# Extending Diffusion of Innovations Theory for Continued Adoption of Agricultural ICTs among Small and Middle-Level Farmers in Uganda

**Nassanga Sharifa[1], Dr. Erick Oteyo Obare [2], Dr. Samuel Oonge[3]**

[1]PhD student Department of Computer Science Maseno University Maseno Kenya Informatics Department,
[2,3]Department of Computer Science Maseno University Maseno Kenya

**Abstract**
The sustained use of agricultural Information and Communication Technologies (ICTs) remains uneven among small- and middle-level farmers despite the potential of digital tools to improve access to information, market participation and farm decision-making. This study develops and tests an extended Diffusion of Innovations (DOI)-informed framework that treats Continued User Adoption as a distinct behavioural outcome and examines two additional relationships: Knowledge to Confirmation and Confirmation to Implementation. A sequential explanatory mixed-methods design was used. Survey data from 380 farmers in Luweero, Isingiro and Mbarara districts of Uganda were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM), and qualitative interviews with farmers, ICT developers and agricultural extension officers were analysed thematically. All six structural paths were positive and significant: Knowledge to Persuasion ($\beta = .653$, $p < .001$), Knowledge to Confirmation ($\beta = .598$, $p < .001$), Persuasion to Decision ($\beta = .709$, $p < .001$), Decision to Implementation ($\beta = .490$, $p < .001$), Confirmation to Implementation ($\beta = .407$, $p < .001$), and Implementation to Continued User Adoption ($\beta = .759$, $p < .001$). Decision and Confirmation jointly explained 73.2% of the variance in Implementation, while Implementation explained 57.6% of Continued User Adoption. The qualitative findings converged with the structural results and identified stage-specific determinants across the adoption process. The study contributes by distinguishing continued adoption from confirmation and by conceptualising confirmation of anticipated value as a reinforcing mechanism that can facilitate fuller implementation. The findings offer a stage-based basis for designing agricultural digitalisation interventions in Uganda.

**Keywords:** Agricultural ICTs; Diffusion of Innovations; Continued User Adoption; PLS-SEM; Technology Adoption; Uganda

## 1. Introduction
Agricultural production increasingly depends on timely information about weather, markets, inputs, finance and production practices. Digital advisory services, mobile platforms, electronic marketplaces and other agricultural ICTs can improve the speed and reach of such information and strengthen farmers'

decision-making (Chavula, 2014; Takahashi et al., 2019). Yet the presence of digital tools does not guarantee sustained use. Farmers may become aware of a technology, try it, and still fail to integrate it into routine agricultural practice. Evidence from developing-country settings therefore points to a persistent gap between the availability of agricultural technologies and their consistent use over time (Ruzzante et al., 2021).

Much of the technology-adoption literature concentrates on determinants of initial acceptance or the decision to adopt. This emphasis is useful, but it gives less attention to how determinants operate at different stages of the adoption process and how initial implementation becomes continued use. Rogers' Diffusion of Innovations (DOI) theory provides a staged account of adoption through Knowledge, Persuasion, Decision, Implementation and Confirmation (Rogers, 2003), but continued user adoption is not specified as a separate behavioural outcome. This limitation is important in agricultural contexts because the benefits of ICTs are realised only when farmers continue to use and integrate them into farming activities.

This study addresses that gap by developing and empirically testing an extended DOI-informed framework for small- and middle-level farmers in Uganda. The framework retains the staged logic of DOI, introduces Continued User Adoption as a distinct outcome, and evaluates two additional relationships: Knowledge to Confirmation and Confirmation to Implementation. In the proposed extension, Confirmation is treated as a benefit-validation and reinforcement mechanism through which farmers assess whether anticipated benefits are sufficiently valuable to justify fuller implementation. A sequential explanatory mixed-methods design is used so that the quantitative structural relationships can be interpreted alongside farmers' and practitioners' accounts of the adoption process.

## 2. Literature Review and Theoretical Development

### 2.1 Agricultural ICT Adoption and Continued Use

Agricultural ICTs include mobile advisory services, weather information systems, digital market platforms, mobile financial services and e-extension applications. These technologies can reduce information constraints and improve farmers' access to production and market intelligence (Chavula, 2014; Takahashi et al., 2019). However, adoption is often constrained by unequal access to information, differences in digital skills, affordability and the fit between technologies and farmers' production circumstances. The relevant analytical question is therefore not only whether farmers adopt ICTs, but also how they progress from awareness to actual use and, ultimately, continued use.

Existing agricultural technology studies have generated important evidence on adoption determinants, but many treat adoption as a single decision rather than a sequence of related stages. This can conceal the fact that a factor that matters when a farmer first encounters an ICT may differ from the factor that matters when the farmer decides to implement or continue using it. The present study responds to this limitation by locating specific determinants within adoption phases and by modelling Continued User Adoption as an outcome that follows successful implementation.

### 2.2 Diffusion of Innovations as the Core Framework

Rogers' DOI theory explains innovation adoption as a process that unfolds through Knowledge, Persuasion, Decision, Implementation and Confirmation (Rogers, 2003). Knowledge concerns awareness and understanding of an innovation; persuasion concerns the formation of favourable or unfavourable perceptions; decision concerns adoption or rejection; implementation refers to putting the innovation into use; and confirmation concerns reinforcement or reconsideration of the adoption decision. The staged structure is especially relevant to agricultural ICTs because farmers typically move through information acquisition, evaluation, trial and practical integration rather than making a single instantaneous choice.

The present model extends this logic in two ways. First, Continued User Adoption is separated from Confirmation because evaluating the value of an ICT and continuing to use it are conceptually related but behaviourally distinct. Second, the model tests an incorporating role for Confirmation in which farmers' validation of anticipated value—captured through affordability, attitude, profitability and relative advantage—can reinforce movement toward fuller implementation. This is an extension of DOI rather than a claim that Rogers' original temporal ordering is unchanged.

### 2.3 Supporting Theoretical Lenses

Cognitive Processing Theory provides a mechanism for understanding why knowledge can influence later evaluations. Individuals acquire, interpret, retain and use information in forming judgements and behaviour (Neisser, 1967; Anderson, 1983). Applied to agricultural ICTs, greater awareness and access to relevant information can shape both initial persuasion and subsequent assessments of whether an ICT is worthwhile. This provides a cognitive rationale for examining Knowledge as an antecedent of both Persuasion and Confirmation.

Vroom's Expectancy Theory offers a focused explanation for the Confirmation-to-Implementation relationship. The theory proposes that motivation is stronger when individuals expect their effort to produce successful performance, believe that performance will lead to desired outcomes, and value those outcomes (Vroom, 1964). In this study, farmers who validate the affordability, profitability and relative advantage of an agricultural ICT are more likely to expect worthwhile outcomes from fuller use. Confirmation of anticipated value can therefore reduce uncertainty and strengthen motivation to implement the technology.

Bhattacherjee's (2001) expectation-confirmation model of information-systems continuance is useful for distinguishing post-adoption evaluation from continued behaviour. Continued use depends on experience with a system and on whether that experience sustains favourable evaluations. The present study does not treat Confirmation and Continued User Adoption as identical constructs: Confirmation captures evaluative reinforcement, whereas Continued User Adoption captures sustained behaviour following implementation.

### 2.4 Hypothesis Development

Knowledge provides the informational foundation from which farmers form perceptions of an agricultural ICT. As farmers become aware of a technology and understand its availability and functions, they are better able to evaluate its usefulness and fit. DOI therefore implies a positive relationship between Knowledge and Persuasion (Rogers, 2003).

**H1:** Knowledge Phase positively influences Persuasion Phase.

Knowledge may also remain relevant beyond the initial awareness stage because information acquired earlier is retained and used in later evaluations. Cognitive processing suggests that greater understanding equips farmers to assess whether anticipated ICT benefits are credible and relevant to their farming needs (Neisser, 1967; Anderson, 1983).

**H2:** Knowledge Phase positively influences Confirmation Phase.

During persuasion, farmers form attitudes toward an ICT on the basis of perceived efficiency, usability and social influence. Favourable evaluations should increase the likelihood of an affirmative adoption decision, consistent with DOI and with established technology-acceptance research (Davis, 1989; Venkatesh et al., 2003).

**H3:** Persuasion Phase positively influences Decision Phase.

A favourable decision should increase the likelihood that the farmer moves from intention or choice to actual use. DOI therefore anticipates that Decision will positively influence Implementation, particularly where farmers possess the skills and opportunities to trial the technology before fuller integration (Rogers, 2003).

**H4:** Decision Phase positively influences Implementation Phase.

The proposed extension further argues that implementation can be reinforced when farmers validate the expected value of an ICT. Under Vroom's expectancy logic, confirmation that the technology is affordable, profitable and advantageous strengthens the perceived connection between effort and worthwhile outcomes, thereby increasing motivation to implement.

**H5:** Confirmation Phase positively influences Implementation Phase.

Implementation gives farmers practical experience of the technology and creates the basis for repeated use. Where an ICT is successfully incorporated into farming practice and continues to generate value, continued user adoption becomes more likely. This reasoning is consistent with the broader post-adoption logic of information-systems continuance (Bhattacherjee, 2001).

**H6:** Implementation Phase positively influences Continued User Adoption.

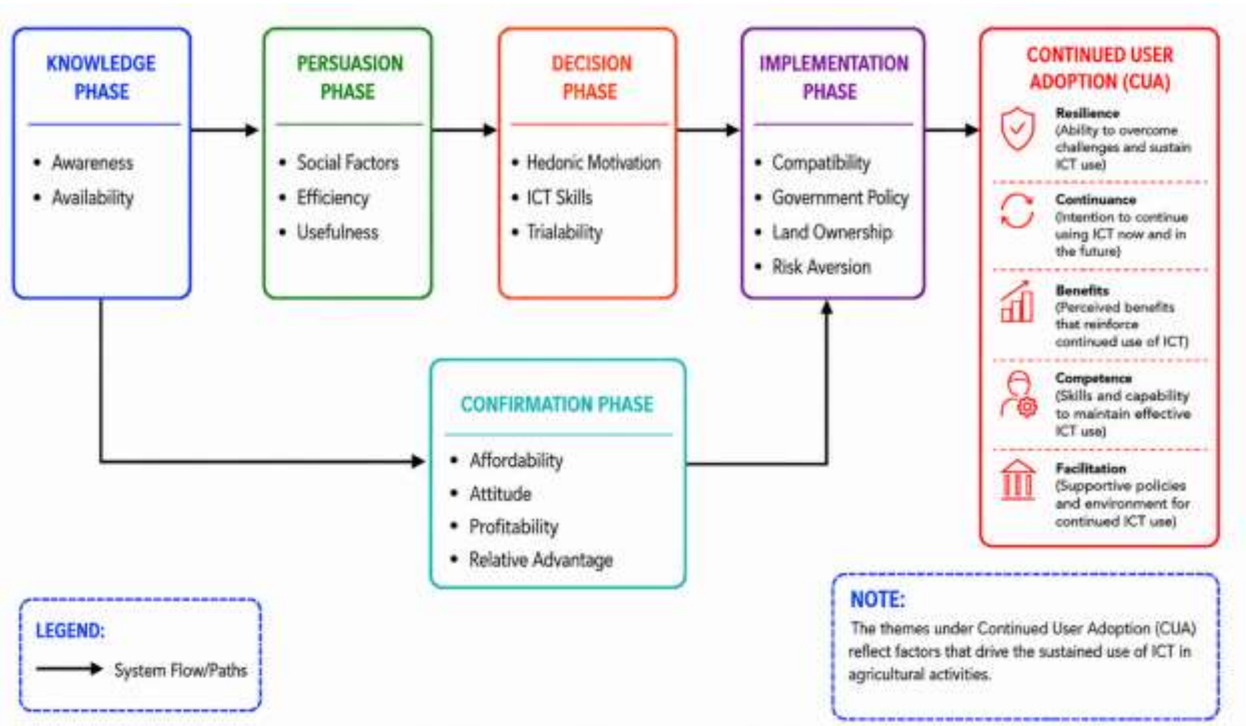


***Figure 1. Proposed extended DOI-informed framework for continued agricultural ICT adoption.***

## 3. Methodology

### 3.1 Research Design

The study adopted a sequential explanatory mixed-methods design to test and contextualise the proposed framework. The quantitative phase provided evidence on the measurement and structural relationships among the model constructs, after which qualitative interviews were used to explain how farmers and agricultural ICT stakeholders understood the factors underlying those relationships. This sequencing allowed statistical evidence to be interpreted alongside contextual accounts from the study setting (Creswell & Plano Clark, 2018).

### 3.2 Study Area, Sample and Data Collection

The research was conducted in Luweero, Isingiro and Mbarara districts in Uganda. These districts provided differing agricultural settings and levels of exposure to agricultural ICTs, making them suitable for examining both adoption and continued use. A structured questionnaire was administered to small- and middle-level farmers. Of 400 questionnaires distributed, 380 valid questionnaires were returned, yielding a 95% response rate.

The qualitative phase used semi-structured interviews with farmers, ICT developers and agricultural extension officers. The interviews explored the factors influencing movement through the adoption stages and the conditions that support or constrain continued use. The two strands of evidence were integrated by comparing the themes emerging from the interviews with the statistically supported structural relationships.

### 3.3 Data Analysis

Quantitative data were analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM) in SmartPLS 4. The measurement model was assessed using retained outer loadings, Cronbach's alpha, composite reliability (rho_C), average variance extracted (AVE) and the heterotrait-monotrait ratio (HTMT). The structural model was assessed using inner variance inflation factors (VIF), path coefficients, coefficients of determination ($R^2$ and adjusted $R^2$), effect sizes ($f^2$), and bootstrapping with 5,000 subsamples. The analysis therefore focused on measurement quality, explanatory power, substantive effect sizes and the statistical significance of the hypothesised paths (Hair et al., 2021).

Qualitative interview data were analysed thematically following Braun and Clarke (2006). Coding was conducted manually in Microsoft Word, and related codes were organised into themes corresponding to the constructs and stages in the proposed framework. Integration focused on convergence and complementarity between the qualitative themes and the PLS-SEM results.

## 4. Results

### 4.1 Measurement Model Assessment

#### 4.1.1 Indicator Reliability and Internal Consistency

The retained indicators generally demonstrated satisfactory reliability. Outer loadings ranged from .674 to .879, with most indicators meeting or exceeding the preferred .70 level. Internal consistency was strong for five constructs. Cronbach's alpha ranged from .585 to .927 and composite reliability (rho_C) ranged from .777 to .938. The Knowledge Phase recorded the lowest alpha (.585), but its composite reliability (.777) exceeded the .70 criterion; the construct was therefore retained because the broader reliability and validity evidence remained acceptable, while its alpha was interpreted cautiously.

**Table 1. Internal consistency reliability of the measurement model**

| Construct | Cronbach's alpha (α) | Composite reliability (rho_C) | Threshold | Assessment |
|---|---|---|---|---|
| Confirmation Phase (CP) | 0.925 | 0.938 | ≥ 0.70 | Excellent reliability |

| Construct | Cronbach's alpha (α) | Composite reliability (rho_C) | Threshold | Assessment |
|---|---|---|---|---|
| Continued User Adoption (CUA) | 0.907 | 0.931 | ≥ 0.70 | Excellent reliability |
| Decision Phase (DP) | 0.919 | 0.936 | ≥ 0.70 | Excellent reliability |
| Implementation Phase (IP) | 0.927 | 0.938 | ≥ 0.70 | Excellent reliability |
| Knowledge Phase (KP) | 0.585 | 0.777 | ≥ 0.70 | Alpha below threshold; rho_C acceptable |
| Persuasion Phase (PP) | 0.855 | 0.897 | ≥ 0.70 | Good reliability |

*Source: Researcher's field data (2026), analysed using SmartPLS 4.*

### 4.1.2 Convergent Validity

Convergent validity was evaluated using AVE. Every construct exceeded the minimum criterion of .50, with values ranging from .538 for Knowledge Phase to .729 for Continued User Adoption. The results indicate that each construct accounted for more than half of the variance in its retained indicators.

**Table 2. Convergent validity of the measurement model**

| Construct | AVE | Threshold | Assessment |
|---|---|---|---|
| Confirmation Phase (CP) | 0.627 | ≥ 0.50 | Established |
| Continued User Adoption (CUA) | 0.729 | ≥ 0.50 | Established |
| Decision Phase (DP) | 0.676 | ≥ 0.50 | Established |
| Implementation Phase (IP) | 0.605 | ≥ 0.50 | Established |
| Knowledge Phase (KP) | 0.538 | ≥ 0.50 | Established |
| Persuasion Phase (PP) | 0.635 | ≥ 0.50 | Established |

*Source: Researcher's field data (2026), analysed using SmartPLS 4.*

### 4.1.3 Discriminant Validity

Discriminant validity was assessed using HTMT. All construct-pair values were below the adopted .90 threshold, ranging from .575 to .890. The highest values occurred between Confirmation and Continued User Adoption (.890), Knowledge and Persuasion (.889), and Confirmation and Decision (.888). Although these values indicate relatively strong associations, each remained within the adopted criterion, supporting the empirical distinctiveness of the constructs.

**Table 3. Heterotrait-monotrait ratio (HTMT)**

| Construct | CP | CUA | DP | IP | KP | PP |
|---|---|---|---|---|---|---|
| Confirmation Phase (CP) | — | | | | | |
| Continued User Adoption (CUA) | 0.890 | — | | | | |
| Decision Phase (DP) | 0.888 | 0.789 | — | | | |
| Implementation Phase (IP) | 0.867 | 0.825 | 0.886 | — | | |
| Knowledge Phase (KP) | 0.784 | 0.575 | 0.708 | 0.638 | — | |
| Persuasion Phase (PP) | 0.762 | 0.650 | 0.798 | 0.745 | 0.889 | — |

*Source: Researcher's field data (2026), analysed using SmartPLS 4.*

### 4.2 Structural Model Assessment

#### 4.2.1 Collinearity Assessment

Inner VIF values ranged from 1.000 to approximately 3.05. Knowledge was the sole predictor of Persuasion and Confirmation, Persuasion was the sole predictor of Decision, and Implementation was the sole predictor of Continued User Adoption; each of these relationships therefore recorded a VIF of 1.000. Decision and Confirmation jointly predicted Implementation and each recorded a VIF of approximately 3.05. These values were below the conventional threshold of 5.00 and also below the conservative 3.30 guideline, indicating that structural collinearity did not materially threaten the model estimates.

**Table 4. Structural-model collinearity assessment**

| Predictor construct | Endogenous construct | VIF | Assessment |
|---|---|---|---|
| Knowledge Phase | Persuasion Phase | 1.000 | No collinearity concern |
| Knowledge Phase | Confirmation Phase | 1.000 | No collinearity concern |
| Persuasion Phase | Decision Phase | 1.000 | No collinearity concern |
| Decision Phase | Implementation Phase | ≈ 3.05 | Acceptable |
| Confirmation Phase | Implementation Phase | ≈ 3.05 | Acceptable |
| Implementation Phase | Continued User Adoption | 1.000 | No collinearity concern |

*Source: Researcher's field data (2026), analysed using SmartPLS 4.*

#### 4.2.2 Coefficient of Determination ($R^2$ and Adjusted $R^2$)

The model showed meaningful explanatory power across its endogenous constructs. Knowledge explained 35.8% of the variance in Confirmation and 42.6% in Persuasion. Persuasion explained 50.2% of Decision. Decision and Confirmation jointly explained 73.2% of Implementation, the strongest explanatory result in the model. Implementation subsequently explained 57.6% of Continued User Adoption. The adjusted $R^2$ values were almost identical to the corresponding $R^2$ values, indicating stable explanatory estimates.

**Table 5. Coefficient of determination**

| Endogenous construct | $R^2$ | Adjusted $R^2$ | Interpretation |
|---|---|---|---|
| Confirmation Phase (CP) | 0.358 | 0.356 | Moderate |
| Persuasion Phase (PP) | 0.426 | 0.425 | Moderate |
| Decision Phase (DP) | 0.502 | 0.501 | Moderate |
| Implementation Phase (IP) | 0.732 | 0.731 | Substantial |
| Continued User Adoption (CUA) | 0.576 | 0.574 | Moderate-to-substantial |

*Source: Researcher's field data (2026), analysed using SmartPLS 4.*

#### 4.2.3 Effect Size ($f^2$)

Effect size was used to assess the substantive contribution of each predictor to its endogenous construct. Using Cohen's (1988) benchmarks of .02, .15 and .35 for small, medium and large effects, respectively, Knowledge had large effects on Persuasion ($f^2$ = .742) and Confirmation ($f^2$ = .558). Persuasion had a large effect on Decision ($f^2$ = 1.009), Decision had a medium effect on Implementation ($f^2$ = .294), and Confirmation had a medium effect on Implementation ($f^2$ = .203). The largest effect in the model was Implementation on Continued User Adoption ($f^2$ = 1.356).

***Table 6. Effect sizes of the structural relationships***

| Structural relationship | $f^2$ | Interpretation |
|---|---|---|
| Knowledge Phase → Persuasion Phase | 0.742 | Large |
| Knowledge Phase → Confirmation Phase | 0.558 | Large |
| Persuasion Phase → Decision Phase | 1.009 | Large |
| Decision Phase → Implementation Phase | 0.294 | Medium |
| Confirmation Phase → Implementation Phase | 0.203 | Medium |
| Implementation Phase → Continued User Adoption | 1.356 | Large |

*Source: Researcher's field data (2026), analysed using SmartPLS 4.*

### 4.2.4 Hypothesis Testing Using Bootstrapping

Bootstrapping with 5,000 subsamples was used to test the structural paths. All six coefficients were positive and statistically significant at $p < .001$, and every 95% confidence interval excluded zero. The strongest direct relationship was Implementation to Continued User Adoption ($\beta = .759$), followed by Persuasion to Decision ($\beta = .709$) and Knowledge to Persuasion ($\beta = .653$). The results therefore supported all six hypotheses.

**Table 7. Hypothesis-testing results**

| Hyp. | Structural relationship | β | SE | t-value | p-value | 95% CI | Decision |
|---|---|---|---|---|---|---|---|
| H1 | Knowledge → Persuasion | 0.653 | 0.034 | 19.233 | < .001 | [0.584, 0.717] | Supported |
| H2 | Knowledge → Confirmation | 0.598 | 0.035 | 16.879 | < .001 | [0.530, 0.669] | Supported |
| H3 | Persuasion → Decision | 0.709 | 0.037 | 18.943 | < .001 | [0.633, 0.779] | Supported |
| H4 | Decision → Implementation | 0.490 | 0.080 | 6.130 | < .001 | [0.331, 0.639] | Supported |
| H5 | Confirmation → Implementation | 0.407 | 0.075 | 5.441 | < .001 | [0.264, 0.555] | Supported |
| H6 | Implementation → Continued User Adoption | 0.759 | 0.030 | 25.528 | < .001 | [0.700, 0.816] | Supported |

*Source: Researcher's field data (2026), analysed using SmartPLS 4; 5,000 bootstrap subsamples.*

### 4.3 Qualitative Findings and Mixed-Methods Integration

The qualitative analysis identified stage-specific factors that closely matched the constructs retained in the quantitative model. Availability and awareness characterised the Knowledge Phase. Social factors, efficiency and usability shaped Persuasion, while hedonic motivation, ICT skills and trialability characterised Decision. Compatibility, government policy, land ownership and risk aversion were associated with Implementation. Affordability, attitude, profitability and relative advantage shaped the Confirmation Phase.

The qualitative evidence also clarified the structural relationships. Farmers described access to and awareness of agricultural ICTs as the informational basis for forming favourable perceptions, consistent with the Knowledge-to-Persuasion path ($\beta = .653$). Confidence in ICT skills, opportunities to trial technologies and positive user experiences supported movement from Persuasion to Decision ($\beta = .709$). Implementation depended on whether technologies fitted farming practices and resource conditions and whether the policy environment and perceived risks were manageable, consistent with the Decision-to-Implementation path ($\beta = .490$).

The interviews further suggested that farmers were more willing to deepen implementation where they validated the affordability, profitability and relative advantage of the technology. This interpretation is consistent with the Knowledge-to-Confirmation (β = .598) and Confirmation-to-Implementation (β = .407) relationships. Finally, the strong Implementation-to-Continued-User-Adoption path (β = .759) aligned with qualitative accounts that sustained use depended on whether the technology became practically integrated into farming activities.

## 5. Discussion

The findings support a staged account of agricultural ICT adoption while also showing that continued use requires more than an initial adoption decision. The Knowledge-to-Persuasion relationship (β = .653) indicates that awareness and availability provide the basis from which farmers form evaluations of digital technologies. This is consistent with DOI, which places knowledge at the beginning of the innovation-decision process (Rogers, 2003), and with evidence that access to agricultural information strengthens farmers' ability to evaluate technology options (Mittal & Mehar, 2016; Takahashi et al., 2020).

Knowledge also had a substantial positive relationship with Confirmation (β = .598). This result suggests that information acquired at the beginning of the adoption process remains cognitively available when farmers later assess whether the technology is sufficiently affordable, profitable and advantageous to justify deeper use. Cognitive Processing Theory helps explain this continuity: information is not merely acquired but interpreted, retained and applied in later judgement (Neisser, 1967; Anderson, 1983). The result therefore supports the study's argument that knowledge can influence both initial persuasion and later benefit validation.

Persuasion strongly influenced Decision (β = .709). Social factors, efficiency and usability appear to shape whether farmers move from evaluation to an affirmative choice. This finding is compatible with technology-acceptance research in which perceived usefulness, effort-related evaluations and social influence contribute to behavioural intentions (Davis, 1989; Venkatesh et al., 2003). Within the agricultural setting, the implication is that technically available tools may still fail to progress to adoption if they are difficult to use, socially unsupported or perceived as inefficient.

Decision positively influenced Implementation (β = .490), showing that an affirmative adoption choice is an important but not sufficient condition for actual integration into farming practice. Trialability and ICT skills are especially relevant at this transition because farmers need both confidence and practical opportunities to move from intention to use. Rogers (2003) similarly emphasises trial and learning as mechanisms that reduce uncertainty around innovations.

Confirmation also contributed independently to Implementation (β = .407). This path is the most distinctive extension in the model and should be interpreted as reinforcement through validation of anticipated value rather than as a simple reversal of Rogers' terminal confirmation stage. Vroom's (1964) expectancy logic provides the relevant mechanism: farmers are more motivated to commit effort when they believe implementation can succeed, expect it to produce desirable outcomes and value those outcomes. Where affordability, profitability and relative advantage are positively validated, uncertainty is reduced and fuller implementation becomes more attractive.

Implementation had the strongest direct effect on Continued User Adoption (β = .759) and the largest $f^2$ value in the model. This result indicates that continued adoption is primarily grounded in successful practical integration. It also supports treating Continued User Adoption as distinct from Confirmation: farmers may positively evaluate a technology, but sustained behaviour requires the technology to become workable within everyday farming activities. Bhattacherjee's (2001) post-adoption perspective similarly highlights the importance of actual system experience in shaping continuance.

Taken together, the quantitative and qualitative evidence shows that agricultural ICT adoption is better understood as a sequence of linked transitions than as a single binary choice. Different determinants become salient at different stages, and successful implementation serves as the immediate bridge between initial adoption and sustained use.

## 6. Theoretical Contribution

The study makes three related theoretical contributions. First, it extends the outcome space of DOI by modelling Continued User Adoption as a distinct behavioural outcome rather than treating confirmation as the endpoint of the process. This distinction separates evaluation from sustained behaviour and provides a clearer basis for studying whether agricultural ICTs remain in use after initial adoption.

Second, the study introduces and empirically supports an incorporating role for Confirmation. Rather than treating confirmation only as a terminal post-implementation stage, the extended model conceptualises confirmation of anticipated value as a reinforcing evaluation that can facilitate fuller implementation. The significant Confirmation-to-Implementation path provides empirical support for this proposed mechanism, while Vroom's Expectancy Theory supplies a motivational explanation for why validated benefits can strengthen implementation effort.

Third, the study links DOI with complementary cognitive and post-adoption perspectives. Cognitive Processing Theory clarifies how knowledge acquired early in the process can influence later evaluations, while the expectation-confirmation logic of information-systems continuance helps distinguish evaluation from continued use. The resulting framework therefore combines stage progression, cognitive evaluation, motivational reinforcement and sustained behaviour in one agricultural ICT adoption model.

## 7. Practical Implications

The stage-based findings imply that interventions should be matched to the point at which farmers encounter difficulty in the adoption process. At the Knowledge stage, policymakers and extension agencies should prioritise awareness, access and understandable information about available agricultural ICTs. At the Persuasion stage, developers should emphasise usability, efficiency and social credibility, including demonstrations that allow farmers to see how the technology fits real farming tasks.

At the Decision stage, practical training and opportunities for trial can strengthen ICT skills and reduce uncertainty. During Implementation, attention should shift to compatibility with farming practices, enabling government policy, resource and land-use conditions, and manageable perceptions of risk. The Confirmation findings further suggest that farmers need credible evidence that the technology is affordable, profitable and advantageous. Post-adoption support should therefore focus on helping users realise and recognise value rather than ending support immediately after initial uptake.

Because Implementation strongly predicts Continued User Adoption, programmes designed to increase agricultural digitalisation should evaluate success in terms of routine integration and sustained use, not only registrations, downloads or first-time adoption. ICT developers, extension practitioners and policymakers should therefore monitor whether technologies remain useful and workable after farmers begin using them.

## 8. Limitations and Future Research

The study was conducted among small- and middle-level farmers in three Ugandan districts, and the resulting framework should therefore be tested in additional agricultural settings before broad generalisation. Future studies could examine whether the same stage relationships hold across different agricultural technologies, regions and categories of farmers. The Knowledge Phase also recorded a Cronbach's alpha of .585, although its composite reliability and AVE were acceptable; replication with refined indicators would provide useful evidence on the stability of this construct. Further research may also examine additional post-adoption mechanisms linking implementation to long-term continuance.

## 9. Conclusion

This study developed and validated an extended DOI-informed framework for explaining continued adoption of agricultural ICTs among small- and middle-level farmers in Uganda. All six hypothesised relationships were positive and statistically significant. Knowledge influenced both Persuasion and Confirmation; Persuasion influenced Decision; Decision and Confirmation independently contributed to Implementation; and Implementation strongly influenced Continued User Adoption. The model explained 73.2% of Implementation and 57.6% of Continued User Adoption, indicating substantial explanatory value at the stages most closely connected to sustained use.

The findings show that continued adoption should not be treated as synonymous with confirmation. Confirmation represents evaluative reinforcement, whereas Continued User Adoption represents sustained behaviour. By separating these constructs and by identifying a reinforcing role for confirmation of anticipated value, the study offers a more differentiated account of how farmers move from awareness to sustained agricultural ICT use. The framework provides a basis for both further theoretical testing and more stage-specific digital agriculture interventions.

## References

1. Aker, J. C. (2011). Dial "A" for agriculture: Using information and communication technologies for agricultural extension in developing countries. Agricultural Economics, 42(6), 631–647.
2. Anderson, J. R. (1983). The architecture of cognition. Harvard University Press.
3. Bhattacherjee, A. (2001). Understanding information systems continuance: An expectation-confirmation model. MIS Quarterly, 25(3), 351–370.
4. Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa
5. Chavula, H. K. (2014). The role of ICTs in agricultural production in Africa. Journal of Development and Agricultural Economics, 6(7), 279–289.
6. Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.
7. Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE Publications.
8. Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340.
9. Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2021). A primer on partial least squares structural equation modeling (PLS-SEM) (3rd ed.). SAGE Publications.

10. Mittal, S., & Mehar, M. (2016). Socio-economic factors affecting adoption of modern information and communication technology by farmers in India. The Journal of Agricultural Education and Extension, 22(2), 199–212.
11. Neisser, U. (1967). Cognitive psychology. Appleton-Century-Crofts.
12. Rogers, E. M. (2003). Diffusion of innovations (5th ed.). Free Press.
13. Ruzzante, S., Labarta, R., & Bilton, A. (2021). Adoption of agricultural technologies in developing countries: A literature review. World Development, 146, 105599.
14. Takahashi, K., Muraoka, R., & Otsuka, K. (2019). Technology adoption and agricultural productivity. Food Policy, 83, 136–145.
15. Takahashi, K., Muraoka, R., & Otsuka, K. (2020). Technology adoption, impact, and extension in developing countries' agriculture: A review of the recent literature. Agricultural Economics, 51(1), 31–45.
16. Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425–478.
17. Vroom, V. H. (1964). Work and motivation. Wiley.