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Analyzing the Role of Agricultural Extension Agents in Transfer of Improved Technologies Regarding Citrus Production (Sweet Orange) In District Malakand

Furqan Shafiq
Agriculture Extension Education and Communication, The University of Agriculture Peshawar
Furqanfurqan750@gmail.com
Shah Hassan
Agriculture Extension Education and Communication, The University of Agriculture Peshawar

ABSTRACT
This study examines the role of agricultural extension agents in facilitating the transfer of improved technologies for citrus (sweet orange) production in District Malakand, Khyber Pakhtunkhwa, Pakistan. Citrus farming is a vital economic activity in the region, yet productivity remains below potential due to inadequate dissemination of modern agricultural practices. The research aims to evaluate the linkage between citrus growers and the agricultural extension department, assess the effectiveness of extension services, identify key constraints in technology adoption, and propose recommendations for enhancing service delivery. A structured survey was conducted among 90 citrus growers from two major citrus-producing union councils, Palai and Wartair, using proportionate sampling. Data were analyzed through SPSS, employing frequency distributions and chi-square tests. The findings reveal that while most farmers were engaged in citrus cultivation, their access to and application of improved technologies are limited. Key issues include low literacy rates, insufficient extension agent visits, poor marketing knowledge, and financial constraints. The role of extension agents was found to be suboptimal, both in moral and mandatory dimensions. Farmers highlighted the need for frequent extension visits, training programs, and improved input availability. The study concludes with policy recommendations including enhanced training for extension agents, improved infrastructure support, the use of demonstration plots, and stronger institutional linkages to boost citrus productivity and farmer livelihoods.

Keywords: *Agricultural Extension, Technology Transfer, Citrus Production, Sweet Orange, district Malakand*.

Introduction

Agriculture is an essential part of the economy of the world's poorest nations like Pakistan. A large portion of Pakistan's economy is based on its agriculture sector. (GoP, 2024-25). Citrus (Citrus sinensis) is a fruit pertains Rutaceae family, thereby, grown-up in more than 140 countries around the world in tropical and subtropical climates Northern Hemisphere is considered the major cultivating and producing region of the world. Around are 78 species of the Rutaceae family sown across the globe for marketing and commercial purposes?

Historically, Citrus fruit first seemed on the planet centuries back. It is believed that birth place of citrus is India, neighboring China, and south part of Himalayan area (Gmitter and Hu, 1990). Pakistan is home of nice and temperate fruits. Citrus is Pakistan's most popular fruit, with a market share of more than 50%. More than 5,751,900 million tonnes of fruits are produced in Pakistan's 681,080 hectares of land. The nation exports 264 thousand tonnes of fruits, of which (Govt. of Pakistan, 2020-21). It's not uncommon for citrus fruit to be of varying quality throughout the nation. Between the northern and southern latitudes, semi-tropical climates are ideal for growing citrus (Mahmood and Akhtar, 2006). There are a myriad of citrus fruits grown in the Pakistan. There are a number of popular citrus cultivars cultivated in Pakistan, including Mandarins (Feutrell's Early and Kinnow), as well as Sweet Oranges (Mausami or Musambi and Red Blood).

The climate in Khyber Pakhtunkhwa is thought to be ideal for nearly all types of fruit growing (Asian Development Bank, 1990). Citrus (sweet orange) is one of the most important fruits grown in Khyber Pakhtunkhwa's various regions. In Khyber Pakhtunkhwa, the total citrus output and area is 4049, with a total volume of 31330 tons (GoKP, 204-25).

District Malakand has a large variety of citrus (sweet orange), which is used for commercially purpose. Some prominent areas include palai and wartair (Akbar, 2020). Pakistan is one of the top 10 citrus-producing countries in the world. The company is also the world's top producer of citrus reticula (kinnow). Foreign vendors prefer Pakistani kinnow due to its inherent high quality of taste. Citrus production in Pakistan is currently threatened by a variety of issues, including inadequate harvest practices, harvest delays, a lack of disease control, and unfavorable weather conditions. As a result, citrus farmers suffer significant economic losses. In such a scenario, the position of agricultural extension agents becomes a cry of the day in order to abandon gap between current and potential citrus production. As a result, the current study will be carried out in the district of Malakand to investigate the role of agricultural extension agents in the transition of improved citrus (sweet orange) production technologies.

Agricultural extension agent, mainly responsible to create awareness among farmers across the country, has a strong reliance to exchange information among farmers. Agricultural education, information and skill development are the main concerns of agricultural extension agents. Thus agricultural extension organizations are assigned with the primary task of educating and disseminating the latest modern agricultural technologies to the farmers, using various extension teaching methods like: individual, group and mass contact methods, have thus wider coverage (Saeed, 2013).

As far Khyber Pakhtunkhwa and specially Malakand is concerned, Agriculture extension agents can play a vital role in transferring of modern technologies, but unfortunately extension agents could not deliver as per demand. One of the several reasons is the low education level, less training opportunities, scarcity of budget. Due to these reasons extension agents confronted a lot of problems; Government should put these problems on its top priority and solve these problems. However, better education and proper training is necessary for extension agents to change the behavior of the traditional farmers toward modern technology (Nagel, 1998).

The objectives of this study are to assess the linkage between the Agriculture Extension Department and citrus growers in the study area, examine the roles and functions of agricultural extension agents in the dissemination of improved citrus (sweet orange) production technologies,

identify the key problems and constraints faced by farmers in accessing and adopting these innovations, and finally, to propose practical policy recommendations based on the empirical findings to enhance the effectiveness of agricultural extension services in District Malakand.

Materials and Methods

This study analyzes the role of agricultural extension agents in the transfer of improved technologies regarding citrus (sweet orange) production in District Malakand. The materials and procedures were designed to guide the systematic process of data collection, analysis, and interpretation, as outlined by Nachmias (1992). The universe of the study was District Malakand, a hilly region in Khyber Pakhtunkhwa known for citrus farming, where citrus growers face various production-related challenges. Out of the 28 union councils in the district, two major citrus-producing UCs—Palai and Wartair—were purposively selected. Using proportionate sampling, 90 citrus growers were selected from a total population of 120 (60 from Palai and 30 from Wartair), representing 75% of the population, due to financial and time constraints. The formula ($ni=Ni/N \times n$) was used to determine the sample size from each union council. A well-structured interview schedule was developed in English, containing both open- and close-ended questions, including Likert-scale items. It was pre-tested on 15 non-sample respondents, and necessary revisions were made based on feedback and expert validation. The interviews were conducted in the local language, Pashto, at the respondents' farms or homes to ensure clarity and comfort. The data collection involved both primary and secondary sources; primary data were gathered through face-to-face interviews, while secondary data were obtained from relevant literature and official reports. The survey method was employed for its effectiveness in capturing attributes of the broader population. The collected data were analyzed using SPSS software, and results were presented in frequencies and percentages. To examine relationships among variables, chi- square tests were applied at a 5% level of significance using the formula where O represents observed frequencies and E represents expected frequencies.

Results and Discussion

Literacy status

Human resource development is greatly aided by education, which has a significant impact on human behaviours. Education may help people acquire skills, information, and problem-solving strategies, all of which have a beneficial impact on human behaviour. As a consequence, educated farmers are regarded to be more aware of agricultural innovations and more scientific in their approach to farming operations (Aziz et al., 2018) when it comes to agricultural skills, knowledge and information, educated individuals are anticipated to be more positive than those who are not.

Table 4.1 Distribution of the respondents regarding their literacy status

Union council	Literacy status					Total
	Illiterate	Primary	Middle	Metric	Intermediate	
Palai	13 (14.4)	16 (17.8)	6 (6.7)	16 (17.8)	9 (10.0)	60
Wartair	7 (7.8)	3 (3.3)	10 (11.1)	5 (5.6)	5 (5.6)	30
Total	20 (21.2)	19 (21.1)	16 (17.8)	21 (23.3)	14 (15.6)	90

Source: Field survey, 2021

Note: Value in parenthesis are percentages

Results in Table 4.1 indicates that 21.2% of the sample respondents were illiterate, whereas, 21.1% were educated up to primary level. Among the literate respondents 17.8%, 23.3%, and 15.6% of the respondents were educated up to the intermediate level, respectively. According to Waman et al. (1998), there were 22.3% illiterate people.

Major citrus variety

When a variety occurs naturally or is carefully grown, it differs from the rest of the species in specific traits, which results in higher quality yields, greater pest and disease resistance, and higher yields per unit area than when the variety does not occur naturally or does not differ from the rest of the species in specific traits.

Table 4.2. Distribution of the respondents regarding major citrus variety

Union Council	Mosami	Red blood	Total
Palai	17 (18.9)	43 (47.8)	60
Wartair	10 (11.1)	20 (22.2)	30
Total	27 (30.0)	63 (70.0)	90

Source: Field survey, 2021

Note: Value in parenthesis are percentages

It is found from the study that out of total, respondents in which majority 70.0% of the respondents were cultivating red blood variety of citrus while rest of the respondents were cultivating mosami variety of citrus in the research area. Our research has matched with Saeed (2013) who conducted research in district Dir where he found that majority of 73.3% respondents cultivated red blood variety.

Factors affecting citrus productivity

Productivity is defined as the ratio of output to input in a manufacturing process. It is a measure of the effectiveness of a manufacturing process. Increased national productivity has the potential to improve people's living standards because more income increases people's ability to purchase goods and services, participate in leisure activities, obtain better housing, and receive a better education, as well as contribute to social and environmental programs.

Table 4.3. Distribution of the respondents regarding factors affecting citrus production

Union Council	Technology	Extension worker role	Diseases	Financial status	Marketing	Total
Palai	28 (31.1)	15 (16.7)	6 (6.7)	5 (5.6)	6 (6.7)	60
Wartair	13 (14.4)	10 (11.1)	3 (3.3)	2 (2.2)	2 (2.2)	30
Total	41 (15.6)	25 (27.8)	9 (10.0)	7 (7.8)	8 (8.9)	90

Source: Field survey, 2021

Note: Value in parenthesis are percentages

Results in Table 4.11 indicates that majority respondents 15.6% were facing technology problems then 27.8% were affected by the role of extension worker. Similarly, 10.0% had a disease problem. There were 8.9% who did not have any idea about marketing and 7.8% were facing financial issues. The result 10.0% calculated for disease attack was in good comparison with Plaza et al. (2003) whose result for disease was 12.2%.

Problems of citrus grower

Farmers have different problems which they face during citrus growing. They need knowledge regarding marketing, inputs and so more. Farmers were asked about their problems of citrus.

Table 4.4. Distribution of the respondents regarding problems of citrus grower

Union Council	Lack of transportation	Lack of information	Lack of marketing techniques	Lack of input knowledge	Disease attacks/insects/pest	Total
Palai	6 (6.7)	21 (23.3)	16 (17.8)	11 (12.2)	6 (6.7)	60
Wartair	3 (3.3)	6 (6.7)	11 (12.2)	5 (5.6)	5 (5.6)	30
Total	9 (10.0)	27 (30.0)	27 (30.0)	16 (17.8)	11 (12.2)	90

Source: Field survey, 2021

Note: Value in parenthesis are percentages

Data in this Table shows different citrus growers problems. Results show out of 90 respondents, majority 30.0% were facing lack of marketing technique, lack of information. Then 10.0% were facing transportation problems. Similarly, 17.8% had no knowledge of input and 12.2% were reportedly complaining regarding disease attacks. Majority of the respondents had no information and did not have knowledge about marketing technique. If we compare our finding with Saeed (2013), he found that 29.9% respondents lacked marketing techniques.

Farmer's suggestion/opinions

Farmers are the most objective observers of all field activities, are keen and they have a wealth of knowledge and expertise in the farming and field operations of the citrus producing industry. The researcher observed and noted during data collection and was agreed with these comments, which is appropriate given that the researcher comes from the study region in question.

So, their comments and proposals should be taken into consideration, and they may be sent to policymakers for future development, in order to boost citrus production and increase yields while simultaneously increasing the socio-economic position of farmers.

Table 4.5. Distribution of the respondents regarding farmer's suggestions about citrus

Union Council	Installation of tube wells	Extension worker should visit frequently	Training programs for farmers	Better land preparation	Total
Palai	16 (17.8)	26 (28.9)	10 (11.1)	8 (8.9)	60
Wartair	5 (5.6)	16 (17.8)	3 (3.3)	6 (6.7)	30
Total	21 (23.3)	42 (46.7)	13 (14.4)	14 (15.6)	90

Source: Field survey, 2021

Note: Value in parenthesis are percentages

The above Table revealed that out of 90 respondents, majority 46.7% told that extension worker should frequently visit. Then 23.3% argued that installation of tube wells is necessary while 14.4% argued that there should be some training programs for farmers and 15.6% gave their suggestion regarding betterment for land preparation.

Agriculture Extension Role

Generally, extension worker has two roles; mandatory role and moral role. He/she is the key figure in the whole extension program. Due to his/her multipurpose nature of the work he/she plays an important role in the uplift of rural life. Farmers were asked about the moral role of extension workers.

Table 4.6 Statement of Moral Role

S.NO	Statement of Moral Role	1	2	3	4	5	Mean	S.D	Rank
A	Extension worker cooperation with the people	5 (5.6)	10 (11.1)	12 (13.3)	48 (53.3)	15 (16.7)	3.64	1.063	I
B	A close contact with rural people	4 (4.4)	12 (13.3)	18 (20.7)	40 (44.4)	16 (17.8)	3.57	1.070	II
C	Understanding village people and their problems	6 (6.7)	10 (11.1)	40 (44.4)	18 (20.0)	16 (17.8)	3.31	1.097	III
D	Adjust himself with the local society	6 (6.7)	10 (11.1)	38 (42.2)	24 (26.7)	12 (13.3)	3.28	1.051	IV
E	Feels needs of local people	4 (4.4)	8 (8.9)	48 (53.3)	20 (22.2)	10 (11.1)	3.26	0.933	V
F	Participation in sorrows and joys of the village	10 (11.1)	38 (42.2)	20 (22.2)	12 (13.3)	10 (11.1)	2.71	1.173	VI
G	Respect for local customs and traditions	10 (11.1)	50 (55.6)	8 (8.9)	14 (15.6)	8 (8.9)	2.60	1.109	VII

Scale: 1= Strongly Agree 2= Agree 3= Neutral 4= Disagree 5= Strongly Disagree

S.D: Standard Deviation

Table 4.22 shows that extension workers' cooperation with the people of village was ranked 1st with highest mean value 3.64 and standard deviation 1.063. Furthermore, a close contact with rural people was ranked 2nd with mean value 3.57. Respect for local customs was ranked lowest. Table 4.22 shows that extension workers' cooperation with the people of village was ranked 1st with highest mean value 3.64 and standard deviation 1.063. Furthermore, a close contact with rural people was ranked 2nd with mean value 3.57 and standard deviation 1.070. Similarly, comprehensive understanding of village people and their problem ranked 3rd with mean value 3.31 and standard deviation 1.097. Then, adjust himself with local society was ranked 4th with mean value 3.28 and standard deviation 1.051, followed by extension worker feel needs of local people ranked 5th with mean value 3.26 and standard deviation .933. Participation in sorrows and joys of village was ranked 6th with mean value 2.71 and standard deviation 1.173. Moreover, respect the local customs and tradition of life was ranked 7th with lowest mean value 2.60 and standard deviation 1.109.

Farmers were then asked about mandatory role.

Table 4.7 Statement of mandatory role

S.NO	Statement of mandatory role	1	2	3	4	5	Mean	S.D	Ranks
A	Gets information regarding all of the families in the village and their problems, needs and capabilities?	6 (6.7)	10 (11.1)	48 (53.3)	20 (22.2)	6 (6.7)	3.11	.929	I
B	Take the problem of citrus growers to research institute for solution	5 (5.6)	16 (17.8)	49 (54.4)	12 (13.3)	8 (8.9)	3.07	.914	II
C	Bring latest technology regarding sweet orange to the citrus grower	8 (8.9)	12 (13.3)	50 (55.6)	11 (12.2)	9 (10.0)	3.01	1.011	III
D	Work for the uplift of citrus grower life and environment	9 (10.0)	14 (15.6)	45 (50.0)	12 (13.3)	10 (11.1)	3.00	1.070	IV
E	Use a variety of extension teaching methods to work related to the situation	11 (12.2)	16 (17.8)	35 (38.9)	20 (22.2)	8 (8.9)	2.97	1.121	V
F	Arrange training, workshops and seminars to skilled and inform the grower	9 (10.0)	14 (15.6)	47 (52.2)	13 (14.4)	7 (7.8)	2.94	1.009	VI
G	Bring a psychological change in the minds of citrus grower to adopt improved citrus	7 (7.8)	12 (13.3)	55 (61.1)	10 (11.1)	6 (6.7)	2.92	.881	VII
H	Provide an opportunity to citrus grower to work in cooperative action	12 (13.3)	15 (16.7)	40 (44.4)	15 (16.7)	8 (8.9)	2.91	1.108	VIII

Scale: 1= Strongly Agree 2= Agree 3= Neutral 4= Disagree 5= Strongly Disagree
S.D: Standard Deviation

Table 4.23 reveals that "Gets information regarding all of the families in the village and their problems, needs and capabilities" was ranked 1st with the highest mean value 3.11 and standard deviation .929. "Take the problem of citrus growers to research institute for solution" was ranked 2nd with mean value 3.07 and standard deviation .914. "Bring latest technology regarding sweet orange to the citrus grower" was ranked 3rd with mean value 3.01 and standard deviation 1.011. "Work for the uplift of citrus grower life and environment" was ranked 4th with mean value 3.00 and standard deviation 1.070. "Use a variety of extension teaching methods" ranked 5th with mean value 2.97 and standard deviation 1.121. "Arrange training, workshops and seminars" ranked 6th with mean value 2.94 and standard deviation 1.009. "Bring a psychological change in the minds of the citrus grower to adopt and grow improved citrus" ranked 7th with mean value 2.92 and standard deviation .881. Finally, "Provide an opportunity to citrus grower to work cooperative action" ranked 8th with lowest mean value 2.91 and standard deviation 1.108.

Association between literacy status and problems of citrus grower

This table shows the association between literacy status and problems of citrus grower in the research study area. The result showed a highly significant association (**p < 0.05**).

Table 4.8 Association between literacy status and problems of citrus grower

Literacy Status	Lack of transportation	Lack of information	Lack of marketing technique	Lack of input knowledge	Disease attacks/insects/ pests	Total (%)
Illiterate	0 (0)	6 (6.7)	8 (8.9)	5 (5.6)	1 (1.1)	20 (22.2)
Primary	0 (0)	8 (8.9)	5 (5.6)	6 (7.8)	0 (0)	19 (21.1)
Middle	4 (4.4)	5 (5.6)	0 (0)	1 (1.1)	6 (6.7)	16 (17.8)
Metric	3 (3.3)	7 (7.8)	8 (8.9)	1 (1.1)	2 (2.2)	21 (23.3)
Intermediate	2 (2.2)	1 (1.1)	6 (6.7)	3 (3.3)	2 (2.2)	14 (15.6)
Total	9 (10.0)	27 (30.0)	27 (30.0)	16 (17.8)	11 (12.2)	90 (100.0)

χ^2 = 36.016 P = 0.000* (**Significant at p < 0.05**)

Conclusion and Recommendation

This study analyzed the role of agricultural extension agents in the transfer of improved technologies for citrus (sweet orange) production in District Malakand, focusing on their linkage with citrus growers, their functional effectiveness, and the challenges faced by farmers. The findings revealed that most farmers were dissatisfied with citrus productivity due to limited access to modern technologies, insufficient technical guidance, and weak engagement from extension agents. Although agriculture was the primary occupation of the respondents, awareness regarding improved citrus varieties, pest and disease management, and marketing techniques remained low. Farmers predominantly relied on traditional practices, with minimal satisfaction reported from extension services, particularly in terms of variety recommendations and field visits. Key barriers to technology adoption included high input costs, lack of irrigation and subsidized equipment, and the absence of practical demonstrations or professional training. Overall, the study highlighted a

significant disconnect between the agricultural extension department and citrus growers, underscoring the need for stronger, more responsive, and technology-driven extension support.
Following recommendations were formulated after detail investigations of the data analysis in the research study area:

1. Technical support and good Agriculture practices for citrus orchards should be offered in accordance with the needs of the citrus producing region in order to maximize citrus production per acre.
2. The Agriculture extension department should remain in contact with research scientists about the challenges faced by citrus producers and provide timely Agriculture input to enhance production.
3. Professional training by extension personnel is required for citrus producers in order to keep up with the latest citrus production technologies at the union council level.
4. Credit should be made available to citrus producers at the appropriate time and in the appropriate quantity to purchase of inputs such as fertilizers, insecticides, and better citrus varieties, among other things.
5. Demonstration is required to encourage citrus producers in the areas of citrus orchard layout, insect/pest detection, and effective use of contemporary technology. Demonstration should take held in a location where the majority of citrus growers can readily participate in the lesson.
6. The government should develop regulations in the future to increase the availability of contemporary technologies, such as tube wells and solar systems, among other things.
7. Geographical Information System (GIS) should introduce in Model farm service centers.
8. Government should set up proper Data Base system, which will enable Extension department to keep year wise data and also identify the loopholes in the Extension department.
9. Government and private sector should be involved for raising certified plants on commercial level.
10. Quarantine measure should be observed strictly.

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