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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(7): 21-25

www.thepharmajournal.com
Received: 11-04-2023
Accepted: 13-05-2023

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Performance of cluster front line demonstrations on yield and economics of soybean in Shivpuri District of Madhya Pradesh

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Abstract
The study was carried out in selected cluster of Shivpuri district of Madhya Pradesh during consecutive *Kharif* seasons of the year 2020 and 2021 to assess the yield gap between improved variety with recommended practices for cultivation and farmer's practice under cluster front line demonstrations. Cluster Front Line Demonstrations on improved var. (JS-20-34) with improved practices were conducted at 25 framers' fields in 10 ha area. The data were collected from all selected farmers' fields and analyzed using simple tabular analysis. The improved technologies consisting use of new improved variety JS 20-34, seed treatment, line sowing with seed cum fertilizer drill, balanced dose of fertilizer based on soil test and integrated pest and disease management. The average yield of two years under improved technologies in CFLD was observed 11.67 q/ha which was 46.48 percent higher than the yield obtained over farmers practice (8.50 q/ha). Average Net income of Rs. 23,182 per ha with B: C ratio of 1.97 was obtained under cluster demonstrations as compared to farmers practice with Rs.10982 per ha and 1.46 respectively. The average technological and extension gap were found 13.33% and 3.17 q/ ha respectively.
The study registered higher benefit cost ratio under improved technological demonstrations and gave higher return over farmer's local practices and it could be concluded that the front line demonstrations have given a good impact over the farming community of Shivpuri district of Madhya Pradesh.

Keywords: Soybean, Cluster Front line demonstration (CFLD,) gap analysis, technology index, net income, b:c ratio

Introduction
Madhya Pradesh is known as the "soybean state" of India, comprising 55% of the total national area (5.56 million hectare) of soybean cultivation. Soybean has established its reorganization as both pulses and an oilseed crop. Soybean (*Glycine max.* L.) ranks first amongst oilseed crops in the world and it contributes nearly 25 per cent of worlds total oil and fat production. Soybean is a major crop grown during the *Kharif* season in the rain fed areas of central India and it is also observed as major *Kharif* crop of Shivpuri district of Madhya Pradesh in recent years. It is the cheapest and richest source of high-quality protein (40%) and 20% oil (Basediya *et al.*,2018 & 2020, Verma *et al.*, 2013, Singh, 2018, Singh *et al.*, 2019,) [2, 3, 21]. It supplies most of the nutritional constituents essential for human health. Hence, soybean is called as wonder crop or golden bean or miracle bean (Basediya *et al.*, 2018 & 2020) [2, 3]. The soybean is a crop of global importance and it is one of the most popularly cultivated crops worldwide. In Madhya Pradesh soybean is generally referred to as golden as well as wonder bean because seeds are rich in oil and proteins, amino acids, lysine (5%), which are deficient in most of the cereals (Singh, 2019) [21].
India is the 4thlargest producer of oilseeds in world after USA, China & Brazil and accounts for about 20 per cent of the total area under cultivation globally and accounting 10% of global production. Oilseed crops are the second most important determinant of agricultural economy next to cereals. In India, oilseeds account for 3% to the Gross Domestic Products and 10% to the total value of all agricultural commodities. Oilseed production assumes great importance in India because there is the huge gap in demand and supply which was resulted in import of vegetables oil worth millions of rupees per year. Soybean crop grown in rainfed condition and has higher price in market, so increased the rural economy of marginal and small farmers in our country.

Oilseeds are raised mostly under rainfed conditions and important for the livelihood of small and marginal farmers in arid and semi-arid areas of the country. In India, the soybean cultivation has gained momentum on oil front with the steady increase in the area and production. This crop has a greater potentiality to substitute different oilseeds to overcome the shortage of edible oil and protein rich food. It is a versatile crop with numerous possibilities of improving agriculture and associated industries not only as an oil seed crop and feed for livestock and aquaculture, but also as a good source of protein for the human diet and as a bio-fuel feedstock (Gupta *et al*., 2017) [20].

Soybean is an most important oilseed crop and emerged as an important commercial oilseed in Madhya Pradesh. Madhya Pradesh has its major share in area (70%) and production (65%) of soybean in India. Soybean crop is most important oilseed crop and plays an important role in agriculture economy in Madhya Pradesh and occupied the area of 66,74,411 ha with total production of 33,70,661 metric tones and average productivity of crop recorded 505 kg/ha during 2020-21 (https://mpkrishi.mp.gov.in). Soybean crop plays a important role in supplementing income for small and marginal farmers of Shivpuri district and this crop was grown in 211390 ha area with production of 82442 metric tones and average productivity of 390 kg/ha during 2020-21(https://mpkrishi.mp.gov.in).

The agriculture development is primarily depending on the application and adoption and extension of the scientific technologies by making the best use of available resources. Cluster Front Line demonstrations is the new concept of field demonstrations evolved by the ICAR with the inception of the technology mission on oilseed crops during mid-eighties (Ghintala *et al*., 2018) [1]. Introduction and transfer of improved technologies and proven package of practices is one of the mandates of Krishi Vigyan Kendra. Demonstration on farmer's field help to identify the constraints and potential of the crop in specific area. The main objective of the front-line demonstrations is to transfer of scientific technology to the farmers to increase their income. The new technologies and package of practice and improved varieties will lead to replacement of the old technologies/varieties and narrow down the technological gap with the adoption of newer technologies by the farmers.

Cluster front line demonstration (CFLD) is a novel approach to provide a direct interface between researcher and farmer for the transfer of technologies developed by them and to get direct feedback from farming community (Jha *et al*., 2020) [18]. These demonstrations are conducted under the supervision of team of KVK scientists to disseminate the technologies among the farmers and to get their feedback about the demonstrated technologies. Soybean is the most important oilseed crop in central region of the Madhya Pradesh, however, having lower levels of yield in farmer's field is due to lack of awareness and non-adoption of improved variety and technologies. Keeping above in views the present study was undertaken by RVSKVV- Krishi Vigyan Kendra, Shivpuri (M.P.) with the main objectives as: 1. To increase the production and productivity of soybean, 2. To know the yield gap between improved variety with recommended technologies and farmer's practice., 3. To demonstrate the productivity potentials and profitability of the latest and improved soybean production technology under real farm conditions with cluster front line demonstrations.

Methodology

The farmers were selected by organizing group meeting prior to conduction of demonstrations and specific comprehensive training was also conducted for the selected farmers regarding detail package of practices of soybean crop. Total 50 farmers were selected from different clusters and blocks of Shivpuri district to conduct the 50 Cluster Frontline Demonstrations (CFLDs) on farmer's field with GPS locations which covered an area of 20 ha with plot size 0.4 ha each consecutively during *Kharif* seasons of the year 2020 and 2021. Improved variety of soybean JS-20-34 with all recommended package of practices was used in carrying out cluster demonstrations. Layout of demonstrations was followed as suggested by Chaudhary (1999) [4] for the selection of site and farmers. Krishi Vigyan Kendra Shivpuri facilitated the farmers to conduct effective demonstrations and monitored the programme with time to time visits on the fields. All the technological interventions were taken as per prescribed package and practices for improved variety of crop (Table-1). The data for grain yield and economics of the soybean production under CFLD and farmers practice plot (local check) were recorded for computation of technology and extension gap, net return and additional return, B:C ratio (Table-2&3). Assessment of gap in adoption of recommended/demonstrated technology through personal discussions with selected farmers was carried out before laying out the CFLDs. The extension activities i.e., trainings, Scientist's field visits and crop field days were organized at the CFLDs locations. A base line survey was carried out to find out the problems under soybean crop cultivation in the demonstration area and it was observed that lower crop yield was mainly due to use of poor-quality local variety seed, no seed treatment, no soil testing, improper method of sowing and indiscriminate and imbalance use of inorganic fertilizers and plant protection chemicals resulting in poor plant population, growth and pod bearing. The improved technology and package of practices included high yielding and new variety (JS 20-34) seed, soil testing-based plant nutrition, seed rate, seed treatment, timely sowing, line sowing, maintenance of optimum plant population, use of integrated plant protection measures etc. In the study, technology index was operationally defined as the technical feasibility obtained due to implementation of demonstrations (Ghintala *et al*., 2018) [1] and finally the extension gap, technology gap and technology index were calculated using formula suggested by Samui *et al*., (2000) and Yadav *et al*., (2004) [17] and performance data has been recorded, compiled and compared for interpretation and inference.

Extension gap = Demonstrated yield - Farmer's practice yield

Technology gap= Potential yield - Demonstration yield

Additional return= Demonstration return- Farmer's practice return

$$\text{Technology index (\%)} = \frac{\text{Potential yield - Demonstration yield}}{\text{Potential yield}} \text{ X } 100$$

Results and Discussion

Technological intervention in cluster demonstrations

Krishi Vigyan Kendra Scientists and farmers made efforts in collaborative manner for making difference in higher production and productivity of soybean crop in the Shivpuri district of Madhya Pradesh. All recommended packages of practices for soybean were followed to conduct CFLDs with improved variety JS 20-34 at the farmer's field in different

clusters. The major differences were observed between demonstration package and farmer's practices are regarding recommended varieties, seed rate, seed treatment, soil testing, and fertilizer dose, method of fertilizer application and plant protection measures. Details of demonstration package and existing practices (farmer's practice) of soybean crop cultivation are given in Table-1. The data were collected from 50 farmers of two consecutive years 2020 & 2021 and analyzed using simple tabular analysis.

Grain yield

Grain yield performance and gap analysis of soybean crop under farmer's practice and CFLD plots are given in Table-2. From these results it is evident that the performance of improved variety with recommended package of practices was found better than the farmer's practice (local check) under same agro-ecological conditions. It was found that the average grain yield of soybean variety JS 20-34 under cluster demonstrations was recorded as 11.67 q/ha as compared to average local check (farmer's plots) yield of 8.50 q/ha with 46.48 percentage increase in the demonstration yield over local check was recorded. Similar yield enhancement results in different crops under demonstration were documented by Samui *et al.,* (2000), Hiremath *et al.,* (2007) [7], Mishra *et al.,* (2009) [12], Dhaka *et al.,* (2010) [5], Kumar *et al.,* (2010) [10], Deshmukh *et al.,* (2014) [6], Singh *et al.,* (2014) [15], Singh (2015) [16] and Singh *et al.,* (2017).

Technology gap, extension gap and technology index

The data pertaining to gap analysis of soybean crop cultivation under farmer's practice and CFLDs are presented in Table-2. Yield of the CFLDs and potential yield of the crop was compared to evaluate the yield gap/technology gap which was further categorized into technology index. The technology gap presents the gap in the demonstration yield over potential yield or there is a gap between the potential yield and demonstration yield and it was found 13.33 q/ha. This may be attributed to dissimilarities in soil fertility, environmental/climatic and weather situations, varietal suitability and adoption of recommended technological practices. Similar results were reported by Patel *et al.,* (2013) [13]. Hence, location specific recommendations may become necessary to narrow down the technology gap.

The extension gap indicating the need to educate and enhance the skills of the farmers through various extension approaches for the adoption of improved variety and technologies. Higher level of adoption of latest production technologies with use of suitable high yielding disease and pest tolerant crop variety will subsequently change this alarming trend of galloping extension gap.

Technology Index shows the feasibility of adoption of the technology and improved variety at the farmer's field. The lower value of technology index indicated the more feasibility of the demonstrated crop production technology. The value of technology gap and technology index were found as 3.17 q/ha and 53.32% respectively (Table-2). These results are in close proximity with the findings of Singh *et al.,* (2007), Patel *et al.,* (2013) [13] and Singh (2015) [16].

Economic analysis of soybean cultivation

The economics performance of soybean production in gird agro-climatic zone under CFLDs were evaluated and results are presented in Table-3. The overall average net returns and B:C ratio under cluster demonstration was Rs. 23,182 per ha and 1.96 whereas for farmer' practice (Local check) was Rs.10,982 per ha and 1.46 respectively. This improvement in economical parameters of demonstration plots might be due to higher level of yield of crop obtained with the application of seed treatment, balance dose of fertilizers, timely sowing, mechanical sowing method, proper and timely weed management and integrated pest and diseases management practices. The results revealed that the CFLDs gave good impact over the farmers practice (Local check). These findings are in accordance with the finding of Hirenmath *et al.,* (2007) [7], and Hirenmath and Nagaraju (2009) [8].

Further, additional cost of Rs.320 per ha in demonstration was increased additional net returns Rs.12,200 per ha, suggesting it has higher profitability and economic viability of the demonstration. The higher additional returns obtained under demonstrations could be due to improved production technology and regular monitoring of scientists of Krishi Vigyan Kendra. Similar results were also reported by Hirenmath *et al.,* (2007) [7] Dhaka *et al.,* (2010) [5], Lathwal (2010) [11], Patel *et al.,* (2013) [13] and Singh *et al.,* (2012).

Table 1: Details of package of practices followed by farmers under soybean crop cultivation

Intervention	Farmer's Practices	Demonstrated/recommended practices (CFLD)	Gap
Farming situation	Irrigated	Irrigated	-
Cropping system	Soybean-Mustard/wheat	Soybean-Mustard/wheat	-
Summer deep ploughing	No	Summer deep ploughing in April month	Fully gap
Soil treatment	No soil treatment	*Trichodarma viridae* 5 kg/ha with 250 kg rotten Cow dung (FYM)	Fully gap
Variety	JS 95-60	Improved variety JS 20-34	Varietal Gap
Seed rate (kg/ha)	100-125	80	More seed rate
Seed treatment	No application	Carbendazim+Mencozeb @3g/kg seed treatment	Fully gap
Spacing	Un uniform scattered plant population	Plant to plant: 8-10 cm Row to row: 30	Partially gap
Method of sowing	Line sowing by seed drill with mixing of seed and fertilizer	Line sowing with seed cum fertilizer drill	Partially gap
Nutrient management	Indiscriminate and imbalance fertilizer application (NPK: 27:69:0)	Balance dose of fertilizer based on soil testing (NPKS: 20:60:20:20)	Fully gap
Weed management	No use of herbicide and interculture	Imazethapyr @100 g/ha at 18-20 DAS + 1 HW at 40 DAS	Fully gap
Plant protection measures	Indiscriminate use of pesticides	Integrated pest and disease management practice for the management of pest and diseases and ned based use of pesticides.	Fully gap
Harvesting and threshing	Harvested of over-matured crops	Harvested as the pods turn yellowish and moisture	Fully gap

	causes shattering and losses of grains. Not considered of seed moisture content at harvesting and storage time.	content of the seed is about 18%. Storage of seed at 10% moisture content.	

Table 2: Average yield, Technology gap, Extension gap and Technology index of soybean as affected by recommended and farmer's practices:

CFLD conducted year	No. demo.	CFLD Area (ha)	Grain yield (q/ha)			% increased over FP	Straw yield (q/ha)		Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
			Potential yield of variety	RP	FP		RP	FP			
2020	25	10	25.00	8.44	5.00	68.80	9.44	5.20	16.56	3.44	66.24
2021	25	10	25.00	14.90	12.00	24.16	13.66	11.90	10.10	2.90	40.40
Average			25.00	11.67	8.50	46.48	11.55	8.55	13.33	3.17	53.32

Table 3: Economics of soybean crop production as affected by recommended practices and farmer's practices:

Year	Cost of cultivation (Rs./ha)		Gross return (Rs. /ha)		Net return (Rs. /ha)		B:C ratio	
	RP	FP	RP	FP	RP	FP	RP	FP
2020	23640	23000	33880	20024	10240	-2976	1.43	0.87
2021	24000	23960	60086	48900	36124	24900	2.50	2.03
Average	23820	23480	46983	34462	23182	10982	1.97	1.46

Conclusion

Cluster front line demonstrations gave higher yield and net returns with improved production technologies than the existing farmer's practice. The higher yields and returns in demonstrations showed that production and productivity of soybean crop at farmer's fields increased by adopting improved variety and technologies. The higher average grain yield was recorded in demonstrations field as compared to local check (farmer's practices) due to increase the awareness and use of improved variety, crop protection and production technologies.

The extension gap indicating the need to educate and enhance the skills of the farmers through various extension approaches for the adoption of latest technology. More and more adoption of latest technology package will subsequently change this alarming trend of galloping extension gap. The lower value of technology index indicated the feasibility of the demonstrated crop production technology.

Farmers were motivated by performance technological interventions in the CFLDs and it is expected that they would adopt and spread these packages and practice technologies in the coming years in the adjoining areas and villages. Therefore, the results advocated that the cluster front line demonstrations by intervention of improved variety and technology gave positive effects on production and productivity of crop. It can be concluded the production and productivity of soybean crop could be increased through cluster demonstrations approach by motivating the farmers for the adoption of improved production technologies.

Acknowledgements

The authors are thankful to the Director, ICAR-ATARI, Zone-IX, Jabalpur (M.P.) for providing financial assistance towards conducting these front-line demonstrations under CFLD oilseed programme.

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