

Digital technologies in the lifeworld of smallholder farmers: A hermeneutic phenomenological critique of adoption-centric digital agriculture research

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ABSTRACT

Digital agricultural technologies are increasingly promoted as solutions to the challenges confronting smallholder farming, particularly in Sub-Saharan Africa. However, much of the research in this field remains anchored in adoption-centric frameworks that conceptualise technology use as a rational and measurable decision shaped by factors such as perceived usefulness and ease of use. While these models have generated valuable empirical findings, they provide only a partial account of how farmers encounter and live with digital tools in everyday practice. This paper critically interrogates the conceptual and ontological assumptions embedded within adoption-centric research. Drawing on hermeneutic phenomenology, the study reorients analysis toward farmers' lived experience, everyday practice, and processes of meaning-making. Rather than presenting new empirical fieldwork, the study undertakes a critical interpretive synthesis of global and African digital agriculture scholarship. This literature is read through phenomenological theory to illuminate dimensions of engagement that remain underexplored. The analysis shows that adoption-centric frameworks marginalise key dimensions of digital engagement, including temporality, embodiment, intersubjectivity, language, historical memory, and infrastructural instability. In practice, farmers' engagement with digital technologies is often negotiated, intermittent, and shaped by shifting social and material conditions. Technologies may be adopted, adapted, reinterpreted, or abandoned in ways that exceed explanation through behavioural intention alone. Digital tools are not neutral instruments but acquire meaning within specific social and material lifeworld contexts. Understanding digital agriculture, therefore, requires moving beyond the question of adoption toward exploring how digital technologies are experienced within everyday farming life. By foregrounding lived experience, this paper contributes to debates on the limits of adoption-centric approaches in agricultural research and rural development and argues that phenomenologically informed inquiry can complement quantitative adoption studies while supporting more context-sensitive policy, design, and intervention strategies.

Keywords: Digital Agriculture, Hermeneutic Phenomenology, Lifeworld, Smallholder Farmers, Sub-Saharan Africa, Technology Adoption

I. INTRODUCTION

Agriculture continues to play a central role in global socio-economic development as nations confront mounting pressures associated with population growth, climate variability, and land degradation. Sustaining rural livelihoods while safeguarding environmental systems requires adaptive and innovative approaches capable of enhancing productivity and strengthening long-term resilience. Agricultural development remains closely linked to poverty reduction, livelihood security, and farm performance, particularly for vulnerable populations whose well-being depends directly on agricultural outcomes (Gumbi *et al.*, 2023).

Within this evolving landscape, digital agricultural technologies have emerged as prominent instruments of agricultural transformation, supporting progress toward the Sustainable Development Goals, including No Poverty and Climate Action (Choruma *et al.*, 2024; Gumbi *et al.*, 2023; Hinson *et al.*, 2019; Mulungu *et al.*, 2025; Smidt & Jokonya, 2022). Across global contexts, digital technologies are reshaping farming systems through mobile advisory platforms, sensor-based monitoring, precision agriculture tools, and digitally enabled supply-chain systems. Technologies such as the Internet of Things (IoT), artificial intelligence (AI), and big data analytics are increasingly deployed to improve decision-making, optimise resource use, enhance crop yields, and strengthen food security (Bronson, 2019; Geng *et al.*, 2024; Klerkx *et al.*, 2019; Mulungu *et al.*, 2025).

Although digital agriculture is frequently presented as universally transformative, its meaning and practical significance remain contingent upon the socio-material contexts in which it is encountered. Within smallholder-dominated farming systems, infrastructural, institutional, and socio-cultural conditions fundamentally shape how digital technologies are interpreted and integrated into everyday farming life. The transformative promise of digital agriculture, therefore, cannot be assumed as uniform; it must be understood as situated and contextually mediated.

At the continental level, Africa's digital transformation agenda positions digitalisation as a key driver of inclusive growth, competitiveness, and sustainable development. The African Union's Agenda 2063 underscores the role of science, technology, and innovation in modernising agriculture and strengthening food systems. Complementing this vision, continental strategies such as the African Union Digital Transformation Strategy (2020–2030) and the African Union Digital Agriculture Strategy (2023–2030) frame digital technologies as central to productivity, resilience, and market integration across agri-food systems. These policy commitments reflect a broader aspiration for a technologically enabled Africa in which agricultural innovation contributes to economic transformation, employment creation, and food security (African Union, 2025; GSMA, 2024; Okwatch, 2024).

Despite these ambitious continental policy commitments, farmers' engagement with digital agricultural technologies across Sub-Saharan Africa remains uneven and highly context-dependent. Empirical studies across Sub-Saharan Africa indicate that mobile-enabled services can improve access to weather forecasts, agronomic advice, and market information, with reported gains in productivity and income under specific conditions (Abate *et al.*, 2023; Choruma *et al.*, 2024; Mulungu *et al.*, 2025; Omulo & Kumeh, 2020). However, evidence also shows that digital technology engagement remains uneven and highly contingent upon infrastructural capacity, institutional support, literacy levels, socio-cultural dynamics, and local farming conditions (Abate *et al.*, 2023; Baumüller, 2018; Tabe-Ojong Jr *et al.*, 2023). Digital agriculture should therefore not be understood as a homogeneous technological shift but as a set of situated practices embedded within diverse social and environmental contexts.

Despite the expanding availability of digital agricultural technologies across Africa, utilisation among smallholder farmers remains inconsistent and often intermittent (Choruma *et al.*, 2024; Kudama *et al.*, 2021). Existing explanations typically emphasise infrastructural limitations, digital literacy constraints, and affordability barriers (Abate *et al.*, 2023; Gumbi *et al.*, 2023). While such analyses identify important structural conditions, they provide limited insight into how digital technologies are experienced, interpreted, and incorporated into everyday farming life. Underutilisation persists even in contexts characterised by relatively favourable infrastructure, suggesting that barriers extend beyond access to include experiential and interpretive dimensions of engagement.

Much of the existing literature approaches digital agriculture through adoption metrics, usage rates, and economic outcome models (Choruma *et al.*, 2024; Klerkx *et al.*, 2019; Kudama *et al.*, 2021). Although these studies offer important insights into patterns of access and impact, they tend to conceptualise technology engagement as an individual cognitive decision shaped by measurable predictors. In doing so, survey-based and techno-centric approaches privilege behavioural determinants while constraining attention to embodied experience, contextual meaning, temporality, and intersubjective relations.

Conceptually, digital agricultural technologies are frequently framed in terms of technical features and functional capabilities rather than through the meaning-making horizons of the farmers who engage with them. Drawing on Schutz's (1967) notion of the lifeworld, meaning emerges through everyday experience rather than through externally defined technological functions. Understanding digital agriculture, therefore, requires moving beyond the question of adoption toward exploring how technologies are encountered, interpreted, and woven into the rhythms of everyday farming life.

1.1 Statement of the Problem

Although digital agriculture is widely promoted as transformative (Food and Agriculture Organization of the United Nations [FAO], 2024; Klerkx *et al.*, 2019; World Bank, 2021), engagement among smallholder farmers in Sub-Saharan Africa remains uneven and intermittent (Abate *et al.*, 2023; Choruma *et al.*, 2024; Kudama *et al.*, 2021). The prevailing research response has been to refine adoption-centric frameworks, identify behavioural determinants, and enhance predictive accuracy through models such as the Technology Acceptance Model, Diffusion of Innovations, and the Unified Theory of Acceptance and Use of Technology (Ajzen, 1991; Davis, 1989; Rogers, 2003). Yet persistent gaps between technological promise and lived engagement (Baumüller, 2018) indicate that explanatory models grounded primarily in behavioural intention and rational evaluation are insufficient.

The problem addressed in this study is therefore conceptual and ontological rather than technical. Dominant adoption frameworks conceptualise technology engagement as an individual cognitive decision shaped by measurable variables. In doing so, they abstract technological engagement from temporality, embodiment, intersubjectivity, and historically situated meaning. Empirical studies in African contexts show that infrastructural instability, literacy levels, institutional trust, and socio-cultural dynamics significantly shape how digital technologies are encountered in practice (Abate *et al.*, 2023; Baumüller, 2018; Gumbi *et al.*, 2023). However, these dimensions are often treated as external determinants rather than as constitutive elements of lived engagement.

Drawing on phenomenological scholarship, particularly Schutz's notion of the lifeworld, technological meaning emerges through everyday experience rather than solely through pre-use evaluation. Without attending to these lived dimensions, digital agriculture research risks producing analytically robust yet experientially thin accounts of technological engagement. There is therefore a need for a complementary interpretive orientation capable of illuminating how digital technologies are encountered, interpreted, and made meaningful within everyday farming life.

1.2 Research Objectives

- i. To explore the conceptual and ontological assumptions underlying dominant adoption-centric frameworks within digital agriculture research.
- ii. To describe the experiential dimensions of technology engagement that are marginalised within adoption-centric frameworks.
- iii. To articulate hermeneutic phenomenology as an alternative interpretive orientation capable of capturing the lived meanings of digital agricultural engagement among smallholder farmers.

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Theoretical Foundations: Hermeneutic Phenomenology

Hermeneutic phenomenology provides the theoretical orientation for this study. Rooted in the ontological turn initiated by Martin Heidegger, and further developed by Hans-Georg Gadamer, Alfred Schutz, and Max van Manen, this tradition shifts inquiry from abstract cognition to situated existence (Gadamer, 1989; Heidegger, 1996; Schutz, 1967; van Manen, 2023). Rather than treating understanding as detached evaluation, hermeneutic phenomenology conceives meaning as emerging through practical involvement in the world.

In *Being and Time*, Heidegger reconceptualised phenomenology around the question of being-in-the-world, arguing that human existence is always already embedded in social, historical, and material contexts (Heidegger, 1996). Technologies are not encountered as neutral objects first evaluated through rational choice; rather, they are disclosed through use, breakdown, and practical engagement. Meaning unfolds through lived activity rather than pre-use assessment.

Gadamer extended this insight by emphasising the historical and dialogical character of interpretation. Understanding is shaped by tradition, language, and prior experience, and develops through a fusion of horizons between interpreter and phenomenon. Schutz introduced phenomenology into the social sciences by foregrounding intersubjectivity and the lifeworld—the taken-for-granted horizon within which everyday action unfolds. Van Manen further articulated practice-oriented methods for researching lived experience, highlighting the importance of reflective interpretation in qualitative inquiry (Gadamer, 1989; Heidegger, 1996; Schutz, 1967; van Manen, 2023).

Taken together, these thinkers provide a conceptual framework for exploring digital agricultural technologies not as abstract technical systems but as phenomena encountered within socially structured lifeworlds. Meaning is therefore not reducible to perceived usefulness or behavioural intention; it emerges through embodied practice, relational interaction, and temporally unfolding experience.

2.2 Empirical Review

2.2.1 Digital Agriculture in Global and African Contexts

Globally, digital agricultural technologies are commonly framed as transformative solutions to long-standing challenges such as food insecurity, climate variability, market inefficiencies, and resource constraints. They are further positioned as contributors to broader development and sustainability agendas, including the Sustainable Development Goals (SDGs) (FAO, 2024; Hinson *et al.*, 2019; World Bank, 2021). Within international development and policy discourse, digital agriculture is associated with innovation, efficiency, scalability, data-driven decision-making, and environmental sustainability (Geng *et al.*, 2024; Klerkx *et al.*, 2019; Niedbała *et al.*, 2024).

The global literature highlights a wide range of digital interventions, including mobile-based advisory services, remote sensing and satellite analytics, precision agriculture technologies, digital financial services, and supply-chain traceability systems (Aker *et al.*, 2016; Choruma *et al.*, 2024; Rotz *et al.*, 2019). These technologies are frequently presented as universally applicable tools capable of improving productivity and resilience across diverse farming systems.

However, much of the global literature adopts a techno-centric orientation that prioritises system functionality, data integration, and innovation potential while giving limited attention to how farmers experience and interpret digital technologies within everyday life (Glover *et al.*, 2019; Hinson *et al.*, 2019; Klerkx *et al.*, 2019). Farmers are often positioned as users or adopters of technology rather than as meaning-making actors embedded within the lived agricultural world. Consequently, global perspectives tend to abstract digital agriculture from the social, cultural, and experiential contexts through which technologies are encountered.

This critique is reinforced by Glover *et al.* (2019), who argue that technological change in smallholder agriculture should not be reduced to the diffusion or adoption of discrete innovations, but understood as a process of encounter and interpretation within specific social and cultural worlds. Glover shows that technologies are not taken up simply because they exist or perform well technically; rather, they are interpreted, evaluated, and disposed toward in relation to farmers' existing practices, values, and lived realities. From this perspective, technologies become meaningful only through situated engagement, thereby challenging global framings that treat digital agriculture as universally applicable or inherently transformative.

In Sub-Saharan Africa, digital agriculture is widely promoted as a mechanism for addressing structural challenges such as limited access to extension services, weak market linkages, climatic uncertainty, and resource constraints (Abate *et al.*, 2023; Kudama *et al.*, 2021). Mobile advisory platforms, digital market information systems, climate early-warning tools, and digital financial services have expanded rapidly across the region (Choruma *et al.*, 2024; McCampbell *et al.*, 2021).

Despite this expansion, regional studies consistently demonstrate that farmers' engagement with digital agricultural technologies remains uneven and highly context-dependent. Structural barriers—including digital literacy gaps, language constraints, gendered inequalities in phone ownership, unreliable network coverage, and affordability challenges—shape how technologies are encountered and taken up in practice (Abate *et al.*, 2023; Gumbi *et al.*, 2023; Mulungu *et al.*, 2025).

Beyond infrastructure and access, regional research indicates that farmers' engagement with digital tools is mediated by social trust, communal learning, and alignment with existing farming practices (McCampbell *et al.*, 2021; Omulo & Kumeh, 2020). However, much of the literature remains descriptive or adoption-focused, emphasising opportunities and constraints while giving limited attention to how digital technologies are lived, interpreted, and integrated within everyday farming life (Choruma *et al.*, 2024; Gumbi *et al.*, 2023). While regional studies provide important insight into structural and institutional conditions, they offer only limited understanding of the experiential and interpretive dimensions through which farmers encounter digital agricultural technologies.

2.2.2 Structural and Institutional Conditions

Beyond broad regional patterns, farmers' engagement with digital agricultural technologies is further shaped by the structural and institutional arrangements that organise everyday farming life. Access to credit, extension services, markets, and infrastructure influences whether digital tools appear as enabling resources or as sources of frustration and exclusion (Steinke *et al.*, 2021). At the policy and systems level, digital agriculture is frequently promoted as a pathway to efficiency, sustainability, and innovation. However, critical scholarship shows that such technologies are embedded within governance structures and institutional arrangements that may produce uneven outcomes and deepen existing inequalities (Klerkx & Rose, 2020; Niedbała *et al.*, 2024; Rotz *et al.*, 2019).

In contexts where connectivity is unstable, devices are unaffordable, or institutional support is inconsistent, digital agricultural technologies may be experienced as unreliable or burdensome rather than enabling. Institutional arrangements also matter. Technologies introduced through top-down programmes may be interpreted differently from those embedded within trusted extension networks or cooperative structures (Mulungu *et al.*, 2025). These conditions do not merely constrain use; they configure the meanings farmers attribute to digital technologies and influence whether such tools are perceived as relevant, trustworthy, or worth engaging.

2.2.3 Cultural and Knowledge-System Contexts

Cultural norms and local knowledge systems fundamentally shape how farmers encounter, interpret, and evaluate digital agricultural technologies. In many rural contexts, farming knowledge is not primarily abstract or formalised but accumulated through embodied practice, intergenerational transmission, and communal learning. These locally grounded ways of knowing constitute epistemic environments into which digital advisories and tools are introduced. Even within user-centred design approaches, studies indicate that decision-support tools are most effective when they engage farmers' experiential knowledge and contextual reasoning rather than presuming uniform interpretations of information (Rose *et al.*, 2018). As a result, digital technologies do not enter neutral or empty knowledge spaces but lifeworlds already structured by shared meanings, experiential understandings, and socially embedded interpretive practices (Glover *et al.*, 2019; Šūmane *et al.*, 2018).

When digital information resonates with farmers' existing knowledge, observations, and lived experience, it may be incorporated into established interpretive frameworks. However, when such information contradicts embodied cues, traditional forecasting practices, or trusted communal advice, farmers are compelled to negotiate between competing sources of meaning. This negotiation entails interpretation, translation, and selective engagement rather than straightforward acceptance or rejection. Through these processes, digital tools may be trusted, questioned, adapted, marginalised, or quietly set aside in practice (Glover *et al.*, 2017; Ingram & Maye, 2020).

Importantly, this interpretive work is neither automatic nor solely individual. It is socially situated within community norms, linguistic repertoires, and shared typifications of what counts as credible and actionable knowledge

in farming practice. Empirical evidence indicates that farmers' knowledge acquisition is strongly mediated by social networks, peer interactions, and relational trust, through which information is collectively evaluated and rendered meaningful (Pratiwi & Suzuki, 2017). Therefore, meanings attributed to digital agricultural technologies emerge through collective sense-making grounded in social relations, historical experience, and cultural context. These dynamics underscore that the evaluation of digital technologies is inseparable from the lifeworlds in which they are encountered, rather than reducible to technological attributes alone (Šūmane et al., 2018; Thomas et al., 2020).

Building on this insight, empirical research consistently indicates that farmers engage with new information not as passive recipients but as active interpreters situated within culturally grounded knowledge systems. Drawing on a multi-country qualitative study, Šūmane et al. (2018) illustrate that farmers integrate formal scientific and advisory knowledge only when it resonates with tacit, experiential understandings developed through practice and social learning. Knowledge integration, in this account, depends on recognition of existing cultural norms, shared meanings, and locally legitimate ways of knowing rather than on the technical authority of information alone.

In a similar vein, Glover et al. (2017) argue that agricultural technologies are not adopted as fixed or stable artefacts when they move into smallholder contexts. Instead, farmers “unpack” and reconfigure technologies through local interpretive practices, reshaping them to align with existing routines, values, and environmental conditions. This process underscores how technologies are translated within everyday farming life, with meaning emerging through situated use rather than from original design intentions.

Thomas et al. (2020) further emphasise that farmers' acceptance and use of externally generated knowledge are mediated by social relations and trust networks embedded in everyday community life. In their study of catchment-sensitive farming initiatives, knowledge circulates through shared experiences, peer discussions, and collective interpretations, reinforcing that engagement with new information is a communal and relational process. Technologies are therefore interpreted, adapted, and sometimes repurposed through collective sense-making processes. Engagement is not merely individual but relational, embedded within community norms and shared typifications of credible knowledge.

Across global and regional scholarship, a consistent insight emerges: digital agricultural technologies are encountered within historically and socially constituted contexts. They are not simply adopted as neutral artefacts but interpreted within lifeworlds shaped by structural conditions, cultural practices, and relational networks (Burrell & Oreglia, 2015; Glover et al., 2019; Klerkx et al., 2019). This synthesis underscores that context is not external to technology engagement but constitutive of its meaning. Understanding digital agriculture therefore requires attention not only to technological attributes but to the experiential and interpretive processes through which technologies become integrated into everyday farming life. This understanding resonates with Glover's (2019) argument that technological interventions in smallholder agriculture do not operate through linear adoption pathways but through processes of encounter, interpretation, and selective engagement. Technologies acquire meaning only insofar as they are oriented toward farmers' lived worlds, reinforcing the view that context is not external to experience but constitutive of how digital agricultural technologies are encountered and rendered meaningful.

III. METHODOLOGY

3.1 Research Design

This study adopts a qualitative and interpretive research design grounded in hermeneutic phenomenology. Rather than generating primary empirical data, it undertakes a critical interpretive synthesis of existing scholarship on digital agriculture and technology adoption, with particular attention to smallholder contexts in Sub-Saharan Africa. The objective is not statistical aggregation but conceptual interrogation: to explore the ontological and epistemological assumptions embedded in dominant adoption frameworks and to reinterpret them through a phenomenological lens.

Hermeneutic phenomenology is appropriate for this task because it understands knowledge as historically situated and interpretive rather than neutral or purely observational. Accordingly, digital agriculture scholarship is treated not as a collection of isolated empirical findings but as a discursive field that reflects particular assumptions about technology, rationality, and human action. The purpose is to surface these assumptions and illuminate their conceptual boundaries.

3.2 Data Sources and Materials

The materials analysed were purposively selected across three interrelated categories. First, influential adoption-oriented frameworks—such as the Technology Acceptance Model (TAM), Diffusion of Innovations (DOI), Theory of Planned Behaviour (TPB), and the Unified Theory of Acceptance and Use of Technology (UTAUT)—together with their empirical applications in agricultural contexts. Second, global and regional empirical studies examining digital agriculture in Sub-Saharan Africa and other smallholder settings. Third, foundational and contemporary texts in phenomenology and hermeneutics, particularly the works of Heidegger, Gadamer, Schutz, and van Manen.

Selection prioritised theoretical influence, citation impact, and conceptual relevance rather than exhaustive coverage. Literature was approached dialogically, entering into conversation with emerging interpretive insights rather than serving as a predetermined explanatory template. The search process was iterative and abductive. Initial engagement with digital agriculture scholarship informed early conceptual framing, while subsequent returns to the literature deepened theoretical clarification as themes emerged. This recursive movement reflects the hermeneutic circle, in which understanding develops through ongoing movement between parts and whole.

Peer-reviewed journal articles, scholarly monographs, policy documents, and selected institutional reports were consulted to ensure both academic rigour and contextual breadth. Electronic databases, including Scopus, Web of Science, ScienceDirect, SpringerLink, and relevant agricultural and development repositories, were used to identify interdisciplinary sources spanning agricultural economics, rural sociology, information systems, and qualitative research methodology. Search terms evolved during the review process and included combinations of “digital agriculture,” “smart farming,” “agricultural digitalisation,” “smallholder farmers,” “technology adoption,” “technology acceptance,” “phenomenology,” “hermeneutic phenomenology,” “lifeworld,” and “lived experience.” Inclusion decisions were guided by conceptual contribution rather than rigid procedural criteria. Emphasis was placed on works that illuminated technology engagement, contextual influences, interpretive meaning-making, or phenomenological theory.

While priority was given to recent scholarship to reflect contemporary developments in digital agriculture, seminal philosophical texts were included to provide ontological grounding. Foundational works were engaged not for historical completeness but for conceptual clarity. Contemporary studies were therefore interpreted through a phenomenological lens, allowing philosophical insights to inform analysis of current digital agriculture discourse.

3.3 Analytical Approach

Analysis followed the logic of the hermeneutic circle, moving iteratively between individual texts and the broader conceptual landscape. Initial readings identified explicit claims concerning adoption, behavioural determinants, and diffusion processes. Subsequent readings explored implicit assumptions about technology, agency, rationality, and the nature of engagement. Through recursive engagement, several recurring patterns emerged: the reduction of experience to measurable constructs; the treatment of technology as a stable and context-independent artefact; the abstraction of engagement from social and historical conditions; and the marginalisation of temporality, embodiment, and intersubjectivity.

These patterns were interpreted using phenomenological concepts such as being-in-the-world, readiness-to-hand, intersubjectivity, and lifeworld. The purpose of the analysis is not to dismiss adoption research but to clarify its conceptual limits and to open space for complementary interpretive inquiry. By situating digital agriculture within a phenomenological framework, the study reorients attention from predictive determinants to lived engagement and meaning-making.

IV. FINDINGS & DISCUSSION

4.1 Findings

4.1.1 Adoption-Centric Digital Agriculture Research: Conceptual Orientation

Digital agricultural technologies are most commonly analysed through behavioural and adoption-oriented frameworks. Models such as the Technology Acceptance Model (TAM), Diffusion of Innovations (DOI), Theory of Planned Behaviour (TPB), and the Unified Theory of Acceptance and Use of Technology (UTAUT) conceptualise technology engagement as the outcome of individual cognitive evaluations concerning usefulness, ease of use, perceived norms, and facilitating conditions (Ajzen, 1991; Davis, 1989; Rogers, 2003).

Empirical applications of these models within agricultural contexts focus primarily on identifying measurable predictors of adoption, including education level, access to devices, training exposure, perceived benefits, and social influence. For example, in farming contexts, Abioye *et al.* (2024) applied an extended Technology Acceptance Model (TAM) to investigate smallholder farmers' willingness to adopt digital agricultural application tools in Ogun State, Nigeria, finding that education, training, internet access, smartphone ownership, awareness of digital tools, willingness to use paid applications, and perceived cost significantly shape adoption, while female farmers exhibit lower willingness to adopt. Similarly, in the Nigerian context, Eweoya *et al.* (2021) applied the Unified Theory of Acceptance and Use of Technology (UTAUT) to examine the acceptance and use of e-agriculture, finding that performance expectancy, effort expectancy, social influence, and habit significantly shape behavioural intentions, with performance expectancy emerging as the most influential determinant of use, while facilitating conditions, hedonic motivation, and price value showed weaker or insignificant effects.

In Nepal, Mishra *et al.* (2024) used the Technology Acceptance Model (TAM) to examine factors influencing farmers' behavioural intention toward adopting Agriculture 5.0 technologies, showing that perceived usefulness and ease of use significantly predicted intention to adopt digital tools. In the Chinese context, Zhang *et al.* (2024) applied an extended Unified Theory of Acceptance and Use of Technology (UTAUT/UTAUT2) to investigate small rural farmers'

acceptance and use of new agricultural technologies, finding that performance expectancy, effort expectancy, and hedonic motivation significantly influenced intention to use, while facilitating conditions and intention directly shaped actual technology use. The study further shows that intention mediates the relationship between key expectancy variables and use, reinforcing the treatment of adoption as a function of measurable cognitive evaluations and behavioural intentions.

In the European context, Mohr and Köhl (2021) applied a composite Technology Acceptance Model (TAM) and Theory of Planned Behaviour (TPB) to examine farmers' acceptance of artificial intelligence (AI) in German agriculture, finding that perceived behavioural control and attitudes toward AI were the strongest predictors of acceptance, with perceived ease of use influencing acceptance indirectly through perceived usefulness. While the Diffusion of Innovation is less frequently applied in recent empirical farm technology adoption literature, in South Africa Zondo and Ngoro (2023) explicitly used Diffusion of Innovations (DOI) to examine smallholder farmers' adoption of social media as an agricultural advisory tool in South Africa, showing that relative advantage, compatibility, trialability, observability, and complexity significantly shape adoption patterns, with effects varying by gender, age, education level, and cooperative membership.

These studies have contributed significantly to understanding patterns of uptake and identifying structural barriers. They provide valuable insight into observable determinants of technology adoption across diverse contexts. However, these models share a common conceptual orientation: they treat engagement as a rational decision process shaped by quantifiable variables. Technology appears as a discrete artefact evaluated prior to use, and the farmer is positioned primarily as an individual decision-maker.

4.1.2 Ontological Assumptions Embedded in Adoption Models

Building on this conceptual orientation, adoption-centric frameworks rest upon specific ontological assumptions about technology and human action. First, they assume that technology engagement is fundamentally cognitive and evaluative. Behavioural intention is positioned as the primary explanatory mechanism through which use is explained. Technology engagement is therefore reduced to measurable perceptions such as usefulness, ease of use, or perceived norms. However, lived experience is not reducible to attitudes or intentions. Farmers' engagements with digital tools are shaped by memories of past interventions, seasonal rhythms, social obligations, and embodied familiarity with farming practices—dimensions that exceed behavioural quantification (Bronson, 2019; van Manen, 2023). By conceptualising engagement primarily as a cognitive assessment, adoption frameworks risk misrepresenting how technologies are actually lived in practice.

Second, adoption models treat technology as a stable and functionally defined object whose meaning is assumed to be intrinsic to its features. Technologies appear as neutral tools awaiting acceptance or rejection. Yet empirical studies suggest that digital tools are continually reinterpreted, adapted, repaired, improvised, or repurposed through situated and collective use (Klerck *et al.*, 2019; Steinke *et al.*, 2021). Meaning does not reside solely in technological features but emerges through practical involvement. From a phenomenological perspective, technologies become meaningful—or meaningless—through use, breakdown, and routine engagement rather than through pre-use evaluation (Heidegger, 1996).

Third, adoption frameworks abstract engagement from temporal and historical situatedness, conceptualising adoption as a discrete decision rather than an unfolding process. Decision-making is treated as temporally bounded, overlooking how past experiences and future anticipations shape present engagement (Laverty, 2003). Heidegger's notion of historicity reminds us that understanding is always situated within temporal horizons shaped by biography and collective memory (Heidegger, 1996). Farmers' interpretations of digital technologies are therefore informed by prior encounters with development projects, institutional trust or distrust, and accumulated farming experience.

These assumptions are not methodological errors but conceptual orientations. They prioritise measurable determinants while backgrounding experiential, relational, embodied, and historical dimensions of technological engagement. In doing so, adoption frameworks illuminate certain aspects of engagement while leaving others analytically underdeveloped.

4.1.3 Experiential Dimensions Marginalised in Adoption Research

When viewed through a phenomenological lens, several dimensions of engagement appear insufficiently explored within adoption-centric research. Recent critiques in digital agriculture increasingly argue that behavioural models fail to capture the complexity of farmers' lived engagements with technology. Rather than illuminating how technologies are encountered, negotiated, and made meaningful in everyday farming life, adoption models tend to abstract use into simplified variables that obscure experiential, relational, and contextual realities. *Temporality*: Engagement with digital technologies unfolds across time. Farmers may experiment, discontinue, revisit, or reinterpret technologies across seasons and changing circumstances. Meaning develops gradually through trial, error, trust-building, disappointment, and adaptation (Baumüller, 2018; Rose *et al.*, 2021).

However, adoption frameworks typically conceptualise uptake as a discrete decision point rather than an ongoing temporal process. Their reliance on linear assumptions of diffusion and sustained use struggles to account for the non-linear, intermittent, cyclical, or partial engagement patterns observed in sub-Saharan Africa (Klerkx *et al.*, 2019; Tabe-Ojong Jr *et al.*, 2023). Technologies may be adopted, abandoned, and later reintroduced depending on market fluctuations, infrastructural instability, or seasonal pressures.

Moreover, adoption models rarely account for the temporal rhythms of farming life itself—such as timing of rainfall, seasonal labour intensity, or moments of heightened climatic risk. Yet these rhythms fundamentally shape when digital information becomes relevant, urgent, or impractical. Engagement is therefore woven into lived agricultural temporality rather than occurring at a single moment of ‘adoption.’ *Embodiment*: Technologies are encountered through practical activity. Digital advisories are interpreted in relation to embodied knowledge, sensory cues, accumulated farming experience, and tacit skill. Farmers assess recommendations not only cognitively but through comparison with soil texture, crop appearance, weather patterns, and experiential memory. Phenomenological scholars argue that meaning emerges through practical involvement rather than detached evaluation (Heidegger, 1996). By reducing experience to attitudinal variables, adoption models overlook how engagement is bodily, skill-based, and situated within ongoing agricultural practice. *Intersubjectivity*: Engagement is rarely purely individual. Learning occurs through peer interaction, communal experimentation, and shared narratives of success and failure. Farmers interpret digital information within kinship networks, cooperatives, extension relationships, and community discussions. Schutz’s phenomenology emphasises that meaning is socially constructed through intersubjective relations rather than individual cognition alone (Schutz, 1967). Empirical studies confirm that trust in extension officers, collective decision-making, and peer validation strongly shape engagement with digital technologies (Klerkx *et al.*, 2019; Steinke *et al.*, 2021). Adoption models, however, privilege individual perception and behavioural intention, thereby marginalising collective meaning-making processes central to smallholder farming life. *Historicity and Memory*: Past experiences with development interventions, technological breakdowns, subsidy programmes, or institutional promises shape present orientations toward digital tools. These historical layers influence expectations, scepticism, trust, and openness. Adoption models seldom account for how memory and biography structure engagement. Yet farmers’ present interpretations are inseparable from prior encounters with both success and failure. Engagement is therefore historically sedimented rather than purely contemporary or attitudinal.

Infrastructural and Environmental Situatedness: Environmental realities—including climatic uncertainty, seasonal labour pressures, cultural norms, and linguistic constraints—fundamentally shape how digital technologies are encountered and used (Baumüller, 2018). Unstable connectivity, unreliable electricity, and shifting institutional support further render engagement intermittent and negotiated. These contextual conditions do not merely influence adoption decisions; they actively structure the meaning and feasibility of technology use in everyday agricultural life. In such contexts, engagement may become situational, partial, or adaptive rather than linear and sustained. Collectively, these limitations do not invalidate adoption research. Rather, they demonstrate the boundaries of its explanatory scope. Adoption frameworks illuminate patterns of uptake and measurable determinants but remain less equipped to account for experiential, embodied, relational, temporal, and interpretive dimensions of digital agriculture. Understanding how farmers make meaning of technologies within their lifeworlds, therefore, requires methodological orientations attentive to lived experience—orientations grounded in phenomenology rather than behavioural prediction.

4.4 Discussion

4.4.1 Phenomenological Reorientation: From Adoption to Engagement

Phenomenology offers an alternative orientation to adoption-centric frameworks by shifting attention from predictive determinants of uptake to the structures of lived engagement. Rather than asking why farmers adopt or reject technologies, a phenomenological approach seeks to understand how technologies are encountered, interpreted, and woven into everyday agricultural practice. Its concern lies not with behavioural prediction but with the meanings that emerge within farmers’ historically and socially situated worlds (van Manen, 2023). Its concern is not with predicting behaviour or measuring determinants of uptake, but with revealing the structures of lived experience that render technology meaningful, or meaningless, within the farmer’s world.

A hermeneutic phenomenological approach, grounded in the philosophy of Martin Heidegger and further developed by Hans-Georg Gadamer, Alfred Schutz, and Max van Manen, provides the conceptual resources for such an inquiry (Alsaigh & Coyne, 2021; Gadamer, 1989). Heidegger’s ontology of being-in-the-world challenges the view of technology as a detached object evaluated through rational choice. Instead, technologies are encountered as integrated elements of practical activity, lived through bodily engagement, concern, and relational involvement. Concepts such as *Zuhandenheit* (readiness-to-hand), *Sorge* (care), and *Mitsein* (being-with) illuminate how digital tools become part of farmers’ meaningful worlds, shaping experiences of time, space, embodiment, and social relations.

Central to this phenomenological stance is the concept of the *lifeworld*, the taken-for-granted horizon of everyday experience within which action and understanding unfold (Schutz, 1967). Technologies are not neutral instruments encountered prior to use; rather, their meaning emerges through use, practice, and situated engagement

(Heidegger, 1996). Understanding, therefore, is not simply a function of information access or technical knowledge but develops through ongoing interaction within concrete farming contexts.

Hermeneutic phenomenology further recognises that meaning is always interpretive, historically situated, and co-constituted between researcher and participant (Gadamer, 1989). Drawing on Schutz's (1967) emphasis on intersubjectivity, this approach highlights how technological meanings are negotiated through dialogue with peers, extension officers, cooperatives, and community networks. Digital technologies become meaningful when they resonate with farmers' lived vulnerabilities, aspirations, and daily struggles; conversely, non-use may reflect misalignment with lifeworld realities rather than resistance, ignorance, or irrationality.

By attending to these existential, practical, and relational dimensions, hermeneutic phenomenology provides the conceptual depth necessary to illuminate digital agricultural technologies as lived phenomena. It opens analytic space for interpretations grounded in farmers' everyday worlds, offering an alternative to externally imposed models of rational adoption and enabling a richer understanding of technology as experienced, interpreted, and woven into the fabric of everyday farming life.

4.4.2 Implications for Digital Agriculture Research

Re-orienting digital agriculture research toward lived experience carries significant implications at multiple levels of scholarship and practice. At the theoretical level, such a shift unsettles the dominance of adoption as the primary explanatory framework in digital agriculture. Rather than positioning technology use as a function of measurable behavioural determinants, an experiential orientation foregrounds meaning-making as central to understanding how farmers engage with digital tools. This perspective recognises that technologies acquire significance through situated use, interpretation, and relational involvement, thereby challenging techno-centric and predictive models that reduce engagement to rational evaluation (Bronson, 2019).

Methodologically, an emphasis on lived experience supports qualitative, interpretive, and idiographic research designs capable of capturing the depth and texture of farmers' engagements with digital technologies. Approaches grounded in hermeneutic phenomenology, narrative inquiry, and other interpretive traditions enable researchers to explore how technologies are encountered, embodied, negotiated, and woven into everyday agricultural practice (Ajjawi & Higgs, 2007; Conroy, 2003). Such methods move beyond surface-level indicators of uptake to explore the experiential structures that shape use over time.

At the level of policy, this reorientation encourages the development of context-sensitive digital interventions grounded in farmers' lived realities rather than assumed rationalities. Recognising that technology engagement is shaped by social relations, historical memory, linguistic context, and infrastructural conditions allows policymakers to design programmes that resonate more closely with rural lifeworlds (Klerkx & Rose, 2020). Finally, for technology design, an experiential perspective underscores the importance of participatory and user-centred approaches that respect and incorporate farmers' lived worlds. Engaging farmers directly in iterative co-creation processes helps ensure that digital tools align with practical routines, cultural norms, and collective practices. Such design philosophies move beyond technological functionality alone and attend to how technologies are experienced and made meaningful in everyday life (Rose *et al.*, 2021).

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

Digital agricultural technologies continue to be positioned as transformative instruments for strengthening smallholder farming systems. This study has shown, however, that dominant adoption-centred research frameworks offer only a partial understanding of how such technologies are encountered in practice. While behavioural models provide valuable insight into measurable determinants of uptake, they conceptualise engagement primarily as an individual cognitive decision shaped by quantifiable variables. By contrast, this study has argued that digital agricultural technologies are encountered within historically and socially structured lifeworlds. Engagement unfolds as a situated process shaped by temporality, embodiment, intersubjective relations, and infrastructural conditions. Technologies acquire meaning through practical involvement rather than through abstract evaluation alone.

The central contribution of this study lies in clarifying the conceptual and ontological limits of adoption-centric research. Rather than displacing adoption-centric research, this analysis clarifies its conceptual boundaries and demonstrates the value of complementary interpretive inquiry capable of illuminating dimensions of engagement that remain analytically underdeveloped. A phenomenological orientation therefore broadens the scope of digital agriculture research by foregrounding lived meaning and situated practice. Understanding digital agriculture thus requires moving beyond the question of whether technologies are adopted to exploring how they are interpreted and integrated within everyday farming life. Such a shift strengthens the analytical depth of scholarship concerned with digital transformation in smallholder contexts.

5.2 Recommendations

Future studies should integrate interpretive and phenomenological approaches into digital agriculture scholarship. Empirical research grounded in lived experience can deepen understanding of how technologies are encountered across different seasons, institutional environments, and social networks. Longitudinal and qualitative designs may be particularly valuable in exploring how engagement evolves over time rather than treating adoption as a discrete event. Researchers should also explore how trust, historical experience, and relational dynamics influence engagement with digital tools. Such inquiry would complement behavioural models by incorporating dimensions that extend beyond measurable predictors.

Policymakers and development practitioners should recognise that infrastructural provision and training alone do not guarantee meaningful engagement. Digital interventions must be responsive to existing knowledge systems, relational networks, and contextual realities. Designing context-sensitive initiatives requires attention to how technologies are interpreted within specific farming environments rather than assuming uniform applicability. Institutional support mechanisms should prioritise continuity, reliability, and trust-building processes to mitigate experiences of infrastructural instability that may undermine sustained engagement.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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