REPORT

Digital Adoption among Farmer Collectives and its Members in India: Status and Opportunities for Intervention

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Authors:
Shubhangi Jaiswal (SARDI Fellow)
Sridhar Easwaran and Poorna Pushkala, Samunnati (Mentor, SARDI Fellowship)
Vatsima Tripathi and Santanu Pramanik, LEAD at Krea University

Analysis and Data Visualization Support:
Abhinav Motheram, LEAD at Krea University

Survey Team:
Sachin Srivastava, Durgesh Pandey, Pramod Tiwari, Prasenajit Samanta, LEAD at Krea University

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We hope that this report illuminates the current state of digital adoption among FPOs and reveal the existing gap in reaching member farmers with these tools. We believe the findings and recommendations will resonate with policymakers, encouraging them to consider interventions that can further bridge the digital divide for smallholder farmers in India.

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Abbreviations

APEDA	:	Agricultural and Processed Food Products Export Development Authority
AGMARKNET	:	Agricultural Marketing Information Network
API	:	Application Programming Interface
B2B	:	Business to Business
B2C	:	Business to Customer
CBBO	:	Cluster Based Business Organizations
CCE	:	Claim Crop Estimation
CSR	:	Corporate Social Responsibility
DPI	:	Digital Public Infrastructure
eNAM	:	National Agriculture Market
ERP	:	Enterprise Resource Planning
FPC	:	Farmer Producer Company
FPO	:	Farmer Producer Organization
GDP	:	Gross Domestic Product
GVA	:	Gross Value Added
ILO	:	International Labour Organization
INR	:	Indian National Rupee
MABIF	:	Madurai Agri-business Incubation Forum
MCX	:	Multi Commodity Exchange
MeitY	:	Ministry of Electronics & Information Technology
MIS	:	Management Information Systems
MNAIS	:	Modified National Agricultural Insurance Scheme
MSME	:	Micro Small and Medium Enterprises
NAIS	:	National Agricultural Insurance Scheme
NABARD	:	National Bank for Agriculture and Rural Development
NAFED	:	National Agricultural Cooperative Marketing Federation of India Ltd.
NAFPO	:	National Association for Farmer Producer Organizations
NCDC	:	National Cooperative Development Organization
NCDEX	:	National Commodity and Derivatives Exchange

OCEN	:	Open Credit Enablement Network
ONDC	:	Open Network for Digital Commerce
PC	:	Producer Company
PMFBY	:	Pradhan Mantri Fasal Bima Yojana
PMJDY	:	Pradhan Mantri Jan-Dhan Yojana
PM-KISAN	:	Pradhan Mantri Kisan Samman Nidhi
PODF	:	Producers Organization Development Fund
RKVY-RAFTAAR	:	Rashtriya Krishi Vikas Yojana-Remunerative Approaches for Agriculture and Allied Sector Rejuvenation
SFAC	:	Small Farmers Agribusiness Consortium
UPNRM	:	Umbrella Programme for Natural Resource Management
USD	:	United States Dollar
VIUC	:	Vegetable Initiative for Urban Clusters

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Executive Summary

Despite employing a substantial 43 per cent of India's workforce, the agricultural sector contributes only 16 per cent to the national GDP (The World Bank, 2024). This reflects some of the challenges the agricultural sector faces in India. 86 per cent of India's farmers fall in the small and marginal category with landholdings of less than two hectares (Ministry of Agriculture and Farmers Welfare, 2019). The main impact of this fragmentation has been a reduction of mean plot size below the threshold for mechanization, inefficient land use, and substitution of labor for mechanical and chemical technology, which has curtailed agricultural productivity and profitability for smallholder farmers. Furthermore, dependence on middlemen for market access and expensive informal credit creates additional burdens.

By consolidating farmers into Cooperatives or Producer Companies (FPCs), Farmer Producer Organizations (FPOs) in India have ensured that farmers have greater control over their produce. This consolidation fosters economies of scale, enables access to better quality and competitively priced inputs, facilitates knowledge sharing on best practices, and promotes an 'improved' market access and bargaining power leading to higher output prices. With the aim of 'doubling farmers' incomes', the Government of India has pushed for the creation of 10,000 new FPOs by 2024 (GoI 2020). By November 2023, 75 per cent of the target has been achieved leading to registration of nearly 7600 FPOs (Mukherjee 2023).

While some FPOs have achieved remarkable success, many struggle because of operational inefficiencies and difficulties securing credit and market access. In this context, the rise of digital solutions in agriculture offers immense potential. These solutions can improve yields through resource-efficiency, enhance farm management practices, and empower FPOs with digital tools like document management, member records, and inventory management systems. Increased transparency and improved governance within FPOs can open doors to formal credit and market linkages with larger buyers.

This study delved into the levels of digital adoption by FPOs and their member farmers across various dimensions of digital technology, such as ownership of computers, having a website, digital recordkeeping, registration on online portals, sale of output through digital platforms, digital member engagement, and digital transactions. We also explored the association between FPOs' digital adoption and digital adoption by their member farmers.

Through analysis of data from 275 FPOs and 541 member farmers across five Indian states (Bihar, Madhya Pradesh, Maharashtra, Odisha, and Rajasthan), the research investigates two key aspects: Firstly, the characteristics of FPOs and farmers associated with different levels of digital adoption, and secondly, whether FPO digitalization leads to increased digital adoption among member farmers. It aimed to identify successful strategies and highlight areas where rethinking and designing of interventions are required. These insights can inform strategies that foster higher digital adoption within FPOs, creating a "trickle-down effect" where member farmers are empowered.

Ultimately, the goal is to create a more efficient, sustainable, and profitable FPO ecosystem that benefits all stakeholders with farmers at the center.

Key Findings

FPO Characteristics

- **49 per cent** of the FPOs in our sample are newly founded and only two to three years old. Bihar and Rajasthan **(23 per cent each)** have older FPOs which are in operation for more than **10 years compared to only 10 per cent in the overall sample.**
- Among **275 FPOs** in our sample, only **66** of them **(24 per cent)** are cooperative societies and the remaining **76 per cent** are producer companies. Bihar has a significantly higher proportion **(78 per cent)** of cooperatives compared to any other states (ranging between three per cent and **31 per cent**).
- The median number of shareholders per FPO is **500**, with Odisha having a higher number of shareholders **(median being 651)**. The proportion of female shareholders is low, overall median being **27 per cent**. However, Odisha has significantly higher female representation **(median being 38 per cent)** among members.
- The majority **(53 per cent)** of the FPOs reported a turnover between INR **10 lakhs** and one crore **(between ~ USD 12,000 and 120,000)** for the financial year **2022-23**. A higher percentage **(39 per cent)** of producer companies have a turnover exceeding INR one crore **(~ USD 120,000)** compared to cooperatives **(26 per cent)**.
- A small proportion (five per cent) of FPOs are all-women FPOs. Out of **33** sampled FPOs in Madhya Pradesh, six FPOs **(18 per cent)** were all women. The sample from Bihar did not have any all-women FPOs.

Farmer Characteristics

- The majority **(73 per cent)** of the respondent farmers fall within the age group of **26-45**.
- A large proportion **(59 per cent)** of farmers in our sample has more than **10 years** of schooling.
- The sample has a nearly even distribution of members who are shareholders **(48 per cent)** and those who are not shareholders **(52 per cent)**.
- Agriculture is the primary occupation for a vast majority **(94 per cent)** of members.
- Compared to national estimates of marginal and small farmers **(86 per cent)**, the sample has a lower proportion of marginal and small farmers **(64 per cent)** and a higher proportion of medium to large farmers.

FPO Digital Adoption

- As per the scores on this digital adoption index, **275 FPOs** were grouped into tertiles: low **(33 per cent)**, medium **(26 per cent)** and high **(41 per cent)** levels of digital adoption.
- More than half of the surveyed FPOs from Bihar and Odisha exhibit low levels of digital adoption. Maharashtra and Rajasthan both have relatively higher proportion of FPOs **(45 per cent)** that have a high level of digital adoption.
- Among surveyed FPOs, the ones which were established more than ten years ago have a higher proportion **(48 per cent)** of FPOs belonging to the low level of digital adoption, compared to the overall proportion of **33 per cent** belonging to the lowest level of digital adoption.
- **45 per cent** of surveyed FPOs which are registered as Producer Companies exhibit high levels of digital adoption, compared to **30 per cent** of surveyed farmer cooperatives.

- FPOs who received low levels of digital training in the last two years preceding the date of survey, **46 per cent** had low levels of digital adoption. However, in the overall sample, **33 per cent** of the FPO falls in the low digital adoption category.

Farmer Digital Adoption

- **Significant state-level variations in farmer digital adoption:** The study reveals substantial differences in digital adoption among farmers across Indian states, even after adjusting for farmer's background and FPO characteristics. Farmers in Madhya Pradesh and Maharashtra exhibit significantly higher digital adoption compared to those in Bihar. On the other hand, farmers in Rajasthan seem to be less likely to adopt digital tools compared to farmers in Bihar.
- **Farmer's education plays a significant role in their digital adoption:** Among surveyed farmers, the higher the levels of formal education, higher are the levels of digital adoption.
- **Potential link between FPO shareholding size and farmer digital adoption:** The study suggests a possible negative correlation between the number of shareholders in an FPO and levels of digital adoption among its members. FPOs with a smaller shareholder base might dedicate more resources to member engagement, potentially leading to higher levels of digital adoption among farmers.

Association Between FPO Digital Adoption and Member Farmer's Digital Adoption

- Bivariate association test between FPO digital adoption levels and member farmer's digital adoption levels, indicates a statistically significant association between the two indicators.
- However, the effect of FPO digital adoption on farmer's digital adoption diminishes as we add other variables in the regression model, such as location state of the FPO, farmer background characteristics, and FPO characteristics. The regression coefficients no longer remain statistically significant.

Recommendations

- Increase access to training in digital tools for FPOs and farmers
- Promote gender equity within FPOs to reap the benefits of 'feminization of agriculture'
- Push for ground-up innovations tailored to FPO's needs
- Bridge the information gap with a national FPO repository
- Requires further assessment of FPO digital adoption spillover effect on farmers' digital adoption and well-being.

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1. Introduction

Despite growth over the last few years, the overall contribution of the agriculture sector has decreased from 34.4 per cent of India's GDP in 1980 to 16.7 per cent in 2022. The sector remains a major provider of rural livelihoods in India, contributing to 43 per cent of total employment. As such, it is critical to invest in the sector to boost productivity, minimize environmental impact, and increase farmer income, to ensure its growth journey. Emerging technologies and digitalization hold immense potential in that regard (World Economic Forum, 2021).

According to the National Statistical Office, the contribution of agriculture and allied activities to India's GDP stood at 17 per cent in 2022, while the sector employed over 43 per cent of India's workforce, as per ILO-modelled estimates (The World Bank, 2024). Agriculture accounts for 11.4 per cent of India's total exports and 2.1 per cent of the world's exports of agricultural products (Pocketbook of Agricultural Statistics 2020). The sector has witnessed robust growth with an average annual growth rate of 4.6 per cent over the last six years (Department of Economic Affairs, 2023). This has enabled agriculture and allied activities sector to contribute significantly towards country's overall growth, development and food security.

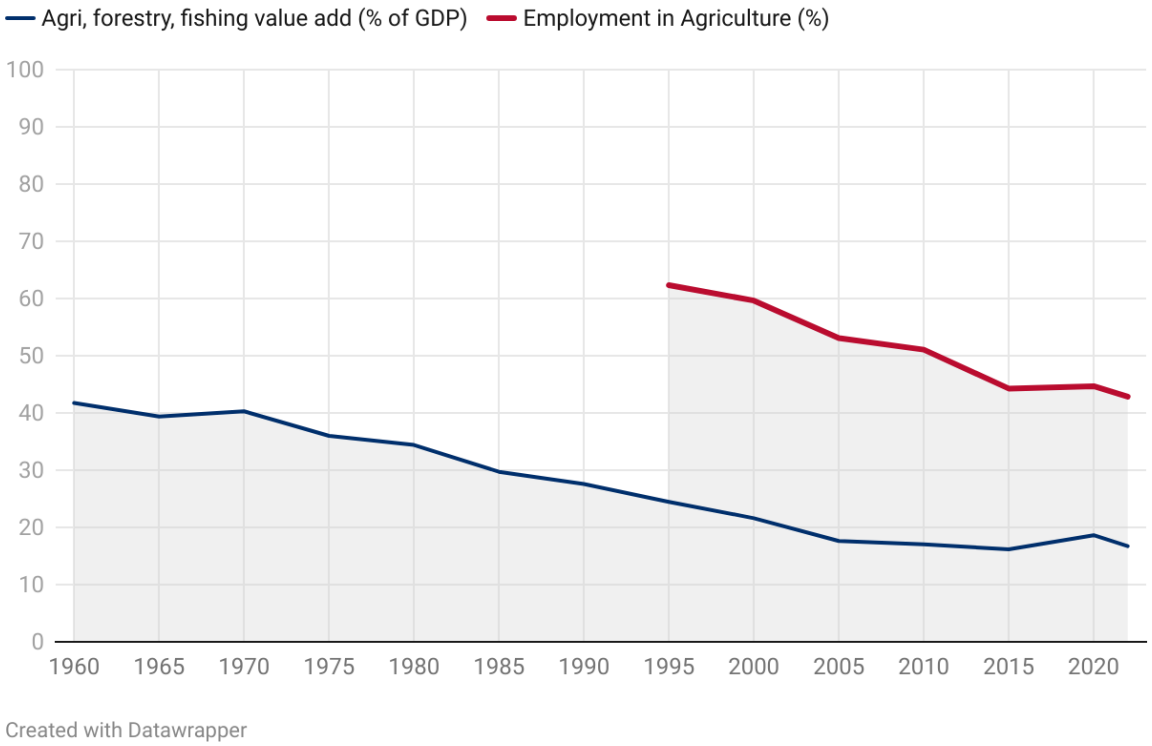

Figure 1: Contribution of the Agricultural Sector to GDP and Proportion of Employment in Agriculture

Source:
1. Agriculture, forestry, and fishing, value added (Percentage of GDP) - National Statistical Office, Ministry of Statistics & Programme Implementation, Government of India- compiled by World Bank
2. Employment in agriculture (Percentage of total employment): ILO modelled estimate - compiled by World Bank

1.1. Challenges Faced by India's Agricultural Sector

A decline in agriculture's percentage contribution to the country's GDP can be attributed to internal challenges faced by the sector, along with the growth of India's services and manufacturing sectors.

According to a study conducted by the Central Institute of Post-Harvest Engineering & Technology (CIPHET) Ludhiana in 2015, poor logistics and warehousing have led to an annual agricultural waste value of a mindboggling

INR 92,651 crores (~USD 11.12 billion) at the national level even before reaching the consumer. The study used agricultural production data from 2012-13 at 2014 wholesale prices (Ministry of Food Processing Industries, 2016). This study was commissioned by the Indian Council of Agricultural Research (ICAR) which is an autonomous organization under the Ministry of Agriculture and Farmers Welfare, Government of India. No other quantitative assessment of post-harvest losses has been conducted since then.

Challenges faced by India's agriculture sector:

- Small landholdings
- Outdated farming practices
- Soil degradation and land erosion
- Water scarcity and irrigation
- Climate change and natural disasters
- Inadequate infrastructure
- Limited access to technology and research
- Market volatility and price fluctuations
- Lack of access to credit and finance

Source: Nayyar, 2023; Kaka *et. al.,* 2019

Several government schemes, as discussed later in Section 2, have been implemented to support India's agricultural sector. Yet, ineffective delivery mechanisms have failed to improve productivity, reduce costs, or increase price realization in any real way (Nayyar, 2023). A persistent obstacle hindering agricultural productivity and farmer income is the fragmentation of agricultural land holdings, as land owned by parents is often distributed among potential heirs as inheritance. Plot sizes keeps decreasing with each successive generation, primarily due to such inheritance rules and customs (Padmanabhan, 2018). Approximately, 86 per cent of India's farming population currently comprises smallholder farmers with land holdings less than two hectares of land (Ministry of Agriculture and Farmers Welfare, 2019).

The main impact of this fragmentation has been a reduction of mean plot size below the threshold for mechanization, inefficient land use, and substitution of labor for mechanical and chemical technology, which has in turn curtailed agricultural productivity and profitability for smallholder farmers (Deininger, Monchuk, Nagarajan, & Singh, 2016). The level of farm mechanization in India stands at about 40-45 per cent. While states such as Uttar Pradesh, Haryana and Punjab demonstrate high mechanization levels in agriculture, north-eastern states demonstrate negligible mechanization. The average level of farm mechanization in India is relatively lower compared to countries such as the United States of America (95 per cent), Brazil (75 per cent) and China (57 per cent). Despite this, the Indian agricultural sector has seen an average growth rate of 3.6 per cent over the last decade (NABARD, 2018).

Smallholder farmers cultivate nearly half (47.3 per cent) of India's agriculture land (Ministry of Agriculture and Farmers Welfare, 2019). These farmers struggle due to limited resources and weak bargaining power. Challenges in accessing markets, credit, government schemes, and crucial information, render smallholder agriculture economically unsustainable. Consequently, the average monthly income for agricultural households is relatively low at INR 10,218 (~ USD 122) (MoSPI, 2021) compared to a country-level average of around INR 30,000 (~ USD 360) (People Research on India's Consumer Economy, 2021).

1.2. Collectivization of Farmers

Collectivization of farmers into producer organizations - Farmer Producer Organizations (FPOs) - offers a promising new approach to address the vulnerability associated with small landholding and poor bargaining power of small farmers (Jayashree et. al 2023; Trebbin 2014; Shah 2016; Trebbin and Hassler 2012).

Advantages of FPO Membership

Evidence suggests that FPO membership has improved the lives of the farmers in various ways. FPOs enable farmers to access new information about crops and the use of digital technology in farming, ensure access to high-quality and reduced-cost inputs at the right time, provide assistance on the right application of fertilizers and pesticides (Roy et al., 2020), and ensure a minimum price for agricultural produce (Mahapatra et al., 2023). This improves the incomes and socio-economic status (Shelake et al., 2022) of farmers, and increases their savings (Wankhade et al., 2022). There is also evidence of spillover benefits on water and sanitation facilities at the community level (Desai & Joshi, 2013; Jena & Grote, 2016). As member-based institutions, FPOs are embedded in local communities and have the potential to provide strong local support to farmers, including

marginalised producers. FPOs like the Indian Organic Farmers Producer Company Ltd, Vanilla India Producer Company Ltd (VANILCO), Indian Organic Farmers Producer Company Ltd (Kumari, 2022) and Kazani Farmer Producer Company Limited are testimony to the huge potential and outreach of FPOs.

Challenges faced by FPOs

Despite potential benefits, FPOs face several challenges which can hinder their growth in terms of their annual turnover and restrict the collective's impact on the agricultural sector. Some key challenges are outlined below:

1. **Limited Capital:** A major roadblock for FPOs is securing sufficient capital (Chauhan et al., 2021). Unlike large corporations, they have smaller member contributions to paid-up capital. Additionally, capital injection from external agencies or organizations is not a common practice. This limited access to funds restricts their ability to invest in infrastructure, technology, and other resources needed for growth.

2. **Balancing Alliances and Costs:** FPOs can engage in collaborative projects and resource sharing with other FPOs and develop networking platforms to build horizontal alliances. On the other hand, building vertical alliances by entering into long-term contracts with input suppliers and processors (vertical alliances) is crucial for FPO viability. However, these alliances require careful cost-benefit analysis to ensure efficient allocation of limited FPO resources. The key is to ensure that the potential rewards of the alliance outweigh the risks involved, leading to more informed decision-making. FPOs must find a balance between effective governance and efficient operations. Cook and Chambers (2007) and Shah (2016) warn against losing focus on internal effectiveness once initial success is achieved.

3. **Managing Risk Sharing:** FPOs can reduce risks for their member farmers through shared insurance schemes or developing mutual support mechanisms. The goal is to create an environment where members can rely on each other for support during difficult times, such as through labor exchange systems or emergency funds. However, the variation in the degree of risk preference among members can impact the effectiveness of risk-sharing mechanisms (Mazzocco and Saini, 2012). While it can promote equity, it also leads to inefficiencies within the FPC.

Digital Technologies Paving the Path Ahead

Digital technologies are revolutionizing the way farmers and FPOs operate in India. Integration of digital technologies can provide data-backed solutions to minimize crop failure and gauge weather related changes. Digital transaction trails enable improved access to credit for FPOs as well as for farmers. Digital tools related to bookkeeping and inventory management further strengthen the backend governance of FPOs, making operations efficient. From "super-apps" to "agri-fintech," technology facilitates direct-to-farmer sales channels for providers of agrochemicals, fertilizers, and seeds (Dubashi et al, 2023). Collective information sharing with member farmers through a connected network overcomes information asymmetry to improve members' knowledge and awareness, thus enhancing its impact on member farmers.

While current data suggests moderate digital adoption among FPOs (PIB, 2022), government initiatives and ag-tech platforms like FPONext, Sammunati FPO Academy and MANAGE-FPO Academy are paving the way for improved communication, market access, information sharing, and training (NAFPO, 2022). Deltafiia, a farmer producer company, is an example of how simple practices, like using management information systems (MIS), can help track the activities of the Board of Directors and farmer members. Through an online portal, the FPC keeps track of all farmer members, their past output, their input requirements, current cultivation and, therefore, the FPC is able to forecast supply and commit to large buyers like Reliance Fresh and Dehaat (Samunnati, 2024). Telangana became the first state in India to adopt a public private partnership model in partnership with the World Economic Forum to scale digital agriculture in the state. The Forum in India has two initiatives focused on agriculture and food systems – artificial intelligence for agriculture innovation (AI4AI) and the food innovation hubs that aim to transform the agricultural sector leveraging ag-tech and innovations (Neo and Rao, 2023).

This study aims to uncover the status of digital adoption among FPOs and its members farmers. It employs desk research and primary data collection to understand factors that influence FPOs' digital behavior. The study, further, explores whether FPO digitalization trickles down to digital adoption among member farmers.

Photo Credit: Shubhangi Jaiswal

2. Literature Review

This section highlights existing evidence about FPOs as a collective model in the agricultural sector and factors that make it function better. It also reviews agricultural policies in India and gaps that digital tools can fulfill.

2.1. History of FPOs in India

"Farmer producer organization" is a generic term that encompasses both FPCs and agricultural cooperative societies (also known as "cooperatives") registered under various central and state cooperative society laws. The consolidation of agricultural land or cooperative farming has long been suggested to address poor productivity arising from land fragmentation in India, to leverage economies of scale in agriculture (Kumar and Moharaj, 2023; Duan et. al, 2021).

Agricultural cooperative societies (see glossary) emerged as one of the earlier attempts to collectivize farmers and pool resources to improve their socio-economic status. While some cooperatives, especially in the dairy sector, became successful in India, cooperatives in the farm sector have fallen short of effectively collectivizing farmers and building successful, sustainable organizations due to lack of market orientation, small sizes (Singh, 2017), corruption, bureaucratic lethargy, restrictive laws and an "external locus of control" (Shah, 2016).

Given the myriad challenges facing smallholder farmers and the shortcomings of farmer cooperatives, Farmer Producer Companies (FPCs) (see glossary) have emerged over the last two decades as an effective and popular solution to collectivize smallholder farmers and address these challenges. FPCs function similarly to any normal private limited company, with a Board of Directors, CEO, Staff member and highest authority being general body.

FPCs and cooperatives share important similarities. For example, institutions registered as cooperative societies and FPCs both have legal provisions for sharing profits earned by the FPO by way of dividend. Both legal forms can offer better prices for the produce they procure from their members, thus, benefiting the latter. Similarly, they can procure inputs/raw material in bulk and sell to members with low margins.

However, there are also important differences between FPCs and cooperatives. While FPCs are run like private limited companies, co-operatives' operations are not always very efficient due to potential interference from their politically appointed registrars. Another potential avenue of interference comes through the mandatory elections for chairperson or other such representative positions. Such elections sometimes see political parties deploying manipulation tactics.

To support FPO development, two key institutions act as one-stop shops: The Small Farmers' Agribusiness Consortium (SFAC), and National Bank for Agriculture and Rural Development (NABARD). Both the bodies are responsible for providing technical support, financial assistance, training, research, and knowledge management resources for FPOs.

The journey of FPOs in India can be traced back to the year 2000. The Y. K. Alagh Committee (see glossary), established in 1999, recognized the need for empowering small producers. Their recommendation led to the creation of the Producer Companies Act in 2002. This act provided the legal framework for producer collectives, paving the way for small farmers to pool resources, and establish businesses together, thus improving farmer incomes and mitigating long term risks (Govil et al., 2020). While the policy for FPOs was initiated in 2003, FPOs gained significant momentum after 2013. A series of crucial developments during 2013- 2015 are credited with propelling the FPO movement forward. Key developments include:

- **2011-2013:** NABARD initiated FPO financing through two schemes: Umbrella Programme for Natural Resource Management (UPNRM) and Producers Organization Development Fund (PODF).
- **2013:** National Policy and Process Guidelines for FPOs provided a framework for the Central and State Government agencies who wanted to promote and support FPOs, especially producer companies and

link them to benefits under various programs and schemes of the Central and State Governments (MoA, 2013).

- **2013-14:** Funds were sanctioned to SFAC for Equity Grant and Credit Guarantee Fund Scheme for FPCs (SFAC, 2014). FPCs having shareholding of 50 members or more became eligible for matching equity grants equivalent in amount to the equity contribution of their shareholders up to INR 10 lakhs (~ USD 20,000). The Credit Guarantee Fund was set up with the objective of providing a credit guarantee cover to FPCs having shareholding of 500 members or more to enable them to provide collateral free credit by minimizing their lending risks with respect to loans not exceeding INR 100 lakhs (~ USD 120,000).
- **2014-15:** The Government established the PRODUCE Fund for building 2,000 FPOs with a corpus of INR 200 crores (~USD 2.4 million) (NABARD, 2015).
- **2021:** The "Formation and Promotion of 10,000 FPOs" scheme aimed to create 10,000 new FPOs with a budgetary allocation of INR 6,865 crores (~USD 825 million) (Government of India, 2020). This policy initiative has resulted in a surge in FPO registrations, with over 7,500 established by November 2023 (Mukherjee, 2023).

2.2. Factors Associated with the Success of Farmer Collectives

Existing literature highlights several factors that can significantly contribute to the success and long-term impact of FPOs among its members.

Support Ecosystem: The establishment and long-term viability of FPOs depend on a carefully cultivated support ecosystem (Dey, 2018). During their initial stages, FPOs require support from resource institutions like government agencies or agricultural universities, alongside strategic partnerships with development organizations. This crucial initial investment provides technical expertise, marketing guidance, and financial aid, strengthening the foundation of the FPO and equipping it to navigate early challenges (Cherukuri & Reddy, 2014). These partnerships can provide access to new markets, valuable industry connections, and expertise in business development. The three key aspects that contribute to the viability of an FPO include member centrality (ensuring the FPO caters to the needs of its members), domain centrality (effectively addressing the core business functions of the organization), and patronage centrality- securing and retaining member participation, fostering a sense of ownership (Shah, 1995, 1996; Francesconi and Wouterse 2015).

Adoption of Digital Technology: There is a growing body of research highlighting the transformative potential of digital technology in boosting agricultural productivity. These solutions can enable easier access to credit, improved output forecasting, stronger market linkages, a more organized agri-value chain, and ultimately, enhanced income security for farmers (Kaka et al., 2019; Dubashi et al., 2023). Digital technology can enhance efficiency, transparency, and trustworthiness within FPOs, ultimately improving market access for smallholder farmers (Bhatia, 2018; Gupta, 2019). Hence, it is crucial that the FPOs adopt those digital technologies and facilitate adoption among member farmers.

2.2.1. Case Study. Beyond Niche: How Kazhani FPCL is Pioneering Millets and Blockchain for Farmer Empowerment

In this section we present a case study of Kazhani Farmers Producer Company Limited (FPCL) to showcase marketing strategies which could create an impact on the income and the livelihoods of farmers through the development of profitable marketing linkages (Yadav, Paliwal, and Wadkar, 2022). K.P. Kavitha, the driving force behind Kazhani FPCL, began her career fostering agricultural development. Working with MYRADA, a community-focused non-profit, Kavitha championed farmer empowerment promoting grassroots organizations with NABARD. This dedication led her to a pivotal opportunity: spearheading the creation of Kazhani FPCL. As part of a program promoting five new Farmer Producer Companies (FPOs), Kavitha's vision and experience paved the way for Kazhani FPCL's emergence. Established in 2016, this farmer producer company in Erode district, India, broke new ground by cultivating and supplying unpolished rice, a niche market at the time. When faced with marketing challenges, Kazhani pivoted by establishing a Millet Value Addition Centre, demonstrating its agility and willingness to innovate.

Millet Trailblazers: Entering the millet value chain as early as 2017-18, Kazhani became a frontrunner even before the central government announced its focus on millets. The company sources small millets from tribal farmers, ensuring better prices for these producers. Kazhani boasts of 25 millet-based products under two brands, catering to the growing demand for healthy alternatives. Their online presence on Amazon and Smartcatch and a planned payment gateway on their website reflect their commitment to wider market reach. Their current distribution network spans over 100 retailers across Tamil Nadu, Karnataka, and Kerala.

Blockchain for Transparency: To meet the strict export standards of European nations, Kazhani FPCL embarked on a pilot project with Madurai Agri-business Incubation Forum (MABIF), in February 2020 for the export of red bananas. This project implemented blockchain technology for traceability, establishing a direct link between farmers and consumers. This innovative approach not only enhances product credibility but also empowers small farmers by potentially bypassing middlemen.

Organic farming: This is being promoted by Kazhani, with member farmers using almost 80 per cent organic inputs covering almost 100 acres of land. All the organic banana is certified by TNOCD (Tamil Nadu Organic Certification Department).

Kazhani FPCL's story exemplifies how an FPC can thrive through innovation and by focusing on market trends. Their commitment to ethical sourcing, organic farming, value addition, and embracing technology positions them as a leader in the agricultural sector.

2.3. Government Initiatives to Promote FPOs and Farmers

The Government of India's Ministry of Agriculture and Farmers' Welfare has been instrumental in promoting FPOs through various initiatives like the Rashtriya Krishi Vikas Yojana–Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RKVY–RAFTAAR). This scheme includes programs like the Vegetable Initiative for Urban Clusters (VIUC) and the integrated development of 60,000 pulses and oilseeds villages, both of which actively promote FPO formation. Several states like Odisha, Karnataka, and Maharashtra have implemented their own FPO promotion policies. The policies offer guidance, incentives, and subsidies to nurture FPO development, encourage technology adoption, and strengthen backward and forward linkages. Backward linkages are in the form of input sale, provision of farm machinery, capacity building and advisory services to the farmers. On the other hand, strong market linkages for the farm produce or its value-added products are crucial for long-term sustainability of FPOs. Beyond the government efforts, a diverse range of actors are driving FPO development across India. These include corporates, local non-profit organizations, multilateral donors, and state government departments, each contributing unique models and approaches.

One of the most prominent initiatives is the Central Sector Scheme on "Formation and Promotion of 10,000 Farmer Produce Organizations (FPOs)" launched in 2021 (PIB, 2021). This ambitious plan, with a budget of INR 6,865 crores (~USD 825 million), aims to establish 10,000 new FPOs across the country. The scheme primarily provides financial support for FPOs, including credit for Chief Executive Officer (CEO) salaries, equity grants up to INR 15 lakhs (~USD 18,000), and credit guarantees up to INR 2 crores (~USD 240,000). This financial backing has resulted in a significant rise in registered FPOs in recent years. In order to leverage economies of scale, improve market access and promote specialization, the scheme focuses on "One District One Product" rather than promoting FPOs in aspirational districts.

In a significant move to strengthen farmer organizations, the Government of India has recently introduced a number of measures. Key among them are:

1. **Operation Greens:** Inspired by the success of Operation Flood in the dairy sector, this initiative allocates a budget of INR 500 crores (~ USD 60 million) to promote FPOs for tomato, onion, and potato (TOP) crops. Operation Greens aims to empower FPOs in these areas by focusing on value addition, processing, and post-harvest management of vegetables.

2. **Tax Incentives:** To provide financial relief and encourage growth, the government offers a 100 per cent tax deduction for FPOs on profits up to INR 100 crores (~ USD 12 million) for a period of five years, starting from 2018-19.

Government efforts extend beyond FPOs to empower individual farmers. Direct benefit transfer schemes like PM-KISAN provide financial assistance, while credit access programs like "Innovation and Agri-Entrepreneurship

Development Program" support farm businesses. Initiatives like **Gramin Bhandaran Yojana** offer storage facilities, addressing a critical need for farmers.

Despite this progress, and the increase in the number of FPOs across India, scholars have highlighted the concerns over the surge in FPO formation (Prasad, 2019). The Doubling Farmers Income Report (2019) highlights the need for dedicated bodies similar to the National Dairy Development Board to lead the FPO revolution in India. Alternatively, some advocate for a combined effort involving NABARD, SFAC, civil society organizations, and Corporate Social Responsibility (CSR) foundations (Prasad, 2019).

2.4. Push towards Digital Adoption

The Committee on Doubling Farmers' Income (DFI) in its 2018 report acknowledged the importance of digital technology, which can play a transformational role in modernizing and organizing how rural India performs its agricultural activities. Digital platforms can enhance networking along the agricultural value chain and enable the farming community to absorb shocks and recover from stresses, such as market fluctuations and climatic events. In the last one decade or so, the Government of India has created various initiatives to push digital agriculture in the country. New government initiatives like the Digital Agriculture Mission 2021-2025 aim to provide technology-led support that will equip farmers with tools for supply forecasting, input selection, and informed decision-making on pricing and sales. Additionally, various digital platforms like eNAM, Open Network for Digital Commerce (ONDC), and Agricultural and Processed Food Products Export Development Authority (APEDA) Farmer Connect Portal aim to connect farmers directly to buyers, reducing middlemen and enabling price discovery.

2.4.1. Digital Alternative Markets

Electronic National Agriculture Market (eNAM): Digital platforms like eNAM can connect FPOs directly with buyers, eliminating intermediaries and fetching better prices for farmers. The effectiveness of the platform is demonstrably linked to the rise in the average number of bids per lot. This increased competition directly translates to fairer price discovery for farmers, a critical aspect for FPOs. By facilitating direct connections with a broader buyer base, digital platforms empower FPOs to circumvent traditional limitations and secure better returns for their members.

However, the emergence of digital alternative markets, while positive, doesn't guarantee complete freedom for farmers in choosing where to sell (Prasad, 2019). A crucial factor remains the farmer's debt to local money lenders, who often exert control over the sale of produce. This issue of trade-loan nexus of money lending business has been discussed in detail by BalaChandran and Dhal (2018). Money lenders integrate their money lending business with other agricultural factor markets such as land, labor and output to accommodate higher default risk in the agricultural loans (Bardhan, 1984). Kurup (1976), in the context of Kerala in India, showed that coconut traders provide advance loans to the cultivators which the cultivators repay through their produce. Bell et al. (1997) provided evidences from rural Punjab in India that loan contracts were tied to the marketing of the produce through the money lender.

This creates a conflict: money lenders benefit from opaque pricing, while the system strives for transparency through eNAM. Furthermore, even after a successful eNAM transaction, the physical movement of goods and transfer of funds can still be influenced by the existing network of traders.

Open Network for Digital Commerce (ONDC): ONDC aims to democratize the e-commerce sector by working on an open protocol structure (see glossary) and moving away from the current platform-centric approach of buying and selling. ONDC plans to enable sellers and buyers to be digitally visible and transact through an open network, regardless of what platform or application they use. As of March 2024, 5,000 FPOs have been onboarded on the platform (PIB, 2024). Since joining the platform, the FPOs have been able to sell 3,100 varieties of value-added agricultural products in 28 states. The platform has been able to provide FPOs easy access to digital marketing, online payments, Business to Business (B2B) and Business to Customer (B2C) transactions and has encouraged local value addition (Das, 2023).

APEDA Farmer Connect: Farmer Connect is an initiative undertaken by the Agricultural and Processed Food Products Export Development Authority (APEDA), Government of India, to provide a 24/7 online digital platform in the form of a portal and mobile application. It helps to bridge the gap between FPOs and exporters because FPOs make profiles and post offers. Exporters can post enquiries and view matching sell offers.

2.4.2. Use of Mobile Tech for Improved Data Accuracy and Transparency

The Government of India's flagship scheme for promoting farmer wellbeing, the **Pradhan Mantri Fasal Bima Yojana** (PMFBY), launched in 2016, replaced earlier government-subsidized crop insurance schemes like the National Agricultural Insurance Scheme (NAIS) and Modified National Agricultural Insurance Scheme (MNAIS). A key innovation of the PMFBY scheme is the use of mobile phone technology to capture and upload crucial Claim Crop Estimation (CCE) data through a specially designed Android app that allows field workers to record and transmit data directly using smartphones. This approach offers several advantages (Pancharatnam, Mahendiran, et. al., 2020):

- **Enhanced Data Quality:** The app facilitates features like geo-tagging, time stamping, and the inclusion of photos and videos. This ensures greater accuracy and transparency in the data collection process.
- **Geo-tagging for Verification:** Geo-tagging of plot coordinates ensures that the primary worker's plot choice for CCE matches with the Directorate of Economics and Statistics' CCE plan.
- **Offline Functionality:** The app can function even in areas with limited internet connectivity, allowing data collection to proceed uninterrupted. Once online, the app transmits information such as crop area, estimated harvest date, yield weight, and visual documentation of the field and harvest process.

Leveraging mobile technology enables the PMFBY scheme to streamline data collection, improve data quality, and foster greater transparency in the crop insurance claim assessment process.

Further, the creation of Agri Stack by the Ministry of Agriculture and Farmer Welfare – built on the architecture of the Ministry of Electronics and Information Technology (MeitY) – has enabled a centralized registry of farmers, farmlands, and crops, representing a significant step towards digitalization. Agri Stack is the Government of India's digital foundation that seeks to improve agricultural outcomes by bringing stakeholders together, using data and digital services to enable better outcomes and results for farmers. It is an effort to aggregate and make available high-quality data to key stakeholders so that they can create new services using this data. This platform will allow for accurate crop production estimation, facilitating targeted interventions and support from the government.

2.4.3. Non-Government Initiatives

Over time, private companies and non-governmental organizations (NGOs) have supported the government with technical expertise and have piloted different digital tools with farmers across the country. Experiments with smallholder farmers in India suggest that mobile technology clubbed with satellite information has led to improved self-reported fertilizer management practices, but did not produce measurable effects on yields (Cole et al., 2023). Other studies show that smallholders' use of precision agriculture has translated to increased yields and reduced waste, ultimately contributing to environmental sustainability (Mandal & Maity, 2013).

While extensive research exists on various aspects of FPOs, such as market access, financial inclusion (Vipra, 2023; Murray, 2020; Murray, 2019), government scheme utilization (NAFPO, 2023; Bijman et al., 2016; Nayak, 2012; Cherukuri & Reddy, 2014), factors influencing FPO success (Sahu et al., 2017; Gupta, 2015; Nayak, 2014), and benefits for member farmers (NAFPO, 2023; Mahapatra et al., 2023; Jena & Grote, 2016; Desai & Joshi, 2013), a critical gap remains. There is a scarcity of research examining the impact of digital adoption on FPOs and how it may translate to improved performance among member farmers (NAFPO, 2023). This lack of concrete evidence on the digitalization-performance link necessitates further investigation.

3. About the Study

This study investigates the characteristics of FPOs and farmers associated with higher levels of digital adoption. It further explores whether FPO digitalization trickles down to digital adoption among member farmers. By analyzing digitalization practices among FPOs and their member farmers, the study aims to identify successful strategies and highlight areas where rethinking and other interventions are required. Considering the status of digitalization for FPOs and farmers and the pivotal role played by FPOs in collectivizing farmers and improving farmers' perceived wellbeing, the study has three major objectives:

1. **Identifying characteristics of FPOs and member farmers associated with greater digital adoption:** We investigate adoption of different digital tools among FPOs and member farmers. We use Principal Component Analysis (PCA) to create an index of digitalization at both FPO and farmer levels. We then look at characteristics of FPOs and their member farmers that are associated with greater usage of digital tools.

2. **Understanding the association between FPO digital adoption and digital adoption by farmer members.** Using the FPO-farmer linked dataset and the digitalization status of FPOs and farmers, we fit a logit regression to understand if higher digital adoption by an FPO is associated with the likelihood of greater digital adoption for their member farmers after adjusting for FPO and farmer background characteristics.

3. **Exploring the association between FPO digital adoption and perceived well-being of member farmers.** We use farmer's responses on services received from their FPOs and their own experience of perceived well-being to corroborate results from the literature on impact of FPO membership on farmers, with a focus on digital adoption of FPOs.

By addressing these objectives, this research aims to provide a comprehensive understanding of how FPOs can leverage digital adoption to bridge service gaps, enhance member engagement, and ultimately benefit farmers.

3.1. Study Site

The sample selection strategy aimed to achieve a heterogeneous sample that captures diverse FPO ecosystems, including states where the presence of FPOs is well-established (Maharashtra and Madhya Pradesh) and states with emerging FPOs (e.g., Odisha). Two other states (Bihar and Rajasthan) were included to explore the influence of government support programs on FPO digital adoption. According to the data in Tata Cornell Institute FPO Platform for India, the five states selected for the study account for 50 per cent of the total FPOs in the country (33,711). Maharashtra (11,540) and Madhya Pradesh (1,757) rank first and third, respectively, and collectively account for 16 per cent of total FPOs.

Given the lack of a comprehensive database of FPOs across the country, the sampling in this research follows a convenience sampling method[1]. The study relies on proprietary data on FPOs shared largely by Samunnati (~95 per cent), with ACCESS Development Services sharing the remaining sample.

Samunnati is an open agri-network (see glossary) and India's largest agri-enterprise. Headquartered in Chennai, Samunnati provides financial and advisory services for the entire agri-value chain, enabling farmer collectives and the larger agricultural ecosystem to be more efficient and productive. Samunnati currently has access to over 6,500 farmer collectives, reaching out to over eight million farmers. Samunnati also hosts the Lighthouse FPO Conclave.

[1] Convenience sampling is a nonprobability sampling method where units are selected for inclusion in the sample because they are feasible to include due to various reasons such as availability, geographical proximity, or willingness to participate in the research.

ACCESS Development Services is a national livelihood support organization focusing on incubating innovations for sustainable livelihoods for the poor. ACCESS aims to improve the incomes of farmers and FPOs by improving price realization and assisting in developing value-added products for FPOs. ACCESS also hosts the coveted FPO Impact Awards in partnership with Rabo Bank to recognize and encourage exemplary FPOs.

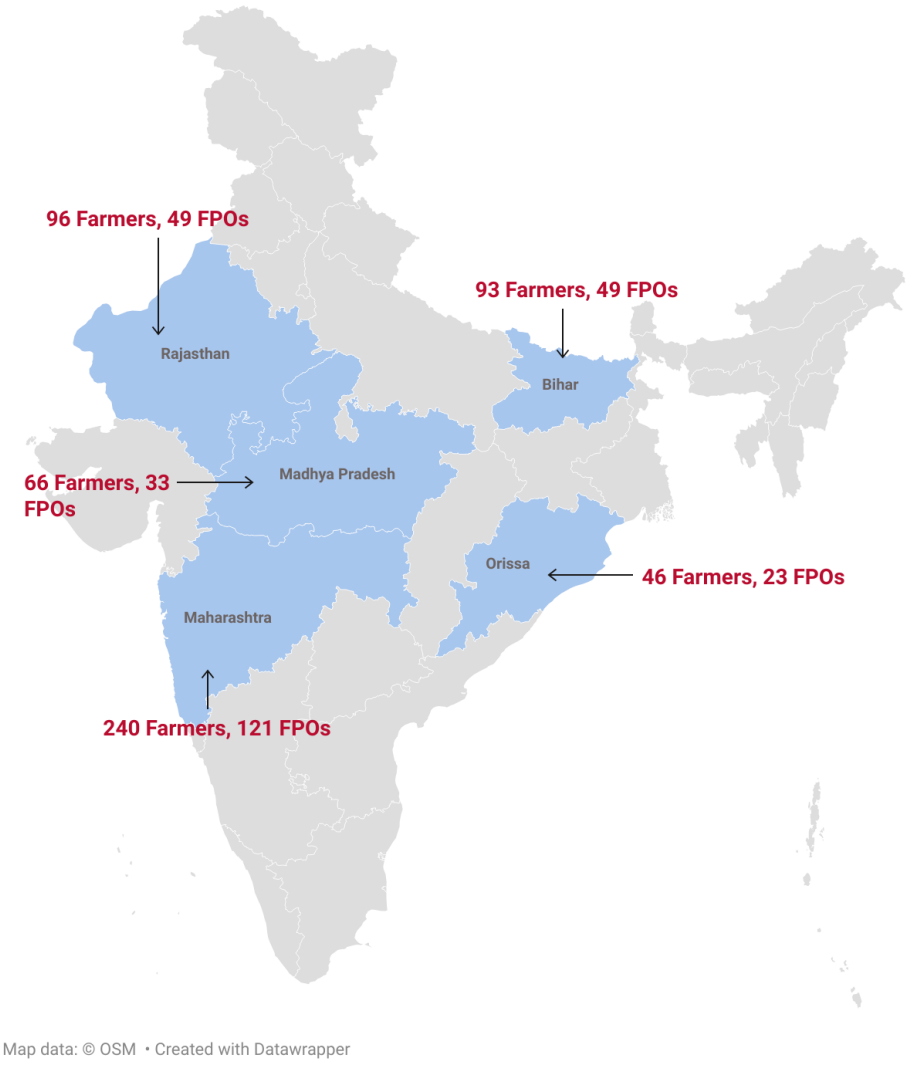

Figure 2: Study Sites and Sample Distribution Across States: LEAD Survey of FPOs and Member Farmers (Nov-Dec 2023)

Our sample includes 275 FPOs and two members from most of the selected FPOs, resulting in a total of 541 farmer members. However, for the analysis based on merged data, we have considered data from 271 FPOs and 539 farmers. While merging two datasets, we realized that in a few rare instances where surveyed FPOs do not have a member farmer selected for the study, we had surveyed member farmers who do not have a surveyed FPO associated with them. Because of this reason, we could not use data from four FPOs and two farmers in the merged analysis. However, for separate analysis of FPO and farmers, we used all data points as collected.

3.2. Methodology

To explore the aforementioned objectives, we adopted a mixed methods research approach; and used both quantitative and qualitative data to answer the research questions. We designed and implemented two primary surveys, one at the FPO level and another at the level of member farmers belonging to the FPOs surveyed. We conducted the surveys through in-person interviews with the senior management of the FPOs and two member farmers from each FPO.

- The FPO Survey sought to understand the uptake of digital tools used in FPO operations and management such as computers, digital recordkeeping software, digital transactions, and FPOs' access and usage of digital platforms related to access to credit, market linkage, among others.
- The Farmer Survey sought to understand farmers' use of digital tools and FPO engagement with farmers.

Through these two primary surveys, we created a unique dataset linking FPOs to their farmers so that all variables from both surveys are included in one data file. To complement the quantitative analysis and to interpret the findings, the study relied on in-depth interviews (IDIs) with the FPO senior management, focus group discussions (FGDs) with FPO farmers, and key informant interviews (KIIs) with practitioners and academicians in the FPO space. Additionally, the study relied on secondary research to design the quantitative and qualitative tools and validate the research findings.

3.3. Inclusion Criteria

- Only active FPOs – i.e., those which have filed annual tax returns and financial statements for the preceding two financial years - have been included in the sample.
- In order to focus on FPOs which have been legally registered and operating for at least two financial years, we only considered the FPOs registered before 31st December, 2021, for our sample.

3.4. Limitations

The study acknowledges limitations arising from data access and resource constraints.

- As the study utilizes proprietary data, nearly 95 per cent of the sample comes from FPOs directly associated with Samunnati. This raises the possibility of selection bias, where results might not be generalizable to the broader FPO population.
- Interviewed FPOs identified surveyed farmers, leading to the adoption of a convenience sampling approach. FPOs might have suggested farmers with whom they have a stronger engagement, skewing the farmer data towards those with a more positive FPO experience.
- Additionally, rather than existing in clusters, FPOs are geographically spread out even within states. Given the time and resource constraints, it was not possible to cover other states or more FPOs within each state.
- When analyzing benefits from FPO membership for farmers, we relied on the farmers' own perception of how their incomes and input costs have changed since joining the FPO.

Photo Credit: Kazhani Farmer Producer Company Limited

4. Analysis and Findings

This section discusses findings from the quantitative surveys and qualitative interviews with FPO shareholders and non-shareholders, board members, and farmers. It outlines the characteristics of the sample for whom the data is collected, while also highlighting findings from the descriptive analysis.

4.1. Sample Characteristics

The sample for the study is disaggregated at the FPO and member farmer level (Table 1).

Table 1: Sample Characteristics of Selected FPOs and Member Farmers: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

FPO Characteristics (N = 275)		
State Name	**Frequency (n)**	**Percentage (%)**
Bihar	49	18%
Madhya Pradesh	33	12%
Maharashtra	121	44%
Odisha	23	8.4%
Rajasthan	49	18%
Legal Form		
Cooperative Society	66	24%
Producer Company	209	76%
Vintage of FPO		
2-3 years	135	49%
4-6 years	48	17%
7-10 years	65	24%
>10 years	27	9.8%
No. of Shareholders		
<300	72	26%
300-499	65	24%
500-999	88	32%
>=1000	50	18%
Turnover Size in INR (FY 2022-23)		
<10 lakhs	28	11%
10 lakhs - <50 lakhs	74	28%
50 lakhs - <1 crore	67	25%
>=1 crore	96	36%
Promoting Institution		
NABARD	78	28%
SFAC	46	17%
NCDC	16	6%
NAFED	9	3%
Self-promoted	126	46%
FPOs Where All Shareholders are Female	14	5.1%

Farmer Characteristics (N = 541)		
Gender	**Frequency (n)**	**Percentage (%)**
Male	496	92%
Female	45	8%
Age		
18-25	16	3%
26-35	208	38%
36-45	190	35%
>45	127	23%
Education		
Primary or below	48	9%
6-10 years of schooling	169	31%
11-12 years of schooling	154	28%
> 12 years	170	31%
Membership Status		
Non-Shareholder Member	279	52%
Shareholder Member	262	48%
Farmer Primary Occupation		
Agriculture	509	94%
Salaried Work/ Non-Farm Business/ Other	32	6%
Land Holding		
Marginal (<1 hectare)	162	30%
Small (1-2 hectare)	183	34%
Medium (>2-10 hectare)	183	34%
Large (>10 hectare)	10	2%

4.1.1. Key Highlights of FPO Characteristics

- Nearly half (49 per cent) of the FPOs in our sample are newly founded and only two to three years old as on survey date (Table 1). Maharashtra has a mix of old and new FPOs, while Bihar and Rajasthan (23 per cent each) have older FPOs which are in operation for more than 10 years compared to only 10 per cent in the overall sample.
- The median number of shareholders per FPO in the sample is 500, with Odisha having the highest number of shareholders (median being 651). The proportion of female shareholders is low, the overall median being 27 per cent. However, Odisha has significantly higher female representation (median being 38 per cent) among members. On the other hand, Rajasthan has only 17 per cent female shareholders, on an average (median).
- The majority (53 per cent) of the surveyed FPOs reported a turnover between INR 10 lakhs and INR one crore (between ~ USD 12,000 and 120,000) for the financial year 2022-23. FPCs have a higher percentage (39 per cent) of turnover exceeding INR one crore (~ USD 120,000) compared to cooperatives (26 per cent). Bihar (62 per cent) and Rajasthan (71 per cent) have a larger share of FPOs in the medium turnover category of 10 lakhs to one crore (~ USD 12,000 to 120,000).
- A small proportion (five per cent) of surveyed FPOs are all-women FPOs. Out of 33 sampled FPOs in Madhya Pradesh, six of were all-women FPOs (18 per cent). The sample from Bihar did not have any all-women FPOs.

4.1.2. Key Highlights of Farmer Characteristics

- The majority (73 per cent) of the respondent farmers fall within the age group 26-45.
- A large proportion (59 per cent) of farmers in our sample has more than 10 years of schooling.

- The sample has a nearly even distribution of members who are shareholders (48 per cent) and those who are not shareholders (52 per cent).
- Agriculture is the primary occupation for a vast majority (94 per cent) of surveyed members. Only a small percentage have salaried jobs (three per cent) or non-farm businesses (two per cent) as their main source of income.
- Compared to national estimates of marginal and small farmers (86 per cent), the sample has a lower proportion of marginal and small farmers (64 per cent) and a higher proportion of medium to large farmers. This suggests FPO members may have larger landholdings on average compared to the national average. State-wise variations exist, with Bihar (81 per cent) and Odisha (74 per cent) having a higher percentage of marginal and small farmers, while Madhya Pradesh has the highest proportion of medium to large farmers (49 per cent).

4.2. Status of Digital Adoption among FPOs

This section investigates the digital landscape of FPOs in India. While access to computers seems promising, a significant gap exists between ownership and actual utilization of digital tools. The study reveals variations in digital adoption across states and FPO legal form and organizational structures.

Our study assessed the status of digital adoption among FPOs across various access and usage indicators. Indicators like access to computers, having a website, digital record-keeping practices, use of digital tools for FPO operations, digital transactions, registration on the FPO portal, online sales of produce, and utilization of WhatsApp for member communication were explored separately and also in the form of a composite index of digital adoption.

Ownership of a computer seems to be a prevalent phenomenon among FPOs, as 89 per cent of sampled FPOs reported owning a computer. However, the study revealed significant disparities in digital tool usage among states (Figure 3). Despite 100 per cent computer ownership among FPOs in Odisha, only 13 per cent have websites. This may indicate a significant gap between access and utilization of digital tools among FPOs. However, this finding needs to be interpreted with caution as Odisha has a small sample size of 23 FPOs only. A relatively smaller proportion (69 per cent) of FPOs in Bihar own a computer compared to the other four states of Madhya Pradesh, Maharashtra, Odisha, and Rajasthan. However, the proportion of FPOs with a website (47 per cent) or registered on the FPO portal (86 per cent) is significantly higher in Bihar relative to other states. This may seem counterintuitive, suggesting alternative access methods like resource sharing within farmer cooperatives, as Bihar has a significantly higher proportion (78 per cent) of cooperatives compared to any other states (ranging between three per cent and 31 per cent).

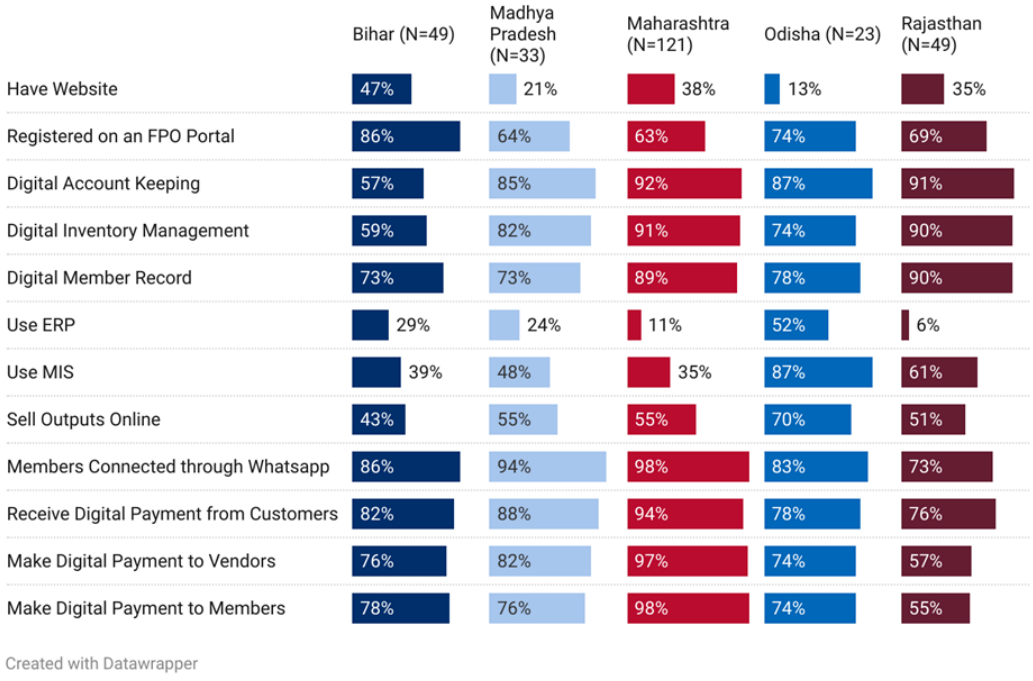

Figure 3: Usage of Digital Tools in FPO Operations and Management: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

Nearly 90 per cent of FPOs in Rajasthan and Maharashtra reported using some level of digitized accounting and inventory management systems, while such adoption is much lower in Bihar (59 per cent), Odisha (74 per cent), and Madhya Pradesh (82 per cent). A difference in the distribution of FPO legal forms (FPCs vs farmer cooperatives) might explain the lower digital recordkeeping practices in Bihar, as FPCs exhibited better performance across various digital adoption indicators such as access to computers, digital record keeping practices, use of management information system (MIS) for member management, online selling of outputs, and utilization of WhatsApp for member communication, among others. Only 22 per cent of FPOs in Bihar are FPCs, and the remaining 78 per cent are farmer cooperatives.

When it comes to the adoption of digital payments – which includes payment receipt from customers, payments made to vendors, or regular payment made to members – FPOs in Maharashtra are way ahead of all the other four states, and in particular is significantly better than Rajasthan (Figure 3).

The study suggests that digital transactions are largely "need-driven" for FPOs that are larger in terms of shareholding size and turnover. Handling larger quantities of inputs and outputs, along with a higher number of transactions, may necessitate the adoption of digital payment methods for efficiency and security. For example, the proportion of FPOs in the highest turnover bucket of more than INR one crore (~ USD 120,000) report digital payment receipt from customers (95 per cent) and digital payments made to vendors (96 per cent). These numbers are significantly higher than that of FPOs belonging to the lowest turnover bucket (79 per cent and 64 per cent, respectively). Among FPOs with more than 1000 members, 88 per cent reported making digital payments to their members, compared to 78 per cent of FPOs with less than 300 members.

4.2.1. FPO Integration with Digital Platforms

Traditionally considered one of the least digitalized sectors in India, agriculture is now undergoing a transformation with the introduction of digital platforms. In this section, we discuss the survey findings related to how well FPOs are integrated with the government's recently created digital platforms.

Figure 4 shows the awareness and uptake of digital platforms among FPOs for trade, credit linkages, and commodity exchanges. It suggests that the majority of FPOs (more than 50 per cent) are unaware of digital platforms like ONDC, MCX, Open Credit Enablement (OCEN), Trade Receivable Discounting System (TReDS), and National Commodity & Derivatives Exchange Limited (NCDEX), let alone avail them. Awareness about trading platforms like eNAM and APEDA Farmer Connect that help bridge the gap between farmer collectives and exporters is relatively better, though that has not translated into higher uptake of these platforms. Among all relevant platforms, eNAM (the pan-India electronic trading portal) has a maximum uptake among FPOs (29 per cent) varying between 15 per cent (Madhya Pradesh) and 52 per cent (Odisha) across states. According to eNAM's website, 3,366 FPOs have been onboarded on the platform out of a total of 33,711 FPOs in India as on 26 May 2024, as per the data in Tata Cornell Institute FPO Platform for India. This equals 10 per cent of all FPOs in the country. In the study sample, however, this figure stands at 29 per cent, which is much higher than the national average. Active FPO and farmer engagement on eNAM can exponentially increase digital transactions in the agri-sector, as it relies on e-payment facilities for transactions.

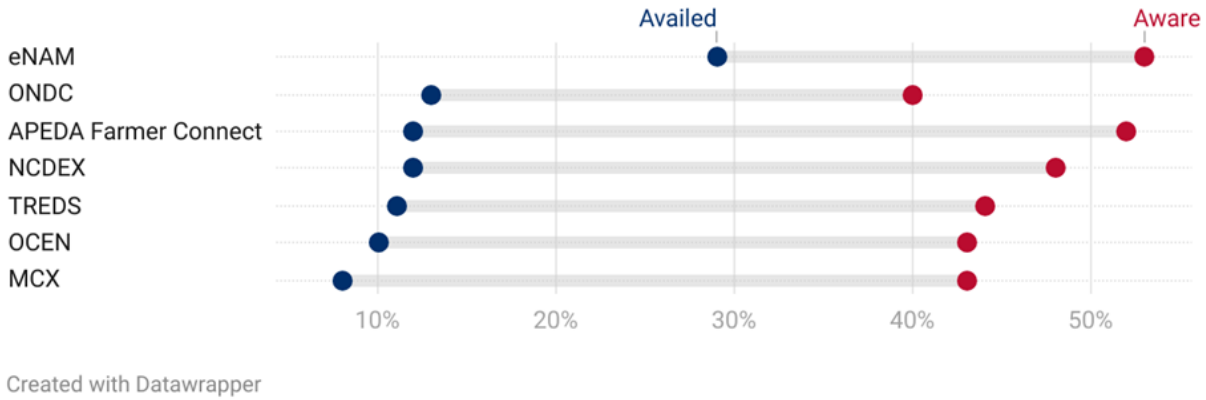

Figure 4: Difference in Awareness and Uptake of Digital Platforms by FPOs: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

Similarly, the Ministry of Agriculture & Farmers Welfare reported that 5,000 FPOs have been onboarded to ONDC for selling the produce online to consumers across the country. This amounts to 15 per cent of 33,711 FPOs in India, which is very similar to 13 per cent FPOs in the sample which are registered on ONDC. However, state-level estimates in Table 2 suggest a very low uptake of the ONDC platform in Bihar (four per cent) and Odisha (four per cent).

Table 2: Percentage (%) of FPOs registered on Digital Platforms Across Five States: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

Digital Platforms	Overall Sample N = 275	Bihar N = 49	Madhya Pradesh N = 33	Maharashtra N = 121	Odisha N = 23	Rajasthan N = 49
Credit Linkage						
Udyam Certificate	78	65	73	90	30	86
TREDS (Trade Receivable Discounting System)	11	14	12	11	13	4
OCEN (Open Credit Enablement Network)	10	2	24	9	9	8
Trading						
eNAM (National Agriculture Market)	29	35	15	28	52	27
ONDC (Open Network for Digital Commerce)	13	4	27	12	4	18
APEDA (Agricultural and Processed Foods Development Authority)	12	10	21	15	4	4
Commodity Exchange						
NCDEX (National Commodities and Derivatives Exchange)	12	2	33	13	4	10
MCX (Multi Commodity Exchange of India Ltd.)	8	4	9	13	0	4

4.2.2. FPO Characteristics Associated with Digital Adoption

The above findings indicate a huge variation in the various digital adoption indicators across states, FPO legal forms, shareholding size, and turnover size. In order to identify factors associated with the overall level of digital adoption among FPOs, we created a composite index of digital adoption using Principal Component Analysis (PCA) to understand the degree of digital adoption in FPO operations. Similar to the McKinsey Global Institute's (MGI) India Firm Digitization Index that scores the level of company digitization on a scale of 0 to 100 (Kaka et al., 2019), in our method, each variable was assigned a weight generated through PCA. Then, the standardized variables were multiplied by the weights and summed to produce the FPO digital adoption index.

The index was generated by combining variables describing the adoption of digital tools for FPO operations management like:

- Ownership of computer, having a website
- Digital recordkeeping of account books, inventory, cash books, bank books, share capital, sales and purchase, member records.
- Registration on online portals
- Sale of output through digital platforms, and
- Digital member engagement

As per the scores on the digital adoption index, the FPOs in the sample were grouped into tertiles: low, medium, and high. The tertile indicates the percentage of FPOs that exhibit low, medium, and high levels of digital adoption. Ideally, one would expect to see an equal division of FPOs across each tertile based on the digital adoption index. However, in our case, we have categorized the FPOs in a way that 33 per cent, 26 per cent, and 41 per cent FPOs belong to the low, medium and high categories of digital adoption respectively. Since the PCA is based on a finite set of binary variables (no continuous variables were part of the list), it is possible to have clumping of the index at certain values, which leads to unequal division of FPOs across digital adoption categories. It would be unfair to assign different groups to FPOs having the same index value. This problem of 'clumping' and 'truncation' is well acknowledged and discussed at length in studies that involve the construction of an index based on Principal Component Analysis method and binary variables (Vyas and Kumaranayake, 2006; McKenzie, 2005). Figure 5 exhibits how the distribution of FPO digital adoption levels varies across various background characteristics relative to the overall sample distribution.

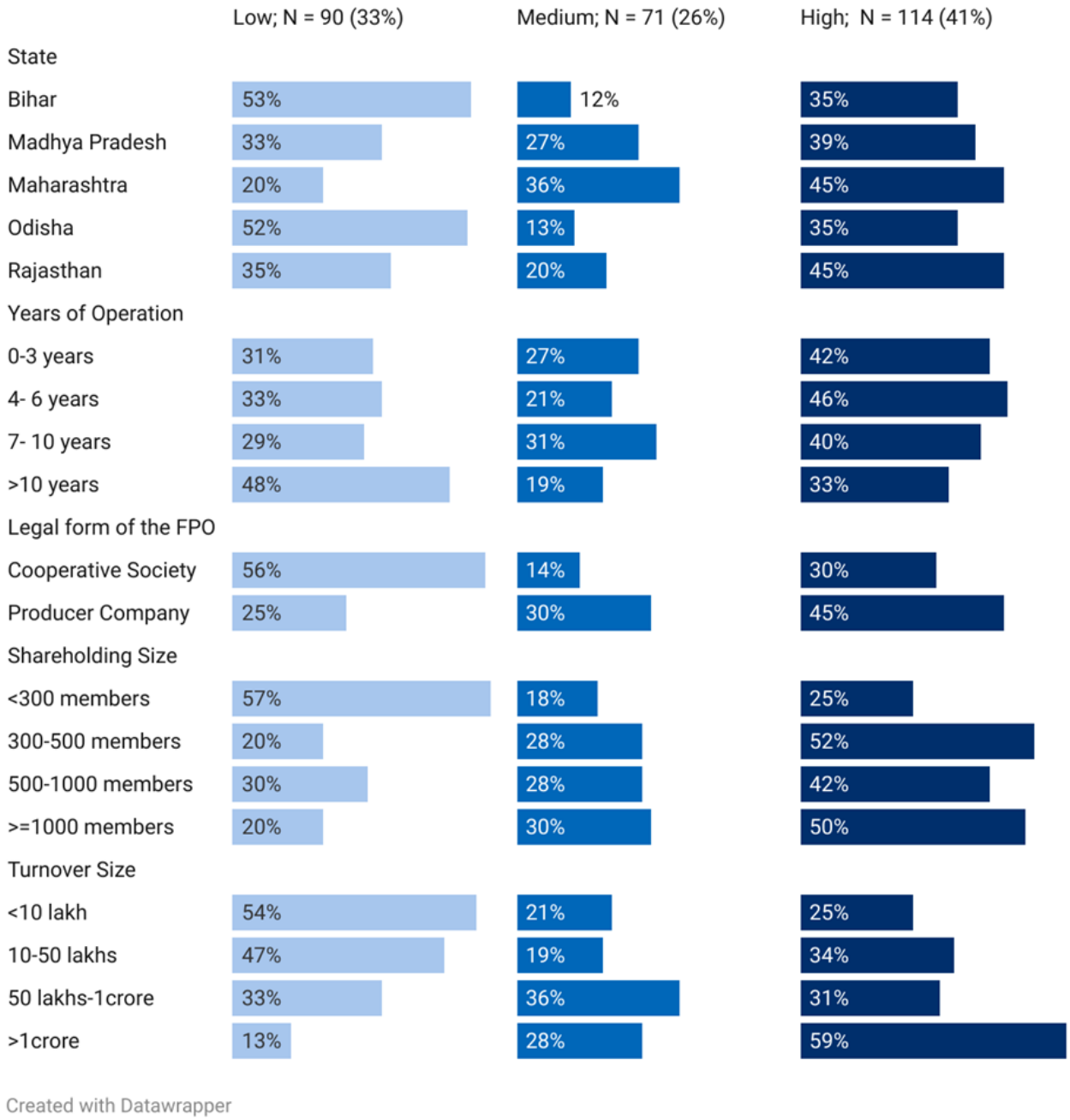

Figure 5: Distribution of FPO Level of Digital Adoption (Low, Medium and High) for Various Background Characteristics: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

Interpretation of the Findings

State: More than half of the FPOs from Bihar and Odisha exhibit low levels of digital adoption. Interestingly, both Odisha and Bihar also have 35 per cent of FPOs exhibiting high levels of digital adoption. From our earlier analysis, Bihar has a higher percentage of FPOs registered as cooperatives, which fare poorly overall (56 per cent) on the digital adoption index (Figure 5). Maharashtra has a remarkably large proportion of FPOs (80 per cent) with medium and high levels of digital adoption. Maharashtra and Rajasthan both have relatively higher proportion of FPOs (45 per cent) belonging to the high level of digital adoption.

Vintage: A higher proportion of FPOs (48 per cent)established more than ten years ago belong to the low level of digital adoption, compared to the overall proportion of 33 per cent belonging to the lowest level of digitalization.

Legal Form: 45 per cent of FPOs registered as FPCs exhibit high digital adoption compared to 30 per cent of farmer cooperatives. Additionally, 56 per cent of FPOs registered as cooperatives fall in the low category.

Size by Shareholding and Turnover: In the overall sample, 33 per cent of the FPOs belong to the low digital adoption tertile, whereas a remarkably higher proportion (57 per cent) of FPOs with fewer than 300 shareholders belong to the low digital adoption tertile. On the other hand, 50 per cent of FPOs with more than 1000 shareholders exhibit high levels of digital adoption. Similarly, 54 per cent of FPOs with an annual turnover of less than INR 10 lakhs (~ USD 12,000) fall in the low tertile compared to only 13 per cent FPOs with annual turnover above INR one crore (~ USD 120,000) falling in the lowest level of digital adoption.

4.2.3. Can Training Improve Digital Adoption?

In the previous section, we saw that FPO characteristics such as state of domicile, years of operation, FPO legal form, shareholding size, and turnover are associated with digital adoption. To some extent, these factors suggest that growth of FPOs, both in terms of shareholding size and annual turnover, may eventually lead to higher levels of digital adoption. At the same time, there is a potential issue of endogeneity here. For example, digitalization might be an occupational requirement to manage operations for larger FPOs. On the other hand, greater digital adoption may also lead to streamlining operations to assist in expansion and success of the FPO. Irrespective of the directionality of the association, it may take a much longer time to see the impact of increased FPO size on better digital adoption, as growth is a time-consuming process.

In order to identify potential areas of intervention to increase digital adoption among FPOs, we investigated the level of digital-related training that FPOs reported receiving in the last two years, and how such training could have impacted digital adoption. Based on the information collected on digital training in the FPO survey, we created a composite index to categorize FPOs in terms of number of digital trainings received in the last two years on the following topics:

- Digital bookkeeping
- Digitalization of member information
- Managing member information
- Selling output through e-commerce platforms
- Digital tools

Figure 6 depicts a cross tabulation of training in digital tools against the FPO digital adoption index. A chi-squared association test reveals that a low level of digital training is significantly associated with low levels of digital adoption. As shown in Figure 6, among 85 FPOs who did not receive any training in the last two years (low category), 46 per cent have a low level of digital adoption. However, in the overall sample, 33 per cent of the FPO falls in the low digital adoption category. Similarly, 58 per cent of the 99 FPOs that scored high on digital training also scored high on overall digital adoption. Comparatively, only 26 per cent of the FPOs that scored low on digital training scored high on digital adoption. These findings build a strong case to train FPOs in digital operations.

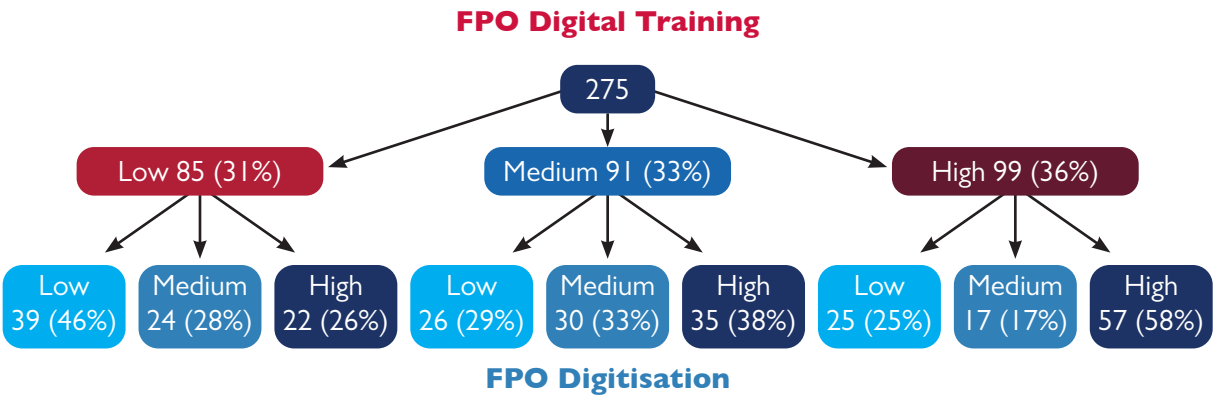

Figure 6: Association between Training in Digital Tools and FPO Digital Adoption: LEAD survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

4.3. Farmer Characteristics Associated with their Digital Adoption

To understand the levels of digital adoption among member farmers of the FPOs surveyed, we constructed a digital adoption index for farmers using the PCA method, as we did for the FPOs. The variables considered in the creation of the index included information on whether member farmers:

- Owned a smartphone
- Used digital payments for personal transactions
- Used digital payments for transactions with their FPO
- Used agri-related mobile apps such as Plantix, FarMArt, Kisan Mitr, Agro Star, Krushi.
- Had taken any loans or insurance digitally.

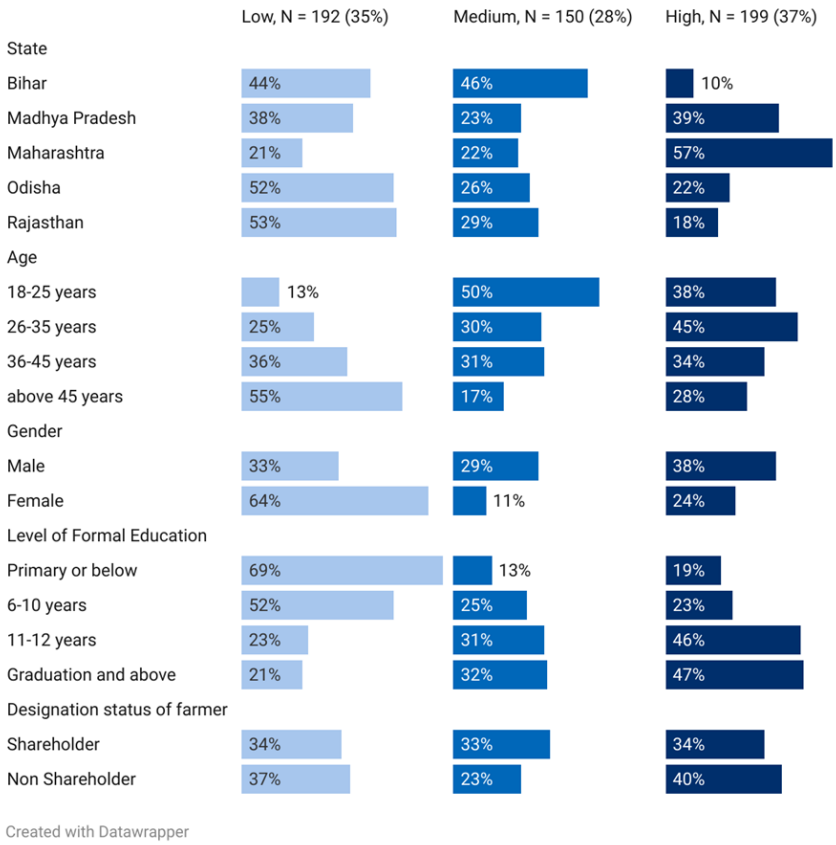

Figure 7: Distribution of Farmer's Level of Digital Adoption (Low, Medium and High) for Various Background Characteristics: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

Figure 7 depicts the distribution of a farmer's level of digitalization (low, medium and high) for various background characteristics. The findings can be interpreted as follows:

State: A relatively higher proportion of surveyed farmers from Rajasthan (53 per cent), Odisha (52 per cent), and Bihar (44 per cent) exhibited low levels of digital adoption, compared to 35 per cent of farmers in the overall sample. Maharashtra (57 per cent) have the highest proportion of farmers exhibiting high levels of digital adoption, compared to 37 per cent of farmers in the overall sample. The distribution of farmer digital adoption levels across states are similar to the findings for FPOs.

Age: 55 per cent of surveyed farmers above the age of 45 performed low on the digital adoption index, as compared to only 24 per cent of younger farmers aged 35 years or below belonging to this category. About 44 per cent of the younger farmers 35 or below exhibit high levels of digital adoption, as compared to 28 per cent of farmers in the oldest age group (above 45).

Gender: 64 per cent of surveyed female farmers exhibit low digital adoption, as compared to 33 per cent of male farmers.

Education: A clear pattern between education and digital adoption emerges. Farmers having a higher number of years of formal education are likely to demonstrate high levels of digital adoption, as is evident from the descriptive analysis (Figure 7). A higher proportion of surveyed farmers having more than 12 years of education (47 per cent) and 11-12 years of schooling (46 per cent) belong to the high digital adoption category, as compared to 19 per cent of surveyed farmers with primary education and less.

4.3.1. Digital Payments between FPOs and Member Farmers

The survey asked farmers whether they receive payments from their FPO digitally for the outputs sold to the FPO and whether they pay their FPO digitally for the inputs purchased. Table 3 shows the association between the digital payment behavior of FPOs and their member farmers. Digital payments here include payments made through net banking, real-time digital payment system UPI, or through mobile wallets.

Table 3: Association Between the Digital Payment Behavior of FPOs and their Member Farmers: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

	Farmer makes digital payments for inputs purchased from FPO			p-value
Farmer receives digital payments for output sold to FPO	**Yes**	**No**	**Total**	**<0.001**
Yes	318 (88%)	44 (12%)	362	
No	37 (21%)	142 (79%)	179	
Total	355	186	541	

The findings suggest a statistically significant association between the digital payment behavior of FPOs and their member farmers. About 88 per cent of the 362 surveyed farmers who receive payment digitally from FPO also make digital payments to their FPO. On the other hand, 79 per cent of the 179 surveyed farmers who do not receive payment digitally from their FPO, also do not make digital payments to their FPO.

4.4. Case Study. From Forest Floor to Financial Security: COFE Producer Company Limited

Prior to 2015, tribal women from Mokhed village (district Chhindwara) in Madhya Pradesh collected custard apples from the forest and sold them in the local market or markets outside the village. They earned INR 50-100 (~ USD 0.60 – 1.20) for a day's work.

Photo Credit: COFE Producer Company Limited

SRIJAN (Self-Reliant Initiatives through Joint Action), a national non-profit operating in this area, started developing value added products from custard apples, which grow naturally in the local forests. SRIJAN was confident about being able to ensure income for these women, based on a similar experiment they conducted in Rajasthan.

In 2015, they convinced the women to form an FPO, and Chhindwara Organic Farmers Enterprise Producer Company Limited (COFE PCL), an all-women FPO, was registered. The company currently has 928 shareholders with a collective membership of about 2000 farmers across 300 villages. With a registered office in Mokhed, the company now boasts an annual turnover of INR 57 lakhs (~ USD 68,000, FY 2022-23) and is looking at a turnover of INR 1.35 crore (~ USD 162,000) in 2023-24. They have secured seeds and a Mandi license and have a GST number as well. The FPC processes and trades in custard apple and orange pulp and has expanded operations into processing cotton, maize, toor dal, and mangoes.


Photo Credit: COFE Producer Company Limited

The women of Mokhed and surrounding villages have found a safe space to work, with fixed working hours. They also earn more than they would have laboring on farms or collecting and selling food crops to the market on their own. Improvements in their take-home income has also helped them gain greater autonomy. For example, when the panchayat (village council) refused to help COFE PCL financially to build a processing unit, the women in the company pooled their resources, got a loan from the bank and were able to purchase a processing unit, which is now an asset for their organization.

Data monitoring has helped COFE with credit and market linkages: COFE is an excellent example of how using simple data monitoring and record keeping tools can solve the issues of backward and forward linkages. Due to their meticulous record keeping with board meeting minutes, member records, and output produced and supplied over the years, COFE has secured a loan of INR 20 Lakhs (~USD 24,000) from a private bank. Through SRIJAN, they have also been successful in securing grants from the World Wildlife Fund (WWF). COFE currently supplies custard apple and orange pulp to manufacturers like Dinshaw in Nagpur.

4.5. Association Between FPO Digital Adoption and Farmer Digital Adoption

To explore the association between FPO digital adoption and farmer digital adoption, we analyzed the merged dataset having data from 271 FPOs and 539 farmers. Figure 8 shows the link between FPO digital adoption and digital adoption by member farmers. FPOs that score low on digital adoption have 43 per cent of their member farmers scoring low on digital adoption and only 29 per cent of their member farmers scoring high on digital adoption. In comparison, FPOs scoring high on digital adoption, have 43 per cent of their member farmers exhibiting high levels of digital adoption.

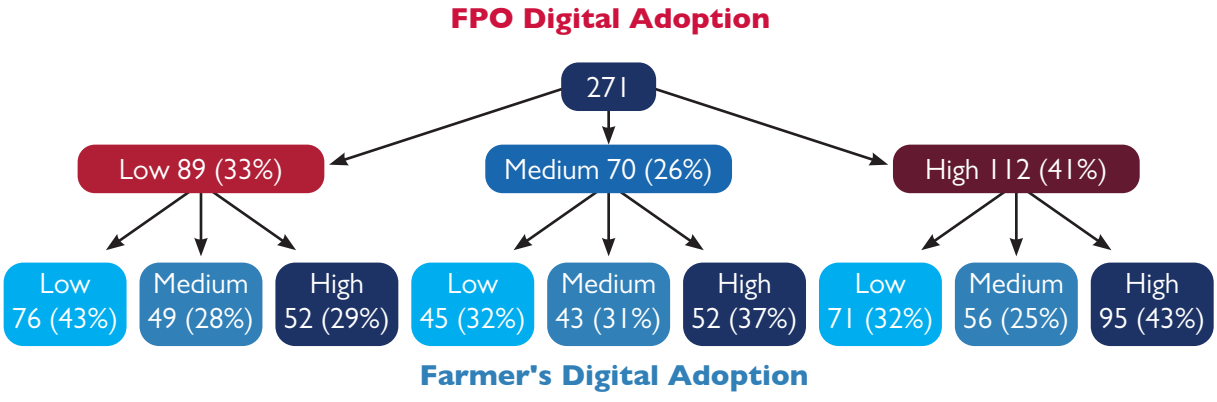

Figure 8: Association Between FPO Digital Adoption and Farmer's Digital Adoption: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

4.5.1. Logistic Regression of Farmer Digital Adoption on FPO Digital Adoption

To test this association further between FPO digital adoption and farmer digital adoption, we ran a regression of farmers' digital adoption on FPO digital adoption, controlling for FPO and farmer characteristics. Table 4 shows results from a logit regression of farmer digitalization on FPO digitalization.

Dependent Variable: The dependent variable for the regression model is a binary variable indicating the level of digital adoption by member farmers. The variable takes the value of one if a farmer exhibits high levels of digital adoption, among the three categories of farmer digital adoption (low, medium and high, as discussed in Section 4.3). The variable takes a value of zero if the farmer falls in the medium or low category based on their digital adoption score.

Independent Variable: The key independent or explanatory variable in the regression model is the FPO digital adoption tertile; low medium and high levels of digital adoption, as discussed in Section 4.2.2.

Controls: Farmer demographic characteristics and other FPO characteristics may possibly drive digital adoption among farmers other than the FPO's digital adoption. To isolate these effects, the regression thus controls for the following:

- **Farmer Characteristics:** Farmer education, age, gender and land holding size.
- **FPO Characteristics:** Legal form, vintage, turnover size, shareholding size, whether the FPO is institutionally promoted, and whether it is an all-women FPO.
- **State Fixed Effects** to control for unobserved factors like variation in institutional, socio-economic, and political factors across states.

Columns two to five in Table 4 present regression coefficients from the logit regression of farmer digital adoption on FPO digital adoption. Positive coefficients corresponding to an independent variable indicate a positive impact on farmer digital adoption while negative coefficients indicate negative impact on farmer digital adoption. Coefficients expressed in bold indicate that the variable has a significantly positive or negative effect on farmer digital adoption at five per cent level of significance. We have fitted four different models of farmer digital adoption to understand how the coefficients corresponding to FPO digital adoption change as we add other controls in the model. The models are described as follows:

- Model I: FPO digital adoption tertile
- Model II: Model I + state fixed effects
- Model III: Model II+ farmer's background characteristics
- Model IV: Model III + FPO characteristics

Photo Credit: Kazhani Farmer Producer Company Limited

Table 4: Results from Logistic Regression of Farmer Digital Adoption on FPO Digital Adoption: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

Dependent Variable: Binary indicator for farmer digital adoption level (1 if digital adoption level is high and 0 if digital adoption level is low or medium)				
(1)	(2)	(3)	(4)	(5)
Characteristics	**Model I**	**Model II**	**Model III**	**Model IV**
Intercept	-0.88	-2.25	-3.64	-4.85
FPO Digital Adoption (ref: Low)				
Medium	0.35	-0.35	-0.40	0.28
High	**0.59**	0.22	0.13	0.20
State (ref: Bihar)				
Madhya Pradesh		**1.82**	**2.05**	**2.68**
Maharashtra		**2.57**	**2.68**	**3.26**
Odisha		**0.92**	**1.05**	**1.77**
Rajasthan		0.66	**0.77**	**0.91**
Farmer's background characteristics				
Education (ref: primary or below)				
6-10 yrs. of schooling			0.65	**0.87**
11-12 yrs. of schooling			**1.47**	**1.66**
more than 12 yrs. of schooling			**1.33**	**1.56**
Age Category (ref: 18-35 years)				
36-45 years			-0.15	-0.21
>45 years			-0.33	-0.33
Gender (ref: Female)				
Male			0.63	0.78
Land Holding size (ref: Marginal)				
Small			-0.17	-0.07
Medium			-0.44	-0.49
Large			-0.08	-0.37
FPO characteristics				
Legal Form (ref: Cooperative Society)				
Producer Company				-0.17
Vintage (ref: 2-3 years)				
4-6 years				0.03
7-10 years				-0.81
>10 years				0.57
Turnover for FY 2022- 23 (ref: <10 Lakhs INR)				
10 lakhs-<50 lakhs				0.66
50 lakhs - <1 crore				0.65
>1 crore				0.68
Number of Shareholders (ref: <300)				
300-499				**-0.76**
500 -999 Shareholders				-0.38
>1000 Shareholders				0.10
Promoted by (ref: Self-Promoted)				
Institutionally Promoted FPO				0.41
All women FPO				0.07

Coefficients expressed in bold indicate that the variable has a statistically significant association (positive or negative) with farmer digital adoption at 5% level of significance.

Key Findings from the Regression Analysis: Effect on Farmer Digital Adoption

Effect of FPO Digital Adoption Diminishes as we Add Other Variables in the Model

In model 1, we see that a high level of FPO digital adoption has a significant positive effect on the higher digital adoption of member farmers belonging to such FPOs compared to low levels of FPO digital adoption. However, as we add variables such as location state of the FPO, farmer background characteristics, and FPO characteristics, the coefficient is no longer statistically significant. However, for all the four models the sign of the coefficient corresponding to the high level of FPO digital adoption remains positive.

Significant State-Level Variations in Farmer Digital Adoption

The study reveals substantial differences in digital adoption among surveyed farmers across Indian states, even after adjusting for farmer's background and FPO characteristics. Farmers in Madhya Pradesh and Maharashtra exhibit significantly higher levels of digital adoption compared to those in Bihar. On the other hand, farmers in Rajasthan seem to be less likely to adopt digital tools compared to farmers in Bihar. This suggests potential variations in factors influencing farmer digital adoption beyond the data collected on FPOs and farmers themselves. These factors could include variations in efficient policy implementation related to digital adoption, institutional differences across states, or unmeasured characteristics of FPOs and farmers in those regions. Further investigation is needed to understand the specific reasons behind this state-wise variation.

Years of Formal Education of Farmers Play a Significant Role in their Digital Adoption

Levels of farmer's education, as measured by four categories: primary or below, 6-10 years of schooling, 11-12 years of schooling, and more than 12 years of schooling, seem to have a significant positive association with their digital adoption. The higher the number of years of schooling, the higher are the levels of digital adoption.

Potential Link Between FPO Shareholding Size and Farmer Digital Adoption

The study suggests a possible negative correlation between the number of shareholders in an FPO and levels of digital adoption among its members. FPOs with a smaller shareholder base might dedicate more resources to member engagement, potentially leading to higher levels of digital adoption among farmers. However, further research is needed to confirm the strength and causality of this relationship.

Other Key Observations

- Older farmers are less likely to consider digital adoption compared to younger counterparts as indicated by negative coefficients in Table 4. However, the association is not statistically significant after adjusting for other control variables.
- Farmer's landholding does not seem to have any impact on their digital adoption.
- We have seen in the FPO digital adoption section that FPCs have higher levels of digital adoption behavior than farmer cooperatives. However, this does not trickle down to the members of FPCs.

4.6. FPO Engagement and Farmers' Perceived Well-being

In this section, we explore the association between FPO engagement, their digital adoption, and the perceived well-being of member farmers. We use farmers' responses to questions about the services and benefits they receive from FPOs to gauge their own perceptions of their well-being, with proxy indicators including increased income, decreased cost of production, and decreased cost of transportation of agricultural produce. We believe that the findings from our study will corroborate the literature on impact of FPO membership on farmers, with a focus on digital adoption of FPOs.

4.6.1. Services Offered by FPOs as Reported by Farmers

Services Throughout the Value Chain: Surveyed farmers were asked about the services they receive from FPOs throughout the agricultural value chain. Figure 9 depicts the different services that FPOs offered to their members across states. Key findings are as follows:

- Input-related services emerged as the most prominent services that FPOs offer to their members, compared to providing storage facility for farmer's produce, transportation of produce, and farm equipment on rent.

- Relative to other states, a relatively lower proportion (63 per cent) of surveyed farmers in Rajasthan reported that their FPO can service their input requirements.
- Availability of storage facilities for agricultural produce is higher in Maharashtra (66 per cent) and Bihar (52 per cent) compared to other states. Among all states in the sample, Maharashtra has the highest proportion of farmers (53 per cent) reporting that their FPOs provide farm equipment on rent.

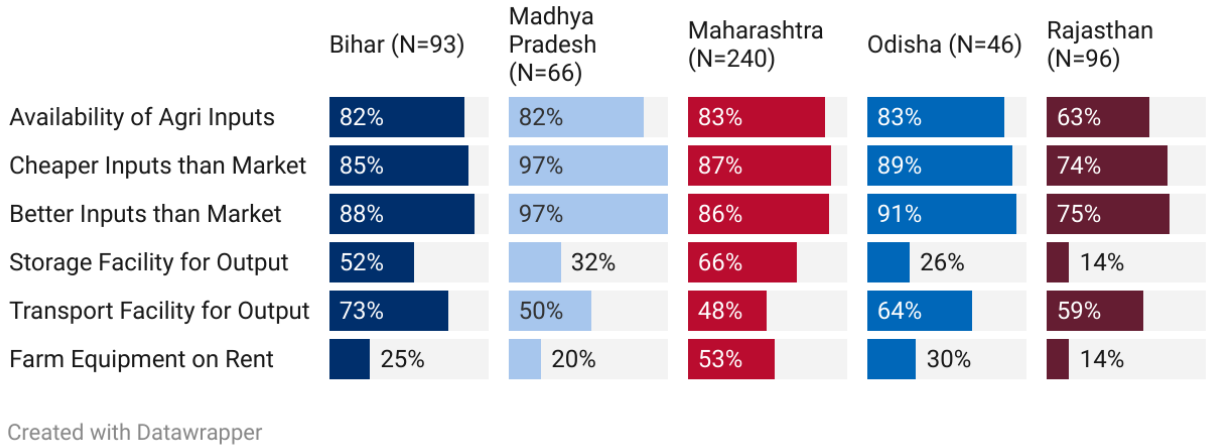

Figure 9: Services Offered by FPOs to their Member Farmers as Reported by the Farmers: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

Knowledge sharing by FPOs: Farmers were also asked about the knowledge sharing services they receive from the FPOs. Knowledge about agricultural practices, technological innovations, information on crop insurance, and presence of farmer interest groups (see glossary) might have an impact on the agricultural productivity and profitability of farmers. Figure 10 depicts the knowledge sharing services that FPOs offer to their members across states. Key findings are as follows:

- 73 per cent of surveyed farmers in Rajasthan reported receiving training in agricultural practices from the FPOs, which is the lowest among five states. On the contrary, surveyed farmers in Rajasthan tend to receive information on technological innovations and government schemes from their respective FPOs more than farmers in any other state.
- Across all states in the sample, the highest proportion of farmers in Madhya Pradesh (88 per cent) reported that their FPOs have farmer interest groups. This proportion is surprisingly the lowest in Maharashtra (39 per cent), the state which has performed better than the four other states on most other indicators as far as our sample goes.
- A high proportion of surveyed farmers in Madhya Pradesh (94 per cent) and Maharashtra (84 per cent) reported receiving information on crop insurance from their FPOs relative to farmers from other states. On a related note, surveyed farmers from Rajasthan (55 per cent) and Maharashtra (48 per cent) tend to receive more assistance from their FPOs on crop failure than the other three states (between 19 per cent and 24 per cent).

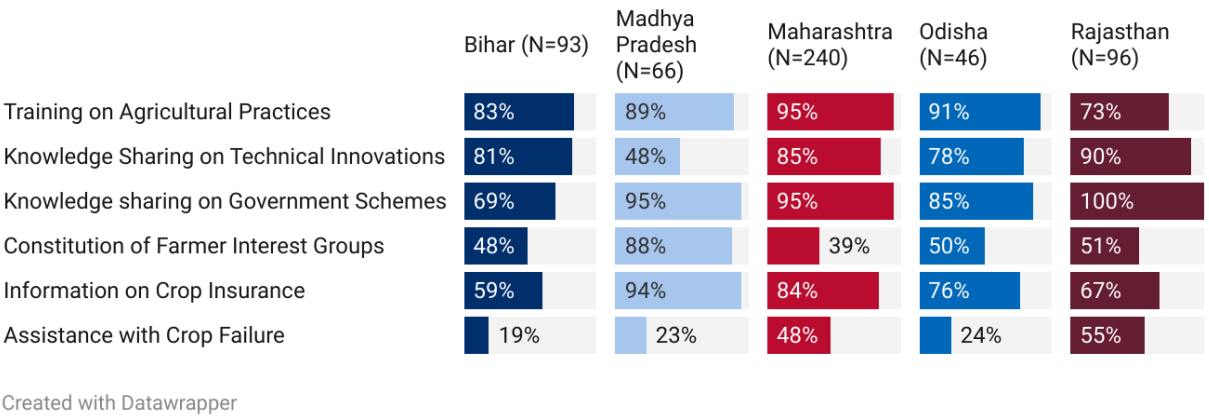

Figure 10: Knowledge Sharing by FPOs with their Member Farmers: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

4.6.2. Association Between FPO Services and Farmers' Perceived Well-being

As discussed in the previous section, we considered indicators such as farmer perceptions around increases in income, decreased cost of production, and decreased cost of transportation of agricultural produce since becoming a member of the FPO as a proxy for their perceived wellbeing. In this section, we present the bivariate association between various indicators of FPO engagement and farmers' perceived wellbeing. Table 5 presents the association between FPO engagement and decreased cost of agricultural production as perceived and reported by farmers. From the p-values (if less than 0.05) of almost all the association tests, surveyed farmers who receive services from FPO tend to think that their cost of production has decreased over time. Similar findings hold true for other proxy indicators of farmers' perceived wellbeing such as increase in income and, decreased cost of transportation of agricultural produce.

Table 5: Cross Tabulation of Various Types of FPO Services and Farmer's Perception on Decreased Cost of Production: LEAD Survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

		Percentage (%) of farmers reporting decreased cost of production since joining the FPO		p-value
FPO Services		**YES**	**NO**	
FPO is able to service full quantity of inputs required	YES	41.3	58.7	0.001
	NO	23.7	76.3	
FPO provides cheaper inputs than market	YES	40.8	59.2	0.000
	NO	18.2	81.8	
FPO provides better quality inputs than market	YES	40.7	59.4	0.000
	NO	17.8	82.2	
FPO provides farm equipment on rent	YES	51.6	48.4	0.000
	NO	29.9	70.1	
FPO Knowledge Sharing				
FPO provides training on agricultural practices	YES	40.3	59.8	0.001
	NO	8.2	81.8	
FPO provides information on crop insurance	YES	40.4	59.6	0.012
	NO	27.4	72.1	
FPO helps in case of crop failure	YES	44.6	55.5	0.007
	NO	33.0	67.0	
FPO has instituted Farmer Interest Groups to support farmers	YES	33.6	66.4	0.059
	NO	41.5	58.5	

4.6.3. Association between FPO Digital Adoption and Farmers' Perceived Wellbeing

In this section we investigate whether there is any association between FPO digital adoption and farmers' perceived wellbeing, perhaps mediated by FPO digital adoption leading to better engagement with the farmers. Table 6 presents the bivariate association between FPO digital adoption and farmers' perceived wellbeing. The crosstabulations and the p-values (if less than 0.05), as presented in Table 6, suggest that farmers who are members of FPOs have higher level of digital adoption, and they are likely to perceive increased income and decreased cost of production.

Table 6: Cross Tabulation of FPO Digital Adoption and Farmers' Perceived Wellbeing: LEAD survey of FPOs and Member Farmers on Digitalization (Oct-Dec 2023)

Farmers reporting an increase in agricultural income (%)			
FPO Digital Adoption	YES	NO	P-value
Low	88.6	11.4	0.046
Medium	93.6	6.4	
High	95.0	5.0	
Farmers reporting a decrease in cost of production (%)			
FPO Digital Adoption	YES	NO	0.013
Low	31.4	68.6	
Medium	47.5	52.5	
High	36.5	63.5	
Farmers reporting a decrease in cost of transportation (%)			
FPO Digital Adoption	YES	NO	0.841
Low	38.9	61.1	
Medium	38.1	61.9	
High	41.0	59.0	

Photo Credit: Kazhani Farmer Producer Company Limited

5. Recommendations

Recognizing that digital adoption can be an important means to achieve greater credit and market access for FPOs and improve FPO functioning and member networking, the study makes the following recommendations:

Increase Access to Training in Digital Tools for FPOs and Farmers

Key Finding

- Survey findings suggest strong association between digital skills training among FPOs and FPO adoption of digital tools.
- Field experience suggests that FPOs are eager to learn new practices, especially those boosting output and income and involving digital tools.
- FPO digital adoption is not associated with member farmer's digital adoption.
- Use of agriculture related mobile applications is low among farmers.

Current Initiatives towards Training in Digital Tools Include

- **Government initiatives:** SFAC initiated the Learning Management System (LMS) to provide training related to FPO promotion, governance, access to finance, value addition & processing, marketing, bookkeeping, compliance requirements and MIS. Under the Digital India Program, videos on the above topics are also posted online for easy access and uptake. Similarly, the National Institute of Agricultural Extension Management's MANAGE FPO Academy provides targeted trainings for farmers, FPOs, and Cluster-Based Business Organizations (CBBOs).
- **Private companies and NGOs:** The Samudra Network, Samunnati, non-profits like the National Association for farmer Producer Organizations (NAFPO) and industry organizations like the Confederation of Indian Industry (CII) have ventured into training on digital tools. These organizations have been facilitating private sector engagement through digital delivery of capacity building programs along with developing online portals for FPO operations management.
- While these organizations provide training for capacity building of CEOs and board of directors of FPOs and even training for CBBOs, there is still a long way to go to reach farmers who struggle to sustain themselves beyond the three-year threshold.

Actionable Suggestions

- **Make knowledge and training accessible through open source educational videos.**
- Connect FPOs with local chartered accountants so that they can ensure compliance and provide on-the-job learning opportunities. Financial support from SFAC and NABARD for these services can further incentivize uptake.
- Enhance awareness on the availability of existing digital tools and platforms and the benefits therein. Mass Campaigns could be undertaken, for example, *Jago Grahak Jago* (see glossary). There could be a similar digital campaign that the central government or respective state institutions can undertake to enhance the knowledge and understanding of benefits of various digital technology in agriculture.

Promote Gender Equity within FPOs to Reap the Benefits of 'Feminization of Agriculture'

Key Finding

- Female representation in FPOs is poor. The study sample shows a median of two female board members and 26 per cent female shareholders.
- Field experience suggests that all-women FPOs thrive with handholding and support.

Actionable Suggestions

- **Conduct targeted training programs:** FPO promoting institutions such as SFAC, NABARD, NAFPO, and CII can provide training specifically designed to equip women with the skills and knowledge needed for FPO leadership. Moreover, drawing from the importance of training in improving digital adoption, training on different aspects of the agricultural value chain could also be beneficial for women-led FPOs.
- **Enhance mentorship and networking opportunities:** these institutions can connect women with experienced leaders in the agricultural sector for guidance and support.
- **Offer financial incentives:** Offering grants or subsidies to FPOs that promote female leadership and gender equity.

Push for Ground-up Innovations Tailored to FPO Needs

Key Findings

- KIIs undertaken for the study suggest that FPOs often resist new tools due to a lack of awareness and apprehension towards new technology.
- On the supply side, many innovations lack cultural context and overwhelm small FPOs with complex interfaces (e.g., farm enterprise resource planning (ERP) solutions).

Actionable Suggestions

- Establish university research fellowships or residencies, where tech talent can collaborate with FPOs to develop user-friendly field-tested solutions. FPO promoting institutions such as SFAC, NABARD can support these programs through establishing networks and arranging funds.

Bridge the Information Gap with a National FPO Repository

Key Findings

- NABARD, SFAC and now the Tata Cornell Institute have made databases of FPOs available. While this enables us to extract information on the size and scale of the sector, the databases do not provide FPO contact information. This prevents connecting the FPOs with start-ups or research bodies planning interventions.

Actionable Suggestions

- Create a National FPO Repository that provides accurate and updated information on FPOs and contact information of the Board of Directors. This would bridge the information gap, empowering FPOs with improved resource access and facilitating collaboration across the agricultural sector.

Assess the FPO Digital Adoption Spillover Effect on Farmers

Key Findings

- FPOs having higher levels of digital adoption lead to improved perceptions of farmer well-being of its member farmers.
- FPO digital adoption has not translated into increased digital adoption among individual farmers.

Actionable Suggestions

- Conduct rigorous impact assessments to explore the causal link between FPO digital adoption and farmer digital adoption. Evidence generated from such studies can provide critical information to bridge the gap between FPO digitalization and farmer digital literacy, ultimately leading to more effective strategies for empowering both FPOs and farmers in the digital age.
- Evidence from such research can encourage policy makers to come up with basic training programs for farmers and enable greater outreach through their existing systems.
- It is crucial to change FPO member engagement strategies where the FPOs need to take up the mandate of empowering their member farmers with access to technology tools and promote adoption through their services and other transactions. This can be incentivized through the FPO promoting institutions, concerned government departments, and public-private partnerships.

Photo Credit: Kazhani Farmer Producer Company Limited

6. Conclusion

Recognizing technology's potential to revolutionize agriculture, the Indian government is pushing digitalization across the sector. Initiatives like the Digital Agriculture Mission (2021-25) deploy AI, remote sensing, and GIS tools to empower farmers. Additionally, e-commerce platforms like eNAM, AGMARKNET, and ONDC allow farmers and FPOs to bypass intermediaries and access better prices for their produce (Ministry of Agriculture & Farmers Welfare, Government of India, 2021). This focus on digitalization reflects a growing consensus among stakeholders that technology can boost agricultural productivity, enhance sustainability, and improve farmer returns (World Economic Forum, 2021).

While FPOs have made strides in improving farmer outcomes, credit and market access remain the biggest challenges towards building a sustainable FPO ecosystem. This study contributes to the existing literature by arguing for digitalization of FPO operations as a potential solution to the gap in credit and market access for FPOs. Digital operations improve transparency, allowing FPOs to track progress, manage member data, and forecast demand. These streamlined processes improve transparency and governance within FPOs, signaling trustworthiness to external actors, potentially improving credit and market access for FPOs.

In this context, this study makes some key contributions. Firstly, there exists a strong link between FPOs receiving digital training and their ability to adopt digital tools and processes. This suggests that equipping FPOs with the necessary skills can foster a digital environment within the organization. Secondly, there is a positive association between FPO digital adoption and a farmer's perception around increased income and decreased production costs. This implies that FPOs leveraging digital technologies can potentially streamline processes and achieve cost efficiencies that benefit their members. Thirdly, despite the positive outcomes for FPOs, the study doesn't find strong evidence of a "trickle-down effect" on farmer digital adoption. There seems to be a crucial disconnect between FPO digital adoption and digital adoption by individual farmers.

Finally, it is important to remember that,

"Digitalization is not indispensable to agriculture and therefore for the next two decades, digital technology in agriculture will be an enabler, not a driver"

- Pravesh Sharma, Co-Founder & CEO, Kamatan Farm Tech

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Glossary

Agricultural Cooperative Society (Ag co-ops): Ag co-ops are organizations owned and operated by their member farmers. They unite single growers to boost their productivity and increase yields. Compared to individual farmers, co-op members are more economically protected and face lower risks. Farmers in agriculture cooperatives produce goods and render various services, being owners and users at the same time. Besides, ag co-ops can sell their products avoiding middlemen fees, which increases farmers' profits. The main idea behind agricultural co-ops is self-support: all members help each other and share risks. The primary focus of such organizations is member interests.

Alagh Committee: The Ministry of Law, Justice and Company Affairs (Department of Company Affairs), Government of India, constituted a High Powered Committee on 1st November, 1999 to (a) examine and make recommendations with regard to framing legislation which would enable incorporation of cooperatives as companies and conversion of existing cooperatives into companies; and (b) ensure that the proposed legislation accommodates the unique elements of cooperative businesses within a regulatory framework similar to that of a private limited company. The committee was chaired by Dr Y.K. Alagh along with seven other members.

APEDA Farmer Connect: Farmer Connect is an initiative undertaken by the Agricultural and Processed Food Products Export Development Authority (APEDA), Government of India, to provide a 24/7 online digital platform in the form of a portal and mobile application. It helps bridge the gap between FPO/FPC/Cooperatives and exporters. FPO/FPC/Cooperatives can make their profiles and post sales offers. Exporters can post enquiries and view matching sales offers.

APMC: Agricultural markets in India are mainly regulated by state Agriculture Produce Marketing Committee (APMC) laws. APMCs were set up to ensure fair trade between buyers and sellers for effective price discovery of farmers' produce. APMCs can: (i) regulate the trade of farmers' produce by providing licenses to buyers, commission agents, and private markets, (ii) levy market fees or any other charges on such trade, and (iii) provide necessary infrastructure within their markets to facilitate the trade.

eNAM: National Agriculture Market (eNAM) is a pan-India electronic trading portal which builds networks between the existing APMC mandis to create a unified national market for agricultural commodities. Small Farmers Agribusiness Consortium (SFAC) is the lead agency for implementing eNAM under the aegis of Ministry of Agriculture and Farmers' Welfare, Government of India.

Farmer Interest Group (FIG): A Farmer Interest Group is a self-managed, independent group of farmers with shared goals and interests. FIGs are formed under every Farmer Producer Organization (FPO) to ensure smooth conduct of the mandates and the objectives set before it. The members work together to achieve this goal by pooling their existing resources, gaining better access to other resources and sharing the resulting benefits.

Farmer Producer Company (FPC): An FPC is a Private Limited Company that operates under the regulatory framework of the Companies Act, 2013, which is distinctly different from that of the cooperatives. An FPC can have 10 or more individual producers, or two or more producer institutions or a combination of both. An FPC retains the one-member-one vote principle.

Farmer Producer Organization (FPO): Farmer Producers' Organizations are incorporated/ registered either under Part IXA of the Companies Act or under the Co-operative Societies Act of the concerned States, and are formed to leverage collectives through economies of scale in the production and marketing of agricultural and allied sector.

Gramin Bhandaran Yojana: This is a warehouse construction subsidy scheme provided by the government for the construction, renovation and repair of warehouses, which are built for storing farm produce in rural parts of India.

Jago Grahak Jago (Wake up Customer Wake up): It is a consumer awareness program launched in 2005 by the Ministry of Consumer, Government of India. Under this scheme, various channels spread awareness

about consumer rights to put an end to malpractices by merchants. A consumer forum was established, and a consumer court was created to handle consumer cases. At the consumer forum, complaints are received and then proceedings over the case are carried out in courts. By providing various helpline numbers *Jago Grahak Jago* achieved mass popularity and quickly reached out to the last mile beneficiary i.e., the consumers.

Logit Regression: This is a statistical analysis method to predict the probability of occurrence of a binary outcome, such as yes or no, based on observations in a data set.

MCX: The Multi Commodity Exchange of India Limited (MCX) is a commodity derivatives exchange that facilitates online trading of commodity derivatives transactions, thereby providing a platform for price discovery and risk management. The Exchange, which started operations in November 2003, operates under the regulatory framework of the Securities and Exchange Board of India (SEBI).

NCDEX: National Commodity & Derivatives Exchange Limited (NCDEX/ the Exchange) is a professionally managed online, commodity exchange, with diverse product offerings setting a benchmark for both agriculture and the non-agri commodities derivatives segment. NCDEX was incorporated on April 23, 2003, as a public limited company and commenced operations on December 15, 2003, as a recognized association under The Forward Contracts (Regulation) Act of 1952. According to the 2023 annual report, the NCDEX featured futures contracts on 23 agricultural commodities. In establishing and maintaining an online futures market for crops, the NCDEX has helped increase market transparency. The exchange assists Indian farmers in the price discovery process.

OCEN: The Open Credit Enablement (OCEN) initiative is an online platform for digital credit for MSMEs. It enables borrowers to choose the best offer from multiple lenders and choose the best one. OCEN could further improve access to working capital for MSMEs, including farmers and small shop owners.

ONDC: Open Network for Digital Commerce (ONDC) is an e-retail platform that offers opportunities to FPOs to sell their output online. It is yet another tech-based initiative to transform the way e-commerce functions in India by enabling e-commerce through an open protocol based on open-source specifications. Its mission is to dramatically increase e-commerce penetration in the country by enabling population-scale inclusion of all types and sizes of sellers.

Open-Agri Network: An open-agri network connects FPOs, farmers, traders, input suppliers, government authorities and the end consumers. For instance, farmers can find competitively priced credit, agricultural inputs and the best prices for their harvest through a "tap to access" digital format as part of the service suite on the network.

Open Protocol: Open protocol consists of open application programming interface (API) specifications to enable seamless communication between consumers and providers across diverse platforms. These specifications allow for communication between two distinct platforms and create a decentralized, yet interoperable framework.

PM-KISAN: This Central Government scheme that provides income support of INR 6000 (~ USD 72) per year is given to all farmer families across the country in three equal instalments of INR 2000 (~USD 24) every four months.

Precision Agriculture (PA): PA is the science of improving crop yields and assisting management decisions using high technology sensor and analysis tools. PA is a new concept adopted throughout the world to increase production, reduce labor time, and ensure the effective management of fertilizers and irrigation processes. It uses a large amount of data and information to improve the use of agricultural resources, yields, and the quality of crops (Mulla, 2013).

Principal Component Analysis: Principal component analysis (PCA) is a dimensionality reduction method that is often used to reduce the dimensionality of large data sets, by transforming a large set of variables into a smaller one that still contains most of the information in the large set. In a PCA method, each variable is assigned a weight and the standardized variables are multiplied by the weights and summed to produce the index, or principal component.

TReDS: This is an online electronic platform and an institutional mechanism for financing/factoring of MSME sellers' trade receivables against corporate buyers, government departments and public sector undertakings. It helps MSMEs access to working capital digitally.