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Yield Gap Analysis, Economics and Adoption of Sesame Cultivation through Front Line Demonstration in Pathankot District of Punjab, India

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A B S T R A C T

Sesame is one of the major oilseed crops cultivated in rainfed areas of India, which plays a major role in supplementing the income of small and marginal farmers of Pathankot district of Punjab state. Total 68 front line demonstrations (FLDs) were conducted on farmer's field in Pathankot district for three consecutive years (2017-18 to 2019-20) in two blocks. Prevailing farmer's practices were treated as control for comparison with demonstrated technology. The result of FLDs conducted by Krishi Vigyan Kendra, Pathankot in sesame crop shows a greater impact on farmer's livelihood due to significant increase in yield (551.6 kg ha^{-1}) over local check (365.3 kg ha^{-1}). The extension gap ranged between 71.0to294kg ha^{-1}, whereas the trend of technology gap ranged between 31to253kg ha^{-1}. The benefit cost ratio (B: C) was recorded higher under demonstrated practice (4.05), while it was 2.27 under check. The results of improved technological intervention brought out 33.77 % increase in yield of sesame. The overall adoption level of demonstrated sesame production technology was increased about 399.5 % due to the adoption of package and practices are followed.

Keywords

Benefit cost ratio, Front line demonstration, Grain yield, Sesame, Technology gap

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Introduction

Sesame (*Sesamum indicum* L.) is an ancient oilseed crop grown in India which is the largest producer of this crop in the world. Sesamum (*Sesamum indicum* L.) are flowering plants, which are cultivated in the tropical regions and is widely cultivated for the edible seeds. Sesame is called as queen of oilseed crops by virtue of its excellent oil quality. It is having the highest oil content (46-64%) and dietary energy (6355 k calkg^{-1}). It is used as a very common ingredient in the foods all over the world. Sesame crop can be grown in wide range of environments, extending from semiarid tropics and subtropics regions. It is mostly cultivated under rainfed conditions on marginal and sub-marginal lands with sub-optimal rate of fertilizer and poor management practices. Sesame is grown in areas rainfall of 625-1100mm and temperature of >27 ^{o}C. The crop is tolerant to drought, but not to water logging. This probably indicates a great opportunity for a higher increase in sesame productivity in India. India ranks first in terms of sesame growing area (23 %). In India, sesame is grown in 1784 lakh ha with an annual production of 850 M tonne and productivity of 486 kg ha^{-1} (www.indiastatcom, 2015-16). Though India is the largest producer and exporter of sesame in the world, the productivity is only 250 kg ha^{-1} (Puspha *et al.*, 2003). The main reason for low productivity of sesame is use of low yielding varieties (local), poor soil fertility and imbalanced nutrition (Engoru and Bashaasha, 2001). The oilseeds scenario in the country has undergone a sea change. The main contributors to such transformation are availability of improved oil seeds production technology along with its adoption and expansion of cultivated area. The improved technology packages were found to be financially attractive. Yet, adoption levels for several components of the improved technology were low emphasizing the need for better dissemination (Kiresur *et al.*, 2001).

Sesame constitutes nearly 11 per cent of the area and four per cent of the total oilseed production in the Punjab state and is the third important oilseed crops after rapeseed/mustard and sunflower, grown in Punjab. The area under sesame declined from 25.6 thousand hectares in 1966-67 to 13.4 thousand hectares in 1989-90 and further to 10.6 thousand hectares in 2004-05 (Statistical Abstracts of Punjab, 2005). The sesame production is concentrated in the districts of Amritsar, Ferozepur, Gurdaspur, Hoshiarpur and Pathankot. In Punjab, with more than 75 per cent of its production base (Grover and Singh,2007). The productivity level of sesame in the Amritsar and Ferozepur districts is above the state average, but the overall state average productivity of the crop has been almost stagnant over the years, reflecting inadequate research efforts made for the upliftment of sesame in the state (Grover and Singh, 2007). Sesame is also cultivated by the farmers belonging to the rainfed areas of Pathankot district but with local varieties and poor management practices leading to low yield of crop than average. The extent of adoption of improved agricultural technologies is a crucial aspect under innovation diffusion process and the most important for enhancing agricultural production at a faster rate. Large number of technologies evolved in the field of agriculture is not being accepted and adopted to its fullest extent by the farmers. The gap between recommendations made by the scientists and actual use by farmers is frequently encountered (Rohit and Singh, 2019). With the start of Cluster, frontline demonstrations, frontline demonstration on *kharif* oil seed crops using new crop production technology was started with the objectives of sowing the production potential of the new technologies under real farm situation over the locally cultivated oilseed crops. Total sixty eight frontline demonstrations were conducted by Krishi Vigyan Kendra, Pathankot in different villages of rainfed areas of Pathankot district. The main objective of FLD is to demonstrate the crop production technologies and management practices in the farmers' field under different agro-climatic regions and farming situations.

Materials and Methods

The present study was conducted by Krishi Vigyan Kendra, Pathankot of Punjab Agricultural University, Ludhiana across two blocks of the district *viz.* Pathankot and Dhar Kalan during *kharif* 2017-18 and 2018-19, but during 2019-20 it was conducted in dhar kalan block only. During the entire course of study, a total of 68 farmers were selected for conducting Cluster front line demonstrations of sesame on 30 hectare area. The crop raised by farmers following their own practices was taken as local standard check. Whereas, for front line demonstration plots an integrated crop management approach was demonstrated to farmers.

In this approach, all the practices demonstrated to farmers starting from quality seed to fertilizer, weed, insects and disease management were according to recommended package of practices. The crops were harvested at maturity stage with suitable method. To accomplish the integrated approach of demonstrations, KVK scientists conducted various monitoring visits on farmer fields. In addition to this, these visits were helpful in providing valuable feedback from different farmers that can be utilized for further improvement in research and extension programmes. Other extension activities including training programmes, exhibitions, group meetings and Field days were also organized at the demonstration sites to create awareness among the farming community of neighbouring areas about the advantages of demonstrated technologies.

To know the status of soil health, soils samples from each demonstration were collected and various parameters of soil like pH, EC, OC (%), available N, P and K were analyzed. Soil test results were helpful in need based application of all the three essential nutrients of N, P and K. The data on yield were collected through field observations. Gross return was calculated by multiplying yield with the current market price of the sesame crop. Whereas, For calculating input cost, the total sum of expenditure including land preparation, planting method, fertilizer, insecticide, fungicide, herbicide, irrigation cost, labour, harvesting cost, etc. were taken from each demonstration. Further, net return and benefit cost were calculated from these data. Potential yield of chickpea crop in Punjab is 700 kg ha^{-1} To estimate the technology gap, extension gap and the technology index the formulae used (Samui *et al.,* 2000) are as follows:

Technology Gap = Potential yield - Demonstration plot average yield

Extension Gap = Demonstration plot average yield - Farmer's plot average yield

Technology Index = (P-D) / P X 100

Where,

P= Potential yield of the crop
D= Average demonstration plot yield of the crop

A comparative analysis of the package and practices in demonstration plot and local check is given in Table 1.

The soils of the area are mostly sandy loam in texture. To know the status of soil health, soils samples from each demonstration were collected and various parameters of soil like pH, EC, OC (%), available N, P and K were analysed. Soil test results were helpful in need based application of all the three essential nutrients of N, P and K. In Pathankot block the average pH of soils was 7.5 with electrical conductivity of0.38 dSm^{-1}. The average organic carbon, available phosphorus and available potassium was0.39%, 14.6 and 46.8 kg ha^{-1}, respectively. Similarly, the soils of Dhar kalan block were normal in reaction with pH of 6.7 and electrical conductivity was 0.58 dSm^{-1}. The average organic carbon, available phosphorus and available potassium of Dhar kalan was 0.58%, 21.6 and 56.0 kg ha^{-1}, respectively. The temperatures generally remains between 35 °C to 45 °C during summer and 7 °C -15 °C (max) to 0 °C to 8 °C (min) in winters.

Results and Discussion

Grain yield

The data in Table 1 indicates that the average grain yield of sesame was higher in demonstration plots (551.6 kg ha^{-1}) in comparison with average grain yield of check plots (365.3 kg ha^{-1}) during the course of study. Further, there was 33.77 per cent increase in yield of demonstration plots as compared to farmer's practice (Table 1). These results are in agreement with the findings of Meena (2017); Purushottam *et al.,* (2012); Narwale *et al.,* (2009) who have reported similar results of higher yield of demonstration plots in comparison with check plots. In addition to overall average yield, the yield of sesame was higher in comparison to check within clusters. Among the different demonstration plots, maximum yield was obtained in the second cluster of dhar kalan block (669, 554 and 512kg ha^{-1}) during 2017, 2018 and 2019, respectively. Again in the check plots, maximum yield was obtained in the second cluster of dhar kalan block (375 and 382 kg ha^{-1}), as compared to first cluster of Pathankot block (371 and 376kg ha^{-1}) during 2017 and 2018, respectively. This data clearly indicated the higher yield of demonstration practices over farmer's local practices .Meena *et al*., (2018) also reported that the yield of sesame was higher in front line demonstrations with the adoption of high yielding variety as compared to the local check. This increased yield of demonstration plot from check plots is attributed to the use of all the farming practices like sowing time, fertilizer application, plant protection measures according to the recommended package of practices. Grain yield data clearly indicated that FLD programme had a positive impact over the existing practices in enhancing the crop productivity. Kirar *et al.,* (2005) also reported higher productivity in demonstration plots as compared to control. Among the other factors that contributed to lower yield of check plots following farmer's own practices include early sowing of sesame crop that led to susceptibility of sesame tophyllody disease due to which yield was significantly decreased in check as compared to demonstration plot. The higher results obtained from front line demonstrations triggered other farmers to adopt recommended farming practices and the new technologies.

Technology gap

The technology gap indicates the gap between the demonstrations yield and potential yield. In Punjab, potential yield of sesame is 700kg ha^{-1}. The average of three years indicated that the technology gap in Pathankot district was 148.4 kg ha^{-1} (Table 1). Whereas, technology gap in district was 57.5, 199.5 and 188.0 kg ha^{-1}during 2017, 2018 and 2019, respectively. The technology gap was higher in Pathankot block (84.0 and 253.0 kg ha^{-1}) as compared to Dhar kalan block (31.0 and 146.0 kg ha^{-1}) during 2017 and 2018, respectively. This technology gap may be due to the differences in the fertility status of soil and weather conditions Rao and Ramana, 2017.Mukharjee (2003) have also opined that depending on identification and use of farming situation, specific interventions may have greater implications in enhancing system productivity. To bridge this gap, region specific recommendations are required.

Extension gap

The variations in yield could be attributed to extension gap. The extension gap of 186.3 kg ha^{-1} was found in Pathankot district of Punjab. In the two blocks, highest extension gap of 294.0 and 172.0 kg ha^{-1} was recorded in second cluster of Dhar kalan as compared to the first cluster (245.0 and 71.0 kg ha^{-1}) during 2017 and 2018, respectively. During the year 2017, the extension gap in block Pathankot was 245.0 kg ha^{-1}which was decreased to 71.0 kg ha^{-1} during 2018. The highest extension gap in this block during 2017 emphasized the need to educate the farmers through various means for the adoption of improved varieties which results in decreased extension gap during the year 2018. However, the extension gap in Dhar block was not decreased upto that extent which showed that there are enormous prospects for different extension activities in the area.

Massive awareness through campaigning and print media like folder and leaflets was done which results in decreasing trend of extension gap in Dhar kalan block (157.0 kg ha^{-1}) during the year 2019.Meena et al 2018 also reported that the new technologies adopted in front line demonstrations along with the awareness campaigning helped in decreasing the extension gap.

Technology index

The technology index indicates the feasibility of new technology at the farmer's fields and lower the value of technology index, more is the feasibility of the technology (Jeengar *et al.,* 2006).

The average technology index was 21.20 percent in Pathankot district (Table 1). The technology index was less in Dhar kalan block during 2017 and 2018 as compared to Pathankot block. The results are in conformity with the findings of Naik *et al*., (2016).The wider gap in technology index (ranging between 4.42-26.85 per cent) during the study period in a region may be attributed to the difference in soil fertility status, weather conditions.

This showed that the FLD programme was found to be useful in imparting knowledge and adoption level of farmers in various aspects of sesame production technologies. The results are in conformity with the findings of Rohit and Singh (2019).

Economic return

The economics of sesame production under front line demonstration have been presented in Table 2. The economic viability of improved demonstrated technology over farmers practice was calculated depending on prevailing price of inputs and output cost and represented in term of benefit cost ratio (B: C ratio).

The cost of production of sesame was varied from Rs 12,500 to 13000 per hectare with an average of Rs 12833.3 per hectare as against Rs 11,800 to 12,500 per hectare with an average of Rs 12,266.6 per hectare under control. The additional cost increased in check plots was due to the use of 2-3 un-recommended pesticides for insect control by the farmers.

Table.1 Existing farmer's practices and improved practices demonstrated in frontline demonstrations at farmer's field in Pathankot

S. No.	Operations	Existing Farmers Practices	Improved Recommended Practices
1	Variety	Local	Punjab Til No.2
2	Time of Sowing	June - July	First fortnight of July
4	Method of Sowing	Broad casting	Broadcasting
5	Plant Protection Measures	Non-adoption of recommended package of practices and injudicious use of pesticides.	Adopted recommended package of practices for sesame crop developed by Punjab Agricultural University, Ludhiana

Table.2 Yield, technology gap, extension gap and technology Index of Sesame in District Pathankot

Year	Blocks of district Pathankot	No. of Clusters	Total no. of demonstrations	Yield (kg ha^{-1})			% increase over check	Technology gap (kg ha^{-1})	Extension Gap (kg ha^{-1})	Technology Index (%)
				Potential	Demonstration	Check				
2017-18	Pathankot	I	14	700	616.0	371.0	39.12	84.0	245.0	12.0
	Dhar kalan	II	6	700	669.0	375.0	44.54	31.0	294.0	4.42
	Blocks Total/Average		**20**	**700**	**642.5**	**373.0**	**41.94**	**57.5**	**269.5**	**8.21**
2018-19	Pathankot	I	15	700	447.0	376.0	14.54	253.0	71.0	36.14
	Dhar kalan	II	8	700	554.0	382.0	32.12	146.0	172.0	20.85
	Blocks Total/Average		**23**	**700**	**500.5**	**368.0**	**26.47**	**199.5**	**132.5**	**28.50**
2019-20	Dhar kalan	I	25	700	512.0	355.0	30.66	188.0	157.0	26.85
Total/Average			**68**	**700**	**551.6**	**365.3**	**33.77**	**148.4**	**186.3**	**21.20**

Table.3 Gross return, Cost of cultivation, net return and B:C ratio of sesame in district Pathankot

Year	Blocks of district Pathankot	No. of Clusters	Gross Return (Rs. ha^{-1})		Cost of cultivation (Rs. ha^{-1})		Net Return (Rs. ha^{-1})		B:C ratio	
			Demonstration	Check	Demonstration	Check	Demonstration	Check	Demonstration	Check
2017-18	Pathankot	I	49,280	30,000	11,800	12,500	37,480	17,500	4.17	2.40
	Dhar Kalan	II	53,520	29,680	11,800	12,500	41,720	17,500	4.53	2.37
	Block Total/Average		**51,400**	**29,840**	**11,800**	**12,500**	**39,600**	**17,500**	**4.35**	**2.38**
2018-19	Pathankot	I	40,230	30,560	12,500	13,000	27,730	17,000	3.22	2.35
	Dhar Kalan	II	49,860	30,080	12,500	13,000	37,360	17,000	3.98	2.31
	Block Total/Average		**45,045**	**29,440**	**12,500**	**13,000**	**32,545**	**17,000**	**3.60**	**2.31**
2019-20	Dhar Kalan	I	46,080	31,950	12,500	13,000	33,580	20,750	3.68	2.45
Total/Average			**49,644**	**29,224**	**12,266.6**	**12,833.3**	**37,377.4**	**16,390.7**	**4.05**	**2.27**

Table.4 Impact of Front Line Demonstration (FLDs) on adoption of Sesame production technology

Technology	Number of Adopters (N= 68)		Change in No. of Adopter	Impact (% Change)
Land preparation and FYM application	Before Demonstration	After Demonstration		
Recommended variety	14	68	65	385.7
Seed rate	12	68	56	466.6
Sowing time/sowing method	17	68	61	258.8
Balance Fertilizer	9	68	59	655.5
Weed Management	32	68	36	112.5
Recommended Insect pest management	11	68	57	518.2
Overall Impact				399.5

The data revealed that the gross return from the demonstration were substantially higher than control plots. Higher average gross return was observed in demonstration plots (Rs. 49,644 ha^{-1}) in comparison with check plots (Rs. 29,224 ha^{-1}). Whereas, among demonstrations within two blocks, higher gross return (Rs. 53,520 and Rs 49,860 ha^{-1}) were observed in Dhar kalan block as compared to the first cluster of Pathankot block (Rs. 49,280and Rs 40,230 ha^{-1}) during 2017 and 2018, respectively. Also, the average net returns were higher under demonstration plots (Rs 37,377.4 ha^{-1}) as compared to check plot (Rs. 16,390.7 ha^{-1}).

Similar observations of higher returns in demonstration plots as compared to farmer's practice have been reported by Singh *et al.*, (2014); Bhargav *et al.*, (2017). B: C ratio was recorded to be higher under demonstration against check during all the years of study (Table 2). Scientific method of sesame cultivation can reduce the technology gap to a considerable extent, thus leading to increased productivity of sesame in the district which in turn will improve the economic condition of the growers. Tomar (2010); Meena and Dudi (2012) have also reported higher benefit from demonstration plots (Table 3).

The results of improved technological intervention brought out an increase in yield of sesame to the tune of 14.54 to 44.54% (Table 4). Improved package of practices can decrease the technology gap, thereby productivity of the crop can be increased. It was found that adoption of recommended variety of sesame by the farmers before demonstration was negligible, which increased by 399.5 % after demonstration. Therefore, target oriented training programme on improved sesame production technology along with multiple demonstrations is required to enhance level of knowledge and skills of growers which ultimately lead to adoption of technologies. Singh et al 2018 also reported that the adoption of appropriate package and practices in FLD's increased the adoption level of production technology.Sesame cultivation and adoption of new technologies enhanced sesame seed/oilseed consumption nutritional security and overall livelihood security of the district.

In conclusion the results of front line demonstration programme showed that the farmers can achieve higher yields and net profit in sesame cultivation by adopting recommended practices. Technological and extension gaps may be filled by the efforts of extension agencies through popularizing package of practices, advisory services, field visits and by organizing exhibitions and field days. Replacement of local farmer's practice and local varieties would be another viable option to enhance the production as well as net returns from sesame crop.

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