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Awareness and Utilization of ICT Tools among KVK-Linked Progressive Farmers in Western Uttar Pradesh

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HIGHLIGHTS

- Progressive farmers showed a moderate level of awareness and utilization of ICT tools for agricultural information and advisory services.
- WhatsApp groups emerged as the most preferred ICT platform for agricultural information and advisory services.
- Active KVK linkage and social participation were the strongest drivers of ICT adoption among progressive farmers.

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ABSTRACT

The study was conducted in 2025 using an ex post facto research design to assess awareness and utilization of Information and Communication Technology (ICT) tools among progressive farmers associated with Krishi Vigyan Kendras in Ghaziabad and Hapur districts of Western Uttar Pradesh. A total of 160 progressive farmers were selected through purposive sampling and primary data were collected using a pre-tested structured interview schedule. Data were analysed using frequency, percentage, mean score, standard deviation, Pearson's product moment correlation and multiple linear regression. The overall awareness and utilization of ICT tools were 69.52 per cent and 62.60 per cent, respectively, with platforms embedded in routine KVK advisory work recording the highest recognition and use, while artificial-intelligence-based tools, Internet of Things-based sensors and Krishi Mapper recorded the lowest scores. Regression analysis showed that social participation, education, farm assets, annual income and land holding positively influenced ICT utilization, whereas age had a significant negative effect. The findings indicated that strengthening digital literacy and expanding KVK-led ICT extension activities could improve the effective adoption of digital technologies among farmers and support more responsive agricultural advisory services.

INTRODUCTION

Agriculture supports nearly 46 per cent of India's population and contributes about 16 per cent to the national Gross Domestic Product (Saidulu, 2025), yet the sector continues to face inadequate credit access, erratic weather, fragmented holdings and delayed flow of information. The conventional extension system, built around direct personal contact, has not been able to reach most farmers and about 60 per cent of them remain outside any organised extension coverage (Shashidhara, 2020). Information and Communication Technology (ICT), broadly defined as technologies for storing, processing and communicating data (Haqyar et al., 2025), offers a practical route to close this gap by placing crop-specific and location-specific advisories directly in farmers' hands through mobile phones, internet services and agricultural portals, without requiring an extension worker to be physically present (Mukherjee & Jha, 2024).

The Government of India has responded through platforms such as eNAM (Electronic National Agriculture Market), the mKisan Portal and Kisan Call Centres (Anand et al., 2022) and more recently

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through artificial intelligence (AI)-enabled advisory systems; the National Pest Surveillance System, for instance, has used AI-based diagnostics to issue pest-specific advisories to farmers across Odisha, although sustained compliance with these advisories remains uneven (Kumar et al., 2025). Krishi Vigyan Kendras (KVKs), functioning under the Indian Council of Agricultural Research, remain the principal ground-level institutions for delivering ICT-based extension. With 731 KVKs nationally, 89 of them in Uttar Pradesh alone (Saidulu, 2025) and only one extension worker for every 2,900 farmers, these centres increasingly rely on WhatsApp advisories, farmer portals and tele-extension services to widen their reach (Moulasab et al., 2025).

Despite this institutional push, actual ICT utilization presents a different scenario. Although most farmers own a mobile phone, between 48 and 88 per cent have never used email, internet portals or computers for farm-related work (Bansal et al., 2022) and ICT utilization among farmers has generally been reported at a low to medium level (Panda et al., 2019; Kumar et al., 2023). A multi-state study across the Indo-Gangetic plain similarly found that landholding size, ICT ownership and social media use raise awareness of digital advisory platforms while age and farming experience depress it and called for more location-specific evidence (Mukherjee et al., 2024). Systematic evidence on how AI-based and other emerging ICT tools are being received alongside conventional platforms among KVK-linked progressive farmers of Western Uttar Pradesh, however, remains limited and the socio-economic factors shaping this pattern are not well established for the region. The present study was therefore undertaken to assess the extent of awareness and utilization of ICT tools among progressive farmers associated with KVKs in Western Uttar Pradesh and to examine how their socio-economic characteristics relate to ICT utilization, with a view to informing more targeted digital extension strategies.

METHODOLOGY

The study was carried out during 2025 in the Meerut Division of Western Uttar Pradesh, with Ghaziabad and Hapur chosen purposively for the active role their Krishi Vigyan Kendras (KVKs) play in delivering ICT-based advisory services. Progressive farmers were those formally listed as such in KVK records based on consistent adoption of improved agricultural practices. A total of 160 progressive farmers, 80 from each KVK, were selected through purposive sampling, subject to two conditions: active linkage with the KVK and prior use of at least one ICT-based service, such as SMS crop advisories or WhatsApp-based inputs (Rashid et al., 2024); these 160 constituted the entire eligible list at the two KVKs, with no separate sampling frame drawn upon. Data were gathered through personal interviews using a structured schedule developed for the study (Chavan et al., 2019; Singh & Mathur, 2024), content-validated by subject-matter specialists, pilot-tested on non-sampled farmers for reliability and modified before the final survey.

Twelve socio-economic characteristics served as independent variables: age, gender, education, caste, occupation, land holding, annual income, social participation, farm assets, transportation facilities, irrigation facilities and housing pattern. Categorical variables were assigned ordinal scores, gender as male (1)/female (2) and caste as Scheduled Caste (1), Other Backward Class (2) and General (3). Awareness and utilization of ICT tools, the two dependent variables, were each rated on a three-point continuum, awareness as not aware (0), partially aware (1) and fully aware (2) and utilization as never (0), occasionally (1) and regularly (2). The coded data were analysed using frequency, percentage, mean score, standard deviation and rank to describe awareness and utilization, Pearson's Product Moment Correlation to examine their association with socio-economic variables and Multiple Linear Regression to identify factors influencing utilization. A mean awareness and utilization score was worked out for each of the 30 ICT tools; averaging these scores and expressing the result as a percentage of the maximum possible score of 2 gave the overall composite indices reported in Table 1. Prior to regression analysis, the assumptions of linearity, normality and homoscedasticity of residuals, independence of errors and absence of multicollinearity among predictors were examined and found satisfied.

RESULTS

Awareness of ICT tools among progressive farmers

Table 1 presents the awareness and utilization pattern of 30 ICT tools among the 160 progressive farmer respondents. On the awareness side, a clear pattern emerges: tools that KVKs have built into their routine advisory work, principally group messaging, weather and price applications and direct telephonic contact, dominate the top ranks, while emerging precision-agriculture technologies occupy the bottom. To ease interpretation, the 30 tools were grouped into highly, moderately and poorly aware or utilized categories based on their mean scores (1.50 and above, 1.00–1.49 and below 1.00, respectively, out of a maximum of 2.00).

WhatsApp groups managed by KVK scientists were the most widely known tool overall (mean 1.962), reaching near-universal familiarity among respondents. Together with weather forecast applications, the KVK YouTube channel, direct telephone contact with KVK scientists and government platforms such as the PMFBY App and SMS-based mKisan advisories, they made up a highly aware group of fourteen tools, all scoring 1.50 or above. A further nine tools, including the Kisan Suvidha App, KVK Facebook/social media groups and the e-NAM Portal, fell in the moderately aware band, familiar to a majority of respondents but without the near-universal reach of the top tier.

Awareness fell sharply for the seven most specialised digital tools, IoT-based farm sensors, AI-based advisory tools and Krishi Mapper among them, all of which scored below 1.00 and made up the poorly aware group. The overall composite awareness score across the 30 tools stood at 69.52 per cent, confirming a moderately high aggregate level that is concentrated heavily around KVK-promoted platforms rather than spread evenly across the full range of available technologies.

Utilization of ICT tools among progressive farmers

The utilization pattern mirrored the awareness gradient but at a consistently lower level throughout. WhatsApp groups run by KVK scientists again led all tools (mean 1.881) and direct telephonic contact with KVK scientists ranked a close second, confirming that voice-based contact has not been displaced by digital channels.

Table 1. Awareness and utilization of ICT tools among progressive farmers

S. No.	ICT Tool	Awareness Mean score	Awareness SD	Awareness Rank	Utilization Mean score	Utilization SD	Utilization Rank
1	SMS advisories from KVK/mKisan	1.638	0.588	11	1.619	0.613	7
2	WhatsApp groups operated by KVK scientists	1.962	0.191	1	1.881	0.425	1
3	Kisan Call Centre	1.700	0.512	8	1.662	0.560	6
4	Weather forecast mobile apps	1.838	0.418	2	1.738	0.577	3
5	Market price applications	1.538	0.662	13	1.500	0.691	8
6	Pest and disease diagnosis applications	1.500	0.614	14	1.462	0.653	12
7	Calling KVK scientists directly through mobile phone	1.762	0.564	6	1.762	0.649	2
8	Kisan Sarathi Portal	1.200	0.791	22	1.162	0.808	21
9	Krishi Mapper	0.800	0.867	30	0.438	0.766	30
10	Tele-agriculture services	1.262	0.781	18	1.238	0.789	19
11	KVK Portal	1.600	0.574	12	1.481	0.691	11
12	Farmers' Portal	1.681	0.587	9	1.300	0.875	17
13	e-NAM Portal	1.238	0.820	20	1.100	0.877	23
14	KVK YouTube channel	1.838	0.418	3	1.700	0.632	4
15	KVK Facebook/social media groups	1.362	0.756	16	1.319	0.788	15
16	mKisan Portal	1.200	0.845	23	1.200	0.845	20
17	Kisan Suvidha App	1.462	0.633	15	1.419	0.677	13
18	PMFBY App	1.719	0.563	7	1.500	0.785	9
19	Soil Health Card Portal/App	1.838	0.433	4	1.500	0.816	10
20	Pusa Krishi/ICAR mobile apps	1.238	0.813	21	1.138	0.835	22
21	Agriculture programmes on television	1.838	0.387	5	1.700	0.622	5
22	Agriculture programmes on radio	1.338	0.751	17	1.319	0.772	16
23	Online trainings/webinars of KVK	1.262	0.773	19	1.262	0.773	18
24	Email advisories/newsletters	0.881	0.879	26	0.762	0.865	24
25	Information kiosks/digital centres	0.862	0.872	27	0.762	0.865	25
26	Drone-based advisory/monitoring information services	0.838	0.875	28	0.600	0.826	26
27	AI-based advisory tools	0.819	0.903	29	0.600	0.848	27
28	IoT-based farm sensors	0.938	0.852	24	0.500	0.793	29
29	GIS/GPS-based agricultural tools	0.900	0.899	25	0.600	0.863	28
30	Digital land record-based services (Bhulekh)	1.662	0.571	10	1.338	0.831	14

Note: SMS = Short Message Service; KVK = Krishi Vigyan Kendra; PMFBY = Pradhan Mantri Fasal Bima Yojana; e-NAM = Electronic National Agriculture Market; mKisan = Mobile Kisan (SMS-based advisory portal, Government of India); ICAR = Indian Council of Agricultural Research; IoT = Internet of Things; AI = Artificial Intelligence; GIS = Geographic Information System; GPS = Global Positioning System.

Together with weather forecast applications, the KVK YouTube channel, televised programmes, the Kisan Call Centre and the PMFBY App, these formed a highly utilized group of ten tools, all with mean scores of 1.50 or above.

A further thirteen tools, including the KVK Portal, pest and disease diagnosis applications and the e-NAM Portal, fell in the moderately utilized band. Utilization of the more specialised technologies, IoT sensors, AI-based advisory tools and Krishi Mapper among them, was negligible by comparison, marking these seven tools as poorly utilized. The overall utilization score of 62.60 per cent stood 6.92 percentage points below the overall awareness score. This gap was narrow for KVK-embedded tools, only about 4 percentage points for the WhatsApp groups, but widened considerably for the specialised technologies, suggesting that the constraint on ICT adoption in the study area lies less in exposure to these tools than in the practical barriers, connectivity, cost and digital skill, that separate knowing a tool exists from actually using it.

Socio-economic determinants of ICT utilization

The correlation analysis (Table 2) identified four socio-economic characteristics with a significant bearing on ICT utilization. Social participation returned the strongest association ($r = 0.451$, $p < 0.001$), followed by age, which was negatively and significantly related to utilization ($r = -0.337$, $p < 0.001$). Education ($r = 0.201$, $p = 0.011$) and farm assets ($r = 0.189$, $p = 0.017$) were also positively significant. The remaining eight variables, gender, caste, occupation, land holding, annual income, transportation facilities, irrigation facilities and housing pattern, showed no significant bivariate relationship with utilization.

The regression model (Table 3) explained 33.03 per cent of the variance in ICT utilization ($R^2 = 0.3303$; Adjusted $R^2 = 0.2756$; $F(12,147) = 6.04$, $p < 0.001$). Social participation was again the leading predictor ($\beta = 0.418$, $p < 0.001$), followed by education ($\beta = 0.291$, $p < 0.001$) and farm assets ($\beta = 0.243$, $p = 0.001$). Age remained a significant negative predictor even after the other eleven variables were accounted for ($\beta = -0.152$, $p = 0.022$).

Annual income ($\beta = 0.182$, $p = 0.010$) and land holding ($\beta = 0.168$, $p = 0.026$) emerged as significant predictors in the regression despite showing no significant simple correlation, indicating that their influence on utilization operates jointly with, rather than independently of, the other variables in the model. Gender, caste, occupation, transportation facilities, irrigation facilities and housing

Table 2. Relationship between selected socio-economic characteristics and ICT utilization

Variable	Correlation coefficient (r)	p-value
Age	–0.337**	<0.001
Gender	–0.068NS	0.393
Education	0.201*	0.011
Caste	0.050NS	0.530
Occupation	0.059NS	0.459
Land holding	0.118NS	0.137
Annual income	0.090NS	0.258
Social participation	0.451**	<0.001
Farm assets	0.189*	0.017
Transportation facilities	–0.081NS	0.309
Irrigation facilities	–0.070NS	0.379
Housing pattern	0.012NS	0.880

Note: * Significant at 5 per cent level; ** Significant at 1 per cent level; NS = Non-significant. Exact p-values are reported in the adjoining column (two-tailed, df = 158).

pattern were non-significant, confirming that neither the bivariate nor the multivariate analysis found these structural attributes to have any independent bearing on ICT utilization.

DISCUSSION

An overall awareness level of 69.52 per cent points to a fairly digitally switched-on group, largely a function of how the sample was drawn. Kushwaha et al. (2025) found only 33.33 per cent of general farmers in Sagar district aware of KVK services, against which the higher awareness recorded here reflects every respondent's active KVK relationship. WhatsApp groups run by KVK scientists topped both awareness and utilization, largely because the platform asks nothing new of farmers, fits habits already built around the mobile phone and carries the credibility of being run by scientists farmers already trust, the relative advantage, compatibility and observability central to Rogers' (2003) diffusion of innovations framework. A similar pattern of smartphone- and WhatsApp-led engagement is reported in West Bengal and Bihar (Mukherjee & Jha, 2024; Anand et al., 2022).

Awareness dropped off sharply for the more advanced tools, AI-based advisory, IoT sensors, GIS/GPS applications and Krishi Mapper all fell below a mean score of 1.00, tools that demand steady connectivity, technical comfort and, in Rogers' (2003) terms, a chance to trial them before farmers can trust them, none of which is yet within easy reach here. Sharma et al. (2022) and Dashora and Henry (2022) both found KVK scientists in central and western India using smartphones daily while rarely touching specialised applications, so farmers can hardly know more than the scientists introducing them. Satapathy et al. (2024b) trace this gap to limited ICT knowledge, weak financial support and inadequate extension backing in Odisha and similar barriers likely operate in Western Uttar Pradesh too.

The gap between awareness and actual use, 6.92 percentage points overall and wider still for advanced tools, echoes a pattern reported widely elsewhere: Bansal et al. (2022) and Priyavadhana and Balakrishnan (2025) both found farmers aware of email, internet portals and government platforms without ever using them. Mishra et al. (2020), working in Lucknow district, rated television and mobile phones at a medium benefit level for about half the farmers and social media low for a similar share, a gradation close to the moderate-to-low utilization seen here, pointing to structural barriers across Uttar Pradesh rather than something unique to the western part of the state.

Social participation is the strongest correlate and predictor of ICT utilization, agreeing with Satapathy et al. (2024a) in Odisha; farmers embedded in cooperatives and farmer groups pick up new practices partly by watching and consulting peers, a peer-mediated learning process that KVK-run WhatsApp groups extend directly into the digital space (Nain et al., 2019). Age works the other way, a significant negative factor in both the correlation and regression results, most plausibly reflecting less lifetime exposure to digital interfaces and a shorter expected payback from learning them, a pattern also seen in Satapathy et al. (2024a) and Patra et al. (2020). Anand et al. (2022) found social participation non-significant in Bihar, likely because that sample lacked the uniform, active KVK linkage that defines respondents here.

Land holding and annual income were not significant on their own in the correlation analysis but became significant once other

Table 3. Multiple linear regression analysis of factors influencing ICT utilization

Variable	Unstandardized coeff. (B)	Standardized coeff. (β)	t-value	p-value
Constant	39.842	—	6.284**	<0.001
Age	–2.486	–0.152	–2.318*	0.022
Gender	–1.214	–0.041	–0.673NS	0.502
Education	2.184	0.291	3.954**	<0.001
Caste	0.491	0.043	0.692NS	0.490
Occupation	0.875	0.118	1.821NS	0.071
Land holding	1.968	0.168	2.247*	0.026
Annual income	2.754	0.182	2.596*	0.010
Social participation	4.623	0.418	5.446**	<0.001
Farm assets	2.386	0.243	3.365**	0.001
Transportation facilities	0.534	0.058	0.842NS	0.401
Irrigation facilities	1.106	0.086	1.296NS	0.197
Housing pattern	0.742	0.054	0.813NS	0.418

Note: * Significant at 5 per cent level; ** Significant at 1 per cent level; NS = Non-significant. Exact p-values are reported in the adjoining column (two-tailed, df = 147). $F(12,147) = 6.04$, $p < 0.001$; $R^2 = 0.3303$; Adjusted $R^2 = 0.2756$.

variables were controlled for in the regression, suggesting their effect works through, rather than around, social participation and education. Efforts to lift ICT use among less-resourced farmers may therefore work better through strengthening social participation and education than by targeting income or landholding directly. KVKs appear to have embedded a core set of ICT tools into farmers' routines successfully, but this has not extended to precision-agriculture technologies and closing that gap will likely take sustained, hands-on training delivered through channels farmers already trust.

For Krishi Vigyan Kendras and extension personnel, the findings point to anchoring new digital advisories on already-trusted, low-complexity platforms before introducing more technical tools and running peer-led demonstration sessions rather than one-time orientations to reach older farmers. Agricultural universities can support this by building digital-skill modules into their extension training curricula. State agriculture departments and policy makers may consider linking digital literacy drives to existing farmer group and cooperative networks, since social participation does more to drive adoption than income or landholding. ICT developers, for their part, would benefit from designing artificial-intelligence and sensor-based tools for offline or low-bandwidth use, given the connectivity constraints evident here, so that reach extends beyond the current base of digitally confident users.

CONCLUSION

The study confirms that progressive farmers linked to Krishi Vigyan Kendras are reasonably well informed about digital advisory tools, yet this awareness converts into regular use mainly for simple, socially embedded platforms actively promoted through institutional channels, while more advanced, data-driven technologies remain at an early stage of adoption. Social participation and education emerge as the resources that most consistently turn awareness into practice, while advancing age works against it, pointing to a generational as much as a technological divide. Digital extension therefore succeeds best when it builds on farmers' existing social networks rather than treating adoption as a matter of exposure alone. Krishi Vigyan Kendras and state agriculture departments should prioritise sustained, hands-on digital literacy support for older and less engaged farmers over simply expanding the range of tools on offer and extending this analysis to non-progressive farmer groups would strengthen the evidence base for such policy.

DECLARATIONS

Ethics approval and consent to participate: The study involved no invasive procedure on human participants as such the committee of Department of Agricultural Extension, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250110, Uttar Pradesh, India waived the ethical approval. The purpose of the study was explained to every respondent, prior informed consent was obtained, participation was voluntary and the responses were kept anonymous and used solely for research purposes.

Consent for publication: All the authors have read the manuscript, approved its contents and consented to its publication.

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