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Impact of Cluster Front Line Demonstrations on the Yield and Economics of Chickpea under National Food Security Mission in Bharatpur District of Rajasthan, India

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ABSTRACT

Background: Chickpea is an important legume crop that plays an important role in the food and nutritional security of people in the developing countries and contributing to protein intake. It is a soil building crop and being a leguminous crop, it fixes atmospheric nitrogen through symbiotic fixation, there by helps in N cycling within the ecosystem.

Methods: Cluster front line demonstrations of chickpea were conducted by Krishi Vigyan Kendra, Kumher, Bharatpur (Rajasthan) during *Rabi* season from 2016-17 to 2019-20. A total 350 front line demonstrations were conducted on chickpea in 140 ha area by the active participation of the farmers with the objective of improved technologies of chickpea production potentials.

Result: The results of the demonstrations observed that on an average yield of chickpea under improved technology ranged from 11.83 to 17.52 q/ha with a mean of 14.47 q/ha; which was 20.95 per cent more yield as compared to farmer's practices (11.97 q/ha). Moreover, average yield was also recorded higher under demonstration (14.47 q/ha) over district (8.17 q/ha) and State (10.74 q/ha) average. The study exhibited mean extension gap of 250.75 Kg/ha, mean technology gap of 627.75 kg/ha with mean technology index of 29.71 per cent. Higher mean net return of Rs. 46618/ha with mean B: C ratio of 3.10 was obtained with improved technologies in comparison to farmers' practices (Rs. 36737/ha). The present study resulted to convincing the farming community for higher productivity and returns.

Key words: B:C ratio, Chickpea, Economics, Extension gap, Front line demonstrations, Impact, Technology gap, Technology index.

INTRODUCTION

Pulses are the climate resilient crops as they promote sustainable agriculture, decrease greenhouse gases, fix atmospheric nitrogen, improve soil fertility and use less water compared to other crops (Singh, 2016; Meena and Biswas, 2013). Chickpea or gram (*Cicer arietinum* L.) is a major *rabi* pulse crop has cheap source of protein (18-22%), 62% carbohydrate, fat and good quality lysine, tryptophan *etc.* India contributes as a largest chickpea producer as well as consumer in the world. In India, chickpea is mainly grown in Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Andhra Pradesh, Gujarat, Karnataka, Haryana, Bihar and West Bengal. In India, chickpea covers an acreage of 10.56 million hectares contributing 11.23 million tons of production with an average productivity of 1063 kg/ha during 2017-18 (Anonymous, 2018a). In Rajasthan, chickpea is grown in an area of 1.57 million hectares with an average production of 1.68 million tons and productivity of 1074 kg/ha; whereas, Bharatpur district of Rajasthan covers total production of 2823 tons of gram from an area of 3455 hectares with productivity of 817 kg/ha (Anonymous, 2018). It clearly indicates that average productivity of chickpea (817 kg/ha) in Bharatpur district is comparatively lower than the State average yield (1074 kg/ha). However, still it is low as compared to production potential of the demonstrated variety GNG 1581, RSG 895, CSJ 515 and RSG 974 (20.0-23.0 q/ha). Severe biotic and abiotic stress and partial adoption of recommended improved production technology are the major reasons for low productivity of chickpea. The productivity of chickpea can be further enhanced by adopting improved high yielding varieties and scientific crop management practices (Kumar, 2014 and Meena *et al*. 2020). Indian government imports large quantity of pulses to fulfil the domestic requirement of pulses. In this regard, to sustain this production and consumption system,

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Government of India has initiated Cluster frontline demonstrations (CFLDs) under National Food Security Mission. Frontline demonstration is the method of field demonstration evolved by the ICAR with the inception of Technology Mission on Oilseed crops. The main aim of this programme is to demonstrate latest crop production and protection technologies and crop management practices at the farmers' field under different agro-climatic zones and real farming situation under the supervision of Agricultural scientists.

MATERIALS AND METHODS

Cluster frontline demonstrations of chickpea were carried out by Krishi Vigyan Kendra, Kumher, Bharatpur (under the administrative control of SKN Agriculture University, Jobner, Jaipur, Rajasthan) during *Rabi* season from 2016-17 to 2019-20 (4 consecutive years). As per the agro climatic Zones of Rajasthan, Bharatpur district falls under Flood Prone Eastern Plain Zone-IIIB. A total 350 FLDs on chickpea were carried out by KVK, Kumher, Bharatpur to harness production potentialities of demonstrated chickpea variety GNG 1581, RSG 895, CSJ 515 and RSG 974 along with full fledged cultivation package of practices in 140 ha area. The technologies to be demonstrated for chickpea were identified based on participatory rural approach (PRA) technique. Under demonstration, 0.4 ha area is allotted for individual partner farmer and adjacent 0.4 ha was considered local check (farmers' practice). Farmers were trained to follow the improved package and practices of chickpea cultivation recommended for Flood Prone Eastern Plain Zone-IIIB. The required critical inputs like improved variety seed (GNG 1581, RSG 895, CSJ 515 and RSG 974); for seed treatment bio-fertilizer like *Rhizobium* and PSB culture were supplied to the farmers from the scheme budget. Farmers were advised to use seed rate (60 kg ha^{-1}) with recommended package of practices. The sowing method keeping 30×10 cm spacing was demonstrated on their fields. For fertilizer management, application of 20 Kg N+40 Kg P_2O_5 per ha in the form of Urea and DAP as per demonstration were applied by the partner farmers. In addition to N and P_2O_5, sulphur @ 25 kg/ha was supplied by KVK. The seed was treated before sowing with liquid *Rhizobium* and PSB culture @ 10 ml/kg seed, weed management (manually) and spray of Quinalphos 25 EC @ 1 litre/ha as per need for the management of gram pod borer (*Helicoverpa armigera* Hubner). Regular visits to the demonstration fields by KVK Scientists ensured proper guidance to the partner farmers. At flowering or maturity stage of crop, field days and group meetings were also organized to provide the opportunities for other farmers to witness the benefits of demonstrated technologies. Simultaneously, feedback from the farmers were also taken on the demonstrated technologies. In case of local check, traditional practices were followed by using existing varieties. Data were collected from both the demonstration as well as local check plot of partner farmers through personal contacts and finally extension gap, technology gap and technology index were worked out as suggested by Raj *et al*. (2013) as per formula given below:

Increase in yield (%) =

$$\frac{\text{Yield of demonstration - Yield of farmer practice}}{\text{Yield of farmer practice}} \times 100$$

Technology gap =
Potential yield (Kg/ha) -Yield of demonstration (Kg/ha.)

Extension gap = Yield of demonstration (Kg/ha) -Yield under farmer practice (Kg/ha.)

$$\text{Technology index} = \frac{\text{Pi-Di}}{\text{Pi}} \times 100$$

Where,
Pi = Potential yield of the variety.
Di = Demonstration yield of the variety.

Additional cost (Rs./ha.) = Cost of cultivation of demonstration (Rs./ha.) - Cost of cultivation of farmer practice (Rs./ha.)

Additional return (Rs./ha.) = Gross return of demonstration (Rs./ha.) - Gross return of farmer practice (Rs./ha.)
Effective gain (Rs./ha) = Additional return (Rs./ha.) -Additional cost (Rs./ha.)

B.C. Ratio= Gross return/ Cost of cultivation

RESULTS AND DISCUSSION

Major gap was observed between improved technology and farmer's practice of chickpea cultivation in Bharatpur district of Rajasthan (Table 1). Among varying technological component, full gap was observed in the component *viz*., variety and seed treatment by liquid bio-fertilizers and partial gap was observed in seed rate, seed treatment by chemical fungicide, fertilizer management and plant protection measures. These gaps observed at the farmers' field are ascribed to the slow pace of extension activities; coupled with unreached extension system, poor accessibility of advanced or improved agro-technologies especially among small holder farmer's (Shivran *et al*. 2020). Under farmer's practice, seed of local/old variety with low yield potential was sown instead of newly recommended varieties for the zone with improper application of improved recommended package technologies. On the basis of observed gap, under the demonstration, improved variety (GNG 1581, RSG 895, CSJ 515, RSG 974), fungicide, insecticide and bio-fertilizer (*Rhizobium* and PSB culture) were provided to the partner farmers by KVK and other component *viz*., chemical fertilizers and all other crop management practices were timely performed by the partner farmer itself under the supervision of KVK Scientist. Similar findings have also been observed by Meena *et al*. (2021), Saikia *et al*. (2018), Bhargav *et al*. (2017) and Meena and Singh (2017).

Chickpea yield

Under National Food Security Mission (Pulses), total of 350 cluster frontline demonstrations of chickpea were

Table 1: Technological gap between FLDs and farmers practices on chickpea.

Component	Technological intervention	Farmers' practices	Gap
Variety	GNG 1581, RSG 895, CSJ 515 and RSG 974	Unidentified/local variety	Full gap
Seed rate	60 kg/ha	10-15% higher	Partial gap
Time of sowing	2nd or 3rd week of October	2nd or 3rd week of October	No gap
Seed treatment by chemical fungicide	Carbendazim @ 2g/kg seed	10% farmers used Thiram/ Carbendazim as seed treatment	Partial gap
Seed treatment by liquid bio-fertilizers	*Rhizobium* / PSB culture @ 10 ml/kg seed	No seed treatment	Full gap
Method of sowing	Line sowing	Line sowing	No gap
Fertilizer dose	Recommended dose of fertilizer (RDF)	Imbalance use of fertilizer	Partial gap
Weed management	Manual weeding	Manual weeding	No gap
Plant protection measures	Quinalphos 25 EC @ 1 litre/ha	Indiscriminate use of insecticide	Partial gap
Irrigation	Irrigated and Rainfed	Irrigated and rainfed	No gap

demonstrated during 2016-17 to 2019-20 in agro-climatic zone of Bharatpur. The findings obtained during last four years of demonstrations are presented in Table 2 which revealed that average yield of chickpea through improved technology ranged from 11.83 to 17.52 q/ha as compared to 9.85 to 14.40 under farmer's practice. Average yield of total 350 demonstrations was 14.47 q/ha from improved technology whereas, the average yield from farmer's practices was 11.97 q/ha. Under improved technology, it recorded 19.39 to 22.77 per cent increased in yield over the local check. Thus, there was on an average 20.95 per cent increase in demonstration yield over local check. Demonstrated chickpea variety CSJ-515 gave the highest yield (17.52 q/ha) during the year 2018-19. The results also revealed that yield under improved technology as well as under farmer's practices were higher than the district and State average yield during all the years of demonstrations. The higher yield of chickpea could be attributed due to adoption of improved variety with improved production practices of chickpea. These results corroborate the findings of Reager *et al*. (2020) and Meena *et al*. (2020), and Meena and Singh (2017) in green gram, Wadkar *et al*. (2018) in chickpea. However, on an average, 6.30 q/ha higher yield of chickpea was recorded under improved technology over district average. Similarly, 3.73 q/ha higher yield of chickpea was recorded under improved technology over State average. It was due to use of high yielding improved variety, improved agronomic practices and adoption of improved management practices. Meena *et al*. (2021) and Shivran *et al*. (2020) also reported the higher grain yield of chickpea and Indian mustard respectively, under front line demonstrations over district and state average.

Technology gap

The data of Table 2 depicted the technology gap in demonstration yield against potential yield which ranged from 2.48 to 10.28 q/ha during different years of demonstration. Technology gap was maximum (10.28 q/ha) during 2016-17 and minimum (2.48 q/ha) during 2018-19. On an average technology gap during four years of demonstrations were 627.75 kg/ha for chickpea cultivation in Bharatpur district. This also reflects the poor extension activities, which resulted in lesser adoption of package of practice by farmer. Hence, extension activities and a location specific technological recommendation appear to be necessary to decline the technology gap. These results corroborate the findings of Meena *et al*. (2021) and Jat *et al.* (2013).

Extension gap

Extension gap is considered as a parameter to know the yield difference between the demonstrated improved technology and farmer's practices. Results of the demonstrations (Table 2) stated that the extension gap ranging between 1.98-3.12 q/ha was found between demonstrated technology and farmer's practices. On an average extension gap during period of study was 250.75 Kg/ha. So as to enhance the farmers income, there is need to reduce the wider extension gap, therefore, it is necessity to educate the farmers through various means for more adoption of recommended improved high yielding varieties and implementation of latest agro-technique (Reager *et al.* 2020, Meena *et al*. 2020 and Meena and Singh (2017) in green gram and Meena *et al*. (2021) in chickpea.

Technology index

The technology index is a parameter to show the feasibility of the improved technology at the farmer's fields. Data on technology index presented in Table 2 shows that technology index varied from 12.40 to 44.69 per cent. During study period of frontline demonstrations, highest technology index 44.69 per cent and lowest 12.40 per cent was recorded during year of 2016-17 and 2018-19, respectively. Further, on an average technology index 29.71 per cent was observed during four experimental years of chickpea, which shows the efficacy of good performance of technical interventions. This will accelerate the adoption of demonstrated technological intervention to increase the yield performance of chickpea at farmer's field. Similar findings were recorded by Meena *et al*. (2021), Reager *et al*. (2020), Wadkar *et al*. (2018), Bhargav *et al*. (2017) and Jat *et al*. (2013).

Table 2: Comparative statement of yield and other parameters of front line demonstrations on chickpea in Bharatpur district of Rajasthan.
(Potential yield of GNG-1581 =2300 kg, potential yield of RSG-895/CSJ-515/RSG-974 = 2000 kg per hectare).

Year	Village	Block	Variety	No. of Demo.	Area (ha)	Yield of demo. (Kg/ha) H	L	Av.	Average yield under FP (Kg/ha)	% increase over FP	EG (Kg/ha)	TG (Kg/ha)	TI (%)
2016-17	Kheda Karoli, Kumharedi, Mavai, Maharawar	Kumher, Nagar, Deeg	GNG-1581	50	20	1550	1050	1272	1036	22.77	236	1028	44.69
2017-18	Dahgaon, Sinsini, Murraki, Seedpur, Reethauthi, Ibrahimpur, Daurda	Bayana, Deeg, Kumher, Roopwas	RSG-895	100	40	1450	862	1183	985	20.10	198	817	40.85
2018-19	Kumharedi, Kheda Karoli, Ballabhgarh, Moroli Khurd, Maharawar	Nagar, Kumher, Weir, Bharatpur	CSJ-515	150	60	2750	1000	1752	1440	21.66	312	248	12.40
2019-20	Bartai, Karenua	Kumher	RSG-974	50	20	1650	1450	1582	1325	19.39	257	418	20.90
Average	-	-	-	-	-	1850	1090	1447.25	1196.50	20.95	250.75	627.75	29.71
Total	-	-	-	350	140	-	-	-	-	-	-	-	-

Demo. = Demonstration, H= Highest, L= Lowest, Av. = Average, FP= Farmer's practice (Local check), EG= Extension gap, TG= Technology gap, TI= Technology index.

Table 3: Economics of the front line demonstrations on chickpea in Bharatpur district of Rajasthan.

Year	Variety	No. of Demo.	Area (ha)	Cost of cultivation (Rs./ha)		Gross return (Rs./ha)		% increase in gross return	Net return (Rs./ha)		% increase in net return	Additional cost (Rs./ha)	Additional return (Rs./ha)	Effective gain (Rs./ha)	Benefit-cost Ratio	
				Demo.	Local check	Demo.	Local check		Demo.	FP					Demo.	FP
2016-17	GNG-1581	50	20	25350	23150	69960	56980	22.77	44610	33830	31.86	2200	12980	10780	2.75	2.46
2017-18	RSG-895	100	40	21075	19075	47320	39420	20.04	26245	20345	28.99	2000	7900	5900	2.24	2.06
2018-19	CSJ-515	150	60	23700	20600	80942	66528	21.66	57242	45928	24.63	3100	14414	11314	3.41	3.22
2019-20	RSG-974	50	20	18750	17750	77123	64594	19.39	58373	46844	24.61	1000	12529	11529	4.11	3.63
Average	-	-	-	22219	20144	68836	56880	21.02	46618	36737	26.89	2075	11956	9881	3.10	2.82
Total		350	140	-	-	-	-	-	-	-	-	-	-	-	-	-

Demo. = Demonstration, FP= Farmer's practice (Local check).

Economics

Economics of improved technology under frontline demonstration were estimated (Table 3) on the basis of prevailing market rates which recorded higher gross monetary return (Rs.80942/ha.), additional returns (Rs.14414/ha.) with improved technology demonstration compare to farmer's practice in the year 2018-19 in case of chickpea variety CSJ-515. The higher net returns (Rs. 58373/ha.), effective gain (Rs. 11529/ha.) and B: C ratio (4.11) with improved technology demonstration compare to farmer's practice in the year 2019-20 in case of chickpea variety RSG-974. Seed yield, cost of variable inputs, labour charge and sale price of produce determine the economic return and these vary from year to year. The present investigation showed improved technology fetched higher net return to the tune of Rs. 26245/ha to Rs. 58373/ha with the average of four years (Rs.46618/ha). However, under farmer's practice, the net return ranged from Rs. 20345/ha to Rs. 46844/ha over the years and its average value fetched to Rs. 36737/ha. Further, on the average, of all four years of study revealed that improved technology demonstration gave higher mean gross return (Rs. 68836/ha.), mean net return (Rs. 46618/ha.), mean additional returns (Rs. 11956/ha.), mean effective gain (Rs. 9881/ha.) and mean B: C ratio (3.10) compare to farmer's practice. Similar economic benefits owing to adoption of improved technology interventions were also reported by Meena *et al*. (2021), Reager *et al*. (2020), Meena *et al*. (2020) and Jat *et al*. (2013).

CONCLUSION

The frontline demonstrations conducted on chickpea at the farmers' field revealed that the adoption of improved technologies significantly increased the yield as well as net returns to the farmers. So, there is a need to disseminate the improved technologies among the farmers with effective extension activities like trainings, group meetings, demonstrations and field days. The farmers' should be encouraged to adopt the recommended package of practices realizing for higher returns. The beneficiary farmers of demonstrations also play an important role as source of information and quality seed for wider dissemination of the high yielding variety of chickpea for other nearby farmers.

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