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Empowering Farmers through Agricultural Extension: A Comparative Study of Yield Optimization and Resource Barriers in District Abbottabad Khyber Pakhtunkhwa.

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Abstract

Agriculture extension agent serves as the vital link between research and the farming community. This study assessed the effectiveness of extension services and identified production constraints in District Abbottabad, Pakistan. Data were collected from 112 farmers across four villages and analysed using SPSS. The demographic attributes revealed that majority of the respondents were literate (69%) and (43%) were from age group of 51 and above. About (33%) of the respondents were landholding size "5.1 acres and above" and had good farming experience of "21years and above" (84%). Paired sample t-tests revealed highly significant improvements ($P < 0.01$) following the extension interventions, where scientific recommendations reduced seed rates for wheat (from 64.08 to 50 kg/acre) and maize (8.09 to 6.63 kg/acre) while simultaneously increasing respective yields by 285.94 kg/acre and 178.78 kg/acre". Chi-square analysis confirmed that literacy levels significantly influenced ($p < 0.01$) farmers' knowledge of extension services. Programs like field days and demonstrations successfully disseminated technology. The study identified key challenges, including poor financial conditions, water scarcity and less number of extension workers. The study recommends that policymakers should prioritize the strengthening of agricultural extension services in District Abbottabad, along with that, government may take into account the provision of advanced trainings to the farmers. Furthermore the study suggested that farming communities should be actively involved in the planning and implementation of agricultural extension services.

Introduction

Agriculture is a keystone of Pakistan's economy, contributing about 24% to the GDP and employing nearly 37% of the labour force (GoP, 2024). With a population exceeding 241 million and growing rapidly, the sector faces increasing pressure to ensure food security and economic stability. Despite its critical role, Pakistan's agricultural productivity remains below potential, primarily due to out-dated farming practices, limited adoption of technology, and weak linkages between research and field application.

Agricultural extension plays a pivotal role in narrowing the gap between research and practice disseminating scientific knowledge and contemporary agricultural techniques to farmers, thereby improving yields and livelihoods (Pervaiz et al., 2020). Over the decades, numerous governmental

initiatives—such as the Village AID Program, Crop Maximization Projects, and the Prime Minister's Agriculture Emergency Program—have sought to enhance agricultural performance productivity through education, innovation, and resource support (GoP, 2021). Despite these efforts, substantial challenges persist including inadequate infrastructure, socio-economic barriers, and weak coordination among research, education, and extension services.

In District Abbottabad, the Agriculture Extension Department has contributed significantly to local development through initiatives in horticulture, irrigation improvement, and farmer training. Yet, factors such as diverse terrain, small landholdings, and lack of tailored extension services continue to constrain progress. Given Abbottabad's potential for high-value crops and off-season vegetables, effective extension activities are essential for sustainable agricultural growth.

Therefore, this study aims to evaluate agricultural extension activities in the District, focusing on their effectiveness, the problems faced by farmers, and the factors influencing the success of these initiatives. The findings will help guide future policies for strengthening extension systems and promoting agricultural development in the region.

Objectives

1. To assess the effectiveness of extension activities in the study area.
2. To identify farmers' problems in the study area.
3. To determine the main factors affecting agricultural extension activities.

Materials and Methods

The study was carried out in District Abbottabad of Hazara region in Khyber Pakhtunkhwa (KP) ranging from approximate area of 1969 square kilometre bounded by latitudes of 34-36 and 73-75. Abbottabad climate is moderate with its elevation and landscape diversity offering cool , pleasant summers (20 C to 30 C degree) with cold winters, especially in the highlands of North Abbottabad (temperature drops below freezing), while rainfall amounts from 800 to 1200 mm per year ensuring the diverse biodiversity and agriculture. A multistage sampling technique was used for data collection: firstly, Tehsil Abbottabad was randomly selected from the four tehsils of the district, secondly four union councils (Salhad, Kakul, Phalkot and Mirpur) were purposively select based on the agricultural activity, thirdly with the help of the Patwari, four villages were randomly selected from each union council and fourthly with the help of the Agricultural Officer (AO), a list of 186 farmers was compiled out of which the sample size of 112 respondents were selected using proportional allocation at 60%. A structured interview schedule, pre-tested and administered in the local language (to ensure accuracy and reliability) was used to collect primary data. Data were analysed using SPSS v.20. Descriptive statistics: including frequencies and percentages and inferential statistics: including the Paired Sample T-test, were used to evaluate differences in crop yield and seed rates pre and post-intervention. Additionally, the Chi-Square test was applied to determine associations between literacy knowledge about extension services.

Results and Discussion

Demographic characteristics of the sample respondents

Demographic characteristics of the sample respondents were presented in Table 1. Age is a critical factor influencing the integration and adoption of the advanced agricultural technologies including improved agricultural practices, the use of high quality crop varieties and efficient fertilizer management. In addition, age plays a significant role in the widespread adoption of innovations in the agricultural community (Agwu et al., 2008)**.** Out of 112 respondents 8(7%) respondents fall in age group of "up to 30 years", 29(26%) of respondents age group "31- 40 years", 27(24%) of respondents age group "41-50 years", and the remaining 48(43%) age group "above 51 years". Studies of Danso et al. (2018) show that the older the villagers the less extension services they receive.

The level of education of farmers is directly related to the adoption of advanced agricultural

technologies and overall farm production (Buhari et al., 2021)**.** It shows that out of 112 respondents 35(31%) were illiterate and 77(69%) were literate. Out of the total literate respondents only 38(34%) had primary education, 26(23.2%) had secondary education and 13(11.6%) were higher education. Our results are consistent with (Al-Zahrani, 2019) who reported an overall literacy rate above 58% among the respondents.

Farming experience profoundly influences farmer's perception and adoption of innovative practices as highlighted by (Aldosari et al., 2019). Data regarding farming experience indicates that 94(84%) of the farmers were involved in farming from the past 21 years and above, followed by 11(9.8%) respondents having farming experience from "11-20 years", only 7(6.2%) respondents reported having "up to 10 years" of farming experience. Our results were in line with Pervaiz et al., (2020) who reported that majority i.e. 80.5% of the farming community in the study area were having farming experience for more than 20 years.

Landholding size, commonly referring to the area of land possessed by a farmer, is another important demographic attribute. It is usually observed that large landholders have more field knowledge and are passionate to adopt modern technologies as compared to those having less land (Chaudhary, 2006). It shows that out of 112 respondents 25(22.3%) of the farmers were having land up to 1 acre, 24(21.4%) of the farmers were having land from "1.1-3acre", 26(23.2%) of the farmers were having land from "3.1-5acre", while 37(33%) of the farmers had "5.1 acre land and above".

Extension workers play a vital role in narrowing the gap between research institutions and the agricultural community (Sanaullah et al., 2020). It shows that out of 112 respondents 37(33%) of respondents weren't familiar with extension workers of their areas while 75(67%) respondents reported that they knew extension workers of their area.

Table: 1 Demographic Characteristic of the Sample Respondents

Variables	Frequency	Percentage
Age in (years)		
Up to 30	8	7
31-40	29	26
41-50	27	24
51 and above	48	43
Education		
Illiterate	35	31
Literate	77	69
Primary	38	34
Secondary	26	23.2
Higher education	13	11.6
Farming experience		
Up to 10	7	6.2
11-20	11	9.8
21 and above	94	84
Size of land holding		

Up to 1 acre	25	22.3
1.1-3 acre	24	21.4
3.1-5 acre	26	23.2
5.1 acre and above	37	33
Knowledge about extension worker		
Yes	75	67
No	37	33

Source: Field Survey

Agricultural Extension Worker's Visits to Farmers

Extension worker's visit involve the experts from the agricultural extension services visiting farms or rural areas to provide guidance and support to farming community (Pervaiz et al., 2020). During these visits, extension staff offers advice on best practices for crop management, pest infestations and soil health (Abbas et al., 2023).

Data presented in Table 2 shows that majority of the respondents 75(67%) had knowledge about extension workers in their area, while 37(33.0%) did not have any. Second part of Table 2 shows that out of 75 respondents who knew the extension workers of their area, 40(35.7%) reported that the extension workers visited them off and on. For instance, a study by Brown and Smith (2022) also observed similar disparities in extension engagement across different areas were noted.

Table: 2 Distribution of Respondents on the Basis of Extension Worker Visits to Farmers

Villages	**Do extension worker visits your farm?**		**Total**	**How often does the Extension worker visit**			**Total**
	No	**Yes**		**Weekly**	**Monthly**	**Off and On**	
Islamkot	8(27.5)	21(72.4)	29	0(0)	9(31.0)	12(41.4)	21
Jabarriya	16(66.7)	8(33.3)	24	0(0)	7(29.2)	1(4.2)	8
Malsah	6(22.2)	21(77.8)	27	1(3.7)	10(37.0)	10(37.0)	21
Neloar	6(18.8)	25(78.1)	32	0(0)	9(28.1)	17(53.1)	25
Total	37(33.0)	75(67.0)	112	1(0.9)	35(31.2)	40(35.7)	75

Source: Field Survey

Benefited from Extension Activities

Extension workers introduce various types of activities to their farming community. Their goal is to educate the farmers in the best possible way (Takahashi et al., 2020). Agricultural extension is a two way educational process. On one hand it brings new knowledge and technologies to the farming community and on the other hand it brings back farmers problems to the research station for solution (Sanaullah et al., 2010).

Data presented in Table 3 show that about 50(44.6%) of respondents were benefited from extension services while remaining 62(55.4%) did not get any benefits. Our results were somewhat in line with Pervaiz et al. (2020) who reported that 64% of the respondents in the study area were benefited from extension activities.

Table: 3 Distribution of Respondents regarding Benefited by Extension Activities

Villages	Benefited from extension activities?		Total	If yes type of activity , you are benefited						Total
	No	Yes		Field days	Demonstrations	Farm visits	Group meetings	Trainings	Awareness campaigns	
Islamkot	13(44.8)	16(55.2)	29	9	11	16	13	16	11	76
Jabarriya	20(83.3)	4(16.7)	24	6	4	4	5	4	15	38
Malsah	14(51.9)	13(48.1)	27	12	9	14	14	13	14	76
Neloar	15(46.9)	17(53.1)	32	13	11	16	17	17	13	87
Total	62(55.4)	50(44.6)	112	40	35	50	49	50	53	277

Source: Field Survey

Adoption of Modern Technologies

The adoption of modern technologies in agriculture has greatly improved the ways in which farmers practice farming, with increase in productivity, efficiency, and sustainability. Technology is being integrated across small-scale farms to large agricultural enterprises to improve productivity, reduce waste (Abbas et al., 2023).

Table 4 show that out of 112 respondents 42(37.5%) agreed on adoption of modern technologies, 70(62.5%) did not adopt any. Table 4 also shows that out of 112 respondents, 36 faced small land holding issue, 82 faced lack of irrigation issue and 62 respondents faced the issue of poor financial position. Our findings are similar with that of (Ali and Ahmad, 2014).

Table: 4 Distribution of Respondents on the Basis of Adopting Modern Technologies

Villages	Adoption of modern technologies		Total	Constraints facing in adoption of modern technologies			
	No	Yes		Small land holding	Lack of irrigation	Poor financial position	total
Islamkot	17(58.6)	12(41.4)	29	12	16	15	43
Jabarriya	15(62.5)	9(37.5)	24	13	20	16	49
Malsah	19(70.4)	8(29.6)	27	9	19	18	46
Neloar	19(59.4)	13(40.6)	32	2	27	13	42
Total	70(62.5)	42(37.5)	112	36	82	62	180

Source: Field Survey

Seed Rate Comparison of Wheat and Maize Crop before and after Extension Recommendations

Table 5 reflected that results are highly significant in case of wheat and maize and it can be concluded that seed rate kg/acre decreases after adoption of extension recommendations.

Table: 5 Seed Rate Comparison of Maize and Wheat Crop before and after Extension Recommendations

Crops	Seed rate kg/acre Before extension recommendations		Seed rate kg/acre After extension recommendations		Mean difference	t-value	p-value
	Mean	SD	Mean	SD			
Maize	8.09	11.159	6.63	9.163	1.455	7.408	0.000***
Wheat	64.08	4.823	50	0.000	14.080	4.823	0.000***

Source: Field Survey; Level of significance: 1%

Yield Comparison of Maize and Wheat Crop before and after Extension Recommendations

Table 6 shows significant results. It is concluded that the mean difference value evaluated was -178.781 which means that 178.781kg/acre increase was recorded in maize yield after extension recommendations. The mean difference value evaluated was -285.936 which means that 285.936 kg/acre increase was recorded in wheat yield after extension recommendations.

Table: 6 Yield Comparisons of Maize and Wheat Crop before and after Extension Recommendations

Crops	Yield kg/acre Before extension recommendations		Yield kg/acre before After extension recommendations		Mean difference	t-value	p-value
	Mean	SD	Mean	SD			
Maize	2309.85	3902.120	2488.63	4159.885	-178.781	-5.000	0.000***
Wheat	1434.11	320.235	1720.04	334.604	-285.936	-13.968	0.000***

Source: Field Survey; Level of significance: 1%

Rate the Severity of Challenges Faced by Farmers

Farmers have to face different problems while farming in the fields. They encounter different levels of challenges ranging from low to very high, with water scarcity, pest infestation, financial constraints and many more.

Water scarcity is a major challenge for farmers globally, and in Pakistan as well. Planting drought-resistant crop varieties can help reduce the impact of water scarcity on crop yields (Muhammad et al., 2024). Table 7 shows that out of 112 respondents majority 60(53.6%) had high rate of water scarcity, 30(26.8%) very high, 18(16.1%) moderate and 4(3.6%) had low rate of water scarcity.

Similarly, Pest infestation refers to the invasion of crops by insects, or other organisms that cause damage to the crops. Pest infestation can result in significant yield losses, reducing farmer income and food availability (Savary et al., 2019). Out of 112 respondents 48(42.9%) had low rate of pest infestations, 30(26.8%) very low, 27 (24.1%) moderate and 7(6.2%) had high rate of pest infestations.

Along with that, financial constraints are also considered as a significant challenge faced by farmers, affecting their farm productivity, income and lives. Financial constraints can lead to reduced agricultural productivity, as farmers may not be able to afford essential inputs or invest in technology

(Ali et al., 2020). Out of 112 respondents 61(54.5%) respondents had very high rate of financial constraints and 51(45.5%) had high rate.

Table: 7 Distribution of Respondents on the Basis of Rating the Severity of Challenges Faced by Respondents

Challenges	Severity of challenges				Total
	Low	Moderate	High	Very high	
Water scarcity	4(3.6)	18(16.1)	60(53.6)	30(26.8)	**112**
Pest infestations	30(26.8)	48(42.9)	27(24.1)	7(6.2)	
Financial constraints	0(0)	0(0)	51(45.5)	61(54.5)	

Source: Field Survey

Rate the Effectiveness of Extension Activities

Agricultural extension is a non-formal type of education that provides advisory activities by the use of educational approach in acquiring knowledge and skills to deal with the growing needs of the world. In Pakistan, Agricultural extension activities are being provided by the Extension Field Staff EFS of agriculture department to uplift the living standard of rural people who are nearly 67% of the whole population (Lodhi et al., 2006).

The data in Table 8 presents a comprehensive evaluation of various extension activities. Regarding training programs, 44(39.3%) respondent rated them as good, though a majority (55.4%) did not provide a rating. In terms of demonstrations, 22(19.6%) participants viewed them as average, while 5(4.5%) categorized them as good; notably, 77(68.8%) of the sample remained non-responsive on this specific activity. The effectiveness of individual outreach was also assessed, with 24(21.4%) respondents identifying farm visits as beneficial and 21(18.8%) rating them as average, while 55.4% did not answer. Similarly, field days were considered effective by 19(16.9%) respondents and average by 15(13.4%), with 72(64.3%) individuals opting not to rate this category. Finally, awareness campaigns received a "good" rating from 26(32.2%) respondents and an "average" rating from 24(21.4%), whereas 59(52.3%) did not provide feedback. High satisfaction was observed in technology dissemination, which was rated as very good by 60(53.6%) respondents, while 51(45.5%) did not respond to this question.

Table: 8 Distribution of Respondents on the Basis of Effectiveness of Extension activities in the Study Area

Activities	Effectiveness of extension activities			
	Average	Good	Very good	No response
Training	6(5.3)	44(39.3)	0(0)	62(55.4)
Demonstrations	22(19.6)	5(4.5)	8(7.1)	77(68.8)
Farm visit	21(18.8)	24(21.4)	5(4.4)	62(55.4)
Field day	15(13.5)	19(16.9)	6(5.3)	72(64.3)

Awareness campaigns	24(21.4)	26(32.2)	3(2.7)	59(52.3)
Technology dissemination	1(0.9)	0(0)	60 (53.6)	51(45.5)

Source: Field Survey

Association of Literacy Level of Respondents with Knowledge about Extension Department

Table 9 shows that, the more educated farmers, the more likely they are to know about the extension department. The Chi-square value 12.346 and p-value 0.006 indicates a statistically significant association between education and knowledge about extension department at 1% probability level ($p<0.01$). It means farmers who were better educated were more likely to be informed about extension department and its activities.

Table: 9 Association of Literacy Level of Respondents with Knowledge about Extension Department

Variable	**Categories**	**Knowledge about extension department**		**Total**
		No	**Yes**	
Literacy level	**Illiterate**	9(36.0)	16(64.0)	25
	Primary	6(25.0)	18(75.0)	24
	Secondary	7(15.4)	22(84.6)	26
	Higher education	1(2.7)	36(97.3)	37
	Total	20(17.9)	92(82.1)	112
	χ^2 = 12.346 P value= 0.006			

Source: Field Survey; Level of significance 1%

Conclusions and Recommendations

Conclusions

The following conclusions were derived from the present study:

The study concludes that farmers in District Abbottabad encounter a range of interrelated constraints that significantly limit their agricultural productivity. Although most farmers possess considerable experience and familiar with the role of the extension department, their adoption of advanced technologies remains relatively low. This limited adoption is largely attributed to persistent challenges such as water scarcity, fragmented landholdings, financial difficulties, and lack of irrigation facilities. The use of certified seeds, integrated pest management, and extension-led training programs has demonstrated promising outcomes in improving yields and reducing input costs, yet these benefits are not equitably accessible to all farmers. The findings suggest that extension services play a crucial role in transferring knowledge and improving farming practices, but their coverage and frequency need to be strengthened. Specifically, the results demonstrate that extension workers guidance significantly improved seed use efficiency and crop yields for wheat and maize. Nevertheless, farmer's limited access to modern machinery and inadequate adaptation measures against climate change continue to hinder agricultural growth. Overall, the study underscores the need to enhance the effectiveness of agricultural extension services, ensuring wider access to certified seeds, advancing water management solutions, and providing financial support to farmers. A more proactive and inclusive extension system has the potential not only to increase productivity but also to enable farming communities to better adapt to emerging climatic and economic challenges.

Recommendations

The following suggestions were offered in light of the study's findings.

- More extension staff should be appointed by the Government so that farmers can get regular visits and timely advice in their areas.
- Extension department needs to arrange training sessions more often, focusing on simple, practical topics such as pest control, irrigation, and modern farming methods.
- Farmers require easier access to loans or subsidies so they can invest in better inputs and technologies without financial stress.
- Small irrigation projects, water storage tanks, and efficient systems like drip irrigation should be introduced to reduce water shortage.
- Modern farm machinery should be provided on rental or community-sharing bases so even small farmers could be benefited from it.
- There is a need to increase awareness about climate change and training in climate-smart practices, such as planting drought- and pest-resistant varieties.

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