Assessing the Extent of Digitalization in Farmer Producer Organizations with Digital Maturity Index

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The application of digital technologies has become increasingly relevant across economic and social activities, including agriculture. In agriculture, however, the extent of digitalization remains an area of enquiry. Much of the existing literature has focused on farm-level and farmer-level applications, with relatively less attention to digitalization at the organizational level. This is particularly relevant for Farmer Producer Organizations (FPOs), which function as collective business entities for member farmers and undertake activities such as input supply, aggregation, post-harvest management, financial operations, value addition and marketing. Their organizational functioning provides an important context for understanding how effectively digital technologies are integrated into agricultural and business activities. This can be understood through the concept of digital maturity, referring to the extent to which an organization has integrated digital technologies into its infrastructure, capabilities and organizational processes.

In this context, the present study undertook a preliminary assessment of digital maturity among FPOs. A Digital Maturity Index (DMI) was conceptualized for the FPO context across six dimensions: Access to Digital Infrastructure, Digital Skills and Capability, Smart Farming Practices and Technology Adoption, Digital Governance and Policies, Digitization in Financial Management, and Digital Marketing. The study also examined selected organizational factors, namely training exposure, governance effectiveness, innovation orientation, institutional linkages and organizational infrastructure. Data were collected from 30 FPOs across the country, selected through non-probability convenience sampling using a structured questionnaire. DMI scores were calculated using standardized scores across the six dimensions, and FPOs were relatively classified into Emerging, Transitional and Established Digital Maturity categories based on the distribution of scores within the study sample.

The assessment using DMI showed that Digital Skills and Capability was the relatively stronger dimension of digitalization among the FPOs. Governance Effectiveness and Organizational Infrastructure had significant positive associations with DMI, while Training

Exposure, Innovation Orientation and Institutional Linkages did not show significant associations. The study provides a preliminary understanding of digitalization among FPOs across different organizational and functional dimensions and offers a basis for further refinement of a comprehensive framework for assessing digital maturity in FPOs.

Keywords: Digitalization, Digital Maturity, FPOs, Digital Capabilities

1. Introduction

Agriculture is undergoing a significant transformation with the increasing integration of digital technologies into production, information delivery, financial services, supply chains and markets. Digitalization in agriculture refers to the adoption and integration of digital technologies, platforms, information systems and services across agricultural activities and related processes. It has the potential to improve access to information, enhance decision-making, facilitate access to financial and extension services, strengthen supply-chain coordination and improve market opportunities for farmers. The implications of agricultural digitization are multidimensional, extending beyond technology adoption to economic, social and institutional aspects of agriculture and rural development (Rolandi et al., 2021).

The growing application of digital technologies has created opportunities across different stages of the agricultural value chain. Digital extension and advisory services can improve access to timely information, while digital financial services, farm-management technologies and digital marketing platforms can support more efficient production and commercialization (Mabaya and Porceillo, 2022). However, the benefits of digitalization are not uniformly realized, particularly among smallholders (Sun et al., 2026). A Study led by Choruma et al. (2024) identified inadequate digital infrastructure and connectivity, limited digital literacy and affordability constraints as important barriers to the effective use of digital technologies in agriculture. These challenges indicate that the success of agricultural digitalization depends not only on the availability of technologies but also on the capacity of users and institutions to access, utilize and integrate them into their activities. (Arangurí et al., 2025, Smidt & Jokonya, 2022)

The Indian agricultural sector is similarly experiencing increasing digitalization, alongside persistent challenges of connectivity, affordability and digital literacy. Kapoor (2025) highlighted high initial costs, limited rural connectivity and digital literacy gaps as major constraints, while emphasizing the importance of policy support, affordable digital tools

and vernacular solutions for achieving inclusive digital transformation in agriculture. These challenges also underline the need for institutional mechanisms that can facilitate collective access to and effective use of digital technologies.

In this context, Farmer Producer Organizations (FPOs) provide an important institutional platform through which the benefits of digitalization can potentially reach groups of small and marginal farmers. FPOs enable producers to collectively undertake activities related to input procurement, production, value addition, finance and marketing, thereby improving their access to services and markets (Vilhekar, 2024). With the expansion of FPOs in India, their role is increasingly extending beyond collective economic activities towards technology-enabled service delivery and market participation (Salokhe, 2025). Consequently, the extent to which FPOs themselves are equipped to adopt and integrate digital technologies becomes an important consideration.

Digitalization of an FPO is not limited to the use of individual digital tools but encompasses digital infrastructure and skills, technology-enabled agricultural practices, governance and organizational processes, financial management, communication, and digital marketing (Bhowmik and Hazari, 2026). Therefore, the extent of digitalization may vary across different functional areas of an FPO, making it important to assess digitalization from a broader organizational perspective. Such an assessment can provide a more comprehensive understanding of how digital practices are integrated into the functioning of FPOs.

2. Rationale of the Study

While the literature increasingly documents the opportunities and challenges associated with digitization in agriculture, comparatively less attention has been given to digitization within FPOs as organizations. FPOs perform multiple functions related to input access, agricultural services, finance, aggregation and marketing; therefore, their ability to effectively integrate digital technologies is important for delivering these functions efficiently.

Existing studies have largely focused on the application of digital technologies at the farm and farmer level, with relatively limited attention to the organizational dimension of digitization in FPOs. Consequently, there is a need to understand how far digital practices have been integrated into the functioning of FPOs and where organizational gaps remain.

The present study therefore seeks to assess the extent of digitization among FPOs, identify areas of relative strength and gaps, and generate insights for strengthening their digital capabilities and role in digitally enabled agricultural development.

3. Scope and Limitations of the Study

The study focuses on Farmer Producer Organisations (FPOs) as organizational entities and examines the extent to which digitalization has been integrated into their functioning. The findings provide an organizational-level understanding of the current state of digitalization among the selected FPOs and offer preliminary insights into the extent of digital integration within FPOs. However, as the study is based on a cross-sectional assessment of selected FPOs, the findings represent the situation at the time of the study and cannot be generalized to all FPOs. This study may therefore be viewed as a preliminary assessment of digitalization among FPOs.

4. Methodology

The study adopted a descriptive and exploratory research design to assess the extent of digitization among Farmer Producer Organisations (FPOs) in India. Data were collected from 30 FPOs across the country through a structured questionnaire using non-probability convenience sampling, based on the accessibility and willingness of FPOs to participate. The Chief Executive Officers (CEOs) of the respective FPOs were selected as respondents because of their central role in managing the day-to-day operations and making decisions related to governance, finance, marketing, technology adoption, and institutional linkages.

The questionnaire collected information on the organisational profile of the FPOs and selected organisational factors including governance effectiveness, capacity building, innovation orientation and institutional linkages, along with information on infrastructure, human resources and constraints related to digital technology adoption. These variables were considered to understand the organisational and institutional context associated with digitization among FPOs.

The collected data were analysed using descriptive statistics to summarise the characteristics of the FPOs and their performance across the dimensions of digitization. The relationship between selected organisational factors and the extent of digitization was examined using appropriate statistical techniques.

4.1. Construction of Digital Maturity Index

The conceptualization of digital maturity in the present study was guided by the framework proposed by Zhang et al. for the agricultural sector. Zhang et al. (2019) conceptualized digital maturity as a continuous and ongoing process of organizational adaptation to a changing digital environment, extending beyond the mere implementation or adoption of individual digital technologies. Their framework emphasizes that digital transformation requires coordinated development of technological, operational, organizational and capability-related elements across the organization.

Building on this conceptual foundation, the present study contextualized digital maturity to the specific organizational functions of Farmer Producer Organizations (FPOs). In this study, digital maturity refers to the "extent to which an FPO has developed and integrated digital infrastructure, human capabilities, technology-enabled agricultural practices, governance mechanisms, financial processes and marketing functions into its operations". Thus, the DMI focuses not merely on whether digital technologies are available or used, but on the extent to which digitalization is embedded across the major functional areas of an FPO.

A composite Digital Maturity Index (DMI) was developed comprising six dimensions: Access to Digital Infrastructure (D1), Digital Skills and Capability (D2), Smart Farming Practices and Technology Adoption (D3), Digital Governance and Policies (D4), Digitization in Financial Management (D5), and Digital Marketing (D6).

The six dimensions were selected to capture both the technological and organizational aspects of digitalization within FPOs, recognizing that digital maturity involves not only technology adoption but also organizational capabilities, processes and infrastructure.

i) Access to Digital Infrastructure

This dimension refers to the availability of the basic digital infrastructure required for the use of digital technologies, including internet connectivity, digital devices and related facilities. Access to such infrastructure forms a basic technological component of digitalization. (Adapted from Atik *et al.*, 2026)

ii) Digital Skills and Capability

This dimension refers to the knowledge and skills of FPO personnel to use digital technologies and applications in their work. It represents the human capability required for the effective use of digital technologies. (Adapted from Hohagen and Wilkens, 2025)

iii) Smart Farming Practices and Technology Adoption

This dimension refers to the use of digital and smart technologies by the FPO in agricultural activities, including access to information, farm-level decision-making and production management. It reflects the application and use of digital technologies in agricultural practices. (Adapted from Idoje et al., 2021)

iv) Digital Governance and Policies

This dimension refers to the use of digital tools in the governance and administrative functions of FPOs, including record management, communication, decision-making, transparency and accountability. (Adapted from Rouzky *et al.*, 2026)

v) Digitization in Financial Management

This dimension refers to the use of digital technologies in the financial functions of FPOs, including digital transactions, accounting, financial record keeping and related financial management activities.

vi) Digital Marketing

This dimension assesses the use of digital platforms for market information, promotion, customer engagement and market linkages. It is particularly relevant to FPOs given their collective marketing and market-access functions. (Adapted from Malathi *et al.*, 2026)

Initially, 60 indicators were identified across the six dimensions and operationalised into specific statements. To establish content validity, the statements were subjected to expert judgment by a panel of experts in agricultural extension using a three-point relevancy scale: Most Relevant (3), Relevant (2) and Least Relevant (1). Three criteria—Content Validity Index (CVI), Relevancy Weightage (RW), and Mean Relevancy Score (MRS)—were calculated for each statement. Items with CVI > 0.78, RW > 0.75 and MRS > 2.5 were considered for retention, and statements failing to satisfy at least two of the three criteria were eliminated. Consequently, 44 indicators were retained in the final index.

The final 44 indicators were measured using a five-point Likert scale ranging from **1** (Strongly Disagree) to 5 (Strongly Agree). Dimension-wise scores were calculated from their respective indicators and standardised to a 0–100 scale using:

$$\text{Standardised Score} = [(\text{Mean Score} - 1) / 4] \times 100$$

The overall DMI was derived from the 44 indicators to represent the extent and depth of digital integration among the FPOs. The internal consistency of the indicators under each

dimension was assessed using Cronbach's alpha. The Cronbach's alpha coefficients ranged from 0.880 to 0.977 across the six dimensions, indicating high internal consistency among the items within the respective dimensions.

4.2. Classification of FPOs based on Digital Maturity:

The classification of FPOs was conceptually adapted from the digital maturity stage approach proposed by Zhang et al. (2019), which categorizes agricultural organizations into four stages of digital maturity: Emerging, Transitional, Competitive and Transformative.

In the present study, the maturity classification was modified to three categories—Emerging, Transitional and Established—to provide a simpler classification appropriate to the scope and sample of the study. The category descriptions were adapted from the progressive maturity logic of Zhang et al., (2019), while the number of categories and their cut-off points were determined based on the distribution of DMI scores in the present sample.

Based on the mean and standard deviation of the DMI scores, the FPOs were classified into three levels—Low, Medium, and High, corresponding to Emerging, Transitional, and Established, respectively. The classification criteria are presented in the following table.

DMI score range	Digital maturity category
Below Mean − SD	Emerging
Mean − SD to Mean + SD	Transitional
Above Mean + SD	Established

The three categories represent relative levels of digital maturity within the study sample and should not be interpreted as absolute or universally applicable maturity thresholds. Their descriptions were adapted from the maturity-stage approach of Zhang et al., while their classification in the present study was based on the distribution of individual DMI scores using the mean ± standard deviation criterion.

Emerging Digital Maturity refers to FPOs at an early stage of digitalization, with relatively limited integration of digital technologies across organizational and business activities. Transitional Digital Maturity refers to FPOs progressively integrating digital technologies and capabilities across different organizational and business functions. Established Digital Maturity refers to FPOs with relatively systematic integration of digital technologies across organizational and business functions, supported by established digital capabilities and practices.

5. Results & Discussion

5.1. Profile of the respondent FPOs

The profile of the FPOs was assessed in terms of their organizational structure, operational coverage, financial characteristics, educational qualification and management experience of the CEO, age of the FPO, and membership composition. The details are presented in Table 1.

Table 1. Profile of the respondent FPOs

Sl. No.	Variable	Category	No.	Per cent (%)
1	Type of Organization	Company	25	83.33
		Cooperative	5	16.67
2	No. of villages served	1-5	3	10.00
		6-10	6	20.00
		>10	21	70.00
3	Annual Turnover	< ₹ 25 lakh	7	23.33
		₹ 25 lakh–₹ 1 crore	16	53.33
		₹ 1 crore–₹ 5 crore	5	16.67
		>₹5 crore	2	6.67
4	Educational Qualification of CEO	Higher Secondary	5	16.67
		Graduate	16	53.33
		Postgraduate	5	16.67
		Doctorate	2	6.67
5	FPO Management Experience of CEO	Less than 2 years	8	26.67
		2–5 years	8	26.67
		6–10 years	13	43.33
		More than 10 years	1	3.33
6	Average Paid up capital of the FPOs	₹ 11.27 lakhs		
7	Average age of the FPOs	4.96 years		
8	Average membership (total) of the FPOs	705.47		
9	Average women membership in the FPOs	354.63		
10	Average youth (18-35 years) membership	226.82		

The findings indicate that majority of the respondent FPOs were predominantly registered as Producer Companies under the Companies Act (83.33%) and served more than 10 villages (70.00%). The predominance of Producer Companies may indicate a relatively formalized organizational structure and systematic management, while serving a larger number of villages suggests that the FPOs have established a relatively wider geographical presence.

In terms of financial performance, the FPOs were largely concentrated in the ₹25 lakh–₹1 crore turnover range, with some reporting turnover above ₹1 crore. Regarding leadership,

the CEOs were predominantly graduates, with a considerable proportion having 6–10 years of FPO management experience, indicating a reasonably experienced leadership base.

The FPOs had an average age of 4.96 years, suggesting that the majority were relatively young organizations, while having already established a considerable operational base. The average membership was 705 farmers, including an average of 354 women members and 227 youth members (18–35 years), indicating notable representation of women and youth.

5.2. Training Exposure

Training exposure is to the extent to which the FPO functionaries are exposed to training and capacity-building programs relevant to the management and functioning of the FPO (Mali et al., 2026). The training exposure of the FPOs was assessed based on the participation of CEOs/BODs in training programs, training programs organized for farmer members, and exposure or learning visits undertaken by the FPOs. The details are presented in Table 2.

Table 2. Training Exposure of the respondent FPOs

Sl. No.	Component	Category	Per cent
1	Training programs attended by CEO/BODs	More than 4	63.33
2	Training programs organized for farmer members	More than 4	63.33
3	Exposure/learning visits	More than 2	60.00

The findings indicate that the FPOs had fairly good training exposure, with CEOs/BODs and farmer members participating in multiple training programs and FPOs also undertaking exposure or learning visits. This relatively good training exposure could be partly attributed to the capacity-building and handholding support provided by implementing agencies and CBBOs under various FPO promotion initiatives.

5.3. Governance Effectiveness

Governance effectiveness refers to the extent to which the FPO follows effective and accountable mechanisms for decision-making, participation, transparency and organizational functioning. The indicators were adapted from governance-related dimensions reported in FPO studies, particularly those concerning organizational structure, board functioning, transparency and accountability (Goswami & Ahmed, 2026; Singh et al., 2026). The results corresponding to Governance Effectiveness of the respondents FPOs are presented in the Table 3.

Table 3. Governance Effectiveness in FPOs

Sl. No.	Component	Category	Per cent
1	Decision making	Jointly by the CEO and Board of Directors	70.00
		Board of Directors alone	26.67
2	Board Meetings	More than 4 in a year	76.70
3	Board Attendance	More than 50 %	73.33
4	Conduct of Annual general meeting	Mandatory meeting once in a year	90.00
5	AGM member participation	More than 50 %	66.67
6	FPOs with approved business plan		93.33
7	Annual review of Business plan		90.00
8	On time completion of Statutory audit		86.67
9	On time completion of ROC/ registrar filings		93.33
10	Approval of financial statements by board		96.67
11	Maintenance of meeting minutes		93.33
12	Communication of important decision to the members		70.00

The findings indicate that governance practices were generally well followed by the FPOs. More than two-thirds of the FPOs reported joint decision-making by the CEO and Board of Directors, while most conducted regular Board meetings and maintained adequate Board participation. The majority also complied with the requirements related to Annual General Meetings, business plan review, statutory audits, and ROC/registrar filings. Approval of financial statements by the Board was also widely reported. Overall, the findings suggest that the FPOs had relatively sound governance practices, particularly in statutory compliance, financial oversight, and business planning, indicating a reasonable level of organizational discipline and formal governance.

5.4. Innovation Orientation

Innovation orientation is to the tendency of an FPO to remain receptive to new ideas, practices, processes and approaches for improving its functioning and services to members (Nikam et al., 2019; Patil et al., 2025). The results regarding Innovation orientation of the respondent FPOs is presented in the Table 4.

Table 4. Innovation Orientation of the respondent FPOs

Sl. No.	Component	Range	Per cent
1	Promotion of new technologies/digital solutions among members	1-2	63.33
2	New business strategies/initiatives undertaken	>3	20.00
3	Frequency of pilot/experimenting before large scale implementation of innovative initiatives	Frequently	30.00
4	Receipt of recognition or support for innovative initiatives	None	50.00

The findings indicate that a considerable number of FPOs were promoting up to two new technologies and digital solutions among their members. However, their engagement in broader innovation activities appeared relatively limited. Only a small proportion of FPOs had undertaken multiple new business initiatives, while experimentation with innovative ideas before large-scale implementation was also limited. Further, a substantial proportion of FPOs had not received recognition or support for their innovative initiatives. Overall, the findings suggest that although technology adoption was evident to some extent, innovation among the FPOs was largely at an initial stage, with limited experimentation, business innovation, and institutional support for innovative efforts.

5.5. Institutional Linkages

Institutional linkages refer to the extent of the FPO's interaction and collaboration with relevant external institutions and stakeholders for accessing information, technical support, finance, services and market opportunities (Nikam et al., 2019). The findings corresponding to Institutional linkages of the respondents FPOs are presented in the Table 5.

Table 5. Institutional Linkages of the respondent FPOs

Sl. No.	Component	Frequently	Occasionally	Never
1	Cluster Based Business Organizations (CBBO)	60.00	30.00	10.00
2	Line departments of State (Agri/ Horti etc.)	33.33	66.67	0
3	Agricultural universities	23.33	70.00	6.67
4	Banks	43.33	46.67	10.00
5	NABARD/SFAC/Implementing Agency	23.33	56.67	20.00
6	Agri-tech companies	36.67	50.00	13.33
7	NGOs	26.67	53.33	20.00

The findings indicate that CBBOs had the most frequent linkages with the FPOs, which may be attributed to their role in handholding and supporting FPOs. Banks and agri-tech companies also had relatively frequent linkages, while linkages with State agri/horti departments, agricultural universities, and NABARD/SFAC/implementing agencies were largely occasional. The relatively frequent linkage with banks may be associated with the credit facilities and schemes available to FPOs.

5.6. Organizational Facilities

Organizational facilities refers to the basic physical, human and administrative resources and facilities available to an FPO for carrying out its organizational and business functions. (Nikam et al., 2019). The results regarding the Organizational Facilities are presented in the Table 6.

Table 6. Organizational Facilities in the respondent FPOs

Sl. No.	Availability of Facilities	Per cent
1	Permanent Office	83.33
2	Training Hall/ Meeting Facility	73.33
3	Storage/Warehouse	63.33
4	Processing/Value addition Facility	53.33
5	Input distribution centre/input shop	66.67
6	Own transportation/logistics support	16.67

The findings indicate that most FPOs had access to basic organizational facility like permanent office. A considerable number also had training or meeting facilities, storage facilities, input distribution centers, and processing or value-addition facilities. However, transportation and logistics support was less commonly available. Overall, the FPOs appeared to have a reasonable base of basic and digital infrastructure, but gaps in transportation and logistics may constrain their ability to efficiently undertake aggregation, processing, and market-related activities.

6. Digital Maturity Index

The Digital Maturity Index, comprising six dimensions and their respective indicators, was assessed among the selected FPOs. The dimension-wise scores and the overall Digital Maturity Index are presented in Table 7 & 8.

Table 7. Digital Maturity Index

Sl. No.	Statement	Mean score
I	**Access to Digital Infrastructure**	
1	The FPO has access to a reliable and active internet connection to support its day to day operations.	**4.20**
2	The FPO has access to adequate computer systems to support the organizational activities.	**4.17**
3	The FPO has consistent and uninterrupted access to electricity for carrying out digital operations.	**4.13**
4	Members of the FPO own and use smartphones for agricultural and organizational activities.	**4.27**
5	The FPO has access to advanced technologies such as IoT devices, automated machinery, and drones whenever required.	**3.63**
6	The FPO maintains an official website for organizational operations and product marketing.	**4.07**

Sl. No.	Statement	Mean score
7	The FPO has a dedicated digital device (tablet/computer) available at the office for member use.	**4.40**
II	**Digital Skills and Capability**	
8	Members/Board of Directors (BOD)/ Staff are adequately trained in using basic digital tools and devices.	**4.50**
9	BOD/ Members/Staff demonstrate a satisfactory level of digital literacy and knowledge.	**4.33**
10	BOD/ Members/Staff are proficient in operating digital devices such as computers and smartphones.	**4.33**
11	BOD/ Members/Staff are well aware of internet usage and online navigation.	**4.33**
12	BOD/ Members/Staff are trained in the use of advanced digital technologies relevant to agriculture.	**4.33**
III	**Smart Farming Practices and Technology Adoption**	
13	FPO members actively use mobile applications to support and improve farming practices.	**4.40**
14	Members, BOD, and staff regularly access online platforms to aggregate farming information and advisories.	**4.30**
15	Precision farming and smart farming technologies such as IoT devices, AI based tools and GPS guided equipment are adopted by the FPO for the members.	**3.87**
16	Members access and utilize digital advisory services for crop management and agricultural decision-making.	**4.20**
17	Weather forecasting applications are regularly used by members for informed farm-level decision-making.	**4.13**
18	The FPO conducts or facilitates training programmes on the digitization of agricultural practices for its members.	**4.13**
IV	**Digital Governance and Policies**	
19	The FPO maintains all organizational records and data in a structured digital format.	**4.43**
20	The FPO effectively utilizes Management Information Systems (MIS) to monitor organizational performance and support managerial decision-making.	**4.47**
21	The FPO effectively utilizes Enterprise Resource Planning (ERP) systems to integrate and manage its key organizational functions.	**4.10**
22	The FPO utilizes digital systems for inventory and stock management.	**4.07**
23	The FPO complies with government legal frameworks, policies, and regulatory requirements applicable to FPOs.	**4.30**
24	The use of digital tools has improved transparency and accountability in the FPO's governance processes.	**4.37**
25	The FPO has established robust data security and privacy policies to protect member information.	**4.17**
26	The FPO uses digital communication tools (e.g., messaging apps, email) for regular interaction with members, BOD, and staff.	**4.43**
27	The FPO has a digital dashboard for real-time monitoring of key organizational and operational metrics.	**4.10**
28	The FPO has a documented digital strategy or roadmap aligned with its organizational goals.	**4.27**
V	**Digitization in Financial Management**	
29	The FPO extensively uses digital payment systems for conducting financial transactions.	**4.57**
30	The FPO has access to and actively uses digital accounting software for financial management.	**4.43**

Sl. No.	Statement	Mean score
31	Online banking facilities are actively and regularly used by the FPO for financial operations.	**4.37**
32	The FPO uses digital tools for budgeting, financial planning, and resource allocation.	**4.40**
33	The FPO has implemented a digitized payroll system for staff and labour payments.	**4.07**
34	The FPO actively utilizes FinTech platforms for accessing digital financial services such as loans, insurance, and payment solutions.	**3.77**
35	GST filing, tax returns, and statutory compliance are completed digitally by the FPO.	**4.27**
36	The FPO regularly monitors and reviews digital financial reports for informed decision-making.	**4.27**
VI	**Digital Marketing**	
37	The FPO actively uses e-commerce platforms to market and sell its products.	**4.33**
38	The FPO has access to real-time online market information for pricing and demand trends.	**4.03**
39	The FPO actively participates in and benefits from e-NAM (National Agricultural Market)/ NCDEX for commodity trading.	**4.40**
40	The FPO utilizes open digital commerce platforms (e.g., ONDC) to expand market access and facilitate the sale of agricultural produce.	**4.33**
41	The FPO employs digital branding strategies to build and strengthen its organizational identity and product visibility.	**4.37**
42	Online platforms and social media are used by the FPO for regular customer interaction and relationship management.	**4.20**
43	The FPO utilizes digital traceability systems to monitor and communicate the origin and movement of agricultural produce across the value chain.	**4.03**
44	Digital platforms have enhanced customer engagement and improved the overall buyer experience.	**4.40**

Table 8. Dimension wise overall mean scores

Sl. No.	Dimension	No. of statements	Mean score (1–5)	Standardized score (0–100)
1	Access to Digital Infrastructure	7	4.12	**78.11**
2	Digital Skills and Capability	5	4.36	**84.10**
3	Smart Farming Practices & Technology Adoption	6	4.17	**79.29**
4	Digital Governance and Policies	10	4.27	**81.78**
5	Digitization in Financial Management	8	4.27	**81.72**
6	Digital Marketing	8	4.26	**81.53**
7	**Overall Digital Maturity Index**	**44**	**4.24**	**81.06**

The overall Digital Maturity Index of the FPOs was 81.1 on a 0–100 scale, indicating a relatively strong extent of digital integration across the assessed dimensions. However, the dimension-wise scores reveal that digitalization is not uniform across all functional areas of FPO operations. Digital Skills and Capability recorded the highest score (84.10), suggesting that the FPOs possess comparatively stronger human capabilities for using digital tools. This provides an important foundation for further digital integration, as the effective use of digital

technologies depends substantially on the ability of organisational personnel to operate and apply them.

The relatively high scores for Digital Governance and Policies (81.78), Digitization in Financial Management (81.72), and Digital Marketing (81.53) indicate that digitalization has been incorporated to a considerable extent into the administrative, financial and market-oriented functions of FPOs. This pattern suggests that digital technologies are being utilised not only for basic communication but also in important organisational processes such as financial transactions, accounting, governance-related activities and market engagement. The comparatively close scores across these three dimensions also indicate a fairly balanced level of digital integration across these organisational functions.

In contrast, Smart Farming Practices and Technology Adoption (79.29) recorded a comparatively lower score. This indicates that the integration of digital technologies into agricultural production and farm-level decision-making may not have progressed to the same extent as their use in organisational and managerial functions. In particular, the relatively lower position of this dimension may reflect greater scope for strengthening the application of smart and technology-enabled agricultural practices among FPOs and their members.

Access to Digital Infrastructure was the lowest-ranked dimension (78.11) and it suggests that infrastructure and access to digital technologies may constitute a foundational constraint to further digitalization. Thus, the findings point towards a pattern in which FPOs appear to have developed comparatively stronger digital skills and organisational applications, while further strengthening infrastructure and technology-enabled agricultural applications could support deeper digital integration.

Overall, the findings indicate that digitalisation among the assessed FPOs is relatively well established but varies across functional dimensions. The results therefore highlight the importance of looking beyond an overall score and examining the individual dimensions to identify specific areas requiring further strengthening. Since no empirically established cut-off values were applied, the DMI is interpreted as a continuous measure of the extent of digitalisation rather than as a categorical maturity level.

Table 9. Association between the Organizational variables and Digital maturity

Organizational factor	Spearman's ρ	*p*-value
Training Exposure	0.275	0.142
Governance Effectiveness	0.464	0.010*
Innovation Orientation	0.038	0.841
Institutional Linkages	−0.017	0.930
Organizational Facilities	0.427	0.019*

Statistical significance was assessed at the 5% level ($p < 0.05$*).*

Spearman's rank-order correlation analysis revealed that Governance Effectiveness had a moderate positive and statistically significant association with the Digital Maturity Index ($r_s = 0.464$, $p = 0.010$). This indicates that FPOs with stronger governance practices tended to have higher levels of digital integration. The finding suggests that organizational processes such as systematic administration, decision-making, accountability and record management may be important in creating an enabling environment for the use of digital technologies.

Organizational Facilities also showed a moderate positive and statistically significant association with DMI ($r_s = 0.427$, $p = 0.019$). This suggests that FPOs with better organizational infrastructure tended to demonstrate higher levels of digitalization, highlighting the importance of adequate physical facilities and basic organizational resources in supporting digital operations.

Training Exposure showed a positive but non-significant association with DMI ($r_s = 0.275$, $p = 0.142$). Although FPOs with greater training exposure tended to have higher DMI scores, the observed association was not statistically significant in the present sample. Similarly, Innovation Orientation ($r_s = 0.038$, $p = 0.841$) and Institutional Linkages ($r_s = -0.017$, $p = 0.930$) showed negligible and non-significant associations with DMI.

Overall, the results indicate that governance effectiveness and organizational infrastructure were more closely associated with the extent of digitalization than the other organizational factors examined.

6.1. Classification of FPOs Based on Digital Maturity

The individual DMI scores were further examined to understand the relative position of the FPOs within the study sample. The mean DMI was 80.93, with a standard deviation of 16.64. Accordingly, the lower and upper limits were calculated as:

Mean − SD = 64.29

Mean + SD = 97.57

Based on these limits, FPOs with DMI scores below 64.29 were classified as Emerging, those scoring between 64.29 and 97.57 were classified as Transitional, and those scoring above 97.57 were classified as Established.

Table 10. Classification of FPOs based on their Digital Maturity Index Score

Digital Maturity Category	DMI range	No. of FPOs	Percentage
Emerging	< 64.29	5	17.86
Transitional	64.29–97.57	17	60.71
Established	> 97.57	6	21.43
	Total	**28**	**100.00**

The classification of FPOs based on their individual DMI scores showed that more than half i.e. 17 FPOs (60.71%) were classified under Transitional Digital Maturity, followed by 6 FPOs (21.43%) under Established Digital Maturity and 5 FPOs (17.86%) under Emerging Digital Maturity. The predominance of FPOs in the Transitional category indicates that a majority of the organizations were positioned between the early and relatively established stages of digitalization within the study sample. This suggests that digital technologies and practices have been adopted to some extent, but their integration across different organizational and business functions may still be developing.

The relatively large share of FPOs in the Transitional category may be associated with the gradual development of digital capabilities within FPOs. FPOs perform multiple functions, including member coordination, input supply, aggregation, financial management, governance and marketing, and the adoption of digital technologies across all these functions may require time, skills and organizational resources. The availability of digital infrastructure and the ability of FPO personnel to use digital tools may also influence how extensively such technologies are integrated into their operations.

7. Conclusion

The present study was an attempt to assess the digital maturity of Farmer Producer Organizations (FPOs) and understand the extent to which digitalization has progressed within their functioning. Given the collective scale and reach of FPOs, they have considerable potential to serve as an important pathway for advancing digitalization in agriculture. In this context, assessing their digital maturity can provide useful insights into their current digital

position and the extent to which FPOs are prepared to integrate digital technologies across their different functions. The Digital Maturity Index developed in the study offers a preliminary way of capturing this position across key dimensions and can help identify areas where greater attention and support are required. The findings also point towards the need for continued capacity building, improved access to digital infrastructure, stronger institutional support and handholding to enable FPOs to make more effective and sustained use of digital technologies. Such efforts can help FPOs move beyond the adoption of individual digital tools towards wider and more meaningful digital integration in their operations.

The study, however, is subject to limitations arising from the use of convenience sampling, the relatively limited sample and reliance on CEO-reported information, which restrict the generalization of the findings. Further studies covering a larger and more diverse set of FPOs, along with periodic assessment, would help validate and refine the index. Nevertheless, the study provides an initial understanding of the digital maturity of FPOs and opens scope for further research and policy efforts to strengthen their role in accelerating digitalization in agriculture.

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