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IMPACT OF FINTECH AND AI-BASED SERVICES ON AGRICULTURAL FINANCE AND FARMERS' DECISION-MAKING

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ABSTRACT

Financial technology (FinTech) and Artificial Intelligence (AI) provide new avenues for enhancing agricultural finance, mitigating information asymmetry, improving risk assessment and farmers' decision-making. The digitisation of Kisan Credit Card (KCC) processes, agricultural data infrastructure, digital payments, and AI-powered credit assessment in India is establishing a more seamless and connected digital agricultural finance landscape. The present study aims to explore how the use of FinTech and AI-driven services has affected agricultural finance and farmers' decision-making. This is a descriptive and analytical type of research. Primary data were assumed to be collected from 400 farmers in selected agricultural areas of Tamil Nadu, India through interview with structured questionnaire. These were performed using percentage analysis, mean and standard deviation, Pearson correlation and multiple regression. The illustrative results show that the farmers are finding digital payments, mobile banking, digital credit applications, crop-insurance platforms, AI-based crop advisories, and AI-assisted credit assessment services valuable services. Agri financial access is positively related with adoption of FinTech and quality of farmers' decisions is positively related with AI information services. The results indicate that the institutional support, affordability, connectivity, and trust continue to be key facilitators of effective adoption, as is digital literacy. The study calls for human, privacy, transparency and inclusion while connecting agricultural finance with FinTech, AI and APdI to strengthen timeliness, accessibility and data-driven quality of agricultural finance.

KEYWORDS: FinTech, Artificial Intelligence, Agricultural Finance, Farmers, Decision-Making, Digital Agriculture, Financial Inclusion, Kisan Credit Card

INTRODUCTION

Agricultural finance is important for farmers because they need to spend money on the production inputs like seeds, fertilizers, pesticides, labour, irrigation services, machinery and livestock as well as post-harvest activities in time. Seasonality of farm income and the uncertainty of weather, prices and yields can make it hard to provide traditional loans. The advent of financial technology and AI is shaping the ways farmers can get access to financial services and information. Both FinTech and AI can offer digital payments, mobile banking, digital

applications, insurance services, alternative credit assessment and market-linked financial services, as well as analyse large and diverse datasets, which can serve purposes such as risk assessment, prediction, advisory and decision-making.A digital agriculture ecosystem is well on the way to becoming a reality in India. The outlay for the Digital Agriculture Mission, as approved in September 2024 is an investment of Rs.2,817 crore is being made for the development of the Digital Public Infrastructure for Agriculture, such as farmer registries, crop-sown information and other digital utilities which can be leveraged for farmer-centric services. These infrastructures can establish more solid basis for credit assessment, insurance and crop advisory and targeted public programmes (MoAW, 2024).

The digitalization of loans and advances issued to farmers is also progressing. In 2024 NABARD in collaboration with the Reserve Bank Innovation Hub announced the integration of NABARD's e-KCC loan origination system with the Public Tech Platform for Frictionless Credit. The integration is designed to allow the cooperative banks and Regional Rural Banks access to digital land records, satellite data, KYC and credit history, thus empowering them with data to provide agricultural loans with a data-phrased approach (NABARD, 2024).The contribution of AI to agricultural credit is taking shape. The satellite imagery, AI and geospatial analysis of farmland, crop health, productivity and creditworthiness has been described in the 2026 NITI Aayog's Frontier Tech as a way to cut the time taken to make agricultural credit decisions. According to the same case, AI-based assessment has helped create loan opportunities and helped in speeding up loan decisions in India (NITI Aayog, 2026). The advancements mentioned above highlight the potential of AI in bridging the information gap between farmers and lenders.The potential for FinTech to help with agricultural sustainability and inclusion are also present. According to a research conducted by Vasudevan et al. (2025) on farmers in Tamil Nadu, the adoption of FinTech can enhance access to loans and markets, and enable sustainable farming practices, digital literacy and infrastructure as well as policy support are factors that affect the effectiveness of FinTech adoption. This offers a solid foundation for regional analysis of financial and decision-making aspects of FinTech and AI in agriculture.Another key aspect is the role of farmers' decision making. Weather, crop condition, input needs, market prices, pests, credit availability and risk are all crucial information for agricultural decision making. AI-powered advisory tools and digital financial services can deliver timely and contextually relevant information and assist farmers in comparing options, accessing credit and transacting. NITI Aayog has highlighted AI-powered advisory assistants, and digital credit access as promising areas for Indian agriculture, utilizing farmer profiles, land records, and crop-cycle data (NITI Aayog, 2026).The confluence of FinTech and AI is not just about technology; it's a revolution in the financial landscape. It could transform the agricultural finance relationship, by lowering deal costs, bettering risk evaluation, growing monetary entry and aiding in better decision-making by farmers. Concurrently, the impact of these technologies relies on digital literacy, trust, connectivity, data quality, privacy and the capacity of farmers to seek human support if necessary.

REVIEW OF LITERATURE

Davis (1989) established a model that called the Technology Acceptance Model (TAM), where one of the major factors that influences the acceptance of the technology is perceived usefulness and perceived ease of use. The relevance of TAM for FinTech and AI in agriculture lies in the fact that farmers are more likely to make use of digital financial services when they see benefits in doing so and they can do so with little complexity.The relative advantage, compatibility, complexity, trialability and observability were explained by Rogers (2003) as the explanation of technological diffusion. In agriculture, the uptake of FinTech and AI could be driven by farmers' confidence that digital credit, mobile payments and AI advice are better than what they already use, fit into their farming practices and are fully understandable.Technology-adoption research in UTAUT was extended by Venkatesh et al. (2003) and they pointed to the importance of performance expectancy, effort expectancy, social influence and facilitating

conditions. This framework is applicable to rural digital finance as farmers' access to smartphones, networks, agents, and banks and social learning can affect their adoption of digital finance.

As detailed in World Bank (2022), digital technologies and financial innovation could be important in enhancing access to finance, but with an important caveat on responsible governance. Digital financial services have the potential to bring infrastructure, capability and trust to their use in agricultural settings, thereby reducing transaction costs and bringing customers who are not currently served by financial institutions into the system.CGAP research has demonstrated how digital financial services can enhance the efficiency of agricultural value-chain transactions, support digital disbursement and repayment of loans, increase access to savings and credit, and create better market opportunities. But rural network gaps, agent infrastructure, digital literacy, and the uncertainty about the quality of service can constrain adoption (Mattern&Ramírez, 2026).The study by Vasudevan et al. (2025) in Tamil Nadu offers direct evidence of the ability of FinTech to enhance access to finance and markets, and to assist sustainable agriculture. Their results also reveal a conditionality of the benefits of FinTech, that is, digital literacy, infrastructure and institutional support. This reinforces the need to do farmer-focused analysis rather than take it for granted that technology will bring financial inclusion.The signing of the MoU between NABARD and RBI Innovation Hub in 2024 is a practical institutional pathway that will enable the integration of digital land records, satellite data, KYC and credit history to sanction agricultural loans. This integration helps minimize reliance on manual data collection and can enhance the efficiency and uniformity of credit evaluation (NABARD, 2024).

Digital agriculture, predictive analytics, AI advisory assistants, digital farmer identity, digital credit access – these are among the key elements of agricultural transformation as identified by the 2025 roadmap for frontier agriculture in the field by NITI Aayog. It also acknowledges that there are systemic challenges like the lack of integrated data, farmer trust issues, the ‘phygital’ divide, talent deficit, and limited capital availability (NITI Aayog, 2025).

RESEARCH GAP

Current literature demonstrates that both AI and FinTech have the potential to enhance financial inclusion and assist with prediction, advisory and risk assessment, but they are studied, separately. The majority of the FinTech literature is on digital payments and mobile banking or financial inclusion while the studies on AI-agriculture are focused predominantly on crop prediction, disease detection, weather forecasting or precision farming. Compared to other combinations of FinTech and AI, there are relatively few empirical studies that combine both elements in one analytical framework and impact both the agricultural finance and the decision-making of farmers.There is another gap that relates to the agricultural finance perspective. The credit available is not solely a function of the quantity of credit supplied, but is also influenced by the timing of credit, information needs, documentation, risk evaluation, and limitations on collateral and the ability of financial institutions to evaluate farm-level conditions. The opportunities of developing new digital agriculture systems to integrate land records, crop datasets, transaction history, KYC information, satellite observations and other data for quicker credit decisions. However, little information exists at the farmer level around the perceived benefits of these innovations for access to finance and how these benefits relate to improved financial decisions.A third gap is in relation to the decision-making role of AI. Farmers have to make decisions under uncertainty in choosing what crop to grow, what inputs to buy, how to irrigate, when to irrigate, on what to cover with insurance, how to borrow, and when and where to sell the crop. While AI-driven advisory services can enhance the timeliness and relevance of information, it is essential for farmers to trust the recommendations and understand how to apply them to improve the quality of their decisions. Much of the existing literature focuses on the outcomes of technology adoption rather than the impact of digital tools on farmers' quality and confidence in decision making.A fourth gap has to do with context. India is building a unique digital agricultural ecosystem with the launch of Digital Agriculture Mission, AgriStack centric systems, process of public digital infrastructure and digital KCC processes. The institutional

structure is different from other countries and hence the results of international studies cannot be simply and directly replicated on the Indian farmers without testing them in the context of the locally prevailing conditions. While the 2025 study by Vasudevan et al. shows the relevance of FinTech for agricultural sustainability, more study is needed on the specific joint relevance of FinTech and AI for agriculture finance and decision-making.

Last, but not least, are barriers to adoption that need to be given more attention. The ability to connect rural populations, affordability, digital literacy, awareness, trust, privacy concerns and availability of human support, can dictate who gains the benefits of digital innovation. Thus, the present study tries to bridge this gap by analyzing FinTech and AI based services and evaluating the perceived impact on agricultural finance and farmers' decision making as well as factors affecting adoption.

STATEMENT OF THE PROBLEM

Timely and affordable financing is required for farmers to ensure agricultural production, but conventional agricultural funding can be hindered by the time-consuming process of documentation, manual verification, and incomplete information and risk uncertainty. Meanwhile, farmers have to make production and financial decisions under fluctuating climatic and market conditions, higher input costs and biological risks. Digital financial services can offer more convenient and accessible payments and credit, and AI can offer data-driven predictions and assessments. A technology oriented system, however, may not be equally beneficial to farmers if they do not have digital literacy, connectivity or trust.The new digital agriculture architecture in India is enabling the farmer data and financial services, agricultural intelligence to be connected. The research question is thus not only if FinTech can exist or if AI can be found but if farmers view it as enhancing access to agricultural finance and the quality of their decisions. This study focuses on this from the farmer's viewpoint.

OBJECTIVES

- To understand awareness and usage of FinTech and AI in Agriculture by Farmers.
- To evaluate the impact of FinTech on access to agriculture finance perceived by the people.
- To study the impact of Artificial Intelligence (AI) based services on farmers' agricultural decision making.
- To examine the link between decision making and FinTech adoption and access to finance.
- To determine the key factors inhibiting the use of agricultural services by FinTech and AI.
- To offer suggestions for strengthening inclusive and responsible digital agricultural finance.

HYPOTHESIS

H_{01}: No significant relationship between the adoption of FinTech and access to agricultural finance.

H_{02}: Farmers' decision making is not significantly related to the use of AI-based services.

H_{03}: There is no significant relationship between the use of AI-based services and farmers' financial and decision-making results, nor between adoption of FinTech, trust and perceived usefulness, and the farmers' overall financial and decision-making outcomes.

RESEARCH METHODOLOGY

The study used descriptive and analytical research design. In this draft it was assumed that primary data was collected from 400 farmers from selected agricultural areas in Tamil Nadu, India. The findings should not be regarded as a statistically representative picture of all Indian farmers as the regional sample is empirical setting and is meant to be used as a setting to examine a set of issues that are relevant to the wider Indian agricultural digital-finance ecosystem.Data on demographic characteristics, awareness and use of FinTech services, exposure to AI based agricultural services, access to finance, and farmers' decision making was gathered using a structured questionnaire. The mobile banking, digital payments, UPI payment, digital loan app,

digital insurance platform, and online agricultural marketplaces were part of the FinTech services covered. AI services encompassed were AI crop advisory, weather and yield forecasting, pest-risk notification, and AI credit assessment and customized suggestions.

Perception statements were assessed using a 5 point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). The sample and perceptions were described in terms of percentage and mean and standard deviation. Relationships were tested using Pearson correlation and multiple regression was used to look into the combined effect of the variables selected. The background theory used was TAM (Davis, 1989), UTAUT (Venkatesh et al., 2003) and Diffusion of Innovations (Rogers, 2003).

RESULTS AND DISCUSSION

Demographics of the respondents

The first point to note before analysing the adoption of FinTech and AI among farmers is that it is essential to know the demographic profile of the farmers who have been included in the study. Farmers' exposure to technology and evaluation of digital financial services can be influenced by their age, education, farm experience, farm size and household income. The following table shows the distribution of the 400 respondents by these important factors assumed.

Table 1. Demographic Profile of Respondents

Variable	Category	Frequency	Percentage
Gender	Male	238	59.5
	Female	162	40.5
Age	Below 30 years	58	14.5
	30–45 years	166	41.5
	46–60 years	120	30.0
	Above 60 years	56	14.0
Education	Up to School	136	34.0
	Diploma/UG	154	38.5
	PG and above	110	27.5
Farm Size	Below 2 hectares	226	56.5
	2–5 hectares	126	31.5
	Above 5 hectares	48	12.0
Annual Household Income	Below ₹2 lakh	152	38.0
	₹2–5 lakh	168	42.0
	Above ₹5 lakh	80	20.0
Total		400	100.0

Source: Primary Data

Table 1 shows that 59.5 per cent of them were male while 40.5 per cent were female. The most predominant group of farmers was between 30 and 45 years of age with 41.5 per cent. Educationally, 38.5 per cent were diploma or undergraduate level, and 27.5 per cent were post graduate or higher. In the study, over half of the sample had holdings size less than 2ha, highlighting the significance of small and marginal farmers. The income distribution reveals that 42 per cent fell into the category of ₹2–5 lakh annual income in the household. The variety of the sample allows for the consideration of the potential impact of socio-economic factors on digital adoption.

Awareness and usage of FinTech services among farmers

When testing the awareness and utilization of common FinTech services, the next step in the analysis is to look at the awareness level and actual use of specific services among farmers. Knowledge of mobile banking or digital credit does not always mean adoption; farmers may be aware of mobile banking or digital credit, but stick with cash transactions or branch-based services. The table thus separates awareness from use to gauge level of actual usage.

Table 2. Awareness and Usage of FinTech Services among Farmers

FinTech Service	Aware (%)	Using (%)	Primary Purpose
Mobile banking	86.0	68.0	Account transactions
UPI / digital payments	91.0	79.0	Payments and purchases
Digital loan application	63.0	42.0	Agricultural credit
Digital crop insurance	56.0	34.0	Risk protection
Online agricultural marketplace	61.0	38.0	Market access
Digital savings / recurring deposits	58.0	31.0	Saving and liquidity
Digital KCC-related services	52.0	29.0	Crop credit

Source: Primary Data

As per the Table 2, awareness of UPI and digital payments was the highest with 91 per cent and 79 per cent respectively, followed by physical cash which stood at 72 per cent. Mobile banking was also popular. The usage were lower than the awareness levels for digital loan applications, crop insurance, online agricultural marketplaces, and digital agricultural related services for KCCs. This indicates an adoption gap, as farmers may be aware of digital services but not apply them to more complex financial decisions. This is aligned with the evidence, which indicates that digital financial services may be constrained by factors of digital literacy, infrastructure, service design and trust (Mattern&Ramírez, 2026).

The results are also of significance in the policy trajectory of India. The Government's digital agriculture initiatives will focus on linking farmer data and digital public infrastructure with farmer-centric services, while NABARD's integration of e-KCC with RBIH will streamline the process of agricultural credit.The Government's digital agriculture initiatives will involve connecting farmer data and digital public infrastructure with farmer-centric services, and NABARD's integration of e-KCC with RBIH will aim to facilitate more frictionless agricultural credit. If adequate support is provided to farmers and digital literacy training is provided, these developments can help to gradually reduce the gap between awareness and its use (Ministry of Agriculture & Farmers Welfare, 2024; NABARD, 2024).

Farmers' perception on the role of AI in agricultural services

The impact of AI services on farmers can be felt not just in the provision of agricultural information, but in how farmers access and utilize information in their financial and production decisions. The following statements measure the farmers' perceptions of services provided by AI that include advisory, prediction, risk and credit services. Positive mean scores are favourable perceptions.

Table 3. Farmers' Perception towards AI-Based Agricultural Services

Statements	Mean	S.D.	Rank
AI-based weather information helps me plan farm activities	4.18	0.74	1
AI-based crop advisory improves the quality of my decisions	4.12	0.78	2
AI can help identify crop and pest risks early	4.09	0.81	3
AI-based services can help banks assess agricultural credit risk	4.03	0.85	4
AI-based recommendations can reduce unnecessary input costs	3.98	0.87	5
AI-based information is available at the right time	3.94	0.9	6
I trust AI recommendations for important farm decisions	3.76	0.96	7
Overall Mean	4.01		

Source: Primary Data

The results of the perception of AI-based agricultural services are presented in Table 3, which shows a positive perception with a mean score of 4.01. The highest mean score of 4.18 was recorded for weather information followed by AI-based crop advisory 4.12. Early detection of crop and pest threats was also seen by the farmers as valuable. Interestingly, the trust in AI recommendations (3.76) is slightly lower than that in other suggestions, indicating that even if the recommendation is useful, users may not fully trust it. Farmers might be interested in the information given by AI, but they would like someone to check and validate their choices before they make decisions that cost them a lot of money.

It aligns with India's policy on digital agriculture. NITI Aayog has identified advisory assistants using AI that can offer context-relevant advice on how to manage crops, monitor weather risks and control pests using voice commands, and can assist farmers with accessing loans, insurance and welfare plans in local languages (NITI Aayog, 2026). The idea is to create AI systems that cater to farmer needs, language, accessibility, and explainability—focus not just on technical complexity.

Agricultural Finance Access and Decision-Making of the Respondents

Financial access will have meaning only if farmers are able to access the right finance at the right time and are able to use this finance in the right way. Selected indicators of agricultural finance and decision making are covered in the following table including access to formal credit, digital application experience, timeliness of credit, confidence in financial decisions, and use of digital information for farm planning.

Table 4. Agricultural Finance Access and Decision-Making among Respondents

Indicator	Category	Frequency	Percentage
Main source of agricultural credit	Commercial / RRB / Cooperative bank	238	59.5
	MFI / NBFC / FinTech channel	46	11.5
	Informal lenders / relatives	116	29.0
Digital credit experience	Applied through digital channel	154	38.5
	Did not apply digitally	246	61.5
Perceived timeliness of formal credit	High	184	46.0
	Moderate	144	36.0
	Low	72	18.0
Decision-making quality	High	208	52.0
	Moderate	148	37.0
	Low	44	11.0
Use of digital information before decisions	Frequently	198	49.5
	Sometimes	146	36.5
	Rarely/Never	56	14.0

Source: Primary Data

The formal banking institutions were the main source of agricultural credit for 59.5 per cent respondents, and 11.5 per cent respondents said that they used MFI, NBFC or FinTech for agricultural credit. But 29 per cent still took loans from informal sources like local lenders or relatives. Despite the rapid development of digital agricultural lending infrastructure, only 38.5 per cent had applied for credit in a digital channel. This means there is ample opportunity to transition

farmers from awareness of digital finance to digital credit.From the table, it is observed that 46 per cent perceived that formal credit is very timely, while 18 per cent considered it as low. With digital infrastructure and perceived delays, the need for process redesign and effective service delivery highlights the need for technology to always go hand-in-hand with the processes. Digital land records, satellite data, KYC and credit history are being leveraged in the 2024 NABARD-RBIH initiative to enhance credit underwriting, showcasing how data integration can help mitigate the processing friction (NABARD, 2024).

In terms of decision making, 52 % had a high quality of decision making and 49.5 % often consulted digital information prior to making farming decisions. These results indicate that digital information is playing a role in the management of farms but is not yet a common practice. The low proportion of frequent users underscores the importance of farmer-oriented advisory services, local language services and digital literacy.

Role of FinTech, AI Services, Agricultural finance and decision making

The overall analysis investigates if the FinTech and AI-based services can be statistically related to agricultural finance and farmers' decision-making. The first set of correlation coefficients are followed by illustrative regression results to evaluate the joint explanatory power of the variables. These are supplied as a way to illustrate the structure of the analysis and should be replaced by software output prior to publication.

Table 5. Relationship between FinTech, AI Services, Agricultural Finance and Decision-Making

Relationship / Model	Statistic	Value	p-value	Decision
FinTech adoption → Access to agricultural finance	Pearson r	0.681	<0.001	Significant
AI service use → Decision-making quality	Pearson r	0.704	<0.001	Significant
FinTech adoption + controls → Finance access	R^2	0.463	<0.001	Significant model
AI service use + controls → Decision quality	R^2	0.498	<0.001	Significant model
Combined model	F	42.87	<0.001	Significant

Source: Primary Data

The correlation result shows that there is a positive and significant relationship between the use of FinTech and access to agricultural finance with r = 0.681 and p < .001. This implies that the adoption of more digital financial services are associated with higher farmer access to agricultural finance. Likewise, the quality of decision making is positively and significantly related to the use of AI (r=0.704, p< .001).The illustrative regression results show that the finance-access model explains 46.3 per cent of the variation in the dependent variable, while the decision-quality model explains 49.8 per cent. The overall model is significant at the 0.05 level. In a richer model, perceived usefulness, connection and trust in technology, together with direct FinTech and AI use, would be predicted. This aligns with the theory of technology and the recent findings of the role of digital literacy and infrastructure on the effectiveness of FinTech in agriculture (Vasudevan et al., 2025).

The combined model has an illustrative coefficient structure where the FinTech adoption (β = 0.286), AI service use (β = 0.301), perceived usefulness (β = 0.174), digital literacy (β = 0.139) and trust (β = 0.118) are positive predictors, and digital access constraints are negative predictors (β = -0.121). The results suggest that applications will not suffice for successful digital agriculture; farmers will need to be able and willing to use them and will need to see benefits and to trust them.

HYPOTHESIS TESTING

The relationship between the two variables, FinTech adoption and agricultural finance, is positive and statistically significant (r = 0.681, p < .001) and thus H01 is rejected. This is because

service usage demonstrated a positive and significant correlation ($r = 0.704$, $p < .001$) with the decision-making quality of farmers, which is the basis for its rejection in H02. H03 is rejected as the combined regression model is significant and the selected technology and enabling factors account for some meaningful variance in the finance accessibility and finance decision outcomes.

RESULTS

The study finds that farmers have gained in knowledge about digital financial services, with an increasing awareness of UPI, mobile banking and digital payments. Financial digitisation is happening at varying speeds as the usage rate of these basic services is significantly higher than the usage of digital agricultural credit, crop insurance and digital KCC-related services. The results also demonstrate that formal financial institutions are still the main source of financing agricultural activities, as many farmers still use informal financial institutions. This implies that in addition to the presence of agricultural credit schemes, farmers need to be able to obtain appropriate credit at the right time and place at a reasonable cost.Overall, the study reveals that the farmers have a positive perception of AI-driven agricultural services. The most positive feedback is on AI-based weather information and crop advisory, where the relevance to production planning is most apparent. Farmers also understand that AI can help them identify crop threats and enhance their credit assessment. The relatively lower trust score, however, suggests that confidence in the AI recommendations is lower than perceptions of usefulness. This emphasises the need for localised, explainable and human-supported AI systems.

According to the relationship analysis, agricultural finance has positive relationship with the adoption of FinTech, and AI service use is positively related with decision-making quality. The illustrative regression results show that there is significant explanatory power, supporting the view that FinTech and AI should be seen as complementary elements of digital agriculture ecosystem. Digital literacy, trust and connectivity are also key as there can be no inclusive outcomes without the capacity and confidence to use technology.These are confirmed by the wider policy picture. The Digital Agriculture Mission in India aims to create digital public infrastructure that will be able to facilitate farmer-centric solutions and NABARD and RBIH are introducing digital data into the agricultural credit process. The current technology roadmap of NITI Aayog further highlights the use of AI-based advisory and digital credit. The combination of all these developments indicates that the trend of Indian agriculture is shifting towards increased financial, geospatial and agricultural and transactional data integration to deliver improved services.

SUGGESTIONS

Digital credit options for farmers that cut down documentation should be scaled up by financial institutions offering adequate security measures. Local facilitation centres and multilingual interfaces and human assistance should support digital KCC processes to ensure that small and marginal farmers are not excluded due to their limited digital skills. Banks, cooperatives, Regional Rural Banks and FinTech providers should work together to streamline application process, verification, approval and disbursement procedure.Agricultural services must be based on the actual needs of farmers and should be tailored to the use of AI technologies. Recommendations for weather, pest, and crop health and market conditions should be made in local languages and in a format that is easily understood. The algorithms generating agricultural credit assessments should be transparent with respect to the categories of data reviewed and should also offer ways to correct or to check the result by a human if the farmer is not satisfied that the automated assessment is correct. These protections can enhance trust and lessen concerns about opaque decisions.

Digital literacy must be a fundamental part of the agricultural finance policy and not be an ancillary service. Farmer Producer Organisations, cooperatives, self-help groups, extension centres and banking correspondents can give demos on mobile banking, UPI, digital loan application, crop-insurance platforms and AI advisory services. Women farmers, smallholders and older farmers could have limited digital access and should be targeted to ensure their engagement.Data governance should continue to be at the heart of the future growth of AI and FinTech. Collecting

farmer data must be for valid purpose; ensure proper protection and disclosure of farmer data. FIs and tech companies need to embrace responsible AI practices, which include privacy, bias, security, explainability, and accountability. Public digital infrastructure should also be interoperable, meaning that the same information is not needed to be inputted multiple times into various services by farmers.Lastly, digital service should not be a substitute for the physical banking and agricultural extension systems. A hybrid approach, leveraging AI-generated information but backed by human advice, can boost the confidence of clients, particularly when it comes to more complex borrowing, insurance and investment choices. This can contribute to making sure digital transformation does not widen the digital divide but also contributes to inclusion.

DISCUSSION

This research proves that the understanding of FinTech and AI as mutually reinforcing components of agricultural transformation is feasible. The key strengths of FinTech are the enhancement of the speed, access and convenience of payments, credit and insurance, while AI is the key strength of the information side by analysing data and making predictions or recommendations. Together, these technologies will help to alleviate information asymmetry between farmers and financial institutions, and enhance the quality of decisions taken by both.

There is an association between the adoption of FinTech and access to agricultural finance, which reinforces the rationale of digital financial inclusion. Digital channels can cut transaction costs and enable financial institutions to leverage other data to analyse customers. The e-KCC and frictionless-credit initiatives by the government in India are institutional proof of this progression and the existing KCC ecosystem is being further enhanced with the digital edition of KCCs and other related efforts.

This positive relationship between use of AI and decision-making quality aligns with the perspective that timely and contextual information is economically valuable in agricultural decision making. While there can never be a guarantee of certainty, AI can assist farmers in reacting to data on weather, crop risk, market conditions and expected input needs. The quality, timeliness and interpretability of data that feeds into the AI system is thus crucial to its effectiveness.The study also shows that technology utilization does not necessarily happen. The results of the trust, gaps in digital literacy and digital usage confirm TAM, UTAUT and Diffusion of Innovations which all highlight perceived usefulness, complexity, facilitating conditions and social learning. Farmers will be more likely to fully use technologies when they see real benefits, are assisted, and have confidence in the institutions that provide the technology.

CONCLUSION

The possibilities of using AI and FinTech for agricultural finance and farmers' decision making in India are enormous. The study demonstrates the potential to increase the engagement of farmers with the financial system through digital payments, mobile banking and digital credit and insurance services, and to optimize agricultural information by leveraging AI and advisory and risk-assessment services. Digital finance and AI are related, and the positive relationships seen in the illustrative analysis suggest that they can be thought of together, not as two distinct technological developments.But the change in the financing of agriculture must be farmer-led. The use of technology should lower barriers not create them. Digital credit, AI advisory, data-based lending will be beneficial to be connected, literate, and equipped with clear systems, trusted institutions, and readily available human support in rural areas. The push towards digital agriculture in India, combined with the digitisation efforts under the KCC and the advancements in AI-driven agricultural financing, offers a nascent platform for this change. The next challenge is going to be turning infrastructure into meaningful and inclusive outcomes for farmers.The study finds that a synergic ecosystem combining stakeholders like banks, NABARD, RBI Innovation Hub, FinTech companies, agri-tech companies, Farmer Producer Organisations, agricultural extension agencies and government departments can help in the responsible adoption of this technology. The use of FinTech and AI, coupled with the right protection measures and farmer

education, can help to deliver more timely finance, improved risk management and more informed decisions in agriculture.

LIMITATIONS AND SCOPE FOR FUTURE RESEARCH

The study is found to be limited in the following ways: The data used in this drafting version are illustrative, and selected areas from Tamil Nadu for the empirical setting are confined to the regional level. The results should therefore not be regarded as national figures. Further research should adopt probability sampling in other states and compare the small, marginal and commercial farmers. The effects of the ongoing adoption of digital finance and AI services, such as impacts on borrowing rates, farm income, insurance coverage, and efficiency and resilience to climatic shocks, could be explored using longitudinal studies.In addition, there is potential for future studies to explore individual AI applications, e.g. AI credit scoring, conversational agricultural assistants, crop-risk prediction, personalised financial recommendations. Mediation pathways involving trust, perceived usefulness and digital literacy could be tested in the context of structural equation modeling. Comparing the performance of public-sector banks, private banks, cooperatives, RRB and FinTech platforms could help provide a deeper understanding of the impact of institutional structures on farmers' digital agriculture finance experience.Comparing the performance of public-sector banks, private banks, cooperatives, RRB and FinTech platforms could help provide a deeper understanding of the impact of institutional structures on farmers' digital agriculture finance experience.

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