Review Paper

The Role of Financial Technology in Transforming Agriculture

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ABSTRACT

Financial technology (Fintech) has revolutionized various sectors by offering innovative solutions to persistent financial challenges. However, the agricultural sector in India, which employs roughly 46 percent of the country's workforce and contributes 18 percent to the country's GDP, continues to face significant financial constraints, including limited access to credit, high interest rates, and a lack of financial literacy. Agri-Fintech, a subset of Fintech, shows promise in meeting the financial requirements of farmers. By leveraging technologies, Agri-Fintech start-ups facilitate efficient credit disbursement, risk management, and market linkages. This paper examines the current status of Fintech in India and evaluates how Agri-Fintech facilitates financial inclusion and enhances farmers' livelihoods through innovative solutions. The study also analyses the services offered by Agri-Fintech startups and their role in addressing the financial challenges faced by farmers. It further identifies the key barriers hindering the adoption of Fintech in agriculture.

Keywords: *Agriculture, Fintech, Technology, Agri-Fintech startups*

INTRODUCTION

Technological advancements play a crucial role in the agriculture sector, greatly aiding in poverty reduction and improving the quality of life for people in rural communities (Gaffney et al., 2019). Integrating innovative technologies fundamentally changes farmers' perceptions, expectations, and preferences regarding their agricultural practices (Sharma & Singh, 2015). Challenges such as poverty, hunger, and malnutrition remain a critical concern for approximately 874 million individuals (FAO, 2021) engaged in agriculture globally. Additionally, inadequate infrastructure within the agriculture sector, including transportation systems, electricity access, telecommunications, marketing facilities, and limited credit support, poses substantial challenges to progress (Gaffney et al., 2019).

India's vast geography and large population pose significant challenges for banks and financial institutions trying to reach every individual. There are three main obstacles: first, providing access to essential banking services; second, ensuring that people stay engaged in the financial system by making regular transactions; and third, improving financial literacy (Grand Thornton, 2020). According to the World Bank, India had about 21 ATMs for every 100,000 adults in

2019, a relatively low number compared to other countries. ATM distribution is especially uneven, with metropolitan areas having 53 ATMs, while rural areas have only nine ATMs per one lakh. This is significant because over 65 percent of India's population lives in rural areas, yet these regions account for just 20 percent of the country's ATMs (Bajaj, 2022). The Reserve Bank of India (RBI) notes that the high costs of building and maintaining infrastructure are significant factors that prevent formal financial institutions from operating ATMs in rural areas.

The internet subscriber base currently reaches 954.4 million, accounting for a significant share of India's total population of 1.44 billion (Kemp, 2024). Of these subscribers, 556.05 million are in urban areas, while 398.35 million are in rural regions, resulting in a strong teledensity of 85.7 percent in 2024 (Singla, 2024). Furthermore, the digital payment industry in India has seen remarkable expansion, with transaction volumes rising from 2,071 crore in FY 2017-18 to an impressive 18,737 crore in FY 2023-24 (Deshpande, 2017; WEF, 2023). This rapid increase indicates that financial technology (Fintech) has the potential to effectively address existing challenges and fully leverage the sector's extensive capabilities.

The fintech industry is composed of companies that leverage technology to enhance financial systems and provide financial services more efficiently. As illustrated in Figure 1, the structure of the Indian fintech landscape is quite intricate. Fintech encompasses the innovations brought about by digital advancements in the financial sector. This means that fintech involves technology-driven financial innovations that can pave the way for new business models, processes, applications, or products, all of which can significantly influence financial markets, institutions, and the overall delivery of financial services.
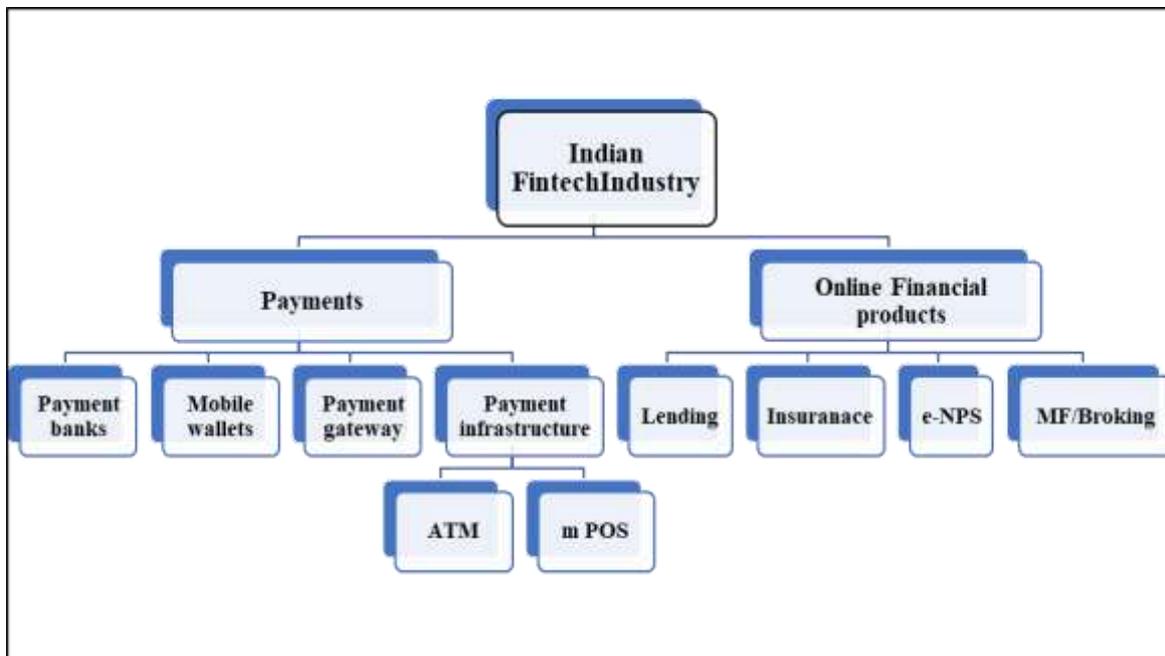

Figure 1: Indian Fintech industry structure
Source: Adapted from Singh et al., 2018.

FINTECH IN INDIA: A GLIMPSE

The Indian Fintech sector has grown recently, fueled by rising smartphone use and a strong digital payments infrastructure. Major industry players are using innovations to improve financial inclusion and develop new solutions. Support from policymakers and a vibrant startup scene also strengthen the sector's potential,

making India one of the top global hubs for financial technology advancements.

India ranks as the third-largest Fintech economy worldwide and leads in Fintech adoption with an impressive rate of 87 percent, far exceeding the global average of 64 percent (NPCI, 2024). Despite its vast population, India's financial services market remained underserved. According to Fortune India (2024), only 35 percent of Indian adults had a bank account in 2011, which increased to 53 percent by 2014. However, ongoing efforts by the government and regulatory bodies to formalize the economy caused this figure to rise significantly to 80 percent by 2017. The growth of Fintech in India has been driven by several government initiatives, including the Jan Dhan-Aadhar-Mobile (JAM) trinity, which laid the groundwork for programs like Pradhan Mantri Suraksha Bima Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana, and Atal Pension Yojana. Today, India's Fintech ecosystem encompasses a wide range of sub-segments, including alternative lending, digital payments, Wealth Tech, Insur Tech, neo-banking, and Emerging Tech.

The agriculture sector must adapt to align with Sustainable Development Goals (SDGs), were technology, especially financial technology, can act as a crucial tool for driving progress (Hinson et al., 2019). The increasing adoption and penetration of Fintech across various sectors have positively impacted the Indian economy. Agriculture, too, stands to gain from this transformative wave. However, fintech usage within the agriculture sector remains significantly underutilized.

APPLICATIONS OF FINTECH IN AGRICULTURE

Fintech has become a key driver of sustainable growth and financial inclusion in agriculture. Smallholder farmers often face difficulties accessing traditional banking services because of limited collateral and credit histories. Fintech solutions, such as digital lending platforms and mobile payment systems, address this issue by providing farmers with convenient access to funding and seamless payment options. This access empowers farmers to invest in high-quality inputs, adopt modern farming practices, and increase crop productivity. Additionally, Fintech innovations like blockchain technology enhance transparency within agricultural value chains, ensuring fair pricing and reducing exploitation by intermediaries. By leveraging the potential of FinTech, the agriculture sector can achieve greater sustainability, improved financial inclusion, and stronger economic integration (Rufaidah et al., 2023).

AGRI-FINTECH

Agri-Fintech is revolutionizing the agriculture sector by integrating cutting-edge financial technology with farming practices. It enhances financial access and promotes sustainable farming methods (Joy et al., 2024). This concept involves the use of financial technology within agriculture. It integrates the principles of fintech, which is defined as the technology used to provide various financial products or services (Knewtson & Rosenbaum, 2020), in accordance with the needs and challenges faced by farmers.

The convergence of financial technology and agriculture aims to improve financial services and increase access for farmers, agribusinesses, and other participants in the agricultural value chain. Notably, the concept of Agri-Fintech aligns with the broader trend of fintech disrupting traditional financial systems and promoting financial inclusion. Fintech can provide financial services to populations without bank access, especially in rural areas (Setiawan et al., 2021). This is particularly important for the agriculture sector, where many farmers and small-scale producers may not have access to formal financial institutions. Additionally, it has the potential to leverage emerging technologies like blockchain, artificial intelligence, and machine learning (Varma et al., 2022) to

improve financial services, manage risks, and boost overall efficiency in agriculture. As the financial technology sector experiences significant growth and expands into various industries (Cao et al., 2021), Agri-fintech is poised to play a crucial role in enhancing the agricultural sector.

Agri-Fintech startups are helping farmers improve their livelihoods by addressing a variety of challenges that go beyond just financial needs. By providing quality and affordable resources, connecting farmers to markets, increasing crop yields, reducing post-harvest losses, and offering storage solutions, these startups aim to lower production costs and boost farmers' incomes.

To increase farm incomes, the DFI (Doubling Farmers' Income) committee has recognized the important role of technology in improving market outcomes. It is concerning that the progress of these technologies could limit their accessibility and implementation. Fintech has become a crucial tool to address this challenge. By leveraging technology to raise farmers' incomes, fintech allows for the efficient and effective use of labor and capital, impacting various sectors along the supply and value chains. Additionally, technologies that simplify the delivery of financial services are likely to create a ripple effect, enhancing stakeholders' ability to access other essential inputs and technologies. Table 1 outlines the Agri-Fintech startups and services.

Table 1: Agri-Fintech startups and services

Services offered	Description	Startups
Finance and Insurance	This includes solutions facilitating finance and insurance offerings solely for agriculture and allied sectors. Typically, companies in this space explore novel credit solutions and leverage farm and value chain data to enable financing and insurance, offered through traditional and emerging distribution channels.	Arya.Ag, Jai Kisan, DeHaat, Bijak, Samunnati, Farmart, Hesa, GramCover, Samaaru, Samunnati, Jai Kisan, Ayecart, GramCover, Agrifi, Agrizy, PayAgri
Supply Chain Technology (Upstream)	These companies aim to enhance farmers' access to inputs by digitizing the supply chains, including e-commerce platforms for seeds, agricultural inputs, livestock feed, and more.	AgroStar, Bighaat, Unnati, Kamatan, Crofarm, Waycool, Farmpal, MeraKisan
Supply Chain Technology (Downstream)	Companies in this category leverage technology-driven solutions to streamline output supply chains and establish connections with end consumers and businesses. This involves utilizing e-commerce platforms to bring agricultural, horticultural, aquacultural, and dairy products closer to consumers.	Ninjacart, WayCool, DeHaat, Vegrow, Bijak, Captain Fresh, Jumbotail, Wheelocity, FreshToHome, Country Delight
Warehousing and Logistics	This segment encompasses innovations that facilitate post-harvest activities beyond the sale of produce. These include warehousing, cold chain solutions, other preservation methods, and processing or value-addition technologies. It excludes general logistics startups that may also cater to the agriculture sector.	Ergos, PostHarvest, AgriBazaar, Bijak, Whrrl, Arya Collateral, Origo Commodities, NCML, StarAgri
Precision and Digital Agriculture Technology	Companies in this segment utilize sensing technologies for smart farming and imaging technologies for quality control. They leverage tools such as satellite data, drones, and IoT devices, combined with machine learning, to improve analytics and predictability both on the farm and throughout the value chain.	CropIn, Stellapps, Satsure, Intello Labs, Fasal, AgNext, Garuda Aerospace, Omni Present Robot Tech, Fyllo, Eruvaka Technologies, Agricx, Nubesol, Sickle, Future Farms, Clovers, Toolsvilla, Kheyti, Ecozen, SatSure, Farmguide, TartanSense

Controlled Environment Agriculture	This category comprises companies designing innovative farming systems that focus on controlling environmental factors such as water, soil nutrients, air composition, temperature, and humidity to cultivate produce.	Eeki Foods, Gourmet Garden, Nutrifresh, Simply Fresh
Farming-As-A-Service (FAAS)	This business model enables farmers to access various agricultural services—such as precision farming tools, data analytics, equipment rentals, and labor support—on a pay-per-use or subscription basis. It facilitates the use of advanced technology and expertise without requiring significant investments in equipment or specialized knowledge.	CropIn, Intello Labs, FarmERP, Nebulaa's Matt, TartanSense, Yuktix, Fasal, FarMart

Source: Authors' compilation based on Adhya and Sahoo, 2022; Pahwa, 2020; PIB, 2022 Prajapati and Singh,2023; Pushkarna and Upadhyaya 2025; ThinkAg, 2024.

The adoption of Financial Technology (FinTech) and Agricultural Financial Technology (Agri-Fintech) in India is steadily on the rise, driven by various government initiatives aimed at integrating advanced technologies into the agricultural sector. Notable programs include the National e-Governance Plan in Agriculture (NeGPA), the Sub Mission on Agricultural Mechanization (SMAM), the Rashtriya Krishi Vikas Yojana (RKVY), and initiatives focused on improving agricultural mechanization for effective crop residue management. Additional key initiatives such as the National Mission for Sustainable Agriculture (NMSA), the Pradhan Mantri Krishi Sinchai Yojana (PMKSY), the Pradhan Mantri Fasal Bima Yojana (PMFBY), and the ATMA Scheme further support this transition (PIB, 2024).

Despite these advancements, the use of these technologies in agriculture remains limited compared to their adoption in manufacturing and services. Several challenges hinder the effective implementation of Fintech solutions in agriculture, including:

- Inadequate Infrastructure: Despite increasing smartphone penetration globally, mobile phone ownership among farmers remains limited. Additionally, poor infrastructure, including transportation systems, electrification, telecommunications, and marketing facilities, continues to be a significant barrier.

- Low Digital Literacy: Financial and digital literacy pose major challenges, with only 27 percent of the Indian population being financially literate (PWC and ASSOCHAM, n.d.). Farmers, often belonging to older demographics, face significant difficulties in adopting digital tools. Even those who own mobile phones are often unaware of mobile finance platforms.

- Cash Dependency: The agricultural value chain is heavily reliant on cash transactions, leading farmers to prefer cashing out their funds, even when they possess digital wallets.

- Lack of Data: Smallholder farmers often lack access to traditional information and collateral, limiting their ability to participate in formal financial systems.

- Dependence on Middlemen: Limited familiarity with the formal banking sector, from opening accounts to obtaining loans, drives farmers to rely on local middlemen for credit needs.

- Resistance to Technology: A lack of trust and confidence in using digital platforms independently contributes to farmers' reluctance to adopt new technologies for financial transactions.

Over 70 percent of India's population resides in rural areas, yet the uptake of Fintech services is largely focused on metropolitan regions and Tier I and II cities. Representing about 17 percent of the global population, India currently boasts more than

45 percent of its residents online. However, only 24 percent of the population is considered financially literate. This creates an extra challenge in attracting and serving customers, which hampers the country's goal of achieving financial inclusion. Expanding access to rural areas will be essential for increasing market awareness, encouraging adoption, and building trust in modern Fintech platforms for underserved communities (PWC and ASSOCHAM, n.d.).

CONCLUSION

Over the past two decades, the digital revolution, e-commerce, and B2B (business-to-business) technology have primarily focused on India's expanding middle class and urban markets. This period saw remarkable growth for digital startups as technology adoption increased in urban India alongside rising wealth levels among residents. More people migrated from rural to urban areas, fueling growth across various sectors over the years, with the agriculture sector expected to undergo a significant transformation. Although the impact of this change is still small at present, it is becoming noticeable.

Agri-Fintech is transforming agriculture by offering innovative financial solutions, improving access to funding, and enhancing distribution channels. The integration of Fintech into digital marketplaces is transforming agricultural operations, connecting various participants in the farming ecosystem while promoting transparency and empowerment (Anshari et al., 2019). The influence of Agri-Fintech can be observed at every stage: from procuring farm inputs, to improving farming and harvesting techniques, to distribution and transportation of produce, post-production processing and handling, and finally retailing and financing - every touchpoint of the agri-business has potential for innovation.

More than 500 startups are working on various aspects of pre- to post-harvest management systems. Agri-Fintech startups have also helped farmers increase production and get better prices, while providing greater value to end consumers. These developments highlight a promising future for Indian agriculture. As this sector advances, addressing challenges such as infrastructure gaps, regulatory hurdles, and digital literacy is crucial to fully unlock Agri-Fintech's potential in promoting sustainable and efficient farming worldwide. By overcoming these obstacles, India's Fintech sector can leverage its extensive capabilities, improve financial inclusion, and make a major contribution to the country's economic growth, positioning itself as a global front-runner in financial innovation. This effort will also support the goal of making India a seven trillion-dollar economy by 2030.

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