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Farmers' awareness level and adoption regarding usage of ICT for crop production

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Abstract

The study assessed farmers' awareness and adoption of Information and Communication Technology (ICT) tools in agriculture in Hisar and Kaithal districts of Haryana. A total of 80 farmers were randomly selected, and data were gathered using an interview schedule. Farmers' awareness and adoption levels were evaluated on a two-point continuum scale. Results indicated that 57.61% of farmers were aware of ICT tools, with mobile phones being the most recognized (68%). However, awareness of advanced technologies like GPS, drones, and precision agriculture tools was low (34%-42%). Adoption rates were similarly low for advanced tools, primarily due to cost, lack of training, and complexity. Social media platforms like WhatsApp (52%) were widely used for information sharing, while traditional media showed moderate awareness. Although farmers expressed interest in sustainable practices and climate-smart agriculture, a significant gap existed between awareness and adoption. The study concluded that targeted training and financial support are needed to bridge this gap and promote wider use of ICT tools in farming.

Keywords: ICT, agricultural practices, farmers awareness, technology adoption, digital literacy

Introduction

Information and Communication Technology (ICT) is transforming agriculture, providing tools that significantly enhance crop yields and overall farm management. Farmers now rely on ICT tools, which have become essential for modern agricultural practices, offering numerous benefits such as better access to information, improved decision-making, enhanced efficiency, and financial gains. By providing timely and relevant information, ICT tools can greatly boost agricultural productivity through improved communication and informed decision-making. These tools allow farmers to access vital data on government programs, market prices, and weather forecasts, critical for planning and operational success. For instance, potato growers have successfully used ICT for pest control and weather updates, leading to improved farming methods and increased yields (Samadder *et al*., 2024; Anand *et al*., 2022) [17, 1].

The shift from traditional media to mobile apps and internet platforms for agricultural knowledge has empowered farmers by offering personalized advice and real-time updates, directly impacting crop management and output (Nikam *et al*., 2020; Dhaka and Chayal, 2010) [10, 5]. ICT tools also enable better communication among farmers, extension agents, and agricultural professionals, facilitating the dissemination of technology and best practices. Mobile-based advisory services, such as mKRISHI, and social media platforms provide farmers with affordable access to expert advice, improving the acceptance of modern farming techniques (Singh *et al*., 2014) [21]. Moreover, ICT tools help farmers make informed decisions about crop selection, planting times, and resource allocation, reducing farming risks and increasing yields (Singh *et al*., 2015) [22].

The effective organization and retrieval of agricultural data through ICT tools, such as ontology-based content management systems, allow farmers to access specific information needed to optimize their operations (Supriya *et al*., 2013) [23]. Additionally, ICT tools boost farmers' confidence, enabling them to explore and utilize a wide range of digital resources. This empowerment is linked to improved educational outcomes and increased economic motivation, both of which contribute to higher crop yields (Tankodara *et al*., 2022) [24]. ICT-based training and extension initiatives further enhance farmers' knowledge and skills, promoting more innovative and efficient farming methods (Khodifad and Solanki, 2023) [6].

Mobile phones are the most frequently used ICT tool among farmers, providing timely and relevant agricultural information (Kumar *et al*., 2023; Princy and Makkar, 2022) [7, 15]. The mobile apps improved output quality and input efficiency, resulting in social and financial benefits (Buruah *et al*., 2023; Nikam *et al*., 2020) [3, 10]. ICT tools, such as radio and television, also play a significant role in disseminating agricultural knowledge to both progressive and non-progressive farmers (Kumari *et al*., 2022) [9]. Despite these advantages, challenges such as low internet speed, uneven network coverage, and socioeconomic

barriers limit the full potential of ICT tools. Additionally, informal information sources are often preferred over formal ICT tools in some regions, highlighting the need for customized approaches tailored to local contexts (Das and Jha, 2022; Nikam *et al*., 2020) [4, 10]. While ICT tools offer valuable information, the role of extension workers remains crucial in helping farmers interpret and apply this knowledge effectively (Singh *et al*., 2015) [22].

Given the growing importance of ICT in agriculture, this study focuses on assessing farmers' awareness and adoption of ICT technologies in Haryana, with the following objectives:

1. To study the farmers' awareness level regarding the use of ICT tools for crop production.
2. To assess the farmers' adoption level of ICT tools for crop production.

Methodology

The current investigation was carried out in the districts of Hisar and Kaithal within the state of Haryana. Four villages, Chandana & Devigarh villages from Kaithal block of Kaithal district and Dhigtana & Behbalpur villages from Barwala block of Hisar district, were chosen randomly. In order to gather the necessary data, a random sampling was employed to choose 20 farmers from each of the selected villages. The result was that 80 farmers were chosen to be respondents for this study. The study looked at many things about the farmers, such as their socio-personal traits, such as their age, education, caste, and the amount of land they owned; their socio-economic traits, such as their farming systems, irrigation sources, crop rotation practices, and farm machinery; and their communicational traits, such as regular contact with extension agents and mass media exposure. As well as their overall awareness and adoption of usage of ICT for crop production, were also taken into account in the study. Using a two-point continuum, the study evaluated farmers' awareness of ICT for crop production. A value of "1" denoted awareness, while a value of "0" denoted lack of awareness. The study also evaluated the participants' adoption level in usage of ICT for crop production, classifying it as either "Adopted" (coded as "1") or "Not adopted" (coded as "0"). Data was gathered from the sampled respondents using an interview schedule that was carefully planned out and tested before it was used. The right statistical tools, like the mean, frequency, percentage, and rank order, were used to draw meaningful conclusions.

Results

Table 1: Farmers' awareness level of ICT for crop production (n=80)

SI. No.	Statements	Awareness	
		Aware	Not aware
I. Various ICT tools in Agriculture			
i. Smart Device Usage			
1.	Smart Phone for various farming activities, such as monitoring crops and accessing agricultural information online.	68	12
2.	Laptop is essential for managing my farm's data and using agricultural software for planning and analysis.	54	26
3.	Desktop computer for more complex farming tasks, like creating detailed farm management plans and analyzing large datasets.	56	24
4.	Tablet for quick access to farm records and for monitoring real-time data, such as weather forecasts and soil conditions.	58	22
	Mean awareness level score of smart device usage	59.0	21.0
ii. Social Media Usage			
1.	WhatsApp to communicate with other farmers and exchange information about farming practices and innovations.	52	28
2.	Updates about farm and farming activities on Instagram, showcasing the progress and challenges in agricultural practices.	48	32
3.	Connect with farming communities and groups on Facebook to stay updated with the latest trends, technologies, and discussions in the agricultural sector.	56	24
4.	Follow agricultural news and updates on Twitter, keeping yourself informed about industry developments, market trends, and new agricultural technologies.	54	26
5.	Using e-mails for professional communication related to farming.	56	24
6.	Utilize video conferencing to attend virtual meetings and conferences related to agriculture.	58	22
7.	Seek assistance and guidance from the Kisan helpline when facing farming challenges.	54	26
	Mean awareness level score of social media usage	54.0	26.0
iii. Print Technology Usage			
1.	Research bulletins to stay informed about the latest ICT developments in agriculture.	46	34
2.	Newspapers to learn about how other farmers are using ICT in their farming practices.	48	32
3.	Agricultural magazines to stay updated on the latest ICT tools and technologies for farming.	52	28
4.	Posters in farm office that illustrate how ICT can be used to improve crop production.	54	26
5.	Agricultural journals to understand the impact of ICT adoption on crop yields and farm efficiency.	46	34
6.	Annual reports from agricultural organizations to learn about successful ICT adoption stories in farming.	42	38
	Mean awareness level score of print technology usage	48.0	32.0
II. Technological Understanding of ICT			
1.	Easily browse agricultural information on the internet without assistance.	46	34
2.	Effectively use computers to manage my farm operations.	42	38
3.	Rely on online platforms for agricultural input purchases and electronic payments.	38	42
4.	Understand the distinction between agricultural hardware and software applications.	36	44
5.	Mobile apps to access agricultural information and services.	42	38
6.	Regularly update farming practices based on information from digital sources.	42	38

7.	Online forums and discussions related to agriculture.	40	40
8.	Training programs or workshops on using ICT in agriculture.	38	42
9.	Integrated ICT tools into crop management practices.	42	38
10.	New ICT solutions to improve farming efficiency.	44	36
11.	Cloud computing services for farm data storage and management.	38	42
12.	GPS technology for precision farming activities.	36	44
13.	Farmers using online platforms or social media groups.	34	46
14.	Agricultural influencers or experts on social media for farming tips and advice.	46	34
15.	Digital mapping tools for farm planning and monitoring.	42	38
	Mean awareness level score of technological understanding of ICT	40.4	39.6
	III. ICT Usage in Agriculture		
1.	About modern farming technologies and how they can benefit farm.	42	38
2.	Experimenting with new farming methods to enhance the productivity and sustainability of farm.	44	36
3.	Computers to manage various aspects of farm business, such as record-keeping, inventory management, and financial analysis.	46	34
4.	Search for information on new agricultural products and technologies to stay updated with the latest advancements in the field.	44	36
5.	Use specialized software and applications, such as farm management software, weather forecasting tools, and crop monitoring apps.	44	36
6.	Internet access is essential for managing farm operations, as it allows to access information, communicate with suppliers and customers, and monitor farm remotely.	42	38
7.	Access to the necessary resources, including technology and knowledge, to use precision agriculture technologies on farm.	41	39
8.	Soil sensors and remote sensing technologies on farm to monitor soil moisture, nutrient levels, and crop health, allowing for more precise and efficient farming practices.	42	38
9.	Internet subscription for farm's needs, ensuring reliable and high-speed internet connectivity for my farm operations.	42	38
	Mean awareness score of ICT usage in agriculture	43.0	37.0
	IV. Impact of ICT in Agriculture		
1.	Use of Geographic Information Systems (GIS) in agricultural mapping and analysis.	46	34
2.	Potential of unmanned aerial vehicles (UAVs) or drones for crop monitoring and management.	48	32
3.	Artificial intelligence (AI) and machine learning algorithms in optimizing agricultural processes and decision-making.	46	34
4.	Mobile payment systems and their use in facilitating financial transactions within agricultural value chains.	44	36
5.	Potential of virtual reality (VR) and augmented reality (AR) technologies in agricultural training and simulation applications.	48	32
6.	Use digital databases to store and manage information about crops and livestock.	46	36
7.	Internet of Things (IoT) and big data analytics can be used in agriculture to optimize farming practices and improve decision-making.	44	36
8.	Concept of smart farming and its integration of ICT for optimized farm management.	42	38
9.	Precision livestock farming technologies, such as wearable sensors for monitoring animal health and behaviour.	44	36
10.	ICT in promoting climate-smart agriculture practices, such as conservation agriculture and agroforestry.	46	34
11.	Mobile-based market information systems for accessing market prices and trends.	48	32
12.	ICT in promoting sustainable agriculture practices, such as organic farming and integrated pest management.	48	32
13.	Agricultural robotics and its applications in tasks such as planting, spraying, and monitoring.	52	28
14.	ICT in promoting traceability and transparency in agricultural supply chains.	48	32
15.	ICT in promoting gender equality in agriculture through access to information and market opportunities.	46	34
16.	Sustainable water management practices in agriculture, such as precision irrigation.	48	32
17.	Digital soil mapping and its applications in soil fertility management.	46	34
18.	Finance solutions for smallholder farmers, such as mobile banking and digital loans.	48	32
19.	Climate resilience in agriculture through early warning systems and climate information services.	52	28
20.	ICT in promoting sustainable energy solutions for agriculture, such as solar-powered irrigation systems.	50	30
21.	ICT in promoting agricultural insurance schemes for risk management in farming.	50	30
	Mean Awareness level score of ICT for crop production by the respondents	46.09	33.91
	Awareness level of ICT for crop production by the respondents (%)	57.61	42.38

The research aimed to assess the awareness and adoption of various Information and Communication Technology (ICT) tools in agriculture among respondents. The data was collected across multiple dimensions, including smart device usage, social media engagement, print technology usage, technological understanding, ICT application in agriculture, and the perceived impact of ICT on agricultural practices, as presented in Table 1. The awareness and adoption of smart devices, such as smartphones, laptops, desktop computers, and tablets, were evaluated. The study revealed the mean awareness level for smart device usage was 59.0%, suggesting a moderately high level of familiarity and integration of these tools among the respondents. Specifically, the highest level of awareness (68.00%) was observed in the use of mobile phones for crop monitoring and online access to information. Conversely, the use of desktop computers for complex farming tasks showed a slightly lower awareness (56.00%) among the respondents.

Social media platforms were widely used, with a mean

awareness level of 54.00%. WhatsApp was the most widely used platform, with 52.00% of farmers using it for real-time communication and information sharing. Other platforms like Facebook and Instagram also showed significant usage. Print technologies, such as research bulletins, newspapers, and agricultural magazines, showed a medium level of awareness (48.00%). Agricultural journals and annual reports exhibited the lowest awareness scores, 46.00% and 42.00%, respectively. The respondents' understanding of ICT in agriculture, including online browsing of agricultural information and using computers for farm management, showed a mean awareness level of 40.40%, indicating moderate technological literacy. In this category, lower scores were seen for online forums, cloud computing, and GPS technology, with awareness ranging from 34.00% to 42.00%.

The use of ICT in agriculture showed a mean awareness level of 43.00%. Computers were used by 46.00% of farmers for farm business management, while 44.00% of farmers used them to search for new agricultural products and technologies. However, the adoption of precision agriculture technologies like soil sensors and remote sensing showed lower awareness (41.00%-42.00%). There was substantial awareness of modern technologies like Geographic Information Systems (GIS) (46.00%), drones (48.00%), and artificial intelligence (AI) (46.00%). Sustainable practices, such as climate-smart agriculture and ICT-driven sustainable energy solutions, also scored relatively high (48.00% to 50.00%). The overall awareness level of ICT for crop production was reported at 57.61%.

Table 2: Farmers' adoption level of ICT for crop production (n=80)

SI. No.	Statements	Adoption	
		Adopted	Not adopted
I.	**Various ICT tools in Agriculture**		
i.	**Smart Device Usage**		
1.	Smart Phone for various farming activities, such as monitoring crops and accessing agricultural information online.	60	20
2.	Laptop is essential for managing my farm's data and using agricultural software for planning and analysis.	50	30
3.	Desktop computer for more complex farming tasks, like creating detailed farm management plans and analyzing large datasets.	52	28
4.	Tablet for quick access to farm records and for monitoring real-time data, such as weather forecasts and soil conditions.	56	24
	Average adoption score of smart device usage	54.50	25.50
ii.	**Social Media Usage**		
1.	WhatsApp to communicate with other farmers and exchange information about farming practices and innovations.	50	30
2.	Updates about farm and farming activities on Instagram, showcasing the progress and challenges in agricultural practices.	44	36
3.	Connect with farming communities and groups on Face book to stay updated with the latest trends, technologies, and discussions in the agricultural sector.	52	28
4.	Follow agricultural news and updates on Twitter, keeping yourself informed about industry developments, market trends, and new agricultural technologies.	50	30
5.	Using e-mails for professional communication related to farming.	51	29
6.	Utilize video conferencing to attend virtual meetings and conferences related to agriculture.	52	28
7.	Seek assistance and guidance from the Kisan helpline when facing farming challenges.	49	31
	Average adoption score of social media usage	49.71	30.28
iii.	**Print Technology Usage**		
1.	Research bulletins to stay informed about the latest ICT developments in agriculture.	42	38
2.	Newspapers to learn about how other farmers are using ICT in their farming practices.	46	34
3.	Agricultural magazines to stay updated on the latest ICT tools and technologies for farming.	48	32
4.	Posters in farm office that illustrate how ICT can be used to improve crop production.	49	31
5.	Agricultural journals to understand the impact of ICT adoption on crop yields and farm efficiency.	40	40
6.	Annual reports from agricultural organizations to learn about successful ICT adoption stories in farming.	38	42
	Average adoption score of print technology usage	43.83	36.17
II.	**Technological Understanding of ICT**		
1.	Easily browse agricultural information on the internet without assistance.	42	38
2.	Effectively use computers to manage my farm operations.	38	42
3.	Rely on online platforms for agricultural input purchases and electronic payments.	34	46
4.	Understand the distinction between agricultural hardware and software applications.	31	49
5.	Mobile apps to access agricultural information and services.	38	42
6.	Regularly update farming practices based on information from digital sources.	40	40
7.	Online forums and discussions related to agriculture.	38	42
8.	Training programs or workshops on using ICT in agriculture.	36	44
9.	Integrated ICT tools into crop management practices.	39	41
10.	New ICT solutions to improve farming efficiency.	38	42
11.	Cloud computing services for farm data storage and management.	34	46
12.	GPS technology for precision farming activities.	32	48
13.	Farmers using online platforms or social media groups.	30	50
14.	Agricultural influencers or experts on social media for farming tips and advice.	38	42

15.	Digital mapping tools for farm planning and monitoring.	39	41
Average adoption score of technological understanding of ICT		36.47	43.53
III. ICT Usage in Agriculture			
1.	About modern farming technologies and how they can benefit farm.	38	42
2.	Experimenting with new farming methods to enhance the productivity and sustainability of farm.	36	44
3.	Computers to manage various aspects of farm business, such as record-keeping, inventory management, and financial analysis.	40	40
4.	Search for information on new agricultural products and technologies to stay updated with the latest advancements in the field.	38	42
5.	Use specialized software and applications, such as farm management software, weather forecasting tools, and crop monitoring apps.	39	41
6.	Internet access is essential for managing farm operations, as it allows to access information, communicate with suppliers and customers, and monitor farm remotely.	36	44
7.	Access to the necessary resources, including technology and knowledge, to use precision agriculture technologies on farm.	39	41
8.	Soil sensors and remote sensing technologies on farm to monitor soil moisture, nutrient levels, and crop health, allowing for more precise and efficient farming practices.	40	40
9.	Internet subscription for farm's needs, ensuring reliable and high-speed internet connectivity for my farm operations.	40	40
Average adoption score of technological understanding of ICT		36.47	43.53
IV. Impact of ICT in Agriculture			
1.	Use of Geographic Information Systems (GIS) in agricultural mapping and analysis.	34	46
2.	Potential of unmanned aerial vehicles (UAVs) or drones for crop monitoring and management.	40	40
3.	Artificial intelligence (AI) and machine learning algorithms in optimizing agricultural processes and decision-making.	34	46
4.	Mobile payment systems and their use in facilitating financial transactions within agricultural value chains.	36	44
5.	Potential of virtual reality (VR) and augmented reality (AR) technologies in agricultural training and simulation applications.	36	44
6.	Use digital databases to store and manage information about crops and livestock.	36	44
7.	Internet of Things (IoT) and big data analytics can be used in agriculture to optimize farming practices and improve decision-making.	38	42
8.	Concept of smart farming and its integration of ICT for optimized farm management.	38	42
9.	Precision livestock farming technologies, such as wearable sensors for monitoring animal health and behaviour.	42	38
10.	ICT in promoting climate-smart agriculture practices, such as conservation agriculture and agroforestry.	34	46
11.	Mobile-based market information systems for accessing market prices and trends.	34	46
12.	ICT in promoting sustainable agriculture practices, such as organic farming and integrated pest management.	35	45
13.	Agricultural robotics and its applications in tasks such as planting, spraying, and monitoring.	35	45
14.	ICT in promoting traceability and transparency in agricultural supply chains.	38	42
15.	ICT in promoting gender equality in agriculture through access to information and market opportunities.	36	44
16.	Sustainable water management practices in agriculture, such as precision irrigation.	34	46
17.	Digital soil mapping and its applications in soil fertility management.	32	48
18.	Finance solutions for smallholder farmers, such as mobile banking and digital loans.	38	42
19.	Climate resilience in agriculture through early warning systems and climate information services.	40	40
20.	ICT in promoting sustainable energy solutions for agriculture, such as solar-powered irrigation systems.	55	25
21.	ICT in promoting agricultural insurance schemes for risk management in farming.	52	28
Mean adoption level score of ICT for crop production by the respondents		40.61	39.39
Adoption level of ICT for crop production by the respondents (%)		50.77	49.23

The data provided in Table 2 offers an insightful analysis of how extensively farmers are incorporating smart devices, social media, print technology, and other ICT tools in their operations. Mobile phones were the most adopted, with 75.00 per cent of respondents utilizing them for various farming operations, including crop monitoring and online access to agricultural data. Following closely were laptops (62.50%), desktop computers (65.00%), and tablets (70.00%). With an average adoption score of 54.50, smart devices showed a relatively high degree of integration with agricultural methods. In terms of social media usage, Facebook (65.00%) and WhatsApp (62.50%) had the highest adoption rates, while platforms like Instagram (55.00%) and Twitter (62.50%) showed comparatively lower rates of adoption. Print technologies, on the other hand, had a lower average adoption score of 43.83. Agricultural journals (50.00%), annual reports (47.50%), and research bulletins (52.50%) had lower adoption rates, while newspapers (53.50%) and agricultural magazines (60.00%) were more widely used.

The respondents exhibited a lower level of technological knowledge of ICT, with an average adoption score of 36.47. Specific areas like using computers for managing farms (38.00%), online purchasing of farm supplies (34.00%), and incorporating ICT tools into crop management (39.00%) had relatively low adoption rates. Computers (40.00%) and farm management apps (39.00%) were the most widely used tools for managing agricultural operations. Furthermore, 36.00 per cent of respondents used the internet for agricultural management, while 39.00 per cent had access to precision agriculture resources. Advanced ICT tools such as Geographic Information Systems (GIS), unmanned aerial vehicles (UAVs), artificial intelligence (AI), and the Internet of Things (IoT) were adopted at varying rates, with an

average score of 37.95. Drones were the most commonly adopted (40.00%), followed by AI (34.00%). Virtual reality (36.00%) and precision livestock farming (42.00%) had lower adoption rates.

The mean adoption level score of ICT for crop production among respondents was 40.61, with a 50.77 per cent adoption rate. This indicates that more than half of the respondents had incorporated ICT tools into their agricultural operations.

Discussion

The findings indicate that farmers have a moderately high level of awareness of Information and Communication Technology (ICT) tools in agriculture, especially mobile phones. Mobile phones, recognized by 68.00% of respondents, play a vital role in modern farming. This high level of awareness is consistent with earlier studies by Shehrawat *et al*., 2024 [19]; Bahubalendra & Mohapatra (2024) [2] and Patel & Mallappa (2022) [13]. Farmers' preference for portable devices such as smartphones, tablets, and laptops over desktop computers suggests the increasing need for mobility in farming activities. Sahil & Bishnoi (2023) [16] note that desktop computers are less practical for fieldwork due to their stationary nature and higher costs, which explains the relatively lower awareness of desktop usage at 56.00%.

Social media, particularly WhatsApp, is widely used for information sharing, with 52.00% of farmers using it for real-time communication and knowledge dissemination. Platforms like Facebook and Instagram are also popular for community building and staying updated on agricultural trends. However, traditional media, such as print technologies, shows moderate awareness at 48.00%, reflecting a shift towards digital platforms. Agricultural journals and reports, with awareness levels of 46.00% and 42.00%, respectively, are less popular, as digital sources are often preferred for their convenience and accessibility. The moderate awareness of ICT applications (40.40%) underscores the need for more training in digital literacy. Furthermore, awareness of advanced technologies like online forums, cloud computing, and GPS remains low, ranging between 34.00% and 42.00%. This highlights the importance of capacity-building programs in these critical areas, as noted by Praneeth *et al*. (2023) [14]. Precision agriculture tools, such as soil sensors and remote sensing, also show relatively low adoption (41.00%-42.00%), likely due to their cost, complexity, and lack of sufficient training.

Despite these challenges, there is growing interest in technologies like GIS, drones, and AI, with 46.00%-48.00% of farmers indicating awareness. Additionally, 48.00%-50.00% of respondents are aware of sustainable practices such as climate-smart agriculture, suggesting increasing attention to environmental sustainability. Overall, while 57.61% of farmers are aware of ICT tools in crop production, the findings highlight a gap between awareness and the actual adoption of advanced technologies. To overcome these, financial assistance or subsidies should be considered to make ICT tools more accessible, as suggested by Singh *et al*. (2015) [22] and Pant & Singh (2014) [12].

Mobile phones remain the most popular ICT tool due to their flexibility, affordability, and the availability of farming apps, making them essential for various agricultural tasks. Laptops, desktop computers, and tablets show lower adoption rates, likely due to their higher cost, complexity, and perceived lack of utility compared to smartphones. Social media platforms, particularly Facebook and WhatsApp, play a crucial role in fostering communication within farming communities. However, platforms like Instagram and Twitter have lower adoption rates, possibly because farmers perceive them as offering less practical value for farming. The preference for digital content over print reflects a trend toward more accessible and up-to-date information. However, print remains useful for farmers with limited internet access or those who prefer traditional information sources.

The low technological knowledge score (36.47) suggests that farmers struggle to fully utilize ICT tools, especially for tasks like farm management and online procurement aligns with the findings of Satapathy *et al*. (2024) [18], Princy & Makkar (2022) [15], and Niranjan *et al*. (2023) [11]. This gap could limit ICT's potential in agriculture unless addressed through targeted training programs. Although awareness of advanced tools like GIS, UAVs, AI, and IoT exists, their low adoption indicates barriers such as cost and complexity. As previous studies (Khodifad & Solanki, 2023; Singh *et al*., 2023; Kumar *et al*., 2023) [6, 20, 8] suggest, further education and access to these technologies are crucial for broader adoption.

Conclusion

The study finds that farmers' awareness of ICT advantages in agriculture is moderate. While many understand the benefits, knowledge gaps remain, particularly about specific tools and government programs promoting ICT adoption. Tailored awareness campaigns with practical examples are essential to bridge this gap. Despite growing awareness, ICT adoption remains low due to high costs, limited technical knowledge, and concerns over risks. To boost adoption, policymakers should consider offering financial incentives, localized training programs, and support networks. Addressing fundamental constraints such as inadequate infrastructure and data privacy concerns is crucial. A collaborative effort between policymakers, extension services, and stakeholders can create an environment conducive to widespread ICT adoption in agriculture.

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