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Exploring knowledge structure in farmer producer organisations and agri-entrepreneurship: A bibliometric visualisation

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Abstract

This study explores the evolving knowledge structure of research on Farmer Producer Organisations (FPOs) and Agri-entrepreneurship through a bibliometric visualisation using VOSviewer. The network visualisation reveals several interconnected clusters highlighting key research themes such as innovation, sustainability, productivity, and farmer participation, indicating strong linkages between organizational, technological, and socio-economic aspects. The overlay visualisation demonstrates the temporal evolution of the field, where early studies focused on conceptual frameworks of innovation and entrepreneurship; transitioning towards empirical analyses of productivity, farmer engagement, and institutional mechanisms; and recently advancing toward technology-driven and application-oriented research. The density visualisation further identifies high-intensity research zones around production, growth, and sustainability, confirming these as the core thematic areas, while emerging topics such as waste management, resilience, and circular economy remain underexplored. Collectively, these findings depict an increasingly interdisciplinary and dynamic research landscape, emphasizing innovation-led sustainability and the transformative role of FPOs in promoting agri-entrepreneurial development and rural advancement.

Keywords: Farmer producer organisations, agri-entrepreneurship, bibliometric analysis, VOSviewer, network visualization

1. Introduction

In India a large proportion of the farmers are small and marginal and the average landholding size has been decreasing. While the farmers are producing surplus amount of food products, they face challenges while processing, value addition and marketing of the produce (Yazhini *et al*. 2025) [30]. Even if the production and productivity have increased, farmers income has decreased over the years. According to Chand (2017) [8], The farmer's income, which was 34% of the income of a non-agricultural worker in 1980's, fell to 25% after 1993-94. At present, a farmer earns only 20% of the national per capita income (Birthal *et al*. 2017) [7]. The number of disguised employments, i.e. employment of people more than what is required is also on an inclining trend in the field of agriculture (Mukherjee *et al*. 2023, Khan *et al*. 2022, Singh *et al*. 2020) [20, 18, 27].

A farmer producer organisation is a type of producer organisation where the members are farmers. An farmer producer organisation satisfies characteristics such as, "it is formed by a group of primary producers", "it is a registered body and legal entity", "producers are primary stakeholders in the organisation", "it deals with business activities related to the primary produce/product/ related inputs", "it works for the benefit of the member producers", "portions of profit are shared amongst the producers and the balance goes to the share capital or reserves", and "portions of profit are shared amongst the producers and the balance goes to the share capital or reserves" (NABARD, 2015).

Agri enterprise can go a long way in uplifting the economy, enhancing farmers income (Pani *et al*. 2023) [24] and increasing farm employment (Trivedi *et al*. 2024, Singh *et al*. 2023, Berdegué *et al*. 2025) [29, 28, 3]. FPOs can act as effective means to promote agri-enterprises and enhance the income of farmers by promoting collective production (Bikkina *et al*. 2018) [6], enabling savings through reduced input, transportation, labour costs and market intelligence (Darshan *et al* 2017) [10], though securing sufficient capital remains a major obstacle (Bikkina *et al*. 2018) [6]; limited strategies for developing climate-resilient supply systems, weak mechanisms for information sharing and financial support, and the lack of competitive marketing models, all of which constrain the evolution of traditional cooperatives into sustainable business enterprises (Bhunia and Singh 2025) [5].

1.1 Review of literature

Gautam *et al*. (2024) [11] in a study reported that FPOs form a core part of the strategy to sustain the life of small and marginal farmers out of poverty and enhance their income and competitiveness in agricultural markets. Hadawale and Sharma (2025) [13] highlight that the success of FPCs in horticulture largely depends on crop-specific specialization, alignment with regional conditions, and effective integration across the value chain. FPOs can play a crucial role in enhancing farmers productivity, increasing their access to credit and market and their technology adoption (MP *et al*. 2018) [19]; improves net returns, ROI, and overall profit margins (Gurung *et al* 2024) [12].

Women-led FPOs enable small and marginal women farmers to collectively negotiate fair prices, access

institutional credit, and adopt modern farming techniques. Prasad *et al*. (2019) [26] reported that the very purpose of the FPO movement has been to establish farming as an enterprise and provide more voice to small and marginal farmers whose exclusion from PACS is legion in many parts of India. The capacity of an FPO to build and maintain connections beyond its immediate network plays a crucial role in its long-term success (Nikam *et al*. 2019) [23].

The review by Ihou and Paul (2025) [14] reveals a notable gap in the literature concerning farmers' entrepreneurial mindset, knowledge, and aspirations, as well as the influence of government support and existing facilities on sustainable entrepreneurship among smallholder farmers. The study by Barman and Singh (2025) [2] emphasize that farmer-led innovation is strengthened by a combination of grassroots knowledge, enabling policy frameworks, and the effective integration of technology. The study by Patil *et al*. (2025) [25] emphasizes the value of focused policy action and continued empirical research to reinforce FPOs as viable pathways for improving farmers' livelihoods. The study (Bharti 2020) [4] concludes that minor adjustments in the intervention's design and structure could significantly enhance the organization's ability to help participants achieve their objectives.

The findings (Nasution *et al*., 2025) [22] highlight that rural development requires a holistic strategy combining sustainable agriculture, digital innovation, and strong community engagement to promote self-sufficiency. The findings (Chebrolu and Dutta 2021) [9] indicate that sustainable transitions require not only technological advancements but also institutional innovations like community-supported farming, Participatory Guarantee Schemes, and FPOs. The findings by Jose *et al*. (2023) [15] indicate that a majority of FPO members display moderate levels of entrepreneurial behavior across multiple domains. The factors of education, group leadership, communication, adherence to rules, participation, and team spirit exhibited a positive and significant relationship with performance (Amitha *et al*. 2021) [1]. A further policy measure could involve establishing a network of institutions dedicated to entrepreneurship promotion, enabling resource pooling, best-practice sharing, and streamlined delivery of specialized incubation services (Kademani *et al* 2024) [16].

Given the high relevance of FPOs and Agri entrepreneurship for the farm sector, the current study entitled "Exploring knowledge structure in Farmer producer organisations and Agri-entrepreneurship: A Bibliometric visualisation" was taken up to identify key trends, focus area of study and gap thereof with respect to these areas.

1.1 Objective of the study

To analyse the publication trends on farmer producer organisations and agri-entrepreneurship over the previous years to understand the key focus areas.

2. Methodology

To accomplish this objective bibliometric analysis was conducted using Dimensions.ai data base and VOSviewer software.

2.1 Data collection: To collect the data from the Dimensions.ai data base, keywords such as, (FPO OR farmer producer organizations OR farmer producer organisations OR producer groups) AND (agri-entrepreneurship OR agripreneurship OR AGRO-ENTREPRISE OR ENTREPRENEUR OR ENTREPRENEURSHIP OR AGRI ENTREPRENEURSHIP). Following this string, a total number of publications were found in the database spanning from 2010 to 2025.

2.2 Co-occurrence analysis

The data set was transferred into Excel in CSV format, and VOSviewer software was utilized to generate thematic maps. During the process, specific filters were applied carefully to ensure that only pertinent terms were included in the co-occurrence visualization. The threshold for terms was established at 30 occurrences, meaning only terms appearing in a minimum of 30 documents were considered. Out of the 58880 terms, 416 meet threshold and afterwards 250 terms were selected which fell in the set of 60 percent most relevance terms.

3. Results and Discussion

The results of the network, overlay and density visualization analysis are presented and discussed below.

3.1 Network visualization

The network visualization (figure 1) provides a map depicting the co-occurrence of terms related to the field of agribusiness incubation. These co-occurring terms represent key concepts that frequently appear together in the literature on agribusiness incubation. Using VOSviewer software, these terms have been organized into three distinct thematic clusters. Each cluster shown in Figure 1 corresponds to a specific research theme, offering valuable insights into the current knowledge landscape and highlighting emerging trends within the domain.

3.1.1 Discussion of clusters in the network visualisation

3.1.1.1 Cluster 1 – Innovation, Sustainability, and Organizational Perspective (Red Cluster)

Theme: Innovation-driven and sustainability-oriented entrepreneurship and organizational development.

Key terms are innovation, organization, entrepreneurship, sustainability, business model, circular economy, and systematic literature review.

Interpretation

- Represents theoretical and conceptual studies exploring how innovation, entrepreneurship, and organizational models contribute to agricultural transformation.
- The linkages to "sustainability" and "circular economy" indicate a strong sustainability-oriented innovation discourse.
- Keywords like "literature", "article", and "review" show that this cluster also covers meta-analysis and bibliometric trends, possibly mapping how knowledge evolves around FPOs and agri-business ecosystems.

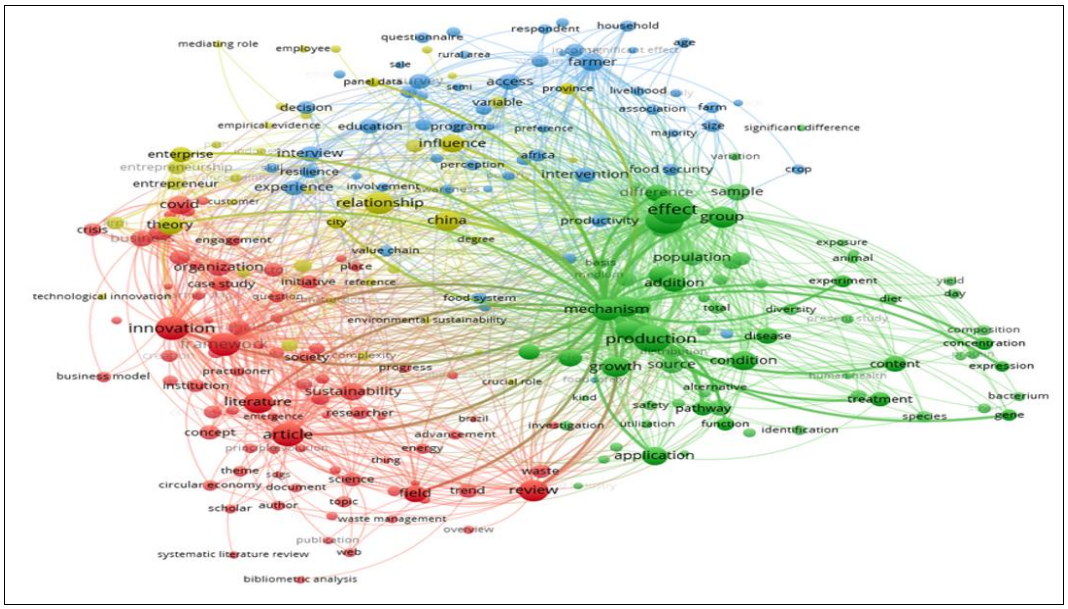

Fig 1: Network visualization of keyword co-occurrence terms, illustrating the formation of four distinct thematic clusters

3.1.1.2 Cluster 2 – Production Systems, Mechanisms, and Technological Applications (Green Cluster)

Theme: Technological and production-based research in agricultural entrepreneurship.
Key terms are production, mechanism, growth, condition, source, application, treatment, content, pathway, disease, species, bacterium.

Interpretation

- This cluster relates to agricultural productivity, biological/technological interventions, and production efficiency studies.
- Indicates that a significant portion of the literature integrates agri-biotechnological or production-based research into entrepreneurship and FPO contexts.
- The terms "mechanism" and "application" suggest scientific and technical perspectives complementing socio-economic analyses.

3.1.1.3 Cluster 3 – Farmer-Centric and Development-Oriented Studies (Blue Cluster)

Theme: Developmental and impact-oriented research focusing on farmer livelihoods and interventions.
Key terms are farmer, group, sample, effect, intervention, food security, livelihood, program, access, decision, variable, education.

Interpretation

- This cluster reflects empirical and developmental research focused on farmers, interventions, and impacts on livelihoods and food security.
- It represents field-level studies assessing how FPOs, programs, and interventions affect farmers' welfare, productivity, and access to resources.
- Links to "empirical evidence", "questionnaire", and "rural area" show a quantitative, field-based research orientation.

3.1.1.4 Cluster 4 – Relationships, Value Chains, and Policy Interfaces (Yellow Cluster)

Theme: Policy, value chain linkages, and institutional relationships in FPO and agri-enterprise ecosystems.
Key terms are relationship, China, value chain, influence, resilience, enterprise, engagement, initiative, policy.

Interpretation

- Indicates studies focusing on relational and institutional dimensions - such as how FPOs connect farmers to markets, strengthen value chains, and influence resilience.
- The presence of "policy", "initiative", and "engagement" hints at governance and institutional mechanisms that support or hinder FPOs.
- Also shows cross-country comparative research (e.g., "China", "Africa") suggesting a global and policy comparative perspective.

3.2 Overlay visualization

3.2.1 Cross cluster linkages

The overlay visualization map (figure 2) generated through VOSviewer provides a dynamic representation of the bibliometric network by integrating a temporal dimension. It illustrates how the key terms related to agribusiness incubation have evolved across different periods, revealing shifts in research emphasis and the emergence of new thematic areas. The color gradient, ranging from purple to green to yellow, corresponds to studies published between 2010 and 2025, thereby depicting the chronological progression of scholarly interest in this field. The red and yellow clusters are strongly connected, indicating close theoretical integration between innovation/organization and policy/value chain research. The blue and green clusters are also interconnected, showing a bridge between production-level interventions and farmer-level outcomes. Central nodes like "relationship", "influence", and "production" act as bridging concepts, integrating scientific, economic, and social research.

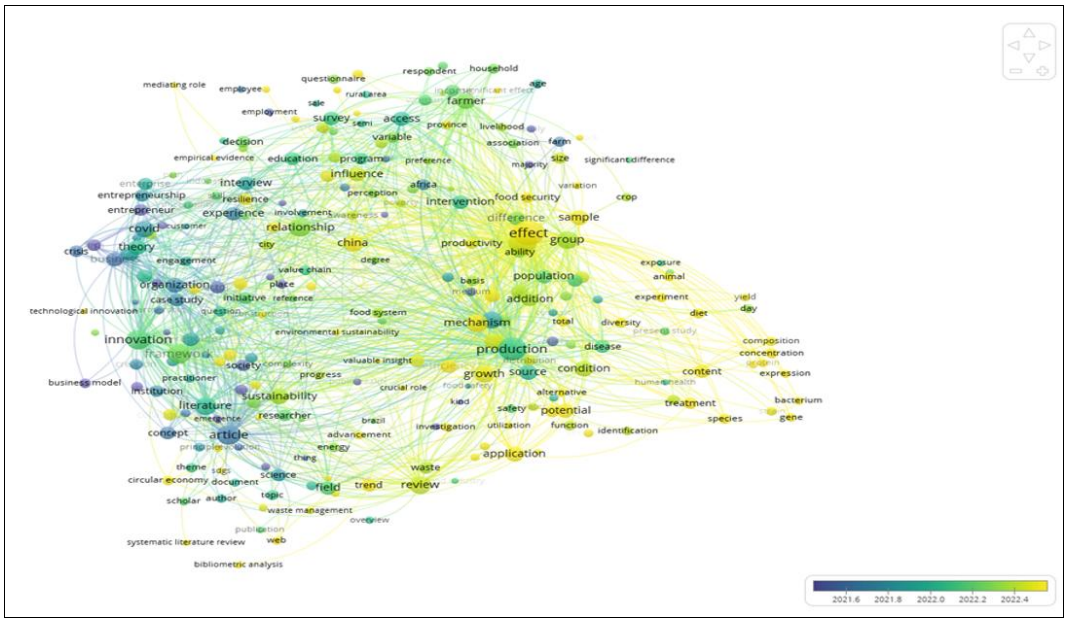

Fig 2: Overlay visualisation map

3.2.2 Interpretation of the Colour Gradient (Temporal Evolution)

3.2.2.1 Blue Nodes (2010–2019)

Represent earlier research focus areas. These are foundational or traditional themes in the literature. Key terms such as Innovation, entrepreneurship, business model, sustainability, bibliometric analysis, systematic review appeared in this cluster. Early research largely emphasized conceptual development around innovation, entrepreneurship, and sustainable business models in agriculture.

3.2.2.2 Green Nodes (2020–2022)

Indicate the transitional phase of research, where empirical evidence and applied frameworks began to emerge. Key focus areas were, relationship, influence, intervention, productivity, growth, food system, environmental sustainability. During this phase, scholars explored linkages between FPOs, farmer participation, productivity improvement, and sustainability outcomes.

3.2.2.3 Yellow Nodes (2022–2025)

Represent recent and emerging themes and are current research frontiers. Key terms under this aspect are mechanism, effect, population, condition, potential, application, gene, species, treatment. Newer research has started connecting agripreneurship and FPOs with technological applications, biological interventions, and production mechanisms, often under the influence of climate resilience and smart-agriculture approaches. The interconnected nodes illustrate strong thematic linkages, showing how innovation, sustainability, and productivity are interrelated, reflecting the multidisciplinary and evolving nature of research on FPOs and agri-entrepreneurship.

3.3 Density visualization

Density visualization map (figure 3) depicts the intensity and concentration of research attention within the field of Farmer Producer Organisations (FPOs) and Agri-entrepreneurship.

Each term (node) corresponds to a keyword extracted from the literature, while the color intensity indicates the frequency of occurrence and the strength of connections among those terms.

3.3.1 Interpretation of Colour Gradient

3.3.1.1 Yellow Regions (High Density)

Represent the core research themes dominating the literature.

Key terms are production, growth, source, mechanism, effect, population, innovation, sustainability, theory. These reflect strong scholarly attention toward production efficiency, innovation mechanisms, and sustainability frameworks within agribusiness and FPO contexts. The concentration around these terms indicates that the conceptual and practical dynamics of innovation and productivity are the main pillars of this research field.

3.3.1.2 Green Regions (Moderate Density)

Key terms are relationship, influence, intervention, entrepreneurship, organization, framework, field, article. Represent supporting areas that link core research (innovation and production) with institutional structures, farmer behavior, and empirical models. This suggests growing scholarly interest in how organizational dynamics and stakeholder interactions shape agripreneurial success.

3.3.1.3 Blue Regions (Low Density)

Terms located at the periphery like education, waste management, bacterium, species, identification, etc. Indicate emerging or niche areas, possibly new intersections of agri-biotechnology, resource efficiency, and sustainability science that are not yet mainstream but show potential for future research.

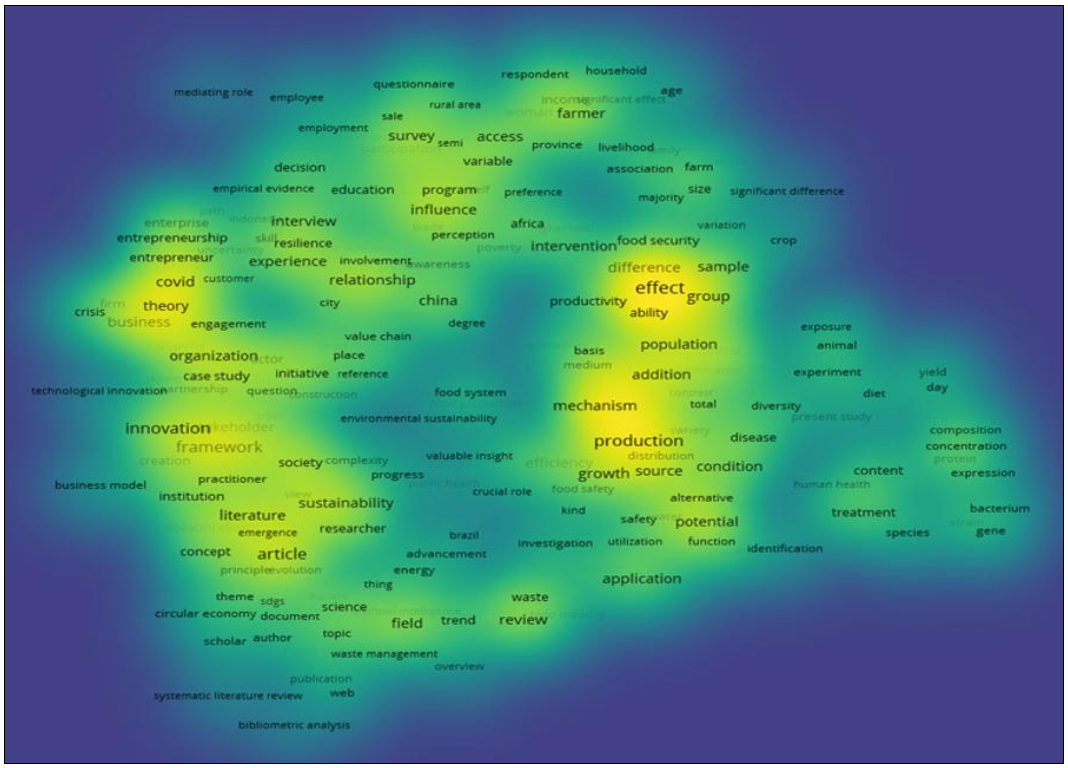

Fig 3: The density visualisation map

3.3.2 Key insights and emerging trends

- The bright yellow concentration around production, growth, and mechanism highlights a current emphasis on improving agricultural productivity and efficiency.
- The presence of sustainability and innovation near the high-density zone implies an evolving focus on sustainable agripreneurial models and innovation-driven rural development.
- Peripheral green and blue regions suggest underexplored but promising themes such as waste management, resilience, and circular economy-potential future directions for agribusiness incubation and FPO development research.

4. Conclusion

The bibliometric visualisation reveals that research on FPOs and agri-entrepreneurship has progressed from conceptual studies on innovation and sustainability toward data-driven and technology-oriented approaches focusing on productivity and resilience. Despite this progress, emerging areas such as digitalisation, circular economy, and waste management remain underexplored. Policymakers should strengthen innovation ecosystems within FPOs, support digital platforms for market integration, and embed sustainability principles into agri-enterprise development. Promoting capacity building, R&D collaboration, and financial inclusion will further enhance the effectiveness of FPOs as instruments for inclusive and innovation-led rural growth.

5. Plagiarism: All submissions are original.

6. Conflict of interest: None.

7. Ethical approval: Not appeared.

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