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Yield gap and impact assessment of frontline demonstrations of pulses in sub-mountainous area of Punjab

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Abstract

Cluster frontline demonstrations of improved technologies of pulse crops is one of the ventures taken up by Government of India, in which the new technology is demonstrated at the farmers' field parallel to the local practices followed by the farmers (FPP). During 2017-18, Krishi Vigyan Kendra, SBS Nagar, Punjab conducted demonstrations of summer greengram, *Kharif* blackgram, soybean and chickpea. KVK collected and presented block-wise data of all the demonstrations and compared with farmers' practices. A survey was also conducted in the succeeding year (2018-19) for the impact assessment in terms of adoption and horizontal spread of improved production technologies that were demonstrated during the preceding year. The results revealed that all the pulse crops recorded high grain yield in all the blocks of the district. In Aur block, summer greengram registered seed yield of 8.95 q/ha which was 13.65% higher than FPP (7.88 q/ha). Similarly, chickpea crop registered 7.91% higher grain yield in demonstration plot in contrast to FPP. Demonstration of improved variety of summer greengram (1.37) in Aur block recorded 28.04% higher b:c than FPP (1.07). In block Banga, summer greengram recorded highest value of extension gap (1.15) followed by Aur (1.08) and Saroya (2018). Minimum value of extension gap was observed in Nawanshahr block (0.83) which means that improved technologies performed better in this block as compared to other blocks. Similarly, highest value of extension gap was recorded in block Banga for *Kharif* blackgram, soybean and chickpea crops also with minimum value in block Nawanshahr. Summer greengram highest value of technology gap in block Saroya (3.80) and minimum in block Aur (2.30). Demonstration of summer greengram had lowest value of technology index in block Aur (20.44) and highest in block Saroya which means adoption of summer greengram is more feasible in former block as compared to later one. Demonstration of summer greengram, chickpea, *Kharif* blackgram and soybean registered 20.14, 23.64, 17.62 and 16.94% over all adoption level in the survey. Demonstration of summer greengram, chickpea, *Kharif* blackgram and soybean also resulted in 14.62, 11.58, 7.91 and 5.56% overall horizontal spread of improved production technologies.

Keywords: Cluster frontline demonstrations, horizontal spread, grain yield, pulse crops, technology gap

Introduction

Pulses are an important commodity group of crops that provide high quality proteins complementing cereal proteins for vegetarian population of the country. The total world acreage under pulses is about 93.18 (Mha) with production of 89.82 (Mt) at 964 kg/ha yields level. In India, pulses are cultivated on an area of 28 Mha with total production of 25.46 Mt with productivity at 885 kg/ha. Pulses contribute by 22 and 8 per cent in total food grain production of India in terms of area and production, respectively (Anonymous 2021) [1]. Because of spatial and temporal variation, farmers having assured irrigation facility and fertilizer availability go for cultivation of alternate crops like paddy, wheat, oilseeds etc. Therefore, meeting the demands of ever growing population and checking the load of pulse imports is a challenge for agriculture research and extension system. However, there is a wide gap between the potential and the actual production realized by the farmers due to non-adoption or partial adoption of recommended package of practices. Technology gap i.e. poor knowledge about newly released crop production and protection technologies and their management practices in the farmers' fields is a major constraint in pulse production. No systematic approach was implemented to study the technological gap existing in various components of cultivation. So building the technical competency of farmers plays critical role in improving acreage and productivity of pulse crops. One of the ventures carried out by GOI is conducting cluster frontline demonstrations of pulse crops at the farmers' fields with an objective to promote the improved crop production technologies under different farming situations and at different agro-climatic regions. Improved technology can be an improved variety, improved nutrient management, improved plant protection technique etc. that helps improvise monetary benefits of the farmers without harming the ecology of the locality. For example, integration of chemical methods of weed control would not only reduce the cost of cultivation but would benefit the crop by providing proper aeration and conservation of moisture (Jaidka and Sharma, 2018) [6]. Farmer itself uses both technologies at two different plots maintained parallel to each other and the results of the improved technology and farmer's practice are compared. Frontline demonstrations work on the basis of principle of 'learning by doing' concept. Jaidka and Brar (2024) [5] concluded that demonstration plots of mustard crop registered 22.70, 26.50, 26.28% higher grain yield during 2019-20, 2020-21 and 2021-22, respectively. Increase in grain yield by adopting resource efficient technologies resulted in better B: C in demonstration plots than farmers' practice (FPP) during all the years. The performance of the demonstration plots relative to FPP is assessed through various techniques like extension gap, technology gap etc. the assessing the performance helps in identification of growth factors, regions which need more emphasis for further improvisations. The Krishi Vigyan Kendra, SBS Nagar, Punjab also undertakes the cluster frontline demonstrations of pulses and other crops. The present study was undertaken to analyze the performance of frontline demonstrations of pulse crops relative to farmers' practices.

Material and Methods

The present study was undertaken to evaluate the effectiveness of front line demonstrations in terms of increased crop productivity and returns of the farmers. The study was carried out in operational area of Krishi Vigyan Kendra (KVK), Langroya, Distt. Shaheed Bhagat Singh Nagar, Punjab. The district has been divided into five blocks *i.e.*, Banga, Nawanshahr, Aur, Balachaur and Saroya with highly distinguished agro climatic and ecological conditions *i.e.*, central plain zone, Bet area and *Kandi* area. The central plain zone includes Nawanshahr, Aur and some parts of Banga block with heavy to sandy loam soils. The bet area includes some parts of Nawanshahr, Aur and Balachaur block with undulating topography and sandy loam soil. The *Kandi* area covers Saroya and some parts of Balachaur block characterized by sandy loam soil and undulating topography. Front line demonstrations (FLDs) were conducted on pulse crops in the district during Summer 2016, *Kharif* 2016 and *Rabi* 2016-17 with the details are given below in table 1. The necessary steps for the selection of site and farmers, lay out of demonstration, *etc.*, were followed as suggested by Chaudhary (2018) [8]. While conducting demonstrations, farmers were guided for improved production technologies (Table 2) through training camps, farm literature and personal contact (Fig. 1). At each farmer field, a check plot containing farmers' practices was maintained parallel to demonstration plot.

Table 1: Number of frontline demonstrations laid out in the District and potential yield of crops

S No	Crop	Variety	Number of Demonstrations	Potential yield (q/ha)
1	Summer greengram	SML 668	72	11.25
2	*Kharif* blackgram	Mash 114	35	9.00
3	Soybean	SL 958	62	18.25
4	Chickpea	PBG 5	43	17.00

Table 2: Details of farmers' practices (FPP) and intervention in demonstration plot

Particulars	FPP	Intervention
Chickpea		
Variety	Local	PBG 5
Time of sowing	First week of Oct to last week of Nov	25th Oct to 10th Nov
Method of sowing	Line sowing or Broadcasting	Line sowing/Bed planting
Seed rate (kg/ha)	60-80	40-45
Nutrient management (kg/ha)	25 kg Nitrogen	15 kg N and 20 kg P
Pest and disease management	Farmers use a number of chemicals without proper identification of pest and diseases	Integrated pest and disease management approach
Summer greengram		
Variety	Local	SML 668
Time of sowing	Feb to April	20th March to 10th April
Method of sowing	Line sowing or broadcasting	Line sowing/Bed planting
Seed rate (kg/ha)	40-45	37.5
Nutrient management (kg/ha)	20-25 kg Nitrogen	12.5 kg N and 40 kg P
Pest and disease management	Farmers use a number of chemicals without proper identification of pest and diseases	Integrated pest and disease management approach
***Kharif* blackgram**		
Variety	Local	Mash 114
Time of sowing	June-July	15-25 July
Method of sowing	Line sowing or broadcasting	Line sowing/Bed planting
Seed rate (kg/ha)	20-25	15-20
Nutrient management (kg/ha)	25 kg N and 30 kg P	12.5 kg N and 25 kg P
Pest and disease management	Farmers use a number of chemicals without proper identification of pest and diseases	Suggested control measures by proper crop monitoring
Soybean		
Variety	Unidentified	SL 958
Time of sowing	June- July	1-15th June
Method of sowing	Line sowing	Line sowing/Bed planting
Seed rate (kg/ha)	80-100	62.5-75
Nutrient management (kg/ha)	Irrational use of nitrogenous fertilizers	Urea 28 kg and SSP 150 kg/acre
Pest and disease management	Farmer use many chemicals without properly identifying pest and diseases	Suggested control measures by proper crop monitoring

While conducting demonstrations, farmers were guided for improved production technologies through training camps, farm literature and personal contact. At each farmer field, a check plot containing farmers' practices was maintained parallel to demonstration plot. All the demonstrations were regularly visited by KVK scientists especially to supervise the critical farm operations and crop health. Extension activities like group meetings and field days were organized at the demonstration site with an objective to spread the outcomes of the technology among other farmers of the area. The data regarding crop yield, cost of cultivation, gross returns etc. were collected from both demonstration and check plots which were further used to calculate various indices and ratios (Samui *et al.*, 2000) [11] as given below:

Extension gap = Demonstration Yield - Farmers yield
Technology gap = Potential yield - Demonstration yield
Technology index= Technology gap/Potential yield×100

The data about the adoption and horizontal spread of improved technologies was collected from farmers by conducting a survey in the succeeding year 2018-19 with help of a well constructed questionnaire. The impact of demonstrations in terms of adoption level and horizontal spread was calculated by using following formulae:

$$\text{Impact in terms of adoption} = \frac{\text{No. of adopters after demon.} - \text{No. of adopters before demon.}}{\text{No. of adopters before demon.}} \times 100$$

$$\text{Impact in terms of hortizontal spread} = \frac{\text{Area after demo. (ha)} - \text{Area before deom. (ha)}}{\text{Area before deom. (ha)}} \times 100$$

Economic analysis of both demonstration as well as check plots was performed to check the economic viability and profitability of the technologies demonstrated. Benefit: cost ratio was derived by calculating the cost of cultivation, gross returns, net returns.
B:C= Net returns/Cost of cultivation

Fig 1: Monitoring of frontline demonstrations by the KVK team

Results and Discussion

Grain yield

Compilation of data on performance of demonstration plots and local practices (Table 3) revealed that improved technologies recorded an enhancement in grain yield of all the pulse crops in comparison to farmers' practice. In block Aur, summer greengram registered grain yield of 8.95 q/ha which was 13.65 per cent higher than FPP (7.88 q/ha). In all the blocks, increase in grain yield of summer greengram ranged from 10.35 to 16.86 per cent. Similar results were observed in other pulse crops where the demonstration plots out yielded the farmers' practices. In all the blocks, chickpea crop registered an increase in grain yield from 5.57 to 12.50 per cent as compared to conventional practices followed by the farmers. The increase in grain yield in demonstration plots can be attributed to use of improved variety, suitable seed rate and method of sowing, integrated nutrient and pest management practices, which in turn, helped in overall growth and development of crop. In contrast, use of local cultivar, non-judicious use of fertilizers, pesticides, and irrigation water resulted in poor performance of FPP. Results show the significance of conducting demonstrations at farmers' field by which the actual benefits and prospects of any technology can be assessed under real and existing weather conditions. High grain yield of pulse crops in demonstration plots is in line with Poonia and Pithia (2011) [9], Patel *et al*. (2013) [7], and Raj *et al*. (2013) [10].

Table 3: Block wise productivity of pulse crops in demonstrations and farmers' practices

Crop	Aur			Banga			Balachaur			Nawanshahr			Saroya		
	Yield (q/ha)		Change over FPP	Yield (q/ha)		Change over FPP	Yield (q/ha)		Change over FPP	Yield (q/ha)		Change over FPP	Yield (q/ha)		Change over FPP
	FPP	FLD	(%)	FPP	FLD	(%)	FPP	FLD	(%)	FPP	FLD	(%)	FPP	FLD	(%)
Summer greengram	7.88	8.95	13.65	7.68	8.83	14.98	6.70	7.73	15.30	7.98	8.80	10.34	6.38	7.45	16.86
Kharif blackgram	6.48	7.50	15.83	6.43	7.75	20.62	5.78	6.95	20.35	6.80	7.70	13.24	6.13	7.15	16.73
Soybean	14.78	15.75	6.60	14.03	15.98	13.90	13.60	14.65	7.72	14.88	15.73	5.71	13.83	14.88	7.59
Chickpea	13.90	15.00	7.91	13.40	15.08	12.50	13.73	14.80	7.83	14.35	15.15	5.57	13.98	14.95	6.98

Benefit-Cost Ratio (B:C)

Economic analysis of any factor or enterprise elaborates the financial liabilities as well as assets emerging as an output of the system. As it is directly describes the avenues of monitory gains or losses, so the economics of the any crop production programme is the major driving force for wide spread adoption. Compilation of data (Table 4) revealed that frontline demonstrations of all the pulse crops recorded higher B:C in comparison to farmers' practices. Demonstration of improved variety of summer greengram registered highest B:C in block Banga (1.63) followed by block Nawanshahr (1.53). In all the blocks, demonstration plots have higher B:C than farmers' practice that can be attributed to better grain yield, less cost of cultivation, which in turn, enhanced the net returns. Demonstration of *Kharif* blackgram also recorded high B:C relative to farmers' practices. Highest B:C was observed in block Banga (1.27) followed by block Nawanshahr (1.20). At the same time, cultivation of improved variety along with good agriculture practices out yielded the farmers' practices in other blocks also. It means that adoption of improved production technology prove propitious in benefitting the farmers in terms of high monetary returns. Demonstrations of soybean as well as chickpea also registered high B:C in all the blocks in contrast to farmers' practices. Soybean and chickpea recorded highest B:C in block Banga, i.e., 3.12 and 2.95, respectively. From the data it can be concluded that cultivation of improved variety of pulse crops with refined production technologies such bed planting in heavy soils, flat (line) sowing in light soils, intergrated nutrient management, integrated pest management etc. helps enhance the seed yield, reduced cost of cultivation, high net returns, in turn, better B:C. Farmers of the all the blocks can go for adoption of the improved variety in combination with site specific production practices to have enhanced monetary returns as compared to conventional practices.

Table 4: Benefit-cost ratio of frontline demonstrations and farmers' practices

	Aur		Banga		Balachaur		Nawanshahr		Saroya	
	FPP	FLD	FPP	FLD	FPP	FLD	FPP	FLD	FPP	FLD
Summer greengram	1.07	1.37	1.14	1.63	1.04	1.24	1.23	1.53	1.01	1.20
Kharif blackgram	0.88	1.11	0.89	1.27	0.80	1.02	0.96	1.20	0.95	1.11
Soybean	2.77	3.02	2.68	3.12	2.59	2.85	2.93	3.09	2.76	2.95
Chickpea	2.55	2.92	2.47	2.95	2.58	2.85	2.71	2.93	2.67	2.87

Extension gap: Extension gap indicates the extent of farmers' education and need for dissemination of information regarding the given technology. More value of extension gap depicts high level of difference between performance of farmers' practice and technology practised in the demonstration and vice-versa. The compilation of data (Table 5) revealed that Banga block, Summer greengram recorded highest value of extension gap followed by Aur and Saroya block. Minimum value of extension gap was observed in Nawanshahr block. Similarly, highest value of extension gap was recorded in block Banga for *Kharif* blackgram, soybean and chickpea crops while block Nawanshahr had minimum value of extension gap. High value of extension gap in Banga block shows that farmers of the block have lower level of awareness, less technical know-how, less exposure to improved technologies due to which their practice could not perform better in contrast to the technology demonstrated. In contrast, low value in Nawanshahr block depicts better technical skills, better adoption of improved technologies owing to which their crop production practices resulted in better seed yield of all crops. It means that there is more requirement to concentrates the extension activities or awareness programmes in Banga block to educate the farmers as compared to other blocks (Singh and Singh, 2020) [13]. The intensification of activities is required to uplift the farmers' skills in the context of improved production technology of all the crops.

Table 5: Extension gap of frontline demonstrations in different blocks of the district SBS Nagar

Crop	Aur	Banga	Balachaur	Nawanshahr	Saroya
Summer greengram	1.08	1.15	1.03	0.83	1.08
Kharif blackgram	1.03	1.33	1.18	0.90	1.03
Soybean	0.98	1.95	1.05	0.85	1.05
Chickpea	1.10	1.68	1.08	0.80	0.98

Technology gap: Technology gap indicates the level of cooperation showed by the farmers in adoption and use of new technology practised in the demonstration. More value of technology gap depicts lesser interest showed by farmers in practising the improved technology, poor performance of improved technology which widens the difference between potential yield and yield obtained in demonstration plot. In case of summer greengram (Table 6), highest value of technology gap was recorded in Saroya block and minimum was in Aur block. It shows that farmers showed lesser cooperation in growing improved variety of summer greengram resulting in poor performance of the demonstration plot relative to potential yield of the variety. Results reveal that there is need to convince the farmers regarding production technology of the variety loke fertilizer requirement, irrigation requirement etc. In case of *Kharif* blackgram and soybean crops, highest value technology gap was recorded in Balachaur block while minimum was observed in Banga block. Highest value of technology gap recorded in Balachaur block bu minimum was there in Nawanshahr. There is need to have crop specific, variety specific, region specific planning and execution of extension activities, packages of practices to enhance the performance of improved technologies of all the crops and bridge the gap between potential and demonstration yield can be minimised (Dash *et al*, 2021) [4]. These findings are similar to the findings of Patel *et al*. (2013) [7].

Table 6: Technology gap of frontline demonstrations in different blocks of the district SBS Nagar

Crop	Aur	Banga	Balachaur	Nawanshahr	Saroya
Summer greengram	2.30	2.42	3.52	2.45	3.80
Kharif blackgram	1.50	1.25	2.05	1.30	1.85
Soybean	2.50	2.27	3.60	2.52	3.37
Chickpea	2.00	1.92	2.20	1.85	2.05

Technology index: Technology index indicates the feasibility of any technology for cultivation or adoption in a given locality. More value of technology index shows lower possibility of adoption at farmers' fields and vice-versa. Less value in a given location indirectly shows importance of promotional activities in those areas to improve performance and adaptability to existing conditions so that the given technology become ecologically and economically viable. For example, block Aur (Table 7) recorded lowest technology index of demonstration of summer greengram (20.44) which means adoption of summer greengram is more feasible in this block as compared to other blocks. Highest value in block Saroya (33.78) indicates less feasibility. So there is need to plan and conduct farmer education and training programmes to create awareness among the farmers regarding improved variety of summer greengram. In contrast, low technology index of *Kharif* blackgram and soybean in Balachaur block shows high feasibility of these crops in given block. In case of chickpea, lowest value of chickpea was recorded in Nawanshahr block which clearly depicts significance of extension activities and programmes in performance of improved variety of chickpea. The wider gap in technology index between the blocks can be attributed to the difference in soil fertility status, weather conditions, and insect-pests attack in the crop (Pawar *et al*. 2018) [8]. The results of the present study are in accordance with the findings of Bar and Das (2015) [2].

Table 7: Technology index of frontline demonstrations in different blocks of the district SBS Nagar

Crop	Aur	Banga	Balachaur	Nawanshahr	Saroya
Summer greengram	20.44	21.51	31.29	21.78	33.78
*Kharif*blackgram	16.67	13.89	22.78	14.44	20.56
Soybean	13.70	12.44	19.73	13.81	18.47
Chickpea	11.76	11.29	12.94	10.88	12.06

Impact assessment of frontline demonstrations: frontline demonstrations are conducted to exhibit the superiority of any technology in contrast to local practices. The good results of the improved technology are presenyed in the form of increased yield, enhanced efficiency, improved B:C etc. Afterwards, it is worthwhile to assess the impact of demonstrations in terms of adoption of that technology by the farmers of the region. The impact can be evaluated in terms of relative change in number of farmers and change in area under that given technology. Compilation of survey data (Table 5) revealed that in all the pulse crops, farmers adopted improved technologies for their cultivation. For instance, in chickpea, 23.26 per cent farmers started cultivating improved variety, 30.23 per cent farmers started cultivating chickpea by following integrated approaches. Among all the pulse crops, summer greengram (20.14%) and chickpea (23.64%) reported high overall impact of demonstrations as compared to *Kharif* blackgram (17.62%) and soybean (16.94). It can be attributed to more preference of farmers to grow summer and winter season pulses as compared to *Kharif* season which in turn affects probability of infusion of improved technology among the farmers. Data on horizontal spread of improved technologies (Table 9) depicted that frontline demonstrations recorded notable expansion of improved technologies of all the pulses at farmers' fields. Higher overall spread was recorded in summer greengram (14.62%) and chickpea (11.58%) relative to Kharif blackgram (7.91%) and soybean (5.56%). It clearly shows more preference of farmers to adopt improved technologies in summer greengram and chickpea than other two pulses. Singh and Sharma (2018) [12] also observed an increase in adoption level and horizontal spread of cumin cultivation through frontline demonstrations. In an impact assessment study of cluster frontline demonstrations of oilseeds, Jaidka and Brar (2024) [5] reported horizontal spread of oilseeds to the tune of 29.64%.

Table 8: Impact of frontline demonstrations on adoption of improved technologies

S No	Technology	Per cent change w.r.t adopter count			
		Summer greengram	*Kharif* blackgram	Soybean	Chickpea
1.	Cultivation of improved variety	22.22	20.00	17.74	23.26
2.	Recommended date of sowing	20.83	17.14	14.52	20.93
3.	Seed treatment	19.44	14.29	17.74	23.26
4.	Method of sowing as per soil type	13.89	11.43	12.90	20.93
5.	Optimum seed rate	18.06	17.14	16.13	23.26
6.	Integrated nutrient/pest/weed management	26.39	25.71	22.58	30.23
7.	Overall impact	20.14	17.62	16.94	23.64

Table 9: Impact of frontline demonstrations on horizontal spread of improved technologies

S No	Technology	Per cent change w.r.t area			
		Summer greengram	*Kharif* blackgram	Soybean	Chickpea
1.	Cultivation of improved variety	23.61	7.3	7.16	19.35
2.	Recommended date of sowing	11.59	8.5	5.14	10.57
3.	Seed treatment	19.52	11.4	6.02	13.26
4.	Method of sowing as per soil type	05.16	5.49	4.31	4.69
5.	Optimum seed rate	12.43	8.41	5.24	9.16
6.	Integrated nutrient/pest/weed management	15.39	6.33	5.47	12.47
7.	Overall impact	14.62	7.91	5.56	11.58

Conclusion

The results of the study indicate that the frontline demonstrations showed an increase in grain yield, enhanced B:C in all the blocks of the district. Yield gap analysis revealed that there is need to develop crop specific, variety specific, region specific package of practices for pulse crops. As frontline demonstrations work on the grounds of "learning by doing", the impact assessment of showed that these are worthwhile in adoption as well as horizontal spread of improved technologies. Demonstrations satiate the need to improve the knowledge base, technicality and confidence level of farmers which, in turn, can certainly prove propitious in increasing area, production and productivity of pulse crops.

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