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Future of Pulses and Legumes Seed Systems in India

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Context

India is one of the world's largest producers and consumers of pulses. These grains are the cornerstone of India's food and nutrition security, and the country's ability to meet future demand depends on how swiftly it can transform its seed systems.

The Big Challenge

- India must increase pulse production by 2.2% annually to reach 39 million tons by 2050 (IIPR, 2015).
- The country still imports 4.7 million tons annually, despite rising output, from 16.3 million tons in 2015–16 to 24.5 million in 2023–24 (PIB, 2024).

This paradox underscores a deeper challenge: while pulses enrich diets and restore soils, the seed systems for pulses remain underdeveloped compared with cereals and other high-value crops. In response, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and the Centre for Research on Innovation and Science Policy (CRISP) brought together key stakeholders in a national policy dialogue in November 2024 to rethink the future of pulses and legume seed systems in India. This brief captures the urgent context, the persistent challenges, and the way forward.

Challenges in Pulse Production

- Climate-related constraints and biotic/abiotic stresses
- Farmers relegate pulses to marginal and residual lands and reserve fertile land for paddy and wheat
- Limited access to markets
- Inefficient post-harvest management systems
- Slow pace of technological advancement
- Gaps in the distribution of improved pulse varieties
- Constraints on skill development and capacity-building systems
- Underdeveloped seed systems for pulses.

Key Policy Recommendations

- Ensure Quality Assurance Mechanisms and Reform the Seed Certification and Notification Process
- Expand Storage and Processing Infrastructure
- Enhance the Quality of Extension Services
- Develop Climate-Resilient Varieties
- Incentivize the Private Sector to Manage Risks
- Promote Inclusive and Sustainable Seed Systems
- Strengthen Public-Private Collaboration

Challenges in the Pulses Seed Systems

Inadequate Quality Assurance Mechanisms

Farmers often encounter challenges in accessing genuine, high-quality seeds of pulses. The inconsistencies in seed quality undermine farmer confidence and productivity. Additionally, the lack of decentralized seed testing facilities create delays in quality assurance processes, particularly in rural and remote areas[1]. Ensuring that seeds meet the standards claimed on their labels remains a persistent issue.

Infrastructure and Storage Deficiencies

The lack of sufficient storage facilities for pulses, particularly at the local levels, is a significant bottleneck. Pulses, being delicate and prone to damage, require specialized storage conditions to maintain their viability. Farmers often resort to storing seeds in suboptimal conditions, leading to spoilage and loss of potential yield. Moreover, the absence of adequate processing units further hinders the ability of farmers and farmer-producer organizations (FPOs) to market their seeds effectively.

Knowledge Gaps and Weak Extension Services

Sustainable seed availability and choice are crucial for farmers who rely on multiple sources with varying strengths and risks (Louwaars and Manicad. 2022). There are limited extension interventions in the pulses sector. Farmers often lack access to comprehensive, location- specific information about seed varieties best suited to their soil and climatic conditions. The gap between research outputs and field-level application exacerbates this issue, with many innovations in seed technology failing to reach their intended beneficiaries.

Climate Change Impacts

Rainfed pulses productivity is threatened by climate change, with high temperatures and drought during podding. Many pulse-growing regions face temperatures exceeding the 35°C tolerance limit. Additionally, pulses cannot benefit from high CO_2 levels due to their stressed growing conditions (Basu et al. 2016). Many pulses varieties are ill-suited to cope with these rapid climatic changes. For instance, warmer winters have disrupted the planting and growth cycles of chickpea and lentils in some regions of India.

High Costs of Seed Production

Due to the lack of economies of scale and quality assessment mechanisms, traders and merchants primarily focus on consolidating, sorting, and grading pulses (Abraham and Pingali. 2021). Without sufficient financial incentives or subsidies, the prices of seeds produced can't be reduced, and this adversely affects the adoption of improved seed varieties.

Fragmented Seed Systems

India's pulses seed system is characterized by a fragmented structure with weak linkages between the formal and informal systems. While formal systems focus on producing breeder and foundation seeds, informal systems—driven largely by farmer-saved seeds—account for over 70% of the seed supply[2]. The lack of integration between these systems leads to inefficiencies and missed opportunities for scaling up production.

Weak Commercial Seed Value Chains

The seed value chain for pulses is predominantly public-sector-driven, with limited private-sector engagement (See box). While crops like rice and wheat benefit from robust commercial seed markets, pulses largely rely on public initiatives like the Seed Village Program and the National Food Security Mission. The absence of profitable hybrids in pulses disincentivizes private companies from investing in their development, commercialization, and distribution, leaving gaps in the availability and accessibility of high- quality seeds.

[1]https://tracextech.com/forward-traceability-in-theindian-seed-industry/

[2]Mula MG, Saxena KB, Gaur PM and Upadhyaya HD. 2013. Legumes Seed System in Asia: A Case in India. In: FAO & ICRISAT 2015. Community Seed Production, by Ojiewo CO, Kugbei S, Bishaw Z & Rubyogo JC (Eds). Workshop Proceedings, 9 - 11 December 2013, Jupiter International Hotel, Addis Ababa, Ethiopia.

WHY IS THE PRIVATE SECTOR NOT INVESTING ENOUGH IN SEED SYSTEMS OF PULSES?

The private sector's role in the pulses seed market is notably limited compared to its involvement in other crops like cereals and oilseeds. This reluctance stems from structural and economic factors that discourage investment in research, development, and commercialization of pulses seeds. These barriers are as follows:

- The lack of exclusivity diminishes the incentive for private companies to invest in breeding programs, as farmers can save and reuse seeds, reducing repeat purchases.
- Developing high-performing varieties requires significant resources and long-term commitments, but the returns on such investments remain uncertain. Furthermore, the regulatory environment does not sufficiently incentivize private entities to collaborate with public research institutions, limiting opportunities for innovation.
- Even when improved pulses varieties are developed, commercializing them poses challenges due to fragmented markets and low demand. Farmers often prioritize cost over quality, relying on saved seeds or purchasing cheaper alternatives from informal sources. This price sensitivity dissuades private companies from engaging in the pulses seed market, which lacks the scalability and profitability of other crop segments.
- The pulses seed value chain involves substantial costs for quality assurance, storage, transportation, and promotion. For private companies, maintaining the purity and quality of seeds is a logistical and financial burden. The lack of adequate infrastructure further exacerbates these challenges, increasing operational costs and reducing profit margins.
- In India, intellectual property protection for self-pollinated crops like pulses remains inadequate. Without mechanisms such as patents or plant variety protection laws that ensure exclusive market rights, private players are hesitant to introduce proprietary innovations. This limits the development of high-yielding, climate-resilient pulses varieties by private firms.
- Collaboration between public research institutions and private companies is often constrained by restrictive policies on sharing pre-release germplasm. This prevents private companies from leveraging publicly developed genetic materials to create and market new pulses varieties. Such barriers hinder potential synergies that could strengthen the seed ecosystem.
- Pulses are typically grown in marginal areas with unpredictable yields and variable market prices (Sekhar and Bhatt. 2012). A high-risk rainfed environment including rice fallows discourages private-sector investments, as farmers may not consistently purchase improved seeds. Additionally, farmers' preference for familiar seed varieties over new options further limits market penetration for private companies.
- Public-sector entities often benefit from subsidies for seed production and distribution, which the private sector does not receive. This creates an uneven playing field, where private firms struggle to compete with subsidized products, further discouraging their participation in the pulses seed value chain.

Opportunities for Improving Pulses Seed Systems

Ensuring Quality Assurance Mechanisms

Though setting up labs in every village to test seed quality is difficult, it is possible to use primary societies or cooperatives at the village level. Farmers could bring seed samples to these centers and receive test results within a certain timeframe, even considering transportation logistics. This system could allow individuals to get their seeds tested, which would have a long-term positive impact on seed quality.

Promoting Decentralized Production, Storage, and Distribution

Establishing small-scale, rodent- and moisture- proof storage units at the village level reduces seed wastage and spoilage. These facilities can be owned and managed by local farmer groups or cooperatives. FPOs can serve as hubs for decentralized seed production, aggregation, and distribution, ensuring that quality seeds reach smallholder farmers. By managing seed production locally, FPOs reduce dependency on external suppliers. Providing targeted financial support, such as grants or low-interest loans, enables FPOs to invest in seed processing units, storage facilities, and marketing infrastructure. Programs to train FPO members in seed production techniques, certification processes, and market strategies are vital. This ensures consistent quality and enhances trust among buyers.

Public and private actors can jointly support FPOs and cooperatives to improve seed multiplication and distribution. Farmer-led distribution networks ensure that seeds are available when needed, mitigating delays caused by centralized systems. Facilitating direct sales of seeds through e-commerce platforms also reduces dependency on intermediaries, ensuring fair pricing for farmers and better accessibility for buyers.

Strengthening Extension Services

AI-powered platforms can recommend location-specific seed varieties to farmers based on soil, climate, and historical yield data. Mobile-based applications and digital platforms can provide farmers with real- time information on seed availability, market prices, and best practices for seed storage and planting. Online marketplaces for seeds, operated collaboratively, can reduce distribution costs and improve accessibility.

Extension programs should focus on engaging women and marginalized farmers, who often lack access to formal agricultural support systems. Empowering these

groups with knowledge and resources can significantly enhance seed system efficiency. Promoting women-led seed enterprises can create additional income streams while boosting local seed availability and quality. Educating farmers to identify and cultivate climate-resilient pulses varieties can mitigate risks associated with extreme weather events.

Development of Hybrids and Climate-Resilient Varieties

Public-sector R&D programs can collaborate with private companies to develop stable hybrids with mechanisms for shared intellectual property rights. Pilot projects for hybrid seed commercialization, supported by public subsidies or incentives, can encourage private-sector participation. Joint research efforts can focus on breeding varieties that withstand extreme weather conditions and shifting planting windows. Pilot programs for testing and scaling climate-resilient seeds can involve both public and private stakeholders, ensuring broad adoption.

Involving farmers in testing and evaluating new seed varieties can ensure that the outcomes align with ground realities. This participatory approach enhances adoption rates and trust in new technologies. Farmer-driven data collection on seed performance under local conditions can guide both public and private research, ensuring continuous improvement in seed systems.

Enhancing Market Access and Risk Sharing

Value chain financing models, where public institutions provide seed purchase guarantees, can mitigate market risks for private players. Collaborative marketing campaigns can educate farmers on the benefits of improved pulses varieties and promote their adoption.

Integration of Formal and Informal Seed Systems

Strengthening informal seed systems, which account for over 70% of pulses seeds, can help bridge gaps in formal systems. Initiatives like community seed banks, supported by public funds and managed by private companies, can ensure the availability of quality seeds.[3] Farmer-managed seed banks preserve traditional varieties and ensure timely availability of seeds tailored to local agro- climatic conditions. These banks enhance seed diversity and resilience against climate change.

Encouraging peer-to-peer seed exchanges can foster trust and spread improved practices. Informal networks often act as the primary source of seeds in rural areas (Coomes et al. 2015). Farmers are custodians of indigenous seed varieties that are often more suited to specific local conditions. Providing incentives for the preservation and propagation of these varieties ensures biodiversity and supports agroecological resilience.

Public-Private Collaboration

Strengthening the pulses seed system in India requires robust collaboration between the public and private sectors. Leveraging the strengths of both can address existing gaps, improve seed availability, and promote the adoption of high-yielding, climate-resilient varieties. Utilizing certified seeds provided by private sector seed companies for the promotion of improved crop varieties in potential areas, explicitly branded with their respective company names, is recommended.

This approach aims to enable farmers to directly observe the performance of commercially available, branded seeds under local conditions, build farmer trust and familiarity with specific varieties, and facilitate direct access for farmers to purchase those seeds after the demonstration period.

Public research institutions such as the Indian Council of Agricultural Research (ICAR) and ICRISAT possess advanced infrastructure and germplasm collections, while private companies have expertise in large-scale product development and marketing.

Collaborative agreements can allow private entities to use public research facilities under clearly defined conditions, incentivizing R&D investments. Joint breeding programs focused on high-yielding, climate-resilient pulses varieties can reduce development costs and risks while ensuring faster commercialization.

[3]Singh SK, Dubey SK, Ali M, Nigam SN, Srivastava RK, Saxena KB and Kumar A. 2013. Development and promotion of an informal and formal seed system through farmer participatory seed production of pigeonpea (*Cajanus cajan L.*) in Uttar Pradesh, India. Agroecology and Sustainable Food Systems, 37(5), 531-549.

Policy Recommendations

The following policy recommendations are proposed to address the challenges facing India's pulses seed systems and unlock its full potential. These recommendations aim to build a sustainable, inclusive, and resilient seed systems that balances public and private sector roles while empowering farmers.

Ensure Quality Assurance Mechanisms and Reform the Seed Certification and Notification Process

- Simplify and FastTrack the Certification Process to reduce delays and bureaucratic hurdles, particularly for FPOs and small- scale seed producers.
- Replace state-based variety notifications with agro-climatic zone-based notifications to ensure broader applicability and adoption of suitable varieties.
- Expand the use of digital traceability systems to ensure the authenticity and quality of seeds throughout the supply chain.

Expand Storage and Processing Infrastructure

- Invest in small-scale, decentralized storage facilities in the Public-Private Partnership (PPP) model tailored to the specific needs of pulses. This includes rodent-proof and climate-controlled storage units. Funding available from Rashtriya Krishi Vikas Yojana (RKVY) and the Agricultural Infrastructure Fund (AIF) can be used to establish such infrastructure for seed storage as well.
- Provide financial and technical assistance to establish processing units for pulses at the local level, enabling FPOs and cooperatives to add value and access new markets.

Enhance the Quality of Extension Services

- Provide targeted grants and training programs for FPOs to enhance their role in decentralized seed production, processing, and marketing. Encourage partnerships with government and private entities to scale operations.
- Support the establishment of village-level seed banks managed by FPOs/ Farmers' collectives to improve access to quality seeds and reduce dependency on external suppliers.
- Develop comprehensive platforms (AI- enabled) that provide region-specific recommendations on seed varieties, agronomic practices, and climate risks. Make these accessible via mobile apps and web portals.
- Define clear metrics to assess the performance of the seed systems initiatives, including adoption rates, yield improvements, and farmer satisfaction.
- Establish channels for continuous feedback from stakeholders, including farmers, researchers, and private companies, to refine policies and programs.

Develop Climate-Resilient Varieties

- Invest in R&D to develop pulses varieties that are tolerant to heat, drought, and erratic rainfall. These programs should prioritize the needs of regions most vulnerable to climate change.
- Engage farmers in the breeding and testing process to ensure new varieties are suited to local agro-climatic conditions.

Incentivize the Private Sector to Manage Risks

- Introduce crop insurance and guaranteed procurement schemes for pulses to reduce market risks and encourage private-sector investments in seed systems.

Promote Inclusive and Sustainable Seed Systems

- Design targeted subsidy programs that prioritize newer, high-performing varieties and focus on marginalized and smallholder farmers. Gradually shift subsidies to incentivize private-sector participation.
- Recognize and support the role of informal seed systems by providing training and resources to farmer-led initiatives. Encourage collaboration between formal and informal systems for knowledge exchange and quality enhancement.

Strengthen Public-Private Collaboration

- Unlock high-potential areas (underutilized agro-ecologies) for pulses expansion through targeted interventions, demonstrate short-duration pulses and establish sustainable and localized seed systems through the PPP model, ensuring sustained seed access.
- Establish structured partnerships between public research institutions and private companies to develop high- yielding and climate-resilient pulses varieties. Incentivize private investment by offering access to public germplasm and infrastructure under fair intellectual property agreements.
- Facilitate public-private co-investment in seed testing, processing, and storage facilities to reduce operational costs and improve seed quality.
- Establish policy frameworks that incentivize private-sector R&D in pulses seeds through tax breaks, grants, or co-funding schemes.

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About

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a pioneering non-profit organization focused on scientific research for development, committed to transforming dryland farming and agri-food systems. Working with global partners, ICRISAT develops innovative solutions to address hunger, poverty, and environmental degradation, benefiting 2.1 billion people across the drylands of Asia, Africa, and beyond.

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