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Empowering Smallholder Farmers in KP: Market Linkages, Challenges, Opportunities, and Strategic Interventions

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ABSTRACT

Smallholder farmers making over 90% of the farming population in Khyber Pakhtunkhwa, are commonly cultivating less than one acre of land. Regardless of playing a principal role in provincial food security and rural employment, these farmers remain side-lined in value chains due to limited access to markets, infrastructure, and institutional support. Based on field surveys conducted in August 2025 and supported by secondary data from KP Agriculture and Planning Departments, IFAD, and global research, this study discovered the key market-related challenges, identified effective case models, and recommended targeted interventions. The survey showed that 50% of farmers are dependent on middlemen to sell their produce, while only 10% use farmer's organizations and 7% of them sell directly to consumers, drawing attention to the lack of organised market access. Post-harvest losses are common: 35% of respondents experience moderate losses (11-30%), and 20% face high losses (above 30%), mainly in fruits, vegetables, and dairy. Contact with public extension is also weak, as 40% of farmers have never received advisory facilities, while only 20% disclose regular contacts with extension workers. Familiarity with key support programs is low: only 34% are acquainted with the IFAD RETP program, and just 15% of them reported taking benefits from these. Notwithstanding these challenges, successful interventions offer effective solutions. For example, the Swat Apple Value Chain project increased farmer incomes through pack houses and branding, while AKRSP's solar drying enterprise in Dir empowered women by providing livelihood opportunities at doorstep and reduced post-harvest losses. Digital tools remain underused-only 15% of farmers were aware of agro-apps, but pilot programs in Peshawar show potential to reduce go-betweens and increase transparency.

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This study recommends a composite strategy: investing in cold chains, upgrading rural infrastructure, promoting farmer producer organizations (FPOs), introducing digital platforms, and reforming outdated marketing rules and regulation. These steps can improve smallholder profitability, decrease losses, and develop resilience against market shockwaves. Empowering youth and women, improving extension outreach, and enhancing institutional coordination are also crucial to enduring transformation.

Keywords:
Agents, cold chain infrastructure, extension services, farm losses, farmer's associations, IFAD, Khyber Pakhtunkhwa agriculture, marketability, policy reforms, small landholder, Smart agriculture, rural enablement.

1. INTRODUCTION

Mainstay of Pakistan's rural economy, agriculture offers livelihoods to over 60% of the population and contributes roughly 19.5% to the country national GDP (Mahmood *et al*., 2025; GOP, 2023). Within this sector, the mainstream farmers are actually the small landholders who grow less than one acre of land and make over 90% of the farming population in Khyber Pakhtunkhwa (Lowder *et al*., 2025; Khan *et al*., 2022; Rehman & Khan, 2022; Phambra *et al*., 2020; Ullah *et al*., 2019; Shahbaz *et al*., 2015). These farmers are critically important in providing household food security**,** livelihood opportunities, sustenance, and agro ecological resilience, particularly in KP's varied terrain and disjointed farming systems (Shah *et al*., 2021).

Smallholder farmers are the mainstay of agriculture worldwide, predominantly in developing economies, where they are central to sustainable food production, generating rural employment opportunities, and bringing down poverty. Despite their significant contributions, they commonly work under a universal pattern of highly unequal and varied land distribution. Research from the Food and Agriculture Organization (FAO) shows that while small farms (under 2 hectares) make over 84% of all farms and farmers worldwide, they grow only around 12% of all agricultural land (Lowder *et al*., 2016). This is in plain contrast to large corporate farms (over 50 hectares), which represent just 1% of land holdings yet occupies more than 70% of the world's farmland. This worldwide trend finds high reflection in KP, where smallholders lead the agricultural landscape, representing the majority of the farming population and overall agriculture. However, they are faced with a range of incessant and intrinsic barriers, with the average land holding size in the province being the smallest in Pakistan.

In KP, small landholdings, low crop productivity, and a heavy reliance on subsistence farming affect the ability of these farmers to attain economies of scale and integrate effectively into broader high-end fruits and vegetables markets. The domination of informal middlemen (the agents), weak bargaining power, and limited access to essential resources such as finance, modern technology, inputs including fertilizers, seeds and pesticides, and credible market information further snares many smallholders in a malicious cycle of low economic returns and entrenched poverty. Therefore, this study theme explores the critical interventions needed to reinforce market linkages, address these structural challenges, and unlock opportunities that can endow KP's smallholder farmers with greater leverage and develop sustainable agricultural development. Gallup Pakistan's analysis of the Agricultural Census 2024 reveal that small farms continue to dominate Pakistan's agricultural land, with 37.41% of holdings below one hectare and 57% below two hectares. With these statistics, the average national farm size is 3.92 hectares, but it fluctuates widely across provinces from 2.20 hectares in KP to 10.32 hectares in Balochistan. Punjab province, despite having the highest agriculture output, has the greatest intensity of small farms, while Balochistan's holdings are fewer but significantly larger in size. Figure 1 states that the Sindh province however, presents a more balanced pattern, with many farms in the range of 5–10 hectare, whereas KP's landholding is highly fragmented which shrink opportunities and scope for mechanization and efficiency (Gallup-Pakistan, 2025; Khan *et al*., 2025; Lowder *et al*., 2016).

In spite of their socio-economic importance, smallholders face complex challenges that severely curb their ability to transition from subsistence-based farming to smart agriculture, commercial, market-oriented agriculture. These findings are in line with those of IFPRI (Rana & Haider, 2021; IFPRI, 2019; Saleem & Shrestha, 2019), which reported that fragmented landholdings and weak institutional linkages weaken economies of scale and deprive farmers from benefits of innovation, quality certification schemes, or high-end export markets.

Smallholder farmers in KP face numerous hurdles, including severe post-harvest losses. As shown in Figure 2, up to 40% of fruits and vegetables spoil before reaching markets particularly due to insects' pests while 25% losses occur due to ignorance of the farmers. Similarly poor time management, unscientific harvesting and improper transportation

collectively cause 34% losses to agriculture produce of fruits and vegetables (Khan *et al*., 2025; Akram *et al*., 2024; Bashir & Honey, 2024).

Figure 1

Gallup-Pakistan, 2025: Analysis of Agriculture Census 2024

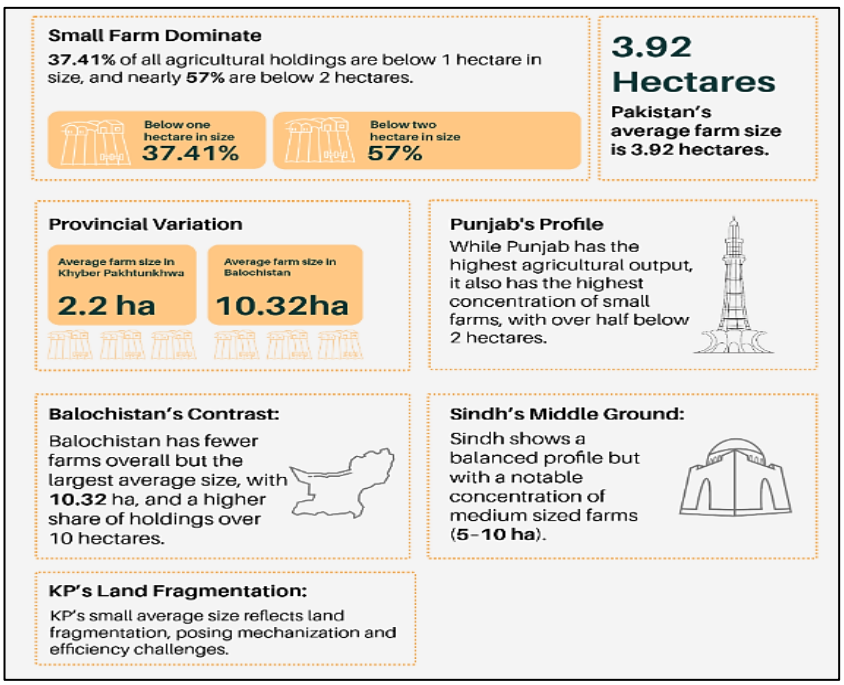
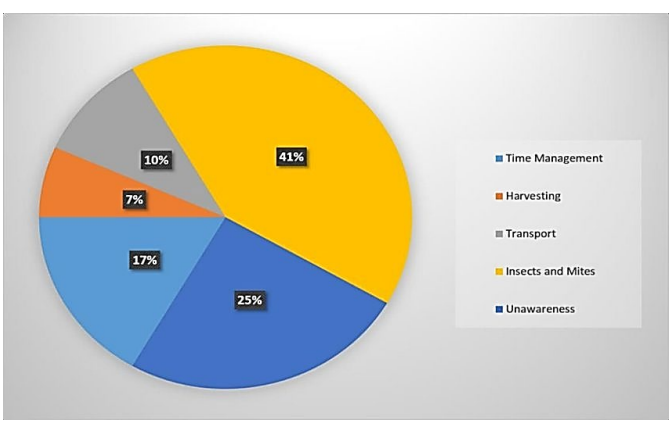


Figure 2

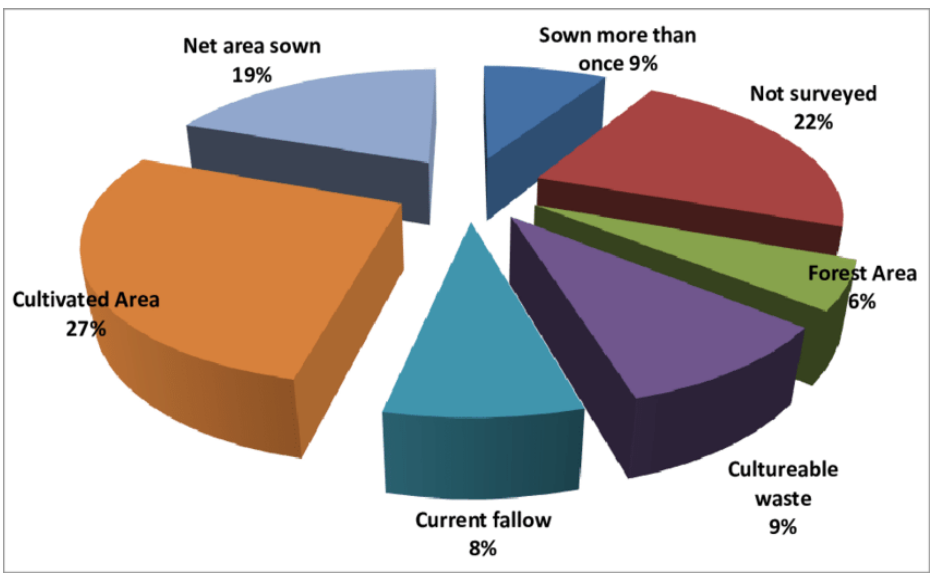
Percentage-wise fruits and vegetables post-harvest losses in Pakistan (Extracted from Khan et al., 2025; Akram et al., 2024; Bashir & Honey, 2024).



In addition, post-harvest losses often due to poor rural infrastructure can exceed 30% for perishable commodities, severely reducing farm income (Białowąs & Budzyńska, 2022; Canton, 2021; FAO, 2020). Limited access to contract farming arrangements, digitalized platforms**,** or farmers' organizations and associations in the form of cooperatives further isolate smallholders from competitive and sustainable supply chains (Salik *et al*., 2025; Ahmed & Ali, 2023; P&DKP, 2022; World Bank, 2021). This situation is exacerbated by low digital literacy**,** gender-based exclusion, deprivation, and poor public-private coordination despite several good initiatives such as the KP Olive Oil Project, Dairy Hub models, and the IFAD-supported RETP Project (Hussain *et al*., 2025; IFAD, 2023; Horst & Watkins, 2022). The limited allocation of land in the larger land-use context within Pakistan (Figure 3) for high-value crops sharply narrows the operational space for smallholders, affecting both production and profitability (Sadiq *et al*., 2025; Ali *et al*., 2022; Mughal, 2019; Tahir & Khaliq, 2018).

Figure 3

Overview of land utilization patterns across Pakistan, showing limited land availability for diverse cropping (extracted from Białowąs & Budzyńska, 2022; Canton, 2021; FAO, 2020).



Review of case studies like the Swat Apple Value Chain (FAO/UNDP) and AKRSP's solar apricot drying interventions in Dir show that selected,

value-chain-based enterprises-when aided by training, on-farm demonstration, processing units, and market linkage support can considerably raise incomes and reduce post-harvest losses. However, such interventions remain limited in scale, availability, and inclusiveness.

The KP Agriculture Policy 2015-2025 recognizes these inherent bottlenecks and stresses transforming smallholder farming toward sustainability, climate resilience, and market competitiveness. The RETP Project (KPRETP, 2022) attempts to achieve these goals by promoting Farmer Producer Organizations (FPOs), models for contract farming, Model Farm Services Centers (MFSC), high-end supply chains, rural infrastructure, and inclusive agribusiness farmers' clusters.

1.1 Statement of the Problem

Majority farmers of Khyber Pakhtunkhwa are smallholders, growing less than one acres of land (Khan *et al*., 2022; Rehman & Khan, 2022; Phambra *et al*., 2020; Ullah *et al*., 2019; Shahbaz *et al*., 2015). Their contribution to the food security, livelihood prospects and rural development of the province is significant. Despite this important role, they face numerous challenges in marketing, financial, infrastructure and technology domains which hinder their progress and consequently affect agricultural development. Smallholders face problems in accessing proper market linkages, resulting in poor price realization and manipulation by middlemen (Białowąs & Budzyńska, 2022; World Bank, 2021; Canton, 2021; FAO, 2020). Inadequate rural infrastructure and weak value chains result in significant post-harvest losses (Planning and Development Department, Khyber Pakhtunkhwa, 2022). Additionally, restricted access to extension services, market intelligence, quality certification schemes, and improved infrastructure restrain these farmers from integrating into high-end export markets (Ahmad & Sher, 2025; Ahmed *et al*., 2017). Small landholdings and lack of collective action reduce economies of scale and limit opportunities to access institutional credit and productivity-enhancing technologies (Rana & Haider, 2021; IFPRI, 2019; Saleem & Shrestha, 2019). Such circumstances call for analysis of these problems faced by the smallholder farmers, devising actionable policy recommendations and strategic interventions to transform smallholder farming in KP from subsistence-based production toward competitive, resilient, and market-oriented agriculture.

In this perspective, this study intends to assess the current environment of market linkages for smallholder farmers in KP, identify

major structural and operational issues, and suggest evidence-based policy and institutional interventions (Khan *et al*., 2024). By integrating desk research, case studies, and structured primary field data collected through a comprehensive farmer questionnaire, the study contributes toward developing a practical roadmap for strengthening KP's smallholder farming communities with the following objectives;

1.2 Objectives and scope of the study

i. To identify and probe the market-related issues facing smallholder farmers in KP

ii. To evaluate institutional and policy frameworks affecting market access and farmer empowerment

iii. To recommend practical strategies and policy reforms focused on strengthening market linkages

1.3 Scope and Significance of the Study

This study focuses on exploring the market-related challenges faced by smallholder farmers in Khyber Pakhtunkhwa and aims to propose strategies to enhance their economic empowerment and market integration. It will critically study the existing market structures, institutional support mechanisms, rural infrastructure deficiencies and the effectiveness of current policies that affect smallholders' ability to access fair, competitive and profitable markets. The study intends to explore how weak market linkages, lack of value chain development, inadequate access to extension services, quality certification systems and gender disparities hinder the potential development of smallholders. For that purpose Selected districts of KP representing varying agro-ecological zones (e.g., Peshawar, Swat, Dir, Chitral, and D.I. Khan) were targeted for the subject study. By reviewing relevant policy frameworks, engaging with stakeholders, and drawing on best practices, the study recommends a set of evidence-based, inclusive, and practicable policy reforms to support the transition of smallholder farming from subsistence to a market-oriented and competitive system. It bears mentioning that this study cannot provide one-size-fits-all solutions applicable across all farming circumstances. Its role is to inform and guide decision-makers by offering a strategic roadmap, recognizing that successful implementation will depend on wider influences including political will, institutional ability, and coordinated stakeholder efforts.

The significance of the study is to critically evaluate the market-related challenges and opportunities confronted by smallholder farmers in KP who constitute over 90% of the farming population and commonly grow piece of land less than one acre. The research aims to identify the structural, institutional, and technological hurdles that restrict their access to high-end markets, post-harvest management, extension services, and policy support. By combining primary field data of farmers with secondary information obtained from government departments, international organizations, and related case studies, the paper seeks to provide evidence-based understandings and actionable strategies that can transform smallholder agriculture from a subsistence model to a more inclusive, competitive, and market-oriented enterprise. These farmers live in rural areas where livelihood opportunities are low and poverty is, in most of the cases, rampant. The ultimate objective is to support rural development, increase farmer's income, enhance livelihood and promote smart and sustainable agricultural growth in KP.

2. LITERATURE REVIEW

Smallholder farmers are the mainstay of agriculture in Pakistan, especially in the province of Khyber Pakhtunkhwa (KP), where over 90% of farming households grow less than one acre of land (Khan *et al*., 2022; Rehman & Khan, 2022; Phambra *et al*., 2020; Ullah *et al*., 2019; Shahbaz *et al*., 2015). These smallholders have a critical role in ensuring household-level food security, sustaining rural livelihoods, and preserving agro-biodiversity. However, despite their importance, they remain side-lined from profitable markets and formal support mechanisms. The literature consistently identifies market linkages as a major hurdle (Detre *et al*., 2011). A large number of smallholders in KP sell their produce through informal channels, primarily via middlemen, which leads to poor price realization and exploitative market conduct (Białowąs & Budzyńska, 2022; FAO, 2020; World Bank, 2021). A well-judged blend of policy reform, resource optimization, empowering youth, and strengthening the value chain integration can significantly improve the transformation in KP agricultural landscape (Khan *et al*., 2024). Emphasizing sustainable energy infrastructure, utilizing untapped natural resources like coal, copper, and gold, and promoting local industries through effective incentives and support are the additional crucial pillars that can uphold this transformative shift. A recent study showed that more than 80% of smallholders in KP conveyed receiving lower-than-market prices due to dependence on intermediaries, while 78% lacked access to timely and

credible market information (Planning and Development Department, Khyber Pakhtunkhwa, 2022). These findings reflect longstanding structural problems, such as the absence of rural cluster centres, digitalised marketplaces, and organized farmer producer groups (FPOs) (Ali, 2025; Mahmood *et al*., 2025; Khan, 2023; Khushk *et al*., 2015). Effective market participation is important for small farm farmers as it enables the farming community to get cash for their livelihood, and inputs, which ultimately leads to socio-economic uplift and poverty alleviation (Mottaleb *et al*., 2025).

Extension services, a critical element of knowledge propagation and market integration, are another area of concern. Several studies have revealed that smallholders in Pakistan-particularly in remote or mountainous areas-receive inadequate technical support (Ali & Rahut, 2013). In KP, only about 35% of farmers report receiving regular extension advice, and many find private services more effective (Shah *et al*., 2021). Weak access and outreach leads to poor uptake of modern production technologies, quality certification systems, and climate-resilient agricultural practices (Hassan *et al*., 2023). Value-chain development has shown promising results in bridging some of these gaps. Case studies in KP like the Swat Apple Value Chain (FAO/UNDP) and Dir Apricot Drying Project (AKRSP) illustrate those selective interventions, such as capacity building in quality grading, solar drying, and collective marketing can lead to higher prices and decreased post-harvest losses. However, cold chain gaps, limited economy scale, and market access challenges still limit the success and sustainability of these models (Saeed & Hussain, 2025; Quibria, 2024; FAO, 2020). Digitalized tools are bringing great change and have started reshaping farming. For example, Telenor and a local aggrotech start up tried a pilot project in the Peshawar vegetable belt that connected farmers directly with retailers through mobile platforms, excluding middlemen. The idea seems promising, but its realization still hinges on farmers' digital literacy, reliable Internet connection, and their confidence in using digital payments and online procurement (Ishfaq *et al*., 2025; Hussain *et al*., 2025; Ullah *et al*., 2024). Similar efforts, like the Digital Dera in Punjab and Digital Hujra in KP, show that mobile and ICT-based extension services can give farmers timely access to weather updates, market prices fluctuation, and better farming practices.

At the policy level, the KP Agriculture Policy 2015-2025 focuses on market-oriented agriculture, public-private partnerships, and farmer

mobilization through cooperatives and clusters. The IFAD-funded Rural Economic Transformation Project (RETP) builds upon this policy by supporting Farmer Producer Organizations (FPOs), rural infrastructure, agribusiness incubation centres, and extension system modernization (Hussain *et al*., 2025; IFAD, 2023; Horst & Watkins, 2022). However, institutional fragmentation and weak inter-departmental coordination often limit the efficiency of these initiatives (Hamid & Akram, 2025; Nawaz & Batool, 2025; GOP, 2023; KPRETP, 2022). Financial exclusion also remains a major barrier. Smallholders often lack access to institutional credit due to land titling issues, insurance issues, and limited financial literacy. Studies show that access to microcredit or group-based lending models can significantly improve input use, adoption of new technologies, and market participation (Ali, 2025; Mahmood *et al*., 2025; Khan, 2023; Khushk *et al*., 2015; Ali & Rahut, 2013). Yet in KP, especially in merged districts, financial outreach remains underdeveloped.

Climate change has further compounded market vulnerabilities. Increased frequency of floods, droughts, and temperature variability affects yields and supply chains. Literature suggests that integrating climate-smart agriculture (CSA) with value chain development can reduce vulnerability and enhance competitiveness (Hassan *et al*., 2023; Rana & Haider, 2021; IFPRI, 2019; Saleem & Shrestha, 2019). Unfortunately, CSA adoption remains limited among KP's smallholders due to poor access to resilient inputs, advisory services, and credit. Gender and social inclusion are often under-researched but critical themes. Projects like the Dir Apricot Drying initiative have demonstrated how empowering women through collective processing and marketing activities can increase household income, build skills, and improve nutritional outcomes. However, broader adoption is hindered by patriarchal norms, limited female mobility, and lack of female extension agents (Ali *et al*., 2025; Nawaz & Batool, 2025; AKRSP, 2021; FAO, 2020).

In summary, the literature clearly identifies multiple interlinked constraints faced by smallholder farmers in KP: weak market access, limited value chain integration, poor extension support, lack of credit, and gender exclusion. At the same time, various case studies and interventions offer scalable solutions—particularly through farmer organization, contract farming, post-harvest infrastructure, and digital platforms. The research study under review builds upon this foundation by providing primary data from KP districts and linking it to broader institutional frameworks such as the KP Agriculture Policy and IFAD's RETP. It fills

a critical gap by synthesizing localized evidence with strategic policy recommendations, offering a practical roadmap for the economic empowerment of smallholder farmers in KP.

3. METHODOLOGY

3.1 Research Design

This study employed a mixed-methods research design, combining quantitative and qualitative approaches to comprehensively explore the market-related challenges, institutional frameworks, and opportunities for empowering smallholder farmers in Khyber Pakhtunkhwa, Pakistan. The design enabled validation and enrichment of findings by drawing on both primary and secondary data sources, making them more accurate and relevant to the situation.

3.2 Study Area and Timeframe

The research was conducted in selected districts of KP representing varying agro-ecological zones (e.g., Peshawar, Swat, Dir, Chitral, and D.I. Khan), to reflect diversity in cropping systems, infrastructure access, and institutional presence. Data collection took place during August 2025, aligning with the post-harvest season of major summer crops to capture first hand experiences with market access and value chain bottlenecks.

3.3 Data Collection Methods

3.3.1 Primary Data

Primary data were collected through multiple complementary approaches, with Agriculture Extension Officers of the KP Agriculture Extension Department playing a central facilitative role throughout the process. Their involvement ensured farmer trust, accuracy of responses, and smooth organization of surveys, interviews, and group discussions in the selected districts.

- **Structured Questionnaire Surveys:** A detailed questionnaire (Supplementray-1) was administered to a sample of smallholder farmers across selected districts. The survey captured socio-economic characteristics, production and marketing practices, access to infrastructure and services, awareness of institutional programs, and perceptions about market constraints and opportunities. A total of 200 smallholder farmers (owning <2 acres) were surveyed using random sampling stratified by region (Ullah *et al*., 2019). The sampled farmers included both registered members of Model Farm Services Centres

(MFSCs)/Farm Services Centres (FSCs) and non-registered farmers, to ensure a balanced representation of institutional beneficiaries and those outside formal structures. Extension Officers assisted in identifying representative farmers, particularly from marginal and remote districts, and ensured the representation of all the agro ecological zones of the province. The extension workers are already in close coordination with the actual farmers which further valued their critical role in interaction with respondents, improving response rates, and clarifying survey objectives. Their contextual knowledge further helped refine survey tools to align with local realities.

- **Key Informant Interviews (KIIs):** Semi-structured interviews were conducted with representatives from the KP Agriculture Department, IFAD RETP Project team, Farmer Producer Organizations (FPOs), agribusiness aggregators, and district-level extension officers. These interviews captured institutional perspectives on program design, service outreach, and market integration. Extension Officers not only shared their own operational experiences but also highlighted implementation gaps, local innovations, and challenges in linking farmers with structured markets.
- **Focus Group Discussions (FGDs):** Separate FGDs were held with farmer groups, women cooperatives (e.g., Dir apricot processors), and digital pilot participants. These discussions were facilitated by Extension Officers, who mobilized participants, arranged venues (often Farm Services Centres), and supported the safe participation of women farmers. This facilitation enabled the research team to gather collective farmer's perspectives on constraints, opportunities, gender roles, and adoption of digital and cooperative models. Extension staff also contextualized farmer insights within broader policy frameworks, enriching the depth of findings.

3.2.2 *Secondary Data*

Secondary data sources included:

- **Government and Institutional Reports**: KP Agriculture Policy 2015–2025, IFAD RETP PC-I, Planning & Development Department (P&D), Pakistan Bureau of Statistics (PBS), and project-specific documentation (e.g., KP Olive Oil Project, Swat Apple Initiative).
- **Donor Reports**: FAO, ADB, World Bank, USAID, IRDA, and CABI publications on market access, smallholder development, and agricultural policy reforms in Pakistan.

- **Academic Literature**: Peer-reviewed articles such as Ali (2025), Mahmood *et al*. (2025), Hassan *et al*. (2023), Khan (2023), Rana & Haider (2021), IFPRI (2019), Saleem & Shrestha (2019) and Khushk *et al*. (2015) addressing smallholder risks, empowerment, and coping strategies.

3.3 Data Analysis

Quantitative data from the questionnaires were coded and analysed using Microsoft Excel for calculating the averages and percentages for accessing the trends in services, infrastructure, and market mechanisms. Key results were tabulated and visualized using bar graphs and pie charts (e.g., market channels, awareness of support programs, post-harvest loss incidence).

Qualitative data from interviews and FGDs were analysed using hybrid thematic analysis. Deductive themes were informed by literature, while inductive themes emerged from FGDs and KIIs. The process included transcription, coding, categorization, and triangulation with quantitative data. Emergent themes included trust in intermediaries, digital literacy, role of cooperatives, barriers to certification, and gaps in extension delivery. These findings were used to complement and contextualize the quantitative data.

3.4 Case Study Analysis (Secondary Evidence)

Seven relevant case studies were reviewed and analyzed to extract lessons and scalable best practices. These included:

- Swat Apple Value Chain (FAO/UNDP)
- Dir Apricot Drying (AKRSP)
- Contract Farming for Tomatoes (Fauji Foods)
- KP Olive Oil Project (Govt./Italian Cooperation)
- Nestlé Dairy Hub Model
- Digital Vegetable Marketing Pilot (Telenor/AgriTech)
- Trout Farming and Tourism Linkages (WWF/KP Fisheries Dept.)

Each case was evaluated based on design, impact, scalability, and challenges using a comparative framework.

3.5 Ethical Considerations

Ethical approval for the study was obtained from the KP Agriculture Department's Extension Wing. All respondents were briefed about the purpose of the study, ensured confidentiality, and provided informed verbal consent. Female participants were interviewed in women-only

settings where required, with the help of female enumerators to ensure cultural sensitivity.

3.6 Limitations

The study does not claim to represent all farming contexts across KP due to geographical and logistic constraints. Seasonal timing may have influenced some perceptions. Moreover, since data are primarily perception-based, some responses may be influenced by recent experiences or recall bias. Despite these limitations, the multi-source triangulation enhances reliability and policy relevance.

4. RESULTS AND ANALYSIS

The data received from 200 smallholder farmers across selected districts of Khyber Pakhtunkhwa (KP) as per the methodology offer valuable insights into their demographic profile, market practices, access to services, and their preferences for support interventions. Of them, only 100 complete responses were used for detailed analysis. These findings provide a strong foundation for shaping policy strategies.

4.1 Demographic Profile of Smallholder Farmers

The majority of surveyed farmers are operating on extremely small plots of land, averaging just over one acre (**Table 1**). This small scale inherently limits economies of scale, mechanization potential, and access to markets. Most are owner-cultivators, although a notable minority (20%) are tenants, which may further constrain their ability to invest in long-term improvements. Subsistence-based farming dominates, indicating that surplus for market sale is limited or seasonal.

Table 1
Demographic Profile of Smallholder Farmers

Variable	Details
Average Landholding Size	1.2 acres
Major Crops Grown	Wheat, Maize, Vegetables, Fruits
Ownership Status	Mostly owner-cultivators (80%); tenants (20%)
Farming Type	Predominantly subsistence (80%)

4.2 Accessibility Tools

Over half the farmers depend on traditional middlemen i.e. agents and brokers to sell their produce, with only 25% accessing direct markets and a small portion (10%) experimenting with digital tools including e-marketing. The long average distance to market (12–18 km) and lack of

cold storage facilities severely impact the quality and value of perishable commodities like vegetables and fruits. These limitations contribute to pre and post-harvest losses, especially among the 35% of farmers reporting fruits and vegetables losses between 11–30% (**Table 2**).

Table 2: Access to Market and Infrastructure.

Variable	Details
Main Selling Channel	Middlemen (50%), Direct Market (25%), Cooperatives (15%), Digital (10%)
Distance to Nearest Market	12–18 km on average
Cold Storage Facility Available	65% respondents have no access
Post-Harvest Losses	11–30% losses in perishables (35% of farmers)

4.3 Access to Support Services and Information

Extension service coverage remains inadequate, with only 40% of smallholders reporting access. Even when available, extension visits are infrequent, limiting the transfer of technical knowledge, especially regarding marketing and post-harvest practices. A staggering 78% of farmers lack timely and reliable market information, underscoring the need for mobile advisory systems or farmer helplines. Furthermore, only a third of farmers are aware of institutional programs such as the RETP (IFAD), indicating poor outreach and communication by implementing bodies (Table 3).

Table 3
Access to Support Services and Information

Variable	Details
Access to Extension Services	40% respondents have access
Frequency of Visits	1–2 times per season
Access to Market Information	78% lack reliable access
Awareness of Support Programs	34% aware of IFAD/Departmental support programs

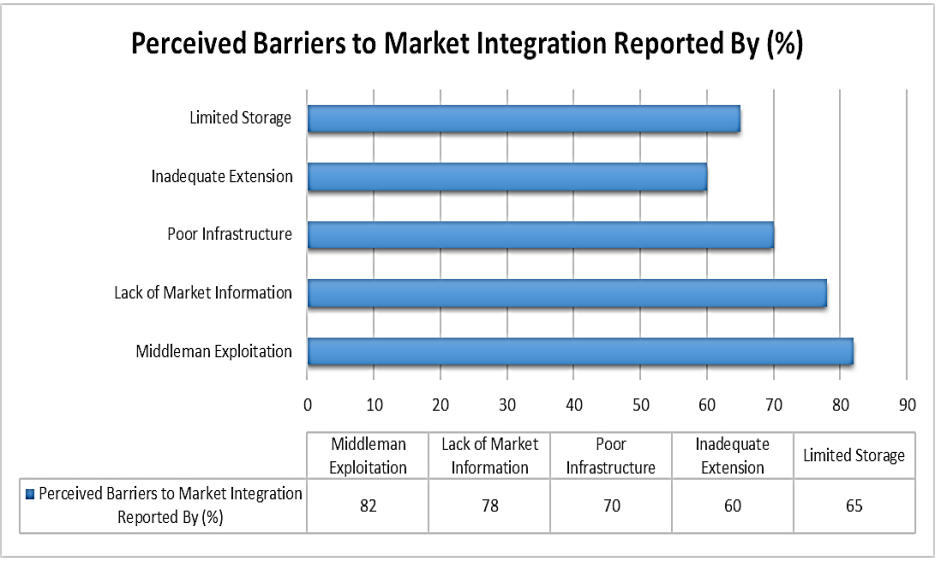
4.4 Barriers to Market Integration

The most prominent barrier is exploitation by middlemen, cited by over 80% of farmers. This reflects a power asymmetry where smallholders lack bargaining leverage and depend on advance payments or immediate cash. The absence of timely market information (78%) and lack of infrastructure (70%) such as rural roads, collection centers, and storage facilities further

isolate farmers from profitable value chains. A significant portion of respondents (60%) expressed frustration with inadequate extension support, while 65% identified storage limitations as a major cause of post-harvest loss and distress sales (Figure 4).

Figure 4

Perceived Barriers to Market Integration.



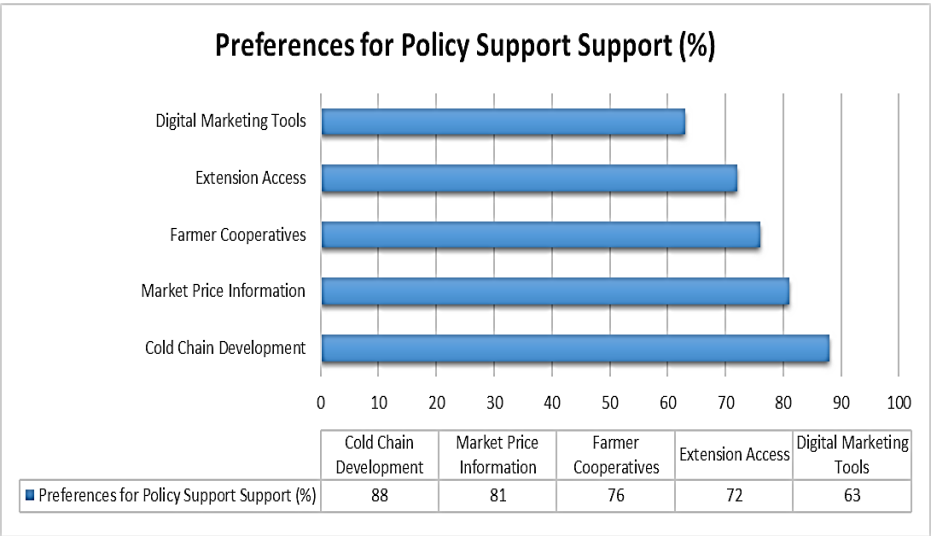
	Middleman Exploitation	Lack of Market Information	Poor Infrastructure	Inadequate Extension	Limited Storage
Perceived Barriers to Market Integration Reported By (%)	82	78	70	60	65

4.5 Preferences for Policy Support

Cold chain development is overwhelmingly favoured by respondents (88%), emphasizing its critical role in minimizing losses and stabilizing prices for perishable commodities. Access to market price information (81%) also ranks high, suggesting demand for ICT-based platforms like mobile alerts or village display boards. Over three-quarters of farmers support the idea of farmer cooperatives, reflecting growing awareness of collective action as a tool for scale and negotiation. Improved extension services and digital marketing tools are also seen as necessary enablers of modernized agriculture (Figure 5).

Figure 5

Preferences for Policy Support.



	Cold Chain Development	Market Price Information	Farmer Cooperatives	Extension Access	Digital Marketing Tools
Preferences for Policy Support Support (%)	88	81	76	72	63

4.6 Awareness vs Benefit of Support Programs

Critical mismatch between mass awareness and benefit from key agricultural initiatives in KP is highlighted in **Figure 6**. Of the given data, 34% of respondents were aware of IFAD's RETP, of which only 15% reported benefiting, indicating either poor program outreach, limited targeting efficiency, or barriers to farmer participation. Similarly, although Farm Services Centres (FSCs) had the highest awareness (40%), only 25% could access actual services or inputs.

Projects like the KP Olive Oil Project**,** Nestlé Dairy Hubs**,** and AKRSP's solar drying units had moderate recognition but low impact in terms of benefit, largely due to geographic concentration or niche focus. Digital agriculture initiatives and trout farming efforts had the lowest awareness and benefit levels, reflecting either limited scale or insufficient dissemination in rural areas. This aforementioned data in **Figure 6**, underscores the need for improved information dissemination, decentralized implementation, and feedback loops to enhance beneficiary targeting and utilization.

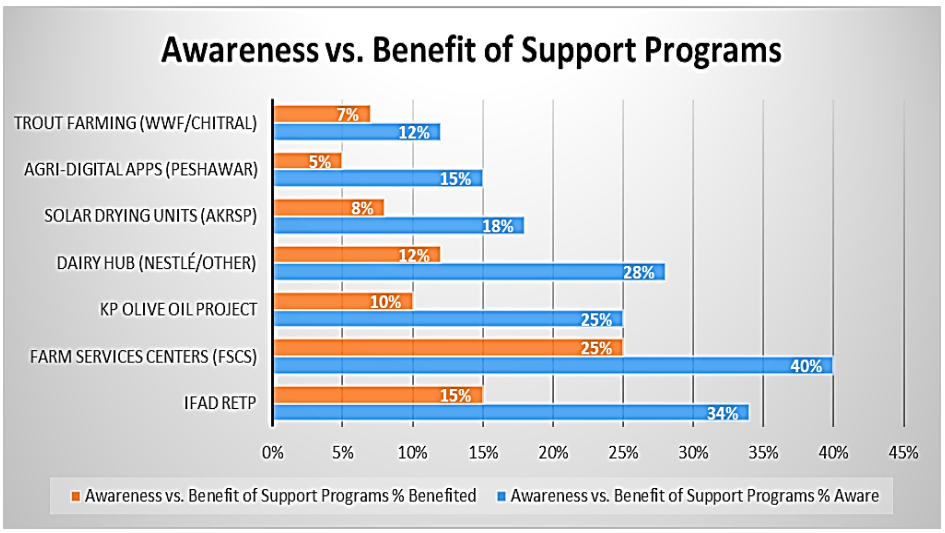
4.7 Modes of Selling Agricultural Produce

The pie chart (Figure 7) illustrates the primary market channels utilized by smallholder farmers in KP. Half of the respondents (50%) reported selling through middlemen, indicating a heavy dependence on informal, often exploitative channels. This reliance is likely driven by the need for immediate payment, ignorance and the lack of structured markets in close

proximity. The next most common outlet is the local market (25%), though this is limited by distance and transport availability. Only 10% sell through Farmer Organizations, suggesting limited farmer mobilization and weak cooperative structures. Contract buyers account for 8%, reflecting slow adoption of formal buyer agreements, often due to quality control issues or lack of buyer trust. Direct-to-consumer sales (7%) remain negligible, likely constrained by low digital literacy, fragmented demand, and lack of processing or packaging facilities. The above findings call for strengthening alternative models like Farmer Producer Organizations (FPOs), expanding contract farming arrangements, and developing digital marketing platforms that enable traceable, direct sales to consumers or retailers.

Figure 6

Awareness vs Benefit of Support Programs



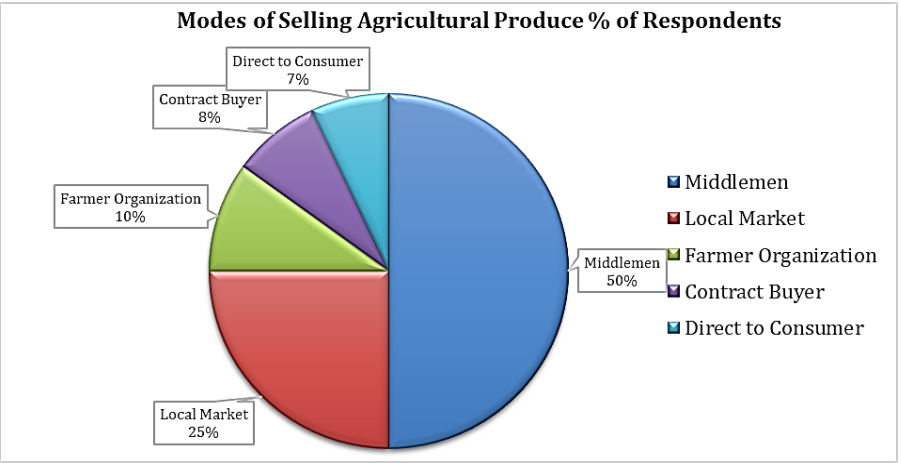
4.8 Impact of Post-Harvest Losses

The chart at Figure 8 reveals significant vulnerability in the post-harvest phase. While 15% of farmers reported no losses, the remaining 85% suffer from various levels of wastage**.** Moderate losses (11–30%) were reported by 35%, making it the most frequently cited category. High losses (>30%) affected 20% of respondents, primarily those involved in perishables like vegetables, fruits, and dairy. These losses are driven by inadequate storage, absence of cold chain infrastructure, poor packaging, and long transport times. The 30% of farmers experiencing low-level losses (1–10%) still represent a sizable share and highlight inefficiencies in even

more stable commodities like grains. Analysis indicates that investment is urgently needed in cold storage units, drying technologies (e.g., solar dryers), village packhouses, and producer training on harvest handling, to reduce post-harvest losses. This would not only increase farmer income but also improve food system efficiency.

Figure 7

Modes of Selling Agricultural Produce



4.9 Access to Agriculture Extension Services

This pie chart (Figure 9) reflects a critical institutional gap: 40% of smallholder farmers report never receiving extension services, and another 40% only receive them occasionally. This means that 80% of the surveyed population lacks consistent technical support, preventing them from adopting new practices, accessing market information, or benefiting from government schemes. Only 20% of farmers have regular contact with extension agents, likely those near urban centers or enrolled in organized schemes (e.g., contract farming, FSCs). This insufficient outreach directly undermines efforts in yield improvement, quality enhancement, post-harvest management, and certification readiness. Critical analysis suggests a pressing need to modernize and expand the public extension system, integrating ICT (mobile apps, SMS alerts), community-based facilitators (especially female agents), and partnerships with private input dealers and NGOs for broader, more inclusive coverage.

Figure 8

Impact of Post-Harvest Losses

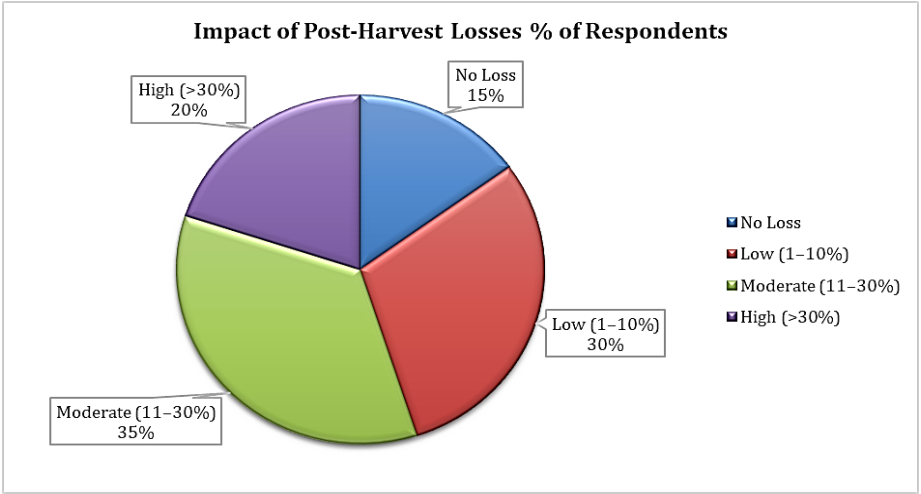
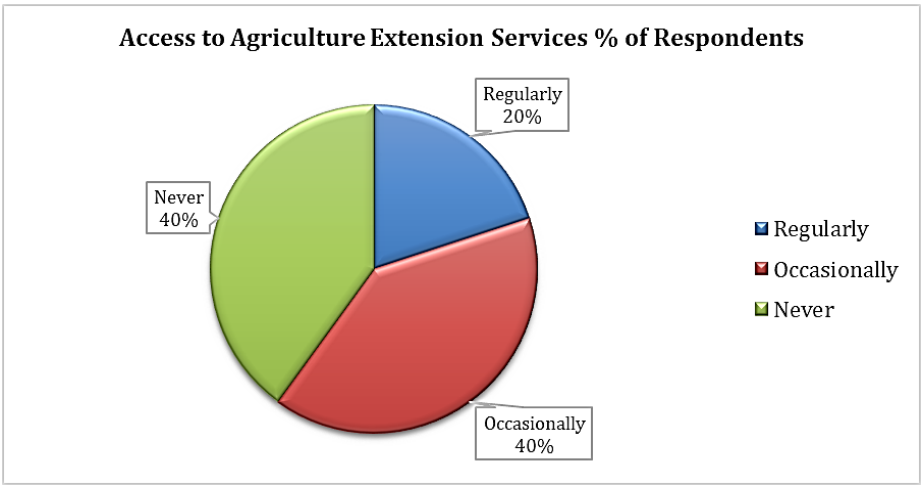


Figure 9

Access to Agriculture Extension Services



4.9 Synthesis and Policy Insight

These results clearly demonstrate that KP's smallholder farmers face a systemic lack of market connectivity, exacerbated by infrastructural, institutional, and informational deficits. Farmers are eager for interventions that reduce transaction costs, provide direct access to markets, and empower them through knowledge and organization. Any meaningful strategy must, therefore, blend infrastructure development with institutional innovation and digital inclusion.

5. DISCUSSION

The findings of this targeted study underscore the complex and multi-dimensional challenges faced by smallholder farmers in Khyber Pakhtunkhwa, Pakistan. The predominant reliance on middlemen, limited access to structured markets, and high post-harvest losses are all indicative of a system where smallholders remain trapped in subsistence farming. These patterns are not unique to KP and resonate with global research showing that smallholders often lack access to profitable markets, institutional support, and essential infrastructure (Reardon *et al*., 2019; Barrett, 2010). A significant concern highlighted in this field-based study is the heavy dependence on informal marketing channels, where 50% of the farmers sell through middlemen. The study may be extended to other districts of KP or Pakistan. This finding aligns with studies in Sub-Saharan Africa and South Asia where middlemen dominate agricultural value chains, often resulting in farmer exploitation due to asymmetric market information and poor negotiation power (Sitko & Jayne, 2014; Chamberlin & Jayne, 2013; Dorward, 2013). Furthermore, only 10% of respondents engaged with farmer organizations and associations, which are critical tools for aggregation and scale efficiencies. Evidence from Latin America and Africa suggests that when organized into cooperatives or producer groups, smallholders gain improved access to markets, finance, and technology (Fischer & Qaim, 2012; Markelova *et al*., 2009). Post-harvest loss remains a key bottleneck in improving rural incomes. Over 55% of respondents in KP reported moderate to high losses, primarily in fruits and vegetables. Various research studies and recent field-based surveys in selected districts of KP suggest that major challenges include lack of credible market information (78%), manipulation by intermediaries (82%), absence of processing and storage facilities (65%), and limited approach to research, extension and financial services (40% have never received). This trend mirrors global statistics where post-harvest losses can range between 15–30% in developing countries due to inadequate storage, transport, and processing infrastructure (Hodges *et al*., 2011; Kader, 2004). Cold chain infrastructure, while highly demanded by 88% of farmers in our survey, remains sparse—echoing findings from India and Bangladesh that link the absence of cold storage to distress sales and quality degradation (Roy *et al*., 2025; Sadiq *et al*., 2025; Mustafa *et al*., 2024; Aravindaraj *et al*., 2020; Zhao *et al*., 2018).

Limited access to extension services and market intelligence significantly limits the adoption of improved practices and market readiness. Only 20% of surveyed KP farmers receive regular extension support. This is consistent with global concerns where public extension systems are often under-resourced and poorly decentralized (Buehren *et al*., 2017; Anderson & Feder, 2007; Birner & Anderson, 2007). In Ethiopia and Vietnam, digital extension models have shown promise in bridging this gap by leveraging mobile platforms (Davis *et al*., 2025; Berrange-Ford *et al*., 2021; Fabregas *et al*., 2019). KP's low awareness of programs such as the IFAD RETP and digital agri-apps (15%) points to communication failures that restrict farmer empowerment. Digital platforms, while still in pilot stages in KP, hold substantial promise. Studies in Kenya and India have demonstrated that mobile platforms, e-commerce websites including YouTube and other websites providing weather forecasts, market prices, and buyer linkages enhance both productivity and profitability (Akram *et al*., 2024; Bhat *et al*., 2024; Khatri *et al*., 2024; Mulungu *et al*., 2025). However, these benefits are only realized when digital literacy, rural connectivity, and institutional trust are addressed in tandem (Bai & Yang, 2025; Ndjama, 2025; Karanfiloğlu, 2025; Abdul Kareem & Oladimeji, 2024).

The study also explored farmers' preferences for strategic interventions. Cold chain development, farmer cooperatives, and price information systems were the top recommendations. These are well-supported by research at global level, which indicate that huge interventions including but limited to combining infrastructure, institutional reforms, and technology produce synergistic effects (Alina & Marinela, 2024; Kosec *et al*., 2023; IFPRI, 2023; World Bank, 2022). Importantly, the success of case studies in KP, such as the Swat Apple Value Chain or Nestlé Dairy Hub, shows the value of public-private-community partnerships (PPPs), an approach promoted in multiple success stories across Africa and Latin America (Ton *et al*., 2018; Devaux *et al*., 2016).

In summary, transforming smallholder agriculture in KP will require multi-layered interventions. These must include (1) improved infrastructure (cold chains, rural or farm to market roads and access), (2) institutional development (FPOs, inclusive contracts), (3) digital tools for marketability of farm produce, and (4) revitalized extension systems. Above all, empowerment must be grounded in inclusive policy design,

ensuring marginalized groups especially women and tenants are not left behind.

5.1 Major Findings

This study revealed that smallholder farmers in KP who make up over 90% of the province's farming population face systemic barriers to market access and productivity. Based on field data and case studies, it was found that 50% of farmers sell through middlemen, while only 25% access local markets, and a mere 7-10% use organized channels such as farmer organizations or contract farming. This results in reduced bargaining power and poor price realization. In terms of post-harvest management, 35% of farmers reported moderate losses (11–30%), and 20% suffered high losses (over 30%), primarily in perishable crops like vegetables and fruits due to lack of cold chains, grading facilities, and proper packaging.

Access to institutional and advisory services is also limited. Only 20% of respondents reported regular contact with agriculture extension workers, while 40% stated they had never received any extension support. Digital agricultural tools remain underutilized only 15% were aware of mobile-based agri platforms, and just 5% had actually benefited from them. Awareness of government and donor-supported initiatives was low: for instance, only 34% were aware of the IFAD-funded RETP project, and 15% reported any tangible benefit. The KP Olive Oil Project, Nestlé's Dairy Hub, and AKRSP's solar drying units in Dir had awareness levels below 30%, despite their success in select areas. Encouragingly, 88% of farmers expressed strong demand for cold storage and value chain infrastructure, and 72% supported the formation of farmer cooperatives to improve market access and reduce dependence on middlemen. The case study of the Swat Apple Value Chain showed that the introduction of pack houses and branding increased farmer profits by up to 25% through better quality grading and direct linkages with exporters. Similarly, AKRSP's women-led apricot drying initiative in Dir resulted in a 30–40% increase in household income for participating families, while reducing waste.

The study clearly demonstrates that while smallholders in KP are underserved, they are willing to adopt improved practices if supported by enabling infrastructure, market information systems, and institutional linkages. Strategic, localized interventions particularly those integrating digital tools, collective action, and gender inclusion can significantly improve the resilience, income, and market participation of smallholder farmers in the province.

6. CONCLUSION

The research comprehensively assessed the market challenges, opportunities, and institutional gaps affecting smallholder farmers in KP. Despite their significant role in the province's food security and rural livelihoods, smallholders continue to face marginalization in value chains due to weak infrastructure, poor market access, and inadequate policy enforcement. Findings reveal that middlemen dominate the agricultural market, post-harvest losses are widespread, and awareness of institutional support remains limited. Moreover, digital tools and extension services are either underutilized or unavailable to most farmers. These conditions collectively limit farmer profitability, innovation adoption, and resilience against shocks like climate variability or price volatility. Nonetheless, successful case studies both from within KP and internationally—highlight scalable models of empowerment through contract farming, cold chains, collective action, and digital platforms. Therefore, while the challenges are considerable, so too are the opportunities for transformation if approached strategically, inclusively, and systematically.

6.1 Policy Recommendations

Based on the evidence gathered, the following strategic recommendations are proposed to strengthen market linkages and empower smallholder farmers in KP.

6.1.1 Infrastructure Investments

- Develop decentralized cold storage units**,** drying facilities, and grading/packaging centres at the tehsil level.
- Upgrade rural farm-to-market roads through co-financing or public-private partnerships.
- Equip FSCs and agro-hubs with ICT access points and mini-market platforms.

6.1.2 Institutional Strengthening

- Promote Farmer Producer Organizations (FPOs) to enhance bargaining power and aggregation.
- Scale-up contract farming models through regulatory frameworks that protect farmers.
- Enable cooperatives to access subsidized credit, equipment, and extension training.

6.1.3 Digital Integration

- Expand access to agri-digital platforms (e.g., mobile apps for pricing, weather, buyers).
- Provide digital literacy training and smartphone subsidy schemes for rural youth and women.
- Partner with local start-ups, telecoms, and banks to ensure seamless digital payment systems.

6.1.4 Extension and Advisory Services

- Recruit and train more local-based extension agents, with special quotas for women.
- Introduce e-extension services (e.g., SMS alerts, WhatsApp helplines, IVR bots).
- Link extension content with ongoing donor/NGO schemes (e.g., IFAD RETP, AKRSP initiatives).

6.1.5 Policy and Regulatory Reform

- Revise provincial agriculture marketing rules to reduce middlemen dependency.
- Establish a Market Intelligence & Coordination Cell under KP Agriculture Department.
- Mainstream climate resilience**,** youth entrepreneurship, and gender equity in all agro-market initiatives.

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