

# DIGITAL FINANCIAL INCLUSION IN AGRICULTURE: A BIBLIOMETRIC AND TCCM BASED SYSTEMATIC LITERATURE REVIEW

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## Abstract

Mobile banking, fintech platforms and digital credit are driving Digital Financial Inclusion (DFI) to boost agricultural finance and rural livelihoods. The study followed a systematic review approach with the PRISMA protocol, bibliometric analysis and the TCCM approach in the field of agriculture DFI research. A total of 67 articles Scopus-indexed, published from 2021–2026 were analysed. Findings show significant research activity, especially since 2022, driven by India, China, the United States, and Indonesia. Key themes include financial inclusion, mobile banking and rural finance, sustainability. Digital illiteracy, lack of infrastructure, cybersecurity threats, gender disparity and regulatory fragmentation are the main barriers highlighted. The review also identifies gaps regarding impact assessment, gendered access and policy-oriented inquiry, emphasising the need for inclusive, resilient and technology-enabled agricultural financial inclusion.

**KEYWORDS:** Digital Literacy, Financial Literacy, Fintech Adoption, Mobile Banking, Rural Development.

## 1. INTRODUCTION

Digital financial inclusion (DFI) which includes mobile money, digital credit, online savings platforms and fintech-enabled services is a game-changing phenomenon in the global journey towards the democratisation of financial services, especially in agrarian economies (Sharma et al., 2024). Despite strides made at the system level, about 1.7 billion adults around the world remain outside the formal financial system, and urban-rural inequalities continue to be deeply entrenched (Damayanti et al., 2026). The rise in global bank account ownership from 51% in 2011 to 71% in 2021 hides underlying structural inequities that make fintech an integral, not optional, pathway for underserved rural populations (Iatzaz Ul Hassan et al., 2025). Agricultural DFI tools have shown significant potential to reduce ongoing credit bottlenecks, modernize agricultural production processes, and facilitate climate-smart agriculture, thereby supporting multiple United Nations Sustainable Development Goals (SDGs) (Anakpo et al., 2023; Hornuf et al., 2025).

The context of India is especially illuminating because, whilst agriculture alone accounts for about 18% of the country's GDP, and supports nearly half of the working population, chronic credit exclusion for smallholder farmers remains severe despite the country's fast-growing fintech trajectory (Sharma et al., 2025). The combined effect of landmark government initiatives such as Digital India, the Pradhan Mantri Jan Dhan Yojana (PMJDY), Aadhar-based biometric identification and the Unified Payments Interface (UPI) has driven the share of the adult population holding formal bank accounts to about 80% (Parlasca et al., 2022; Migozzi et al., 2024). However, constraints to meaningful use among smallholder farmers remain substantial, due to the combined impact of demand and supply side challenges which current policy frameworks are unable to address. Evidence from other developing countries, such as Sub-Saharan Africa, Southeast Asia and Latin America indicates that this issue of infrastructure expansion and substantive financial access is not unique to India and is more systemic in nature (Phan et al., 2024; Sam-Abugu et al., 2025). Where DFI adoption does take place, it has been shown to exert a positive effect on reducing the vulnerability of rural households to poverty, notably for lower-income households, by prompting entrepreneurial behaviour. (Chen et al., 2022)

Adoption barriers exist in various layers. On the demand side, lack of awareness about fintech products, limited or disrupted internet and telecommunication access in rural areas, and the absence of last-mile infrastructure tailored to seasonal agricultural cash flows and risk needs dampen uptake (Sharma et al., 2025; Divi et al., 2025). These compound with low digital literacy, perceived technological risk, social distrust, and gender exclusion and lack of formal identification, making typical financial products inaccessible to the most vulnerable farmers (Zhang et al., 2024; Kong & Loubere, 2021). The rapid growth of digital lending brings serious threats: algorithmic credit scoring models have been shown to reproduce social biases, exacerbating gender credit gaps (Oluoch & Alhassan, 2026). Rising digital fraud and predatory lending by some fintech firms make economically disadvantaged groups more susceptible to financial exploitation (Prashanth et al., 2026; Admiral et al., 2025). The benefits of greater financial access are not necessarily proportional to increased access (the “productivity paradox”); this is attributed

to structural inequalities and threshold effects that diminish DFI's developmental impacts (Yan et al., 2025; Kong & Loubere, 2021). Despite this, human intermediaries such as banking correspondents, SHG leaders and village officials like Lekhpals, and Gram Pradhans have been pivotal in bridging technological and socio-cultural gaps, extending last-mile credit, and enabling access to mobile money, Self-Help Group schemes and digital microfinance (Nova & Gonzalez, 2023; Divi et al., 2025; Sharma et al., 2025; Hornuf et al., 2025).

While this literature has expanded and diversified, gaps remain. Rural-specific, agriculture-contextualized analyses are still relatively limited (Sharma et al., 2024; Kong & Loubere, 2021), and most studies lack integrative frameworks combining structural and behavioural factors of DFI adoption (Damayanti et al., 2026). Long-term impacts of DFI on income inequality, food security, and climate resilience remain under studied (Sharma et al., 2025; Hornuf et al., 2025). Furthermore, prior bibliometric studies have tended to focus separately on fintech or financial inclusion, while a synthesis fintech, India's institutional and policy settings, and the mediating role of human intermediation remains significantly underdeveloped.

Against this backdrop, the present study pursues three interrelated objectives: (1) to conduct a systematic review and bibliometric analysis of the global literature on DFI in rural and agricultural contexts; (2) to map demand-side and supply-side barriers constraining DFI adoption among smallholder farmers; and (3) to examine the mediating role of agricultural extension agents and rural development programmes in facilitating DFI outcomes. These objectives are structured around three research questions (RQs):

RQ1: What are the publication trends, geographical patterns and thematic evolution of digital financial inclusion (DFI) research in agriculture?

RQ2: What is the primary demand-side and supply-side barriers to DFI among smallholder farmers?

RQ3: What role do agricultural extension agents and rural development programmes play in facilitating DFI?

## **2. METHODOLOGY**

The Systematic Literature Review (SLR) approach is used, as it is a systematic, transparent and replicable method of building a literature database. The review is conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021) to assure the methodological rigor in identifying, screening and synthesizing relevant articles.

### **2.1. Document Search**

To get a comprehensive cross-section of literature, the articles were retrieved from the Scopus database, using Search strategy mentioned in (Table 1). Web of Science, EconLit and AGRIS aren't able to package financial technology along with agricultural science literature into a single, consistently indexed platform, as is done in Scopus for this interdisciplinary study. It is recognised that this is a limitation as the use of a single database limits breadth and robustness and future reviews would benefit from a multi-database approach. The search focused on publications from 2021-2026 providing a snapshot of the foundational study of DFI as well as current trends.

### **2.2. Article Screening and Development of Literature Database**

Using predefined inclusion and exclusion criteria, records were processed through five sequential screening stages:

1. Deduplication: Duplicate records were deduplicated using the tools of Scopus and manually checked.
2. Title and Abstract Screening: The title and abstract were screened by using the predefined keywords. Those studies that did not fit the research focus were excluded.
3. Full-Text Review: Articles passed initial screening were submitted for full-text review. Inclusion was based on the (Table 2). To ensure that these articles were not redundant and relevant to the research objectives,
4. Eligibility and Relevance Check was performed.
5. Synthesis: The selected studies were thematically synthesized to discuss the digital financial inclusion in agriculture.

### **2.3. Method of Data Analysis**

Bibliometric analysis was conducted using Bibliometrix (version 4.x) in R (version 4.4.2), accessed via the Biblioshiny graphical interface. Bibliometrix is a widely adopted open-source tool for scientific mapping, offering graphical and statistical outputs for analysing publication trends, author collaboration networks and thematic evolution (Aria & Cuccurullo, 2017). VOS viewer was used to construct keyword co-occurrence network maps that visualize conceptual clustering and thematic linkages within the field (Van Eck & Waltman, 2010). Additionally, the TCCM (Theory-Context-Characteristics-Methodology) framework (Paul et al., 2021) was applied to thematically structure and synthesize the 67 reviewed articles, providing a standardized analytical lens that organizes existing knowledge across theoretical foundations, geographic and sectoral contexts, key research variables and methodological approaches.

### **2.4. Limitations of the Review**

Several limitations of this review should be acknowledged. Firstly, the study is only based on the Scopus database and some studies may not have been found as other databases like Web of Science and Econ-Lit are not included, which may have led to missing related studies, especially those published in the regional or non-indexed journals. Second, the search was conducted in English, which may have missed reports of valuable contributions by other research traditions that are not Anglophone. Third, the five-year boundary (2021-2026) is suitable to capture the contemporary DFI era, but does not include the earlier studies providing theoretical grounding on financial inclusion and agricultural credit in rural areas. Fourth, grey literature (policy reports, working papers or practitioner evaluations) which frequently include current empirical evidence on DFI interventions in agricultural

contexts, is not included in this review. Fifth, any given aspect of the TCCM framework, though analytical, may not be comprehensive enough to describe the dynamics that extend beyond the four dimensions. Further reviews on these limitations, with multi-database search strategies and language-inclusive screening and grey literature integration would significantly enhance the evidence base.

## 2.5. PRISMA Flow Diagram

The selection process followed PRISMA guidelines (Page et al., 2021). A total of 1,497 documents were initially identified from the Scopus database. Following inclusion and exclusion criteria screening, 470 articles were retained for abstract review, from which 139 progressed to full-text evaluation. After rigorous full-text screening against the study's three research questions, 67 articles were ultimately included in the final synthesis (Fig. 1).

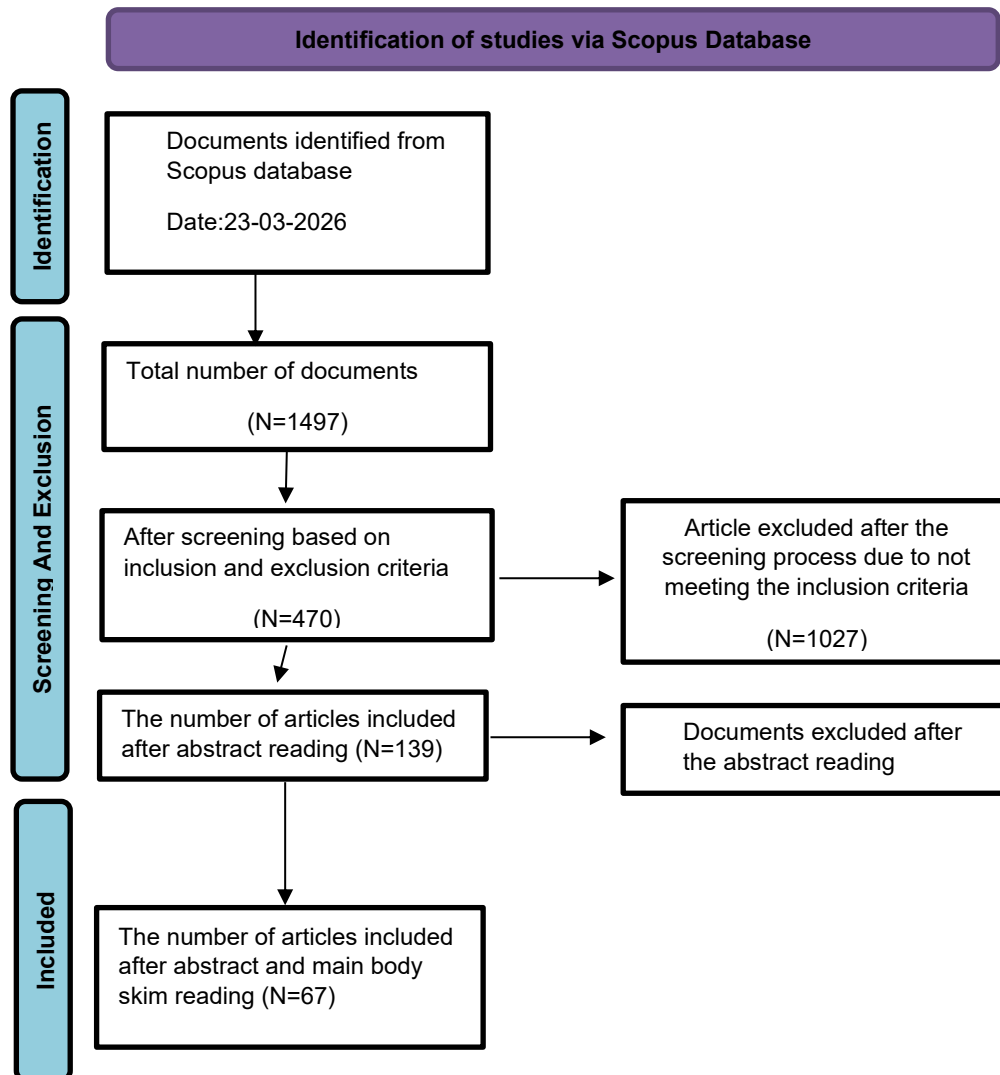


Fig.1 PRISMA framework

## 3. RESULTS

### 3.1. Bibliometric Analysis

#### 3.1.1. Annual Scientific Production

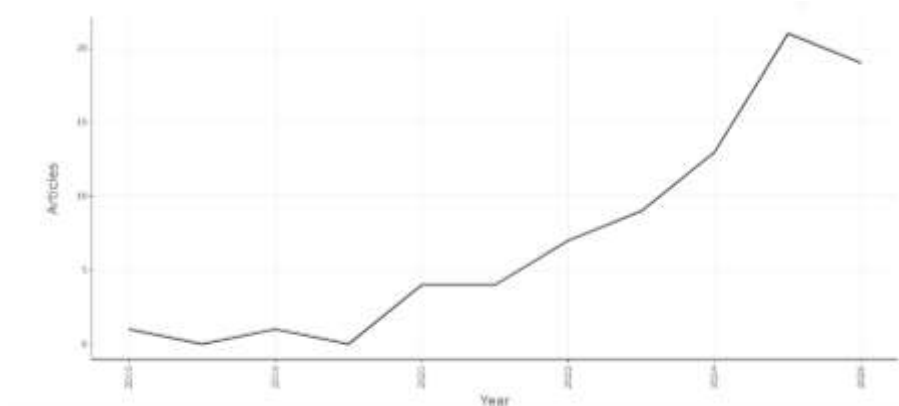
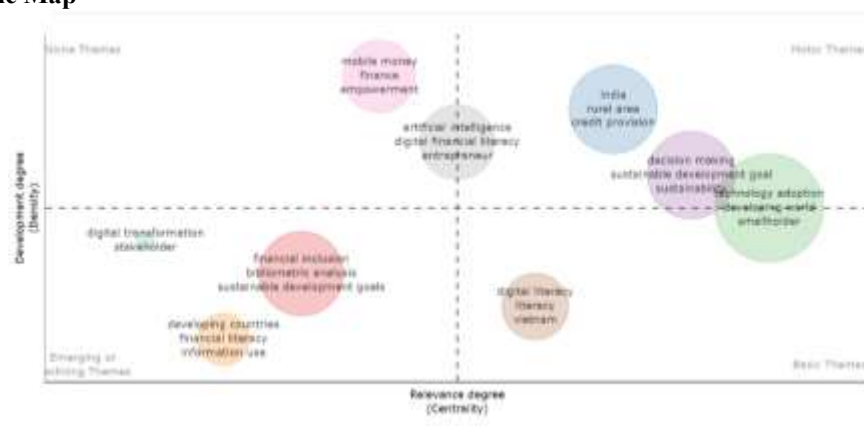


Fig. 2 Annual Scientific Production graph from 2016 to 2026

Fig.2 shows the yearly growth in scientific publications from 2016 to 2026, based on the 67 articles reviewed. Research activity was low from 2016 to 2019, as DFI was still a new field. Activity picked up from 2020, likely due to the COVID-19 pandemic, which increased digital reliance and sped up fintech adoption. The biggest jump happened after 2022, with the most publications in 2025. Overall, the field grew at an annual rate of 34.24%, showing strong and steady interest in this area.

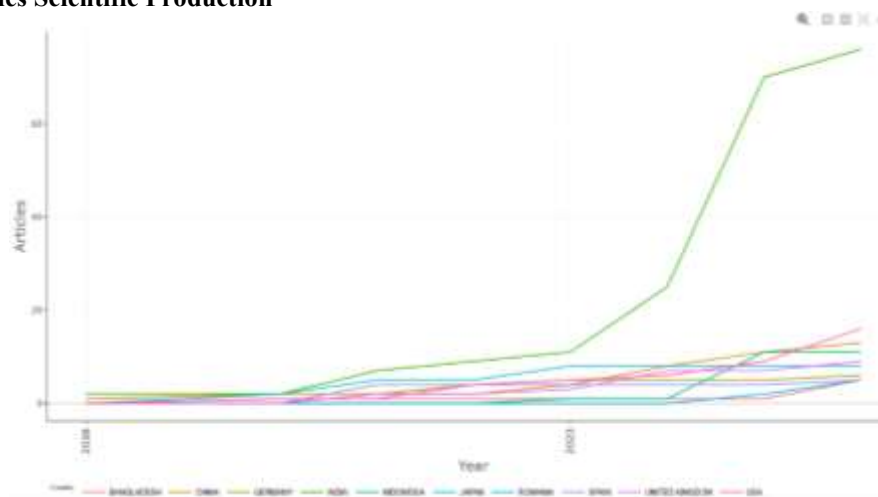
### 3.1.2. Thematic Map



**Figure 3: Thematic Map**

By arranging themes along axes of centrality (relevance to the field) and density (internal development) the thematic map (Fig. 3) illustrates the intellectual structure of the field. “Technology adoption”, “smallholder” and “developing world” are examples of motor topics that fall into the high centrality, high density quadrant, demonstrating their fundamental and cohesive position in the literature. Scholarly attention is increasingly focused on themes like “decision making” and “sustainability”. Well-developed and strategically important themes, such as “rural area”, “credit provision” and “India”, are captured in the upper-right quadrant. Specialized yet internally cohesive study fields are represented by niche themes such as “mobile money”, “finance” and “empowerment”. The lower-left quadrant identifies subjects that need more scholarly attention, such as “financial literacy”, “information use” and “digital transformation”.

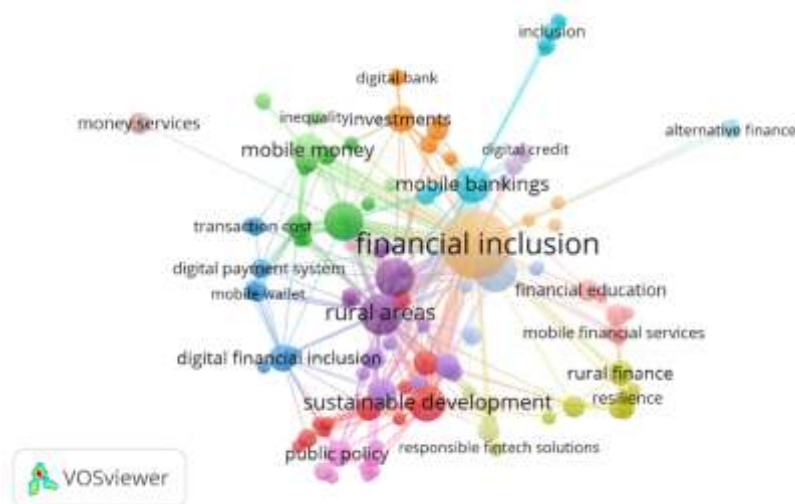
### 3.1.3. Countries Scientific Production



**Fig. 4 Country Production Over Time**

India has the most notable increase trend in publication output among contributing nations; which is indicative of its growing prominence in DFI studies (Fig. 4). Notable but relatively moderate growth is also observed in nations including the United States, China, the United Kingdom and Indonesia. The increasing globalisation of DFI research and the unique value of Asian and Sub-Saharan African countries as empirical frameworks for researching digital financial inclusion in agricultural settings are both reflected in this tendency.

### 3.1.4. Keyword Co-occurrence analysis



**Fig. 5 Co-occurrence Network**

The field's prevailing study themes and connections between concepts are mapped using the keyword co-occurrence analysis (Fig.5). The most prominent keyword is “financial inclusion”, highlighting its fundamental function throughout the literature. The field's increasing focus on digital and technology enabled access is reflected in the strong correlations found between financial inclusion and phrases like “mobile banking”, “mobile money”, “digital financial inclusion” and “financial education”. A noteworthy topic cluster emerges around “sustainable development”, which is closely associated with “public policy”, “fintech solutions”, “resilience” and “rural finance”. This indicates the increasing scholarly attention being paid to the ways in which DFI may support inclusive development. Using terms like “rural areas”, “rural finance” and “mobile financial services”, the network further emphasizes a rural and community focus.

### 3.2. Analysis of TCCM Framework

Theory-Context-Characteristics-Methodology (TCCM) is used to present a systematic synthesis of the 67 studies that were examined, which focuses on DFI and fintech adoption in agriculture. The ensuing subsections go over each dimension, point out prevailing trends and connect them to particular literary masterpieces.

#### 3.2.1. Theory (T)

Perceived usefulness and perceived ease of use are two concepts from the Technology Acceptance Model (TAM) that are still the most widely used in the assessment of attitudes towards digital financial products, as confirmed by other studies (Hornuf et al., 2025; Igamo et al., 2024; Nova & Gonzalez, 2023; Verma et al., 2025). With the inclusion of Performance expectancy, Effort expectancy, social influence and Facilitating conditions, the Unified Theory of Acceptance and Use of Technology (UTAUT/UTAUT2) extend TAM, and it has shown to be more effective in a sociocultural adoption scenario (Hornuf et al., 2025; Sharma et al., 2024; Sharma et al., 2025; Antwi-Boampong et al., 2022). Adopters are classified according to Diffusion of Innovation Theory (DIT), and compatibility and trialability are highlighted as important factors for rural and marginalized (Nyide et al., 2026; Kraiwanit et al., 2024; Igamo et al., 2024; Hornuf et al., 2025). In addition to adoption models, the Theory of Planned Behaviour (TPB) which incorporates subjective norms and perceived behavioral control, provides an explanation for the continuance intention (Marhadi et al., 2024; Igamo et al., 2024). The Resource-Based View (RBV) perspective explains that fintechs are a strategic asset that gives competitive advantage. This theory suggests that technology with the value-rarity-unique-non-substitutable (VRIN) characteristics can enhance the efficiency of transactions and client satisfaction for financial institutions while also reducing churn. The theory states that technology that has value, is rare, unique and non-substitutable (VRIN) can not only help to increase the efficiency of transactions but also improve client satisfaction and decrease churn for financial institutions. Institutional theory, which aims to understand how fintech is de-institutionalizing the access to services, has also been used to study the development of new market regulations, that must eventually be formalized by the authorities (Zhang et al., 2024; Campos-Teixeira et al., 2025; Kadir & Musataklima, 2024).

#### 3.2.2. Context

Empirical contexts are geographically specific. Indian studies address UPI and mobile banking adoption alongside inclusion challenges for smallholder farmers, disadvantaged communities and marginalized groups including transgender individuals (Sharma et al., 2024; Kumari & Mohanty, 2024; Raja & Khan, 2025). Chinese contributions centre on the state-led Digital Village initiative, agricultural mechanization and digitalization of rural households (Zhang et al., 2024; Chai et al., 2023). Islamic rural banks (BPRS) and Shariah-complaint peer-to-peer (P2P) financing are frequently studied in Indonesia (Kadir & Musataklima, 2024; Marhadi et al., 2024). Studies from Kenya, Ghana, Nigeria and the WAEMU region that examine gender-related access barriers, the political economy of financial infrastructure and mobile money adoption are representative of African contexts (Bernards, 2022; Oluoch & Alhassan, 2026; Ahamadou & Agada, 2023). Digital trust and loan access in Southeast Asia is examined in Vietnam, Thailand and Indonesia (Hoang et al., 2026; Kurniasari et al., 2026). In Jordan, vulnerable groups benefit from the use of FinTech to improve the resilience of the markets, but adoption rates are

still low with 38% of users being mobile wallet in cities compared with 24% in rural areas (Mashaqbeh et al., 2026). The COVID-19 pandemic, on one hand, provides an important time context throughout the text, as it became a major driver of digital financialization globally, and on the other, a key driver of structural gaps for financially-disengaged groups, as well as the urgency and inequity of digital financial transformations (Anakpo et al., 2023; Hornuf et al., 2025). Also, there are situations that have not yet been studied, such as technology resistance among older farmers, and the disability vulnerability and marginalisation of rural workers in countries like Colombia (Nova & Gonzalez, 2023; Peprah et al., 2023).

### **3.2.3. Characteristics**

Research variables span psychological, institutional and technological domains. Trust and digital financial literacy are consistently identified as primary adoption determinants (Sharma et al., 2024; Hoang et al., 2026; Phan et al., 2024). Behavioral economics constructs, particularly loss aversion, institutional mistrust and cognitive biases significantly hamper rural adoption (Sudarsan et al., 2025; Setiawan et al., 2021). Institutional performance metrics including Return on Assets (ROA), Return on Equity (ROE) and bank size are measured in relation to fintech adoption's effects on banking profitability (Verma et al., 2025). Barriers combine supply side infrastructure deficits and regulatory ambiguity with demand side obstacles: lack of official identification, information asymmetry, high transaction costs and restrictive gender norms characterize barriers to inclusion (Ahamadou & Agada, 2023; Bernards, 2022; Anakpo et al., 2023). Technological features analysed include Mobile banking platforms, UPI, P2P lending, AI-driven credit scoring and agricultural mechanization (Zhang et al., 2024; Kadir & Musataklima, 2024; Alhassan et al., 2026).

### **3.2.4. Methodology (M)**

A wide variety of methodological techniques are used in the examined works, with a focus on quantitative and econometric modelling. The most widely used technique for evaluating adoption frameworks is structural equation modelling (SEM) and partial least squares-SEM (PLS-SEM) (Sharma et al., 2024; Marhadi et al., 2024). Econometric methods such as probit models, fixed-effects regression and Regression Discontinuity Design (RDD) are applied to household survey data and impact evaluations of digital technologies (Raja & Khan, 2025; Zhang et al., 2024). Qualitative methods include semi-structured interviews and thematic analysis to document the lived experiences of rural users (Damayanti et al., 2026), as well as Design Science Research (DSR) for developing and evaluating agri-apps and digital marketplace platforms (Nova & Gonzalez, 2023). Secondary datasets frequently drawn upon include the Global Findex, FinAccess longitudinal surveys and the China Household Finance Survey (CHFS), often complemented by primary survey data (Oluoch & Alhassan, 2026; Zhang et al., 2024). A common methodological tool for identifying research trends and conceptual co-occurrences is bibliometric mapping utilizing Biblioshiny and VOSviewer (Ashurbayli-Huseynova & Garmidarova, 2025). With TAM and UTAUT dominating the theoretical landscape, China and India driving empirical output and SEM/PLS defining methodological practice, the TCCM synthesis depicts a methodologically rigorous yet theoretically and geographically concentrated discipline, with comparative cross-national frameworks remaining conspicuously absent.

## **4. DISCUSSION**

### **4.1. Demand-Side Obstacle to Smallholder Farmer's Access to Digital Finance**

Demand side barriers are related to the features, capacities and attitudes of smallholder farmers and not with service providers or infrastructure. The literature reviewed above highlights six such barriers, namely financial and digital illiteracy, trust deficits, risk aversion, social and gender exclusion, lack of identity documentation and cultural and religious barriers. These factors drive farmers' adoption and preparedness to use digital financial services even in countries where these digital services are technically available.

#### **4.1.1. Low Financial Literacy and Digital Illiteracy**

Digital illiteracy is consistently found to be the main demand-side obstacle to DFI. Accordingly older farmers exhibit significant resistance to technology (Nova & Gonzalez, 2023) and there is a clear generational split in rural India, where older farmers are particularly challenged by digital interfaces (Divi et al., 2025; Sudarsan et al., 2025). At the psychological level, behavioural intentions are heavily influenced by the trade-off between perceived risks and the relative advantages of digital payment services (Padma Kiran & Vedala, 2025). Social influence and perceived ease of use are key drivers of mobile payment adoption among youth, whereas privacy risks act as a significant deterrent (Purohit et al., 2022). Elderly household heads in Southeast Asia are often excluded from digital financial inclusion and adoption intention remains consistently low wherever users perceive high risk or poor usability (Phan et al., 2024, Kuriakose & Sajoy, 2023, Hoang et al., 2026). These obstacles align with UTAUT's behavioural components, namely low performance expectancy and low effort expectancy, which predict reduced adoption when users doubt digital technology's ease or usefulness. On the enabling side, digital financial literacy functions as a critical moderator of savings behaviour, with an pronounced effect in rural areas and serves as a tool for women's empowerment, by improving their capacity for informed financial decision making (Basar et al., 2025; Mishra et al., 2024). Specific financial knowledge of interest rates and banking procedures has also been identified as the 'leading force' for inclusion, advocating for comprehensive, long-term educational programs over isolated training sessions (Hasan et al., 2021). Furthermore, digital financial inclusion functions as a vital mediator, enabling MSMEs to convert digital literacy and government support into tangible gains in operational efficiency (Tandilino et al., 2025).

#### **4.1.2. Lack of Trust and Fear of Fraud**

Trust is an important intervening variable between the availability of DFI and its adoption. It serves as a core lubricant that enables digital financial transactions, while institutional trust and behavioural risk attitudes are key factors that influence SME's transitions to digital credit channels (Hoang et al., 2026; Pérez-Campdesuñer et al., 2026). Even as UPI is gaining traction in India, systemic distrust, related to Fears of fraud, transaction failure, and financial loss, has maintained the preference of rural people for cash over digital payments (Bernards, 2022; Nova & Gonzalez, 2023). This lack of trust has been exacerbated by the increase in fraudulent activities during this period (Prashanth et al., 2026), and predatory lending practices by some fintech institutions that have negatively impacted the sectoral reputation overall (Admiral et al., 2025). Infrastructure-level effects of high transaction failure rates in the UPI system on user confidence and adoption in rural areas are illustrated by (Kuriakose & Sajoy, 2023). On the other hand, community trust, defined as trust in local leaders, village authorities, like the Gram Pradhans, and familiar intermediaries has become an important facilitator for real DFI adoption (Sharma et al., 2024; Sharma et al., 2025; Soekarni et al., 2024).

#### **4.1.3. Ambiguous Attitudes and risk Aversion**

Compared to urban farmers, rural farmers are more risk averse than their urban peers toward digital financial assets (Zhang et al., 2024). Based on the principles of behavioural economics, rural Indians are extremely vulnerable to potential losses and are more risk averse than urban counterparts (Sudarsan et al., 2025), whereas Indonesian farmers are more likely to think that cash in hand is more secure than cash in digital accounts, indicating that they have a general preference for tangible assets over digital ones (Soekarni et al., 2024). Knowledge asymmetry aggravates these barriers, as rural borrowers often are not digitally literate to process complex financial information, leading to information overload and increased distrust of formal lending sources, as acceptance of DFI will continue to be limited despite the improvement of infrastructure (Phan et al., 2024). However, better information provision and transparency can mitigate subjective risk perception and gradually shift the focus to more diversified digital financial portfolios, over physical ones (Yu et al., 2025).

#### **4.1.4. Social Exclusion and Gender Inequalities**

One enduring structural barrier to smallholder farmers' adoption of DFI is gender. Women continue to be marginalized and their credit gap increased in low-income countries as evidenced by algorithmic lending systems as revealed in (Oluoch & Alhassan, 2026). Reinforcing this concern, in the context of credit rating, AI usage has serious implications of exacerbating existing inequalities in algorithmic outputs (Alhassan et al., 2026). In addition to algorithmic bias, other sociodemographic factors, such as patriarchal norms, women's lower access to smart phones, and a lack of autonomy in making financial decisions, are also working against women who use DFI (Divi et al., 2025; Igamo et al., 2024). In most societies, women are also not allowed to use and own digital tools independently (Anakpo et al., 2023). A community level, (Ren et al., 2023) report that women in rural areas are less likely to be digitally literate or to have adequate assets for an equitable participation in the digital economy, and (Kurniasari et al., 2026) found that traditional gender roles and unequal access to financial networks systematically exclude women from financial ecosystems, compromising the sustainability of women-led businesses. Persons with disabilities (PWDs) are another group that is also under-served, and for whom systemic prejudice and unfavourable institutional attitudes have a significant effect in limiting access to DFI services (Peprah et al., 2023).

#### **4.1.5. Insufficient Official Identity and Records**

For underprivileged communities, formal identity essential represent a substantial structural demand-side obstacle. Throughout their analysis of transgender people in Delhi NCR, Raja & Khan, 2025, discovered that two major barriers to financial inclusion are identity mismatch between gender identity and official documents, affecting 52.5% of respondents, and a sheer lack of documentation, affecting 42% of respondents. At the regional level, (Ahamadou & Agada, 2023), the lack of formal identity as a fundamental exclusion mechanism primarily responsible for the high unbanked rates in the WAEMU region. Efforts to address this barrier have produced remarkable but uneven results. In India, such as, government-led programs such as Aadhaar biometric system have significantly lowered this barrier for the general public by enabling digital Know Your Customer (KYC) procedures and establishing what (Migozzi et al., 2024) referred to as the "India Stack" infrastructure layer. Nevertheless, certain groups, such as women, elderly farmers, and marginalized rural communities, still encounter documentation and digital literacy barriers that limit their meaningful access to DFI services (Soekarni et al., 2024), indicating that infrastructural progress alone does not guarantee inclusive outcomes.

#### **4.1.6. Cultural and Religious Restraints**

Religious and cultural considerations present distinct demand-side constraints that operate beyond literacy or infrastructure barriers. According to (Ahamadou & Agada, 2023; Aljadi et al., 2025), fintech adoption among Muslim communities in WAEMU region and Libya is severely constrained by Islamic restrictions on interest (riba) when products are built around interest-bearing mechanisms. Conversely, (Marhadi et al., 2024; Kadir & Musataklima, 2024) show how this obstacle has fuelled the growth of Islamic rural banking (BPRS) and Shariah-compliant Peer to peer lending in Indonesia, offering an alternative model with significant relevance for comparable religiocultural situations elsewhere. (Choiruddin et al., 2025) argue that aligning financial literacy initiatives with Sharia-compliant fintech is essential for the sustainable performance of MSMEs in markets like Indonesia and Malaysia.



## **4.2. Supply-Side Obstacles to Agriculture's Digital Financial Inclusion**

Structural and institutional factors that constrain supply of digital financial services in rural areas represent supply-side barriers. The reviewed studies highlight five challenges – poor infrastructure, cost of services, regulatory gaps, technology risks and lending constraints specific to agriculture. These constraints on the provider side frequently exacerbate the demand-side constraints outlined above to create a complex picture of how DFI is adopted in agriculture.

### **4.2.1. Inadequate Infrastructure**

Inadequate digital, mobile, and telecommunications infrastructure in rural regions represents a fundamental supply side obstacle to DFI adoption (Kadir & Musataklima, 2024; Verma et al., 2025; Zhang et al., 2024; Ahamadou & Agada, 2023; Antwi-Boampong et al., 2022; Hornuf et al., 2025). (Sam Abugu et al., 2025) report that intermittent power supply and unreliable mobile reception continue to be fundamental barriers to closing the financial inclusion gap in rural areas, while (Muzurura et al., 2021) specifically highlight poor mobile connectivity and frequent electricity outages as critical limiting conditions. (Liu & Li, 2024) further find that expanded network infrastructure directly stimulates rural economic growth by enabling residents to conduct digital transactions easily and bypass the geographical distance to traditional banks. High transaction failure rates that undermine user confidence are also caused by server system malfunctions and persistent connectivity issues (Parlasca et al., 2022). The difficulty of access is further exacerbated by geographic distance from physical bank branches. (Sam-Abugu et al., 2025) observe that rural residents have limited access points because traditional banking institutions remain primarily concentrated in urban areas. Similarly, (Phan et al., 2024), note that Vietnamese rural residents are often required to travel long distances to access formal banking institutions. A structural- historical dimension is added by (Bernards, 2022), who points out that the uneven geographic reach of modern fintech expansion is still shaped by financial infrastructure from the colonial past (Migozzi et al., 2024) reinforced by demonstrating how inherited infrastructure inequalities persist within contemporary digital financial systems.

### **4.2.2. Barriers Associated with cost**

Traditional financial service providers are deterred from serving remote households by the high fixed cost associated with rural expansion and low investment returns (Wang et al., 2022; Anakpo et al., 2023). Where digital financing is available, farmers often encounter exorbitant interest rates: (Parlasca et al., 2022) report that effective annual interest rates for mobile banking loans in Kenya can reach 221%, far exceeding the limits applied to traditional bank loans. Likewise, Soekarni et al. (2024) reported that P2P lending platforms in Indonesia also often charge a high interest rate or a profit-sharing model that entails smallholders to pay high debt. Last-mile service delivery costs and the costs of the server infrastructure further add to these financial hurdles, making it difficult for profit-seeking organisations to provide service to remote agricultural communities without subsidies or policy support (Parlasca et al., 2022; Ren et al., 2023; Vinoth Balaji & Sriram, 2025). In some contexts, efforts to overcome cost obstacles through policy-driven digital finance have so far been successful, as digital inclusive finance has proven to be a game-changing force in agribusiness innovation in China; (Wei and Sutunyarak, 2025) have shown that it can significantly reduce agribusiness borrowing costs and address financing constraints.

### **4.2.3. Regulatory and Institutional Difficulties**

There is a huge supply side gap in the unique needs of smallholder farmers not being addressed by traditional banking institutions. In India, (Khan et al., 2021) argue that microfinance institutions (MFIs) can be an important source of supply and are playing a critical role in strengthening the poor and women in rural slums where the collateral requirement is generally very high, making it unsurmountable for the poor and women. On this, (Daoud et al. 2021) show that social media adoption is a significant factor to help improve the MFI performance in developing countries by making outreach more effective and improving portfolio quality by communicating with clients. Overall, the regulatory landscape makes a difference in the way fintech is working in rural financial environments and is often limiting their potential. As technology evolves, the current regulatory landscape is very uncertain and cannot keep up with technological advances, yet, oversight is still crucial to controlling predatory practices (Admiral et al., 2025; Campos-Teixeira et al., 2025). Without favourable legislative conditions, it may also be challenging for fintech businesses to connect with traditional banking networks (Verma et al., 2025). Moreover, the steady shrinkage of financial service networks in rural regions stems from the low-risk large-value clientele preference of traditional financial institutions, a historical bias towards larger firms (Mohsin et al., 2022; Kong & Loubere, 2021). Regulatory systems and data protection laws are also said to influence fintech ecosystems and trust of customers (Setiawan et al., 2021). Institutions are therefore less willing to provide support to rural communities, especially smallholder farmers, due to their high credit-default risk (Wang et al., 2024). Regulatory sandboxes, however, are an institutional innovation that offers a space for the testing of technologies, in a flexible manner that maintains consumer safety: In the case of Ghana, the environment established around the “sandbox” has allowed for the testing of new technologies, without compromising consumer safety (Vijayagopal et al., 2024; Vinoth Balaji & Sriram, 2025). Additionally, the study by (Hoang et al., 2025) reveals that creating innovative and specialized green finance products, such as cash flow financing, is crucial for improving the accessibility of sustainable financing for agricultural SMEs who are traditionally unable to secure financing due to a lack of collateral.

### **4.2.4. Technological Risks and Discrimination**

Algorithmic bias and sociocultural discrimination in the digital lending platforms add to supply side exclusion. (Alhassan et al., 2026) highlight cybersecurity issues and unfair credit scoring as new technical risks that exacerbate exclusion, while (Oluoch and Alhassan, 2026) show that credit models used by fintech platforms have



not been audited and thus have internalized historical and gender discrimination in automated credit screening. In addition, (Kuriakose and Sajoy, 2023) has also shown that financial institutions participating in these transactions are accountable for high transaction failure rates, which is due to technological inadequacies. Adoption of social media significantly improves the performance of MFIs in developing countries by enhancing outreach and improving portfolio quality through better client communication (Daowd et al., 2021). Empirical evidence from rural Uganda indicates that mobile money adoption acts as a catalyst for agricultural intensification, significantly improving household welfare and crop income (Tabetando et al., 2022).

Adoption is additionally slowed by information overload from digital channels and legal uncertainties (Setiawan et al., 2021; Phan et al., 2024). For marginalized populations such as transgender people (Raja & Khan, 2025) and people with disabilities (Peprah et al., 2023), institutional gatekeeping by front-line bank staff represents a structural design failure. These groups are excluded not by technology itself, but by the human systems surrounding it. Internal challenges that financial organizations must deal with include substantial retraining costs and employee reluctance to digital change (Verma et al., 2025).

#### **4.2.5. Supply Restriction's Specificity to Agriculture**

Traditional financial institutions are hesitant to serve smallholder farmers due to the inherent risk and seasonal income structure of agriculture, small transaction sizes and significant operational expansion costs (Wang et al., 2022; Parlasca et al., 2022; Kong & Loubere, 2021). This is exacerbated by high information asymmetry in rural loan markets where credit records and collateral are not kept or maintained, which makes it challenging to assess risk (Phan et al., 2024; Soekarni et al., 2024; Nova & Gonzalez, 2023). The lack of products for the agricultural cycle is another important structural gap: Many existing digital loan products have short loan periods, such as 30 days, which cannot be aligned with the normal agricultural production cycle (Parlasca et al., 2022). Effective financial planning for farmers is further hampered by market volatility driven by fluctuating prices for essential agro-inputs such as seeds and fertilizers (Mahbubi et al., 2024; Bernards, 2022). Where these barriers have been partially overcome, the evidence is encouraging: empirical findings from rural Uganda indicate that mobile money adoption acts as a catalyst for agricultural intensification, significantly improving household welfare and crop income (Tabetando et al., 2022). Collectively, these factors reduce the commercial incentive for fintech firms to develop agriculture-specific products, leaving a persistent gap between generic digital financial solutions and the specific credit, insurance and savings needs of rural farming communities (Parlasca et al., 2022; Wang et al., 2022; Kong & Loubere, 2021).

### **4.3. The Function of Rural Development Programs and Agricultural Extension Agents in Promoting DFI**

Formal extension workers, village advisors, field officers, cooperative leaders and mobile money agents all consider agricultural extension agents. They play a crucial role in bridging technological, linguistic and social trust gaps between rural agricultural communities and complex fintech systems (Parlasca et al., 2022; Soekarni et al., 2024; Sharma et al., 2025).

#### **4.3.1. Field Officers and Agricultural Extension Workers**

It is reported that formal or informal field personnel plays a role in the adoption of DFI at the farm level. The agricultural field assistants in Indonesia play an important role in overseeing the daily distribution of digital credit, supporting farmers to abandon informal lending, and providing continuous mentorship that prove to be effective in shifting farmers into DFI extension agents at household level (Soekarni et al., 2024; Mahbubi et al., 2024). Likewise, (Parlasca et al., 2022) report that in Kenya, village advisors, who deliver agronomic advice and make digital resources for input credit and insurance more accessible, hold an important position as intermediaries using integrated platforms. In Colombia, farmers find digital technology to be a complement to face-to-face advice, which means that bank advisors and technically competent facilitators are necessary, as shown by Nova and Gonzalez (2023). Technological anxiety and literacy barriers can be overcome through social learning and community trust by incorporating DFI into existing social institutions like SHGs (Sudarsan et al., 2025).

#### **4.3.2. Community Based Organizations and Self-Help Groups (SHG's)**

Self Help Groups are an especially effective mechanism for facilitating DFI in India, and especially among the rural women. SHG leaders act as financial literacy facilitators by providing peer trust, social reinforcement and a group learning environment for digital financial transactions, thereby accelerating financial transaction adoption. The results of Communal trust models in hybrid microfinance organisations decrease resistance to digital tools and individual risk perception (Damayanti et al., 2026). The Collective Learning Dynamic (CLD) in self-help groups can resolve individual problems such as loss aversion and mistrust of institutions; community validation is a significant factor in rural financial decision-making (Sudarsan et al., 2025; Hoang et al., 2026). The overall goal of Community based organisations (CBOs) is to serve as a link between fintech companies and the underserved community that is not well represented in financial or policy discussions (Raja & Khan, 2025). The findings of (Anakpo et al., 2023; Sam-Abugu et al., 2025) further validate the existence of social networks as a critical link between DFI access and actual use, reinforcing the multifaceted nature of digital financial inclusion, which transcends mere technological and individual dimensions.

#### **4.3.3. Government Officers and Village-Level Authorities**

Local government representatives and community leaders play an important legitimising role in the adoption of DFI into rural social networks. There is high reliance by residents of Indian villages on village leaders and village elders for financial advice, suggesting that interventions by DFI are more effective when brought in from within existing social systems than from outside them (Sudarsan et al., 2025). Gram Pradhans, Patwaris and Lekhpals are instrumental in the promotion of digital financial tools as they arrange the accessibility of digital government

schemes in the community and spread information about the schemes. In China, the state's role is more direct as an enabler: the Digital Village program has been recognized as a key enabler of rural structural transformation, and the financial sustainability of the rural digital initiative has been ensured by the local government through its policy support (Zhang et al., 2024). In China, the last-mile connection made by employees of village Taobao Terminals is also a de facto extension of the agent system that works for digital finance, connecting potential borrowers to formal lending platforms (Kong & Loubere, 2021). As stated in (Hoang et al., 2026), community trust in local leaders can act as a “compensatory mechanism” for households to be able to confidently interact with the formal digital systems. This is part of a broader institutional landscape, that (Migozzi et al., 2024) call a “Tech-Fin-State” architecture, an arrangement where the government is taking a proactive role in providing the legitimacy and infrastructure for the digital financial ecosystem to function effectively.

#### **4.3.4. Intermediaries in technology**

Mobile Network Operators (MNOs) are essential in the provision of financial services to the unbanked, especially in East Africa through their large mobile money agent network that deliver the service at the last mile (Parlasca et al., 2022; Bernards, 2022; Oluoch & Alhassan, 2026). Payment Service Providers (PSP) serves as crucial intermediaries that develop application interfaces (APIs) connected to Unified Payment Interface (UPI), supporting huge merchant payments and real-time fund transfers in India (Migozzi et al., 2024; Kuriakose & Sajoy, 2023). Agent banking networks and offline financial products, such as agents providing cash-in/cash-out services, and mobile financial instruments with offline capabilities bridge the digital divide in less connected rural areas (Anakpo et al., 2023; Alhassan et al., 2026; Sam-Abugu et al., 2025). Persistent problems like liquidity constraints for agents, transaction errors and system failures remain major challenges in building long-term trust among smallholder farmers (Parlasca et al., 2022; Kuriakose & Sajoy, 2023).

#### **4.3.5. Institutions of Government and Policy**

At the macro level, the state has created an open “Public utility layer” through various initiatives, like the IndiaStack, UPI, Digital India and the Pradhan Mantri Jan Dhan Yojana (PMJDY), which foster the innovation and competition among private fintech players (Migozzi et al., 2024; Kuriakose & Sajoy, 2023; Sudarsan et al., 2025; Anakpo et al., 2023). These programmes have also helped to build the technological and ID framework necessary for digital financial services and led to a marked increase in account-holding for previously unbanked individuals. Regulatory policies, like those formulated by the Financial Services Authority (OJK) of Indonesia and International organisations like the World Bank and IMF, also determine the enabling environment by developing policies that balance innovation incentives, consumer protection and financial stability, (Soekarni et al., 2024; Marhadi et al., 2024; Anakpo et al., 2023). Public-Private Partnerships (PPPs) are proven to be vital tools in bridging the hard infrastructure gap in rural development where public funding is not enough to encourage private investment (Anakpo et al., 2023). Government, cooperative and financial institution partnerships are vital for building trust among the community and providing the infrastructure needed to achieve DFI reach, as noted by Sharma et al. (2024); Kadir & Musataklima, (2024).

#### **4.4. Research Gaps and Future Directions**

However, while the study of DFI has grown significantly over the years, it is still geographically biased, with China, India and Kenya being well represented, but major agricultural economies such as Latin America, Central Asia and West Africa being systematically underrepresented (Phan et al., 2024; Sudarsan et al., 2025). The thematic map also indicates that there is a lack of relative scholarly attention to the key enabling areas of financial literacy and digital transformation compared to technology adoption frameworks. Few barrier studies were conducted using cross-sectional survey data with self-reported barriers, which do not allow for causal inferences on the evolution of barriers in time and among user types (Sharma et al., 2024; Ahamadou & Agada, 2023). Smallholder farmers' exposure to DFI requires immediate longitudinal designs to capture the dynamics in trust building, risk perception, and digital literacy after facing DFI. It is recommended that longitudinal designs are immediately needed to follow up after DFI exposure the changes in trust building, perception of risk and improvement of digital literacy for smallholder farmers (Damayanti et al., 2026; Sam-Abugu et al., 2025). On the demand side, the reasons for the constrained productive use of mobile credit despite its increasing availability are unclear, as evidenced by a few studies finding that despite increased access, very little productive use is reported (Parlasca et al., 2022; Phan et al., 2024; Nyide et al., 2026). There is also limited research on the gender and disability dimensions; algorithmic bias in lending potentially aggravates the gender credit gap (Oluoch & Alhassan, 2026) and people with disabilities are virtually excluded from DFI barriers research (Peprah et al., 2023). While field officers and SHGs and village level intermediaries have been demonstrated to play a key role in influencing DFI uptake, there are no existing studies that compare the success of human-mediated delivery models relative to standalone FinTech models in terms of uptake or sustainability (Parlasca et al., 2022; Soekarni et al., 2024). Although extension agents play a clear role in practice, they are lacking in formal models like UTAUT (Sharma et al., 2024). Integrated extension-DFI delivery models should be tested using controlled or quasi experimental design in future research and agricultural intermediaries as formal constructs in the behavioural theories of adoption.

### **5. CONCLUSION**

The study of financial inclusion and digital financial transformation has become one of the fastest growing thematic areas of research over the last decade, growing rapidly since 2022, though it remains geographically focused, with China, India and Kenya most dominant. Financial literacy and financial transformation are

underdeveloped themes. Regardless of this momentum, meaningful inclusion cannot be achieved with technology alone. On the demand side, smallholder farmers continue to face low digital literacy, institutional mistrust, risk aversion, gender inequality, exclusion from official records and cultural constraints stemming from religious norms, supply-side challenges, include weak infrastructure, high service costs, fragmented regulation, algorithmic bias and financial products unsuited to the agricultural cycle. Agricultural extension workers, SHG leaders, bank correspondents, village officials and mobile money agents play an intermediation role in adoption, that is empirically observed but not captured in formal theories. There is significant research void in gender-sensitive financing, longitudinal impact assessment, inclusive design for marginalized groups and cross-national comparisons. Future research should explore integrated extension-DFI delivery models using causal designs and formally include human intermediaries in behavioural adoption models. Finally, trust, institutional support and inclusive governance grounded in the realities of smallholder farming are as essential to DFI's success as technological innovation.

## REFERENCES

1. Admiral, A., Suparto, S., Kurniasih, E., Afriani, S., Woodward, J., & Adinda, F. A. (2025). Indonesia's Online Loan Challenges: What Legal Actions Can Solve the Most Pressing Issues? *Jurnal Pengabdian Hukum Indonesia* (Indonesian Journal of Legal Community Engagement) JPHI, 8(1), 275–314. <https://doi.org/10.15294/jphi.v8i1.21959>
2. Ahamadou, M., & Agada, D. B. (2023). Adopting FinTech to promote financial inclusion: Evidence from western African economic and monetary union. *International Journal of Applied Economics, Finance and Accounting*, 17(1), 135–145. <https://doi.org/10.33094/ijaefa.v17i1.1090>
3. Alhassan, T. F., Kalkabayeva, G., & Kurmanalina, A. (2026). The financial sectors of Ghana and Kazakhstan: Comparative analysis of artificial intelligence adoption and implications. *BRICS Journal of Economics*, 7(1), 155–175. <https://doi.org/10.3897/brics-econ.7.e151598>
4. Aljadi, S., Mayhub, A. R., & Ahmoudah, A. (2025). Cultural Dynamics of Islamic Banking in Libya: Overcoming Regulatory Fragmentation and Enhancing Financial Literacy. *BANCO: Jurnal Manajemen Dan Perbankan Syariah*, 7(1), 30–51. <https://doi.org/10.35905/banco.v7i1.12158>
5. Anakpo, G., Xhate, Z., & Mishi, S. (2023). The Policies, Practices, and Challenges of Digital Financial Inclusion for Sustainable Development: The Case of the Developing Economy. *FinTech*, 2(2), 327–343. <https://doi.org/10.3390/fintech2020019>
6. Antwi-Boampong, A., Boison, D., Doumbia, M., Boakye, A., Osei-Fosua, L., & Owiredo Sarbeng, K. (2022). Factors Affecting Port Users' Behavioral Intentions to Adopt Financial Technology (Fintech) in Ports in Sub-Saharan Africa: A Case of Ports in Ghana. *FinTech*, 1(4), 362–375. <https://doi.org/10.3390/fintech1040027>
7. Aria, M. & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis, *Journal of Informetrics*, 11(4), 959–975. <https://doi.org/10.1016/j.joi.2017.08.007>
8. Ashurbayli-Huseynova, N., & Garmidarova, Y. (2025). Bank capital management in emerging and frontier markets: Bibliometric analysis. *Banks and Bank Systems*, 20(1), 304–322. [https://doi.org/10.21511/bbs.20\(1\).2025.25](https://doi.org/10.21511/bbs.20(1).2025.25)
9. Başar, D., Keskin, H., Esen, E., Merter, A. K., & Balçioğlu, Y. S. (2025). Digital financial literacy and savings behavior: A comprehensive cross-country analysis of FinTech adoption patterns and economic outcomes across 12 nations. *Borsa Istanbul Review*, 25, 59–72. <https://doi.org/10.1016/j.bir.2025.09.004>
10. Bernards, N. (2022). Colonial Financial Infrastructures and Kenya's Uneven Fintech Boom. *Antipode*, 54(3), 708–728. <https://doi.org/10.1111/anti.12810>
11. Campos-Teixeira, D., Tello-Gamarra, J., Reis, J., Longaray, A. A., & Hernani-Merino, M. (2025). Fintechs and Institutions: Evidence from an Emerging Economy. *Journal of Risk and Financial Management*, 18(4), 212. <https://doi.org/10.3390/jrfm18040212>
12. Chai, S., Zhou, L., & Chen, Y. (2023). Digital Finance and Entrepreneurial Return Rate: Effects, Mechanisms and Inequality. *Sage Open*, 13(4), 21582440231205501. <https://doi.org/10.1177/21582440231205501>
13. Chen, S., Liang, M., & Yang, W. (2022). Does Digital Financial Inclusion Reduce China's Rural Household Vulnerability to Poverty: An Empirical Analysis From the Perspective of Household Entrepreneurship. *Sage Open*, 12(2), 21582440221102423. <https://doi.org/10.1177/21582440221102423>
14. Daowd, A., Kamal, M. M., Eldabi, T., Hasan, R., Missi, F., & Dey, B. L. (2021). The impact of social media on the performance of microfinance institutions in developing countries: A quantitative approach. *Information Technology & People*, 34(1), 25–49. <https://doi.org/10.1108/ITP-03-2018-0135>
15. Divi, S., Minampati, V. R., Sahoo, M. K., & Shah, K. (2025). Penetration of Digital Transactions in Rural India and Financial Inclusion: An Analysis of Progress and Problems. *Asian Journal of Human Services*, 29(0), 542–550. <https://doi.org/10.14391/ajhs.29.542>
16. Hasan, M., Le, T., & Hoque, A. (2021). How does financial literacy impact on inclusive finance? *Financial Innovation*, 7(1), 40. <https://doi.org/10.1186/s40854-021-00259-9>
17. Hoang, H. T., Pham, T. T., & Tran, N. H. (2025). Determinants of Green Finance and SMEs Performance: An Empirical Study in the Vietnamese Agricultural Sector. *Research on World Agricultural Economy*. <https://doi.org/10.36956/rwae.v6i3.2031>
18. Hornuf, L., Safari, K., & Voshaar, J. (2025). Mobile fintech adoption in Sub-Saharan Africa: A systematic literature review and meta-analysis. *Research in International Business and Finance*, 73, 102529.

<https://doi.org/10.1016/j.ribaf.2024.102529>

19. Iatnaz Ul Hassan, M., Wu, M., Lu, J., Sohu, J. M., Ali, S., Anjum, H. N., & Bilal, M. (2025). Financial technology and banking performance in developing countries: Evidence from an advanced quantile regression approach. *Humanities and Social Sciences Communications*, 12(1), 1455. <https://doi.org/10.1057/s41599-025-05571-8>
20. Igamo, A. M., Rachmat, R. A., Siregar, M. I., Gariba, M. I., Cherono, V., Wahyuni, A. S., & Setiawan, B. (2024). Factors influencing Fintech adoption for women in the post-Covid-19 pandemic. *Journal of Open Innovation: Technology, Market, and Complexity*, 10(1), 100236. <https://doi.org/10.1016/j.joitmc.2024.100236>
21. Kadir, A., & Musataklima, M. (2024). COMMUNITY BANK AS THE PHILOSOPHICAL RATIO LEGIS BEHIND THE PROHIBITION OF ISLAMIC RURAL BANKS FROM OFFERING DIRECT DEBIT IN CONSTITUTIONAL COURT RULINGS: Impacts and Solutions in The Digital Financial Era. *Jurisdictie: Jurnal Hukum Dan Syariah*, 15(2), 412–445. <https://doi.org/10.18860/j.v15i2.26582>
22. Khan, A., Ahmad, A., & Shireen, S. (2021). Ownership and performance of microfinance institutions: Empirical evidences from India. *Cogent Economics & Finance*, 9(1), 1930653. <https://doi.org/10.1080/23322039.2021.1930653>
23. Kong, S. T., & Loubere, N. (2021). Digitally Down to the Countryside: Fintech and Rural Development in China. *The Journal of Development Studies*, 57(10), 1739–1754. <https://doi.org/10.1080/00220388.2021.1919631>
24. Kraiwanit, T., Limna, P., & Wattanasin, P. (2024). Digital wallet dynamics: Perspectives on potential Worldcoin adoption factors in a developing country's FinTech Sector. *Journal of Open Innovation: Technology, Market, and Complexity*, 10(2), 100287. <https://doi.org/10.1016/j.joitmc.2024.100287>
25. Kumari, S. P., & Mohanty, M. (2024). An Investigation on the Relation between Traditional Banking and Peer-to-Peer Lending from a Management Perspective. *Theoretical and Practical Research in Economic Fields*, 15(2), 392. [https://doi.org/10.14505/tpref.v15.2\(30\).18](https://doi.org/10.14505/tpref.v15.2(30).18)
26. Kuriakose, A., & Sajoy, P. B. (2023). Strategies and Challenges of Unified Payment Interface: Towards Facilitating a Digital Payments System in India. *Journal of Telecommunications and the Digital Economy*, 11(4), 33–47. <https://doi.org/10.18080/jtde.v11n4.651>
27. Kurniasari, F., Lestari, E. D., Muslim, N. A., & Mohd Ali, M. A. (2026). From knowledge to prosperity: Financial literacy driving women entrepreneur led-small medium enterprises through technology innovation. *Social Sciences & Humanities Open*, 13, 102443. <https://doi.org/10.1016/j.ssaho.2026.102443>
28. Liu, J., & Li, F. (2024). Rural revitalization driven by digital infrastructure: Mechanisms and empirical verification. *Journal of Digital Economy*, 3, 103–116. <https://doi.org/10.1016/j.jdec.2025.01.002>
29. Mahbubi, A., Ruspenti, I., & Syahdan Ibrohim, M. (2024). Strengthening the Value Chain Resilience of Indonesian Agricultural Fintech in the Aftermath of the Covid-19 Pandemic. *International Journal on Food System Dynamics*, 15(1), 44–54. <https://doi.org/10.18461/ijfsd.v15i1.14>
30. Marhadi, M., Fathoni, A. F., Setiawan, B., Pratiwi, D., Hayati, R., Boros, A., & Sudibyo, N. A. (2024). Continuance intention of Fintech Peer-to-Peer (P2P) financing Shariah: Moderation role of brand schematicity and digital financial literacy. *Journal of Open Innovation: Technology, Market, and Complexity*, 10(2), 100301. <https://doi.org/10.1016/j.joitmc.2024.100301>
31. Mashaqbeh, H., Al-Ababneh, H., Freijat, S., Myroshnychenko, G., & Dalevska, N. (2026). FinTech and digital platforms for financial inclusion in Jordan: Logistics and operations aspects of sustainability. *Acta Logistica*, 13(1), 150–161. <https://doi.org/10.22306/al.v13i1.743>
32. Maya Damayanti, S., Sutardi, A., Aswin Rahadi, R., Mentari Putri, A., Nadhira Aliya Putri, A., & Hanifan, R. (2026). Convergent Microfinance Strategy: Combining Fintech and Conventional Methods to Enhance Rural Financial. *Qubahan Academic Journal*, 6(1), 29–46. <https://doi.org/10.48161/qaj.v6n1a2076>
33. Migozzi, J., Urban, M., & Wójcik, D. (2024). “You should do what India does”: FinTech ecosystems in India reshaping the geography of finance. *Geoforum*, 151, 103720. <https://doi.org/10.1016/j.geoforum.2023.103720>
34. Mishra, D., Agarwal, N., Sharahiley, S., & Kandpal, V. (2024). Digital Financial Literacy and Its Impact on Financial Decision-Making of Women: Evidence from India. *Journal of Risk and Financial Management*, 17(10), 468. <https://doi.org/10.3390/jrfm17100468>
35. Mohsin, A., Sheikh, M. R. I., Tushar, H., Iqbal, M. M., Far Abid Hossain, S., & Kamruzzaman, Md. (2022). Does FinTech credit scale stimulate financial institutions to increase the proportion of agricultural loans? *Cogent Economics & Finance*, 10(1), 2114176. <https://doi.org/10.1080/23322039.2022.2114176>
36. Muhammad Nanang Choiruddin, Heri Pratikto, F. Danardana Murwani, & Nurika Restuningdiah. (2025). **Financial Literacy, FinTech, and Contemporary Innovation in Islamic Economic Law: An Analysis of MSME Performance Sustainability in Indonesia and Malaysia**. *MILRev: Metro Islamic Law Review*, 4(2), 976–1008. <https://doi.org/10.32332/milrev.v4i2.10164>
37. Muzurura, J., Chigora, F., Mutambara, E., Zvavahera, P., & Ndlovu, J. (2021). Determinants of Mobile Learning Systems Adoption in Zimbabwe Rural Secondary Schools. *International Journal of Education and Practice*, 9(1), 201–219. <https://doi.org/10.18488/journal.61.2021.91.201.219>
38. Nelisiwe Fortunate Nyide, N. F. N., Odunayo Magret Olarewaju, O. M. O., & Celani John Nyide, C. J. N. (2026). Do Marginalised Communities Engage with Financial Technology? The Examination Centres on the Involvement of Peri-urban Households in South Africa. *GLOBAL BUSINESS FINANCE REVIEW*, 31(2), 70–84. <https://doi.org/10.17549/gbfr.2026.31.2.70>

39. Nova, N. A., & González, R. A. (2023). A financial inclusion app and USSD service for farmers in rural Colombia. *Information Development*, 39(3), 581–599. <https://doi.org/10.1177/026666669221120050>
40. Oluoch, W., & Alhassan, A. L. (2026). Bridging the gender credit gap in low-income countries: The impact of digital financial inclusion. *Emerging Markets Review*, 70, 101389. <https://doi.org/10.1016/j.ememar.2025.101389>
41. Padma Kiran, K., & Vedala, N. S. (2025). Exploring behavioral intentions of consumers towards different digital payment services through the interplay of perceived risks and adoption factors. *Humanities and Social Sciences Communications*, 12(1), 1141. <https://doi.org/10.1057/s41599-025-05468-6>
42. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>
43. Parlasca, M. C., Johnen, C., & Qaim, M. (2022). Use of mobile financial services among farmers in Africa: Insights from Kenya. *Global Food Security*, 32, 100590. <https://doi.org/10.1016/j.gfs.2021.100590>
44. Paul, J., Lim, W. M., O'Cass, A., Hao, A. W., & Bresciani, S. (2021). Scientific procedures and rationales for systematic literature reviews (SPAR-4-SLR). *International Journal of Consumer Studies*, 45(4), O1–O16. <https://doi.org/10.1111/ijcs.12695>
45. Peprah, J. A., Avorkpo, E. A., & Kulu, E. (2023). People with disability and access to financial services: Evidence from Ghana. *Regional Science Policy & Practice*, 15(6), 1198–1216. <https://doi.org/10.1111/rsp3.12643>
46. Pérez-Campdesuñer, R., Sánchez-Rodríguez, A., Martínez-Vivar, R., Manciatí-Alarcón, R. X., De Miguel-Guzmán, M., & García-Vidal, G. (2026). Socio-Cultural and Behavioral Determinants of FinTech Adoption and Credit Access Among Ecuadorian SMEs. *Journal of Risk and Financial Management*, 19(1), 64. <https://doi.org/10.3390/jrfm19010064>
47. Phan, C., Filomeni, S., & Kok, S. K. (2024). The impact of technology on access to credit: A review of loan approval and terms in rural Vietnam and Thailand. *Research in International Business and Finance*, 72, 102504. <https://doi.org/10.1016/j.ribaf.2024.102504>
48. Prashanth, B. S., Kumar, M., Hoque, A., Al Muraqab, N., Moonesar, I. A., Braendle, U. C., & Rao, A. (2026). Prediction of bank transaction fraud using TabNet—An adaptive deep learning architecture. *International Review of Economics & Finance*, 106, 104916. <https://doi.org/10.1016/j.iref.2026.104916>
49. Purohit, S., Kaur, J., & Chaturvedi, S. (2022). MOBILE PAYMENT ADOPTION AMONG YOUTH: GENERATION Z AND DEVELOPING COUNTRY PERSPECTIVE. *JOURNAL OF CONTENT COMMUNITY AND COMMUNICATION*, (8), 194–209. <https://doi.org/10.31620/JCCC.06.22/14>
50. Raja, R., & Khan, M. A. (2025). Beyond Binaries: Determinants and Impediments of Financial Inclusion among Transgender Individuals in Delhi-NCR, India. *Social Sciences & Humanities Open*, 12, 101878. <https://doi.org/10.1016/j.ssaho.2025.101878>
51. Ren, J., Gao, T., Shi, X., Chen, X., & Mu, K. (2023). The impact and heterogeneity analysis of digital financial inclusion on non-farm employment of rural labor. *Chinese Journal of Population, Resources and Environment*, 21(2), 103–110. <https://doi.org/10.1016/j.cjpre.2023.06.006>
52. Sam-Abugu, C., Luo, X., & Wong, B. (2025). The combined role of FinTech innovation and financial literacy in sustainable financial inclusion in Nigeria. *International Review of Economics*, 72(2), 14. <https://doi.org/10.1007/s12232-025-00490-1>
53. Setiawan, B., Nugraha, D. P., Irawan, A., Nathan, R. J., & Zoltan, Z. (2021). User Innovativeness and Fintech Adoption in Indonesia. *Journal of Open Innovation: Technology, Market, and Complexity*, 7(3), 188. <https://doi.org/10.3390/joitmc7030188>
54. Sharma, A., Mohan, A., Johri, A., & Asif, M. (2024). Determinants of fintech adoption in agrarian economy: Study of UTAUT extension model in reference to developing economies. *Journal of Open Innovation: Technology, Market, and Complexity*, 10(2), 100273. <https://doi.org/10.1016/j.joitmc.2024.100273>
55. Sharma, A., Mohan, A., Johri, A., & Asif, M. (2025). Determinants of financial technology (FinTech) adoption by the farmers in agrarian economy. *Social Sciences & Humanities Open*, 11, 101370. <https://doi.org/10.1016/j.ssaho.2025.101370>
56. Soekarni, M., Adam, L., Thoha, M., Sarana, J., Ermawati, T., Saptia, Y., Adityawati, S., Sujianto, & Wibowo, M. (2024). Strengthening financial literacy of smallholder farmers through agricultural fintech peer-to-peer lending: Evidence and practical implications. *Cogent Social Sciences*, 10(1), 2359011. <https://doi.org/10.1080/23311886.2024.2359011>
57. Sudarsan, H., Alamelu, K., & Karthick, Av. (2025). Socio-Demographics Determinants of Financial Literacy: Evidence from Sivagangai District. *International Journal of Accounting and Economics Studies*, 12(6), 352–363. <https://doi.org/10.14419/awfprq56>
58. Tabetando, R., Matsumoto, T., & Fani, D. C. R. (2022). Mobile Money, Agricultural Intensification, and Household Welfare: Panel Evidence from Rural Uganda. *Journal of Agricultural and Applied Economics*, 54(3), 515–530. <https://doi.org/10.1017/aae.2022.25>
59. Tandilino, C., Pontoh, G. T., Darmawati, D., & Indrijawati, A. (2025). Digital Financial Inclusion as a Mediator of Digital Financial Literacy and Government Support in MSME Performance. *International Journal of Financial Studies*, 13(4), 199. <https://doi.org/10.3390/ijfs13040199>
60. Van Eck, N. J., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric

- mapping. *Scientometrics*, 84(2), 523–538. <https://doi.org/10.1007/s11192-009-0146-3>
61. Verma, Mr. S. S., Sreenu, Dr. N., & Kushwaha, Dr. G. S. (2025). Banks with Higher Levels of Fintech Adoption Exhibit Better Financial Performance Than Those with Lower Levels of Adoption. *International Journal of Accounting and Economics Studies*, 12(6), 774–784. <https://doi.org/10.14419/jkdnj577>
62. Vijayagopal, P., Jain, B., & Ayinippully Viswanathan, S. (2024). Regulations and Fintech: A Comparative Study of the Developed and Developing Countries. *Journal of Risk and Financial Management*, 17(8), 324. <https://doi.org/10.3390/jrfm17080324>
63. Vinoth Balaji, V., & Sriram, M. (2025). CRED: A fintech unicorn's journey and future path. *Journal of Information Technology Teaching Cases*, 20438869251325248. <https://doi.org/10.1177/20438869251325248>
64. Vu Hiep Hoang, V. H. H., Quoc Dung Ngo, Q. D. N., & Huy Nhuong Bui, H. N. B. (2026). Integrating Individual Capabilities, Infrastructure Quality, and Social Capital: A Novel Framework for FinTech Trust in Rural Vietnam. *GLOBAL BUSINESS FINANCE REVIEW*, 31(2), 129–146. <https://doi.org/10.17549/gbfr.2026.31.2.129>
65. Wang, J., Yu, X., Lyu, K., & Feil, J.-H. (2022). The Impact of Mobile Finance Use on Livelihoods of Farmers in Rural China. *Emerging Markets Finance and Trade*, 58(10), 2867–2879. <https://doi.org/10.1080/1540496X.2021.2013195>
66. Wang, Y., Zhao, Z., & Lu, C. (2024). Does digital inclusive finance increase land rent? Evidence from rural China. *Economic Analysis and Policy*, 82, 1025–1043. <https://doi.org/10.1016/j.eap.2024.04.032>
67. Wei, Y., & Sutunyarak, C. (2025). Impact of digital inclusive finance on agribusiness innovation performance: Evidence from listed agribusinesses in China. *Investment Management and Financial Innovations*, 22(2), 180–191. [https://doi.org/10.21511/imfi.22\(2\).2025.15](https://doi.org/10.21511/imfi.22(2).2025.15)
68. Yan, Y., Chen, L., Zhou, Z., & Wei, Y. (2025). Digital financial inclusion and agricultural modernization development in China—A study based on the perspective of agricultural mechanization services. *Humanities and Social Sciences Communications*, 12(1), 577. <https://doi.org/10.1057/s41599-025-04821-z>
69. Yu, G., Qi, Y., & Ren, Y. (2025). FinTech adoption and farmers' wealth distribution: Evidence from a large micro-data in China. *Finance Research Letters*, 72, 106621. <https://doi.org/10.1016/j.frl.2024.106621>
70. Zhang, Z., Song, J., Shu, T., & Zhao, T. (2024). Changes in rural financial exclusion's supply and demand factors from the perspective of digital inclusive financial policies. *Cogent Economics & Finance*, 12(1), 2305480. <https://doi.org/10.1080/23322039.2024.2305480>