Research Article

Information Seeking Behaviour and Knowledge Exchange Roles of Farmers under AKIS Framework in Pakistan

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Abstract | Present research study was designed to examine information seeking behaviour of farmers and their knowledge exchange roles within AKIS framework. The study was conducted in all the four provinces of Pakistan using cross-sectional survey research design. Mix method approach was adopted to seek data from the respondents. Descriptive analytical techniques were used for analyzing collected data. Findings reveal that majority of respondents (35.9%) were economically active having aged 26–40 years. A substantial proportion of respondents possessed low educational level, with 27.0% illiterate and 42.9% hold education upto middle or matric level. Fellow farmers were the most preferred information source as reported by majority (46.0%) of respondents. Results also indicate that most of the farmers (32.0%) accessed information sources on monthly basis. Findings shows that most (43.1%) of the farmers had never used internet-based agricultural information sources and around half (50.4%) of farmers didn't actively search agricultural related information. Most (23.4%) of the farmers primarily used internet-based information sources for agricultural practices. Noticeable knowledge gaps between farmers' current and desired information levels across all agricultural tasks was found, with the largest knowledge gap found in natural calamities (Mean Difference = 1.21). These findings explain the supremacy and control of inter-personal agricultural information sources and slow adoption of digital rural advisory tools under Roger's Theory of Diffusion of Innovation. Additionally, the Sustainable Livelihood Framework highlighted the central role of human & social capital and information access in shaping sustainable livelihood strategies. This has been suggested that there is dire need to strengthen farmer-centered and digitally inclusive extension model in order to significantly enhance agricultural information access, productivity, and livelihood sustainability.

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Introduction

Agriculture is the main driving force for rural development in many of the developing countries (Butt *et al.*, 2022). Like such developing regions of the world, agriculture sector is the single largest sector of Pakistan's national economy that plays a significant role in sustaining rural livelihoods and contributes 23.5% to GDP and employees above 37% to total labour force (Government of Pakistan, 2025).

Inspite of its importance at national and international level this sector faces multiple challenges including climate change and low productivity (Javed *et al.*, 2025). These challenges are interlinked and attributed to limited access to timely quality information to all the stakeholders especially farmers (Mahmood *et al.*, 2025).

In providing information to end-users (farmers), agricultural extension played a crucial role being the primary channel for disseminating scientific knowledge and information (Prajapati *et al.*, 2025). The limitations of linear agricultural technology transfer models were addressed by Röling (1992) with the emergence of Agricultural Knowledge & Information System (AKIS). This framework reported agriculture as a system of interaction among different actors that involved in the generation, dissemination, exchange and utilization of agricultural knowledge for sustained agricultural growth (Luqman *et al.*, 2024; Brike *et al.*, 2025). Research studies reported the effectiveness of AKIS in enhancing innovation capacity through facilitating knowledge creation, dissemination and also strengthening linkages among stakeholders (Proietti and Cristiano, 2023; Kountios *et al.*, 2024; World Bank, 2021).

Agricultural information access is not only a knowledge issue but also an economic determinant of farm performance. Timely and reliable agricultural information enables farmers to improve input allocation, adopt efficient production practices, reduce climate and market risks, and stabilize farm income (Maldayo *et al.*, 2024). Access to advisory services enhances productivity by supporting informed decisions regarding seed selection, fertilizer management, pest control, and irrigation scheduling. Information also reduces uncertainty related to price volatility and extreme weather events, thereby lowering production risks and preventing income shocks (Enwa *et al.*, 2026). Within the Agricultural Knowledge and Information System (AKIS), effective information exchange strengthens innovation capacity, improves resource efficiency, and contributes to sustainable rural livelihoods through enhanced economic resilience.

Information seeking behavior of an individual refers to the ways to identify information needs, seek relevant information, and its use for decision-making (Agarwal, 2022). In agriculture, farmers' information seeking behaviour is much critical for technology adoption, risk management, and adaptive responses to climate vulnerabilities and market uncertainties (Khan *et al.*, 2022). Beyond seeking information, farmers play a vital role in knowledge exchange through peer-to-peer learning, experimentation, and sharing of knowledge. In Pakistan, farmers mostly rely heavily on interpersonal information sources like neighbors, fellow farmers, and relatives for seeking updated agricultural related information, and reliance on formal extension services through extension field staff of public or private sector remains limited (Naveed *et al.*, 2021). Public extension services are often perceived as less accessible or less responsive, leading farmers to depend on informal networks for timely advice. Mass media information sources continue to play a role in information dissemination and creating awareness among communities (Ali *et al.*, 2022). In the context of Pakistan, progressive farmers and local community leaders play a key role in disseminating innovations and influencing adoption decision process.

Farmers prioritize agricultural related information, and yet face notable constraints in accessing timely agricultural knowledge, underscoring gaps within the existing AKIS (Luqman *et al.*, 2025). The integration of farmers under the existing AKIS remains limited and constrained by weak institutional linkages and restricted capacity of extension field staff (Davis and Sulaiman, 2014). With similar lines Spielman *et al.* (2016) reported that integration of farmers all actors of AKIS remains partial, with knowledge flows largely dominated by informal channels or networks rather than formal institutions (Khan *et al.*, 2020). The growing adoption of smartphones among farmers, particularly in the Punjab province of Pakistan, enables their participation in online farmer groups and digital agricultural advisory services (Nawaz *et al.*, 2023). There is a lack of empirical understanding of how information seeking behaviour intersects with knowledge exchange roles among farmers within the AKIS framework-particularly in terms of how these behaviours influence learning, adaptation, and innovation adoption in dynamic rural environments. Therefore, this study aims to analyze farmers' information seeking behaviour and their roles in knowledge exchange under the AKIS framework in Pakistan.

Methodology

The present research was conducted in all the four

provinces of Pakistan. A cross-sectional Survey Research Design was used. Mix-method research approach was followed. This triangulation of data was helpful to have deep understanding about the complexity of issues faced by small-scale farmers in Pakistan under AKIS. This was also allowed to compensate weakness in the multiple methodological approaches being used in the research. For the part of baseline survey, as it was collaborative in nature involving and bridging knowledge and information between different stakeholders of AKIS system. Knowledge and information related to agriculture are the major two variables being under observation in this baseline survey. These variables are being influenced through the research process. Data or information collected under the baseline survey through descriptive research design was only focused on the demographic or socio-economic related information of the respondents. The other reason behind use of descriptive research design was uncontrolled nature of variables. Two districts from Punjab were randomly selected for the baseline survey i.e. Muzaffargarh & Sargodha. For the baseline study non-probability (convenient) sampling procedure was adopted. The reason behind use of convenient sampling was to reach out the small farmers who are easily accessible for the baseline survey.

After completion of baseline survey, a detailed and comprehensive survey was conducted in all the four provinces of Pakistan. Non-probability (purposive) sampling procedure was adopted for the selection of targeted survey areas at first stage and also for the selection of study objects (respondents) at 2nd stage. The detail of survey research areas in all the four provinces of Pakistan is Table 1.

Table 1: *Survey districts for data collection from respective province*

Province	Districts of data collection
Punjab	Sargodha, Hafizabad, Khushab, Sahiwal, Bahawalnagar & Rahim Yar Khan
KPK	Peshawar, Malakand, Noshehra & Swabi
Sindh	Hyderabad & Naushahro Feroze
Baluchistan	Quetta, Kuch & Awaran

Location Maps of the above mentioned targeted survey districts was illustrated with the help of Arc GIS Mapping. Structured interview schedule was used as the data collection for this survey. The data were collected with the help of trained enumerators hired from the respective district. The interview schedule was also translated into Urdu language to avoid in confusion in response by the respondents. The collected data was original in nature. Level of accuracy and reliability of collected data was high. The questions were modified according to the educational, social, economic and motivational level of the respondents. Some additional information or data was also collected along with the mandatory information. The collected data were analyzed through SPSS.

Results and Discussion

The age distribution indicates that nearly half of respondents are below 40 years, suggesting the presence of a relatively active and potentially innovation-oriented farming population (Table 2). Younger farmers generally exhibit greater openness toward new technologies and digital information sources, which enhances the effectiveness of knowledge diffusion within AKIS. Economically, this demographic structure provides opportunities for accelerating productivity growth and technology adoption, provided that extension services effectively target youth engagement and digital advisory systems. These findings are in line with the results obtained by Rehman (2011). With reference to Khyber Pakhtunkhwa province of Pakistan Aldosari *et al.*, (2017) concluded that majority (around 68%) of respondents had age between 25 to 45 years. Similar findings were also reported by Omobolanle (2008).

Table 2: *Age of respondents*

Age group	Frequency	Percentage
Up to 25 years	95	13.6
26 years to 40 years	251	35.9
41 years to 55 years	180	25.7
56 years and above	174	24.9
Total	700	100.0

Educational level of respondents

Education refers to studying for obtaining deeper understanding and knowledge on a particular subject (Johnson and Majewska, 2022). It plays role in developing and enhancing capabilities of individuals in a society (Prasad and Gupta, 2020). At individual level it plays an important role in bringing positive desirable changes in his/her bahaviour. The data regarding educational profile of respondents in the research area was recorded and tabulated in Table 3.

Table 3: *Education level*

Education	Frequency	Percentage
Illiterate	189	27.0
Middle	119	17.0
Matric	181	25.9
Intermediate	107	15.3
Graduation	104	14.9
Total	700	100.0

Educational attainment emerged as a critical determinant of information access. A substantial proportion of farmers possess low formal education, limiting their ability to interpret technical recommendations and utilize digital advisory platforms. Education directly influences farm productivity by improving decision-making capacity, input efficiency, and adoption of improved practices. From an economic perspective, limited literacy contributes to inefficient resource use, lower yields, and reduced income stability. Therefore, extension systems must adopt literacy-sensitive communication approaches, including visual learning methods and community-based knowledge exchange mechanisms.

Table 4: *Occupation as family income source*

Occupation	Frequency	Percentage
No	353	50.4
On need basis	137	19.6
Yes	210	30.0
Total	700	100.0

Findings reveal that there is need to improve education level in order to attain agricultural information needs of farmers and their capacity to access and use agricultural information. This has been reported that low educational level of farmers is attributed to little access to agricultural knowledge and information (Idowu *et al*., 2018). The educational level of farmers effects their agricultural productivity as farm or agricultural productivity is directly related to adoption of improved agricultural practices which in turn directly associated with educational level of farmers (Kafando, 2022). The same was also reported by Panda (2015) while studying impact of farmer education on household agricultural income in rural areas of India. With reference to Pakistan Rehman *et al*., (2013) reported that farmers education had a positive influence on their access to agricultural information which in turn improve their farm productivity. Rehman (2011) reported that educated farmers use mass media at greater rate to get agricultural related information than un-educated farmers.

The above table shows that 30% of the respondents reported having a side business, while 19.6% engage in secondary occupations on a need-basis. This diversification could indicate a strategy to manage risks or supplement income (Table 4). This shows that there is transition from farm income sources to non-farm income generating activities. For sustainable livelihoods, rural households not rely only on farm related income and used to adopt market-oriented rural non-farm based activities (Scoones, 2009). Literature shows a strong co-relation between livelihood assets possessed by the farmers and their livelihood diversification strategies (Habib *et al*., 2023). They concluded that respondents with high literacy level had high level of livelihood diversification as compared to respondents with low level of literacy. In most of the cases, people with high educational level tend to adopt non-farm livelihood activities (Atta-Ankomah *et al*., 2024). The connection between livelihood diversification strategies and education was also reported by Barrett *et al*. (2005).

In majority of the developing countries small-scale farmers are in large proportion and play an important role in agricultural production (Hazell *et al*., 2007). Small size of agricultural land holding generally in the whole country and specifically in the Punjab province is very common and is reported by a number of different research studies like Saqib *et al*., (2019) and Ghafoor *et al*., (2010) and many others. In connection with these findings, Loison (2015) reported that farming is only for subsistence mainly due to small size of land holdings. Khan *et al*., (2011) also reported the small land holding status of farmers in Pakistan. Raza *et al*., (2020) reported that subsistence farming in Pakistan is very common as large majority of the farmers (90.3%) of the Punjab province of Pakistan were small land holders. During qualitative in-depth interviews and focus group meetings with stakeholders of AKIS system, major reasons behind use of multiple income sources especially adoption of non-farm activities by the respondents in the research area were large family size, small size of agricultural land, water scarcity especially in arid region, adoption of traditional farming practices, rapid urbanization, high cost of farm inputs, limited availability of micro-credit schemes especially for small-scale farmers and Farming is not a profitable business.

Table 5: *Preferred information sources*

Preferred information rich sources	Frequency	Percentage
Research stations	29	4.1
Media	148	21.1
Fellow farmers	322	46.0
Private companies	111	15.9
Extension workers	58	8.3
Exhibitions, seminars etc.	32	4.6
Total	700	100.0

The most commonly preferred information sources are informal, with 46% of farmers relying on fellow farmers for knowledge, while only 4.1% turn to research stations and 8.3% to extension workers (Table 5). This reliance on peer networks suggests that the flow of information is often localized and possibly less structured, but it also presents an opportunity to leverage community-based networks for disseminating valuable agricultural knowledge. Formal institutions, such as research stations and extension services, are underutilized, suggesting potential issues with either accessibility or trust in these sources. This is very important to note here that agricultural research stations and exhibitions were the low priority information source by majority of the farmers. This also indicates that respondents had clear preferences for seeking agricultural related information from different information rich sources. When it comes to the frequency of using these information sources, a notable 32% use them on a monthly basis, and 20.9% do so daily (Table 6). However, 14.1% reported never using them, pointing to a gap in engagement that needs to be addressed.

Table 6: *Frequency of using preferred information sources*

Preferred information rich sources	Frequency	Percentage
Never	99	14.1
Yearly	112	16.0
Monthly	224	32.0
Weekly	119	17.0
Daily	146	20.9
Total	700	100.0

Internet usage for agricultural purposes remains limited, with 43.1% never using internet-based sources and only 8.9% using them frequently (Table 7). This digital divide presents a major challenge, as those who are unfamiliar with digital platforms or lack access to the internet are missing out on potentially transformative agricultural resources. In connection with these findings, Arshad *et al.* (2021) reported that utilization of mass media especially internet based media has furthermore proven to be an important strategy for startups in the region to reach out to a larger customer base and promote online portals.

Table 7: *Usage of internet-based information sources*

Usage of internet-based information sources	Frequency	Percentage
Never used	302	43.1
Use to Some extent	241	34.4
Use to Great extent	95	13.6
Frequently use	62	8.9
Total	700	100.0

The data presented in above table shows that, 21.1% seek both problem-oriented and new practice-oriented information, a significant 50.4% do not search for any agriculture-related information at all (Table 8). This lack of engagement highlights the need for interventions that encourage proactive information-seeking behaviors among farmers. In line with this, 9% farmer respond that they only seek problem oriented information, on the other 19.3% have interest to seek new practice oriented. This shows that majority of the respondents didn't seek problem-solving or innovation-related agricultural information that may suggest limited awareness and poor access to information sources, or low perceived relevance to their farm needs (Table 9).

Table 8: *Type of agriculture related information normally search*

Type of agriculture related information normally search	Frequency	Percentage
Problem oriented	64	9.1
New practices oriented	135	19.3
Both	148	21.1
None of these	353	50.4
Total	700	100.0

Data shows 23.4% of respondents use the internet for agricultural practices, 14.3% for market information, and 10.6% for weather forecasting, while 29.9% never use it for farming (Table 10). This pointed out the significant digital gap, with many farmers not fully utilizing online resources. Improving digital literacy and access could help farmers' better leverage the internet for crucial information, boosting productivity and efficiency. This data provides critical insight into the behavior of respondents towards digitalization and their use of internet-based agricultural information

sources for agricultural and non-agricultural purposes. The findings are crucial for understanding how digital technologies can support rural development and improve agricultural extension service delivery mechanism in the context of Pakistan. There is a significant trend of rural people towards digitalization of agriculture. Two theoretical frameworks would be helpful in better understanding of agricultural information seeking behavior of farmers and their engagement in digital agricultural extension services. These frameworks are:

Table 9: *Common purposes for using internet-based information sources*

Type of agriculture related information normally search	Frequency	Percentage
Non-agricultural work	88	12.6
Market information	100	14.3
Harvesting information	65	9.3
Agricultural practices	164	23.4
Weather forecasting	74	10.6
Total	700	100.0

Table 10: *Level of information about latest agriculture related practices*

Agricultural Tasks	Current information level		Desired information level		Mean differences
	Mean	SD	Mean	SD	
Land preparation	3.03	1.46	3.78	1.13	0.75
Selection of seed	3.25	1.30	3.75	1.20	0.50
Nutrient requirements	2.92	1.37	3.71	1.30	0.79
Fertilizer dosage	3.0	1.47	3.73	1.23	0.73
Fertilizer application method	2.86	1.46	3.73	1.29	0.87
Intercultural practices	3.11	1.27	3.71	1.23	0.60
Irrigation scheduling	3.17	1.33	3.78	1.25	0.61
Natural calamities	2.62	1.46	3.83	1.31	1.21
Disease management	3.18	1.34	3.79	1.36	0.61
Insects/Pests management	3.18	1.30	3.84	1.37	0.66
Harvesting time	3.32	1.29	3.92	1.27	0.60
Harvesting methods	3.1	1.30	3.94	1.26	0.84
Storage practices	2.83	1.33	3.87	1.23	1.04
Market information	3.16	1.29	3.98	1.23	0.82

Rogers's Diffusion of Innovation Theory highlighted the significance of personal/informal interpersonal communication channels and networks-farmer-to-farmer extension including the role of digital information communication technologies in accelerating diffusion process.

Sustainable Livelihood Framework developed by DFID human capital is essential for rural development and how farmers use social and physical capital for their farm.

The data presented above reveal gaps between current and desired information knowledge levels regarding key agricultural practices. For land preparation, the current mean is 3.03, while the desired mean is 3.78, creating gap of 0.75. This indicates that farmers possess a moderate understanding but seek additional information to optimize land management techniques. In seed selection, the knowledge gap is 0.5. Nutrient requirements data indicate larger gap of 0.79, showing a significant lack of knowledge about soil nutrition and its impact on crop growth. Moreover, fertilizer dosage and application methods, the gaps are 0.73 and 0.87, respectively. The mean difference for intercultural practices is 0.6. Similarly, irrigation scheduling, 0.61 mean difference is observed, reflecting still a lot of room for improving water management techniques, especially increasing challenges posed by water scarcity and climate variability areas.

Result data on natural calamities show largest mean difference (1.21) as climatically issues continue to disrupt agricultural cycles, thus bringing important development with increased knowledge to manage risks regarding climate change, natural disasters, and extreme weather events. Moreover, the gap for disease management is 0.61, meaning there is a lack of information on how to prevent or control disease which would significantly affect yields. Likewise, the difference in insect and pest management is 0.66 which indicates that farmers need more elaborate measures to control these challenges, which are very destructive to crops. Further, concerning the time of harvesting and the way of harvesting, the mean gaps is 0.6 and 0.84 respectively. Storage practices data indicated significant gap (1.04), suggested that post-harvest handling and storage tasks where farmers feel particularly under informed, resulting food loss, affecting both food security and profitability. Market

information shows mean gap of 0.82, reflecting a need of improved data about pricing, demand patterns, and market trends.

Additionally, in order to measure the magnitude and extent of difference between current information level and desired information level of respondents regarding different agricultural tasks "effect size" was measured using Cohen's d. It was categorized into three categories on the basis of value of effect size as small (0.2 to 0.5), medium (0.5-0.8) and large/higher (>0.8). Most critical and large knowledge gap was found related to "natural calamities" and "storage practices". This indicates that farmers of the research area need urgent training related to natural disaster management to minimize agricultural risks associated with natural disasters. Moderate knowledge gap was found in agricultural tasks related to "Storage practices", "Harvesting methods", "Market information", "Nutrient requirements", "Fertilizer application method", "Land preparation" and "Insects/Pests management". On the other hand, small knowledge gap was found in agricultural tasks related to "Intercultural practices", "Irrigation scheduling", "Harvesting time", "Disease management", "Selection of seed" and "Fertilizer dosage". For illustrating the knowledge gap of respondents regarding different agricultural operation, heat map bar char was designed as given below: The red line in the bar chart showed the moderate knowledge gap 0.5 as the threshold level.

Conclusions and Recommendations

It was concluded that majority of farmers fall within the economically active and productive age bracket (26–40 years). A significant proportion of respondents was either illiterate or holds low levels of formal education, which directly limits their ability to access, interpret, and apply agricultural information. It was also concluded that a considerable number of respondents depend on non-farm or secondary income sources, either regularly or on a need basis. Findings revealed that fellow farmers emerged as the most preferred and trusted source of agricultural information, whereas formal sources such as extension workers, research stations, and exhibitions are minimally utilized. At the same time, it underscores the strong potential of farmer-to-farmer extension, peer learning, and community-based knowledge dissemination. While a segment of farmers actively uses information sources on a monthly, weekly, or daily basis, a notable proportion never engages with any information source. Internet-based agricultural

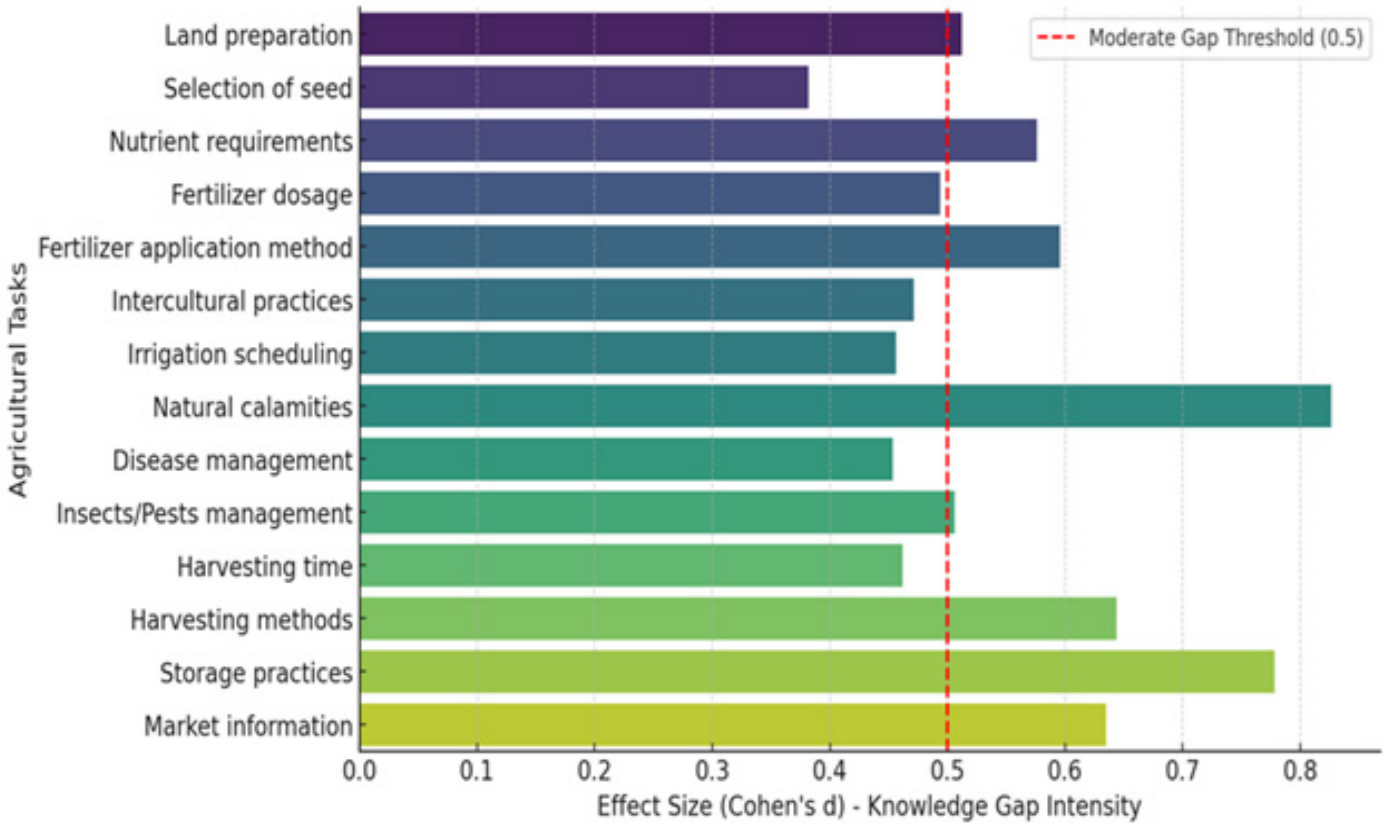

Figure 1: *Knowledge gap intensity of various agricultural tasks*

information sources are underutilized, with a majority of respondents lacking the know-how to search for online agricultural information. Low digital literacy, limited access to devices and internet connectivity, and language barriers significantly hinder the adoption of digital advisory services. Findings revealed that more than half of the respondents do not actively search for agricultural information, whether problem-oriented or innovation-related. Findings identified clear gaps between current and desired knowledge levels in almost all agricultural tasks.

Novelty Statement

This study provides a novel empirical assessment of farmers' information-seeking behavior integrated with their knowledge exchange roles within the Agricultural Knowledge and Information System (AKIS) framework across all provinces of Pakistan. Unlike previous studies, it simultaneously examines the interplay between informal networks, digital advisory tools, and knowledge gaps in agricultural practices. The study uniquely highlights the dominance of interpersonal information channels alongside the emerging digital divide, offering evidence-based insights for developing farmer-centered and digitally inclusive extension models.

Author's Contribution

Muhammad Luqman: Conceptualization
Muhammad Usman: Data curation, writing - review & editing
Tahir Munir Butt: Designed survey research instrument
Muhammad Yaseen: Prepared initial draft of paper

Generative AI and AI-assisted technology statement
The authors declare that no generative AI and AI assisted technology was used in the creation of this manuscript.

Conflict of interest
The authors have declared no conflict of interest.

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