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Institutional efficiency and sustainability determinants of farmer producer organizations: A causal-comparative analysis across agro-ecological zones of Madhya Pradesh

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Abstract

Aims: To comprehensively assess organizational performance, financial sustainability, and operational efficiency of Farmer Producer Organizations (FPOs) across diverse agro-ecological zones, while identifying and prioritizing systemic constraints that impede their long-term viability and member value creation.

Study Design: A causal-comparative research design using a mixed-method approach was adopted, combining both quantitative and qualitative tools. Data were collected through a multi-stage sampling process covering different agro-ecological zones to capture regional diversity and context.

Place and Duration of Study: The research was conducted across four agro-ecological zones of Madhya Pradesh: (1) Kymore Plateau and Satpura Hills (Zone 10), (2) Central Narmada Valley (Zone 9), (3) Vindhyan Plateau (Zone 11), and (4) Malwa Plateau (Zone 6), spanning from mid-decade period before 2024.

Methodology: A multi-stage stratified sampling approach selected 24 FPOs (6 from each agro-ecological zone) representing diverse commodities and operational maturity levels. From these FPOs, 480-member farmers (20 per FPO) and 72 board members/managers (3 per FPO) were surveyed. Advanced analytical tools including financial ratio analysis, Garrett's ranking technique, chi-square test, Pearson's correlation analysis, and binary logistic regression were employed for comprehensive assessment.

Results: Analysis revealed significant inter-zonal and intra-zonal performance variations. Only 37.5% (n=9) of FPOs achieved financial sustainability, with net profit margins ranging from -3.8% to +11.2%. Financial ratio analysis showed healthy performers maintained current ratios >1.8, ROE >12%, and asset turnover >2.4. Garrett's ranking identified inadequate working capital as the primary constraint (mean score: 75.34), followed by weak market linkages (mean score: 71.23) and governance challenges (mean score: 68.47). Binary logistic regression revealed professional management (OR=9.23, p<0.01), share capital adequacy (OR=1.89, p<0.05), and market linkage strength (OR=2.14, p<0.01) as strongest predictors of sustainability. Chi-square analysis demonstrated significant associations between board education level and business turnover ($\chi^2=24.56$, p<0.001), and between professional management and financial performance ($\chi^2=19.87$, p<0.001). Correlation analysis revealed strong positive relationships between member participation rate and profitability (r=0.684, p<0.01), and between operational maturity and sustainability indicators (r=0.562, p<0.01). Zone-wise analysis showed Malwa Plateau FPOs performed better (50% sustainability rate) compared to Vindhyan Plateau FPOs (25% sustainability rate), attributed to better infrastructure and market access.

Conclusion: The study establishes that FPO sustainability across agro-ecological zones is contingent upon professional management, adequate capitalization, robust governance structures, and strategic market integration. Systemic constraints particularly working capital inadequacy, market access limitations, and governance deficits significantly impede performance irrespective of agro-climatic conditions. However, zone-specific factors including infrastructure availability, market proximity, and institutional support create differential success probabilities, necessitating contextualized intervention strategies for FPO viability enhancement.

Sustainable Development Goals (SDGs) discussed in study: SDG 5 (Gender Equality): 23% of FPO board positions held by women (vs. <10% in traditional cooperatives), SDG 8 (Decent Work): Formalized agricultural employment, fair prices, SDG 10 (Reduced Inequality): collective empowerment & SDG 17 (Partnerships): Multi-stakeholder collaboration model.

Keywords: Farmer producer organizations, financial sustainability, operational efficiency, agro-ecological zones, constraint analysis, governance, working capital & Madhya Pradesh

1. Introduction

1.1 Background and Context

Farmer Producer Organizations (FPOs) have emerged as a

critical institutional innovation to address the structural challenges confronting India's smallholder agriculture sector. With over 86% of Indian farmers operating

landholdings below 2 hectares, individual producers face severe disadvantages including limited bargaining power, high transaction costs, inadequate access to institutional credit, and exploitation by intermediaries (Trebbin & Hassler, 2012) ^[15]. FPOs, structured as farmer-owned collectives registered entity, aim to overcome these constraints through aggregation, collective marketing, and economies of scale.

The Government of India's ambitious FPO Promotion Scheme (2020) targeting formation of 10,000 FPOs with ₹6,865 crore allocation reflects policy recognition of collectivization as a pathway to doubling farmer incomes. However, empirical evidence on FPO performance remains fragmented, with studies documenting both remarkable successes (Neti, 2015; Singh *et al.*, 2021) ^[8, 14] and high failure rates (Dutta *et al.*, 2019; Mondal *et al.*, 2017) ^[2, 6].

Madhya Pradesh, India's second-largest state by area with diverse agro-ecological zones and predominantly smallholder agriculture (average landholding: 1.9 ha), presents an ideal context for examining FPO effectiveness across varied agro-climatic conditions. The state's agricultural landscape encompasses the fertile Malwa Plateau, the rugged Vindhyan Plateau, the Narmada valley region, and the tribal-dominated Kymore-Satpura hills each characterized by distinct cropping patterns, infrastructure availability, and market integration levels.

1.2 Research Gap and Rationale

Previous FPO research has predominantly focused on single districts or homogeneous agro-climatic contexts, limiting understanding of how environmental, infrastructural, and market variations influence organizational performance. Moreover, systematic constraint prioritization using robust analytical frameworks remains sparse, as does quantitative modeling of sustainability determinants across diverse contexts.

This study addresses these gaps through multi-zonal comparative analysis employing advanced statistical techniques to establish generalized principles while accounting for contextual variations.

1.3 Research Objectives

The specific objectives of this research are:

1. To analyze organizational characteristics, governance structures, and financial performance of FPOs across four agro-ecological zones of Madhya Pradesh using comprehensive financial ratio analysis ^[1]
2. To identify, quantify, and prioritize operational constraints faced by FPOs using Garrett's ranking technique and constraint severity indexing
3. To establish statistical relationships between FPO

¹In several cases, complete or verified financial records were not available; therefore, financial indicators and ratios have been derived from self-reported data and discussions with key stakeholders. While every effort has been made to ensure accuracy and consistency through cross-verification and logical checks, the findings should be interpreted as indicative rather than audited representations of FPO financial performance.

characteristics and sustainability indicators through chi-square analysis, correlation analysis, and binary logistic regression modeling

1.4 Significance of the Study

This research contributes to FPO by

- Providing cross-zonal comparative evidence on performance variations
- Employing robust constraint prioritization methodology (Garrett's ranking)
- Developing predictive sustainability models with high classification accuracy
- Offering zone-specific insights for targeted policy interventions
- Establishing benchmarks for FPO performance assessment

1.5 Research Gaps

Despite growing literature, several gaps persist:

1. Limited multi-zone comparative studies accounting for agro-ecological variations
2. Inadequate quantitative constraint prioritization using systematic ranking techniques
3. Sparse predictive modeling of sustainability determinants
4. Insufficient financial performance analysis using standard ratio frameworks
5. Limited understanding of zone-specific success factors

This study addresses these gaps through comprehensive multi-zonal analysis

2. Research Methodology

2.1 Study Area and Agro-Ecological Context

Study Location: Four agro-ecological zones of Madhya Pradesh selected to represent diverse agricultural systems:

Zone 1: Kymore Plateau and Satpura Hills (AEZ 10)

- **Districts:** Jabalpur, Mandla, Seoni
- **Characteristics:** Medium to deep black soils, 1200-1400mm rainfall, predominantly rainfed
- **Major crops:** Rice, wheat, pulses, minor millets
- **Infrastructure:** Moderate, improving road connectivity
- **Market access:** District-level markets, limited processor presence

Zone 2: Central Narmada Valley (AEZ 9)

- **Districts:** Hoshangabad, Narsinghpur, Harda
- **Characteristics:** Alluvial soils, 1000-1200mm rainfall, mixed irrigation
- **Major crops:** Wheat, soybean, vegetables
- **Infrastructure:** Good road networks, proximity to urban centers
- **Market access:** Well-developed mandis, processor linkages

Zone 3: Vindhyan Plateau (AEZ 11)

- **Districts:** Rewa, Satna, Sidhi
- **Characteristics:** Red and black soils, 1000-1300mm rainfall, predominantly rainfed
- **Major crops:** Wheat, pulses, oilseeds
- **Infrastructure:** Poor connectivity, remote villages

- **Market access:** Limited, exploitative intermediaries

Zone 4: Malwa Plateau (AEZ 6)

- **Districts:** Indore, Ujjain, Dewas
- **Characteristics:** Deep black cotton soils, 800-1000mm rainfall, good irrigation
- **Major crops:** Wheat, soybean, vegetables, cotton
- **Infrastructure:** Excellent roads, proximity to major cities
- **Market access:** Strong processor presence, organized retail linkages

2.2 Sampling Design

A multi-stage stratified sampling approach was adopted to ensure representation across diverse agro-ecological and socio-economic contexts. In the first stage, four agro-ecological zones were purposively selected to capture variations in agro-climatic conditions, infrastructure, cropping systems, and development levels. The second stage involved selecting two districts from each zone, totaling eight districts. In the third stage, all registered FPOs in these districts were identified using NABARD, SFAC, and state agriculture databases, yielding 112 FPOs. In the fourth stage, 24 FPOs (six per zone) were purposively chosen to ensure diversity in commodities, operational maturity, and registration type.

Finally, respondents included three key informants (CEO/Manager, Board Chairman, and one Board Member) and twenty member farmers per FPO, resulting in a total of 24 FPOs, 72 board representatives, and 480 member farmers. The sample size was good enough against the

minimum requirement of 384 (as per Cochran's formula at 95% confidence and 5% error margin), ensured robust and reliable subgroup analysis.

2.3 Data Collection

This study was conducted during the mid-decade period before 2024. Primary data were collected through personal interactions with FPO stakeholders, including board members, managers, and member farmers. Although structured questionnaires were initially prepared to capture organizational, governance, and financial details, many FPO members were hesitant to respond to formal survey instruments. To overcome this challenge and minimize response bias, we adopted an interactive and conversational approach. Information was extracted through informal discussions, storytelling, and participatory interactions during field visits, which encouraged more open and genuine responses.

Secondary data included FPO financial statements, registration documents, board minutes, annual reports, district agricultural statistics, and NABARD scheme records. Data quality was ensured through pre-testing in two non-sampled FPOs.

2.4 Analytical Framework

We used R & Microsoft Excel programme for statistical computing and data visualizations such as ranking, index construction, chi-square tests (Pkg- stats, gmodels), correlation analysis, and logistic regression efficiently and reproducibly (Pkg-ResourceSelection, pROC, car, caret) etc.

Table 1: Analytical description

S.No.	Major head	Interpretation/Remark
01	Financial Ratio Analysis (Liquidity Ratios: Profitability Ratios: Efficiency Ratios:Solvency Ratios)	Performance Classification: • High Performers: NPM >7%, ROE >12%, Current Ratio >1.8 • Medium Performers: NPM 3-7%, ROE 6-12%, Current Ratio 1.2-1.8 • Low Performers: NPM <3%, ROE <6%, Current Ratio <1.2 (NPM stands for Net Profit Margin)
02	Garrett's Ranking Technique	Procedure: 1. Respondents rank constraints by severity (1=most severe) 2. Calculate percent position for each rank 3. Convert to Garrett score using standard table 4. Calculate mean Garrett score for each constraint 5. Rank constraints by mean score (higher score = more severe)
03	Constraint Severity Index (CSI)	Interpretation: • CSI >80: Very High Severity • CSI 70-80: High Severity • CSI 60-70: Moderate Severity • CSI <60: Low Severity
04	Chi-Square Test of Independence	Application: Test associations between categorical variables (e.g., professional management × sustainability status) Significance Level: $\alpha = 0.05$
05	Pearson's Correlation Analysis	Interpretation: • $r > 0.7$: Strong positive correlation • $0.4 < r < 0.7$: Moderate positive correlation • $0.1 < r < 0.4$: Weak positive correlation Significance: Two-tailed test at $\alpha = 0.05$ and $\alpha = 0.01$
07	Binary Logistic Regression	Sustainability Criteria (Composite Index): • Financial self-sufficiency (revenue covers operational costs) • Positive net worth • Operational continuity (>3 years) • Member retention rate (>70%) Dependent Variable: FPO Sustainability (1 = Sustainable, 0 = Not). Independent Variables: Share capital, board education, management, participation, years, market linkage, and zone.

		Diagnostics: Hosmer-Lemeshow test, ROC-AUC, classification accuracy, VIF. where, FPO Sustainability: Composite index based on four criteria: (1) Operational breakeven, (2) Positive net worth, (3) Continuity >3 years, (4) Member retention >70%. FPO classified as sustainable if meeting ≥3 criteria. Professional Management: Full-time qualified CEO/Manager with formal business/agricultural education managing day-to-day operations, distinct from board governance. Market Linkage Strength: Score (0-10) based on: number of institutional buyers, contract farming arrangements, value addition infrastructure, direct market channels. Board Education Index: Score (0-10) calculated as weighted average of board members' education levels (Illiterate=0, Primary=2, Middle=4, Secondary=6, Graduate+=10). Member Participation Rate: Percentage of registered members who transacted (bought inputs or sold produce) with FPO during last financial year.
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3. Results

3.1 Organizational Profile of FPOs Across Zones

Table 2: Distribution of FPOs by organizational characteristics (n=24)

Characteristic	Category	Kymore-Satpura (n=6)	Narmada Valley (n=6)	Vindhyan Plateau (n=6)	Malwa Plateau (n=6)	Overall (n=24)
Years of Operation	< 2 years	2 (33.3%)	2 (33.3%)	2 (33.3%)	2 (33.3%)	8 (33.3%)
	3-5 years	2 (33.3%)	2 (33.3%)	2 (33.3%)	2 (33.3%)	8 (33.3%)
	> 5 years	2 (33.3%)	2 (33.3%)	2 (33.3%)	2 (33.3%)	8 (33.3%)
	Mean ± SD	3.6±2.1	4.1±2.3	3.8±1.9	4.3±2.2	3.9±2.1
Member Size	150-300	3 (50.0%)	2 (33.3%)	4 (66.7%)	1 (16.7%)	10 (41.7%)
	301-500	2 (33.3%)	3 (50.0%)	1 (16.7%)	3 (50.0%)	9 (37.5%)
	501-850	1 (16.7%)	1 (16.7%)	1 (16.7%)	2 (33.3%)	5 (20.8%)
	Mean ± SD	342±156	398±167	312±134	486±198	385±176
Share Capital	< ₹10 lakhs	4 (66.7%)	2 (33.3%)	5 (83.3%)	1 (16.7%)	12 (50.0%)
	₹10-25 lakhs	1 (16.7%)	3 (50.0%)	1 (16.7%)	3 (50.0%)	8 (33.3%)
	> ₹25 lakhs	1 (16.7%)	1 (16.7%)	0 (0%)	2 (33.3%)	4 (16.7%)
	Mean ± SD	₹11.2±8.4	₹17.8±11.2	₹8.9±6.7	₹22.4±14.3	₹15.1±11.8
Professional Management	Yes (Full-time)	2 (33.3%)	3 (50.0%)	1 (16.7%)	4 (66.7%)	10 (41.7%)
	Part-time	2 (33.3%)	2 (33.3%)	2 (33.3%)	1 (16.7%)	7 (29.2%)
Primary Commodity	Board-managed	2 (33.3%)	1 (16.7%)	3 (50.0%)	1 (16.7%)	7 (29.2%)
	Cereals	2 (33.3%)	2 (33.3%)	3 (50.0%)	1 (16.7%)	8 (33.3%)
	Pulses	2 (33.3%)	1 (16.7%)	2 (33.3%)	2 (33.3%)	7 (29.2%)
	Vegetables	1 (16.7%)	2 (33.3%)	0 (0%)	2 (33.3%)	5 (20.8%)
	Organic/Mixed	1 (16.7%)	1 (16.7%)	1 (16.7%)	1 (16.7%)	4 (16.7%)

Significant inter-zonal variations emerge in organizational characteristics. Malwa Plateau FPOs demonstrate superior capitalization (mean: ₹22.4 lakhs vs. overall mean: ₹15.1 lakhs) and higher professional management adoption (66.7% vs. 41.7% overall). Vindhyan Plateau FPOs show weakest capital base (mean: ₹8.9 lakhs) and lowest

professional management (16.7%), reflecting infrastructure and institutional support disparities. Member size variations suggest differential aggregation capacity, with Malwa FPOs achieving larger scale (mean: 486 members) compared to Vindhyan FPOs (mean: 312 members).

3.2 Financial Performance Analysis

Table 3: Financial ratio analysis by performance category (n=24 FPOs)

Financial Ratio	High Performers (n=9, 37.5%)	Medium Performers (n=8, 33.3%)	Low Performers (n=7, 29.2%)	Benchmark
Liquidity Ratios				
Current Ratio	2.1 ± 0.4	1.4 ± 0.3	0.8 ± 0.2	> 1.5
Quick Ratio	1.4 ± 0.3	0.9 ± 0.2	0.4 ± 0.1	> 1.0
Profitability Ratios				
Net Profit Margin (%)	9.8 ± 1.8	4.2 ± 1.3	-2.6 ± 1.4	> 7%
Return on Equity (%)	15.7 ± 3.2	7.9 ± 2.1	-5.2 ± 2.8	> 12%
Return on Assets (%)	11.2 ± 2.6	5.4 ± 1.8	-3.1 ± 1.9	> 8%
Efficiency Ratios				
Asset Turnover	2.8 ± 0.5	1.9 ± 0.3	1.2 ± 0.3	> 2.0
Inventory Turnover	9.2 ± 1.8	5.8 ± 1.3	3.4 ± 1.1	> 6.0
Solvency Ratios				
Debt-to-Equity	0.5 ± 0.2	1.1 ± 0.3	2.3 ± 0.6	< 1.0
Interest Coverage	5.1 ± 1.2	2.3 ± 0.7	0.6 ± 0.3	> 2.5
Business Metrics				
Annual Turnover (₹ lakhs)	187.6 ± 54.3	98.4 ± 32.1	42.7 ± 18.9	-
Member Participation (%)	78.4 ± 8.7	58.3 ± 9.4	38.7 ± 12.3	> 70%

Table 3.1: Zone-wise Performance Distribution

Zone	High Performers	Medium Performers	Low Performers	Sustainability Rate
Malwa Plateau	3 (50.0%)	2 (33.3%)	1 (16.7%)	50.0%
Narmada Valley	3 (50.0%)	2 (33.3%)	1 (16.7%)	50.0%
Kymore-Satpura	2 (33.3%)	2 (33.3%)	2 (33.3%)	33.3%
Vindhyan Plateau	1 (16.7%)	2 (33.3%)	3 (50.0%)	16.7%

Stark performance differentiation exists across FPOs. High performers (37.5%) demonstrate healthy financial indicators current ratios >2.0, profit margins approaching 10%, and

sustainable debt levels. These FPOs achieve superior asset utilization (turnover ratio 2.8) and member engagement (78.4% participation).

Medium performers (33.3%) show operational viability but limited profitability, indicating vulnerability to external shocks. Low performers (29.2%) exhibit distressed conditions with negative margins, poor liquidity, and excessive leverage three FPOs in this category were at imminent closure risk during the study period.

Zone-specific analysis reveals infrastructure and market access advantages in Malwa and Narmada Valley zones translating to superior performance outcomes. Vindhyan Plateau's 50% low-performer concentration reflects systemic disadvantages requiring targeted interventions.

3.3 Constraint Analysis Using Garrett's Ranking

Table 4: Operational constraints - Garrett's Ranking Analysis (n=72 Board Members/Managers)

Rank	Constraint	Garrett Mean Score	% Rating Most Severe	Standard Deviation	CSI Score	Severity Level
I	Inadequate working capital and cash flow problems	75.34	54.2% (n=39)	8.92	86.7	Very High
II	Weak market linkages and absence of assured buyers	71.23	47.2% (n=34)	9.34	81.4	Very High
III	Governance challenges and board-management conflicts	68.47	40.3% (n=29)	8.76	77.8	High
IV	Insufficient technical and managerial capacity	65.18	34.7% (n=25)	8.54	74.2	High
V	Limited access to institutional credit and financing	61.89	30.6% (n=22)	9.12	70.8	High
VI	Inadequate infrastructure (storage, processing, transport)	58.54	26.4% (n=19)	8.67	67.3	Moderate
VII	Low member participation and patronage	55.23	22.2% (n=16)	9.01	63.9	Moderate
VIII	Complex regulatory compliance requirements	51.87	18.1% (n=13)	8.23	60.2	Moderate
IX	Competition from private traders and middlemen	48.34	15.3% (n=11)	8.45	56.7	Low
X	Lack of government support and handholding	44.76	11.1% (n=8)	7.89	52.8	Low

Table 4.1: Zone-wise Constraint Severity (Top 3 Constraints):

Zone	Rank 1	Rank 2	Rank 3
Kymore-Satpura	Working capital (76.2)	Market linkages (72.1)	Governance (69.3)
Narmada Valley	Working capital (74.8)	Market linkages (70.8)	Technical capacity (66.2)
Vindhyan Plateau	Working capital (77.1)	Infrastructure (73.4)	Market linkages (71.8)
Malwa Plateau	Market linkages (72.3)	Working capital (73.6)	Member participation (67.1)

Primary Constraint (Priority I): Inadequate working capital emerges as the paramount barrier (Garrett score: 75.34, CSI: 86.7) across all zones. FPO business models require substantial working capital for: (1) advance payment to farmers at harvest, (2) inventory holding for 30-90 days during aggregation and price arbitrage, (3) input procurement for member distribution, and (4) marketing expenses. The working capital cycle of 60-150 days demands capital far exceeding typical FPO equity base. A modest FPO handling 500 tonnes of wheat at ₹2,000/quintal requires ₹1 crore working capital far beyond the average share capital of ₹15.1 lakhs. Banks' reluctance to lend due to collateral constraints and perceived risks exacerbates this challenge.

Secondary Constraint (Priority II): Weak market linkages

(score: 71.23, CSI: 81.4) represents structural value chain gaps. Despite aggregating produce, FPOs struggle to access institutional buyers (processors, organized retail, government procurement) due to: inability to meet quality specifications consistently, lack of value addition infrastructure, insufficient volumes for large buyers, and limited negotiation capacity. This forces FPOs into conventional marketing channels, eliminating potential price premiums.

Tertiary Constraint (Priority III): Governance challenges (score: 68.47, CSI: 77.8) manifest as board-management role ambiguity, elite capture by dominant farmers, limited financial literacy among board members, and inadequate transparency in business transactions. Qualitative evidence revealed 45.8% of FPOs experienced significant governance conflicts resulting in CEO turnover and business disruptions.

Zone-specific Patterns: Vindhyan Plateau uniquely ranks infrastructure inadequacy as second-most severe (score: 73.4), reflecting poor road connectivity and absent processing facilities. Malwa Plateau shows lower working capital constraint severity, attributed to better banking access and higher member contributions.

3.4 Chi-Square Analysis: Associations Between Variables

Table 5: Chi-square test results- FPO characteristics and performance (n=24)

Independent Variable	Dependent Variable	χ^2 Value	df	p-value	Interpretation
Board Education Level	Business Turnover Category	24.56	4	< 0.001**	Highly Significant
Professional Management	Financial Sustainability	19.87	2	< 0.001**	Highly Significant
Share Capital Category	Market Linkage Strength	18.34	4	0.001**	Highly Significant
Years of Operation	Member Retention Rate	16.92	4	0.002**	Significant
Agro-ecological Zone	Performance Category	15.67	6	0.016*	Significant
Promoting Institution Type	Governance Quality Score	13.45	4	0.009**	Significant
Commodity Type	Profitability Category	8.92	6	0.178	Not Significant
Member Size Category	Operational Efficiency	7.34	4	0.119	Not Significant

*Significant at 0.05 level; **Significant at 0.01 level

Chi-square analysis validates multiple associations:

- **Board Education $\times$ Turnover ($\chi^2=24.56$, $p<0.001$):** FPOs with educated boards (>50% members with

secondary+ education) achieve significantly higher turnover. Of 9 high-performing FPOs, 8 had educated boards compared to only 1 among 7 low performers. Educated boards demonstrate better financial understanding, strategic planning, and market negotiation capabilities.

- **Professional Management $\times$ Sustainability ($\chi^2=19.87$, $p<0.001$):** Strongest association exists between professional management and sustainability. Among 10 FPOs with full-time professional CEOs, 8 achieved sustainability (80%) compared to only 1 among 7 board-managed FPOs (14.3%). This validates the critical importance of separating governance from operational management.
- **Agro-ecological Zone $\times$ Performance ($\chi^2=15.67$, $p=0.016$):** Significant zone-wise performance variations confirm infrastructure and market access advantages in Malwa and Narmada Valley zones. Vindhyan Plateau's 50% low-performer concentration reflects systemic disadvantages requiring zone-specific interventions.
- **Commodity Type ($p=0.178$):** Absence of significant association suggests success depends more on operational excellence than commodity selection, contradicting assumptions that high-value crops automatically yield better FPO performance.

3.5 Correlation Analysis

Table 6: Pearson's correlation matrix - key FPO variables (n=24)

Variables	1	2	3	4	5	6	7	8
Member Participation (%)	1.000							
Annual Turnover (₹ lakhs)	0.684**	1.000						
Share Capital (₹ lakhs)	0.523**	0.612**	1.000					
Board Education Index	0.498**	0.587**	0.456*	1.000				
Professional Management	0.641**	0.723**	0.534**	0.512**	1.000			
Market Linkage Score	0.571**	0.789**	0.645**	0.467*	0.678**	1.000		
Net Profit Margin (%)	0.672**	0.801**	0.489*	0.534**	0.698**	0.756**	1.000	
Years of Operation	0.562**	0.478*	0.398	0.412*	0.445*	0.523**	0.489*	1.000

*Significant at 0.05 level; **Significant at 0.01 level

Key Findings

- **Turnover $\times$ Profitability ($r=0.801$, $p<0.01$):** Strongest correlation validates that business volume drives financial success through economies of scale. FPOs with >₹150 lakh turnover averaged 9.2% profit margins vs. -1.8% for those <₹50 lakhs, underscoring the need to achieve minimum viable scale.
- **Market Linkages $\times$ Profitability ($r=0.756$, $p<0.01$):** Strong market linkages correlate highly with profitability. FPOs with institutional buyers realized 18-32% price premiums over local markets, had predictable demand patterns, and received timely payments improving cash flows.
- **Professional Management Impact:** Shows strong correlations with turnover ($r=0.723$), profitability

($r=0.698$), and market linkages ($r=0.678$), confirming professional management drives multiple performance dimensions simultaneously.

- **Member Participation $\times$ Profitability ($r=0.672$, $p<0.01$):** Active member engagement drives FPO success through predictable supply volumes, transaction volumes covering fixed costs, and member loyalty reducing marketing costs. FPOs with >70% participation achieved 7.8% average profit margins vs. 1.2% for those with <40% participation.
- **Operational Maturity (Years) $\times$ Performance:** Moderate positive correlations with participation ($r=0.562$), market linkages ($r=0.523$), and profitability ($r=0.489$) suggest performance improves with institutional maturity through learning effects, trust-building, and relationship development.

3.6 Binary Logistic Regression: Predictors of Sustainability

Table 7: Logistic regression model for FPO sustainability (n=24)

Predictor Variable	B Coefficient	Std. Error	Wald χ^2	Odds Ratio	95% CI	p-value
Constant	-9.234	2.567	12.94	0.000	-	< 0.001**
Share Capital (₹ lakhs)	0.189	0.067	7.98	1.208	[1.059-1.378]	0.005**
Board Education Index	0.637	0.278	5.24	1.891	[1.097-3.259]	0.022*
Professional Management (1=Yes)	2.219	0.923	5.78	9.198	[1.506-56.19]	0.016*
Member Participation (%)	0.094	0.038	6.12	1.099	[1.019-1.184]	0.013*
Years of Operation	0.378	0.189	4.01	1.459	[1.007-2.115]	0.045*
Market Linkage Score	0.761	0.289	6.93	2.140	[1.215-3.770]	0.008**
Zone: Malwa (Reference: Vindhyan)	1.456	0.734	3.93	4.289	[1.015-18.12]	0.048*
Zone: Narmada (Reference: Vindhyan)	1.234	0.698	3.13	3.436	[0.875-13.50]	0.077
Zone: Kymore (Reference: Vindhyan)	0.867	0.656	1.75	2.380	[0.658-8.607]	0.186

Model Statistics:

- **-2 Log Likelihood:** 12.34
- **Cox & Snell R²:** 0.723
- **Nagelkerke R²:** 0.867
- **Model χ^2 :** 28.67 (df=9, p<0.001)
- **Classification Accuracy:** 91.7%
- **Hosmer-Lemeshow Test:** $\chi^2=3.89$, p=0.867 (Good Fit)
- **ROC Curve AUC:** 0.964 (Excellent Discrimination)

Table 7.1: Classification Table

Observed	Predicted Sustainable	Predicted Not Sustainable	% Correct
Sustainable (n=9)	8	1	88.9%
Not Sustainable (n=15)	1	14	93.3%
Overall			91.7%

The logistic regression model demonstrates excellent predictive power (Nagelkerke R²=0.867, classification accuracy=91.7%) in identifying sustainability determinants.

- **Professional Management (Odds Ratio=9.20, p=0.016):** Strongest predictor, FPOs with professional management are 9.2 times more likely to be sustainable than board-managed organizations. This validates the critical importance of professional business operations separate from farmer governance.
- **Market Linkages (OR=2.14, p=0.008):** Each unit increase in market linkage score (0-10 scale) more than doubles sustainability odds. FPOs with institutional buyers, contract farming arrangements, and value addition infrastructure demonstrate significantly higher sustainability probabilities.
- **Board Education (OR=1.89, p=0.022):** Each unit increase in board education index increases sustainability odds by 89%, emphasizing the importance of educated governance providing strategic oversight.
- **Zone Effects:** Malwa Plateau FPOs show 4.3 times higher sustainability odds compared to Vindhyan Plateau (reference category), even after controlling for other factors. This confirms infrastructure and market access advantages create differential success probabilities across agro-ecological contexts.
- **Share Capital (OR=1.21, p=0.005):** Each additional ₹1 lakh of share capital increases sustainability odds by

21%. While effect size is modest, adequate capitalization remains foundational for operations.

- **Member Participation (OR=1.10, p=0.013):** Each 1% increase in participation rate improves sustainability odds by 10%, validating the importance of active member engagement for business viability.
- **Model Validation:** Hosmer-Lemeshow test (p=0.867) indicates excellent model fit. ROC curve AUC of 0.964 demonstrates outstanding discrimination between sustainable and non-sustainable FPOs.

4. Discussion

Performance Variations: Sustainability levels differ sharply across zones 50% in Malwa Plateau and Narmada Valley versus 16.7% in Vindhyan Plateau. Strong infrastructure, market connectivity, and institutional support drive success in developed zones, while poor logistics and limited services constrain Vindhyan FPOs. Zone-specific interventions are essential.

Success Factors (R²=0.867; accuracy=91.7%):

- **Professional Management (OR=9.20):** Strongest predictor of sustainability; ensures strategic and financial efficiency but is costly for small FPOs.
- **Capitalization (OR=1.21; r=0.612):** Adequate equity (₹25-50 lakh) is crucial, yet most FPOs remain undercapitalized (₹15.1 lakh average).
- **Market Linkages (OR=2.14; r=0.756):** Access to institutional buyers yields 18-32% price premiums; infrastructure and intelligence gaps hinder this potential.
- **Governance:** Educated, transparent boards are vital but often lacking, requiring systematic capacity building.

Working Capital Constraint affects 73% of FPOs (Garrett: 75.34; CSI: 86.7). Credit barriers and long cash cycles cause delayed payments, reduced member trust, and profitability decline. Innovative financing warehouse receipt, supply chain, and credit guarantees is needed to break this cycle. Findings align with Singh *et al.* (2021) ^[14], Kumar *et al.* (2018) ^[4], and Dutta *et al.* (2019) ^[2] on management, capital, and credit challenges. This study adds zonal differentiation and quantitative severity analysis, confirming sustainability issues are widespread but context-driven.

5. Conclusion

This comprehensive multi-zonal study of 24 FPOs across four agro-ecological zones establishes that FPO

sustainability in Madhya Pradesh is determined by a convergence of organizational, financial, and contextual factors, with significant inter-zonal variations driven by infrastructure and market access disparities.

Key Findings:

1. **Performance Variation:** Only 37.5% of FPOs were financially sustainable. High performers showed healthy profits, good returns, and strong liquidity, while low performers (29.2%) faced losses and weak cash flow.
2. **Key Constraints:** Garrett's ranking identified lack of working capital as the most critical issue, followed by poor market linkages and governance challenges, highlighting areas that need immediate attention.
3. **Sustainability Drivers:** Regression results showed that FPOs with professional management, strong market connections, and educated boards are far more likely to be sustainable, offering a clear, evidence-based framework for improvement.
4. **Zone-Specific Variations:** Malwa Plateau and Narmada Valley zones achieve 50% sustainability rates compared to 16.7% in Vindhyan Plateau, validating infrastructure and market access advantages while emphasizing need for contextualized interventions.
5. **Statistical Validation:** Chi-square analysis confirms significant associations between professional management and sustainability ($\chi^2=19.87$, $p<0.001$), board education and turnover ($\chi^2=24.56$, $p<0.001$), demonstrating quantifiable relationships between organizational characteristics and performance.

6. Limitations

The study acknowledges certain limitations that shape the interpretation of its findings. Being cross-sectional, it captures FPO performance at a single point in time, limiting insights into their growth and transition over the years. The relatively small sample of 24 FPOs restricts the scope for advanced modeling and detailed subgroup analysis. Since the study is confined to Madhya Pradesh, the results may not fully represent conditions in other states with different institutional settings. While significant statistical associations were identified, causal relationships cannot be firmly established without longitudinal or experimental research. Additionally, some data were self-reported, which may involve recall errors or social desirability bias, especially in governance-related responses.

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