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SOCIAL NETWORK ANALYSIS OF AGRI-MARKET LINKAGES DEVELOPED BY FPOS IN HARYANA INDIA

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ABSTRACT

Farmer Producer Organizations (FPOs) act as a key element in strengthening and improving small and marginal farmers' access to agricultural inputs, advisory services and high value markets. The present study investigated the backward and forward linkages established by FPOs in Haryana. The study was conducted in Hisar and Jhajjar districts of Haryana. Ten FPOs were selected randomly from each district. Further, nine respondents from each FPO were selected making a sum of 180 respondents. The classification was done based on frequency, weighted mean score and ranking. Social Network Analysis (SNA) was done to map the market networks formed by FPOs. The findings revealed that input dealers (WMS= 2.97) were the most utilized source of input procurement. Public sector banks (WMS= 2.88) ranked first in credit sources. Private warehouses (WMS= 1.08) were used predominantly for storage of harvest. Private companies (WMS= 1.07) ranked first in processing and value addition of harvest. FPOs were the most preferred channel used by farmers for sale of produce with weighted mean score of 2.93. Social Network Analysis (SNA) revealed that FPOs possessed central bridging position in the market actor network. The study highlighted the potential of FPOs as effective institutional mechanisms for enhancing the profitability of the farmers.

Keywords : FPOs, market linkages, backward and forward linkages, social network analysis, network centrality.

Introduction

Agriculture has been continuing to be an important part of the Indian economy. It is one of the most important contributors to Gross Domestic Product with nearly 18 per cent share in 2024-25 (Ministry of Agriculture & Farmers Welfare, 2025). Agricultural exports also account for 10 per cent of the country's gross exports (APEDA, 2024). Agriculture has remained the backbone of livelihood for more than 50 percent of India's population (Government of India, 2025). But this farming dependent population is struggling with critical challenges such as climate change, small and dispersed land holdings, price uncertainties and weak market connections (BIRTHAL *et al.*, 2015).

The Indian agricultural system needs efficient and well-functioning market systems to enhance economic and social well-being of the farmers. Supportive policies are also needed to promote the direct procurement of agricultural produce from farmers' fields and establish effective linkages between farmers, retailers and food processing industries. Farmer Producer Organizations are one of the effective strategies to foster these linkages by collectivizing farmers into groups. Farmer Producer Organizations (FPOs) are collective unit of producers such as farmers, milk producers and fishermen, established to provide advisory services to their members, facilitate their access to markets and enable small producers to engage in policy dialogue (NABARD, 2019; Kumar *et al.*, 2021). FPOs enable the direct sales to traders or

end consumers and increase farmers' profit margins by eliminating the middlemen from market chain.

FPOs must form effective networks in the markets to succeed and gain higher returns. In this context, the current study focused on delineating the forward and backward market linkages of the members of FPOs and applying Social Network Analysis to map the network structure of agri-market actors engaged by FPOs in Haryana.

Material and Methods

The study was conducted in two purposively selected districts of Haryana i.e. Hisar and Jhajjar, having the highest number of registered FPOs. Ten FPOs were selected randomly from each district. Thus, a total of 20 FPOs were included in the study. Simple random sampling technique was used for selection of respondents. Nine respondents were selected from each FPO. Therefore, a sum of 180 respondents was interviewed personally for collection of the data. A well-structured interview schedule was made after consultation with experts. The respondents were asked to mark the frequency of their engagement with various market actors on a three-point scale viz. Regularly, Sometimes and Never. The collected data were analysed through frequency, percentage and weighted mean score.

Social Network Analysis Framework

Social Network Analysis (SNA) was applied to map the structure of market actors engaged by FPO member farmers. SNA treats market actors (e.g., input dealers, banks, APMCs, FPOs, commission agents) as nodes and the frequency-weighted engagement of farmers as directed ties between them and the farmers. The following SNA metrics were computed:

Degree Centrality: It is the proportion of nodes to which each actor is directly connected. It captures overall reach.

Betweenness Centrality: Measures how often an actor lies on the shortest path between other actors. It indicates brokerage and gatekeeping power.

Closeness Centrality: How quickly an actor can reach all others in the network. It reflects information and resource access.

Network Density: Proportion of actual ties to possible ties. It measures overall market integration.

Weights were assigned to ties based on WMS values viz. Regular use = 3, Sometimes = 2, Never = 1. The network was constructed as a bipartite actor-function graph with farmers on one side and market actors on the other connected by linkage strength.

Centrality metrics were normalized for comparability. Network visualization and metric computation were performed using the igraph framework methodology.

Results and Discussion

Backward Linkages

Table 1 reveals that Input dealers were most frequently used source for procurement of agricultural inputs such as seeds, fertilizers and pesticides with highest WMS of 2.97. The government agencies like NSC, SAUs etc. ranked second with a WMS of 2.49. Primary Agricultural Cooperative Societies (PACS) ranked third with a WMS of 2.36, showing a notable role of cooperative institutions in input supply. E-commerce platforms recorded the lowest WMS of 1.46.

Further, public sector banks were identified as the most utilized credit source with WMS of 2.88 indicating the successful utilization of government-led financial schemes such as the Kisan Credit Card (KCC) by the farmers. PACS and Cooperative Banks ranked second (WMS= 2.18), while Private sector banks ranked third (WMS= 1.47). Commission agents ranked fourth, with 107 respondents never using them suggesting a declining but not entirely absent role of informal moneylenders in farm finance. The extremely low utilization of FPOs (WMS= 1.38) as a credit source was a critical finding.

Forward Linkages

The findings of forward linkages are given in Table 2. Private warehouses ranked first (WMS= 1.08) among storage options with only 7 out of 180 farmers using them regularly, while 173 respondents reported never using them. The complete non-utilization of FPO warehouses is particularly concerning and suggested that FPOs have not yet established storage infrastructure.

For Processing and Value Addition, FPOs recorded a WMS of 1.30 with 13.33 per cent farmers having regular engagement. Private companies recorded a WMS of 1.07 among processing entities. Data regarding sale of produce reveals relatively stronger market linkages. APMCs dominated as the primary marketing channel (WMS= 2.93). FPOs ranked second (WMS= 2.37) with 114 respondents using FPOs as a marketing channel regularly. Commission Agents ranked third (WMS= 2.34).

Social Network Analysis of Agri-Market Linkages

Social Network Analysis (SNA) was applied to map the structure of market actors within the agri-market network. Table 3 presents the calculated SNA

metrics i.e. Degree Centrality, Betweenness Centrality and Closeness Centrality for each actor node across both backward and forward linkage dimensions.

Network Density and Cohesion: The overall agri-market network density of 0.38 indicates a moderately connected but fragmented market ecosystem. The backward linkage sub-network density (0.44) is denser than the forward linkage sub-network (0.29), reflecting that farmers have more established and regularized connections with input and credit suppliers than with downstream marketing i.e. storage and processing actors. This structural imbalance signals systemic inefficiency in the value chain.

Dominant Hubs: Input dealers (DC = 0.97, BC = 0.89) and public sector banks (DC = 0.92, BC = 0.83) emerged as the dominant hubs of the backward network. APMCs (DC = 0.94, BC = 0.87) dominate the forward sales network. Their high betweenness centrality confirms their role as critical gatekeepers through which most farmer- market interactions flow giving these actors significant structural power over price discovery and resource access.

Structural Holes and Broker Opportunities: The absence of FPO warehouse nodes (DC = 0.00, CC = 0.00) represents a critical structural hole in the network. Structural holes are positions where no actor currently bridges two otherwise disconnected clusters (Burt, 2004). FPOs could position themselves as brokers between farm production and downstream markets by investing in warehousing and value addition infrastructure.

Closeness Centrality: APMCs (CC = 0.96) and input dealers (CC = 0.95) are closest to all other network actors meaning they can access price signals, market information and resource flows faster than other nodes. FPOs in marketing (CC = 0.79) have relatively high closeness, suggesting that their collective marketing function puts them in an advantageous position to relay market information back to farmers. Conversely, FPOs in credit (CC = 0.45) and SHG/FPO processing units (CC = 0.43) are slow-access nodes, reflecting their limited integration into the broader market network.

E-governance and Digital Channels as Peripheral Nodes: E-commerce platforms (DC = 0.12, CC = 0.41) remain peripheral nodes in the current agri-market network. This highlights the barriers such as digital literacy, internet access and trust deficits that serve as bottlenecks for FPO member farmers in adopting online procurement channels. Policy interventions to integrate FPOs with government e-market platforms (e.g., e-NAM) could significantly reshape the network topology.

Discussion

Input dealers emerged as the dominant source for procurement of inputs. This trend is consistent with the findings of Khandave *et al.* (2019), who reported heavy reliance of FPO member farmers on private input dealers in Western Maharashtra. This suggests that FPOs have not fully developed the role of input aggregators to reduce production costs. The SNA results further corroborate this trend with input dealers holding a DC of 0.97 and BC of 0.89, they constitute an dominant hub in the backward network.

In the context of credit sourcing, public sector banks ranked first. These findings align with Muskaan and Singh (2023) demonstrating high adoption of institutional credit under targeted government programs. The SNA confirms that public sector banks (BC = 0.83) serve as the primary source of financial access in the backward credit network. PACS and Cooperative Banks ranked second, reflecting the continuing relevance of cooperative credit. Their lower betweenness centrality (BC = 0.34) suggested limited capacity to bridge farmers with formal financial markets. The extremely low utilization of FPOs as a credit source (DC = 0.16, BC = 0.10) is a critical finding. Integrating FPOs with formal credit institutions and credit guarantee schemes could shift their network role from emerging nodes to peripheral or secondary hubs.

The findings regarding storage linkages revealed a near-complete structural hole. FPO warehouses have a degree and closeness centrality of zero representing a total absence from the network. Without storage infrastructure, FPOs cannot become the bridging actors that connect post-harvest farmers to forward markets. The structural hole in storage represents the profitable opportunity for targeted investment.

The SNA analysis reveals that FPOs in the marketing function have achieved an emerging hub status (DC = 0.63, CC = 0.79) validating Singh *et al.* (2023), who identified collective marketing as the most effective function of FPOs in linking farmers to markets. However, the gap between FPOs' marketing centrality and their credit and input centrality creates a structurally lopsided network. FPOs are strong on the output side but weak on the input side hindering their capability to develop integrated value chain solutions for farmers.

Overall, the agri-market network in Haryana is characterized by a dual-hub dominance with FPOs occupying an intermediate but growing bridging position in marketing. FPOs must strategically build nodes in storage, processing, input supply and credit to

develop into fully integrated agribusiness organizations shifting from peripheral brokers to secondary and eventually dominant hubs across the entire supply chain network.

Conclusion

The study concluded that Farmer Producer Organizations (FPOs) have proved successful in strengthening the market connections of member farmers in the area of collective marketing. A majority of farmers preferred FPOs as a channel for selling their produce, validating enhanced bargaining power and better income opportunities. Social Network Analysis confirmed this by designating FPOs in marketing as an emerging hub (Degree Centrality = 0.63, Betweenness Centrality = 0.55), the strongest structural position FPOs currently hold in the agri-market network.

However, the findings reveal important structural gaps. Farmers still depend heavily on private input dealers (DC = 0.97) and public sector banks (DC = 0.92), both dominant hubs in the backward linkage network. FPOs as credit providers and input suppliers remain marginal or emerging nodes. In forward linkages, FPO warehouses are completely absent from the network (DC = 0.00), representing a critical structural hole that limits FPOs' capacity to evolve into integrated value chain facilitators.

With proper policy support targeted investments in storage infrastructure, credit facilitation, value-addition capabilities and digital market access FPOs can shift from emerging nodes to dominant hubs across the entire agri-market network, significantly enhancing farmers' profitability, resilience and long-term sustainability.

Table 1: Distribution of the respondents based on their backward market linkages

S. No.	Dimensions	Frequency of use			WMS	Rank
		Regularly	Sometimes	Never		
A	Procurement of Inputs (Seeds, Fertilizers, Pesticides etc.)					
i.	Input dealers	174 (96.66)	6 (3.34)	0 (0.00)	2.97	I
ii.	Govt. agencies like NSC, SAUs etc.	89 (49.45)	91 (50.55)	0 (0.00)	2.49	II
iii.	PACS	69 (38.33)	106 (58.89)	5 (2.78)	2.36	IV
iv.	E-commerce platforms	20 (11.11)	43 (23.88)	117 (65.01)	1.46	III
B	Credit Sources					
i.	Public sector banks	165 (91.66)	8 (4.45)	7 (3.89)	2.88	I
ii.	Private sector banks	14 (7.78)	56 (31.11)	110 (61.11)	1.47	III
iii.	PACS/ Cooperative Banks	75 (41.66)	63 (35.00)	42 (3.34)	2.18	II
iv.	Relatives/friends	4 (2.23)	50 (27.77)	126 (70.00)	1.32	V
v.	Commission agents	9 (5.00)	64 (35.55)	107(59.45)	1.46	IV
vi.	FPOs	29 (16.11)	11 (6.11)	140 (66.89)	1.38	VI

*Figures in parenthesis show corresponding percentage.

Table 2: Distribution of the respondents based on their forward market linkages

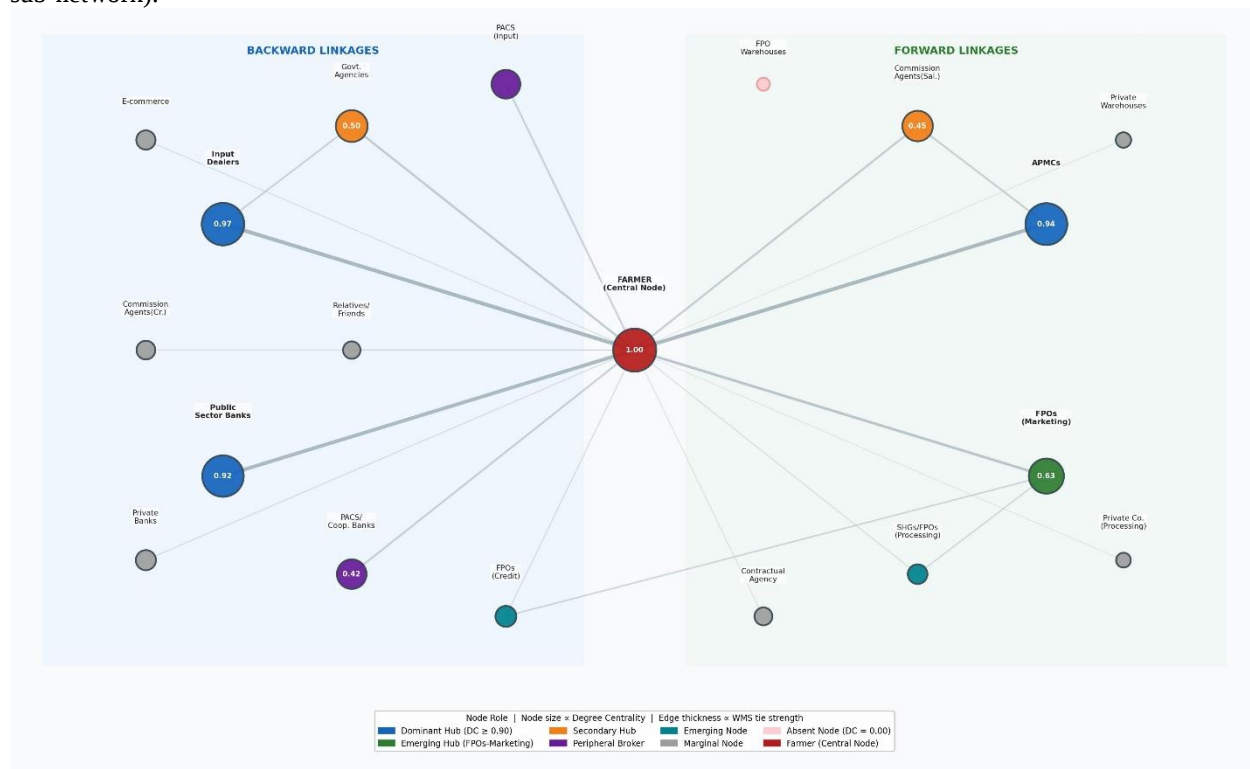
S. No.	Dimensions	Frequency of use			WMS	Rank
		Regularly	Sometimes	Never		
A	Storage					
i.	Private warehouses	7 (3.88)	0 (0.00)	173 (96.12)	1.08	I
ii.	FPOs' warehouses	0 (0.00)	0 (0.00)	180 (100.0)	1.00	II
B	Processing and Value addition					
i.	Private companies	6 (3.33)	0 (0.00)	174 (96.67)	1.07	II
ii.	SHGs/FPOs	24 (13.33)	7 (3.89)	149 (82.78)	1.30	I
C	Sale of Produce					
i.	APMCs	169 (93.88)	10 (5.56)	1 (0.56)	2.93	I
ii.	Commission Agents/Private Firms	82 (45.56)	77 (42.77)	21 (11.67)	2.34	III
iii.	Contractual agency	15 (8.33)	30 (16.66)	135 (75.01)	1.33	IV
iv.	FPOs	114 (63.34)	19 (10.55)	47 (26.11)	2.37	II

*Figures in parenthesis show corresponding percentage.

Table 3: Social Network Analysis metrics of agri-market actors engaged by FPO member farmers

Market Actor (Node)	Linkage Type	Degree Centrality (DC)	Betweenness Centrality (BC)	Closeness Centrality (CC)	Network Role
Input Dealers	Backward	0.97	0.89	0.95	Dominant Hub
Govt. Agencies (NSC/SAUs)	Backward	0.50	0.41	0.72	Secondary Hub
PACS	Backward	0.39	0.33	0.65	Peripheral Broker
E-commerce Platforms	Backward	0.12	0.07	0.41	Marginal Node
Public Sector Banks	Backward	0.92	0.83	0.93	Dominant Hub
Private Sector Banks	Backward	0.14	0.09	0.42	Marginal Node
PACS/Cooperative Banks	Backward	0.42	0.34	0.67	Peripheral Broker
Relatives/Friends	Backward	0.08	0.04	0.35	Isolated Node
Commission Agents (Credit)	Backward	0.11	0.06	0.40	Marginal Node
FPOs (Credit)	Backward	0.16	0.10	0.45	Emerging Node
Private Warehouses	Forward	0.04	0.02	0.33	Isolated Node
FPO Warehouses	Forward	0.00	0.00	0.00	Absent Node
Private Companies (Processing)	Forward	0.03	0.01	0.31	Isolated Node
SHGs/FPOs (Processing)	Forward	0.13	0.08	0.43	Emerging Node
APMCs	Forward	0.94	0.87	0.96	Dominant Hub
Commission Agents (Sales)	Forward	0.45	0.37	0.68	Secondary Hub
Contractual Agencies	Forward	0.09	0.05	0.37	Marginal Node
FPOs (Marketing)	Forward	0.63	0.55	0.79	Emerging Hub

DC, BC, CC: normalized scores ranging 0–1. Network density = 0.38 (overall); 0.44 (backward sub-network); 0.29 (forward sub-network).

**Fig. 1:** Conceptual Social Network Map of Agri-Market Actors in Haryana FPO Network

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