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SWOT ANALYSIS OF EXTENSION SERVICES SUPPORTING FARMERS' ADOPTION OF NATURAL RESOURCE MANAGEMENT PRACTICES IN KHYBER PAKHTUNKHWA, PAKISTAN

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ABSTRACT

Natural resource management (NRM) requires coordinated environmental, social, and economic action to ensure the sustainable use of land and forest resources. This study assessed the strengths, weaknesses, opportunities, and threats associated with extension services that support farmers' adoption of NRM practices in four purposively selected districts of Khyber Pakhtunkhwa, Pakistan: Abbottabad, Mansehra, Swat, and Upper Dir. Using a multistage sampling approach, data were collected from 381 registered farmers through a structured interview schedule. The analyses included descriptive statistics, five-point Likert-scale rankings, SWOT analysis, analysis of variance, and multiple linear regression. Among the respondents, 93.4% had received formal education, 57.0% identified the Forest Department as their main source of NRM information, 56.2% reported more than 25% dependence on natural resources, and 40.2% were satisfied with their current occupation. In addition, 65.6% did not know about policy restrictions on natural-resource use, while 47.7% rated their role as community representatives as "good." The SWOT analysis identified training programs as a strength, inadequate facilities as a weakness, interdepartmental linkages as an opportunity, and limited participatory approaches as a threat. The regression model accounted for 69.2% of the variance in the reported adoption score. The findings indicate that extension agencies should strengthen participatory, farmer-centered activities, technical support, and feedback mechanisms. However, the results should be interpreted cautiously because the districts were selected purposively and the data were cross-sectional and self-reported.

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INTRODUCTION

Pakistan has diverse ecological and climatic zones and considerable agricultural potential (GoP, 2025). Sustainable natural resource management is therefore essential for addressing long-term environmental and economic challenges (Jhariya et al., 2022). Agriculture contributes 23.53% of the national GDP, employs approximately 42.3% of the labor force, and supports the livelihoods of an estimated 65–70% of the population (GoP, 2025). Forestry also contributes to rural livelihoods and the national economy (Khan and Ali, 2017). Globally, more than 1.6 billion people depend on forests for income and subsistence (FAO, 2019). Forests reduce soil erosion, regulate local climates, and support agricultural production (Rahman, 2022), while timber and non-timber forest products provide food and income (Clendon, 2001; World Bank, 2011). Forests cover approximately 4.14 billion ha worldwide, while agricultural land covers approximately 5

billion ha (FAO, 2020). Russia, Brazil, Canada, and the United States together account for about 49% of the world's forest area (FAO, 2025). Figure 1 presents selected international statistics on agriculture and forest area.

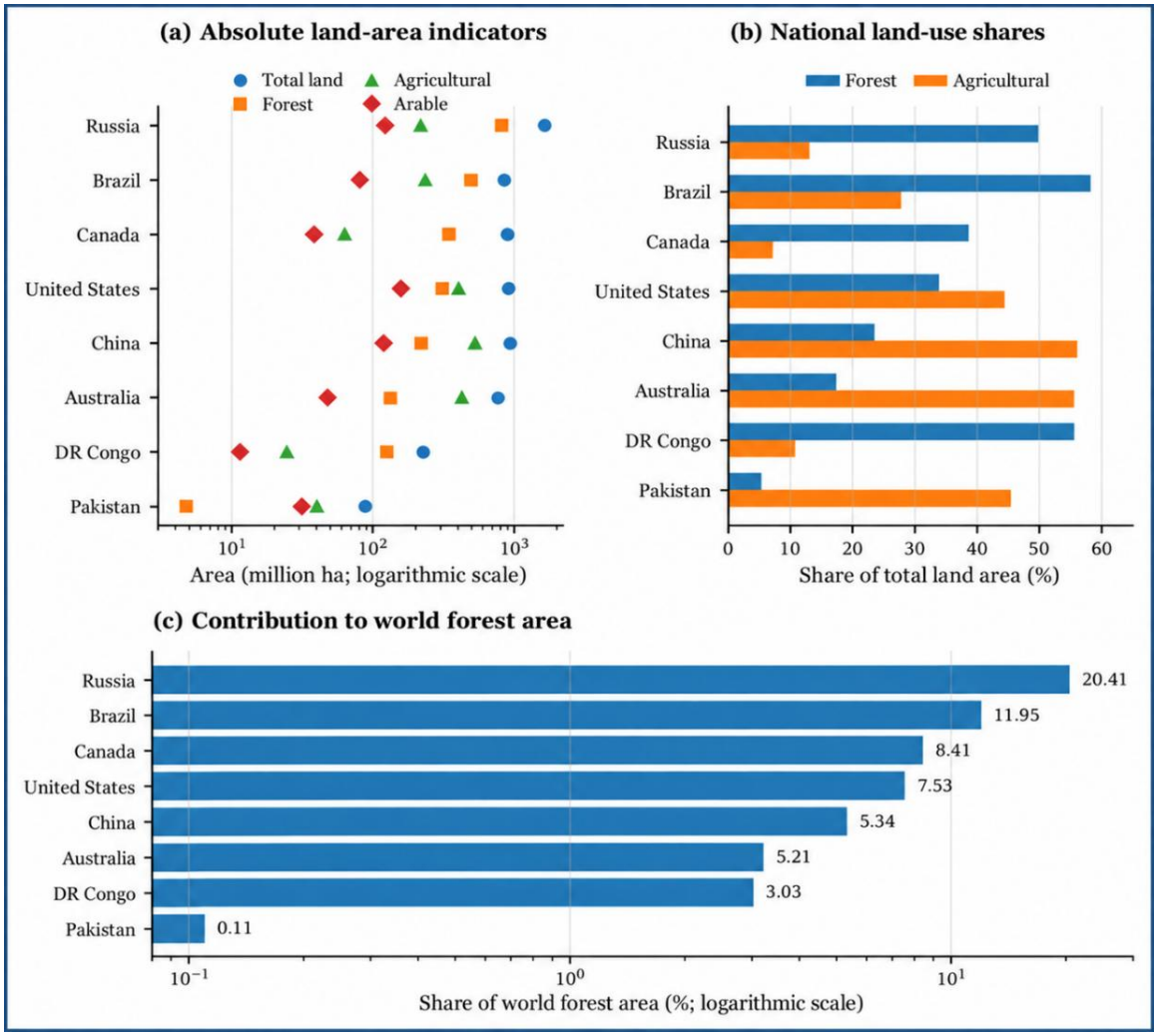

Figure 1. Agriculture and Forest Area Statistics of Some Countries. Source: FAO, 2025.

Over recent decades, agricultural land and forests have been converted into settlements, industrial sites, and other land uses. This conversion has increased pressure to raise agricultural productivity while conserving the resource base needed by future generations (Kitzes et al., 2007).

Pakistan's 2023 census reported an annual population growth rate of 2.55%, which may place further pressure on food systems and supplies of agricultural raw materials (GoP, 2025). Responding to these challenges requires coordinated action by agricultural institutions and other stakeholders, along with stronger scientific knowledge and technical skills among farmers (Shafique, 2008; Zhou, 2010). Khyber Pakhtunkhwa is an agriculture-based province, but only a limited proportion of its land is cultivable (Figure 2).

Extension Services in Context of Natural Resource Management

Effective natural resource management depends on appropriate knowledge and technical skills because land supports both human livelihoods and ecosystems (Singh et al., 2025). NRM promotes sustainable land use by strengthening scientific understanding and environmental conservation (Singh, 2024).

Traditional communities have also managed shared resources through locally developed rules that seek to balance use and conservation (Meinzen-Dick et al.,

2002). Today, extension and NRM agencies promote sustainability in agriculture and forestry, sectors on which communities depend directly or indirectly for their livelihoods and well-being (Vanclay, 2004). Extension services can support this transition by providing timely, relevant, and reliable information and by developing systems that respond to farmers' needs (Rohit et al., 2017). Their role therefore extends beyond production advice to include broader education for sustainability (Sallam, 1994).

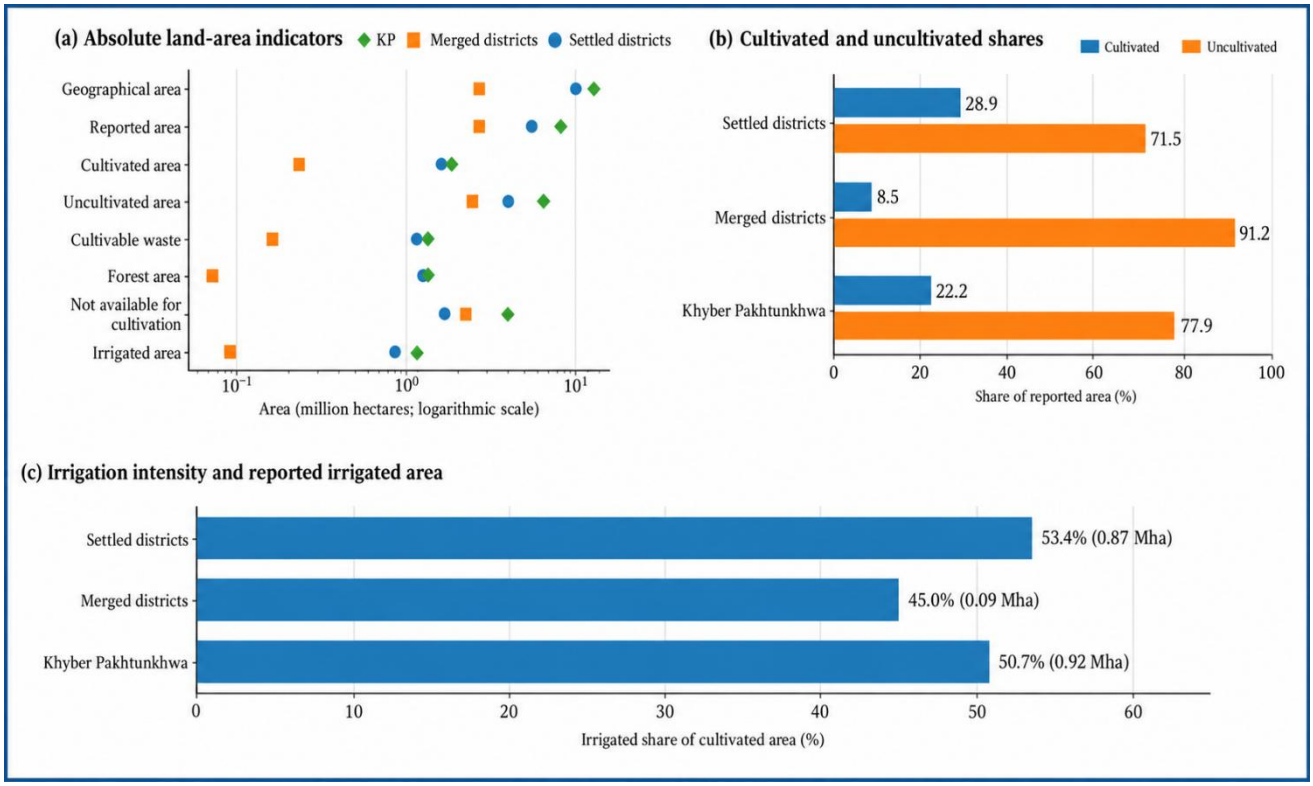

Figure 2. Area Statistics of Khyber Pakhtunkhwa (million hectares).

Significance of the Study

Agriculture and forestry are central to Pakistan's economy, food supply, employment, and rural livelihoods. However, natural-resource degradation, limited land and water availability, and restricted access to inputs increasingly affect production and trade. These pressures can leave farming households vulnerable to unstable incomes and debt. Farmers therefore need extension support that extends beyond production advice to include market information, credit and insurance, inputs, and links with research services (Ghosh, 2012). Previous studies have examined pluralistic extension systems and farmer participation (Allahyari, 2009; Faure et al., 2016), leaving a gap regarding strengths and limitations of agricultural and forestry extension services in promoting NRM practices in Khyber Pakhtunkhwa. This study addresses that gap by applying a SWOT framework to extension services associated with farmers' adoption of NRM practices in the province.

Objectives of the Research

- To identify the perceived strengths and weaknesses of agricultural and forestry extension services in the study area.
- To identify the perceived opportunities and threats affecting extension support for farmers' adoption of NRM practices.
- To analyze the factors influencing farmers' adoption of NRM practices by examining the role of extension services and socioeconomic characteristics.

METHODOLOGY

Khyber Pakhtunkhwa was the study area. The province is divided into nine agro-ecological zones: High Dry Mountains, Sub-Mountain Valleys, Sub-Humid Mountains, Wet Mountains, Valley Plains, Piedmont Plains, Semi-Arid Piedmont, Western Mountains, and Desert Plains (Table 1).

Table 1. Agro-Ecological Zones of Khyber Pakhtunkhwa with Districts.

Zone	Sub-Zone (Reference Code)	Classification	Areas/Districts
1	AI	High Dry Mountains	Chitral, Upper Kohistan, Swat
2	AII	Sub-Mountain Valleys	Abbottabad, Buner, Dir Lower, Dir Upper, Haripur, Torghar, Lower Kohistan, Malakand, Mohmand, Shangla
3	BI	Sub-Humid Mountains	Mansehra
4	BII	Wet Mountains	N/A
5	C	Valley Plains	Charsadda,
	CI		Bajaur, Battagram, Mardan, Nowshera, Peshawar, Swabi
6	DI	Piedmont Plains	Karak, Kohat
7	DII	Semi-Arid Piedmont	Hangu, Khyber, Kurram, Orakzai, North Waziristan, South Waziristan
8	E	Western Mountains	N/A
9	F	Desert Plains	Bannu, D.I Khan, Lakki Marwat, Tank

Source: GoKP, 2022. EPA, Khyber Pakhtunkhwa Climate Change Policy 2022

A multistage sampling approach was used. The High Dry Mountains (AI), Sub-Mountain Valleys (AII), and Sub-Humid Mountains (BI) were selected purposively because of their agro-climatic conditions and the reported presence of extension activities related to natural resources. Four districts—Abbottabad, Mansehra, Swat, and Upper Dir—were then selected. Lists of registered farmers were obtained from the Agriculture Extension and Forest departments. Departmental records identified 56,265 registered farmers in the selected districts. Using Sekaran's (2003) sample-size approach for a finite population, with a 95% confidence level and a ±5% margin of error, a sample of 381 registered farmers was selected. The sample was allocated proportionally across the four districts (Table 2):

$n_i = (N_i / N) \times n$ ..... (1)

where:

n_i = number of sampled farmers in district i

N_i = total number of registered farmers in district i

N = total number of registered farmers in the selected districts (56,265)

n = total sample size (381)

Proportional allocation was calculated as follows:

Total population and sample: N = 56,265 registered farmers; n = 381 farmers.

i. Abbottabad: $N_1 = 15,654$

$n_1 = (15,654 / 56,265) \times 381 = 106.0 \approx 106$ farmers

ii. Mansehra: $N_2 = 14,472$

$n_2 = (14,472 / 56,265) \times 381 = 97.9 \approx 98$ farmers

iii. Swat: $N_3 = 18,755$

$n_3 = (18,755 / 56,265) \times 381 = 127.0 \approx 127$ farmers

iv. Upper Dir: $N_4 = 7,384$

$n_4 = (7,384 / 56,265) \times 381 = 50.0 \approx 50$ farmers

The district populations sum to 15,654 + 14,472 + 18,755 + 7,384 = 56,265, and the allocated district samples sum to 106 + 98 + 127 + 50 = 381.

Table 2. Allocation of the Farmer Sample by District.

Divisions	Study Districts	Farmer Respondents		
		Registered Farmers (N_i)	Calculation	Allocated Sample (n_i)
Hazara Division	Abbottabad	15,654	(15,654/56,265) × 381 = 106.0	106
	Mansehra	14,472	(14,472/56,265) × 381 = 97.9	98
Malakand Division	Swat	18,755	(18,755/56,265) × 381 = 127.0	127
	Dir Upper	7,384	(7,384/56,265) × 381 = 50.0	50
Total		56,265	—	381

Source: (i) Khyber Pakhtunkhwa, Directorate of Agriculture Extension, 2023 (ii) Khyber Pakhtunkhwa, Forest Division, 2023

Primary data were collected through a structured interview schedule developed in accordance with the study objectives. Secondary data were obtained from the Agriculture Extension and Forest departments and from published and unpublished sources. The schedule was written in simple English and translated into local languages to support accurate communication with respondents. It was pre-tested with 20 respondents and reviewed by subject experts from the Department of Agricultural Extension Education and Communication at The University of Agriculture Peshawar to assess face and content validity. Internal consistency was evaluated in IBM SPSS Statistics version 29 using Cronbach's alpha, with a value of 0.70 or higher considered acceptable.

Conceptual Framework

The conceptual framework treated farmers' adoption of NRM practices as the dependent variable and 10 perceived attributes of extension services as independent variables (Table 3). The attributes covered service timeliness, farmers' literacy, satisfaction with service-delivery methods, staff coordination, program timing, awareness activities, field visits, natural-resource use, training opportunities, and problem-solving support. Each attribute was measured on a five-point Likert scale ranging from 1 = not adopted to 5 = fully adopted, with higher scores indicating greater adoption of NRM practices.

The adoption scale was assessed using Cronbach's alpha, with $\alpha \geq 0.70$ considered acceptable. Subject experts reviewed the indicators for content validity, and the instrument was pre-tested with 20 respondents ensure clarity and confirm that the selected indicators adequately represented farmers' NRM adoption behavior. . The model proposed that timely, effective, and farmer-centered extension services would be positively associated with adoption by strengthening farmers' knowledge, awareness, skills, and ability to implement NRM practices.

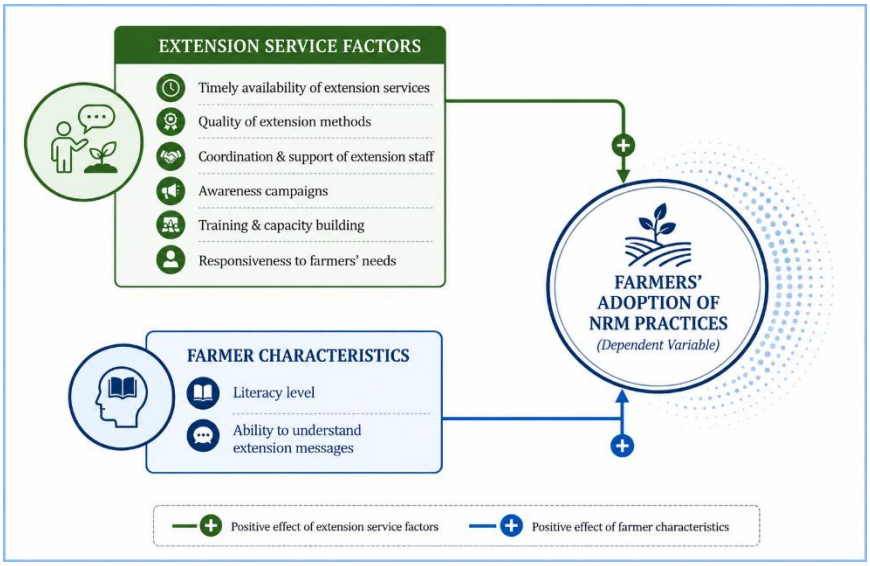

Figure 1. Conceptual framework.

Table 3 Dependent and Independent Variables of the Study.

Dependent Variables	Independent Variables
Farmer's Adoption of Natural Resource Management Practices	1. Timely availability of extension services 2. Literacy level among farmers 3. Farmers satisfied with methods used for services 4. sufficient coordination/support from staff 5. Extension Programs carried out at proper time 6. Awareness raising and extension drives 7. Orientation/cross visits in fields on farmers request 8. Unsustainable use of natural resources 9. Training opportunities to improve skills 10. Support farmers in solving issues

Data Analysis

Data were analyzed using IBM SPSS Statistics version 29. Frequencies, percentages, mean scores, and rankings were used to summarize respondents' characteristics and perceptions of NRM-related extension services. Mean scores were calculated for the five-point Likert-scale responses, with higher values indicating stronger perceptions of service effectiveness. SWOT categories were developed from the ranked mean ratings of factors identified as strengths, weaknesses, opportunities, and threats. One-way analysis of variance (ANOVA) was used to compare perceptions across respondent groups associated with the Agriculture Extension and Forest departments. Statistical significance was set at $p < 0.05$. Eta-squared values were interpreted as small (0.01), moderate (0.06), or large (0.14). Multiple linear regression was used to examine factors associated with farmers' adoption scores.

SWOT Analysis

SWOT analysis separates internal strengths and weaknesses from external opportunities and threats, providing a practical framework for organizational planning and strategy development (Gorski, 1991; Gasparotti, 2009; Tanya and Galea, 2015). It has been used to assess the capacities and constraints of extension and education systems (Murphey and Dooley, 2000; Dubinyuk, 2004).

Vega (2004) applied the approach to identify advantages and disadvantages within an extension system. By organizing internal and external factors, SWOT analysis can clarify existing conditions and support strategic decision-making (Kangas et al., 2001; Nikolaou et al., 2011; Sorensen et al., 2004). In this study, the items listed in Table 4 were classified across the four SWOT domains.

Table 4. Variables/items for SWOT analysis.

STRENGTHS i. Technological Skills ii. Promising Agricultural and Forestry Resources iii. Strong Management & Traditional Knowledge iv. Distribution Channels v. Farmers' Understanding & Reliable Services' vi. Strong Collaboration & Linkages	**WEAKNESSES** i. Lack of Important Skills ii. Poor Management & Knowledge iii. Poor Linkages with Allied Departments iv. Low Farmers' Rapport v. Unreliable Services' vi. Fragile Management
OPPURTUNITIES i. Technological Advancement & Improved Skills ii. Changing Farmers' Attitude Towards Providing Services iii. Changes in Government Polices iv. Participation in Activities v. Providing Facilities at Doorstep vi. Inauguration of Different schemes	**THREATS** i. Untrained Skills ii. Environmental Hazards & Food Security Issues iii. Non- Participation in Activities iv. Untrusted activities & Launch Programs with Zero Output

Internal Factors

External Factors

Positive

Negative

Table 4 presents a broad diagnostic picture of the extension system. Its perceived strengths include technological skills, available agricultural and forestry resources, traditional knowledge, distribution channels, farmers' understanding, reliable service provision, and collaboration. These attributes indicate that the system has an existing base of knowledge, resources, and institutional relationships on which improved NRM support can be built. The listed weaknesses—particularly skill gaps, weak management, poor links with allied departments, limited rapport with farmers, unreliable services, and fragile administrative arrangements—show that the presence of resources does not necessarily translate into consistent field-level

delivery. The opportunities emphasize technological improvement, stronger farmer participation, better doorstep services, changing government policies, and new schemes. However, these opportunities may be undermined by untrained personnel, environmental and food-security pressures, limited participation, and programs that fail to produce meaningful results. Overall, the SWOT matrix suggests that improvement depends less on creating an entirely new extension structure than on strengthening skills, coordination, farmer engagement, accountability, and implementation within the existing system.

Regression Analysis

The following multiple linear regression model was specified, with farmers' adoption of NRM practices as the dependent variable:

The model was expressed as:

$Y = \alpha + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 \ldots + \beta10X10 + \mu \ldots\ldots\ldots\ldots (2)$

where:

Y = dependent variable (farmers' adoption of NRM practices)
X1 = timely availability of extension services
X2 = farmers' literacy level
X3 = satisfaction with service-delivery methods
X4 = sufficient staff coordination and support
X5 = extension programs conducted at the appropriate time
X6 = awareness-raising activities and extension drives
X7 = field orientation and cross-visits at farmers' request
X8 = sustainable use of resources
X9 = training opportunities to improve skills
X10 = support for farmers in resolving problems
α = intercept
β = regression coefficient
μ = error term

Formulating the Adoption Index

The adoption score, ranging from 1 to 5, was calculated for each respondent using the following equation:

$$AI_i = \frac{\sum_{j=1}^{J} X_{ij}}{J} \ldots\ldots\ldots\ldots (3)$$

where:

AI = Adoption Index of respondent *i*
X_{ij} = Adoption score of the j-th recommended NRM practice by respondent *i*
i = represents index for the given equation
j = represents the index over which the sum is taken for the equation (adoption indicator)
J = Total number of recommended NRM practices

The Adoption Index was interpreted using the following formula:

$$AI_i: \left(\frac{AI_i - 1}{4}\right) \times 100 \ldots\ldots\ldots\ldots (3.1)$$

where:

- 0% Adoption Index → The farmer has not adopted any recommended NRM practice.
- 100% Adoption Index → The farmer has adopted all recommended NRM practices.
- Higher Adoption Index values indicate a higher level of adoption.

RESULTS

Education Level of Respondents

Respondents' education was classified into six categories: no formal education, primary, matriculation, technical, intermediate, and above intermediate (Table 5).

Table 5. Distribution of Farmer Respondents Regarding Education Level.

Districts	Education level of respondents						Total
	Illiterate	Primary	Matric	Technical	Intermediate	Above-Inter	
Abbottabad	4(3.8)	6(5.7)	44(41.5)	21(19.8)	23(21.7)	8(7.4)	106
Mansehra	3(3.1)	9(9.2)	19(19.4)	18(18.4)	38(38.8)	11(11.2)	98
Swat	11(8.7)	17(13.4)	33(26.0)	35(27.5)	21(16.5)	10(7.9)	127
Dir Upper	7(14.0)	19(38.0)	16(32.0)	3(6.0)	4(8.0)	1(2.0)	50
Total	25(6.6)	51(13.4)	112(29.4)	77(20.2)	86(22.6)	30(7.9)	381

Note: Values are presented as n (row %). Percentages for each district were calculated using the total number of respondents within that district as the denominator. Percentages in the Total row were calculated using the overall sample (N = 381) as the denominator.

Table 5 shows that 93.4% of respondents had received some form of education, while 6.6% reported no formal education. Matriculation was the largest overall category (29.4%), followed by intermediate education (22.6%) and technical education (20.2%). The district profiles, however, were not uniform. Matriculation was most common in Abbottabad (41.5%), intermediate education in Mansehra (38.8%), and technical education in Swat (27.5%). Upper

Dir differed from the other districts: primary education was its largest category (38.0%), and it had both the highest proportion of respondents without formal education (14.0%) and the lowest proportion with education above intermediate level (2.0%). Formal education was lowest in Mansehra (3.1%), suggesting that extension agencies may need to adapt the complexity, language, and delivery format of NRM information to local educational profiles. Demonstrations and interpersonal communication can be especially important where formal education is limited, whereas written or technically detailed materials may be more suitable for respondents with higher education. These findings do not establish that education caused differences in NRM adoption, land management, or income.

Satisfaction Level of Respondents

Farmers' satisfaction with their current occupation or livelihood was assessed using three response categories (Table 6).

Table 6. Distribution of Farmer Respondents regarding Satisfaction Level with Current occupation/Livelihood.

Districts	Satisfaction level of respondents			Total
	Satisfied	Not Satisfied	Partially	
Abbottabad	41(38.7)	32(30.2)	33(31.1)	106
Mansehra	41(41.8)	28(28.6)	29(29.6)	98
Swat	50(39.4)	37(29.1)	40(31.5)	127
Dir Upper	21(42.0)	14(28.0)	15(30.0)	50
Total	153(40.2)	111(29.1)	117(30.7)	381

Note: Values are presented as n (row %). Percentages for each district were calculated using the total number of respondents within that district as the denominator. Percentages in the Total row were calculated using the overall sample (N = 381) as the denominator.

Table 6 indicates that satisfaction with respondents' current occupation or livelihood was divided across the three response categories. Overall, 40.2% were satisfied, 30.7% were partially satisfied, and 29.1% were not satisfied. The district pattern was notably consistent: satisfaction ranged only from 38.7% in Abbottabad to 42.0% in Upper Dir, while dissatisfaction ranged from 28.0% in Upper Dir to 30.2% in Abbottabad. Partial satisfaction also varied little, from 29.6% in Mansehra to 31.5% in Swat. Thus, no district displayed a markedly different satisfaction profile. Nevertheless, almost three-fifths of the respondents were either only partially satisfied or dissatisfied with their livelihood. This finding may reflect economic or occupational pressures that extension agencies should consider when promoting NRM practices, particularly where adoption requires additional labor, investment, or delayed returns. Programs that combine conservation advice with practical livelihood and market support may therefore be more responsive to farmers' circumstances. However, the table is descriptive and does not show that occupational satisfaction directly influenced adoption behavior.

Source of Knowledge for NRM Practices

Respondents were asked to identify their main source of information about NRM practices. The response categories included village contacts, observed profitability in nearby villages, the Agriculture Extension Department, and the Forest Department (Table 7).

Table 7. Distribution of Farmer Respondents regarding Source of Knowledge for NRM Practices.

Districts	Source of knowledge for NRM practices				Total
	A	B	C	D	
Abbottabad	5(4.7)	11(10.4)	29(27.4)	61(57.5)	106
Mansehra	7(7.1)	13(13.3)	23(23.5)	55(56.1)	98
Swat	9(7.1)	19(15.0)	28(22.0)	71(55.9)	127
Dir Upper	2(4.0)	8(16.0)	10(20.0)	30(60.0)	50
Total	23(6.0)	51(13.4)	90(23.6)	217(57.0)	381

Note: Values are presented as n (row %). Percentages for each district were calculated using the total number of respondents within that district as the denominator. Percentages in the Total row were calculated using the overall sample (N = 381) as the denominator.

A=Motivated by someone in the village
B=Noted improvement in profitability in nearby villages
C=Advice obtained from Agricultural Extension Department
D=Advice obtained from Forest Department

Table 7 identifies formal departments as the dominant sources of information on NRM practices. The Forest Department was the principal source for 57.0% of respondents, followed by the Agriculture Extension Department (23.6%). Informal and observational sources were less prominent: 13.4% were influenced by improved profitability observed in nearby villages, and 6.0% were motivated by someone in their own village. Reliance on the Forest Department was consistently high across all four districts, ranging from 55.9% in Swat to 60.0% in Upper Dir. Advice from the Agriculture Extension Department was most frequently reported in Abbottabad (27.4%) and least frequently in Upper Dir (20.0%). The similarity of the district pattern suggests that the Forest Department has a particularly visible role in communicating NRM information throughout the study area. At the same time, the smaller contribution of village contacts and neighboring examples may indicate that farmer-to-farmer diffusion is underused. Stronger coordination between the two departments, combined with demonstration plots and local peer learning, could broaden the reach and credibility of NRM messages. The findings describe reported information sources; they do not measure the quality or effectiveness of the advice received.

Dependency on Use of Natural Resources

Respondents' reported dependence on natural resources is presented in Table 8.

Table 8. Distribution of Respondents regarding Dependency on Use of Natural Resources.

Districts	Dependency on use of natural resources				Total
	Fully dependent	Above 50% dependent	Above 25% dependent	Not dependent	
Abbottabad	8(7.5)	29(27.4)	67(63.2)	2(1.9)	106
Mansehra	9(9.2)	38(38.8)	49(50.0)	2(2.0)	98
Swat	9(7.1)	37(29.1)	78(61.4)	3(2.4)	127
Dir Upper	11(22.0)	19(38.0)	20(40.0)	0(0.0)	50
Total	37(9.7)	123(32.3)	214(56.2)	7(1.8)	381

Note: Values are presented as n (row %). Percentages for each district were calculated using the total number of respondents within that district as the denominator. Percentages in the Total row were calculated using the overall sample (N = 381) as the denominator.

Table 8 demonstrates the importance of natural resources to respondents' livelihoods. Overall, 56.2% were classified as more than 25% dependent, 32.3% as more than 50% dependent, and 9.7% as fully dependent; only 1.8% reported no dependence. The district distributions reveal meaningful variation. Upper Dir recorded the highest proportion of fully dependent respondents (22.0%), compared with 7.1–9.2% in the other districts. By contrast, the more-than-25% category was most common in Abbottabad (63.2%) and Swat (61.4%), but less common in Upper Dir (40.0%). Mansehra and Upper Dir recorded the largest proportions in the more-than-50% category (38.8% and 38.0%, respectively). No respondent in Upper Dir reported complete independence from natural resources. These patterns suggest that NRM policies and extension recommendations may have especially direct livelihood consequences in Upper Dir and Mansehra. Conservation measures should therefore be accompanied by realistic guidance on sustainable use and, where appropriate, alternative livelihood or energy options. Because the response labels represent ordered categories whose boundaries should be clearly defined in the methodology, comparisons should be interpreted cautiously. The cross-sectional data also do not show whether dependence increased or decreased over time.

Knowledge on Policy Restriction for Natural Resources

Table 9 reveals a substantial information gap concerning policy restrictions on natural-resource use. Overall, 65.6% of respondents did not know whether such restrictions existed, while 20.2% reported that restrictions existed and 14.2% believed that they did not. Lack of awareness was the largest response category in every district, ranging from 56.0% in Upper Dir to 69.3% in Swat. Swat therefore recorded the highest level of uncertainty, followed by Mansehra (66.3%) and Abbottabad (65.1%). Upper Dir had the largest proportion reporting that no restrictions existed (24.0%), compared with 10.2–15.3% elsewhere. Meanwhile, affirmative awareness of restrictions remained close to one-fifth in all districts, ranging from

18.4% in Mansehra to 21.7% in Abbottabad. The consistency of low awareness across districts suggests that policy communication is a system-wide weakness rather than an isolated local problem. Extension agencies should communicate restrictions in clear local languages and connect them with farmers' rights, responsibilities, permitted practices, and available alternatives. The table measures reported awareness and does not establish whether respondents' understanding of specific legal provisions was accurate.

Table 9. Distribution of Respondents regarding Policy Restrictions for natural Resources.

Districts	Policy restrictions for natural resources			Total
	Yes	No	Don't Know	
Abbottabad	23(21.7)	14(13.2)	69(65.1)	106
Mansehra	18(18.4)	15(15.3)	65(66.3)	98
Swat	26(20.5)	13(10.2)	88(69.3)	127
Dir Upper	10(20.0)	12(24.0)	28(56.0)	50
Total	77(20.2)	54(14.2)	250(65.6)	381

Note: Values are presented as n (row %). Percentages for each district were calculated using the total number of respondents within that district as the denominator. Percentages in the Total row were calculated using the overall sample (N = 381) as the denominator.

Representative as a Community Member

Table 10 shows generally positive perceptions of respondents' roles as community representatives in natural-resource management. Overall, 47.7% rated their role as good and 34.6% as very good, meaning that 82.3% selected one of the two positive categories. Only 13.4% rated their role as poor, and 4.2% reported no supportive role. The balance between the two positive categories differed by district. Swat recorded the highest proportion of "very good" ratings (44.1%), whereas Abbottabad recorded the highest proportion of "good" ratings (57.5%). Mansehra had the lowest proportion of "very good" ratings (26.5%) and the highest combined proportion of poor or no involvement (22.5%). Upper Dir also showed some limitation, with 20.0% selecting poor or not at all.

These findings indicate a potentially strong foundation for community-based NRM, although the quality and consistency of participation may differ across locations. Extension departments could build on this foundation by involving community representatives in planning, monitoring, conflict resolution, and the communication of conservation measures. Because the ratings were self-reported, they reflect respondents' perceptions of their roles rather than independently verified levels of performance or influence.

Table 10. Distribution of Respondents Regarding Level of Support as a Community Member for Management of Natural Resources.

Districts	Representative as a community member				Total
	Very Good	Good	Poor	Not at all	
Abbottabad	32(30.2)	61(57.5)	11(10.4)	2(1.9)	106
Mansehra	26(26.5)	50(51.0)	18(18.4)	4(4.1)	98
Swat	56(44.1)	49(38.6)	14(11.0)	8(6.3)	127
Dir Upper	18(36.0)	22(44.0)	8(16.0)	2(4.0)	50
Total	132(34.6)	182(47.7)	51(13.4)	16(4.2)	381

Note: Values are presented as n (row %). Percentages for each district were calculated using the total number of respondents within that district as the denominator. Percentages in the Total row were calculated using the overall sample (N = 381) as the denominator.

Participation in Decision Making for Conservation Activities

Table 11 indicates that participation in conservation decision-making was more often moderate than intensive. Overall, 50.9% described themselves as moderately active, while 23.4% were very active. The remaining respondents were either passive (17.8%) or did not participate at all (7.9%). Moderate participation was the largest category in every district, reaching 58.5% in Abbottabad and falling to 44.1% in Swat.

Very active participation was highest in Swat (26.0%) and Abbottabad (25.5%) but lower in Mansehra (19.4%) and Upper Dir (20.0%). Upper Dir had the largest combined

proportion of passive and non-participating respondents (32.0%), followed by Swat (29.9%), Mansehra (27.6%), and Abbottabad (16.1%). The findings suggest that many farmers are present in conservation-related processes but may not be participating at a level that gives them substantial influence over decisions. Extension agencies should therefore move beyond consultation toward more active involvement in problem identification, planning, implementation, and monitoring. The table records perceived levels of participation and does not show the frequency, quality, or actual decision-making authority associated with that participation.

Table 11. Distribution of Farmer Respondents regarding Participation in Decision Making for Conservation Activities.

Districts	Participation in decision making for conservation activities				Total
	Very active	Moderately	Passive	Not at all	
Abbottabad	27(25.5)	62(58.5)	13(12.3)	4(3.8)	106
Mansehra	19(19.4)	52(53.1)	19(19.4)	8(8.2)	98
Swat	33(26.0)	56(44.1)	24(18.9)	14(11.0)	127
Dir Upper	10(20.0)	24(48.0)	12(24.0)	4(8.0)	50
Total	89(23.4)	194(50.9)	68(17.8)	30(7.9)	381

Note: Values are presented as n (row %). Percentages for each district were calculated using the total number of respondents within that district as the denominator. Percentages in the Total row were calculated using the overall sample (N = 381) as the denominator.

Methods Used by Staff to Motivate Farmers

Extension personnel use interpersonal, group, mass-media, and field-based methods to share information and motivate farmers. Respondents rated the extent to which these methods were used and the data in this context is shown in Figure 3.

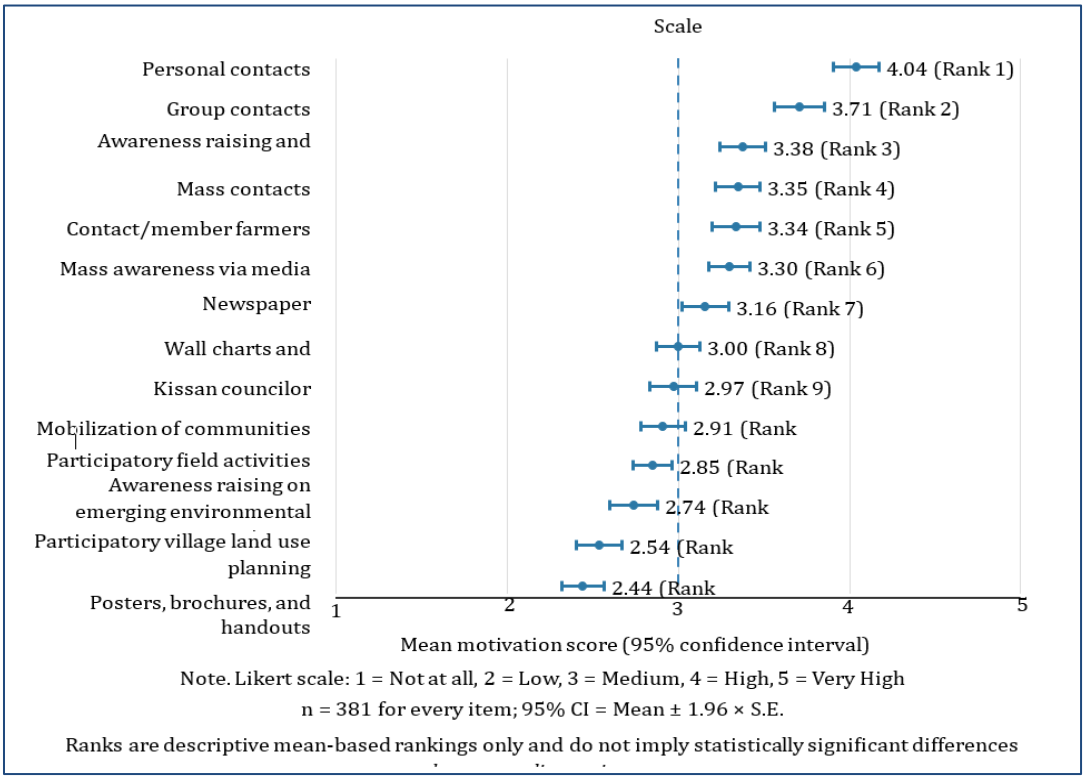

Figure 3. Methods Used by Staff to Motivate Farmers.

Personal contact received the highest mean rating (4.04), followed by group contact (3.71), awareness-raising and extension drives (3.38), mass contact (3.35), contact or member farmers (3.34), mass-media awareness (3.30), newspapers (3.16), and wall charts and advertisements (3.00). Lower ratings were recorded for Kissan councilors

(2.97), community mobilization (2.91), participatory field activities (2.85), awareness of emerging environmental issues (2.74), participatory village land-use planning (2.54), and posters, brochures, and handouts (2.44).

Management of Natural Resources

Respondents rated several aspects of natural-resource management in the region. Five point Likerst scale was used for the rating (Figure 4).

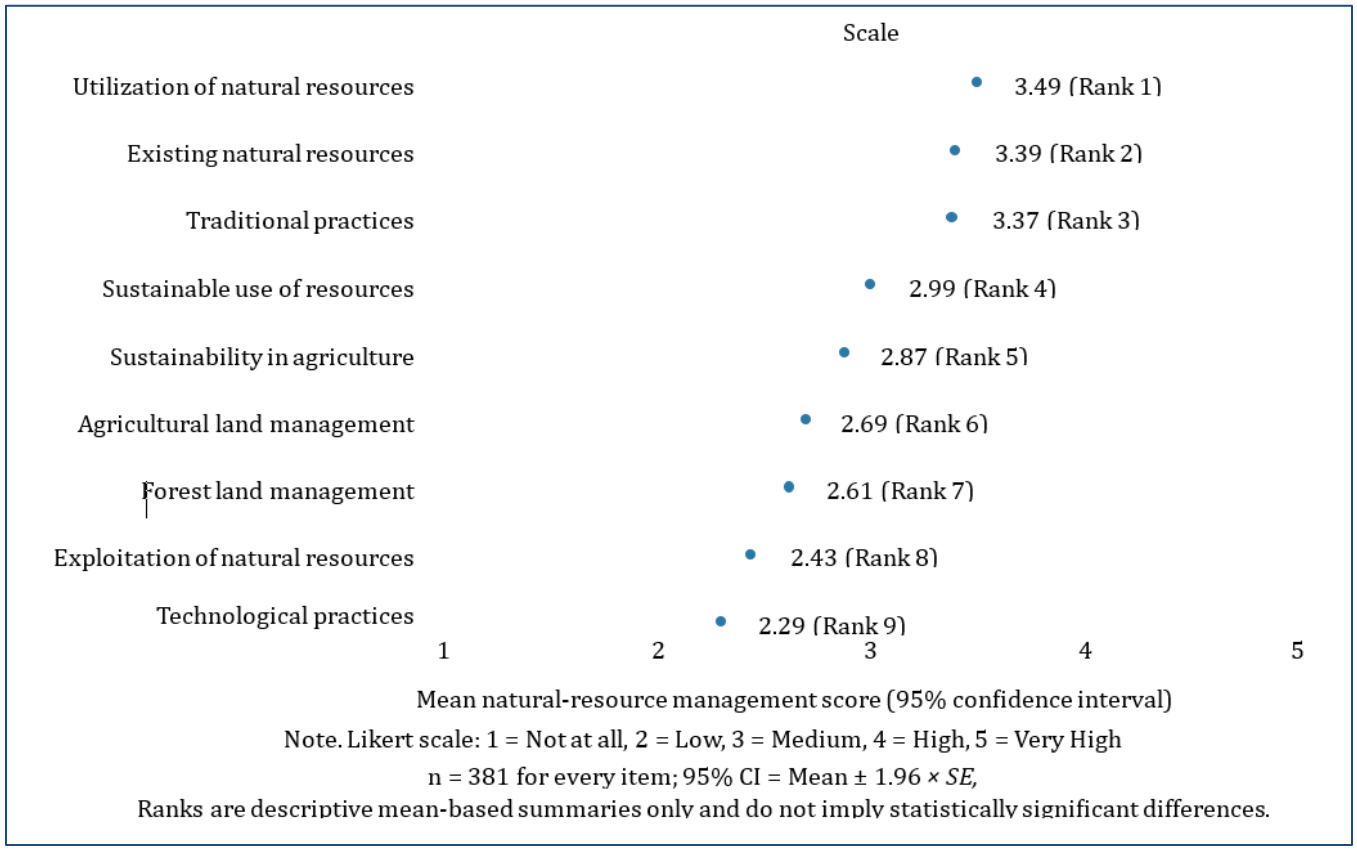

Figure 4. Management of Natural Resources in the Region.

The utilization of natural resources received the highest mean rating (3.49), followed by the management of existing resources (3.39) and traditional practices (3.37). Sustainable resource use was rated near the scale midpoint (2.99). Lower ratings were recorded for sustainability in agriculture (2.87), agricultural land management (2.69), forest land management (2.61), exploitation of natural resources (2.43), and technological practices (2.29). These descriptive ratings point to perceived weaknesses in planned resource use and the application of technology; they should not be interpreted as objective measures of management performance.

Factors Affecting Natural Resources

Respondents rated several factors perceived to affect the condition and use of natural resources (Figure 5). Rapid population growth received the highest mean rating (4.09), followed by limited alternative energy sources for rural households (3.72) and poverty caused by a lack of sustainable livelihoods (3.33). Other mid-ranked factors included disputes over forest land tenure (3.24), degraded wildlife habitat (3.23), and limited capacity among public-sector agencies (3.16). Lower-ranked factors included insufficient stakeholder participation in forest management (2.90), limited technology for sustainable forest management and regeneration (2.89), inadequate recognition of environmental services (2.84), and the appropriation of natural resources by politically influential people (2.71). These ratings reflect respondents' perceptions and do not establish causation.

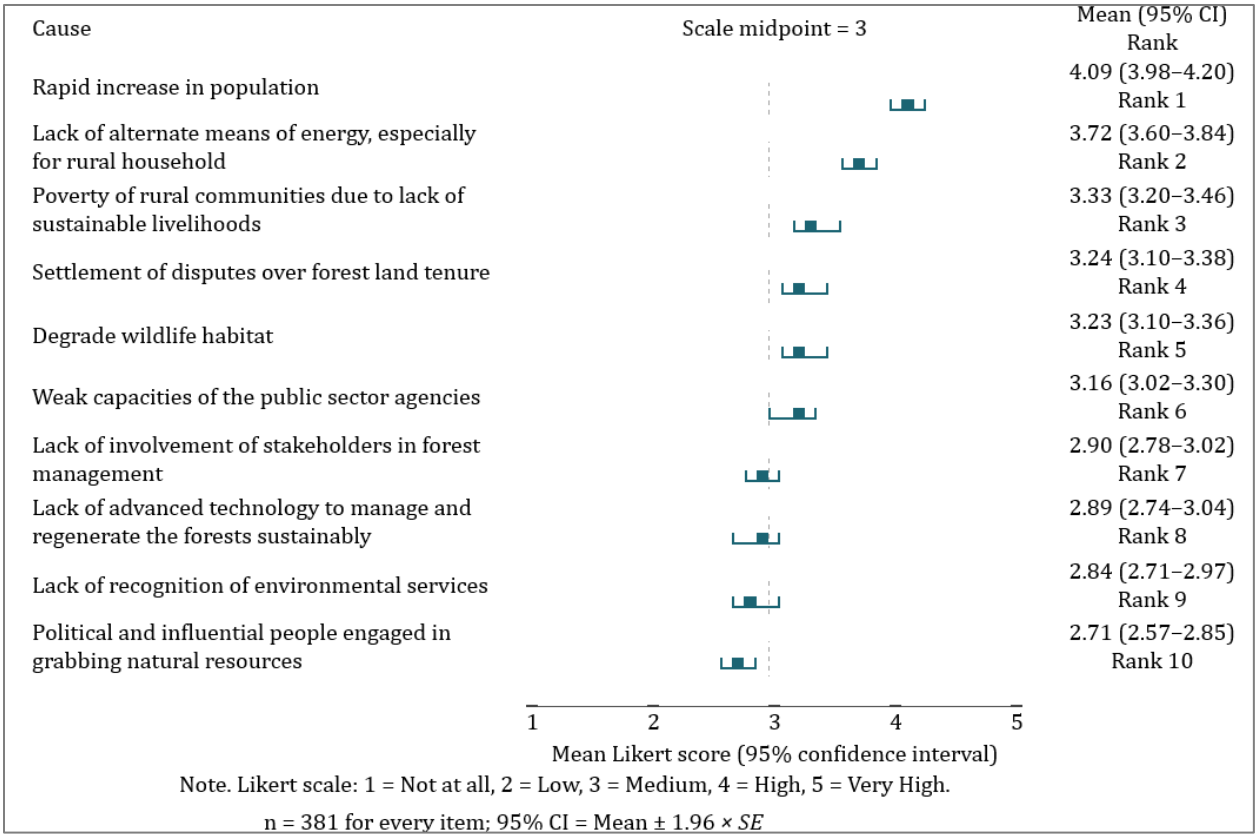

Figure 5. Causes Effect the Natural Resources.

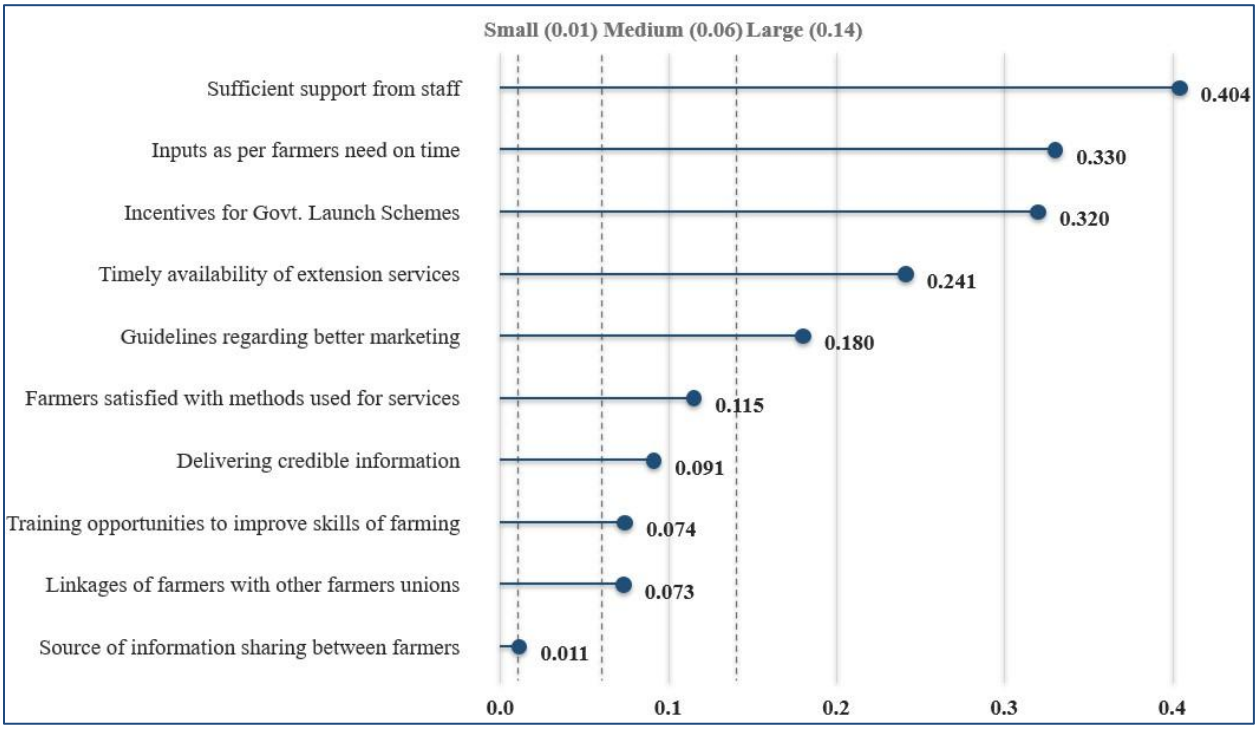

Figure 6. Strengths of extension services.

Figure 6 highlights several perceived strengths of the departments. The timely provision of agricultural inputs according to farmers' needs showed the largest effect (η^2 = 0.33), indicating substantial differences among the groups compared. Equitable distribution of incentives also showed a large effect (η^2 = 0.32), underscoring the perceived value of well-targeted support. Timely extension services produced a large effect (η^2 = 0.242), while market guidance also showed a large effect (η^2 = 0.18). Satisfaction with existing service-delivery methods showed a moderate effect (η^2 = 0.115). Taken together, the findings identify timely inputs, fair incentives, responsive advisory services, and market support as important perceived strengths. These effect sizes describe the magnitude of group differences; they do not, on their own, demonstrate that the services caused changes in productivity or livelihoods.

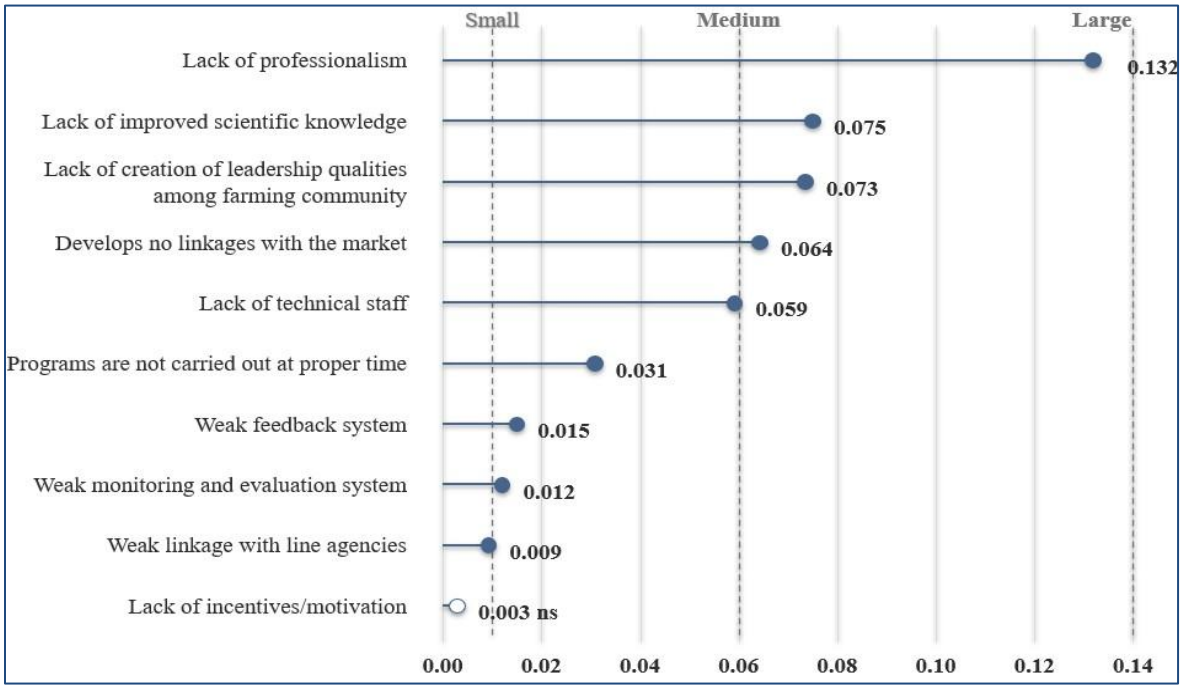

Figure 7. weaknesses of extension services.
Note: Eta squared: a small (η2 = .01-.059); b medium (η2 = .06-.139); c large (η2 > 0.139).

Figure 7 identifies several perceived weaknesses. Lack of professionalism showed a moderate effect, η^2 = 0.13, F(2, 378) = 49.62, p = 0.003, suggesting meaningful differences among the groups compared. Lack of scientific knowledge also showed a moderate effect, η^2 = 0.075, F(2, 378) = 26.51, p = 0.002. Limited leadership development, η^2 = 0.073, F(2, 378) = 25.91, p = 0.004, and weak market linkages, η^2 = 0.073, F(2, 378) = 22.44, p = 0.002, produced effects of a similar magnitude. Weak monitoring and evaluation, weak feedback mechanisms, and poor linkages with other agencies each showed small effects (approximately η^2 = 0.01). Although smaller, these issues remain relevant to departmental improvement, particularly because effective feedback and coordination can support accountability and long-term resource management.

Figure 8 indicates that strengthening farmers' skills and knowledge represents a major opportunity, with a large effect size (η^2 = 0.307). Stronger linkages among extension departments, research institutions, private-sector organizations, financial bodies, and other stakeholders also showed a large effect (η^2 = 0.192).

Such coordination can support technology transfer and access to services, consistent with Swanson (2008). Farmers' adoption of sustainable practices produced another large effect (η^2 = 0.190). By contrast, responses to farmers' requests for field visits showed a very small effect (η^2 = 0.009). Efforts to change farmers' attitudes (η^2 = 0.006) and improve market facilities (η^2 = 0.005) were not statistically significant and explained little variation in perceptions. Findings suggest that capacity-building and institutional linkages may offer stronger opportunities than isolated attempts to change attitudes or improve market facilities.

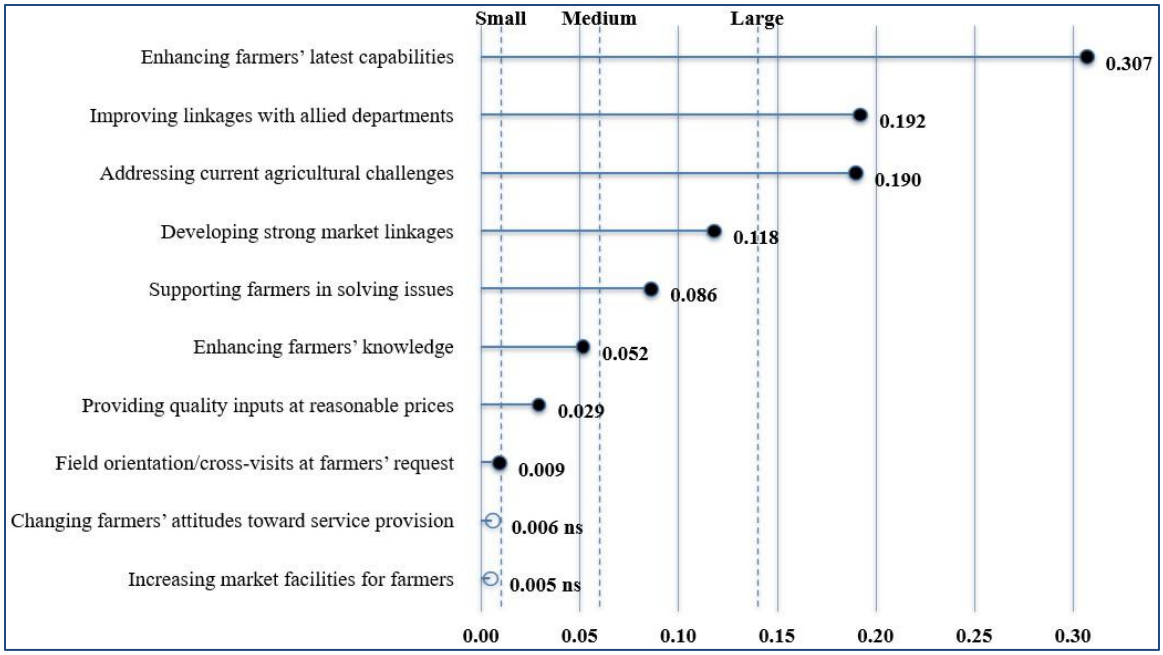

Figure 8. Opportunities for extension services.

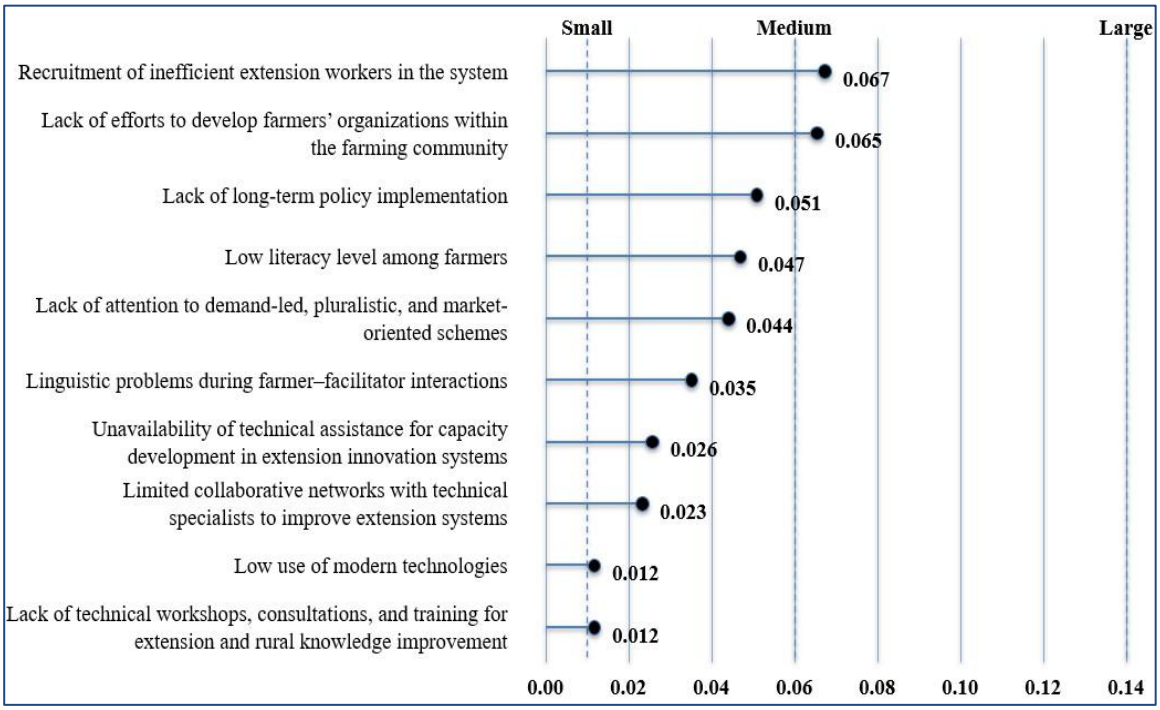

Figure 9. Threats to extension services.

Note: Eta squared: a small (η2 = .01-.059); b medium (η2 = .06-.139); c large (η2 > 0.139).

Figure 9 identifies inefficiency in extension services as an important perceived threat. Inefficient extension workers showed a moderate effect (η^2 = 0.067), highlighting the importance of recruitment, professional competence, and service quality. This interpretation is consistent with Swanson and Rajalahti (2010), who linked ineffective extension services with weak adoption of modern practices and technologies. Limited farmer collaboration also showed a moderate effect (η^2 = 0.065), suggesting a need for stronger peer networks and organized opportunities to share resources, knowledge, and technology. Weak policy implementation showed a smaller effect (η^2 = 0.051), while limited specialist input (η^2 = 0.023),

slow adoption of modern technology (η^2 = 0.012), and insufficient training and workshops (η^2 = 0.012) showed small effects. Addressing these threats will require coordinated technical workshops, consultation, training, and collaboration across relevant sectors.

Regression Analysis of Farmers' Adoption of NRM

The regression model explained 69.2% of the variance in farmers' adoption scores (R^2 = .692; adjusted R^2 = .684; Table 12). The model included 10 predictors: service timeliness, literacy, satisfaction with delivery methods, staff coordination, program timing, awareness activities, field visits, sustainable resource use, training opportunities, and problem-solving support. The overall regression hypotheses were:

H0: All slope coefficients are zero; the predictors are not linearly associated with the adoption score.

H0: $\beta1 = \beta2 = ... = \beta10 = 0$

H1: At least one $\beta j \neq 0$, for j = 1, ..., 10.

The overall model was statistically significant, F(10, 370) = 83.08, p < .001.

Among the reported coefficients, sufficient staff coordination and support (β = .329, p < .001), satisfaction with service-delivery methods (β = .259, p < .001), timely availability of services (β = .171, p < .001), programs conducted at the appropriate time (β = .152, p < .001), sustainable resource use (β = .134, p < .001), field orientation and cross-visits (β = .132, p < .001), and farmers' literacy (β = .081, p = .038) were statistically significant. Awareness-raising and extension drives (p = .709), training opportunities (p = .903), and problem-solving support (p = .090) were not statistically significant at α = .05. Multiple R (.832) and R^2 (.692) describe overall model fit; they do not establish reliability or causation.

Table 12. Multiple Linear Regression Predicting Farmers' Adoption of NRM Practices.

Model	R	R^2	Adjusted R^2	Std. Error of the Estimate
	.832[a]	.692	.684	3.3854

Dependent Variable: Farmer's Adoption of NRM Practices

a. Predictors: (Constant), timely availability of extension services, literacy level among farmers, farmers satisfied with methods used for services, sufficient coordination/support from staff, extension programs carried out at proper time, awareness raising and extension drives, orientation/cross visits in fields on farmers request, sustainable use of resources, training opportunities to improve skills, and support farmers in solving issues.

ANOVA

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	9525.669	10	952.567	83.08	.000[b]
Residual	4240.037	370	11.460		
Total	13765.706	380			

a. Dependent Variable: Farmer's Adoption of NRM Practices

Regression Analysis

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	S.E.	B		
(Constant)	18.839	1.914		9.841	.000
Timely availability of extension services	0.286	0.066	0.171	4.336	.000
Literacy level among farmers	0.216	0.104	0.081	2.086	.038
Farmers satisfied with methods used for services	1.027	0.154	0.259	6.666	.000
Sufficient coordination/support from staff	3.805	0.477	0.329	7.975	.000
Extension programs conducted at the appropriate time	0.780	0.189	0.152	4.116	.000
Awareness-raising activities and extension drives	0.082	0.221	0.014	.373	.709
Field orientation/cross-visits at farmers' request	0.670	0.185	0.132	3.619	.000
Sustainable use of resources	0.855	0.234	0.134	3.662	.000
Training opportunities to improve skills	-.023	0.186	-.005	-.122	.903
Support for farmers in resolving problems	0.298	0.175	0.062	1.699	.090

DISCUSSION

This study examined the strengths, weaknesses, opportunities, and threats associated with extension services that support farmers' adoption of NRM practices in Khyber Pakhtunkhwa. Education can broaden farmers' perspectives and help them understand and adopt new technologies (Rogers, 2003); accordingly, more-educated farmers may be more likely to adopt innovations (Pasquale and Burchi, 2007). Some respondents requested more frequent training and guidance from the Agriculture Extension and Forest departments. This aligns with Sassi et al. (2025), who reported that formal institutions were important sources of information on NRM practices.

Khyber Pakhtunkhwa has substantial natural resources, and their sustainable use is essential to meeting human needs (Rehman, 2011). Policies and programs seek to protect these resources and promote afforestation (Ongachi et al., 2026). Yet limited awareness of policy restrictions emerged as a major concern. Conservation policies are less likely to achieve their objectives when farmers lack clear information about regulations, rights, responsibilities, and sustainable practices. Extension agencies should therefore translate policy into practical guidance that farmers can understand and apply. This interpretation is consistent with Mills et al. (2017), who emphasized the importance of understanding farmers' willingness, capacity, and support needs when promoting long-term adoption.

Community representation can strengthen natural-resource management by bringing local concerns, tenure issues, and conservation priorities into decision-making (Mahmood, 2025). Previous work also suggests that participatory extension helps farmers identify problems and develop locally relevant solutions, potentially improving trust and service effectiveness (Jalvi, 1990; Mahmood, 2025; Athar et al., 2026). In the present study, interpersonal methods—especially personal and group contact—received relatively high ratings. This finding is consistent with Barghusen et al. (2021), who highlighted the role of interpersonal communication in motivating farmers.

The SWOT findings show that extension services have useful service-delivery capacity and opportunities to strengthen farmers' technical capabilities. However, inadequate facilities, limited professionalism and technical capacity, and weak coordination constrain their effectiveness. Stronger linkages among extension departments, research institutions, and other stakeholders could improve support for NRM. The main perceived threats included inefficient services, weak policy implementation, limited farmer collaboration, slow adoption of modern technologies, and inadequate training and capacity-building. Similar constraints have been reported by Agwu et al. (2023), who noted that weaknesses in extension systems can undermine trust, productivity, and sustainable agricultural development.

The regression analysis further emphasizes the importance of institutional and service-related factors. Staff coordination, satisfaction with delivery methods, timely service availability, and field-oriented activities were positively associated with adoption scores. These results suggest that adoption is shaped not only by farmers' individual characteristics but also by the accessibility, reliability, and responsiveness of extension services. Because the study was cross-sectional, these associations should not be interpreted as causal effects.

Limitations and Future Research

- The purposive selection of districts and the focus on registered farmers limit the generalizability of the findings. Future studies should include additional provinces and agro-ecological zones to support national comparisons and improve external validity.
- Data were collected at one point in time, preventing assessment of changes in service delivery and resource-management outcomes. Longitudinal or panel studies could examine trends, policy effects, and the long-term sustainability of extension services.
- Although SWOT analysis provides useful diagnostic insight, it is inherently subjective. Future research could combine SWOT analysis with experimental or quasi-experimental designs to assess program effectiveness and causal relationships.
- The regression analysis identifies associations but does not support strong causal conclusions about the effects of extension services. Future studies should consider impact-evaluation

methods such as matched comparisons or randomized interventions.

CONCLUSION

This study identified several perceived strengths and limitations of extension services related to NRM. Respondents rated personal and group contact, staff coordination, satisfaction with service-delivery methods, and timely service provision relatively highly. Participatory field activities, village land-use planning, printed materials, and technological practices received lower ratings. In the regression model, staff coordination and satisfaction with service-delivery methods had the largest standardized coefficients, whereas awareness activities and training opportunities were not statistically significant after adjustment for the other predictors. The findings support greater emphasis on timely, coordinated, participatory, and technically relevant services. However, because the study involved purposively selected districts, registered farmers, cross-sectional self-reports, and incompletely documented measurement procedures, its conclusions should not be generalized to all farmers without caution. Based on findings following recommendations are made.

- Extension departments should provide farmers with practical guidance on the sustainable use of natural resources.
- Departments should provide credible, locally relevant information on NRM practices through methods matched to farmers' needs.
- The Agriculture Extension and Forest departments, in collaboration with relevant organizations, should offer need-based training on NRM practices to enhance farmers' knowledge, skills, and long-term engagement with this sector.
- Extension agencies should promote sustainable NRM practices through participatory demonstrations, field visits, and farmer-to-farmer learning.
- Departments should strengthen farmer engagement in the design and delivery of NRM extension activities.
- Departments should establish accessible complaint, response, and feedback mechanisms.
- The government and Forest Department should strengthen transparent monitoring and enforcement against the illegal exploitation of natural resources.
- The Forest Department should expand field advisory services, training, field days, and farmer meetings in the study area.

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