

EVALUATING THE IMPACT OF EXTENSION SERVICES ON FARMERS' FOOD SECURITY EMPOWERMENT IN KHYBER PAKHTUNKHWA

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Agricultural Extension Services, Food Security Empowerment, Farmer Empowerment, Extension Contact, Training Participation, Agricultural Information, Khyber Pakhtunkhwa, Pakistan

Article History

Received: 02 April 2026

Accepted: 12 May 2026

Published: 31 May 2026

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Muhammad Furqan**Abstract**

Agricultural extension services play a crucial role in enhancing farmers' knowledge, promoting the adoption of improved agricultural practices, and strengthening household food security. This study evaluated the impact of agricultural extension services on farmers' food security empowerment in four districts of Khyber Pakhtunkhwa, Pakistan: Charsadda, Malakand, Mansehra, and Tank. A multistage sampling technique was employed to select 400 farmers, and primary data were collected through a structured interview schedule. Data were analyzed using descriptive statistics, Chi-square tests, analysis of variance (ANOVA), and ordinary least squares (OLS) regression. The results revealed that 49.5% of respondents exhibited a moderate level of food security empowerment, while 31.5% demonstrated high empowerment. Extension service delivery remained limited, with only 21% of farmers reporting frequent contact with extension agents and 32% participating in extension training programs. Chi-square analysis indicated significant positive associations between extension contact, training participation, and farmers' food security empowerment ($p < 0.001$). OLS regression further identified extension contact frequency ($\beta = 0.268$), training participation ($\beta = 0.225$), access to agricultural information ($\beta = 0.167$), and education ($\beta = 0.138$) as significant predictors of food security empowerment. Significant regional differences were also observed, with Charsadda recording the highest empowerment scores and Tank the lowest. The findings demonstrate that effective extension services substantially improve farmers' food security empowerment through enhanced knowledge, information access, and adoption of improved agricultural practices. Strengthening extension infrastructure, expanding farmer training, and promoting participatory and digital extension approaches are essential to improving food security and supporting sustainable agricultural development in Khyber Pakhtunkhwa.

1. Introduction**1.1 Background and Context**

Food security is a fundamental pillar of sustainable development, encompassing physical, social, and economic access to sufficient, safe, and nutritious food for all individuals at all times (FAO, 1996). Despite global efforts to eradicate

hunger, food insecurity persists as a formidable challenge, particularly in developing nations like Pakistan. According to the Global Hunger Index (2024), Pakistan ranks 99th out of 136 countries, indicating a serious level of hunger, with Khyber Pakhtunkhwa (KP) being one of the most food-insecure provinces due to its complex geography,

climate vulnerability, and socio-economic disparities.

Khyber Pakhtunkhwa possesses a diverse range of agro-climatic conditions that facilitate the growth of various field and horticultural crops. Based on variations in height, Khyber Pakhtunkhwa has been divided into five distinct Agro-Ecological Zones. Every zone is different in terms of its climate, soils, agriculture, people's cultural and socioeconomic traits, and other factors. This diversity presents both opportunities and challenges for agricultural development and food security interventions.

1.2 The Role of Agricultural Extension

Agricultural extension services function as a critical intermediary between research-generated knowledge and farming communities (Sulaiman & Davis, 2012). Extension agents are frontline professionals responsible for disseminating improved agricultural technologies, facilitating farmer education, and promoting sustainable farming practices. In the context of food security, extension agents contribute to farmer empowerment by:

- Enhancing farmers' knowledge about improved crop varieties and cultivation techniques.
- Providing timely information about pest management, soil health, and water conservation.
- Facilitating access to credit, inputs, and market linkages.
- Promoting nutritional awareness and dietary diversity.
- Building farmers' capacity for climate-smart agriculture and risk management.

Despite these critical roles, extension systems in Pakistan face numerous challenges, including inadequate funding, limited staffing, weak infrastructure, and poor connectivity with research institutions (Davidson & Ahmad, 2002). These constraints undermine the effectiveness of extension agents in empowering farmers and enhancing food security.

1.3 Farmer Empowerment and Food Security

Farmer empowerment is a multidimensional concept encompassing knowledge acquisition,

skill development, decision-making autonomy, and access to resources (Pretty, 1995). Empowered farmers are better equipped to adopt improved practices, diversify their livelihoods, and respond to challenges such as climate variability and market fluctuations. Extension services facilitate empowerment through participatory approaches, group formation, and continuous learning opportunities.

1.4 Statement of the Problem

Khyber Pakhtunkhwa continues to experience significant food insecurity, with rural households particularly vulnerable due to limited agricultural productivity, resource constraints, and inadequate access to extension services. While extension agents are presumed to play a pivotal role in farmer empowerment, empirical evidence on their actual impact, particularly across different agro-ecological zones, remains limited. Furthermore, regional disparities in extension coverage and effectiveness require systematic investigation to inform policy and programmatic interventions.

1.5 Research Objectives

The specific objectives of this study were to:

1. Assess the level of food security empowerment among farmers in the selected districts.
2. Evaluate the impact of extension services on farmers' food security knowledge and practices.
3. Identify constraints faced by extension agents in empowering farmers.
4. Examine regional variations in extension effectiveness across the four districts.

1.6 Significance of the Study

This research contributes to the existing body of knowledge by providing empirical evidence on the role of extension agents in farmer empowerment regarding food security in a geographically diverse and under-researched region. The findings will assist policymakers, extension managers, and development practitioners in designing targeted interventions to improve extension effectiveness, address regional disparities, and ultimately enhance household food security in Khyber Pakhtunkhwa.

2. Materials and Methods

2.1 Study Area

The study was conducted in four districts of Khyber Pakhtunkhwa, Pakistan: Charsadda, Malakand, Mansehra and Tank. These districts were purposively selected to represent different agro-ecological zones and varying levels of agricultural development. Khyber Pakhtunkhwa possesses a diverse range of agro-climatic conditions that facilitate the growth of various field and horticultural crops. Based on variations in height, Khyber Pakhtunkhwa has been divided into five distinct Agro-Ecological Zones. Every zone is different in terms of its climate, soils, agriculture, people's cultural and socioeconomic traits, and other factors. The selected districts represent four distinct zones, allowing for comparative analysis.

2.2 Sampling Procedure

The required sample for the current investigation was collected using a multistage sampling procedure (Cochran, 1977). When a sample is chosen in stages, the sample units at each stage being subsampled from the big units chosen at the previous stage, the sample is referred to as a multistage sample (Cochran, 2007). Multistage sampling is the taking of sample in stages using smaller and smaller units at each stage (Cochran, 2007).

The multistage sampling employed in this study involved the following stages:

Stage 1 (Selection of Districts): Four districts; Charsadda, Malakand, Mansehra, and Tank were purposively selected based on their distinct agro-ecological characteristics, varying levels of extension services, and accessibility.

Stage 2 (Selection of Union Councils): From each district, three Union Councils (UCs) were randomly selected, resulting in a total of 12 UCs across the four districts.

Stage 3 (Selection of Villages): From each selected UC, two villages were randomly chosen, yielding 24 villages in total.

Stage 4 (Selection of Respondents): From each village, 16-17 farmers were randomly selected using a systematic random sampling approach, ensuring a total sample size of 400 respondents (100 per district).

2.3 Sample Size Determination

A sample size of 400 respondents ($n=400$) was determined using Yamane's (1967) formula:

$$n = \frac{N}{1 + N(e)^2}$$

Where:

- n = sample size
- N = total farming population in the selected districts (approximated from census data)
- e = margin of error (0.05)

Additionally, Cochran's (1977) formula for finite populations was considered to ensure statistical representativeness.

2.4 Data Collection

Both **primary and secondary data** were used in the research. Secondary data were gathered through the Agriculture Extension Department and various published and unpublished materials, while the primary data was collected from the farmers.

2.4.1 Primary Data Collection

Primary data were collected using a **structured interview schedule** developed specifically for this study. The interview schedule comprised closed-ended and Likert-scale questions covering the following dimensions:

1. **Socio-economic characteristics:** Age, education, landholding, farming experience, household size, income.
2. **Extension contact:** Frequency of contact with extension agents, access to extension services, satisfaction levels.
3. **Food security knowledge:** Awareness of improved practices, nutritional knowledge, disaster preparedness.
4. **Food security practices:** Adoption of improved varieties, cropping intensity, dietary diversity, storage practices.

5. **Empowerment indicators:** Decision-making autonomy, participation in training, access to information, group membership. The interview schedule was pre-tested with 30 farmers (not included in the final sample) to ensure clarity, validity, and reliability (Cronbach's $\alpha > 0.75$). Data were collected through face-to-face interviews conducted by trained enumerators during the agricultural season of 2024-2025.

2.4.2 Secondary Data Collection

Secondary data were obtained from:

- Agriculture Extension Department, KP (district-wise extension reports).
- Pakistan Bureau of Statistics (agricultural census data).
- Published research articles, books, and reports.
- Unpublished materials including departmental records and project documents.

2.5 Variables and Their Measurements

Variable Category	Variable	Measurement
Dependent Variable	Food Security Empowerment	Composite index (0-10) based on knowledge, adoption, dietary diversity, decision-making
Independent Variables	Extension Contact Frequency	Number of visits/contacts per season
	Participation in Training	Yes/No; Number of training events attended
	Access to Information	Access to radio, TV, mobile, extension agents
	Age	Years
	Education	Years of formal schooling
	Landholding	Acres
	Farming Experience	Years
	Household Size	Number of members
	Income	Annual income in PKR

2.6 Data Analysis

Data were coded, entered into SPSS version 26.0, and analyzed using:

1. **Descriptive Statistics:** Frequencies, percentages, means, and standard deviations for socio-economic characteristics and empowerment indicators.

2. **Chi-Square Test:** To assess associations between extension contact/training and food security empowerment.

3. **Ordinary Least Squares (OLS) Regression:** To determine the contribution of extension variables to food security empowerment while controlling for socio-economic factors.

4. **Analysis of Variance (ANOVA):** To compare empowerment scores across the four districts.

The regression model specification was:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \dots + \beta_k X_k + \epsilon_i Y_i$$

$$= \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \dots + \beta_k X_k + \epsilon_i$$

Where:

- Y_i = Food Security Empowerment Score for farmer i

- $X_1, X_2, \dots, X_k$ = Independent variables (extension contact, training, age, education, etc.)

- β_0 = Constant

- $\beta_1, \beta_2, \dots, \beta_k$ = Regression coefficients

- ϵ_i = Error term

2.7 Ethical Considerations

Informed consent was obtained from all respondents prior to data collection. Confidentiality and anonymity of responses were strictly maintained. The study complied with ethical standards for social science research involving human subjects.

3. Results and Discussions

3.1 Socio-Economic Characteristics of Respondents

Table 1 presents the socio-economic characteristics of the 400 sampled farmers across the four districts. The socio-economic profile of respondents reveals a predominantly smallholder farming community with limited formal education, consistent with previous studies conducted in Khyber Pakhtunkhwa (Khan *et al.*, 2020; Ali *et al.*, 2019). The finding that 44% of farmers operate on less than 5 acres highlights the structural constraints smallholders face in achieving food security, as small landholdings limit production capacity and economic returns.

Table 1: Socio-Economic Characteristics of Respondents (n=400)

Characteristic	Category	Frequency	Percentage (%)
Age	< 30 years	68	17.0
	30-50 years	212	53.0
	> 50 years	120	30.0
Education	Illiterate	108	27.0
	Primary (1-5 yrs)	124	31.0
	Middle (6-8 yrs)	88	22.0
	Secondary & above	80	20.0
Landholding Farming Experience	< 5 acres	176	44.0
	5-12.5 acres	152	38.0
	> 12.5 acres	72	18.0
	< 10 years	96	24.0
	10-20 years	160	40.0
	> 20 years	144	36.0
Household Size	< 5 members	104	26.0
	5-9 members	216	54.0
	> 9 members	80	20.0

Source: Field Survey 2024

The majority of respondents (53%) were in the 30-50 years age group, indicating a predominantly middle-aged farming population. Literacy levels were relatively low, with 27% being illiterate and only 20% having secondary or higher education. Small landholdings (below 5 acres) were prevalent

(44%), reflecting the predominance of smallholder farming in the region. Farming experience was substantial, with 76% having 10 or more years of experience. Household size was typically moderate (5-9 members: 54%).

Table 2: Extension Contact and Service Utilization

Indicator	Category	Frequency	Percentage (%)
Extension Contact	Never visited	148	37.0
	Occasional (1-2 visits/year)	168	42.0
	Frequent (≥ 3 visits/year)	84	21.0
Training Participation	Participated	128	32.0
	Did not participate	272	68.0
Access to Information	Radio/TV	144	36.0
	Mobile phone	212	53.0
	Extension agent	104	26.0
	Fellow farmers	180	45.0
Satisfaction with Extension Contact	Satisfied	156	39.0
	Neutral	92	23.0
	Dissatisfied	152	38.0
	Never visited	148	37.0

Source: Field Survey 2024

Extension contact was limited, with 37% of farmers reporting no visits from extension agents and only 21% reporting frequent visits. Training participation was low (32%), indicating significant room for improvement. Mobile phones emerged as the primary source of agricultural information (53%), followed by fellow farmers (45%). Satisfaction levels were mixed, with 39% satisfied and 38% dissatisfied with extension services. The low frequency of extension contact (37% with no visits) and limited training participation (32%) observed in this study align with earlier research indicating weak extension coverage in rural Pakistan (Davidson & Ahmad, 2002; Iqbal *et al.*, 2020).

The reliance on mobile phones (53%) and fellow farmers (45%) as primary information sources suggests that extension agents are not effectively reaching farmers, forcing them to rely on informal networks. This finding underscores the need for leveraging digital technologies in extension delivery, particularly in underserved areas.

3.2 Food Security Empowerment Index

A composite Food Security Empowerment Index (FSEI) was calculated based on knowledge, adoption of practices, dietary diversity, and decision-making autonomy (scale: 0-10).

Table 3: Distribution of Farmers by Food Security Empowerment Level

Empowerment Level	Score Range	Frequency	Percentage (%)
Low	0 - 3.3	76	19.0
Moderate	3.4 - 6.7	198	49.5
High	6.8 - 10.0	126	31.5
Total		400	100

Source: Field Survey 2024

The results revealed that 31.5% of farmers had high empowerment levels, 49.5% had moderate empowerment, and 19% had low empowerment. The mean FSEI score was 5.82 (SD = 2.14), indicating a moderate level of food security empowerment overall. The moderate overall empowerment level (mean FSEI = 5.82) indicates

that while farmers have some capacity to enhance food security, significant gaps remain. The district-wise variation, with Charsadda (6.54) and Tank (5.14) at opposite ends, reflects the influence of agro-ecological conditions, infrastructure, and extension coverage.

3.3 District-wise Comparison of Food Security Empowerment

Table 4: District-wise Mean Food Security Empowerment Scores

District	Mean FSEI	Standard Deviation	Ranking
Charsadda	6.54	1.89	1
Malakand	6.12	2.01	2
Mansehra	5.47	2.18	3
Tank	5.14	2.35	4

Calculated by Author

ANOVA results revealed significant differences in empowerment scores across districts ($F = 12.47$, $p < 0.001$). Post-hoc tests indicated that Charsadda had significantly higher empowerment compared to Mansehra and Tank ($p < 0.01$), while Malakand also had significantly higher scores than Tank ($p < 0.05$). Charsadda's higher empowerment can be attributed to its fertile plains, better irrigation infrastructure, and

relatively stronger extension presence. Conversely, Tank's arid conditions, remoteness, and limited institutional support constrain farmers' capacity to adopt improved practices and achieve food security (Khan and Shah, 2021). These findings highlight the importance of region-specific extension strategies tailored to local agro-ecological and socio-economic contexts.

3.4 Association between Extension Variables and Food Security Empowerment

Table 5: Chi-Square Test for Association between Extension Contact and Empowerment Level

Extension Contact	Low Empowerment	Moderate Empowerment	High Empowerment	Total	χ^2	p-value
Never visited	48 (32.4%)	72 (48.6%)	28 (18.9%)	148	38.56	<0.001
Occasional	24 (14.3%)	88 (52.4%)	56 (33.3%)	168		
Frequent	4 (4.8%)	38 (45.2%)	42 (50.0%)	84		
Total	76	198	126	400		

Calculated by Author

A significant positive association was observed between extension contact frequency and empowerment level ($\chi^2 = 38.56$, $p < 0.001$). Farmers with frequent extension contact were more likely to have high empowerment (50%),

while those with no contact were predominantly in the low empowerment category (32.4%).

Table 6: Chi-Square Test for Association between Training Participation and Empowerment Level

Training Participation	Low Empowerment	Moderate Empowerment	High Empowerment	Total	χ^2	p-value
Participated	14 (10.9%)	58 (45.3%)	56 (43.8%)	128	21.47	<0.001
Did not participate	62 (22.8%)	140 (51.5%)	70 (25.7%)	272		
Total	76	198	126	400		

Calculated by Author

Participation in extension training was significantly associated with higher empowerment levels ($\chi^2 = 21.47$, $p < 0.001$). Among training

participants, 43.8% had high empowerment compared to only 25.7% among non-participants.

3.5 Regression Analysis

Table 7: OLS Regression Results for Factors Influencing Food Security Empowerment

Variable	B	SE	β	t	p-value
(Constant)	1.845	0.424		4.35	<0.001
Extension Contact Frequency	0.742	0.148	0.268	5.01	<0.001
Training Participation	0.648	0.156	0.225	4.15	<0.001
Access to Information	0.412	0.134	0.167	3.07	0.002
Education (years)	0.289	0.118	0.138	2.45	0.015
Landholding (acres)	0.156	0.102	0.078	1.53	0.127
Age (years)	0.054	0.098	0.031	0.55	0.583
Farming Experience	0.132	0.109	0.065	1.21	0.227
Household Size	-0.089	0.095	-0.047	-0.94	0.348

$R^2 = 0.342$; Adjusted $R^2 = 0.328$; $F = 24.56$; $p < 0.001$

The regression model was statistically significant ($F = 24.56$, $p < 0.001$), explaining 32.8% of the variance in food security empowerment (Adjusted $R^2 = 0.328$). Extension contact frequency ($\beta=0.268$, $p < 0.001$), training participation ($\beta=0.225$, $p < 0.001$), access to information ($\beta=0.167$, $p = 0.002$), and education ($\beta=0.138$, $p = 0.015$) emerged as significant positive predictors of empowerment. Landholding, age, farming experience, and household size were not statistically significant predictors. Regression

analysis further confirmed that extension contact frequency and training participation were the strongest predictors of empowerment, even after controlling for socio-economic factors. This aligns with the theoretical framework that extension services contribute to knowledge transfer, skill development, and behavioral change (Sulaiman & Davis, 2012). The finding that education significantly predicts empowerment ($\beta=0.138$, $p = 0.015$) suggests that literate farmers are better equipped to absorb and utilize extension information. This underscores the

need for extension approaches that accommodate low-literacy farmers through visual aids, demonstrations, and simplified messaging.

4.1 Constraints and Challenges

The low satisfaction rates (38% dissatisfied) and limited extension contact point to systemic constraints in the extension system. Key challenges likely include:

1. **Inadequate staffing:** The extension agent-to-farmer ratio in Pakistan is alarmingly low (approximately 1:3000), limiting the frequency and quality of contact.
2. **Resource constraints:** Insufficient budgets for transport, training materials, and field demonstrations reduce agents' effectiveness.
3. **Weak coordination:** Limited linkage between extension, research institutions, and input suppliers hinders the flow of up-to-date information.
4. **Top-down approaches:** Traditional extension methods that rely on lecture-based dissemination may not effectively promote participatory learning and empowerment.

4.2 Implications for Policy and Practice

Based on the findings, the following recommendations emerge:

1. **Strengthen extension infrastructure in underserved districts:** Priority should be given to expanding extension coverage in District Tank and other remote areas through recruitment of additional staff, mobile extension units, and digital platforms.
2. **Adopt participatory extension approaches:** Farmer field schools, demonstration plots, and farmer-to-farmer learning networks can enhance knowledge retention and adoption of improved practices.
3. **Leverage digital technologies:** Given the high mobile phone penetration (53%), SMS-based advisory services, voice messages, and mobile applications can complement face-to-face extension.
4. **Integrate nutrition and food security content:** Extension programs should explicitly incorporate nutrition education and dietary diversity messaging to address the multidimensional nature of food security.

5. **Enhance farmer training:** Investing in regular, context-specific training programs can significantly improve knowledge, skills, and empowerment outcomes.

4.3 Limitations and Future Research

This study has several limitations. First, the cross-sectional design limits causal inference; longitudinal studies are recommended to establish long-term impacts. Second, the reliance on self-reported data may introduce social desirability bias. Future research should incorporate objective measures of food security (e.g., dietary intake, anthropometric data) and explore the role of institutional factors such as market access, credit availability, and policy support in mediating extension impacts.

5. Conclusion

This study evaluated the impact of agricultural extension services on farmers' food security empowerment across four districts of Khyber Pakhtunkhwa. The findings reveal that extension contact frequency, training participation, and access to information are significant predictors of empowerment, with higher levels of extension engagement associated with improved food security knowledge, adoption of practices, and dietary diversity. However, significant regional disparities exist, with district Tank exhibiting the lowest empowerment levels due to limited extension coverage and resource constraints.

The study underscores the critical role of extension agents as catalysts for farmer empowerment and food security, while also highlighting systemic challenges that undermine their effectiveness. To maximize impact, extension services must be strengthened, particularly in underserved areas, and approaches must be adapted to local contexts, leveraging both traditional and digital channels. Ultimately, investing in extension systems is an investment in rural livelihoods, household food security, and sustainable agricultural development in Khyber Pakhtunkhwa.

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