

Digital Access Awareness and Agricultural Use among Farmers in Wayanad District Kerala

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Abstract: *Digital agricultural services can improve access to information, but device ownership, service awareness and agricultural use represent distinct dimensions of participation. This study examines these dimensions among 104 surveyed farmers across three taluks of Wayanad district, Kerala. Awareness is measured as recognition of six selected services, while adoption denotes self-reported digital-tool use for farming decisions. Descriptive statistics, Poisson regression with robust standard errors and binary logistic regression examine patterns and associations. Overall, 76.0% reported awareness of at least one service and 69.2% reported agricultural digital use. Among 98 complete cases, mean awareness was 1.71 out of six. Awareness ranged from 46.2% for digital payments to 9.6% for e-NAM or online markets. Reported estimates associate smartphone ownership with awareness and adoption, larger landholdings with awareness, and age above 60 with lower adoption. Alternative specifications associate internet access with both outcomes. These cross-sectional associations do not establish causal effects or productivity gains. The findings support attention to connectivity, assisted access and practical training alongside device availability.*

Keywords: Digital agriculture; Service awareness; Digital adoption; Agricultural extension; Wayanad

1. Introduction

Digital agricultural services offer farmers additional channels for obtaining crop advice, weather information, market information and financial services. Their importance extends beyond communication infrastructure to the ways farmers obtain and apply information. Porciello et al. [1], in a systematic scoping review of services in low- and middle-income countries, show the breadth of this field while identifying gaps in evidence on environmental sustainability and climate resilience. The expansion of services therefore needs to be assessed through clearly defined measures of participation and outcomes.

In India, the Digital Agriculture Mission, approved on 2 September 2024 with an outlay of ₹2,817 crore, includes AgriStack, the Krishi Decision Support System and soil profile mapping [2]. These initiatives provide a policy context for examining farmers' engagement with digital services. The availability of infrastructure or platforms, however, does not itself establish whether farmers recognise relevant services or use them in agricultural decisions.

Access, awareness and use represent distinct dimensions of digital participation. Access concerns devices and connectivity; awareness concerns recognition of available services; and use concerns their application to farming activities. Evidence from Kenya distinguishes the factors associated with awareness and use of ICT-based market information [3], while research in South Africa shows that access to digital tools can coexist with limited agricultural use

of particular applications [4]. These distinctions are especially important when general-purpose tools and named agricultural platforms are measured within the same survey.

Participation also varies with household resources and the conditions under which services are delivered. A meta-analysis identifies age, education, gender and income as important correlates of digital agricultural technology adoption [5]. Research in Cambodia, the Philippines and Vietnam additionally highlights perceived usefulness, behavioural control and social influences [6]. Together, these studies suggest that device ownership is only one part of an explanation of digital engagement; skills, resources and institutional support may also matter.

This study examines awareness and reported digital-tool use among 104 farmers across Vythiri, Mananthavady and Sulthan Bathery taluks in Wayanad district, Kerala. It analyses recognition of six selected services separately from broader use of digital tools for farming decisions and examines their associations with age, education, landholding, community and digital access. The contribution is a local comparison of these dimensions within a sample containing substantial numbers of marginal farmers and Scheduled Tribe respondents. The analysis concerns associations within the surveyed population and does not establish causal effects or district-wide prevalence.

2. Literature Survey

2.1 Digital services and agricultural information

The literature increasingly treats digital agriculture as a collection of services with different purposes rather than a single technology. Porciello et al. [1] map research on digital services in low- and middle-income countries, including advisory and market-related applications. Their review also identifies gaps in evidence on environmental outcomes. This breadth means that findings about one service cannot automatically be generalised to all agricultural technologies. A market-information service, a payment application and a weather advisory may involve different skills, incentives and patterns of use.

Early Indian evidence by Mittal and Mehar [7] examines the contribution of mobile phones to smallholder agriculture. Their later study of 1,200 farm households in five Indo-Gangetic states identifies age, education and farm size as factors associated with information-source selection [8]. This work supports analysing digital channels within a wider information environment that also includes extension personnel and interpersonal contacts. Digital services may complement existing sources rather than replace them.

2.2 Distinguishing access awareness and agricultural use

Okello et al. [3] analyse data from 379 Kenyan smallholders using regression methods to examine awareness and use of ICT-based market information services. Their findings associate participation with transaction costs, local conditions, and human and financial capital. The distinction between awareness and use is directly relevant to the present study: recognising a service does not necessarily imply that a farmer can access it or finds it useful enough to adopt.

Olorunfemi et al. [4] investigate digital-tool access and use among 120 purposively selected farmers in Nkomazi Municipality, South Africa. The review reports agricultural use of WhatsApp by 43.3% and Facebook by 37.5%, alongside associations involving education and cosmopolitanism, or contacts beyond the immediate locality. The study illustrates the difference between access to communication tools and their agricultural application. Its purposive sample and platform-specific measures limit direct comparison with the broader use indicator employed in Wayanad.

2.3 Socioeconomic differences in digital participation

Amoussouhoui et al. [5] synthesise 52 studies covering 32,400 participants and report a pooled digital agricultural technology adoption rate of 39%. Their analysis identifies age, education, gender and income as important determinants, with greater adoption generally associated with younger age, higher income and higher educational attainment. The pooled figure summarises heterogeneous technologies and settings; it is not a directly comparable benchmark for the Wayanad survey's measure of any digital-tool use.

Drewry et al. [9] examine access and adoption among 1,021 crop, dairy and livestock producers in Wisconsin. Their

survey links differences in internet and agricultural technology use to socioeconomic and farm characteristics, including income, farm size, age and education. This evidence reinforces the value of considering resources and human capital alongside physical connectivity. However, the production systems and institutional setting differ from those of smallholders in Wayanad, so the direction and magnitude of associations require local examination.

Recent Indian studies provide more closely related evidence. Panwar and Sahoo [10], using a survey of 460 farmers in Haryana, associate awareness of digital marketing platforms with education, smartphone use, income and device access. Naik and Kumawat [11] examine farmers' perceptions of cloud-based agricultural services and discuss socioeconomic differences, affordability, digital literacy and gender-related constraints. These studies support attention to uneven participation, but their emphasis on marketing awareness or perceived benefits differs from the present study's separate measures of service recognition and reported farming-related use. Perceptions of usefulness should also be distinguished from measured improvements in productivity.

2.4 Behavioural and institutional conditions

Sen et al. [6] use a Theory of Planned Behaviour framework and structural equation modelling with 937 farmers in Cambodia, the Philippines and Vietnam. They find that perceived usefulness, perceived behavioural control and subjective norms are associated with uptake of digital extension services; household wealth and perceived risk also enter their explanation. This evidence broadens the analysis beyond device possession to farmers' evaluations of services and their perceived ability to use them. The Wayanad models do not directly test these behavioural constructs, so they serve as possible explanations and priorities for further research.

The capacity of service providers is another relevant consideration. Drewry et al. [12] survey 462 agricultural service providers and 223 extension professionals, identifying staffing, training and data-security barriers. These respondents are intermediaries, not a sample of farmers. Their findings therefore inform the institutional side of digital extension rather than farmer adoption rates. They suggest that efforts to improve participation may need to strengthen the people who deliver and explain digital services, as well as farmers' access to technology.

2.5 Adoption and agricultural outcomes

Experimental evidence helps distinguish participation from final agricultural outcomes. Cole and Fernando [13] find that a voice-based advisory service for cotton farmers in India changes information sourcing and adoption of recommended inputs, without systematic evidence of gains in yields or profitability. Singh et al. [14], studying cashew-growing communities in Andhra Pradesh, find that adding mobile communication to video-based extension improves recall, knowledge and adoption of techniques, without establishing positive production or yield effects. These results caution against interpreting a reported use rate as evidence of economic benefits.

2.6 Synthesis and research gap

Across these studies, three recurring issues emerge: access does not ensure agricultural use; socioeconomic and behavioural conditions shape participation; and participation does not necessarily establish improved farm outcomes. The evidence nevertheless varies in its definition of adoption, sampling design, technology and unit of analysis. Farmer surveys, provider surveys and experimental evaluations consequently answer different questions. Their findings motivate the choice of variables in this study but cannot be transferred mechanically to Wayanad.

The reviewed evidence leaves room for a local analysis that measures breadth of service recognition and broader digital use separately within the same surveyed population. This study addresses that question using six awareness items and a binary indicator of use for farming decisions. It examines age, education, landholding and community alongside smartphone ownership or internet access. These variables represent potential correlates, not a complete behavioural model. Because the awareness and use questions cover different domains, the analysis does not estimate a service-specific progression from awareness to adoption. Its contribution is to clarify patterns of participation and their associations in the surveyed Wayanad sample.

3. Problem Definition

The study adds a local comparison of two differently defined outcomes. Its awareness measure covers six named services or service categories, whereas its use measure includes any reported digital tool used for farming decisions. Consequently, the analysis cannot estimate a conversion rate from awareness to adoption of the same services. Doing so would require matched awareness and use questions for each service.

The central research question is: How do awareness of selected digital agricultural services and self-reported farm-related digital use vary among surveyed farmers, and how are these outcomes associated with digital access and selected socioeconomic characteristics? The study describes access, awareness and use; examines their associations with age, education, landholding and community; and considers implications for inclusive agricultural extension.

4. Methodology

4.1 Survey scope

The survey covers 104 farmers: 44 from Vythiri, 36 from Mananthavady and 24 from Sulthan Bathery. The questionnaire records demographic and farming characteristics, phone ownership, internet access, awareness of selected services and digital-tool use for farming decisions. It also includes questions on frequency of use, assistance, perceived benefits and barriers; these additional items are not analysed here because they are outside the reported analysis.

4.2 Measurement of awareness

Awareness covers Soil Health Card, Kisan Suvidha App, the PMFBY/crop insurance portal, weather advisory services, digital payments, and e-NAM/online markets. For respondent i , the awareness score is:

$$AS_i = \sum_{j=1}^6 a_{ij}, \quad a_{ij} \in \{0, 1\}$$

A value of one denotes reported awareness of service j and zero denotes a negative response. Missing or unclear answers are excluded from composite-score calculation rather than treated as lack of awareness. The score ranges from zero to six; 98 respondents have complete awareness information.

The index measures breadth of reported recognition, not depth of knowledge, digital literacy or ability to operate a platform. Its components receive equal weight, although their functions and relevance differ. Digital payments are also a general-purpose service. Awareness of Soil Health Card may refer to the scheme rather than its online interface, depending on the question wording. These features limit interpretation of the index as a measure of specifically digital agricultural capability. Service-level percentages below use all 104 respondents as their denominator and therefore represent the share explicitly reporting awareness.

4.3 Measurement of use

Adoption is operationalised as a binary indicator, D_i , equal to one when a respondent reports using any digital tool for farming decisions and zero otherwise. The term “adoption” is retained for consistency with the survey, but the measure captures self-reported use rather than sustained adoption verified over time. The indicator does not distinguish occasional from frequent use, independent from assisted use, or one service from several. Nor does it verify whether general-purpose transactions were directly connected to farming.

4.4 Explanatory variables

Variable	Coding for value 1	Reference category, value 0
AGE60	Above 60 years	60 years or below
EDU	Post-primary education	Primary education or no schooling
FARMSIZE	Holding of at least one hectare	Holding below one hectare
ST	Scheduled Tribe	Other reported community categories
SMARTPHONE	Smartphone ownership	Basic-phone category
INTERNET	Regular or occasional internet access	No internet access

Source: Author's description of variables

4.5 Statistical models and interpretation

Descriptive statistics summarise respondents' characteristics, service awareness and adoption. The reported awareness analysis uses Poisson regression with robust standard errors:

$$E(AS_i | X_i) = \exp(\beta_0 + \beta_1 AGE60_i + \beta_2 EDU_i + \beta_3 FARMSIZE_i + \beta_4 ST_i + \beta_5 SMARTPHONE_i)$$

Exponentiated coefficients are reported as incidence rate ratios (IRRs); in this application they represent ratios of expected awareness counts. An IRR above one indicates a higher expected score relative to the reference category, conditional on the included covariates.

The reported adoption analysis uses binary logistic regression:

$$\log[p_i / (1 - p_i)] = \alpha_0 + \alpha_1 AGE60_i + \alpha_2 EDU_i + \alpha_3 FARMSIZE_i + \alpha_4 ST_i + \alpha_5 SMARTPHONE_i$$

where p_i is the conditional probability of reported use. Exponentiated coefficients are odds ratios (ORs). An OR is not a probability ratio or a percentage-point change, particularly when the outcome is common. Alternative specifications replace SMARTPHONE with INTERNET; they do not estimate their mutually adjusted associations.

The awareness and adoption regressions report 97 and 103 observations, respectively. These differ from the 98 complete awareness scores and 104 survey responses. The reason for each additional exclusion must be documented from the data or estimation log.

The bounded awareness score deserves particular attention: an unrestricted Poisson model does not enforce its upper limit of six. Robust standard errors address aspects of variance misspecification, but do not correct an unsuitable mean function, omitted variables or selection bias. A sensitivity analysis using a bounded mean specification, alongside inspection of predicted values, would strengthen the analysis. This is proposed additional work, not an analysis already performed.

5. Results & Discussion

5.1 Socioeconomic characteristics and digital access

Table 1: Profile of surveyed farmers (N = 104)

Characteristic	Category	Number	Percentage
Taluk	Mananthavady	36	34.6
	Sulthan Bathery	24	23.1
	Vythiri	44	42.3
Age	Below 30	1	1.0
	30–40	5	4.8
	41–50	37	35.6
	51–60	50	48.1
	Above 60	11	10.6
Community	Scheduled Tribe	53	51.0
	Other Backward Classes	29	27.9
	Scheduled Caste	16	15.4
	General	6	5.8

Characteristic	Category	Number	Percentage
Education	No schooling/illiterate, as reported	4	3.8
	Primary	58	55.8
	Secondary	13	12.5
	Higher secondary	23	22.1
	Graduation and above	6	5.8
Landholding	Marginal	58	55.8
	Small	30	28.8
	Medium	12	11.5
	Large	4	3.8
Phone type	Smartphone	87	83.7
	Basic phone	17	16.3
Internet access	Regular	37	35.6
	Occasional	54	51.9
	No access	13	12.5

Source: Farmer survey; percentages calculated using N = 104. Totals may differ slightly from 100% because of rounding.

The sample is concentrated among farmers aged 41–60, who account for 83.7% of respondents. Scheduled Tribe respondents constitute 51.0%, while 59.6% report primary education or no schooling. Marginal and small holdings together account for 84.6%. These are characteristics of the sample and should not be taken as estimates of Wayanad's farming population.

Smartphone ownership is reported for 87 farmers, or 83.7%. Regular internet access is reported by 35.6%, occasional access by 51.9%, and no access by 12.5%. Thus, widespread device ownership coexists with less widespread regular connectivity.

5.2 Awareness of selected services

Table 2: Reported awareness of selected services (N = 104)

Service or category	Farmers reporting awareness	Percentage of all respondents
Digital payments	48	46.2
Kisan Suvidha App	37	35.6
Soil Health Card	36	34.6
Weather advisory services	27	26.0
PMFBY/crop insurance portal	17	16.3
e-NAM/online markets	10	9.6

Source: Farmer survey. Multiple responses are possible.

Digital payments have the highest reported recognition, while e-NAM/online markets have the lowest. This ordering suggests uneven familiarity across functions; it does not establish differences in usefulness or service quality. Low recognition may reflect limited exposure, limited relevance to particular crops or transactions, or farmers' unfamiliarity with the official names of services mentioned in the questionnaire.

The results identify 79 farmers (76.0%) reporting awareness of at least one service, 54 (51.9%) reporting at least two, and 31 (29.8%) reporting at least three. No respondent is reported as recognising all six. These thresholds use the full sample denominator, whereas the mean of 1.71 is calculated for 98 complete cases.

The results indicate limited breadth of recognition among the complete cases. They do not show that respondents lack

detailed knowledge of the services they recognise, since depth of knowledge was not measured by the score.

5.3 Reported use for farming decisions

Overall, 72 respondents (69.2%) report digital-tool use and 32 (30.8%) report non-use. Broader use can coexist with low recognition of particular services because the questions cover different domains.

Table 3: Reported adoption rates by selected characteristics

Group	Reported adoption rate (%)
All respondents	69.2
Smartphone category	76.7†
Basic-phone category	29.4
Regular or occasional internet access	76.7†

Group	Reported adoption rate (%)
No internet access	15.4
Age 60 or below	75.3
Age above 60	18.2
Post-primary education	83.3
Primary education or no schooling	59.7
Scheduled Tribe	67.9
Non-Scheduled Tribe	70.6

Source: Farmer survey

Adoption is descriptively higher among younger respondents and those with post-primary education, while the reported community difference is relatively small. Only 11 respondents are above 60 and 13 report no internet access.

5.4 Associations with awareness and use

Table 4: Reported regression estimates

Explanatory variable	Awareness: IRR	p-value	Adoption: OR	p-value
Age above 60	1.17	0.350	0.11	0.024
Post-primary education	0.98	0.904	1.78	0.298
Holding of at least one hectare	1.44	0.020	1.81	0.289
Scheduled Tribe	0.78	0.083	0.86	0.772
Smartphone ownership	3.14	<0.001	4.16	0.030
Observations	97	—	103	—
Reported fit statistic	Deviance/df = 1.09	—	Pseudo R ² = 0.18	—

Source: Survey regression estimates. IRR = incidence rate ratio; OR = odds ratio.

Conditional on the included covariates, smartphone ownership is associated with an expected awareness count 3.14 times that of the reference group ($p < 0.001$). Holdings of at least one hectare are associated with a 44% higher expected count (IRR = 1.44, $p = 0.020$). The Scheduled Tribe coefficient is below one (IRR = 0.78), but $p = 0.083$ does not meet the conventional 5% threshold. Age and education do not show statistically significant awareness associations at that threshold.

In the adoption model, smartphone ownership is associated with higher odds of reported use (OR = 4.16, $p = 0.030$). Farmers above 60 have lower estimated odds (OR = 0.11, $p = 0.024$), equivalent to approximately 89% lower odds relative to the younger group. This is not an 89% reduction in probability. Education, landholding and community coefficients are not statistically significant at 5%; limited precision and sample size mean that these results do not establish the absence of meaningful relationships.

5.5 Alternative access specification

Replacing smartphone ownership with any internet access gives a reported awareness IRR of 3.77 ($p < 0.001$) and adoption OR of 9.84 ($p = 0.009$). The alternative analysis also indicates that age above 60 remains negatively associated with adoption, but does not provide that specification's full coefficient table.

The alternative results suggest that the positive association with participation is not confined to the particular device indicator. They do not establish that connectivity has a larger causal effect than smartphone ownership. The predictors have different reference groups and appear in separate models; their point estimates cannot rank their relative importance.

5.6 Discussion in relation to earlier research

The principal finding is the coexistence of widespread smartphone ownership, limited recognition of the selected services and substantial reported use of digital tools. This pattern shows why a single ownership or adoption percentage is an incomplete description of digital participation. It also reflects the study's measurement choices: recognition of named services is narrower than use of any tool for farming decisions.

The positive access associations are consistent with an enabling role for devices and connectivity, but several explanations remain possible. Farmers with stronger demand for information may invest in access, while extension contacts or household resources may support both access and use. Cross-sectional regression cannot separate these pathways. In particular, the models do not demonstrate that digital literacy mediates the relationship, because that mechanism has not been directly tested.

The differing landholding results are also informative. Larger holdings are associated with awareness but not statistically significantly with use in the reported models. This may reflect differences in exposure or information needs, although the estimates do not identify the mechanism. The distinction supports examining awareness and use separately rather than treating them as equivalent outcomes.

The lower adoption odds among older respondents warrant attention to accessible delivery and assistance. Nevertheless, the small number of respondents above 60 limits precision, and chronological age is not itself a measure of digital skill. Future analysis should examine prior experience, assistance and preferences directly. Likewise, the absence of a

statistically significant community coefficient should not be read as evidence that social inequalities have been eliminated.

These findings complement Mittal and Mehar's [8] emphasis on socioeconomic variation in information sourcing. They also fit the broader lesson from Cole and Fernando [13] and Singh et al. [14]: participation in digital information systems and improvements in agricultural outcomes are separate empirical questions. The present evidence supports conclusions about recognition and reported use within the sample, not productivity or welfare effects.

5.7 Implications for extension and service design

The findings motivate four practical priorities, which should be evaluated through implementation rather than presented as interventions proven effective by this survey.

First, extension activities could demonstrate locally relevant tasks, such as interpreting a forecast or finding crop advice, instead of relying only on publicity about application names. Service-level targeting matters because awareness differs considerably across the selected functions.

Second, assisted access could complement independent use. Small-group demonstrations, repeat assistance and support through local agricultural institutions may help farmers who are unfamiliar with digital interfaces. Older respondents' lower reported use provides a reason to investigate their support needs, without assuming that every older farmer faces the same barriers.

Third, service design should consider intermittent connectivity. Low-data content, voice options and material that remains accessible after downloading are plausible responses. Malayalam and other locally appropriate language options could be tested for comprehension. Language barriers and the effectiveness of these design features were not estimated in the reported analysis.

Fourth, programme monitoring should distinguish reach, recognition, successful task completion, repeat use and agricultural outcomes. A service may achieve high registration numbers while remaining difficult to use. Conversely, assisted use may be valuable even when the farmer does not recognise the platform's official name. Monitoring these dimensions separately would provide a more informative assessment of inclusion.

6. Conclusion

Among the 104 surveyed farmers in Wayanad, digital participation is uneven across access, recognition and reported use. Smartphone ownership is widespread, yet the mean awareness score among complete cases is below two of six selected services. More than two-thirds report some digital use for farming decisions, a broader measure that should not be equated with adoption of the named platforms.

The reported regressions associate smartphone ownership with both outcomes, landholding with awareness, and older age with lower adoption. Alternative models also associate internet access with participation. These results support closer

attention to connectivity and assisted engagement alongside devices, while remaining descriptive and associational.

7. Future Scope

Several limitations qualify the conclusions. The sample is small, preventing claims of district representativeness. Cross-sectional observations cannot establish temporal ordering or causal effects. Self-reported awareness and use may be affected by recall, question interpretation and social desirability.

Regression precision is constrained by small comparison groups. Unmeasured factors—including income, extension contact, digital experience and household assistance—could influence the estimated associations. Conventional robust standard errors do not automatically account for village clustering; the appropriate variance estimator depends on the sampling design and number of clusters.

Useful subsequent analyses include a full zero-to-six awareness distribution, matched awareness/use tables for each service, comparison of regular and occasional connectivity, and descriptions of reported assistance and barriers. Longitudinal or experimental research would be needed to assess whether improved access or training changes agricultural practices, costs or returns.

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