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Yield Gap Minimization in Lentil (*Cicer aeritinum* L.) under Front Line Demonstration conducted in Indo Gangetic Plains of Eastern India

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ABSTRACT

Lentil predominantly is the rainfed crop mainly grown in constrained environment. Yield gap of lentil will be minimized by implementation of suitable location specific agro techniques with timely and careful management. Frontline demonstrations (CFLD) on lentil were conducted during *rabi* season of 2015-16 to 2018-19 in Buxar district of Bihar. CFLD was conducted in 20 ha area in each year with plot size of 0.40 ha with active participation of 50 farmers in two clusters to popularize the technology and quantifying the yield gap analysis in lentil. Demonstrated technology under CFLD enhanced the plant growth and yield attributes. Seed yield of lentil was recorded higher under CFLD (14.52 q/ha) compared to farmers' practice (11.46 q/ha) which was 26.70 per cent higher over farmers' practice, 32.12 per cent higher over district yield (10.99 q/ha) and 49.69 per cent higher over state yield (9.70 q/ha). Technology gap was recorded 2.11, 2.08, 1.4 and 0.33 q/ha in year 2015-16, 16-17, 17-18 and 2018-19, respectively. Extension gap was recorded 4.02, 4.05, 2.5 and 1.67 q/ha during 2015-16, 16-17, 2017-18 and 2018-19, respectively. Technology index was recorded 13.19, 13.0, 8.75 and 2.06 per cent during 2015-16, 16-17, 17-18 and 18-19, respectively. Average net return of Rs 36,346/- was recorded in demonstration and Rs 22,281/- in farmers' practice. The net return under demonstration was 63.12 per cent higher over farmers practice. Average benefit cost ratio of 2.41 recorded with demonstration and 1.90 with farmer's practice.

Key Words: Cluster frontline demonstration, Lentil, Pulses and Yield gap minimization.

INTRODUCTION

Pulses are an important group of food crops that can play a vital role to address national food and nutritional security and also play an important role in protecting the environment from the risk associated with high input agriculture (Ali *et al,* 2012). Pulses play an important role in rainfed as well as partially irrigated agriculture by improving physical, chemical, and biological properties of soil and are considered excellent crops for natural resource management, environmental security, crop diversification and consequently for viable agriculture. Cultivation of pulses builds-up a mechanism to fix atmospheric nitrogen to N-compounds in their root nodules and tend to fix 72 to 350 kg N/ha/year, thereby meeting their own nitrogen requirements to a great extent. In India, pulses are generally produced in poor soils not suited to other crops, with a minimum use of resources and have a very low water footprint.

Lentil is one of the most nutritious cool season food legumes and rank next only to chickpea. It is grown throughout the northern and central India for grains. Besides its utilization as a dal, whole or dehulled grains are also used in various other preparations. It is one of the prominent sources of vegetable protein in the Indo Gangetic Plain (IGP) region, essentially grown as a rainfed crop on the residual soil moisture of preceding crop (generally rice). Several causes are responsible for low yield of

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Table 1. Comparison between package of CFLD and farmers practice.

Particular	Demonstration	Farmers' Practice
Farming situations	Rainfed	Rainfed
Cropping system	Rice-Lentil	Rice-Lentil
Varity	PL-8	PL-8
Time of sowing	First fortnight of November	Hole November
Field preparation/Tillage	Minimum tillage	Conventional tillage
Method of sowing	Line sowing	Broadcasting
Seed rate	40 kg/ha	50 kg/ha
Seed treatment	*Trichoderma harzianum*, *Rhizobium* culture, PSB	No seed treatment
Fertilizer dose and application	N:20 P:50:K:30, spray of 2% Urea at 35 DAS	N:18 P:46 (use only 100 kg DAP/ha)
Micronutrient application	Application of B and Mo at 45 DAS/ before flowering	No use
Weed management	Pre emergence application of pendimethalin+1 HW	No use of herbicides, one hand weeding at 45 DAS
Plant Protection	Drenching of *Trichoderrma harzianum* for controlling wilt	Spray fungicide Carbendazim+Mancozeb for controlling wilt

lentil of which the use of traditional local cultivars, low plant density per unit area, complex weed infestation and poor crop management practices constitute the major ones (Singh *et al,* 2017).

The main challenges of research and development are to bridge the gap between actual and attainable yield by enhancing farmers access to quality seed, fertilizers, plant protection measures, improved technologies and information's. Front line demonstrations are one of the practical approaches to maximize the production by display of relevant technologies at farmers' field under strict supervision of agricultural experts helped to narrow down the extension and technological gaps to a considerable extent. CFLD was implanted by Krishi Vigyan Kendra, Buxar with the main objective to harvesting the yield potential of lentil and minimizing the district, state and farmers' yield gap.

MATERIALS AND METHODS

The cluster frontline demonstration (CFLD) on lentil were conducted during *rabi* seasons of 2015-16 to 2018-19-20 in Buxar district of Bihar state on 20 ha area in each year with plot size of 0.40 ha with active participation of 50 farmers in two clusters. Before conducting the CFLD farmers were selected and one training on scientific cultivation and management of lentil was given. Soil samples of all the sites were collected before sowing and analyzed for nutrient management. Under CFLD all the package of practices were used *viz.,* seed dressing with fungicides, PSB and rhizobium, minimum tillage for field preparation, line sowing, drenching with *Trichoderma harzianum* @ 6ml/ liter of water for controlling the wilt problem, management of aphid and one foliar spray of boron + molybdenum (agromin) @ 2 ml/liter of water before flowering in demonstration plots. Visit of farmers and the extension functionaries was organized at

Table 2. Cost of cultivation of CFLD and farmers' practice .

Input	Demonstration cost (Rs)	Farmers Practice cost (Rs)
Field preparation	2500	3200
Seed	5200	5000
Seed treatment	750	0
Sowing	1200	1000
Nutrient management	4400	3000
Weed management	4500	6363
Plant protection	1600	1400
Harvesting & Threshing	5900	5000
Total	26050	24963

demonstration plots to disseminate the message at large scale. The demonstration farmers were facilitated by KVK scientists in performing field operations like line sowing, nutrient management, insect & disease management, weed management, harvesting etc.

The necessary steps for selection of site and farmers, layout of demonstration etc. were followed as suggested by Choudhary (1999). The traditional practices were maintained in case of local checks (farmers' practice). Demonstration was conducted to quantifying the yield gap analysis in lentil. Number of branches and nodule count were collected from each demonstration plot and farmers plot. Yield attributing parameters were collected from each demonstration and farmers plot. For calculation of crop yield crop cutting were conducted in the presence of large number of farmers for popularization of demonstrated technology. Protein content was worked out by multiplying the percentage value of nitrogen content of seed with the factor 6.25. Economic analysis was done on the basis of prevailing market price of input used and output obtained from treatments (Table 3). The estimation of technology gap, extension gap and technology index and yield gap minimized were estimated using following formula (Kadian *et al*, 1997; Samui *et al*, 2000; Dwivedi *et al*, 2014):

RESULTS AND DISCUSSION

Crop growth, yield attributes and quality

The data related number of plants/m^2 at maturity was recorded 20.18 per cent higher under demonstration (52.4) compared to farmers' practice (43.6). Lentil growth parameters *viz.,* number of branches, number of nodules per plant, nodules dry weight per plant and yield attributes namely number of pods/plant, number of grains/pod, 100 seed weight influenced by demonstration (Table 3). Number of branches per plant (13.90) was recorded maximum under demonstration over farmer's practice (9.60). Number of nodules per plant (19.80) in demonstration was recorded 44.52 % higher over farmer's practice (13.70). Dry weight of nodules per plant was also higher in demonstration plot (56.76 mg/plant) over farmers' practice (47.70 mg/plant). Number of pods/plant was recorded higher in demonstration (84.6) and it was 16.20 per cent higher over farmers' practice (72.8). 100 seed weight was also recorded maximum under demonstration plot (2.54 g) compared to farmers practice (2.43). This was mainly due to proper follow of package of practices in demonstration plot, seed treatment with rhizobium culture, PSB and *Trichoderma harzianum* enhanced the nodulation and protect the plant to different soil borne diseases (Singh *et al,* 2017). Protein content (24.81%) was recorded higher in demonstration compared to

Table 3. Effect of CFLD and farmers' practices on growth, yield attributes and protein yield of lentil.

Treatments	No. of plants/ m2 at maturity	No. of branches/ plant	No. of pods/ plant	No of grains/pod	100 grain weight (g)	No of nodules/ plant at flowering	Dry matter of nodules (mg/plant) at flowering	Protein content (%)	Protein yield (kg/ ha)
Cluster Frontline Demonstration	52.4	13.90	84.6	1.67	2.54	19.80	36.76	24.81	360.24
Farmers' practice	43.6	9.60	72.8	1.50	2.43	16.70	47.70	24.37	279.76

Table 4. Yield advantage accrued due to cluster frontline demonstration.

Year	Area (ha)	No of farmers	Yield (kg/ha)					% increase over farmers yield	Absolute yield gap (q/ha) w.r.t. potential yield		
			District	State	Potential	CFLDs	Farmers practice		DYA	SYA	FYA
2015-16	20	50	860	880	1600	1389	987	40.72	740	720	613
2016-17	20	50	939	932	1600	1392	995	39.90	661	668	605
2017-18	20	50	1200	1068	1600	1460	1210	20.66	400	532	390
2018-19	20	50	1397	1001	1600	1567	1400	11.93	203	599	200
Average	20	50	1099	970	1600	1452	1148	28.30	501	630	452

Table 5. Technology gap, extension gap, technology index and economics of CFLDs and farmers practice

Year	Technology gap (kg/ha)	Extension gap (q/ha)	Technology index (%)	Farmers Practice				CFLDs			
				Cost of cultivation (Rs/ha)	Gross return (Rs/ ha)	Net return (Rs/ha)	B:C ratio	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
2015-16	211	402	13.19	20800	44415	23615	2.14	22200	62505	40305	2.82
2016-17	208	397	13.00	26800	39800	13000	1.49	27000	55680	28680	2.06
2017-18	140	250	8.75	26800	51425	24625	1.92	27000	62050	35050	2.30
2018-19	33	167	2.06	25450	62650	37200	2.46	28000	70123	42123	2.50
Average	148	304	9.25	24963	49573	24610	2.00	26050	62590	36540	2.42

Sale price of Lentil Rs 4500/q in 2015-16, Rs 4000/q in 2016-17, Rs 4250/q in 2017-18 and Rs 4475 in 2018-19 farmers practice (24.37%). This was mainly due to farmers using indigenous and very old variety and in CFLD new variety used. Protein yield (360.24 kg) was also recorded maximum in demonstration plots compared to farmers practice (279.76 kg/ha). This might be due to adoption of good agronomic practices and suitable cultivar enhanced the seed yield of lentil and good protein content (Singh *et al*, 2017).

Data on seed yield of lentil showed demonstration plot yield was increased over the year and demonstrated technologies also have significant impact on district yield as well as state yield (Table 4). Farmers plot yield was also improved over the year. Average yield of demonstration plot (1452 kg/ha) was recorded 26.48 per cent higher over farmers plot yield (1148 kg/ha), 32.12 per cent higher over district yield (1099 kg/ha) and 49.69 per cent higher over state yield (970 kg/ha). Demonstration of technologies in CFLD showed significant impact and farmers learn about the scientific agro-techniques and their timely application and management. Per cent yield increase over farmers field was varies from 40.72 to 11.93 per cent. Initial years of demonstration yield increases of lentil were recorded 40.72 per cent, in second year of demonstration it was 39.90 per cent higher over farmers practice, in third year it was 20.66 per cent higher over farmers and in forth year it was 11.93 per cent (Table 4). District yield gap of 740, 661, 400 and 203 kg/ha was recorded in 2015-16, 16-17, 17-18 and 18-19, respectively. State yield gap was recorded 720, 668, 532 and 599 kg/ha in 2015-16, 16-17, 17-18 and 18-19, respectively. Farmers yield gap was recorded 613, 605, 390 and 200 q/ha in 2015-16, 16-17, 17-18 and 18-19, respectively. The difference in yield gap with respect to potential yield was reduced over the year in district, state and farmers' yield. This might be due to popularization of improved agro-techniques at farmers field and supply of quality seed and other input to the farmers and farmers multiplied the seed over the year and reaches to other farmers of the district (Dubey *et al*, 2018 ; Singh *et al*, 2020).

Technology gap

Technology gap was recorded maximum in initial year of demonstration and decreasing over the years. Technology gap was recorded 211, 208, 140 and 33 kg/ha in year 2015-16, 16-17, 17-18 and 18-19, respectively (Table 5). This may be attributed to lack of good quality of seed, bio fertilizers, crop establishment methods, herbicides for weed control, plant protection measures and location specific crop management problems (Saikia *et al*, 2018; Singh *et al*, 2020). The location specific crop management is required to bridge the gap in the potential and demonstration yield.

Extension gap

Extension gap are the indicator of lack of awareness for the adaptation of improved farm technologies by the farmers. The successful development, dissemination and adaptation of improved technologies for small and marginal land holder depends on more than careful planning of research and use of appropriate methodology (Choudhary, 2013). Extension gap was recorded 402, 397, 250 and 167 kg/ha during 2015-16, 16-17, 17-18 and 18-19, respectively (Table 5). First year of demonstration extension gap was 402 kg/ha and in 2018-19 decreased and recorded 167 kg/ha. This showed that proper monitoring and popularization of technology amongst the farmers reduced the extension gap (Saikia *et al,* 2018). The higher extension gap indicates that there is strong need to more aware and motivate the farmers which is emphasizing on need to educate farmers through various means of adaptation of improved agricultural production technologies over existing local practices to minimize the extension gap.

Technology index

Technology index indicates the feasibilities of the evolved technology in the farmer's field under existing variations. Lower the value of technologies index, higher the feasibility of the improved technology. Technology index was recorded 13.19, 13.0, 8.75 and 2.06 per cent during 2015-16, 16-17, 17-18 and 18-19, respectively (Table 5). This was mainly due continuous demonstration at farmer's field and organized training, field day and other awareness programmes motivated to the farmers to adopt new agricultural production techniques for harnessing the potential yield of crop (Saikia *et al*, 2018).

Economics

Economic analysis highlights that use of improved technology and its adoption has substantially enhanced the farm gains over farmer's practice which indicated that use of farm technology can greatly improve the livelihood and profitability of the farming community. Economic analysis of data indicated that cost of cultivation under farmers practice was lower compared to demonstration (Table 5). The higher cost of cultivation under demonstration was mainly due to adoption of seed treatment package, balanced nutrient management and higher harvesting and threshing cost because of higher yield in demonstration. Net return of demonstration plot was recorded higher to farmers practice in each years of demonstration. Average net return of Rs 36,540/- was recorded in demonstration and Rs 24,610/- in farmers' practice. The net return under demonstration was 48.47 per cent higher over farmers' practice. Average benefit cost ratio of 2.42 recorded with demonstration and 2.0 with farmer's practice, which showed that technology under demonstration was supportive to farmers and economically viable (Khedkar *et al*, 2017, Singh *et al,* 2017; Singh *et al,* 2020).

CONCLUSION

On the basis of four years of cluster front line demonstration seed yield of lentil was recorded 26.48 per cent higher over farmers practice. Net return and benefit cost ratio was also higher under demonstration over farmers practice. Potential yield of lentil can be achieved by imparting scientific knowledge to the farmers, providing the quality seed and need based other inputs and proper application techniques of inputs. Horizontal spread of improved technologies might be achieved by the successful implementation of frontline demonstrations and various extensions activities.

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