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ASSESSMENT OF TECHNOLOGICAL INTERVENTIONS ON PRODUCTIVITY AND PROFITABILITY OF CHICKPEA (*Cicer arietinum* L.) THROUGH CLUSTER FRONTLINE DEMONSTRATIONS (CFLDs) IN SAHIBGANJ DISTRICT OF JHARKHAND

Amrit Kumar Jha, Kaushik Chatterjee Birendra Kumar Mehta and Maya Kumari
Krishi Vigyan Kendra (Birsa Agricultural University), Sahibganj, Jharkhand, India

ABSTRACT
Cluster Frontline Demonstrations (CFLDs) were conducted for dissemination of chickpea production technologies during 2016-17 to 2019-2020 at farmer's field in 4 villages of 2 blocks in Sahibganj District of Jharkhand. A total of 130 demonstrations were conducted involving farmers on a total area of 50 ha farmer's field with scientific production technologies to evaluate the performance of improved varieties of chickpea on productivity and profitability. Chickpea is an important rabi pulse crop in Sahibganj district of Jharkhand covering over 7,995 ha with average productivity of 10.1 q/ha which is below the state average (12.58 q/ha) and national average (10.63 q/ha). Unavailability of improved variety as well as non-adoption of scientific cultivation practices in the district is one of the possible reasons for lower average productivity of chickpea in the district. Performance of chickpea varieties JAKI 9218, P 372 and GNG 1581 in 130 locations along with improved cultivation practices like line sowing, treatment of seed with fungicide, insecticide and biofertilizer, balanced nutrition and weed management were evaluated in Barharwa and Rajmahal blocks of the district. It was observed that the yield of chickpea in CFLD under rainfed conditions ranged from 13.0 q to 13.7 q ha^{-1} whereas in FP it ranged between 8 to 8.7 q ha^{-1}. The per cent increase in yield with Improved Practices (IP) over FP was recorded in the range of 56 to 63. The extension gap and technological index were ranging between 4.88 to 5.3 q ha^{-1} and 31.5 to 35 per cent, respectively. The trend of technology gap reflected the farmer's cooperation in carrying out demonstrations with encouraging results in subsequent years. Highest gross return (Rs 66,788 ha^{-1}) and net return (Rs 39,788 ha^{-1}) was fetched during four observation years. The benefit cost ratio varied from 2.3 to 2.57 under demonstration, while it was 1.67 to 1.88 under farmer's practice. Therefore, the results clearly indicate that the use of improved variety and package of practice with scientific intervention under cluster frontline demonstration programme contribute to increase the productivity and profitability.

KEYWORDS: Extension gap, technology transfer, yield, cluster frontline demonstrations, technology index, economics.

INTRODUCTION

India being 2^{nd} most populated country in the world with domination of veg-dietary habits still far from achieving sufficiency in pulse production. Pulses are rich and predominating source of protein with Recommended Dietary Allowances (RDA) for adult male and female is 60 g and 55 g per day, while its per capita availability is @ 42 g per day (Anonymous 2019). India is the largest producer and consumer of pulse with maximum area coverage in the world. Yet, with stagnation of production in spite of increase in demand, there has been an increasing demand supply gap for pulse in India which create huge economic loads in term of import to meet out the domestic demands. According to the vision 2030 of ICAR- Indian Institute of Pulse Research, Kanpur growth rate of 4.2% has to be ensured to meet out projected demand of 32 MT of pulse by 2030 (Tiwari and Shivhare, 2017). In order to ensure self- sufficiency, the pulse requirement in the country is projected to be about 39 million tonnes by year 2050 which necessitates adoption of chickpea as a suitable option in Rabi season for higher crop productivity and profitability with improved soil health. Pulses are grown worldwide on an about 85.40 Mha with a production of 87.40 (Mt) at 1023 kg ha^{-1} yield level. India ranks first in term of area (29.3 M ha) and production (245 lakh tonnes) with 34 per cent and 26 per cent contribution, respectively (Anonymous 2018). A remarkable increase in productivity of pulses over 11^{th} (662 kg ha^{-1}) and 12^{th} plan (745 kg ha^{-1}) was reported in 2016-17 (835 kg ha^{-1}). Chickpea with 11.5 MT production from 14.56 M ha area and 1266.08 kg ha^{-1} productivity also make a record in 2018-19 in the country. However, over the same period, production of pulse in the country increased only by about 47% (Anonymous 2018 I).

Chickpea (*Cicer arietinum*) is one of the oldest pulses crop that have been grown for over 8,000 years (Dhuppar *et al*. 2012). By virtue of its ability to fix atmospheric nitrogen, pulses are traditionally indispensable components of cropping systems in India and are also climate resilient and can be sown in rainfed areas. In Jharkhand chickpea occupies a major position in terms of area, production and productivity among the pulses. Chickpea is mostly sown in November- December and harvested in March-April. The improved varieties adopted in programme viz., JAKI 9218, P 372 and GNG 1581 are bold and medium seeded crop duration of 135-140 days having wide adaptation depending upon the environmental conditions Over a period of time, a number of improved Chickpea varieties and production technologies have been developed, but the full potential of the varieties as well as technologies could not be exploited due to low rate of adoption and low yield. Thus, factor limiting to productivity cannot be overlooked. Research and extension programme need to be diverted to produce value additive pulse. It may emphasize on quality attributes, adoption and popularization o new agro technologies, evolving better varieties for stress conditions and improving present yield potential with an aim to raise production through transfer of farm technology.

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. To meet the growing demand for food grains, National Development Council (NDC) in its 53rd meeting adopted a resolution to enhance the production of rice, wheat and pulse by 10, 8 and 2 million tons respectively by 2011 with an outlay of Rs. 4,882 corers under National Policy for Farmers in the Eleventh Five Year Plan. The proposed centrally sponsored scheme 'National Food Security Mission (NFSM)' is to operationalize the resolution of NDC and enhance the production of food grains (Annonymous, 2011). The concept of Cluster Frontline Demonstration was put forth under this mission. The scheme implemented in a mission mode through a farmer centric approach. The basic strategy of the mission is to promote and extend improved technologies, i.e., seed, micronutrient, soil amendments, integrated pest management, farm machinery and implements, irrigation devices along with capacity building of farmers. The project was implemented by Krishi Vigyan Kendra, Sahibganj with main objective to boost the production and productivity of pulse through CFLD with latest and specific technologies.

MATERIALS AND METHOD

The study was carried out during Rabi season from 2016-17 to 2019-20 (4 consecutive years) by the KVK Sahibganj, Jharkhand. The villages covered under CFLDs were Chapujan (Block – Barharwa) in 2016-17, Bhimpara (Barharwa) in 2017-18, Lalbandh (Block – Rajmahal) in 2018-19 and Madhuapara (Block – Barharwa) in 2019-20 of Sahibganj district of Jharkhand. Number of locations (beneficiaries) during 2016-17,2017-18, 2018-19 and 2019-20 were 50, 28, 26 and 26, respectively totaling 130. Beneficiaries (farmers/ farmwomen) were identified through their participation and feedback received during the preliminary survey, awareness programmes and interactive meetings. Farmers were trained to follow the package and practices for chickpea cultivation as recommended by the Birsa Agricultural University and critical inputs for the technologies like seeds, fungicides, insecticide, biofertilizers were distributed to the farmers however balanced plant nutrients on the basis of soil test value were applied by the farmers from their own resources. Detail of technological interventions is presented in table 1. Regular field visit, monitoring and need based advisories were provided by the scientists of KVK. All 130 demonstrations in 50-hectare area were conducted by the active participation of the farmers with an objective to demonstrate the improved technologies of chickpea production potential in different villages. In case of local check, the traditional practices were followed by using existing variety. In demonstration plots, use of quality seeds of improved varieties JAKI 9218 in year 2016-17, P 372 in 2017-18 and GNG 1581 in 2018-19 as well as in 2019-20 with line sowing, timely application of weedicide and need based pesticide as well as balanced fertilizer were emphasized. In general, the soil of the experimental plots were sandy loam in texture, acidic in soil reaction (pH 5.7 to 6.4), low to medium in organic carbon (0.40 to 0.65 %), medium status in available nitrogen (305 to 370 kg/ha), low to medium in available phosphorus (8.0 to 12.8 kg/ha) and also low to medium in available potassium (110 to 136 kg/ha). The farmers under the programme were facilitated by KVK scientists in performing field operations like sowing, spraying, weedicide application, harvesting etc. Finally, field day was conducted involving demonstration holding farmers, other farmers in the village, scientist from KVK, officials from Department of Agriculture, local extension functionaries to demonstrate the superiority of technology. The basic information was recorded from the demonstration and control plots and analyzed for comparative performance of the cluster frontline demonstrations (CFLDs) and farmer's practice. The yield data were collected both from the demonstration and farmers practice by random crop cutting method and analyzed by using simple statistical tools. The technology gap and technological index (Yadav *et al.*, 2004) along with the benefit cost ratio (Samui *et al.*, 2000) were calculated by using following formula as given below.

$$\text{Extension Gap} = \text{Demonstration Yield} - \text{Farmer}'\text{sPractice Yield}$$

$$\text{Technology Gap} = \text{Potential Yield} - \text{Demonstration Yield}$$

$$\text{Additional Return} = \text{Demonstration Return} - \text{Farmer}'\text{sPractice Return}$$

$$\text{Technology Index} = \frac{\text{Potential Yield} - \text{Demonstration Yield}}{\text{Potential Yield}} \text{x } 100$$

$$\text{Percent increase in yiels} = \frac{\text{Demonstration Yield} - \text{Farmer}'\text{s Practice Yield}}{\text{Farmer}'\text{sPractice Yield}} \text{ x } 100$$

RESULTS AND DISCUSSION

Results of the Cluster Frontline Demonstrations conducted during 2016-17 to 2019-20 in different villages of Sahibganj revealed that the improved package and pracitces is more important with technological intervention for productivity and profitability of pulse. The cultivation practices comprised under CFLD viz use of improved variety, seed treatment, line sowing, balanced application of fertilizers, proper weed control and control of pest through insecticide at economic level evidentially proved superiority over farmer's practice (Table 2). Similar observations were reported by Singh *et al*. (2011). It was found that the average grain yield of chickpea under cluster frontline demonstrations were ranged from 13.0 to 13.7 q ha^{-1} as compared to 8.0 to 8.7 q ha^{-1} in case of Farmer's Practice during 2016-17 to 2019-20. As far as per cent increase in demonstration yield over yield obtained under Farmers Practice is concern, an average of 60.37 per cent increase was found during the four years of demonstrations. However, the yield obtained in demonstration plots over the year was still lower than potential yield which may be attributed to climatic conditions of the areas during the maturity period. Data presented in table 2 also indicates that the yield of chickpea fluctuate little over the years in demonstration plots. Similar yield enhancement in different crops in cluster frontline demonstrations were documented by Hiremath *et al.* (2007) in Onion; Mishra *et al.* (2009) in Potato; Kumar *et al.* (2010) in Bajra; Dhaka *et al.* (2015) in Coriander; Jha *et al.* (2020) in Black gram; Jha *et al.* (2020) in Pigeonpea. The results were also supported by Singh *et al.* (2014) and Tomar (2010). The increase in percent of yield was ranged from 48.5 to 61.5 during the four years of study. The results were in conformity with the findings of Katare *et al.*, (2011), Meena *et al.*, and Saikia *et al*. (2018).

The extension gap ranging from 4.88 to 5.3 q ha^{-1} over the years of study emphasizes the need to educate the farmers through various means for adoption of improved agriculture practices to reverse the trend of wide extension gap. The trend of technology gap ranging between 6.3 to 7.0 q ha^{-1} reflects the farmers cooperation in carrying out demonstrations with encouraging result in subsequent years. Similar findings were recorded by Katare *et al.* (2011) in oilseeds and Saikia *et al.*, (2018) in black gram. The technology gap over the years of study may be attributed to dissimilarity in soil fertility status, rainfall distribution, pest infestation, weed intensity and change in locations of cluster frontline demonstration sites. However, the result observed is an evidence of the better performance in varied environmental condition over farmer's practice. The technology index showed the feasibility of the evolved technology at the farmer's field. The technology index ranging from 31.5 to 35 per cent during the years of study exhibited a decreasing trend over the years with low fluctuation which may be attributed to the dissimilarity in weather condition, soil fertility status and non-availability of water in the crop. The lower the value of technology index the more is the feasibility of the improved technology. On an average Technology Index was 32.65 per cent during four years (2106-17 to 2019-20) which showed the efficacy of good performance of technical interventions. This may accelerate the adoption of demonstrated technical interventions to increase the yield performance of chickpea. Similar type of observation was recorded by Jha *et al.* (2020) in pigeonpea and black gram.

Economic performance of chickpea under cluster frontline demonstration presented in table 3. Results of economic analysis parameter revealed that the chickpea recorded higher total return of Rs. 59,840/-, Rs. 57,200/-, Rs. 62,740/- and Rs. 66,788/- per ha during 2016-17, 2017-18, 2018-19 and 2019-20, respectively under CFLDs as compared to Rs. 37,400/-, Rs. 35,200/-, Rs. 40,194/- and Rs. 40,950/- per ha, respectively under farmers practice. Technologies demonstrated under CFLDs also had positive influence on net return and thereby benefit cost ratio (B:C ration) over farmer's practice. The net return ranged from Rs. 32,400/- to Rs. 39,788/- per ha under recommended practice as compared to Rs. 14,200/- to Rs. 17,894/- per ha in farmer's practice. It was observed that the additional returns ranged from Rs. 22,000/- to Rs. 25,838/- per ha under recommended practices during the years. The higher benefit cost ratio was also recorded under recommended practices and the observed B:C ratio was 2.57, 2.30, 2.42 and 2.47 during 2016-17, 2017-18, 2018-19 and 2019-20, respectively as compared to 1.88, 1.67, 1.80 and 1.72, respectively under farmers practice. These results are in accordance with the findings of Gurumukhi and Mishra (2003), Singh *et al*. (2014), Tomar (2010) Singh *et al.*, (2018), Jayalakshmi *et al.*, (2018) and Jha *et al.* (2020).

CONCLUSION

The cluster frontline line demonstrations (CFLDs) conducted by KVK had enhanced the yield of chickpea vertically and ensured rapid spread of recommended technologies of chickpea production horizontally by implementation of various extension activities like training programmes, field days, exposure visits etc. organized under CFLD programmes in farmer's field. The CFLDs made a positive impact on yield of chickpea by 60.37 %. It was observed that the potential yield of chickpea varieties JAKI 9218, P 372 and GNG 1581 can be achieved by imparting scientific knowledge to the farmers, providing the quality need-based inputs and their proper utilization. Therefore, it is suggested that policy maker may provide adequate financial support to frontline extension system for organising CFLD under the close supervision of agricultural scientists and extension professionals. This strategy may help to increase the pulse crop productivity at micro, meso and macro level.

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TABLE 1: Difference between technological intervention and farmer's practices under CFLD on Chickpea

Particulars	Technological intervention in CFLD	Farmers practices	Gap
Variety	JAKI 9218, P 372 and GNG 1581	Local/own seed	Full gap
Seed rate	75-80 kg/ha	120 kg/ha	High seed rate
Sowing method/ spacing	Line sowing (30 × 10 cm) with seed cum fertilizer drill	Broadcasting, uneven plant population	Partial gap
Time of sowing	15 to 30 November	November 15 to 15 December	Partial gap
Seed Treatment	Seed treatment was done with 2.5 gm of Carbendazim,1. 5 g of Tibuconazole per kg seed for diseases and sucking pest, Trichoderma @ 5 g/kg seed to control wilt and with Rhizobium culture + PSB @ 2 packets each for 10 kg seed	No seed treatment	Full gap
Fertilizer	Balanced fertilizer application as per soil test values, 44 kg of urea and 312.5 kg of SSP as basal dose/ha.	Imbalanced use of fertilizer 50 kg urea as top dressing and 5o kg of DAP as basal dose/ha	Full gap
Weed management	Application of Pendimethalin 30 EC 3 lit ha^{-1} as pre-emergence.	Manual weeding at 35-40 DAS	Full gap
Plant Protection	2 spray of insecticide to control pod borer at 75% flowering and pod filling stage.	Injudicious use of insecticides and fungicides based on advice of input dealers	Partial gap with high cost

TABLE 2: Grain yield and Gap analysis of cluster frontline demonstration on Chickpea

Year	Sample Area (ha)	Sample No. of farmers	Average yield (Q/ha)			% increase over FP	Technology gap (q/ha)	Extension gap (q/ha)	Technology Index (%) CFLD
			Potential	CFLD	FP				
2016-17	20	50	20	13.6	8.5	60	6.4	5.1	32
2017-18	10	28	20	13.0	8.0	62.5	7	5.0	35
2018-19	10	26	20	13.58	8.7	56	6.42	4.88	32.1
2019-20	10	26	20	13.70	8.4	63	6.30	5.30	31.5
Average	-	-	20	13.47	8.4	60.37	6.53	5.07	32.65

TABLE 3: Economic analysis of the cluster frontline demonstrations on Chickpea

Year	Total return (Rs per ha)		Input cost (Rs per ha)		Net return (Rs per ha)		Additional return (Rs per ha) CFLD	B:C ratio	
	Recommended Practice (RP)	Farmer's Practice (FP)	Recommended Practice (RP)	Farmer's Practice (FP)	Recommended Practice (RP)	Farmer's Practice (FP)		Recommended Practice (RP)	Farmer's Practice (FP)
2016-17	59,840	37,400	23,200	19,800	36,640	17,600	22,440	2.57	1.88
2017-18	57,200	35,200	24,800	21,000	32,400	14,200	22,000	2.30	1.67
2018-19	62,740	40,194	25,900	22,300	36,840	17,894	22,546	2.42	1.80
2019-20	66,788	40,950	27,000	23,700	39,788	17,250	25,838	2.47	1.72
Average	61,642	38,436	25,225	21,700	36,417	16,736	23,206	2.44	1.76

Note: Price of Chickpea @ Rs.4400.00 qt^{-1} in 2016-17, Rs.4400.00 q^{-1} in 2017-18, Rs.4620.00 qt^{-1} in 2018-19 and Rs.4875.00 qt^{-1} in 2019-20