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A case study on federation-led seed production system: Enhancing sustainability and inclusion

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Abstract

Small and marginal farmers constitute more than 86 per cent of India's operational landholders, yet they continue to face significant constraints in accessing affordable, high-quality seeds. Women farmers encounter additional structural barriers, further limiting equitable participation in formal seed systems. In response to these challenges, this study examines the Federation Led Seed Production System (FLSPS) implemented through the Sahaja Aharam Producer Company Limited (SAPCO), a federation of Farmer Producer Organizations (FPOs) supported by the Centre for Sustainable Agriculture (CSA) and the International Rice Research Institute (IRRI). The model aims to strengthen decentralized, farmer-led seed production, quality assurance, and distribution through collective institutional architecture.

The study adopts a qualitative research design using stakeholder content analysis. Semi-structured interviews were conducted with 20 stakeholders across six groups, including CSA experts, KVK scientists, CEOs, Board of Directors, Cluster Directors, and Seed Producer Farmers. An analytical coding framework comprising 18 codes across six thematic categories was developed to quantify consensus and divergence in stakeholder perspectives.

Findings reveal that institutional clarity, technical handholding, and decentralized governance are key strengths of the FLSPS model. High frequencies for codes such as "Nodal/Federation Role" (18 mentions) and "Farmer Economics/Profit" (16 mentions) indicate strong recognition of the federation's leadership and economic viability. The Participatory Guarantee System (PGS) has emerged as an innovative internal quality assurance mechanism, promoting technical discipline and inclusivity while reducing certification barriers for smallholders and women farmers. Economically, the federation marketed over 4,700 seed bags in Rabi 2024, generating revenues exceeding ₹2 crores, demonstrating the commercial feasibility of the model.

However, infrastructure gaps, particularly in storage, processing, and laboratory facilities constitute the most critical constraint (21 mentions), limiting scalability despite institutional robustness. The study concludes that federation-based seed systems represent a sustainable and inclusive alternative to centralized seed markets, enhancing farmer autonomy, improving seed quality, and strengthening rural livelihoods. Strategic investments in infrastructure, policy support, and capital mobilization are essential to unlock the full scaling potential of the FLSPS model and to institutionalize decentralized seed sovereignty in India.

Keywords: Case Study, federation led seed production, sustainability, collective models

Introduction

Agriculture remains the backbone of India's economy, providing employment and livelihoods to nearly 50 per cent of the country's workforce (Government of India, 2023) ^[4]. However, small and marginal farmers who constitute more than 86 per cent of India's operational landholders continue to face persistent challenges in accessing critical agricultural inputs, particularly quality seeds (Agriculture Census, 2015-16). Women farmers, despite their substantial contribution to agricultural production and post-harvest operations, encounter additional structural barriers such as insecure land tenure, limited access to credit, restricted mobility, and low participation in decision-making processes (Agarwal, 2018) ^[1]. Ensuring equitable access to high-quality seeds for both smallholders and women farmers is therefore essential for improving agricultural productivity, enhancing food security, and strengthening rural livelihoods (Pingali, 2012) ^[7].

One of the major constraints confronting small and marginal farmers is the limited availability of affordable and certified quality seeds. A significant proportion of farmers still rely on informal seed systems, including farm-saved seeds or purchases from local markets without adequate quality assurance mechanisms (Almekinders & Louwaars, 2002; Louwaars & de Boef, 2012) ^[3, 6]. While informal systems play an important role in maintaining local crop diversity, their limited quality control often results in suboptimal yields and increased vulnerability to pests and diseases. Consequently, this contributes to stagnation in productivity and farm incomes. Moreover, the growing dominance of private seed companies, particularly in hybrid seed markets, has led to increased seed costs, making improved varieties less accessible to resource-poor farmers (Spielman, 2013) ^[9]. The absence of a robust last-mile distribution system further widens the gap between seed innovation and farmer access, underscoring the need to strengthen decentralized, farmer-

led seed production and distribution mechanisms.

Collective institutional models such as Farmer Producer Organizations (FPOs) have emerged as viable mechanisms to address these challenges by aggregating smallholders, improving input access, and enhancing market participation (Trebbin, 2014)^[11]. However, the establishment and long-term financial sustainability of individual FPOs remain critical challenges due to limited managerial capacity, inadequate working capital, and fragmented operations (Prasad *et al.*, 2020)^[8]. In this context, federations of FPOs present a promising institutional innovation. By organizing multiple FPOs under a common umbrella structure, federations enable resource sharing, risk pooling, economies of scale, and stronger negotiation power in input and output markets (Stockbridge, Dorward & Kydd, 2003)^[10].

A federation-based seed production system operates on the principle of organizing smallholder farmers into structured and vertically integrated networks that support seed production, quality assurance, aggregation, and distribution. Through pooled technical expertise, collective infrastructure, and coordinated marketing strategies, federations can enhance access to breeder and foundation seeds, provide capacity building, ensure quality control, and establish efficient market linkages. Such models not only reduce individual transaction costs but also promote inclusive participation in agricultural value chains, thereby improving economic stability and strengthening the resilience of small and marginal farmers (Hellin, Lundy & Meijer, 2007)^[5].

Implementation

With support from the International Rice Research Institute (IRRI), the Centre for Sustainable Agriculture (CSA) established the Sahaja Aharam Producer Company Limited (SAPCO), a federation of Farmer Producer Organizations (FPOs) focusing on seed production, processing and distribution under the unified brand Sahaja Beej. CSA initiated the development of this seed federation using a hub based model, bringing together FPOs it had previously promoted. To formalize the federation's structure, a central meeting was convened on May 8, 2023, at St. Ann's, Tarnaka, where representatives from sixty four FPOs across Telangana and Andhra Pradesh participated. The discussion centered on defining the federation's objectives and governance framework. Following extensive deliberations with sixty four FPOs, these organizations were grouped into regional clusters and each cluster elected leaders responsible for making key decisions at the federation level.

As part of the implementation process, CSA organized a workshop to assess the challenges faced by 64 FPOs involved in seed production. This initiative provided critical insights into operational difficulties and potential areas for collaboration. Building on these findings, an orientation program was conducted to familiarize the FPOs with the federation's objectives, operational mechanisms and long term vision, ensuring a shared understanding of its role in strengthening decentralized seed systems.

Federation led seed production system model

1. Demand collection and planning

Before the start of each season, the federation adopts a

structured approach to collecting seed demand from all participating FPOs. FPO coordinators play a key role in facilitating meetings at the FPO level, assisting board members in accurately forecasting their seed requirements. Once the demand is gathered from each FPO, the federation consolidates the data and shares it with the CEO and board members of the respective FPOs. This process ensures transparency and accountability, allowing for verification and necessary adjustments before finalizing production plans.

2. Seed production

a. Foundation seed supply systems: The Sahaja Beej Federation has primarily depended on research institutes, universities and Krishi Vigyan Kendras' to obtain foundation and breeder seeds for multiplication and distribution to farmers and Farmer Producer Organizations (FPOs). However, acquiring foundation seeds through these institutions is a lengthy process with a high risk of unavailability, while breeder seeds often raise concerns about purity. To address these challenges, Sahaja Beej has taken the initiative to maintain its own foundation seed stock, ensuring the genetic purity of high demand varieties. As part of this effort, the federation is currently preserving and supplying quality seeds of RNR 15048, BPT 5204, KNM 118, JGL 24423, Kudrath, TAG 24, PU 31, and TS3R to FPOs for further multiplication.

b. Criteria for selecting seed production FPOs in CSA intervention areas: To achieve successful seed production, Sahaja Beej has established specific selection criteria. The chosen area must be suitable for cultivation in both kharif and rabi seasons, considering agro-ecological conditions and climate compatibility for particular crops or varieties. Adequate irrigation facilities, appropriate soil type, and optimal fertility are essential requirements. The governing body of the FPO should be willing to initiate and support this initiative by providing production services and managing working capital needs. Accessibility to seed processing and storage facilities, as well as efficient transportation networks, is crucial. Additionally, the presence of experienced farmers knowledgeable in seed production practices such as timely sowing, roughing (removal of off-type plants), and harvesting is necessary. Farmers should also be willing to participate in seed production despite minimal profit margins between seed and grain prices for cereal crops. The selected region should be free from frequent natural calamities. Moreover, strong motivation and commitment from farmers to maintain seed purity, along with active participation from local communities and FPOs, are key factors for the initiative's success.

c. Crop specific locations: Based on these selection criteria and the federation's prior experiences, specific locations have been identified for seed production, tailored to different crops. These locations have been chosen to ensure optimal growing conditions, reliable irrigation, access to processing facilities and the availability of experienced farmers, all of which contribute to maintaining seed quality and purity.

Table 1: Crop specific locations for seed production in FLSPS.

S. No	FPO Name	Suitable crop for seed production	Location
1.	Gayatri	Vegetables (Traditional varieties)	Vempalli, Kadapa
2.	Tungabadra	Miaze, Cotton	C Belagal, Kurnool
3.	CC Kunta	Paddy, Redgram	Mahabubnagar
4.	Thalamadugu	Soyabean	Adilabad
5.	Rajoli	Cotton	Jogulamba Gadwal
6.	Bangaru gattu	Ground nut (TAG 24)	Jogulamba Gadwal
7.	Vemula	Ground nut	Vemula, Kadapa
8.	Proddutur	Black gram, Green gram, Bengal gram	Proddutur, Kadapa
9.	Haritha	Paddy (Traditional varieties)	Boddam, Vizianagaram
10.	Huzurabad	Paddy	Huzurabad, Karimnagar
11.	Karshaka	Paddy	Choppadandi, Karimnagar
12.	Manakondur	Paddy	Manakondur, Karimnagar

d. Rationale for producing seeds in rabi season: The project undertook extensive seed production, spanning 430 acres in Kharif 2023, 120 acres in Rabi 2023, 160 acres in Kharif 2024, and 234 acres in Rabi 2024, covering a variety of crops. A key takeaway from the initiative was the distinct advantage of producing seeds during the Rabi season over Kharif within a formal seed system. Several factors contributed to this preference:

- **Time Availability for Post Production Operations:** In Andhra Pradesh and Telangana, the narrow window between Kharif and Rabi seasons leaves little time for essential post-production activities. Rabi seed production allows sufficient time to prepare seeds for both upcoming Kharif and Rabi seasons.
- **Logistical Constraints:** Limited time between Kharif and Rabi makes it difficult to complete critical post-harvest processes such as drying, seed processing, packaging, and distribution.
- **Market alignment:** Bulk seed production during Rabi ensures a steady supply for all seasons, effectively meeting large scale demand.
- **Reduced Risk of Weather Damage:** Kharif crops are often exposed to excessive rainfall, waterlogging and strong winds, which can damage crops and impact seed production. In contrast, Rabi season offers more stable weather conditions, ensuring uniform growth and proper maturation.
- **Better Seed Quality:** Seeds produced in Rabi exhibit higher vigour, improved germination rates and a longer shelf life due to favourable maturation conditions. Post-harvest drying further reduces moisture content, enhancing seed quality.
- **Water Management:** Kharif season poses challenges with unpredictable rainfall, making water management difficult. Rabi crops, grown under controlled irrigation, benefit from consistent water availability, leading to superior seed quality.

By leveraging the advantages of Rabi seed production, the project was able to enhance seed quality, optimize logistical efficiency and ensure a reliable supply for farmers across seasons.

3. Seed quality assurance through PGS

The Centre for Sustainable Agriculture (CSA) has introduced an innovative approach to seed quality assurance by implementing the Participatory Guarantee System (PGS)

with seed producer groups. This decentralized, farmer driven model gives farmer groups the collective authority to validate the quality of Truthfully Labelled Seeds (TLS). By fostering a trust based system, CSA has simplified the process for marginalized farmers to meet seed quality standards without the financial and logistical challenges associated with conventional certification. Unlike mainstream seed certification, which requires a licensed seed officer to certify seeds per the Indian Minimum Seed Standards, the PGS enables smallholder and women farmers, who may find formal certification processes challenging and costly, to participate in seed certification. By shifting the responsibility of quality assurance to Seed Growers' Associations collectively formed by farmer groups, the PGS promotes inclusivity and reduces bureaucratic barriers for marginalized farmers. The PGS involves six key certification phases:

- **Seed Grower Registration:** Farmers register their crop, variety and seed source details.
- **Seed Source Verification:** The source and class of seed (breeder/foundation) are validated.
- **Field Inspections:** Regular inspections ensure crops meet field standards.
- **Post-Harvest Supervision:** Processing and packaging are monitored for quality.
- **Seed Sampling and Analysis:** Genetic purity and seed health are tested.
- **PGS Certification:** Certification tags and documentation are issued.

Farmers organize into groups and register with the Seed Growers' Association; sourcing foundation seeds themselves or through the association. Applications for certification must be submitted within specified timelines using FORM-1, detailing crop specifics, seed sources and applicable fees. Inspections cover various crop growth stages viz., pre flowering, flowering and pre-harvest to ensure compliance with standards like isolation distance, proper planting ratios and removal of contaminants. Reinspection may be conducted if initial inspections reveal noncompliance, provided corrective actions are possible. Harvesting, threshing and transportation must preserve seed quality and seed processing occurs within a month of harvest. For certain crops like maize and ground nut, on-site sorting and shelling are allowed under peer review due to logistical constraints. PGS enhances seed quality while promoting equity in the seed certification process, making it more

accessible for smallholder and marginalized farmers.

4. Marketing and Promotion

To promote seeds produced by the FPOs, various outreach methods were utilized, including field day events, posters, leaflets and digital platforms. Additionally, videos and farmer testimonials were shared on social media to enhance visibility. The seeds gained recognition for their quality and production process, leading to the sale of 3,378 bags by the CC Kunta FPO, despite initially being marketed under three different brand names due to a delay in obtaining the seed license. Over time, both the FPO and the federation successfully established a strong brand identity beyond just the seeds, enabling them to market more than 4,700 bags during the Rabi 2024 season.

5. Sales strategy

A village level distribution model was piloted, where seeds were made available through distribution points managed by FPO board members or their nominees. To encourage sales, an incentive based system was introduced, offering promoters a commission of ₹10 to ₹30 per sale. This approach led to a significant increase in seed sales, rising by 460 per cent from 603 bags to 3,378 bags during Kharif 2024 and reaching 4,700 seed bags in Rabi 2024. The growth was driven by efficient processing, timely distribution and the proven performance of seeds in previous seasons.

6. Post sales activities

A post sales monitoring system was implemented to assess seed germination and nursery establishment, ensuring any quality issues were promptly addressed. FPO staff, along with crop production experts, provided guidance and support to farmers throughout the process. This proactive approach not only enhanced farmers' trust in the seeds but also strengthened confidence in the FPOs' ability to produce high quality seeds.

7. Revolving fund

Under the Gender Responsive Seed Systems project, a revolving fund of ₹16,00,000 was introduced to provide essential financial support to Farmer Producer Organizations (FPOs) and the seed federation engaged in seed production and distribution. This initiative aimed to bridge the financial gaps faced by FPOs, ensuring they had the necessary working capital to procure raw seeds, process them efficiently and carry out marketing activities without financial constraints. The fund played a crucial role in enhancing financial liquidity for FPOs, allowing them to streamline their operations and expand their reach. By ensuring a steady flow of working capital, these organizations could procure high quality raw seeds at the right time, preventing delays in the production cycle. Additionally, the availability of funds facilitated timely seed processing, improving seed quality and ensuring farmers received well processed, high yielding seeds. With the successful management of the revolving fund, FPOs were able to strengthen their seed business models and establish a more sustainable approach to operations. They gained the confidence to invest in better infrastructure, expand seed production and build stronger relationships with farmers and

stakeholders. As a result, these organizations not only improved their overall efficiency but also contributed to enhancing seed accessibility and availability for a larger farming community, ensuring long term growth and resilience in the seed sector.

Methodology: Stakeholder Content Analysis

To provide an empirical foundation for assessing the FLSPS model, a qualitative research approach was employed. Data was collected from 20 stakeholders across six distinct groups (CSA Experts, KVK Scientists, CEOs, Board of Directors, Cluster Directors, and Seed Producer Farmers) using semi-structured interviews covering 30 questions on system design, challenges, and impact.

Content Analysis Procedure: The interview data was subjected to thematic content analysis. An analytical coding framework consisting of 18 codes across six categories was inductively developed from the transcripts. This framework was then used to systematically count the frequency of concepts, identifying areas of high consensus and divergence across stakeholder roles. This quantification allows for the rigorous comparison of perspectives critical to the system's success.

Institutional Architecture (The System's Core)

The Federation Led Seed Production System Model involves a diverse range of stakeholders from various sectors, institutions, and organizations. These key players work together to ensure the system's efficiency and success by offering vital support and services to farmers. The primary stakeholders include:

- **Centre for Sustainable Agriculture (CSA):** Technical support and facilitation for FPOs'.
- **International Rice Research Institute (IRRI):** Supporting through the **Gender Responsive Seed Systems Project**
- **Financial Institutions and Banks:** Providing necessary funding and financial assistance
- **Sahaja Aharam Seed Producing Company Ltd.:** Coordinating seed production and distribution
- **Research Institutes, Universities and Krishi Vigyan Kendras (KVKs):** Supplying foundation and breeder seeds, as well as technical expertise
- **Seed Producing Cooperatives:** Seeds were procured from Mulkanoor Cooperative Rural Credit & Marketing Society Ltd. (MCRMSL) and Dharmarajpally Dhanya Vithana Raithu Paraspara Sahakara Parimidha Sangam (DDVRSPS) when their own supply was insufficient and sold them within their respective FPOs.
- **Seed Processing centre:** Seed Processing Centers ensure quality seed production by cleaning, grading, treating and packaging seeds. They help in standardize quality, improve market access.
- **Seed Producing Farmers:** Actively engaged in seed cultivation and quality maintenance
- **Consumers:** End users benefiting from high quality seeds
- **Media:** Media plays key role by promoting quality seeds, sharing knowledge, and connecting farmers to markets through digital, print, and broadcast platforms.

Through collaboration and shared expertise, these stakeholders contribute to the seamless operation of the federation led seed production model, ensuring farmers

receive the necessary resources, knowledge and market access.

Results: Quantitative Findings from Content Analysis:
The systematic content analysis of stakeholder responses

provides a quantitative snapshot of the model’s performance. The below table 2, presents the total frequency of mentions for each analytical code, revealing the most salient issues and successes from the perspective of the FLSPS participants.

Table 2: Summary of content analysis in FLSPS. (n=20)

Category	Code	Analytical Code	Total mentions	Top stakeholder group
I. Problem Rationale & Need	1	Conventional System Failure	14	CSA Experts (4), Farmer Members (4)
	2	Decentralization/Control	10	CEOs (3), BODs (3)
II. Institutional Architecture	3	Nodal/Federation Role	18	CEOs (5), BODs (5)
	4	Technical Handholding	16	CSA Experts (6)
	5	Scientific Validation	12	KVK Scientists (5)
	6	Multi-Stakeholder Collaboration	9	Cluster Directors (3)
III. Quality Assurance & Protocol	7	Internal Certification/PGS	10	CSA Experts (3), KVK Scientists (3)
	8	Technical Discipline	15	Seed Prod. Farmers (5), CSA Experts (4)
	9	Quality Checks/Testing	12	CEOs (4)
	10	Three-Tier Monitoring	10	CSA Experts (3), Cluster Directors (3)
IV. Socio-Economic Impact	11	Yield/Quality Improvement	13	Farmer Members (5)
	12	Farmer Economics/Profit	16	Seed Prod. Farmers (6)
	13	Social Recognition/Pride	11	Seed Prod. Farmers (4)
	14	Gender Role	7	Cluster Directors (3)
V. System Challenges & Risks	15	Implementation Difficulty	13	CEOs (4), Cluster Directors (4)
	16	Climatic/External Risk	8	Seed Prod. Farmers (3)
	17	Infrastructure Gap	21	CEOs (6), BODs (6)
VI. Sustainability & Scaling	18	Future Strategy/Expansion	10	BODs (4)

Critical Success Factors and System Impact

The collective assessment of the FLSPS reveals several critical factors that drive its success, strongly supported by the content analysis frequency data.

- **Institutional Clarity and Role Validation**
The system operates on a robust institutional framework with decentralized governance. The high frequencies for Nodal/Federation Role (Code 3, 18 mentions), Technical Handholding (Code 4, 16 mentions), and Scientific Validation (Code 5, 12 mentions) confirm that the key functions are clearly understood and enacted by the respective groups (CEOs/BODs, CSA, and KVK). This validates the structured leadership framework and defined roles across the ten FPO clusters mentioned in the impact assessment.
- **Economic and Social Returns**
The model has generated revenues exceeding ₹2 crores. The content analysis confirms that this financial success is directly linked to farmer motivation: Farmer Economics/Profit (Code 12) was highly cited (16 mentions), led by Seed Producer Farmers (6 mentions). This economic incentive is reinforced by the high frequency of Yield/Quality Improvement (Code 11, 13 mentions) cited by Farmer Members, confirming the model provides value to both producers (higher profit) and consumers (better input). Furthermore, the 11 mentions of Social Recognition/Pride (Code 13) highlight the non-financial benefits of empowerment and community standing.
- **Quality Assurance through Internal Accountability**
The impact assessment notes a 10% improvement in seed quality. The content analysis reveals this is achieved through internal processes rather than formal certification. The high frequency of Technical

Discipline (Code 8, 15 mentions), led by Seed Producer Farmers, demonstrates that adherence to crucial field protocols (e.g., rouging) is successfully internalized. The use of the Participatory Guarantee System (PGS, Code 7), as cited in the implementation process, serves as the necessary quality assurance mechanism that avoids the financial and logistical barriers of conventional certification.

Constraints and Solutions

The implementation of the FLSPS, while successful, highlights a clear disparity between institutional robustness and infrastructural capacity.

- **The Infrastructure Bottleneck**
The most compelling constraint identified by the stakeholders is the Infrastructure Gap (Code 17), which registered the highest count of 21 mentions in the entire analysis. The fact that this code was jointly led by CEOs and BODs (6 mentions each) confirms that the management layer responsible for scale and finance is most acutely impacted by the lack of permanent godowns, advanced cleaning machines, and cluster-level labs. This finding is critical: the social and governance structures of the FLSPS are robust, but its physical capacity to scale and process the increasing seed volume (4,700 bags in Rabi 2024) is severely constrained. This lack of infrastructure exacerbates the Operational Challenges (Code 15) and the difficulties caused by Short Time Gaps Between Seasons, which limits time for drying, processing, and distribution.
- **Regulatory and Operational Challenges**
Other constraints, such as regulatory delays and market instability, are being addressed by adaptive solutions. The centralized seed license obtained under SAPCO (Solution A) addresses the frequently cited Regulatory Delays. The establishment of the Revolving Fund

(Solution G) directly mitigates the Working Capital Constraints, ensuring financial viability (a Critical Success Factor). The prioritization of Rabi season production (Solution H) is a direct, data-driven response to the challenges of weather risk (Climatic/External Risk, Code 16) and limited post-production time.

Conclusion

The Federation Led Seed Production Model has demonstrated the power of collective action in transforming Farmer Producer Organizations (FPOs) into resilient and financially viable enterprises. Through strategic planning, shared resources and innovative marketing approaches, the model has strengthened seed production, improved quality assurance and enhanced market access for smallholder farmers. Despite challenges such as regulatory hurdles, financial constraints and market instability, the federation has successfully implemented adaptive solutions, including participatory quality assurance, demand driven production planning and decentralized distribution networks. By fostering collaboration among FPOs, integrating technology and ensuring governance structures are robust, the model has laid a strong foundation for a sustainable and inclusive seed system. The establishment of Sahaja Beej as a farmer driven seed federation exemplifies how grassroots institutions can scale operations and compete in the broader agricultural market. Moving forward, continuous innovation, policy support, and investment in capacity building will be crucial to further strengthening and expanding this initiative, ensuring long-term benefits for farmers and the agricultural ecosystem.

The content analysis validates the model's key success factors: a strong, recognized institutional framework (Category II), and a powerful economic driver (Code 12). Moving forward, continuous innovation, policy support, and investment in capacity building will be crucial to further strengthening and expanding this initiative. Specifically, the high consensus on the Infrastructure Gap (Code 17) necessitates a strategic shift towards capital investment to unlock the full scalability potential (Code 18) of the FLSPS model. This is how grassroots institutions can scale operations and compete in the broader agricultural market.

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