

Assessing the key drivers of success for farmer producer companies in an Eastern Indian state: a lifecycle analysis

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Abstract

Purpose – This study conceptualizes Farmer Producer Companies (FPCs) as institutional mechanisms for promoting sustainable smallholder agricultural systems. It undertakes a comparative analysis of FPCs at different growth stages and functional domains to assess their effectiveness, dynamism and sustainability. Addressing the limited research on FPC performance across lifecycle stages, the study identifies key drivers of their success and stability to inform future policy advocacy for strengthening FPCs as resilient and inclusive farmer organizations.

Design/methodology/approach – An exploratory sequential research design was employed. The qualitative phase explored organizational performance through focus group discussions with 8–10 Board of Directors from each selected FPC, followed by quantitative data collection to validate the relationships identified. The study covered eight FPCs across five districts of Bihar, India, representing diverse operational histories in agriculture and horticulture. Stratified random sampling was used based on lifecycle stages (1–3 years, >3–6 years, >6 years and registered but nonfunctional), with 40 farmer-members selected from each FPC, resulting in a total sample of 320 respondents.

Findings – FPCs with longer operational duration (>6 years) exhibited higher levels of effectiveness, dynamism and sustainability across economic, social, marketing and environmental indicators. Mid-stage FPCs (3–6 years) also outperformed nascent ones, highlighting the role of organizational maturity in sustainable performance.

Research limitations/implications – One limitation of this doctoral research is the lack of funding, which restricts the ability to expand data collection efforts, access specialized tools or conduct extensive fieldwork. Without financial support, the research scope is confined to more affordable methods and resources, potentially limiting the depth of analysis. Furthermore, the study is geographically limited to a single country in the Eastern region, which may constrain the broader applicability of the findings. The specific context of this country, including its unique economic and political landscape, influences the research outcomes, potentially limiting the transferability of conclusions to other regions or global contexts.

Originality/value – This study contributes to the limited body of knowledge on FPC lifecycle performance by integrating organizational effectiveness and sustainability perspectives, offering an evidence-based framework for policy interventions to.

Keywords Farmer Producer Companies (FPCs), Success criteria, Economic indicators, Social indicators, Market presence, Environmental indicators

Paper type Research article

1. Introduction

Smallholder farms dominate the global agricultural landscape, with approximately 500 million farms worldwide, three-quarters of which are located in Asia; China and India together account for nearly 60% of these, with India alone representing 24% (Eastwood *et al.*, 2010; Lowder *et al.*, 2016). These farmers play a central role in the agricultural economies of developing nations, ensuring both food availability and rural livelihoods. Yet, despite their critical function, smallholders often remain marginalized and are subjected to market



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imperfections, inadequate institutional credit, and limited access to productive technology and extension services (Abraham *et al.*, 2022; Fairtrade Foundation, 2013). In India, small and marginal farmers operate over 86% of total landholdings (GOI, 2019), and their significance in enhancing food security, rural employment, and agricultural growth is well acknowledged. Nevertheless, structural constraints continue to undermine their income potential and market participation.

To address these persistent challenges, collective institutional arrangements such as cooperatives and producer organizations (POs) have gained increasing recognition as vehicles for empowering smallholder farmers and improving their economic outcomes (IFAD, 2003; Markelova *et al.*, 2009; Narrod *et al.*, 2009; Rao and Qaim, 2011; Jitmun *et al.*, 2020; Fernando *et al.*, 2021). Empirical evidence suggests that farmer collectives improve access to high-value markets, strengthen bargaining power, and enhance agricultural performance through economies of scale and joint action (Roy and Thorat, 2008; Fischer and Qaim, 2012; Castella and Bouahom, 2014; Kaganzi *et al.*, 2009). In India, the emergence of Farmer Producer Companies (FPCs), established under the Companies Act with provisions introduced in Section IXA, has offered a hybrid institutional form that combines cooperative principles with the flexibility and efficiency of private enterprises (Gurung and Choubey, 2021; Nikam *et al.*, 2019). FPCs are legally registered entities owned and operated by farmers themselves, providing a platform to access quality inputs, modern technology, agricultural extension services, and remunerative markets (Cherukuri *et al.*, 2014; Raju *et al.*, 2017). The Government of India has actively supported their proliferation, most notably through the 2021 initiative to promote 10,000 FPOs by 2026 (Singh, 2022).

Despite the policy momentum and rapid expansion, the performance of FPCs across India has been uneven and their sustainability remains a growing concern. According to recent data, only about 25–30% of FPCs are operating sustainably, while the rest remain in their formative stages or face operational and financial distress (Govil *et al.*, 2020; Nayaji and Dixit, 2021). Many FPCs are characterized by a low capital base, weak institutional governance, limited member engagement, and inadequate market linkages (Singh and Singh, 2014; Govil *et al.*, 2020). These shortcomings are further exacerbated by the tendency of external agencies to promote FPCs with limited long-term commitment, often resulting in weakened organizational capacity once project-based funding ceases (Singh, 2022). Regional disparities in the distribution and performance of FPCs are also evident, with six states—Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, Tamil Nadu, and Bihar—accounting for nearly two-thirds of all FPCs (Balamatti, 2023). In this context, Bihar stands out as a critical case, given its high share of smallholders, historically weak agrarian infrastructure, and growing network of FPCs facilitated by targeted government programs (Roy *et al.*, 2020; Anand *et al.*, 2023).

To analyse the dynamics of FPCs more rigorously, the study is anchored in three interrelated theoretical frameworks. Organizational lifecycle theory (Greiner, 1989; Adizes, 1979) provides a useful lens to understand how FPCs evolve through stages of emergence, growth, maturity, and potential stagnation or decline. Each stage presents unique management and structural challenges, necessitating appropriate strategic interventions. Cooperative development models, particularly those proposed by Chaddad and Cook (2004), help clarify the structural aspects of FPCs, which operate at the intersection of member-driven governance and market-oriented operations. These models draw attention to the delicate balance required between maintaining democratic control and achieving operational efficiency. Social capital theory, as articulated by Lyon (2003), adds a vital dimension by highlighting the role of trust, mutual norms, and farmer networks in sustaining collective action. In socially stratified and institutionally fragile regions like Bihar, the presence—or absence—of bonding and bridging social capital significantly shapes the trajectory and sustainability of farmer organizations.

While a number of studies have explored the institutional landscape of FPOs and their potential benefits, there remains a lack of systematic research on how FPCs function across different stages of organizational development, especially in underdeveloped regions. Much

of the existing literature emphasizes their initial formation and short-term impacts on income or market access, with limited attention to longitudinal performance, governance capacity, and organizational resilience. Moreover, the socio-political and institutional contexts that influence FPC effectiveness are often treated as peripheral. Against this backdrop, the present study addresses a critical knowledge gap by examining the lifecycle dynamics, performance outcomes, and enabling factors of FPCs operating in Bihar. It offers an in-depth, multi-dimensional analysis informed by organizational, cooperative, and social capital theories to uncover how FPCs evolve, succeed, or struggle over time.

The objectives of this study are to evaluate the performances of FPCs at different stages of their organizational life. It also seeks to analyse the effectiveness, dynamics and sustainability of the FPCs through understanding of the several aspects like internal governance mechanisms, leadership, functional efficiency, members' participation, empowerment and attitude that influence organizational performance. Furthermore, the study aims to identify key economic, social, marketing and environmental factors, including trust networks and institutional support, that shape the success of FPCs. Through this inquiry, the study provides critical insights into the enabling conditions and policy interventions necessary to enhance the long-term viability and scaling potential of FPCs across their developmental stages.

2. Methodology

2.1 Research design

This study employed an exploratory sequential mixed-methods design, integrating qualitative and quantitative approaches to gain a comprehensive understanding of the performance and success of FPCs. The research began with a qualitative phase aimed at exploring the genesis, operational dynamics, and contextual factors influencing FPCs. Insights from this phase guided the development of measurement constructs and instruments used in the subsequent quantitative phase. The rationale behind adopting this design was to ensure that the final analytical framework reflected ground realities and stakeholder experiences, particularly those of smallholder farmers. The sequential nature of the design allowed the researchers to build upon preliminary qualitative findings and test the derived constructs through structured surveys.

2.2 Study locale and sampling strategy

The research was conducted in the eastern Indian state of Bihar ([Figure 1](#)), a region with a predominantly agrarian economy and the highest number of FPOs among eastern states. Bihar was chosen as the study area due to its high concentration of small and marginal farmers, who constitute 97% of landholders and cultivate 76% of the state's agricultural land ([Roy et al., 2020](#); [Nayaji and Dixit, 2021](#)). Furthermore, the state's FPC ecosystem has experienced significant expansion in recent years, with over 1,700 registered FPOs ([TCI, 2024](#)), which are supported by external agencies. Unlike states such as Maharashtra, where FPOs have evolved organically, Bihar's FPOs are largely promoted through structured initiatives. This makes Bihar an ideal setting for examining the success of externally supported FPC models and drawing lessons applicable to other regions with similar agrarian challenges.

A stratified random sampling technique was adopted to ensure that the sample represented FPCs at different stages of development. FPCs were categorized into four strata based on their operational duration: those functioning for 1–3 years, >3–6 years, >6 years, and >6 years old but non-functional during the study period. Two FPCs were selected from each stratum, resulting in a total of eight FPCs. During qualitative phase, each focus group discussion (FGD) included 10 members from the Board of Directors and 10 general members, ensuring a mix of perspectives and experiences. Gender representation was considered in the composition of these groups to capture diverse viewpoints. Thus, FGDs included a total of 160 participants. Subsequently, for the quantitative phase, from each selected FPC, 40 farmer-members were



Figure 1. Location of the present study

randomly chosen, yielding a total sample size of 320 respondents for the personal interview schedule survey representing five districts, 10 blocks and 16 villages. This sample size was considered adequate to capture the diversity of experiences across FPCs while maintaining feasibility within the constraints of time and resources. The stratified approach ensured balanced representation across various stages of organizational maturity, aligning with recommendations in survey sampling literature that emphasize the value of focused, context-specific sampling in resource-limited research environments (Lohr, 2010; Groves *et al.*, 2009).

2.3 Qualitative phase: data collection and analysis

The qualitative phase involved a total of eight FGDs, one with each of the selected FPCs, comprising 20 participants; thus, 160 participants with equal representation of management and general members were involved in FGDs. The discussions focused on understanding the history, formation process, governance structure, market operations, and financial management of each FPC. The data were recorded through detailed field notes and audio recordings. A manual content analysis technique was used to code and analyse the data, with emergent themes guiding the development of performance indicators under group effectiveness, group dynamics and sustainability domains. This phase was instrumental in identifying context-specific success parameters and informed the construction of indices used in the quantitative phase. It also provided critical insights into identifying the parameters under the measures of effectiveness, group dynamics and internal functioning, sustainability and success which were subsequently assessed and quantified.

2.4 Quantitative phase: analytical framework

2.4.1 Socio-economic attributes. The quantitative component of the study focused on assessing the socio-economic characteristics of members and evaluating FPC performance through structured indices. The attributes of the selected FPCs were documented in terms of their year of registration, promoting organization, member strength, area of operation, turnover, commodity profile, service offerings, and market landscape. Parallely, the socio-economic profiles of sampled farmer-members were studied, covering variables such as annual income, farm earnings, earnings from produce sold through FPCs, number of earning

members, and land ownership. These indicators were captured to evaluate members' economic dependence on FPCs and their overall financial status.

2.4.2 Performance measures. Performance of FPCs was measured with three developed indices. The effectiveness index assessed five dimensions: functional efficiency, farmer satisfaction, empowerment, increase in income, and farmers' share in consumer prices. The group dynamics index measured internal social and organizational processes using 10 indicators such as member motivation, group processes, member participation, membership feeling, atmosphere, norms, empathy, conflict, gender difference, and processes of communication. The sustainability index included six dimensions—growth, business planning and outlook, management and governance, value and credibility, branding and promotion, and collaboration and innovation. All components were rated using Likert-type scales to record the farmers' perceptions on each. The use of indices allowed a structured, multidimensional evaluation of FPCs' organizational health, member engagement, and potential for long-term survival.

2.4.3 Measures of success: index construction. The construction of the success index was grounded in the stimulus-response theory of scale construction and Likert's summated rating technique. A detailed literature review and insights from the qualitative phase led to the identification of four major dimensions of success: economic, social, market presence, and environmental sustainability. Under each of these dimensions, an initial set of 12–15 potential indicators was drafted (Edwards, 1957). These were refined through an expert consultation process involving sixty subject matter experts from ICAR institutes, agricultural universities, Krishi Vigyan Kendras, and state-level departments. Experts rated the relevance of each parameter on a three-point scale: most relevant, relevant, and least relevant. Parameters with a mean relevancy score above 2.0 were retained.

The refined set of 50 parameters was tested through a pilot survey involving 60 farmer-members from FPCs outside the main sample. Respondents' total scores were calculated, and individuals were ranked in descending order. The top 25% and bottom 25% of respondents were classified into high and low scoring groups, respectively. Independent *t*-tests were conducted for each parameter to determine their discriminative power. Only those parameters that demonstrated statistically significant differences between the two groups ($p < 0.05$) with *t*-value > 1.75 were retained in the final index (Edwards, 1957). This process resulted in the selection of 36 parameters—eight each under economic, social, and market presence dimensions, and 12 under the environmental dimension.

The reliability of the index was evaluated using the split-half technique, which yielded a reliability coefficient of 0.78. Additionally, composite reliability was calculated, ranging between 0.75 and 0.82, confirming internal consistency. Convergent validity was assessed through Average Variance Extracted (AVE), with all constructs exceeding the threshold of 0.5. This confirmed that the parameters adequately represented the underlying constructs. Thus, the success index demonstrated both statistical robustness and practical relevance, grounded in empirical validation and theoretical coherence.

2.4.4 Data collection and statistical analysis. Data for the quantitative analysis were collected through a structured interview schedule. The success index parameters were integrated into this schedule and measured using 5-point interval scales for social and environmental dimensions, and ratio scales for economic and market presence dimensions. Responses were triangulated through focus group discussions and interactions with FPC leadership to validate organizational-level indicators. This mixed-method approach ensured both breadth and depth in data quality and enhanced the credibility of findings. Recorded responses were digitally processed, cleaned, and coded for statistical analysis.

Descriptive statistics, including means and standard deviations, were used to characterize FPCs and summarize performance indicators. One-way analysis of variance (ANOVA) was conducted to examine differences in different performance indices across FPCs at various stages of development. Upon obtaining significant *F*-statistics, post-hoc analyses using Tukey's HSD were performed to identify specific inter-group differences.

3. Results

3.1 Characterisation of selected FPCs

The evolution and performance of Farmer Producer Companies (FPCs) can be understood through the lens of their lifecycle stages—functioning for 1–3 years (FPC1 and FPC2), >3–6 years (FPC3, FPC4), >6 years (FPC5 and FPC6), and >6 years but non-functional (FPC7 and FPC8) during the present research. The FGDs explored establishment history, membership growth, equity contribution, market engagement, services, and institutional linkages with respect to the selected eight FPCs.

FPCs in the emergent stage are newly established entities with limited outreach, revenue, and operational diversification. The FPC1, established in 2021 in Muzaffarpur, is a classic example. With 325 members from 12 villages and equity of \$3,900 USD, it focuses on maize production and offers basic services like input supply and marketing. Despite a modest turnover of \$10,800 USD, its reliance on a single commodity and restricted market coverage signals its early stage of development. Another emerging FPC (FPC2), formed in 2022 in Darbhanga. With 300 members across 27 villages and \$3,600 USD equity, it engages in makhana and wheat production. Though its turnover is relatively low at \$2,400 USD, its early collaborations with research and cooperative institutions such as ICAR-NRC on Makhana and NCDC indicate promising groundwork.

FPCs in the intermediate growth stage show signs of expansion in operations, membership, and market linkages. The FPC3, established in 2019 in Darbhanga, exemplifies this phase. Starting with 50 members and now reaching 400 with \$4,800 USD in equity, it has scaled to a turnover of \$24,000 USD. Its value addition in makhana-based products and partnerships with NABARD and KVK signify a transition towards higher operational complexity and revenue generation. The FPC4, founded in 2018 in East Champaran, has grown to 551 members across 42 villages with an equity base of \$6,612 USD. Specializing in wheat, rice, and moong, and supported by institutions like ICAR and ATMA, it delivers seed technology, processing, and marketing services. Its turnover of \$14,400 USD reflects a stable growth trajectory.

Mature FPCs exhibit strong institutional networks, diversified product portfolios, and significant market presence. The FPC5 in Darbhanga, operational since 2016, represents this phase. With 1,500 members, \$18,000 USD equity, and a turnover of \$49,200 USD, it provides a wide range of services—input supply, branding, training, and food processing. Its value-added products like *channa sattu* (gram flour) and amla candy cater to both national and state markets, preserving local food traditions while enhancing farmer incomes. The most advanced among the selected FPCs, FPC6 in Purnea, has been operating since 2009. With 5,753 members across 354 villages and equity of \$69,036 USD, it achieves a robust turnover of \$650,400 USD. The FPC deals in diverse commodities including maize, banana, makhana, poultry feed, and potato. Its strong digital presence and partnerships with ATMA, KVK, and state agencies underline its mature and sustainable model.

Two FPCs fall under the decline phase due to operational stagnation and financial underperformance. The FPC7, started in 2015 with 700 members, primarily focused on potato. Despite an equity of \$8,400 USD, its turnover plummeted to \$1,200 USD in 2021, and it is currently inactive. Similarly, FPC8, established in 2014 with 220 members, became non-functional due to a limited product range (maize) and poor financial returns, with a turnover of only \$1,200 USD in 2020.

3.2 Socio-economic attributes

The socio-economic profile of member farmers across selected FPCs reveals considerable diversity, shaped by organizational maturity, resource availability, and regional context. Data from sampled respondents (Table 1) highlight key differences in income, landholding, productivity, and market access across FPCs at different lifecycle stages.

A marked variation in economic status is evident among members of different FPCs. FPC1 reports the highest number of Above Poverty Line (APL) members, with 38 out of 40

respondents, while FPC7 has a predominance of Below Poverty Line (BPL) members (35 respondents), reflecting contrasting socio-economic conditions. These disparities suggest that even within the same lifecycle stage, FPCs can draw members from widely varied economic backgrounds. The annual family income of FPC members further underscores these differences. FPC7 leads with the highest average annual family income at ₹114,330, closely followed by FPC1 and FPC3, each exceeding ₹1.10 lakh. In contrast, FPC2 and FPC8 exhibit lower average incomes, indicating economic constraints. Z-test results confirm significant differences in income levels between FPCs, especially among those in the initial or non-functional stages, highlighting uneven economic prosperity among members.

Agriculture remains the mainstay of farm income. FPC1 and FPC7 report the highest average incomes from agriculture at ₹104,849 and ₹101,580 respectively, suggesting better productivity and access to resources. On the other hand, members of FPC2 and FPC4 earn considerably less, pointing to agronomic or infrastructural challenges. These inter-FPC differences, confirmed by Z-test analysis, reflect the heterogeneity in agricultural potential even within similar lifecycle phases.

Livestock ownership, an important complementary livelihood activity, also varies. Most FPCs have members owning 5 to 11 animals, indicating mixed farming systems. However, FPC8 stands out with relatively lower livestock holdings. Statistically significant differences were observed particularly between the non-functional FPCs (FPC7 and FPC8), suggesting disparities in integrated farming practices. When combining agriculture and livestock incomes, FPC7 emerges with the highest average farming income, reinforcing its relatively strong livelihood base. In contrast, FPC8 again shows the lowest, indicating potential vulnerabilities. Except for FPCs operational for more than six years, Z-tests indicate significant differences in farming incomes among organizations, reflecting diverse economic contexts.

The number of earning members per household is another indicator of household economic resilience. FPC1 and FPC4 report the highest average of three earning members per household, indicating a broader income base. FPC7, however, shows only one earning member on average, suggesting limited sources of income and higher dependency ratios. These differences are statistically significant and underscore the variation in household labour contributions among FPCs. Debt prevalence among members also varies. FPC5 and FPC6, both in operation for over six years, report the highest number of indebted members (22 and 21 respectively), possibly reflecting greater access to formal credit or higher investment levels. In contrast, FPC7 has only eight indebted members, possibly owing to higher earnings reducing borrowing needs. While patterns of indebtedness differ, Z-tests reveal mixed significance across FPCs, with notable variation between FPC7 and FPC8.

Land resources significantly influence productivity. FPC4 members report the largest average cultivable landholding at 3.37 acres, while FPC5 has the lowest at 1.24 acres. Z-test results show significant differences in landholding size, especially between FPC3 and FPC4 and between FPC5 and FPC6, pointing to unequal access to land. Similar patterns are observed in irrigated land. FPC4 again leads with the highest irrigated area, aligning with its higher landholding size, while FPC5 reports the lowest. These disparities reflect unequal access to irrigation, which influence cropping intensity and output.

Production patterns differ seasonally and across FPCs. In the Kharif season, FPC4 records the highest output at 3,031 kg (mainly paddy), benefiting from favourable agro-climatic conditions. Conversely, FPC5, cultivating pulses, produces only 747 kg. Statistically significant differences, especially between FPC5 and FPC6, indicate varied cropping efficiencies. Rabi production shows even sharper contrasts. FPC7 leads with 16,538 kg, primarily due to maize cultivation, while FPC5 lags with only 871 kg (gram). These disparities point to differences in crop selection, resource access, and market orientation. Z-test analysis supports the significance of most inter-FPC differences, barring the comparison between FPC1 and FPC2. Household consumption of produce also varies. FPC6 reports full consumption of its 2,763 kg Kharif produce, suggesting subsistence-oriented farming or larger

Table 1. Socioeconomic attributes of the respondent member farmers of the selected FPCs

Socio-economic attributes	Mean (SD) (n = 40 in each FPC)		Functional for >3–6 years		Functional for >6 years		Non-functional	
	Functional for 1–3 years FPC1	FPC2	FPC3	FPC4	FPC5	FPC6	FPC7	FPC8
1. Economic status								
No. of respondents APL	38	6	9	32	24	16	5	34
No. of respondents BPL	2	34	31	8	16	24	35	6
2. Average annual family income	₹ 112,839 (60,070)	₹ 68,806 (41,178)	₹ 110,488 (90,396)	₹ 101,325 (59,883)	₹ 79,763 (33,037)	₹ 88,879 (44,657)	₹ 114,330 (35,492)	₹ 58,629 (23,712)
Z test statistic	3.563 ^{**}		0.534 ^{NS}		−1.038 ^{NS}		2.580 ^{**}	
3. Average income from agriculture	₹ 104,849 (55,133)	₹ 55,986 (30,236)	₹ 87,199 (70,542)	₹ 54,400 (24,528)	₹ 62,763 (30,880)	₹ 74,017 (33,998)	₹ 101,580 (37,109)	₹ 58,629 (23,536)
Z test statistic	4.915 ^{**}		2.777 ^{**}		−1.550 ^{NS}		1.953 ^{NS}	
4. Respondents with no. of livestock	6 (0.83)	11 (0.83)	6 (0.83)	9 (0.83)	7 (0.83)	5 (0.83)	7 (0.83)	0 (0.33)
Z test statistic	−1.314		−1.458		1.068		2.731 ^{**}	
5. Average income from farming (agriculture + livestock)	₹ 112,099 (63,750)	₹ 68,111 (42,191)	₹ 96,199 (76,656)	₹ 64,200 (30,529)	₹ 70,138 (33,693)	₹ 81,017 (42,290)	₹ 114,330 (35,492)	₹ 58,629 (23,536)
Z test statistic	3.639 ^{**}		2.453 [*]		−1.273 ^{NS}		2.562 ^{**}	
6. Average no. of earning member	3 (1.14)	2 (1.13)	2 (0.95)	3 (1.31)	2 (1.31)	2 (0.99)	1 (0.51)	2 (1.32)
Z test statistic	2.656 ^{**}		−6.133 ^{**}		2.298 [*]		−2.574 ^{**}	
7. Respondents with debts	11 (0.45)	9 (0.42)	16 (0.5)	12 (0.46)	22 (0.5)	21 (0.51)	8 (0.41)	18 (0.5)
Z test statistic	−0.511 ^{NS}		−0.931 ^{NS}		−0.221 ^{NS}		2.446 [*]	
8. Total cultivable land (acre)	2.29 (1.29)	2.89 (2.21)	2.29 (1.73)	3.37 (1.9)	1.24 (0.62)	3.06 (1.56)	2.47 (2.73)	2.66 (1.27)
Z test statistic	−1.480 ^{NS}		−2.666 ^{**}		−6.848 ^{**}		−0.384 ^{NS}	
9. Irrigated land (acre)	2.29 (1.29)	2.89 (2.21)	2.29 (1.73)	3.37 (1.90)	1.24 (0.62)	3.07 (1.55)	2.47 (2.73)	2.66 (1.27)
Z test statistic	−1.480 ^{NS}		−2.666 ^{**}		−6.908 ^{**}		−0.384 ^{NS}	
10. Kharif production (Kg)	1,608 (947) (Paddy)	–	–	3,031 (1,711) (Paddy)	747 (372) (Pulses)	2,763 (1,397) (Paddy)	2,225 (454) (Paddy)	2,390 (1,141) (Paddy)
Z test statistic	–		–		−8.822 ^{**}		−0.384 ^{NS}	

(continued)

Table 1. Continued

Socio-economic attributes	Mean (SD) (<i>n</i> = 40 in each FPC)				Functional for >6 years		Non-functional	
	Functional for 1–3 years FPC1	FPC2	Functional for >3–6 years FPC3	FPC4	FPC5	FPC6	FPC7	FPC8
11. Rabi production (Kg)	2,570 (1,494) (Maize)	1,645 (1,243) (Makhana)	2082 (1,588) (Makhana)	3,650 (1,980) (Wheat)	871 (434) (Gram)	4,912 (2,483) (Maize)	16,538 (1,890) (Maize)	4,248 (2,029) (Potato)
Z test statistic	1.416 ^{NS}		–5.423 ^{**}		–10.138 ^{**}		4.134 ^{**}	
12. Home consumption {Kharif (Kg)}	1,608 (947)	–	–	563 (208)	114 (160)	2,763 (1,397)	2,225 (2,054)	–
Z test statistic	–		–		–11.918 ^{**}		–	
13. Home consumption {Rabi (Kg)}	560 (215)	–	–	510 (165)	193 (173)	–	–	–
Z test statistic	–		–		–		–	
14. Sold through FPC {(Kharif (Kg))}	–	–	–	3,139 (1,674)	678 (258)	–	–	–
Z test statistic	–		–		–		–	
15. Sold through FPC {Rabi (Kg)}	1,081 (1,504)	1,645 (1,243)	2082 (1,588)	2,468 (1,966)	633 (367)	3,920 (1,839)	–	–
Z test statistic	–0.208 ^{NS}		–4.062 ^{**}		–10.931 ^{**}		–	
16. Income from selling through FPC (Rs.)	30,569 (24,478)	56,806 (29,016)	119,215 (107,847)	104,400 (59,597)	70,535 (32,342)	70,562 (33,108)	–	–
Z test statistic	–2.705 ^{**}		0.247 ^{NS}		–0.004 ^{NS}		–	
17. Distance from Mandi (Km)	15.15 (0.66)	18 (0.00)	8 (0.00)	24.58 (2.69)	10 (0.00)	5.93 (0.47)	3 (0.00)	5 (0.00)
Z test statistic	–27.221 ^{**}		–39.00 ^{**}		54.333 ^{**}		–	

Note(s): ^{**}*p* ≤ 0.01 and ^{*}*p* ≤ 0.05, NS: Not significant; I INR (₹) = 83.33 USD (\$)

Source(s): Authors' own work

households. In contrast, FPC4 consumes only 563 kg out of its total production of 1,711 kg. Similarly, for Rabi crops, FPC1 and FPC4 show relatively higher household consumption (560 kg and 510 kg), while FPC5 shows the least (192.5 kg), indicating diverse household consumption needs and market preference.

The volume of produce sold through FPCs offers insight into commercialization levels. FPC4 leads in Kharif crop sales (3,139 kg), while FPC5 lags (678 kg). For Rabi crops, FPC6 excels with 3,920 kg sold, while FPC5 again ranks lowest with 633 kg. These differences suggest varying market integration and post-harvest strategies. Correspondingly, FPC6 generates the highest income from sales (₹70,562), followed by FPC4, while FPC1 earns the least (₹30,569), pointing to differences in price realization and market reach. Statistical analysis confirms significant variations, especially between FPC3 and FPC4 and between FPC5 and FPC6.

Market accessibility is crucial for profitability. The distance to the nearest mandi ranges from 3 km (FPC7) to 24.58 km (FPC4), affecting logistics and market timing. FPC7's proximity enhances market opportunities, while FPC4's greater distance may limit competitiveness and increase transport costs.

The socio-economic attributes of FPC members reveal significant heterogeneity. Participation in FPCs has generally benefited members through improved income from agriculture, enhanced access to inputs, and diversified livelihood strategies. However, addressing disparities in landholding, irrigation access, and marketing infrastructure remains essential for equitable growth among FPCs.

3.3 Comparative effectiveness, dynamics, and sustainability of FPOs/FPCs

The group effectiveness, group dynamics, and sustainability of the FPCs were studied with the help of respective index developed in present research. The effectiveness index encompasses five dimensions; contrasting levels of five dimensions of the FPCs' effectiveness across their growth stages is depicted in Figure 2. It is evident that organizations like FPC6, FPC5, FPC4, and FPC3, have attained relatively high scores (ranging from 60% to 74%), showcasing their ability to efficiently achieve group objectives and goals. FPC6 emerges as a standout performer in this regard, closely followed by FPC5, FPC4 and FPC3. Conversely, FPC8 and FPC7 lag significantly, displaying weaker effectiveness within their groups, as indicated by their notably lower index values.

The group dynamics of FPCs was assessed based on an index comprising of 10 dimensions (Figure 3). In terms of overall level of group dynamics, a similar pattern that of effectiveness is found in FPC6 and FPC5 leading the pack with impressive scores (74%–75%), indicating robust interpersonal relationships, communication channels, and overall cohesion within the groups. The FPCs at their emerging stage (FPC1, FPC2) and intermediate growth stage (FPC3, FPC4) show similar levels of dynamism (68%–70%). However, FPC8 and FPC7 continue to exhibit deficiencies in this aspect, with considerably lower scores suggesting potential challenges in fostering effective group dynamics.

Sustainability, a critical aspect for the long-term viability and success of FPCs was assessed with a developed index comprising of six dimensions (Figure 4) that depict FPC6, FPC5, and FPC3 as top performers (>90% index values), indicating their capacity to maintain operations, adapt to challenges, and thrive over time. On the contrary, FPC8 and FPC7 struggle significantly in this domain, with low sustainability scores.

The comparative analysis of overall effectiveness, dynamics, and sustainability among various FPCs reveals significant variations in their performance (Figure 5). In case of all the functional FPCs, level of sustainability is relatively at a higher level followed by dynamics and effectiveness. Sustainability has been the issue of both non-functional FPCs despite of their existence for a longer period. The variations in group dynamics highlight the importance of fostering positive interpersonal relationships, effective communication, and shared decision-making processes within FPCs. The comparative analysis underscores the diverse

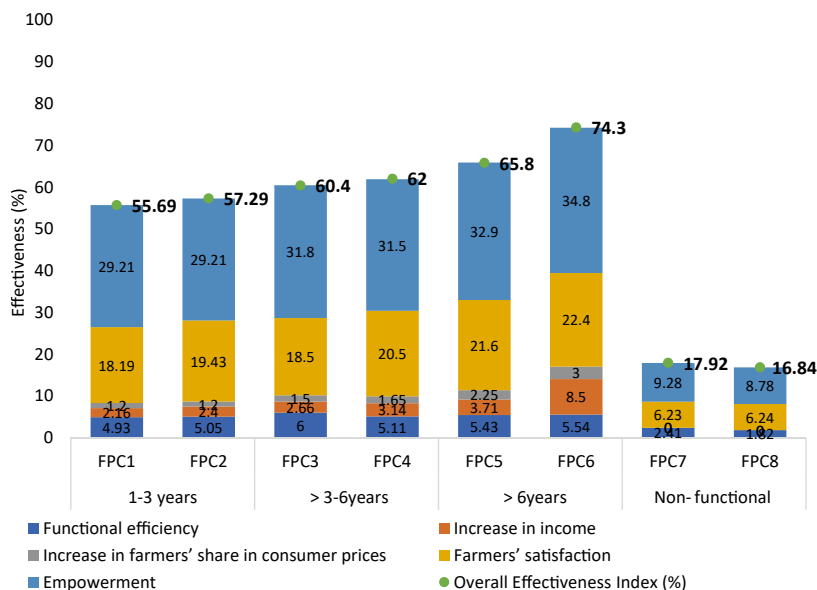


Figure 2. Contrasting dimensions of the FPCs' effectiveness across their growth stage. Source: Authors' own work

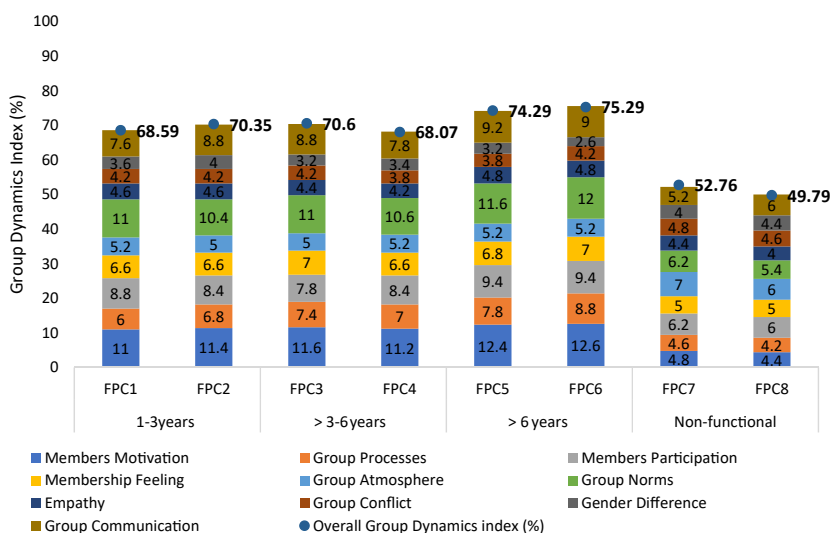


Figure 3. Contrasting dimensions of the FPCs' dynamics across their growth stages. Source: Authors' own work

performance levels among FPCs concerning group effectiveness, dynamics, and sustainability. While longer established FPCs demonstrate strong performance across all three metrics, the non-functional and newly established FPCs face challenges that require targeted interventions and strategies for improvement.

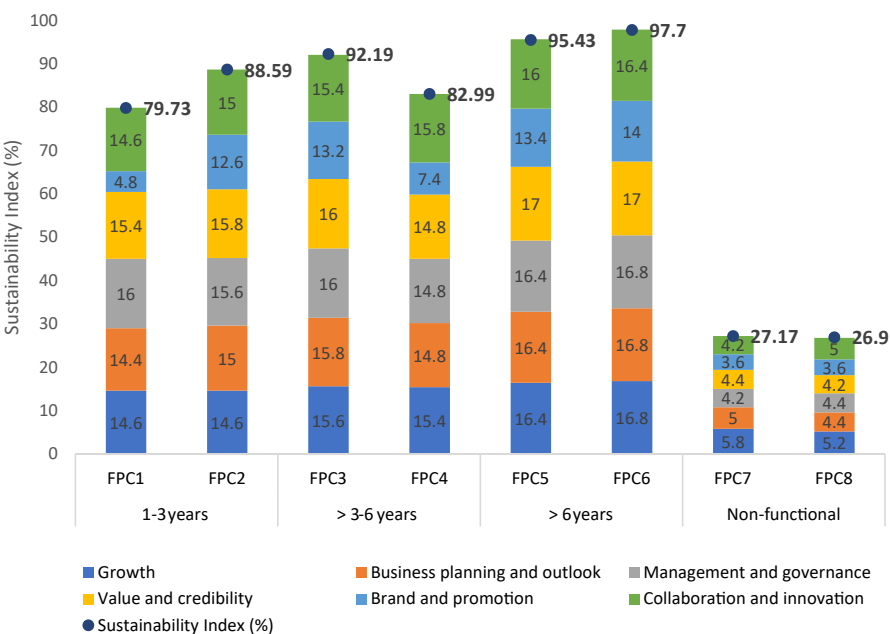


Figure 4. Contrasting dimensions of the FPCs’ sustainability across their growth stages. Source: Authors’ own work

The results of the ANOVA and post hoc analysis (Table 2) reveal significant differences in group effectiveness, group dynamics, and sustainability across the lifecycle stages of FPCs. The ANOVA results indicate highly significant variation between groups for group effectiveness ($F = 3,500.88, p \leq 0.01$), group dynamics ($F = 616.46, p \leq 0.01$), and sustainability ($F = 3,597.46, p \leq 0.01$). Post hoc Tukey HSD tests further show that FPCs in their initial stage (1–3 years) exhibit significantly lower group effectiveness and sustainability compared to more mature FPCs (>3–6 years and >6 years). Significant differences in group dynamics are also evident, particularly between functional and non-functional FPCs. It does not indicate any significant differences between the FPCs with lifecycle up to 6 years. These findings underline the dynamic and evolving nature of FPC performance metrics across different lifecycle stages.

3.4 Success criteria of FPCs

Success of the FPC can be operationally defined as the relative degree of accomplishments and achievements attained by FPC in terms of economic efficiency and social achievements over a period. The success factors for the FPCs are analysed through a set of parameters under the categories of economic indicators, social indicators, market presence and environmental indicators (Tables 3 – 6).

3.4.1 Economic indicators. The assessment of economic indicators related to the provision of benefits to FPC member-farmers reveals notable variations in performance across organizations (Table 3). A comparative analysis of all FPCs highlights distinct strengths and gaps in their operational and support mechanisms. FPC6 stands out as the most successful, achieving a sales volume of 2,232 tonnes and generating Rs. 25 lakhs in revenue—an outcome that reflects a strong market presence and effective marketing strategies. This is reinforced by its high average cost-benefit ratio of 1:2.7, indicating efficient resource use and sound financial

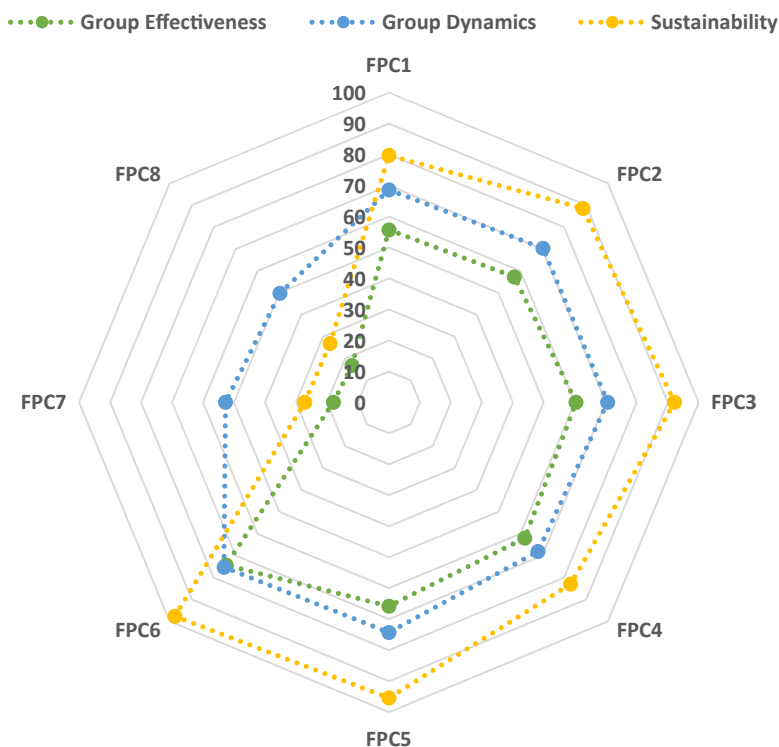


Figure 5. Comparative effectiveness, dynamics and sustainability of FPCs. Source: Authors' own work

practices. FPC5 also shows commendable performance, with 25 tonnes sold for Rs. 15 lakhs, while FPC3 and FPC4 follow closely, reporting sales of 15 and 18 tonnes worth Rs. 12 lakhs and Rs. 10 lakhs respectively. These figures suggest robust market engagement and financial viability.

In contrast, FPC7 and FPC8 report significantly lower sales and minimal capital generation, pointing to possible operational constraints or restricted market access. When evaluating member support, FPC6 again leads by distributing bonuses and providing eight agricultural machines to its members, demonstrating a strong commitment to farmer welfare and productivity. FPC1 and FPC2 offer similar benefits, though to a lesser extent. The lack of such initiatives in FPC7 and FPC8 signals a gap in member support and engagement strategies.

Financial disparities are also evident. FPC6 not only generates the highest working capital (Rs. 12 lakhs) but also holds the largest share capital at Rs. 30 lakhs. Conversely, FPC7 and FPC8 report weak capital bases, highlighting the need for financial strengthening to ensure their sustainability. While some FPCs effectively support their members through incentives and investments, others fall short in delivering essential resources. These differences emphasize the need for context-specific strategies to support FPCs based on their unique challenges and development stages.

3.4.2 Social indicators. The evaluation of social indicators, with a focus on equity and equality within selected FPCs, reveals considerable variation in performance across organizations (Table 4). FPC6 emerges as a clear leader, demonstrating exceptional results in promoting equitable access to resources, ethical conduct, and social cohesion among member-farmers. With an overall score of 4.81 and an impressive social index of 96.25%,

Table 2. ANOVA and Post Hoc test indicating significant differences in group effectiveness, group dynamics and sustainability of the FPCs across their lifecycle stages

ANOVA										
	df	Group effectiveness Sum of squares	Mean square	F value	Group dynamics Sum of squares	Mean square	F value	Sustainability Sum of squares	Mean square	F value
Between groups	3	130729.06	43576.35	3500.881**	40.417	13.472	616.459**	594.957	198.319	3597.459**
Within groups	316	3933.33	12.45		6.906	0.022		17.420	0.055	
Total	319	134662.39			47.323			612.378		

Post Hoc (Tukey HSD)							
(I) FPC lifecycle stage	(J) FPC lifecycle stage	Group effectiveness Mean difference (I–J)	Std. error	Group dynamics Mean difference (I–J)	Std. error	Sustainability Mean difference (I–J)	Std. error
1–3 years	>3–6 years	–4.71762**	0.558	0.02738 ^{NS}	0.023	–0.16925**	0.037
1–3 years	>6 years	–13.59587**	0.558	–0.22287**	0.023	–0.63450**	0.037
1–3 years	Non-functional	39.19162**	0.558	0.72438**	0.023	2.83500**	0.037
>3–6 years	>6 years	–8.87825**	0.558	–0.25025**	0.023	–0.46525**	0.037
>3–6 years	Non-functional	43.90925**	0.558	0.69700**	0.023	3.00425**	0.037
>6 years	Non-functional	52.78750**	0.558	0.94725**	0.023	3.46950**	0.037

Note(s): ** $p \leq 0.01$, NS: Not significant
Source(s): Authors' own work

Table 3. Economic indicators of the selected FPCs

Sl. no.	Particulars	Functional for 1–3 yrs.		Functional for >3–6 yrs.		Functional for >6 yrs.		Non-functional	
		FPC1	FPC2	FPC3	FPC4	FPC5	FPC6	FPC7	FPC8
1	Total sales of produce achieved (in tonnes)	12	8	15	18	25	2,232	–	–
2	Total value of sales (in rupees)	₹6 lakhs	₹4 lakhs	₹12 lakhs	₹10 lakhs	₹15 lakhs	₹25 lakhs	–	–
3	Average cost-benefit ratio attained	1:2.0	1:2.1	1:2.3	1:2.2	1:2.5	1:2.7	1:1.3	1:1.0
4	Bonus distributed to member-farmers (%)	50%	30%	50%	40%	50%	50%	–	–
5	Machines distributed to member-farmers (in terms of number)	2	3	3	5	4	8	–	–
6	Amount of capital generated (credit procured from funding agencies)	₹3.7 lakhs	₹2.5 lakhs	₹5 lakhs	₹3 lakhs	₹8 lakhs	₹12 lakhs	–	–
7	Total share capital	₹5 lakhs	₹8 lakhs	₹10 lakhs	₹12 lakhs	₹15 lakhs	₹30 lakhs	–	–
8	Fund provided for purchasing of machinery/loans for crop/agri -input (pesticide, fertilizers etc.) to member farmer	₹1 lakh	₹2 lakhs	₹5 lakhs	₹3 lakhs	₹6 lakhs	₹7 lakhs	₹50,000	₹30,000

Source(s): Authors' own work

FPC6 sets a benchmark for organizational excellence in fostering inclusive and ethical practices.

Other FPCs show mixed results. FPC5 and FPC3 stand out as strong performers, achieving high scores on several indicators such as social prestige, quality consciousness, and subgroup integration, with social index values of 95% and 92.73%, respectively. FPC4 also records notable achievements, particularly in reducing migration and enhancing quality awareness among farmers. However, despite these strengths, FPC4 slightly trails the top performers with an index of 92.50%.

FPC2 demonstrates consistent efforts in ensuring fairness and equitable access, while FPC1 shows strength in promoting subgroup assimilation and cooperation among members. Nonetheless, their index scores of 83.13% and 81.50% indicate moderate success, suggesting the need for further improvement to match leading FPCs.

At the lower end, FPC7 and FPC8 face significant challenges. Their limited capacity to ensure equitable distribution of resources, uphold ethical standards, and foster collaboration is reflected in their poor performance, with social index scores of just 34.54% and 28.50%, respectively. These figures signal critical gaps that require focused interventions and support mechanisms to enhance their social functioning and organizational effectiveness.

3.4.3 Market presence. Market presence among member farmers reveals interesting insights into the marketing prospects within the selected FPCs (Table 5). A clear disparity in market share is observed, with FPC6 and FPC5 leading at 6% and 4%, respectively, while FPC1 and FPC8 report minimal shares of 0.2% and 0.1%, indicating limited reach and weaker market integration. Quality control practices, particularly FSSAI certification, are widely adopted across most FPCs, except for FPC1 and FPC4, where no such mechanisms are reported.

Table 4. Social indicators of the selected FPCs

Sl. no.	Particulars	Mean (SD)		Functional for 1–3 years		Functional for >3–6 years		Functional for >6 years		Non-functional	
		FPC1	FPC2	FPC3	FPC4	FPC5	FPC6	FPC7	FPC8		
1	Equitable access to organizational assets and resource	4.20 (0.84)	4.33 (0.49)	4.73 (0.47)	4.57 (0.79)	4.75 (0.46)	4.88 (0.35)	1.67 (0.52)	1.80 (0.45)		
2	Ethical, fair, and transparent dealing and transactions	4.20 (0.45)	4.25 (0.45)	4.64 (0.67)	4.71 (0.49)	4.88 (0.35)	5.00 (0)	1.33 (0.52)	1.00 (0)		
3	Duration of migration reduces for local people	3.80 (0.84)	4.17 (0.58)	4.64 (0.50)	4.43 (0.79)	4.75 (0.46)	4.75 (0.46)	2.83 (0.75)	2.00 (1)		
4	Social prestige earned among member-farmer	4.00 (0.71)	3.92 (0.51)	4.64 (0.50)	4.86 (0.38)	4.75 (0.46)	4.88 (0.35)	1.00 (0.00)	1.20 (0.45)		
5	Quality conscious enhanced among farmer	4.20 (0.45)	4.08 (0.29)	4.45 (0.69)	4.71 (0.49)	4.75 (0.46)	4.75 (0.46)	2.17 (0.75)	1.20 (0.45)		
6	Social capital (mutual trust, faith, agreed-upon-norms) built	3.80 (0.84)	4.08 (0.51)	4.73 (0.47)	4.43 (0.79)	4.88 (0.35)	4.75 (0.46)	1.17 (0.41)	1.40 (0.55)		
7	Assimilation among different sub group increased	4.40 (0.55)	4.08 (0.51)	4.64 (0.50)	4.57 (0.53)	4.38 (0.74)	4.63 (0.74)	1.67 (0.52)	1.40 (0.55)		
8	Cooperation among member- farmer increased	4.00 (0.71)	4.33 (0.49)	4.64 (0.50)	4.71 (0.49)	4.88 (0.35)	4.88 (0.35)	2.00 (0.89)	1.40 (0.55)		
Overall score		4.09 (0.65)	4.16 (0.48)	4.61 (0.57)	4.63 (0.59)	4.80 (0.45)	4.81 (0.40)	1.73 (0.54)	1.43 (0.50)		
Social index (%)		81.50	83.13	92.73	92.50	95.00	96.25	34.58	28.50		
Source(s): Authors’ own work											

Brand recognition plays a key role in enhancing market visibility. All FPCs except FPC1, FPC7, and FPC8 have achieved some level of branding through logos, trademarks, or distinct brand identities. Similarly, efforts to streamline the value chain by reducing middlemen have been largely successful in most FPCs. However, FPC1, FPC7, and FPC8 continue to rely on at least one intermediary, potentially affecting profit margins and efficiency.

Advertising investment further distinguishes the market strategies of the FPCs. FPC6 leads with an expenditure of Rs. 2 lakhs, followed by FPC5 at Rs. 80,000, reflecting proactive promotion and outreach efforts. In contrast, FPC2 invests the least at Rs. 15,000. Transport access is another critical factor, with most FPCs equipped with transport facilities, whereas FPC1, FPC7, and FPC8 lack such infrastructure, likely constraining their distribution capacity.

Market exploration also varies significantly. FPC6 and FPC5 have expanded their reach to national and even international markets, demonstrating ambitious growth strategies. In comparison, FPC1 remains confined to district-level operations. Product differentiation is evident among most FPCs, enhancing their competitiveness, but FPC1 and FPC7 report limited product distinctiveness.

3.4.4 Environmental indicators. The comparison of FPCs based on environmental perception scores reveals significant variation in sustainability practices among member farmers (Table 6). FPC6 leads with strong adoption of climate-smart agriculture, efficient water use, and institutional support, reflected in its top index score of 72.50%. FPC5 follows with 66.25%, showing notable efforts in water-efficient and eco-friendly practices. FPC3 and

Table 5. Market presence of the selected FPCs

Sl. no.	Particulars	Functional for 1–3 years		Functional for >3–6 years		Functional for >6 years		Non-functional	
		FPC1	FPC2	FPC3	FPC4	FPC5	FPC6	FPC7	FPC8
1	Market share of products	0.2%	0.3%	0.5%	0.4%	4%	6%	0.1%	0.1%
2	Quality control mechanisms adopted from AGMARK certificate, FSSAI, ISO, BSI, etc.	–	FSSAI	FSSAI	–	FSSAI	FSSAI	–	–
3	Existence pf logo/trade mark/brand image or patent	No	Yes	Yes	Yes	Yes	Yes	–	–
4	Number of middle men in value chain	1	0	0	0	0	0	1	2
5	Money spent on advertising (in INR during last year)	₹60,000	₹15,000	₹40,000	₹35,000	₹80,000	₹200,000	–	–
6	Availability of transport facilities	No	Yes	Yes	Yes	Yes	Yes	No	No
7	Type of markets are explored (village/local/district/state level/national/international)	District	State and National market	State and National market	State	State and National market	National and International	State	Village
8	Product having any significant differentiation in market	No	Yes	Yes	Yes	Yes	Yes	No	No

Source(s): Authors' own work

Table 6. Environmental indicators of the selected FPCs

Sl. no.	Statements	Mean (SD)		Functional for		Functional for		Non-functional	
		Functional for 1–3 yrs. FPC1	FPC2	Functional for >3–5 yrs. FPC3	FPC4	Functional for >5 yrs. FPC5	FPC6	FPC7	FPC8
1	Following environment friendly package and practices	4.20 (0.45)	4.42 (0.51)	4.73 (0.47)	3.71 (1.25)	4.63 (0.52)	4.38 (0.74)	1.33 (0.52)	1.80 (0.45)
2	Adopting practices to conserve water	1.40 (0.55)	3.25 (0.97)	4.45 (0.52)	2.43 (1.27)	2.38 (0.74)	4.38 (0.74)	1.50 (0.55)	1.40 (0.55)
3	Soil conservation practices/conservation agriculture followed	1.20 (0.45)	1.83 (0.39)	2.82 (1.17)	4.14 (0.38)	4.38 (0.74)	4.63 (0.52)	2.17 (0.75)	1.20 (0.45)
4	Encouraging use of organic fertilizers and manures	4.20 (0.84)	4.25 (0.45)	4.00 (0.63)	4.29 (0.49)	4.13 (0.99)	4.25 (0.71)	3.67 (0.52)	1.80 (0.84)
5	Following integrated nutrient management (INM)	2.00 (0.00)	1.58 (0.51)	1.55 (0.52)	2.00 (0.58)	2.25 (0.71)	1.75 (0.46)	1.17 (0.41)	1.40 (0.55)
6	Following integrated pest management practices (IPM)	1.60 (0.55)	1.50 (0.52)	1.64 (0.50)	1.14 (0.38)	1.75 (0.71)	1.88 (0.35)	1.67 (0.52)	1.80 (0.45)
7	Promoting practices aiming more crop per drop of water (like SRI, relay cropping, crop diversification, etc.)	4.40 (0.55)	4.25 (0.45)	1.64 (1.21)	1.14 (0.38)	4.88 (0.35)	4.88 (0.35)	1.83 (0.41)	1.80 (0.45)
8	Following climate-smart agriculture technologies (drought/flood tolerant varieties, etc)	4.60 (0.55)	1.08 (0.29)	3.18 (1.40)	4.29 (0.49)	3.88 (0.64)	4.63 (0.52)	5.00 (0.00)	1.00 (0.00)
9	Providing institutional mechanisms for climate-resilient agriculture (like village level climate advisories, seed bank, fodder bank, community nursery, custom hiring centre, etc)	1.60 (0.55)	4.33 (0.49)	4.55 (0.52)	4.43 (0.53)	4.38 (0.52)	4.75 (0.46)	1.17 (0.41)	1.20 (0.45)
10	Following natural farming	1.20 (0.45)	1.17 (0.39)	1.27 (0.47)	1.14 (0.38)	2.00 (0.53)	2.13 (1.36)	1.67 (0.52)	1.60 (0.55)
11	Use of energy renewal technology (renewal source of energy) like solar pump, etc.	1.20 (0.45)	1.50 (0.52)	1.45 (0.52)	1.86 (0.38)	1.75 (0.46)	1.50 (0.53)	1.17 (0.41)	1.40 (0.55)
12	Soil health management	1.40 (0.55)	1.17 (0.39)	1.55 (0.52)	1.71 (0.76)	3.38 (0.92)	4.38 (0.52)	1.83 (0.41)	1.60 (0.55)
Overall score		2.51 (0.49)	2.53 (0.49)	2.73 (0.70)	2.69 (0.60)	3.31 (0.65)	3.63 (0.61)	2.01 (0.45)	1.50 (0.48)
Environmental index (%)		48.33	50.56	54.70	53.81	66.25	72.50	40.28	30.00
Source(s): Authors' own work									

FPC4 perform moderately well, focusing on soil and water conservation and organic inputs, with index scores of 54.70% and 53.81%, respectively.

FPC2 and FPC1 show average environmental engagement, scoring 50.56% and 48.33%, while FPC7 and FPC8 lag significantly at 40.28% and 30%, indicating minimal adoption of

sustainable practices. Overall, longer-established FPCs display stronger environmental commitment, while others require targeted support to improve. These findings highlight the need for continuous monitoring and tailored interventions to strengthen environmental sustainability across all FPCs.

The ANOVA results reveal statistically significant differences ($p \leq 0.01$) across FPC lifecycle stages for all four dimensions: economic, social, market presence, and environmental indicators (Table 7). Post-hoc Tukey HSD tests show that FPCs functioning for more than 6 years significantly outperform younger and non-functional FPCs, particularly in social and environmental indicators. Notably, non-functional FPCs consistently lag behind across all dimensions, underscoring the critical role of sustained operational maturity in performance outcomes.

4. Discussion

The rapid expansion of FPCs in India during past five years (TCI, 2024) reflects a policy-driven effort rather than grassroots evolution, resulting in a high degree of dependency on promoting agencies (Roy *et al.*, 2020). This dependency questions their long-term sustainability and success once external support phases out (Markelova *et al.*, 2009). The present study of eight FPCs at various lifecycle stages in the eastern Indian state of Bihar reveals the variations in performances reflecting disparities in internal governance quality, leadership capacity, and access to external institutional support. For instance, the superior performance of long-established FPCs (FPC 6 and FPC 5) as well as FPC3, despite its intermediate age, can be attributed to participatory decision-making, consistent leadership, and alignment with market opportunities. In contrast, older FPCs (like FPC7 and FPC8) sometimes become non-functional due to leadership turnover, weak planning mechanisms, or lack of support. These dynamics are consistent with the argument that internal institutional capability—rather than lifecycle stage—is a key determinant of performance (Singh, 2023; Nikam *et al.*, 2023; Pant *et al.*, 2024). A better success across economic, social, environmental, and market indicators are not guaranteed by duration alone but are closely linked to their ability to build strong organizational structures, strategic market linkages, and member trust (Chamola *et al.*, 2022). The broader evidence underscores that successful farmer organizations, whether in Asia, Africa, or Latin America, share common characteristics: strategic leadership, participatory governance, robust support systems, and adaptive business models. The lack of formal extension support and reliance on informal communication networks have restricted the flow of innovation, a pattern also reported in sub-Saharan Africa, where weak institutional linkages have constrained producer organizations' capacity to scale (Hellin *et al.*, 2009). In contrast, FPCs with robust internal communication, trust, and transparency have fostered higher group cohesion and innovation uptake. The Indian FPC experience aligns with this global trajectory. Case studies like Mahagrapes in Maharashtra demonstrate how investments in infrastructure, export market access, and member training can dramatically improve collective performance (Nikam *et al.*, 2023). Similarly, Gorai *et al.* (2022) found that high-performing FPOs in West Bengal achieved better outcomes through cohesive internal environments and trust-based leadership.

Differences in group effectiveness of the FPCs are strongly linked to group dynamics and members' behaviour. The study highlights that farmer satisfaction, attitude, and experience with the FPC shape group cohesion and functionality—corroborating findings from Latin America and Africa where member engagement and leadership consistency were key to producer organizations' resilience (Bingen *et al.*, 2003). Effective communication and inclusive practices foster trust and commitment, enabling better conflict resolution and strategic decision-making (Michailova and Sidorova, 2010). Empowerment and satisfaction indicators further reveal significant disparities. Functional FPCs, particularly those with over six years of operation, demonstrate high member empowerment (>80%), signalling success in fostering ownership and collective agency. These findings echo empirical evidence from

Table 7. ANOVA and Post Hoc test indicating significant differences in success indicators of the FPCs across their lifecycle stages

ANOVA													
		Economic indicators			Social indicators			Market presence			Environmental indicators		
	df	Sum of squares	Mean square	F value	Sum of squares	Mean square	F value	Sum of squares	Mean square	F value	Sum of squares	Mean square	F value
Between groups	3	24344.049	8114.683	32.62**	32471.198	10823.733	596.09**	33188.217	11062.74	68.47**	7754.77	2584.92	126.53**
Within groups	316	13932.968	248.803		1035.002	18.158		9047.407	161.661		1164.498	20.430	
Total	319	38277.017			33506.201						8919.266		

Post Hoc (Tukey HSD)									
(I) FPC lifecycle stage	(J) FPC lifecycle stage	Economic indicators Mean difference (I–J)	Std. error	Social indicators Mean difference (I–J)	Std. error	Market presence Mean difference (I–J)	Std. error	Environmental indicators Mean difference (I–J)	Std. error
1–3 years	>3–6 years	–5.46133*	1.252	–9.68750**	1.31853	–17.85952*	7.836	–4.33**	1.158
1–3 years	>6 years	–32.57533*	8.065	–12.65000**	1.55812	–18.21667*	8.039	–19.33**	1.570
1–3 years	Non functional	24.09467*	0.912	51.15795**	1.69427	39.55714*	10.605	14.40**	1.934
>3–6 years	>6 years	–27.11400*	8.094	–2.96250 ^{NS}	1.50508	–0.35714	1.000	–15.03**	1.616
>3–6 years	Non-functional	–29.55600*	1.140	60.25025**	1.65463	57.77381*	5.432	18.73**	1.969
>6 years	Non-functional	56.67000*	8.048	63.80795**	1.84318	–57.77381*	5.432	33.76**	2.237

Note(s): ** $p \leq 0.01$, * $p \leq 0.05$, NS: Not significant

Source(s): Authors’ own work

South Asia and Latin America where producer organizations have led to improvements in economic and political empowerment, especially for women and marginalized communities (Manfre and Nordehn, 2013). The relationship between organizational maturity, diversification, and effectiveness becomes evident when mapping performance across FPCs in the present study, which reinforces the argument that maturity must be complemented by adaptability and learning systems to deliver impact (dos Santos *et al.*, 2020; Stockbridge *et al.*, 2003).

A key insight from this study is that members' perceptions of sustainability are driven not by duration of operation but by functional indicators—growth, governance, innovation, branding, and collaboration. FPCs with strong governance structures, member-centric planning, and market-oriented strategies exhibit higher perceived sustainability. These findings validate the resource-based view (Barney, 2018), which posits that internal organizational capabilities serve as the foundation for sustained competitive advantage. Similarly, the emphasis on functional efficiency aligns with classical and contemporary management theories emphasizing workflow optimization and participatory governance (Taylor, 1911; Silva *et al.*, 2024).

Regional institutional environments also play a critical role. While internal processes are vital, access to infrastructure, finance, policy incentives, and post-incubation support strongly influence FPC development. Case studies from Brazil and Kenya indicate that policy coherence and targeted technical assistance contribute significantly to the stability of farmer organizations (dos Santos *et al.*, 2020; Fischer and Qaim, 2012). The absence of such support beyond initial period (3–5 years) exacerbates the fragility of FPCs as evident in present study. Crop diversity and market orientation are other differentiating factors. FPCs dealing in high-value perishables (e.g., vegetables or pulses) tend to perform better due to higher margins and lower market saturation, as observed globally (Abraham *et al.*, 2022). Conversely, cereal-focused FPCs face limited value addition and weaker price realization. This distinction has implications for strategic business planning and value-chain integration. Comparative experiences reinforce these conclusions. In Bangladesh, successful dairy cooperatives relied on fair market access and continuous technical assistance (Sultana *et al.*, 2020). In Brazil and Thailand, farmers' education, experience, and access to infrastructure determined cooperative performance (Sathapatyanon *et al.*, 2018; Jitmun *et al.*, 2020; dos Santos *et al.*, 2020). These lessons are directly relevant for the Indian context, where building sustainability of the FPCs depends on integrating technical, financial, and organizational interventions (Pant *et al.*, 2024). Long-term sustainability hinges on balancing internal cohesion with external linkages—underscoring the need for ecosystem-level reforms that extend beyond promotional support.

5. Conclusions and policy recommendations

The findings of present study reveal significant heterogeneity in organizational effectiveness, group dynamics, and sustainability, shaped not merely by years of operation but by internal governance, leadership quality, market orientation, and institutional support. Mature FPCs have demonstrated high performance across economic, social, environmental, and market indicators, underpinned by diversified operations, strategic partnerships, and robust internal systems. In contrast, newly formed or non-functional FPCs faced constraints such as weak market integration, limited product diversification, and poor group dynamics. While early-stage FPCs show promising institutional engagement, they lack the scale and operational depth to deliver significant economic gains. The study underscores that FPC's sustainability hinges on effective member participation, consistent leadership, strong organizational capacity, and the ability to evolve into market-responsive institutions. Furthermore, the association between empowerment, satisfaction, and performance highlights the importance of inclusive governance and member-centric planning. The comparative analysis also emphasizes that functional FPCs perform best when aligned with favourable regional

ecosystems, technical partnerships, and diversification strategies. These insights offer critical implications for both policy and practice, signalling the need to transition from a promotion-centric to a systems-strengthening approach.

The study highlights the need for a policy shift from short-term FPC promotion to sustained, ecosystem-based support. Early-stage FPCs require targeted technical assistance, business planning support, and governance training, which can be institutionalized through grassroots-level incubation hubs led by FPCs promoting agencies. Incentives for product diversification and value addition, including grants and credit support, should be linked to performance benchmarks to help FPCs scale. Marketing infrastructure, branding support, and access to e-marketing platforms must be expanded to enhance market integration. Post-incubation support through periodic performance audits, leadership development, and financial diagnostics should be standardized. Integrating environmental sustainability—such as promoting water-efficient practices and organic inputs—into FPC business strategies will further strengthen their resilience and contribution to national development goals.

6. Limitations of the study and scope for future research

This study is based on a cross-sectional design and limited to eight FPCs, which may constrain the generalizability of findings. The temporal and regional scope limits the ability to capture seasonal dynamics, evolving governance practices, or emerging market shifts. Additionally, the absence of longitudinal data restricts causal inference on sustainability trajectories over time.

Building on the cross-sectional findings of this study, future research should adopt longitudinal approaches to track FPC trajectories over time, enabling a deeper understanding of how institutional dynamics, market environments, and governance evolve across different lifecycle stages. Comparative research across diverse agro-ecological zones can reveal contextual drivers of FPC success. There is also a need to examine the role of digital tools in improving governance, member engagement, and market access. Research on inclusion—particularly the participation of women and marginalized farmers—will help assess the equity outcomes of FPCs. Finally, studies on FPCs' capacity to support climate adaptation and participate in sustainable value chains, including carbon and green certification markets, can inform their role in promoting environmentally resilient farming systems.

Author contributions

Conceptualization: [Shreya Anand]; Methodology: [Souvik Ghosh, Shreya Anand]; Formal analysis and investigation: [Souvik Ghosh and Shreya Anand]; Writing – original draft preparation: [Shreya Anand]; Writing – review and editing: [Souvik Ghosh].

All authors have commented on previous versions of the first draft of manuscript and thoroughly revised it. All authors read and approved the final manuscript.

Informed consent

All the farmers gave a formal verbal consent while sharing data during the course of data collection.

Data availability

The data will be made available on request.

Financial interests

The authors declare they have no financial interests.

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