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# Unraveling the potential of
## soybean in south-eastern Rajasthan

**M. S. Meena*, Raveena Bishnoi and Dilip Panwar**

*ICAR-Agricultural Technology Application Research Institute, Zone-II, Jodhpur, Rajasthan 342 005*

*India, with about 20% of the oilseed area and 10% of production, ranks 4th globally. The area and production of oilseeds have grown significantly over the last 30 years, however, compared to paddy and wheat, the growth of oilseeds has been less pronounced, with wide variability in yield across states. The major causes of poor productivity include traditional practices, use of farm-saved seeds from old varieties, cultivation under input-constrained conditions, and the struggle to combat biotic and abiotic stresses. One of the innovations in the frontline extension approach, implemented since 2016–17, was the use of FLDs in clusters instead of individual farmers' fields. CFLDs were initiated under the ICAR-DA&FW collaborative project, implemented by frontline extension institutions at the district level. This proved an effective tool in educating farmers about improved cultivars and agro-techniques of oilseeds. During 2022, 725 CFLDs on soybean were conducted on 296 ha in south-eastern Rajasthan to popularise improved technologies among farmers. A full package of practices for soybean was demonstrated at farmers' fields by KVKs. Results showed a yield advantage of 24.6% in demonstrations compared to farmer practices. The net return also increased by ₹12,959/ha with the demonstrations. CFLDs, while demonstrating the benefits of new technologies in clusters of adjacent areas, facilitated better learning among farmers, along with efficient use of resources and easy monitoring.*

**Keywords:** CFLDs, Net return, Soybean, Yield

INDIA accounts for about 20% area under oilseeds and 6–7% of vegetable oil production, globally. India is one of the largest vegetable oil-consuming nations with 9–10% of the total edible oil consumption. In terms of acreage, production, and economic value, oilseeds are second only to food grains. India has been importing nearly 60% of its edible oil requirements due to limited domestic production. In the past, policy initiatives have been taken to enhance oilseed production. The National Food Security Mission (NFSM), launched in 2007, aimed to bring additional areas under edible oilseeds through pulse-based cropping systems. After 2014, the majority of the developmental schemes provided for the cluster approach of demonstrations were amply supported by quality seed and associated inputs. The NFSM also transformed to include Cluster Frontline Demonstrations (CFLDs) on pulses/oilseeds, along with assistance for the seed hub on pulses and oilseeds. While pulse production increased substantially, reducing the gap between demand and supply, the edible oil demand and supply gap remains very large. To bridge this gap, concerted efforts have been initiated through the ICAR-KVK system in the form of


Cluster frontline demonstration of soybean

**Table 1.** Area, production, and productivity of soybean in India

| State | Area (million ha) | Share of India (%) | Production (million tonnes) | Share of India (%) | Productivity (Kg/ha) |
|---|---|---|---|---|---|
| Maharashtra | 4.69 | 38.19 | 5.47 | 42.16 | 1168 |
| Madhya Pradesh | 5.51 | 44.94 | 5.39 | 41.50 | 978 |
| Rajasthan | 1.16 | 9.42 | 0.93 | 7.12 | 801 |
| Karnataka | 0.37 | 3.05 | 0.43 | 3.32 | 1152 |
| Gujarat | 0.22 | 1.83 | 0.37 | 2.82 | 1631 |
| Telangana | 0.16 | 1.26 | 0.27 | 2.05 | 1716 |
| India | 12.11 | 100.00 | 12.86 | 100.00 | 1059 |

*Source*: Agricultural Statistics at a Glance, 2022, Ministry of Agriculture and Farmers' Welfare, GOI.

CFLDs on oilseeds.

## Cluster approach of FLDs

Frontline demonstration (FLD) is an easy means of transfer of technology ahead of the mass extension approach. FLD is a form of applied research through the ICAR/ SAUs system on the latest notified/ released varieties, along with a full package of practices on identified farmers' fields to demonstrate the potential of the technologies to the participating and neighbouring farmers, as well as other agencies, and to analyse the performance of the technologies for scientific feedback. CFLD is an innovation over FLDs in which, rather than an individual farmer's field, a cluster of a sizable area is adopted for demonstrating the package of practices. CFLDs aim to enhance the adoption of new technologies and improve agricultural productivity.

Soybean (*Glycine max* L. Merrill) is an important oilseed crop grown under rainfed conditions of vertisols during the *kharif* season. The oil content ranges from 18–22%, with a very high protein content of 38–42%. Among the nine oilseed crops officially reported, soybean constitutes 38% of production and 44% of the total area of oilseeds. The acreage of soybean is 12.11 Mha with production of 12.86 million tonnes, during 2021–22 (MOA 2022). The national average yield of the crop is 1059 kg/ha. Amongst the leading soybeans producing states, Rajasthan ranks third after Maharashtra and Madhya Pradesh. The productivity of soybean in Rajasthan is 801 kg/ha, which is less than the national average. Soybean, in Rajasthan, is predominantly grown in the humid ecosystem of south-eastern Rajasthan. Rajasthan as one of the leading state of soybean production, holds prominence in augmenting soybean production. To capitalise on this potential, 13 KVKs conducted 725 CFLDs to showcase full package of practices for soybean, including new varieties, seeding techniques [Integrated Nutrient Management (INM) and Integrated Pest Management (IPM)], disease management, and intercropping, over a 296 ha area. Four varieties of soybean released after 2011 were demonstrated at farmers' fields. CFLDs on soybeans aim to popularise the latest high-yielding varieties of soybeans, along with production and protection technologies, in this major crop within the edible oilseed group in the country.

**Table 2.** Characteristics of soybean varieties demonstrated during 2022 in Rajasthan

| Variety/year of release | Parent institute | Average yield (q/ha) | Maturity days | Characteristics |
|---|---|---|---|---|
| JS-20-34 (2014) | Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur | 22–25 | 87 | • Extra early maturing<br>• Thermo-insensitive<br>• Resistant to charcoal rot, girdle beetle, and stem fly |
| JS-20-29 (2014) | JNKVV, Jabalpur | 25–30 | 95 | • Early maturing<br>• High yielding<br>• Resistant to Yellow Mosaic Virus (YMV) and charcoal rot |
| JS-20-69 (2016) | JNKVV, Jabalpur | 25–28 | 94 | • Resistant to YMV, charcoal rot, bacterial pustules, Alternaria leaf spot, pod blight, and Indian bud blight |
| RKS-24 (2011) | Agriculture University, Kota | 30–35 | 95–98 | • Moderately resistant to bacterial pustule, collar rot, YMV, girdle beetle, stem fly, and defoliators |

*Source*: http://jnkvv.org/Departments/Dep_DRS_VarietiesDeveloped.aspx and https://www.manage.gov.in/publications/eBooks/Climate%20Smart%20Soybean%20Production%20Technologies.pdf (Assessed on 07.03.2024)

**Table 3.** Performance of soybean varieties during *kharif* 2022 in Rajasthan (n=725)

| Variety | KVKs | Average yield-FP (q/ha) | Average yield-CFLD (q/ha) | Yield gap (%) |
|---|---|---|---|---|
| JS-20-34 | Bhilwara-I | 13.60 | 16.95 | 24.6 |
| | Chittorgarh | 14.90 | 17.30 | 16.1 |
| | Pratapgarh | 13.65 | 16.23 | 18.9 |
| | Udaipur-I | 9.20 | 12.25 | 33.1 |
| | Udaipur-II | 14.70 | 19.05 | 29.5 |
| | Kota | 14.17 | 16.40 | 15.7 |
| | Bundi | 13.66 | 16.64 | 21.8 |
| | Jhalawar | 6.34 | 8.80 | 38.7 |
| | Sawai Madhopur | 9.59 | 11.89 | 23.9 |
| | Baran | 9.40 | 11.70 | 24.4 |
| JS-20-29 | Banswara | 14.60 | 17.80 | 21.9 |
| JS-20-69 | Dungarpur | 11.66 | 15.71 | 34.7 |
| RKS-24 | Rajsamand | 12.80 | 14.88 | 16.2 |
| Weighted mean | | 12.44 | 15.30 | 22.98 |

### Yield and yield gap

The average yield under demonstrations was 15.30 q/ha, with a net return of ₹44,184.12/ha, compared to farmers' practice (12.44 q/ha) with a net return of ₹31,225.21/ha. The CFLDs resulted in a yield increase of 22.98% over farmers' saved seeds grown in control plots.

### Intra and inter-variations in districts and varieties

Substantial inter- and intra-varietal, as well as inter- and intra-district variations, were observed in the performance of soybean under farmer practices as well as CFLDs. Among the four varieties, JS-20-34 was demonstrated by 10 KVKs over an area of 240 hectares. The intra-variety variation for JS-20-34 was in the range of 6.34–14.90 q/ha under farmer practice and 8.8–19.05 q/ha under CFLDs. Intra-varietal variations were observed only for the JS-20-34 cultivar, as it was the only variety among the four that was demonstrated in 10 KVKs across different districts. This variety also exhibited intra-district variation, as demonstrated in two KVKs (Udaipur-I and Udaipur-II) within the same district, Udaipur. CFLDs also exhibited considerable inter- and intra-variety and district variations in their performance across Rajasthan. The intra-varietal and intra-district variation in demonstration plots was 55.51% in Udaipur conditions under JS-20-34, whereas under farmer practice, a variation of 59.8% was observed. In the Jhalawar variety (JS-20-34), production was reduced by 135% and 45% compared to Chittorgarh and Udaipur-I, respectively, under farmers' practices, and by 116% and 33% less than those obtained at Udaipur-II and Baran, respectively under CFLDs. This could be due to the soil and climatic conditions in the district. The constraints in soybean production could not be fully offset by HYVs alone. The management of natural resources and other yield-maximising options holds equal importance for realising the potential of the HYVs to achieve higher production. The soybean variety JS-20-34 proved to be the best-performing, which should be promoted by the State Department of Agriculture. The yield gap between CFLDs and farmers' practices ranged from 15.11–38.81%. The yield gap analysis established the narrowest yield gap of 15.11% under Kota conditions with the soybean variety JS-20-34, and the widest gap of 38.81% under Jhalawar conditions was recorded with the JS-20-34 variety of soybean. This shows a large yield reservoir can be exploited in soybean in Rajasthan. The yield performance of JS-20-34 was lowest at Jhalawar district under CFLDs (8.8 q/ha) as well as farmers' field (6.34 q/ha).

This information underscores the significant variability in soybean yields, both within the same variety across different districts and within the same district. It also indicates that while CFLDs tend to reduce variability compared to traditional farming practices, substantial differences in performance persist. This suggests that factors beyond cultivation practices, such as environmental conditions, soil quality, and local farming practices, continue to have a significant influence on soybean yield outcomes. While CFLDs contribute to more stable and consistent soybean yields, there is a need for further investigation and tailored interventions to address the external factors affecting yield variability. Continued research and adaptive strategies are crucial for optimising soybean production and minimising yield disparities across various regions and practices.

**Table 4.** Economics of CFLDs on soybean in Rajasthan during *kharif* 2022 (n=725)

| KVKs | Economics of FP | | Economics of CFLDs | |
|---|---|---|---|---|
| | Net return (₹/ha) | B:C ratio | Net return (₹/ha) | B:C ratio |
| Bhilwara-I | 41,100.0 | 3.04 | 54,471.0 | 3.50 |
| Chittorgarh | 37,620.0 | 2.42 | 46,040.0 | 2.62 |
| Pratapgarh | 42,290.0 | 2.63 | 53,640.0 | 2.95 |
| Udaipur-I | 17,217.0 | 1.99 | 27,070.0 | 2.34 |
| Udaipur-II | 36,450.0 | 2.63 | 59,415.0 | 3.64 |
| Kota | 35,490.0 | 2.00 | 47,993.0 | 2.41 |
| Bundi | 32,900.0 | 1.93 | 49,890.0 | 2.49 |
| Jhalawar | 12,659.7 | 1.64 | 27,180.6 | 2.24 |
| Sawai Madhopur | 24,211.0 | 2.42 | 31,149.0 | 2.56 |
| Baran | 7,620.0 | 1.23 | 20,020.0 | 1.64 |
| Banswara | 41,900.0 | 2.35 | 54,100.0 | 2.55 |
| Dungarpur | 37,870.0 | 2.02 | 57,247.0 | 2.97 |
| Rajsamand | 38,600.0 | 2.93 | 46,178.0 | 3.22 |
| Average | 31,225.2 | 2.25 | 44184.1 | 2.70 |

### Income augmentation

CFLDs resulted in better average net return and benefit-cost ratio for soybean (₹44,184.12/ha and 2.70, respectively) than farmer practice (₹31,225.21/ha and 2.25, respectively). On average, a yield advantage of 288 kg/ha was achieved by CFLDs, which added ₹1042.93/ha to the farmers' income. Improved varieties of soybean under CFLDs yielded distinct monetary advantages over the farmers' saved seeds or varieties. All four improved varieties of soybean showed beneficial monetary returns, ranging from ₹20,020 with JS-20-34 variety at Baran conditions to ₹59,415 with JS-20-34 variety at Udaipur-II conditions.

### Extension activities under CFLDs

Farmers and scientific staff of KVKs underwent capacity-building through a series of training sessions and various extension activities. These activities included organising field days, facilitating field visits by scientists for crop monitoring, addressing farmers' issues, and

promoting experience-sharing initiatives. During 2022, a total of 13 training sessions, 20 field days, and one field visit were conducted under CFLDs on soybean, engaging 1,251 participants.

### Challenges experienced

- Challenging climatic conditions persisted during the crop period, characterised by drought, prolonged dry spells, water stagnation, and low infiltration rate of the soils (vertisols).
- Increased prevalence of biotic stress, particularly, insect pests and diseases in soybean under humid conditions.
- The majority of the farmers reported no or low degree of seed treatment by fungicides and application of fertilisers, herbicides, and plant protection measures for soybeans.
- Low awareness about contemporary agricultural technologies, hindering their adoption of improved and efficient farming practices.
- Farmers encounter difficulties in obtaining remunerative prices for their produce in local markets, affecting their overall profitability and economic viability.

### Future strategies

- Enhancing the soybean productivity and profitability through genetic enhancement.
- Implementing integrated production technologies to manage climate change impacts.
- Creating crop protection modules for effective biotic stress management.
- Developing speciality soybean varieties to expand their utilisation in the food system.
- Employing innovative technology dissemination methods to bridge technology gaps in soybean cultivation.

### SUMMARY

CFLDs, as an innovation over erstwhile FLDs, have proven their promise in enhancing the productivity and production of soybean in south-eastern Rajasthan. They have been able to create a mobilising ecosystem for transformational effects in soybean. The positive effects of knowledge, attitude, and skill upgrades in farmers' demonstration plots consistently displayed higher yields than those in farmers' practices. A huge yield reservoir of soybean is available for exploitation in south-eastern Rajasthan. The adjoining blocks under CFLDs helped foster better relationships and confidence among farmers, as well as between farmers and scientists, by creating a participatory environment for the exchange of knowledge and experiences. Partner farmers under CFLDs served as a vital source of information and quality seeds, facilitating the farmer-to-farmer dissemination of high-yielding soybean varieties. Soybean variety JS-20-34 proved to be the best-performing, which is recommended for promotion through crop development programmes implemented by mass extension agencies in the district for its outscaling. Another learning from CFLDs is the low availability of quality soybean seeds. The KVKs are advised to promote seed production of farmers' preferred varieties in a participatory mode at the KVK farm as well as in farmers' fields to augment seed availability. The ongoing programme of varietal development needs to evolve climate-resilient, multi-stress tolerant, and high-yielding varieties of soybean for south-eastern Rajasthan.

*Corresponding author email: s.mohar.meena@gmail.com