 50 years age group, 29.0 percent of respondents belonged to the 31 to 40 years age group and 22.7 percent respondents belonged to the 41 to 50 years age group only, with 12.7 percent respondents belonging to the under 30 years age group.

Educational Level of Respondents

Education is a key as a tool to respond to the global problem of global warming in a sophisticated way. Education can shape the societies to learn how to better appreciate climate change and can enable individuals to address the negative effects of climate change in the world since change in their behaviors and attitudes and embrace climate smart agricultural practices. With the increased education, the economic and environmental challenges of climate change will be reduced to a minimum and the educated individuals will be good at the area of climate science. This is because through good education, the extreme negative climate events could be reduced either directly or indirectly. Formal education can directly affect the adaptive capacity of the individuals and in this way the individuals are able to gain knowledge, skills, and competencies (Muttarak and Lutz, 2014).

Table 3.2 Distribution of Farmer Respondents according to their Education Level

District	**Education level**					**Total**
	Primary	**Middle**	**Matric**	**Intermediate**	**Graduate**	
South Waziristan	6 (6.5)	13 (14.0)	20 (21.5)	13 (14.0)	10 (10.8)	62
Bajaur	12 (10.4)	18 (15.7)	17 (14.8)	13 (11.3)	20 (17.4)	80
Khyber	16 (17.4)	18 (19.6)	7 (7.6)	9 (9.8)	11 (12.0)	61
Total	34 (11.3)	49 (16.3)	44 (14.7)	35 (11.7)	41 (13.7)	203

Source: Field Data, 2024.
(Figures in parenthesis are percentages)

Table 3.2 has shown that 11.3 percent of the population survey has obtained Primary education, and 16.3 percent have obtained Middle level. Matric constitutes 14.7, Intermediate is 11.7 and Graduates constitute 13.7. Such educational distribution implies that specific educational policies and programs are necessary to improve the access to literacy and higher education especially in the regions where Matric and Graduate levels do not prevail. More investment in education materials, programs and community awareness might rectify these results**.**

Household Size

One of the major units of the society is the household. A family is a unit of individuals who provide in common food, shelter and other necessities to live. At the household level, numerous decisions on living arrangements, bearing children, health care and education, migration and savings and labor force participation are made since households are central to most demographic, social as well as economic processes. The environmental impact of humans depends on the size and structure of household and closely associated with poverty, well-being and sustainable development. One should know the household size, as worldwide, the figures are declining, which means that there will be more houses and less density (UN, 2017).

Table 3.3 Distribution of respondents by Household Size

District	Household size					Total
	Below 5	6 to 10	10 to 15	16 to 20	above 20	
South Waziristan	15 (16.1)	28 (30.1)	32 (34.4)	5 (5.4)	13 (14.0)	93
Bajaur	15 (13.0)	34 (29.6)	32 (27.8)	26 (22.6)	8 (7.0)	115
Khyber	18 (19.6)	21 (22.8)	23 (25.0)	16 (17.4)	14 (15.2)	92
Total	48 (16.0)	83 (27.7)	87 (29.0)	47 (15.7)	35 (11.7)	300

Source: Field Data, 2024.

(Figures in parenthesis are percentages)

Based on Table 3.3 data, the most frequent household size is the category of 29.0% households comprising of 11 to 15 (which is the most common). The group of between 6 and 10 is near in at 27.7. The percentages are 16.0 (below 5) and 15.7 (larger size 16 to 20) and 11.7 (larger size above 20), respectively.

Knowledge about Agricultural Extension Workers

The role that the extension services play in agricultural production of the developing countries is very dynamic. Demand of such services is rising up with the lapsing of time since majority of the population in these countries are poor and illiterate. The extension worker disseminates appropriate information to the farmers (Aina, 2006). Technical assistance, spread of information, and empowering farmers with the skills and knowledge they should have in order to engage in sustainable agricultural practices make the role of the agriculture extension workers significant. A vast body of literature supports the importance of extension services in helping to increase the capabilities of farmers and in developing agriculture (Swanson, 2008; Rivera, 2019).

Table 3.4 Distribution of Respondents by Agricultural Extension Worker's Acquaintance

District	Yes	No	If yes, how do you know them					Total
			Met him in the field	Visiting agriculture extension agent's office	Met in the Village	Contacted on telephone	Through fellow farmers	
South Waziristan	56 (60.2)	37 (39.7)	17 (18.3)	20 (21.5)	4 (4.3)	7 (7.5)	8 (8.6)	56
Bajaur	70 (60.8)	45 (39.1)	13 (11.3)	25 (21.7)	6 (5.2)	14 (12.2)	12 (10.4)	70
Khyber	56 (60.8)	36 (39.1)	9 (9.8)	20 (21.7)	2 (2.2)	14 (15.2)	11 (12.0)	56

Total	182 (60.7)	118 (39.3)	39 (13.0)	65 (21.7)	12 (4.0)	35 (11.7)	31 (10.3)	182

Source: Field Data, 2024.

(Figures in parenthesis are percentages)

Table 3.4 gives the results on the familiarity with the agricultural extension agents in three districts viz. South Waziristan, Bajaur and Khyber. It refers to the awareness of people about an agricultural extension agent and how they are acquainted with them to learn about agricultural extension workers.

Satisfaction regarding Agricultural extension Services.

The extension service providers have a role to play in ensuring that the farmers are contented with the services rendered. The feedback provided by the extension is gaining more significance in order to enhance the loyalty and trust that farmers have. Customer satisfaction, or in this case, farmer satisfaction, is a vital area that has to be given the due attention and action. Similar to the frequency of the surveys of farmer satisfaction that have been distributed around the globe, it is evident that extension service providers have realized this as a significant matter that requires sensitization (Birner et al., 2009).

Table 3.5 Satisfaction regarding Agricultural extension Services

District	**Satisfied with the services**		**In case if it is yes then level of satisfaction**				**Total**
	Yes	No	Very satisfied	Somewhat satisfied	Unsatisfied	Very unsatisfied	
South Waziristan	56 (60.3)	37 (39.7)	19 (17.6)	22 (20.4)	6 (5.5)	9 (8.3)	56
Bajaur	70 (60.8)	45 (39.2)	16 (16.8)	28 (29.4)	10 (10.5)	16 (16.8)	70
Khyber	56 (60.9)	36 (39.1)	12 (11.0)	22 (20.2)	6 (5.5)	16 (9.2)	56
Total	182 (60.7)	118 (39.3)	47 (15.6)	72 (24.0)	22 (7.3)	41 (13.7)	182

Source: Field Data, 2024.

(Figures in parenthesis are percentages)

According to the data in Table 3.5, it was found that, 60.7 percentage of the respondents between the three districts were satisfied with the performance of Agriculture extension department whereas approximately 39.3 percentage respondents were not satisfied with the performance of Agriculture extension department in their respective areas. It implies that, the extension department must undertake the role of providing extension services to the rest of the population of the area in relation to the fast changing environment and agricultural requirements. Agriculture extension department performance also made the majority (60.3%) of farmers in the district South Waziristan satisfied, as compared to the others who were not satisfied (39.7%). In district Bajaur (60.8) respondents were to be satisfied with the performance of Agriculture extension department and 39.2% were not to be satisfied. In district Khyber (60.7%) respondent stratified services of agriculture department were satisfied and 39.1% did not satisfy.

The number of farmers not satisfied with such services was 39.3 percent and then they were requested to explain the reason why they were not satisfied. The data provided in this regard is presented in Table 3.6.

Table 3.6 Dissatisfaction level of respondents from the services provided by agriculture extension department

District	Not Satisfied with the services	If no then why					Total
	No	They usually visit landlord and progressive farmers	They never visit	They rarely visit	They have no interest	They themselves do not know about the better recommendations	
South Waziristan	37 (39.7)	12 (12.9)	4 (4.3)	8 (8.6)	8 (8.6)	5 (5.4)	37
Bajaur	45 (39.1)	11 (9.6)	10 (8.7)	10 (8.7)	9 (7.8)	5 (4.3)	45
Khyber	36 (39.1)	6 (6.5)	6 (6.5)	9 (9.8)	11 (9.6)	4 (4.3)	36
Total	118 (39.3)	29 (9.7)	20 (6.7)	23 (7.7)	24 (8)	14 (4.7)	118

Source: Field Data, 2024.
(Figures in parenthesis are percentages)

Table 3.6 shows dissatisfaction with agricultural extension services across three districts: South Waziristan, Bajaur, and Khyber. It highlights the reasons for dissatisfaction among respondents who are not satisfied with these services. The data indicates that 39.3% of respondents are not satisfied with agricultural extension services, while a majority (60.7%) expresses satisfaction.

Source of Agricultural Information

Science and technology plays a significant role in the field of agriculture. Different types of new and innovative technologies are used and applied to develop agriculture at maximum level and through electronic media and print media (Irfan et al., 2024).

Table 3.7 Respondent's Source of Agricultural Information

District	Source of information						Total
	Agriculture extension workers	Electronic media	NGOs	Print media	Fellow Farmers	Representative of Private companies	
South Waziristan	35 (11.7)	4 (1.3)	18 (6.0)	4 (1.3)	17 (5.7)	15 (5.0)	93
Bajaur	48 (16)	13 (4.3)	16 (5.3)	13 (4.3)	11 (3.7)	14 (4.7)	115
Khyber	36 (12)	17 (5.7)	8 (2.7)	11 (3.7)	10 (3.3)	10 (3.3)	92
Total	119 (39.7)	34 (11.3)	42 (14.0)	28 (9.3)	38 (12.7)	39 (13.0)	300

Source: Field Data, 2024.
(Figures in parenthesis are percentages)

The sources of agricultural information among the farmers in the study districts were different with the provision of the same being led by the extension workers. In South Waziristan, extension workers were the most important contributors to the farmers, which is 11.7 per cent, then the electronic media, print media, fellow farmers, NGOs, and the representatives of the private companies make up 6, 5 and 5 respectively. Under Bajaur, 16 percent were extension workers with lesser percentages on electronic media (4.3), print media (4.3) and fellow farmers (3.7), NGOs (5.3)

and private companies (4.7). In Khyber, 12% used extension workers, 5.7% electronic media, 2.7% print media, 2.7% NGOs and 3.3% each of fellow farmers and the representatives of the private companies. These results demonstrate that there was high dependency on the extension workers, and this is contrary to Irfan et al. (2006) that indicated that most of the farmers were using the television to be their primary source of agricultural information.

Knowledge about Climate Change

Climate change education is important in coming up with effective adaptation and minimize vulnerabilities. Scientific methods of adapting to climate should be supplemented with traditional and local knowledge. Sustainable development can be improved in the changing climate by involving the local communities and educating them on climate issues (Nyong et al., 2007).

Table 3.8 Distribution of Respondents regarding Knowledge about Climate Change

District	Knowledge about "Climate Change''		If yes then Source of Information					Total
	Yes	No	Agriculture extension staff	electronic media	print media	NGOs	fellow farmers	
South Waziristan	73 (78.5)	20 (21.5)	36 (38.7)	12 (12.9)	6 (6.5)	13 (14)	6 (6.6)	73
Bajaur	86 (74.8)	29 (25.2)	34 (29.6)	10 (8.7)	4 (3.5)	29 (25.2)	9 (7.8)	86
Khyber	69 (75)	23 (25)	37 (40.2)	8 (8.8)	3 (3.3)	16 (17.4)	5 (5.4)	69
Total	228 (76)	72 (24)	107 (35.7)	30 (10)	13 (4.3)	58 (19.3)	20 (6.7)	228

Source: Field Data, 2024.

(Figures in parenthesis are percentages)

Table 3.8 indicates that the majority of farmers (76 Per cent) had heard of climate change. In South Waziristan, the knowledge was reported as 78.5% the most by the extension staff (38.7%), then NGOs (14%), electronic media (12.9%), print media (6.5%), and fellow farmers (6.6%). In Bajaur, the awareness rate was 74.8 ranking extension staff (29.6) and NGOs (25.2) to the top. The awareness was reported to be 75% in Khyber mainly through the extension staff, (40.2), NGOs (17.4) and electronic media (8.8). These results are different than those of Semenza et al. (2008) in which more than 90 percent of farmers in Portland and Houston had heard about climate change.

Farmer's Perceptions Regarding Climate Change Scenario

The rural farmers rely solely on rain and as a result of the incidence of recent alterations in the climate, the farmers will be further reduced socially and economically. The answer to the consequences of climate change is being determined with the degree of awareness and adaptation strategies that have been adjusted (Fosu et al., 2012). Having inquired the farmers about their knowledge and source of information about climate change, they were subsequently asked about perception on climate change about their own knowledge (how did you feel climate). In this case, five point Likert was employed.

Table 3.9 Farmer's Perceptions Regarding Climate Change Scenario

Farmer's own understanding	Strongly Agree	Agree	Don't Know	Disagree	Strongly Disagree	Mean weighted score	Rank
A change in rainfall	167	66	38	17	12	2.13	1

pattern such as seasonal droughts and heavy storms.	(55.7)	(22)	(12.7)	(5.7)	(4.0)		
Late or delayed start of rainy season.	161 (53.7)	56 (18.7)	55 (18.3)	17 (5.7)	11 (3.7)	2.07	2
Unpredictable start of rainy season	118 (39.3)	100 (33.3)	47 (15.7)	22 (7.3)	13 (4.3)	2.04	3
Prolonged dry spells with very hot conditions experienced.	124 (41.3)	86 (28.7)	52 (17.3)	22 (7.3)	16 (5.3)	2.03	4
Reduction in area covered by vegetation due to deforestation	123 (41)	93 (31)	53 (17.7)	20 (6.7)	11 (3.7)	2.01	5
Increased concentration of gages from burning of fuels and plastics.	112 (37.3)	94 (31.3)	50 (16.7)	30 (10)	14 (4.7)	1.87	6
Rainfall has become erratic and temperatures increasing.	131 (43.7)	82 (27.3)	48 (16)	25 (8.3)	14 (4.7)	1.80	7
A reduction in amount of rainfall received in season	178 (59.3)	46 (15.3)	51 (17)	16 (5.3)	9 (3)	1.77	8

Source: Field Data, 2024.

(Figures in parenthesis are percentages)

As it is revealed in Table 3.9, there are different perceptions among farmers about climate change as changes in the rainfall patterns including seasonal dryness and torrent storms topped the list (mean weighted score 2.13). Another cause of concern was delayed rainy season (2.07) and erratic rainfall (2.04), which influenced sowing and crop yield. Dry spells and high temperatures over extended periods of time (2.03) come in the fourth place, as well as vegetation decline because of deforestation (2.01). Emission of fuel and plastic burning (1.87), rising temperatures (1.80) and decreased seasonal rainfall were less urgent threats (1.77). Altogether, farmers are more concerned with the direct weather-related alterations rather than human-induced ones, which is consistent with Pakistan, India, East Africa, and Bangladesh, as well as other studies (Hussain et al., 2020; Abid et al., 2016; Mertz et al., 2009; Ghosh, 2020; Deressa et al., 2011).

Climatic variable affects crop production

Climate change, driven by rising greenhouse gases like carbon dioxide, methane, and nitrous oxide, disrupts rainfall patterns, temperatures, and water and land resources, increasing the risk of floods and droughts. Its effects are especially severe in developing countries such as Pakistan, where agriculture is highly exposed. This leads to reduced crop productivity, threats to food security, and water scarcity. Melting Himalayan glaciers and changing rainfall intensities further exacerbate these challenges (Kurukulasuriya et al., 2006; Kirby et al., 2016).

Table 3.10 District Wise Distribution of Sampled Respondents' Perceptions about Climatic variable affects crop production

District	**Which climatic variable strongly affects your crop production**				**Total**
	Extreme temperature	Weak rainfall/less	Variation in rainfall	Shift in the start of the	

		rainfall		rainy season	
South Waziristan	14 (15.1)	29 (31.2)	42 (45.2)	8 (8.6)	93
Bajaur	11 (9.6)	74 (64.3)	24 (20.9)	6 (5.2)	115
Khyber	8 (8.7)	69 (75)	15 (16.3)	0 (0)	92
Total	33 (11)	172 (57.3)	81 (27)	14 (4.7)	300

Source: Field Data, 2024.

(Figures in parenthesis are percentages)

The Table 3.10 provides insights into which climatic variables are perceived to have the strongest impact on crop production across three districts: South Waziristan, Bajaur, and Khyber. Respondents were asked to identify specific climatic factors affecting their agricultural output. The variables considered are extreme temperature, weak rainfall/less rainfall, variation in rainfall, and shift in the start of the rainy season.

Perceptions of Farmers regarding Climate Change Effect

Generally it is believed that agricultural productivity is affected and dependent directly on climate change. A new era of research has evolved over the past decade discussing the long-term effects of climate change on agriculture. The possible physical effects of climate change on agriculture like effect on livestock production and crop yield and also the economic consequences are addressed by this type of research (Adams et al., 1998).

Table 3.11 Perceptions of Farmers regarding Climate Change Effect

Effect of Climate Change	**Agree**	**Undecided**	**Disagree**	**Mean weighted score**	**Rank**
Climate change has led to rural-urban migration of youths	111 (37.0)	114 (38.0)	75 (25.0)	1.88	1
Death of livestock is increasing	109 (36.3)	149 (49.7)	42 (14.0)	1.78	2
Climate change has resulted to decline in crops yield	166 (55.3)	81 (27.0)	53 (17.7)	1.62	3
The yearly rains are not supporting crop production as before	181 (60.3)	66 (22.0)	53 (17.7)	1.57	4
Climate change has led to changes in livelihood system	188 (62.7)	69 (23.0)	43 (14.3)	1.52	5
Frequent occurrence of floods during the rainy season	203 (67.7)	66 (22.0)	31 (10.3)	1.43	6
Climate change has led to decline in forest resource	225 (75.0)	46 (15.3)	29 (9.7)	1.35	7

Climate change has led to crop infestation and diseases	237 (79.0)	44 (14.7)	19 (6.3)	1.27	8
Decrease in soil fertility	243 (81.0)	37 (12.3)	20 (6.7)	1.26	9
Frequent occurrence of droughts during the rainy season	249 (83.0)	29 (9.7)	22 (7.3)	1.24	10
Climate changes has led to decreasing/drying of water sources	260 (86.7)	26 (8.7)	14 (4.7)	1.18	11
Cost of crops is increasing because of climate change	259 (86.3)	27 (9.0)	14 (4.7)	1.18	12

Source: Field Data, 2024.

(Figures in parenthesis are percentages)

Regardless of technological development in the agricultural sector, crop production is very much determined by weather, soil and the natural conditions, and climate change impact various regions in different manners. Table 3.11 presents the responses of the farmers to the climate change effects in the merged districts. Rural-urban migration of the youth was the highest followed by livestock deaths (1.78), decreasing crop yields (1.62), and inadequate rainfall (1.57). Others were livelihood changes (1.52), floods (1.43), deforestation (1.35), heightened pests and diseases (1.27), poor soil fertility (1.26), droughts (1.24), drying water sources (1.18) and the increase in crop cost (1.18). On the whole, farmers emphasized that direct climatic changes, including irregular rainfall, high temperatures, and flooding, are the most dangerous to farming and livelihoods, which is consistent with the research conducted in Pakistan, South Asia, and Africa (Ahmed et al., 2020; Hussain et al., 2019; Abid et al., 2016).

Conclusion

The paper states that farmers in the Merged Districts of KP possess moderate to high knowledge of climate change but their adaptation is restricted due to the inability to access timely information and technical assistance. Extended workers in agriculture are central to knowledge sharing, and the existing services are too little to deal with the problems of climate variability completely. Direct climatic changes are considered by farmers to be the most direct threat to crop and livestock production, in the form of unpredictable rainfall, incessant droughts, and extreme temperatures. These effects have not only decreased agricultural production but they have also led to socio-economic effects such as rural-urban migration, high production costs, and changes in livelihoods. The results underscore the fact that the sustainability of agriculture in such susceptible areas requires improvement of agricultural knowledge among the farmers, better delivery of agricultural extension services and adoption of climate-resistant agricultural practices.

Recommendations

1. Enhance Agricultural Extension Services: Increase the presence and quality of agricultural extension services through frequent training, technical advice and follow up services to farmers particularly in the remote areas.
2. Incorporate Climate Education: Incorporate climate change awareness and adaptation techniques into extension programs and education systems so as to enhance knowledge and preparedness of the farmers and young people.
3. Enhance Access to Information: Use electronic media, print media and community networks to

increase access of farmers to timely and relevant information on agriculture and climate related matters.

4. Support Climate-Resilient Agriculture: Promote the use of drought-resistant crops, better irrigation methods, soil conservation methods and integrated pest management to reduce the effect of climate.

5. Policy and Institutional Support: Formulate specific policies to reinforce institutional response to extension services, give subsidies on climate-adaptive technologies, and disaster preparedness in the agricultural sector.

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