

Evaluating the Impact and Determinants of Agricultural Extension Services on Potato Farming in District Abbottabad, Khyber Pakhtunkhwa- Pakistan

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Abstract

Agriculture extension is the sole department which provides a bridge for flow of information between research and farmers. It plays a crucial role in enhancing agricultural productivity, improving farming practices, and increasing the livelihoods of farming community. This study aimed to analyze the agricultural extension activities in District Abbottabad Khyber Pakhtunkhwa-Pakistan including the types of services provided, the effectiveness of these services and the challenges faced by extension workers. Data were collected from 112 sample respondents from four selected villages. The firsthand data were analyzed through SPSS v.20. The demographic attributes revealed that majority of the respondents were literate (68.8%), (42.9%) respondents were from age group of 51 and above. About (33.0%) of the respondents were landholding up to 5.1 acres and above and having good farming experience of 21 years and above (83.9%). The yield obtained, seed rate used pre and post training were computed through paired sample t-test. The outcomes indicated a significant difference ($p < 0.01$) with (401.223 kg/acre) increase in potato yield after training. While a significant difference ($p < 0.01$) was recorded for seed rate with the mean difference value decreased after training. Chi-square test was used to assess the association between various variables. Total land holding had significant association with knowledge about extension department at 1% probability level. Farmers' literacy rate also had significant association with knowledge about extension department at 5% probability level. The results show that while agricultural extension services were being provided in the district, there are some important gaps in the coverage and quality of these services. The study identified key challenges, including poor financial conditions, water scarcity and less no of extension workers. The study recommends that policymakers should prioritize the strengthening of agricultural extension services in District Abbottabad.

Introduction

Pakistan's agriculture is a key part of its economy, making up about 24% of the country's GDP and providing jobs for around 37.4% of the workforce (GoP, 2024). With the population now hitting 241.5 million, growing at a rate of 2.55% annually (GoP, 2024), the pressure on agriculture to meet the demand for food and fiber is growing. This population boom highlights the importance of agriculture in ensuring food security and driving economic progress. Beyond that, it is also a major source of foreign exchange, supplies raw materials for industries, and creates a chain of inputs for other sectors. Even though agriculture is crucial to Pakistan's economy, the country's productivity

remains quite low, and urgent action is needed to boost it to keep up with the growing demand for food and fiber. While there have been claims of self-sufficiency in key crops, these claims have been shaky and unsustainable with current farming methods. To truly drive Pakistan's growth and prosperity, the country must significantly increase agricultural output, and that means embracing new technologies and sharing knowledge more effectively.

To make the most impact, agricultural extension specialists must be strategic. They need to focus on the most pressing issues, adapt their methods to the unique needs of farmers, and offer practical support tailored to different environments and economies (Isgren et al., 2023). Leeuwis and Van den Ban (2004) also stressed the importance of building networks and creating partnerships across different organizations. Working together like this helps unlock new opportunities for change and growth in agriculture.

Adopting better farming techniques and advanced machinery is vital to increasing crop yields. Technological advancements have long been a key driver of economic progress (Ruttan, 2003). These improvements cover everything from soil preparation to crop harvesting. To see better yields per acre, it's important to raise farmers' awareness about modern techniques, encourage them to try these innovations, and help them see the real value of adopting new methods. For this to happen, a strong, well-supported extension system is essential, with well-trained staff ready to guide farmers through the process and answer their questions.

Potato (*Solanum tuberosum* L., Solanaceae) is regarded as the world's fourth-largest crop, after rice, wheat, and maize (Guenther et al., 2021; Pandey et al., 2014; Karanja, 2013). In order to produce the maximum yields; potatoes are often an intensively managed crop that requires irrigation, fertilizer, and frequent pesticide applications (Guenther et al., 2021; Waheed et al., 2021).

Potatoes can be classified by color in addition to species and variety throughout the world. Although there are red and blue (purple) fleshed kinds of potatoes, the majority of them are various hues of yellow. When compared to yellow potato species, these colorful cultivars have higher levels of phytonutrients and the pigment anthocyanin, which gives them their distinctive hue. These elements offer a chance to employ potatoes as a natural food colorant, in addition to potential uses for health advantages, such as the healing of burn wounds (Priedniece et al., 2017). The potato is a common farmer's main source of food as well as their main source of income. For low-income households and areas where land scarcity is a problem, potatoes offer a number of advantages (Dersseh et al., 2016). Comparing the crop to a cereal crop, it grows quickly, produces a lot, and has a higher density of protein and energy. As a result, it is crucial in guaranteeing food security, which is a serious worry for the nation. (Dersseh et al., 2016). Over the top food crops, potatoes have a competitive advantage due to a few natural characteristics. In fact, it can yield more protein and carbs per unit area than some leguminous crops, such as soybeans, and cereals (Guenther et al., 2021), it offers a significant number of vitamins and minerals in addition to energy and high-quality protein (Mpogole, 2014; Giordanengo et al., 2013).

Despite its significance, the crop is under pressure from a number of pests and diseases (Obidiegwu et al., 2014). Insect pests are responsible for 16% of crop losses worldwide for potatoes, and they can cause between 30% and 70% decreases in tuber yield and quality (Giordanengo et al., 2013). Poor potato productivity in various agro-ecological zones may be caused by a number of factors, such as limited genetic materials introduced in rural areas, limited access to high yielding varieties, the emergence of new pests and diseases, a lack of access to improved varieties, and a lack of certified quality seed (Okello et al., 2017), Lack of healthy seed tubers and poor seed tuber quality (Kolech et al., 2015), climate change and general environmental and landscape degradation, declining soil fertility due to erosion, continuous cropping and nutrient mining, inappropriate use of chemicals to control fungal diseases and pests, improper sanitation, lack of crop rotation, and varietal resistance to abiotic and biotic stresses are factors affecting potato yield (Dersseh et al., 2016). Sanullah et al. (2020) compared the profitability of maize and potato crops in Pakistan's Upper Dir district by

assessing their costs and net returns. In comparison to maize the results showed that potatoes were more productive and provided growers with more financial rewards. As a result, the majority of respondents assigned additional land to the potato crop. It has been determined that among the farmers in the research area potatoes were a more profitable crop. The dissemination of contemporary agricultural methods as well as timely information and training for potato growers are advised by the extension department. In order to encourage potato farmers to earn a higher net return, the government should subsidize growing inputs and provide them with assistance in accessing local markets.

Objectives

1. To assess the effectiveness of extension activities in the study area.
2. To identify farmers problems in the study area.
3. To pinpoint the main factors that affect agricultural extension activities in study.

Materials and Methods

The study was conducted in District Abbottabad, it is located in the Hazara region of Khyber Pakhtunkhwa (KP), spans about 1,969 square km and is situated between latitudes 34°-36° and longitudes 73°-75°. A multistage sampling method was employed to select the required sample for the study. District Abbottabad is divided into four main tehsils: Abbottabad, Lower Tanawal, Lora and Havelian. One tehsil i.e. Abbottabad was selected randomly for the study. A comprehensive list of union councils from the selected tehsil was obtained with the assistance of the local administration. Out of these, four union councils Salhad, Kakul, Phalkot and Mirpur were selected randomly to capture a diverse set of agricultural practices and challenges. Using data provided by the union councils, a list of villages within the selected union councils was compiled with the assistance of Patwari (local revenue officer). One village from each union council was selected randomly, resulting in a total of four villages for the study. Once the villages were identified, a list of farmers was prepared with the help of local councilors. 60% Farmers were selected from each village included in the sample. This approach ensured proportional representation from the farming communities in each village. For sample selection at village level proportionate allocation technique was followed

The formula for proportional allocation method is as follow:

$$n_i = \frac{N_i}{N} \times n \dots\dots\dots$$

n_i = No. of sample respondents in the village

N_i = total no. of farmer in the village

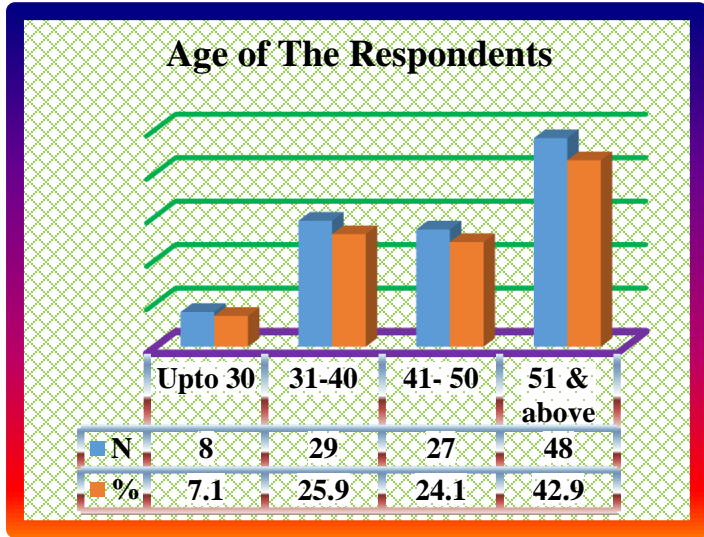
n = whole sample size

N = total no. of farmers in the study area

To collect primary data, a structured interview schedule was designed in alignment with the objectives of the study. The questions were formulated in the local language to ensure accuracy, reliability, and validity of the data. The interview schedule was pre-tested in the field, and modifications were made based on feedback from the pilot testing. Data collected during the study was analyzed using statistical tools, including the Statistical Package for Social Sciences (SPSS) and Microsoft Excel. Descriptive statistics such as percentages were calculated, chi-square and paired t-tests were conducted to evaluate differences between key variables. This comprehensive statistical approach allowed for the effective evaluation of the findings and ensured robust analysis of the data.

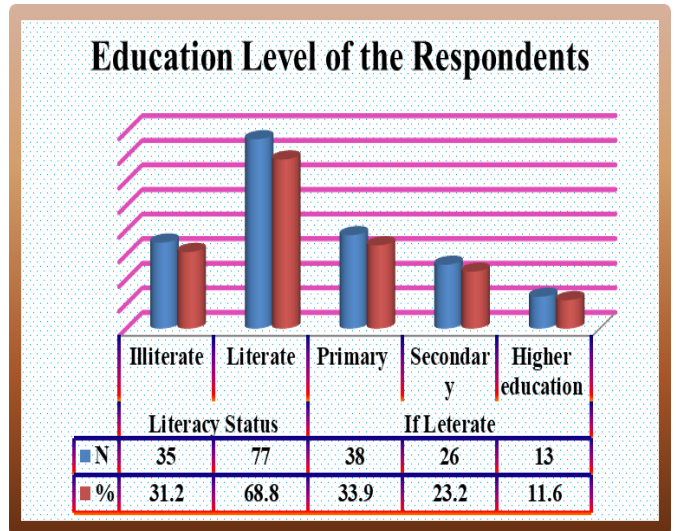
Results and Discussions

Figure 1 N= Number of Respondents



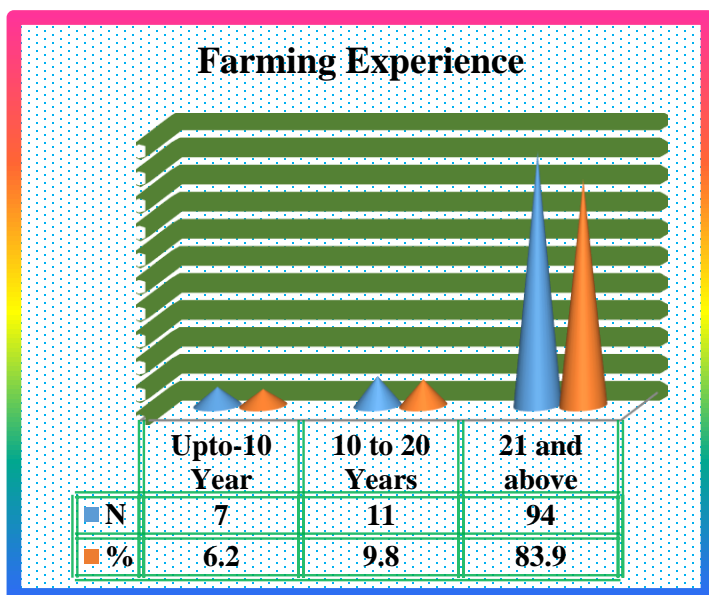
Source: Field Survey, 2024

Figure 2 N= Number of Respondents



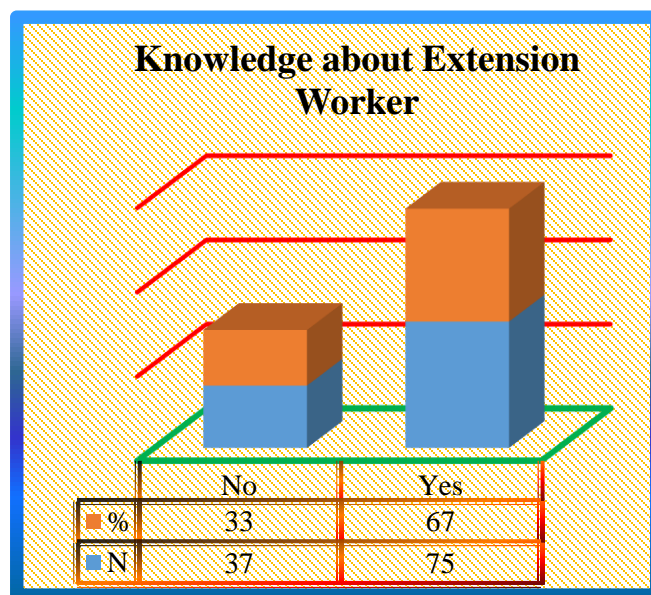
Source: Field Survey, 2024

Figure 3 N= Number of Respondents



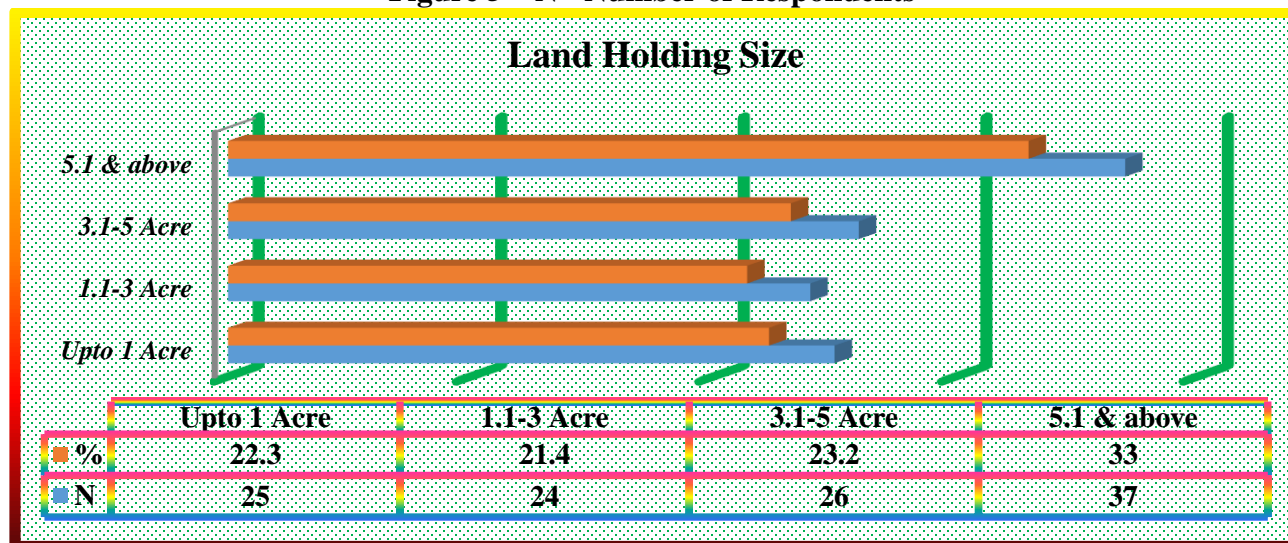
Source: Field Survey, 2024

Figure 4 N= Number of Respondents



Source: Field Survey, 2024

Figure 5 N= Number of Respondents



Source: Field Survey, 2024

The demographic and socio-economic profile of the respondents is summarized across several key measures. **Figure 1** illustrates the age distribution, revealing a sample predominantly composed of older individuals, with those aged 51 and above forming the largest group (42.9%). **Figure 2**, detailing educational attainment, shows that while most respondents are literate (68.8%), the highest level of education for the majority is primary (33.9%) or secondary (23.2%) schooling, with a smaller proportion achieving higher education. Regarding professional experience, **Figure 3** demonstrates that the farming community is highly experienced, as an overwhelming majority (83.9%) possesses 21 years or more of farming experience. **Figure 4** reports on the awareness of agricultural extension services, showing that a majority (67%) of farmers have knowledge of extension workers, though a

significant minority (33%) did not have knowledge about extension workers of their area. Finally, **Figure 5** presents landholding sizes, indicating a diverse range from small to medium and large farms, with a notable portion (33%) holding 5.1 acres or more. Collectively, these figures paint a picture of a respondent base that is largely older, experienced, and operating on varied farm sizes, with basic to moderate education levels and a majority awareness of formal agricultural support systems.

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). These activities can indeed benefit the farmers and play an important role in improving farm practices. Strong coordination and linkages among extension, research and farmers can boost agricultural development. 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).

Table 1 Distribution of Respondents regarding Benefited by Extension Activities

Villages	Have you ever 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	5	28
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	43	267

Source: Field Survey, 2024

Note: Values in parenthesis are percentages

Note: The total may not tally due to multiple responses

Table 1 shows that out of 112 respondents 50 (44.6%) of respondents were benefited from extension services out of which 40 respondents from field days, 35 respondents from demonstration plots, 49 respondents from group meetings, 50 respondents from training sessions and 43 respondents from awareness campaigns while remaining 62 (55.4%) of respondents 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.

Provision of Training by Extension Department

Extension Services plays an important role in the development of the framers. The programs conducted by extension services lead the farmers to the adoption of new technologies (Ali, 2020). Provision of trainings by extension department to farmers includes modern farming techniques, pest control, and efficient resource management. Extension services plays a vital role in helping farmers enhances productivity and improves crop quality. Extension workers play a vital role in educating farmers with knowledge and skills in order to improve their agricultural practices. They introduce different type of trainings to farmers so that the farmers can improve their way of farming and increase their productivity (Sanaullah et al., 2020).

Table 2 Distribution of Respondents Regarding Provision of Trainings in the Study Area

Villages	Attended any training		Total	If yes type of training received				Total
	No	Yes		Organic farming	Kitchen gardening	Integrated pest management	Irrigation management technique	
Islamkot	13(44.8)	16(55.2)	29	7	3	7	5	22
Jabarriya	20(83.3)	4(16.7)	24	4	5	0	0	9
Malsah	14(51.9)	13(48.1)	27	13	2	2	1	18
Neloar	15(46.9)	17(53.1)	32	10	4	7	6	27
Total	62(55.4)	50(44.6)	112	34	14	16	12	76

Source: Filed Survey, 2024

Note: Values in parenthesis are percentages

Note: The total may not tally due to multiple responses.

Data regarding trainings received by the respondents were depicted in Table 2 show that out of 112 respondents 50 (44.6%) of the respondents who attended trainings conducted by extension department while 62 (55.4%) who did not attend any program. This indicates that majority of farmers hadnot exposed to training programs, which likely contributes to their knowledge and practices. Our results were in line with Khil and Pervaiz (2024) who reported that only 41.2% of the respondents in the study area received trainings, whereas majority was deprived of these trainings. These results were in contrast to that of Pervaiz et al., (2018) who reported that 95.2% of study respondents received trainings regarding sowing methods and IPM (this may be fact that they selected registered farmers, who got trainings from extension department). Table 2 also show that out of 112 respondents 34 respondents attended organic farming training, 14 respondents got training regarding kitchen gardening 16 respondents about integrated pest management while 12 respondents got training of irrigation management training.

Area under Potato Crop

The term area under potato crop refers to the total amount of land that farmers dedicate to potato farming. This comprises all fields and farms where potatoes are planted, nurtured and ultimately harvested. Knowing these figures gives us insight into the scale of potato farming in a specific region or country high lightening the importance of potatoes in agricultural practices and food production (Chikaire et al., 2021).

Table 3 Distribution of Respondents on the Basis of Area under Potato Crop

Villages	Area of potato crop cultivation (acre)				Total
	Up to 1	1.1-3	3.1 -5	5.1 &above	
Islamkot	22(79.3)	6(20.7)	0(0)	0(0)	29
Jabarriya	23(95.8)	1(4.2)	0(0)	0(0)	24
Malsah	22(85.5)	4(14.8)	1(3.7)	0(0)	27
Neloar	16(50.0)	3(9.4)	6(18.8)	7(21.9)	32
Total	84(75.0)	14(12.5)	7(6.2)	7(6.2)	112

Source: Field Survey, 2024

Note: The values in parenthesis are percentages

Table 3 shows that the area under potato cultivation, 847 (75.5%) of the area under potato cultivation fell in the range of upto 1 acre, 14 (12.5%) was assigned to 1.1 to 3 acres, about 7 (6.2%) accounted for 5.1 acres and above, while 77 (68.8%) werenot growing potatoes.

Potato Yield

The production of potato crops comprised a series of systematic agricultural practices aimed at maximizing yield and quality. Potatoes thrive in well-draining, loose soil with a pH of 4.5 to 7.0 but in Pakistan the pH of soil for growing potatoes ranges from 5 to 5.5. The ideal soil for potatoes is rich in organic matter, which helps retain moisture and nutrients. Proper storage conditions such as cool dark place, well-ventilated area with low humidity are essential to prevent spoilage. Advances in agricultural technology and practices continue to improve the efficiency and sustainability of potato production (Ortiz, 2019).

Table 4 Distribution of Respondents on the Basis of Potato Yield in the Study Area

Villages	Yield of potato crop (kg/acre)			Total
	Up to 6000	6001-8000	8001 &above	
Islamkot	21(72.4)	3(10.3)	5(17.2)	29
Jabbariya	20(83.3)	0(0)	4(16.7)	24
Malsah	21(77.8)	2(7.4)	4(14.8)	27
Neloar	16(50.0)	2(6.2)	14(43.8)	32
Total	78(69.7)	7(6.2)	27(24.1)	112

Source: Field Survey, 2024

Note: The values in parenthesis are percentages

Table 4 shows that total yield of potato crops in different forms across the study area, 77 (69.7%) of respondents produced up to 6000 kg/acre of potatoes, 7 (6.2%) of respondents got yield from 6001 to 8000 kg/acre, meanwhile 27 (24.1%) of respondents reported yield from 8001 kg/acre. Each category represents a distinct portion of yield, featuring the different scale of potato cultivation among surveyed respondents.

Adoption of Modern Technologies

The adoption of modern technologies in agriculture has greatly improved the ways in which farmers practice farming, with increases 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). From advancements in agriculture, one major barrier lies in the high cost that a great many small-scale farmers are unable to afford regarding equipment such as drones, sensors, and automated machinery. Farmers also often lack the technical knowledge and awareness, along with poor infrastructure so using new technologies effectively is difficult to understand.

Table 5 Distribution of Respondents on the Basis of Adopting Modern Technologies

Villages	Have you adopted 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
Jabbariya	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, 2024

Note: Values in parenthesis are percentages

Note: The total may not tally due to multiple responses

Table 5 shows that out of 112 respondents 42 (37.5%) respondents agreed on adoption of modern technologies, 70 (62.5%) did not adopt. Table 4.20 also shows that out of 112 respondents 36

respondents faced small land holding issue, 82 respondents faced lack of irrigation issue and 62 respondents faced the issue of poor financial position. Our findings are similar with (Ali & Ahmad, 2014).

Adoption of High Yielding Varieties as a Modern Technology

Special crop plant varieties known as High Yielding Varieties (HYVs) yield more food than conventional varieties. They produce more, grow more quickly, and are frequently more resistant to pests and illnesses. However extension services plays an important role in promoting the adoption of HYVs by providing farmers with the knowledge and resources to cultivate these improved varieties, resulting in increased crop yield and better economic returns.

Table 6 Distribution of Respondents on Adoption of High Yielding Varieties as a Modern Technology

Villages	Adopt High yielding varieties		Total
	No	Yes	
Islamkot	17(58.6)	12(41.4)	29
Jabarriya	15(62.5)	9(37.5)	24
Malsah	19(70.4)	8(29.6)	27
Neloar	19(59.4)	13(40.6)	32
Total	70(62.5)	42(37.5)	112

Source: Field Survey, 2024

Note: Values in parenthesis are percentages

Table 6 shows that out of 112 respondents 42 (37.5%) respondents adopted High yielding varieties as modern technology while 70 (62.5%) did not adopt any modern technology.

Impact of Certified Seeds

Certified seeds play a significant role in enhancing agricultural production. Using quality seeds and planting material is crucial for achieving high results in agricultural production.

Table 7 Distribution of Respondents on the Basis of an Impact of Certified Seeds on Farm Productivity

Villages	Impact of Certified Seeds					Total
	No impact	Slight impact	Moderate impact	High impact	Very high impact	
Islamkot	0(0)	1(3.4)	9(31.0)	19(65.5)	0(0)	29
Jabarriya	1(4.2)	2(8.3)	10(41.7)	11(45.8)	0(0)	24
Malsah	1(3.7)	4(14.8)	9(33.3)	12(44.4)	1(3.7)	27
Neloar	0(0)	1(3.1)	6(18.8)	23(71.9)	2(6.2)	32
Total	2(1.8)	8(7.1)	34(30.4)	65(58.0)	3(2.7)	112

Source: Field Survey, 2024

Note: Values in parenthesis are percentages

Table 7 shows that out of 112 respondents 65 (58.0%) of respondents had high impact of certified seeds, 3 (2.7%) very high impact, 34 (30.4%) moderate impact, 8 (7.1%) slight impact, and 2 (1.8%) had no impact of certified seeds at all.

Primary Challenges in Farming Faced by Farmers

Effectiveness of agricultural extension activities substantially depends on the attributes of farmers and farms (Akram et al., 2003). Therefore it is very important to know what factors that affect farmers to receive extension services.

Table 8 Distribution of Respondents on Facing Primary Challenges in Farming

Villages	Primary challenges faced by the respondents					Total
	Lack of knowledge	Financial constraints	Pest infestations	Water scarcity	Lack of market access	

Islamkot	12	17	7	29	6	71
Jabbariya	3	22	0	19	3	47
Malsah	7	13	6	17	10	53
Neloar	12	23	5	25	11	76
Total	34	55	18	90	30	227

Source: Field Survey, 2024

Note: Values in parenthesis are percentages

Note: The total may not tally due to multiple responses

Table 8 shows that out of 112 respondents 34 respondents had lack of knowledge as a primary challenge in farming, 55 respondents faced financial constraints, 18 respondents faced pest infestations, 90 respondents faced water scarcity as a primary challenge, and 30 respondents had lack of access to markets. As findings of Baloch and Hapa (2010) pointed out that poor extension services, pest infestation and water scarcity resulted in 65% decrease in yield.

Agricultural Extension Worker Visit to Farmers

Extension workers visits involve the experts from the agricultural extension services visiting farms or rural areas to provide guidance and support to farmers (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). They also conduct training sessions, introduce new technologies and address specific issues and challenges faced by farmers (Sanallah et al., 2020). The goal of these visits is to improve agricultural productivity and sustainability by sharing important knowledge, skills and resources directly with those working in the fields (Chowa et al., 2013).

Table 9 Distribution of Respondents on the Basis of Extension Worker Visit 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
Jabbariya	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, 2024

Note: Values in parenthesis are percentages

Note: The total may tally due to multiple responses

Table 9 reveals that out of 112 respondents majority of the respondents 75 (67.0%) had knowledge about extension worker, while 37 (33.0%) did not know the extension worker of their area. Second part of Table 9 shows that out of 75 respondents who knew the extension worker of their area, 40 (53.3%) reported that the extension worker visited them off and on, 35 (46.7%) reported that extension worker visited monthly, and the remaining 1 (1.3%) reported that the extension worker visited weekly. This discrepancy suggests differences in the level of engagement with extension workers among the villages. For instance, a study by Brown and Smith (2022) also observed similar disparities in extension engagement across different areas were noted.

Farmer's visit to Agricultural Extension Office

Farmer and extension worker contact is important for effective agricultural development, as it facilitates the exchange of knowledge and technology (Sulaiman, 2003). As we know that majority of the farmers are illiterate, due to which they cannot rely on print material for their guidance. So visit to Agricultural Extension office is more suitable for them to find a best possible solution of their problems (Xu et al., 2023). Extension workers serve as a vital link, ensuring that farmers have access to the latest research and practices (McCole et al., 2014).

Table 10 Distribution of Respondents on the Basis of Farmer’s Visit to Agricultural Extension Office

Villages	Do you visit the extension office for advice		Total	How often do you visit			Total
	No	Yes		Weekly	Monthly	Off and On	
Islamkot	6(20.7)	23(79.3)	29	0(0)	5(17.2)	18(62.1)	23(79.3)
Jabbariya	4(16.7)	20(83.3)	24	0(0)	18(75.0)	2(8.3)	20(83.3)
Malsah	4(14.8)	23(85.2)	27	1(3.7)	8(29.6)	14(51.9)	23(85.2)
Neloar	15(46.9)	17(53.1)	32	0(0)	3(9.4)	14(43.8)	17(53.1)
Total	29(25.9)	83(74.1)	112	1(0.9)	34(30.4)	48(42.9)	83(74.1)

Source: Field Survey, 2024

Note: Values in parenthesis are percentages

Note: The total may tally due to multiple responses

Table 10 shows that regarding visit of farmers to the Agricultural Extension office for assistance, out of 112 respondents 83 (74.1%) of respondents visited the Agricultural extension office and 29 (25.9%) did not visit. Second part of the Table 10 shows that out of 83 respondents who visited the Agricultural Extension office for assistance, 48 (42.9%) reported that they visited the office off and on, 34 (30.4%) reported that they visited monthly, while 1 (0.9%) reported that they visited weekly to the Agricultural Extension office. Strong emphasis has been placed on agricultural extension services intended to provide farmers with access to the improved technologies which are essential for enhancing agricultural production (Rogers 2003; Shah et al., 2010; Al Sharafat, 2012).

Seed Rate Comparison of Potato Crop before and after Extension Recommendations

To find out the mean significant difference of seed rate of potato crop before and after extension recommendation, a paired sample t-test was applied and the following were presented in Table 11

Table 11 Paired Sample t-Test of Seed Rate of Potato Crop before and after Extension Recommendations

Variable	Before extension recommendations		After extension recommendations		Mean difference	t-value	p-value
	Mean	SD	Mean	SD			
Seed rate (kg/acre)	234.76	464.518	198.51	392.401	36.250	4.948	0.000***

Source: Calculated by Author, 2025 *** indicates significance level at 1% probability

Results showed a highly significant difference ($p < 0.01$) in the seed rate of the respondents before and after extension recommendations. The mean difference is 4.948kg/acre. It is clear from the results that a reasonable decrease in seed rate kg/acre was recorded after getting recommendations from the extension department.

Comparison of potato yield before and after extension recommendations

To find out mean significant difference of potato yield before and after extension recommendations, paired sample t-test was used and the calculations were presented in Table 12

Table 12 Paired Sample T-Test Analysis of Comparison of Potato Crop Yield before and after Extension Recommendation

Variable	Before extension recommendation	After extension recommendation	Mean difference	t-value	p-value
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	Mean	SD	Mean	SD			
Actual yield	2057.32	4354.990	2458.54	5215.149	-401.223	-4.359	0.000***

Source: Calculated by Author, 2025 *** indicates significance level at 1% probability

Results showed that there was a highly significant difference ($p < 0.01$) difference between wheat yield before and after extension recommendations. The mean difference value evaluated was -401.223 which means that 401.223 kg/acre increase was recorded in maize yield after extension recommendations. The primary reason behind such increase in potato yield may be due to the diffusion of new skills and improved practices of farming to the farmers by extension department.

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 global 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).

As regular training is the basic component to effectively communicate the new technology to the farmers, therefore proper attention must be given to the trainings of the extension workers.

Extension department plays a crucial role in providing training programs for farmers, workers and other stakeholders. These training programs aim to improve knowledge, skills and agricultural practices leading to improved productivity and livelihoods. Different types of training programs are conducted to educate farmers like commodity based trainings, integrated crop management etc. Agricultural extension workers conduct demonstrations in order to introduce new technologies, practices and innovations to farmers. Demonstrations basically allow farmers to see and experience new technologies and practices by enhancing their knowledge and adaption. Farm visits are considered as important component of agricultural extension activities where extension workers visit farmer field to provide knowledge, guidance and support. These visits basically allow extension workers to assess farmers specific needs, identify problems and offer suitable solutions. Field days are events organized by agricultural extension workers to introduce new farming practices and innovations. These events provide farmers with an opportunity to see and learn about new methods and technologies. Field days basically improves farmer knowledge and understanding. Extension workers conduct campaigns to educate farmers about climatic changes and how to tackle those changes. Awareness campaigns also play an important role in the wellbeing of farmers and aim to improve agricultural productivity and promote sustainable practices. Agricultural extension workers play an important role in disseminating technology to farmers, enhancing their knowledge and improving their productivity. These activities can also reach to remote areas especially in rural communities. Mobile apps provide real time information about weather, forecast and market prices.

Table 13 Distribution of Respondents on the Basis of Effectiveness of Extension Activities in the Study Area

Activities	Effectiveness of extension activities				
	Very poor	Poor	average	Good	Excellent
Training	3 (2.7)	8 (7.1)	43 (38.4)	44 (39.3)	14 (12.5)
Demonstrations	57 (50.9)	28 (25.0)	22 (19.6)	5 (4.5)	0 (0)
Farm visit	23 (20.5)	44 (39.3)	21 (18.8)	24 (21.4)	0 (0)
Field day	26 (23.2)	23 (20.5)	15 (13.4)	48 (42.9)	0 (0)
Awareness campaigns	3 (2.7)	29 (25.9)	50 (44.6)	26 (23.2)	4 (3.6)
Technology dissemination	76 (67.9)	35 (31.2)	1 (0.9)	0 (0)	0 (0)

Source: Field Survey, 2024

Note: Values in parenthesis are percentages

Table 13 presents the ratings from 112 respondents for six agricultural extension methods. For the training program, ratings were distributed with 39.5% good, 38.4% average, 12.5% excellent, 7.1% poor, and 2.7% very poor. Demonstrations received predominantly negative feedback, with 50.9% rating them very poor, 25.0% poor, 19.6% average, and only 4.5% good. Farm visits were viewed unfavorably by many, with 39.3% poor and 20.5% very poor, compared to 21.4% good and 18.8% average. In contrast, field days were rated more positively, with 42.9% good, though 23.2% still rated them very poor and 20.5% poor. Awareness campaigns received a mixed response, led by 44.6% average, followed by 25.9% poor and 23.2% good. The most critical assessments were for technology dissemination, which 67.9% rated very poor and 31.2% poor, with a negligible 0.9% average.

Association of total land holding with extension visits

Table 14 show the comparative analysis of total land holding with visits of extension workers to the sample respondents. The chi-square value of 13.202 and p-value of 0.004 confirm that is statistically significant at the 1% level ($p > 0.01$). These results suggest that farmers with larger land sizes are more connected better informed and have more opportunities to interact with extension officials which increase their awareness compared to smallholders.

Table 14 Association of Total Land Holding with Extension Visits

Variable	Categories	Extension visits		Total
		No	Yes	
Total land holding	Upto 1 acre	14 (56.0)	11 (44.0)	25
	1.1 to 3 acre	10 (41.7)	14 (58.3)	24
	3.1 to 5 acre	8 (30.8)	18 (69.2)	26
	5.1 acre and above	5 (13.5)	32 (86.5)	37
	Total	37 (33.0)	75 (67.0)	112
$\chi^2 = 13.202$ P value= 0.004				

Source: Calculated by Author, 2025 * indicates significance level at 1% probability

Note: values in parenthesis are percentages

Table 14 clearly shows that out of 112 respondents 75 (67%) had knowledge of extension activities, while 37 (33%) did not. Farmers with bigger landholdings were more likely to know about the extension visits compared to those with smaller farms. Among farmers who own Upto 1 acre, less than half 11 (44%) were aware of extension activities. But as land size increases awareness also rises 14 (58.3%) of those with 1.1-3 acres, 18 (69.2%) of those with 3.1-5 acres and a very high 32 (86.5%) of farmers who own more than 5 acres said that extension workers do visits them.

Association of Literacy Level of Respondents with Knowledge about Extension Department

Table 15 shows that the more educated farmer more likely knows about extension department. The Chi-square value 9.853 and p-value 0.020 indicates a statistically significant association between education and knowledge about extension department at 5% probability level ($p < 0.05$). It means farmers who were better educated were more likely to be informed about extension department and their activities.

Table 15 Association of Literacy Level with Knowledge about Extension Department of the Sample Respondents

Variable	Categories	Knowledge about extension department		Total
		No	Yes	
Literacy level	Illiterate	18 (51.4)	17 (48.6)	35
	Primary	11 (28.9)	27 (71.1)	38
	Secondary	7 (26.9)	19 (73.1)	26

	Higher education	1 (7.7)	12 (92.3)	13
	Total	37 (33.0)	75 (67.0)	112
	$\chi^2 = 9.853$	P value= 0.020		

Source: Calculated by Author, 2024 *indicates significance level at 1% probability

Note: Values in parenthesis are percentages

Table 15 clearly show out of 112 respondents 75 (67.0%) had knowledge about extension department and 37 (33.0%) did not. Among illiterate respondents just under half 17 (48.6%) were aware of extension department, while the rest of the respondents did not know about them. Those with primary education, where 27 (71.1%) said they knew extension department, while 11 (28.9%) did not. The secondary group of respondents shows that 19 (73.1%) were aware, while 7 (26.9%) were not and the highest awareness was seen among the farmers with higher education where 12 (92.3%) were aware of extension department, while 1 (7.7%) were not aware.

Conclusions

It is concluded that farmers in District Abbottabad face multiple challenges that limit their agricultural productivity. Although most farmers are experienced and aware of the extension department, their adoption of modern technologies remains low due to constraints such as water scarcity, fragmented landholdings, financial difficulties, and lack of irrigation facilities. Certified seeds, integrated pest management, and extension-led training programs have shown positive results in improving yields and reducing input costs, yet these benefits are not evenly distributed among 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. In particular, the results demonstrate that guidance from extension workers significantly improved seed use efficiency and crop yield for potato. However, limited access to modern machinery and inadequate adaptation measures against climate change continue to hinder agricultural growth. Overall, the study concludes that enhancing the effectiveness of agricultural extension services, ensuring wider access to certified seeds, promoting water management solutions, and supporting farmers financially are essential for sustainable agricultural development in Abbottabad. A more proactive and inclusive extension system will not only increase productivity but also help farming communities adapt to future climatic and economic challenges.

Recommendations

On the basis of the conclusions of the study, the following recommendations were made.

- More extension staff should be appointed by the Government so that farmers can get regular visits and timely advice in their own villages.
- Extension department needs to arrange training sessions more often, focusing on simple, practical topics such as pest control, irrigation, and modern farming methods.
- Certified seeds should be made easily available at affordable prices, along with awareness campaigns to show their benefits.
- Farmers require easier access to loans or subsidies so they can invest in better inputs and technologies without financial stress.
- Awareness about climate change and training in climate-smart practices, such as planting drought- and pest-resistant varieties, should be increased.
- Integrated Pest Management (IPM) should be promoted through demonstrations and farmer-friendly guidance on safer pest control.
- Better marketing channels and farmer cooperatives should be developed so farmers can sell their produce directly and get fair prices.
- Mobile phones, radio, and social media should be used more actively to spread agricultural knowledge to farmers in remote areas.

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