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Response of cluster front line demonstrations on productivity and profitability of lentil in Bhagalpur, Bihar

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Abstract
The study was carried out in the winter season (2015-16 to 2017-18) in thirty nine villages of ten blocks of district Bhagalpur, Bihar. All 250 demonstrations on lentil crop were demonstrated in 100 ha area after Participatory Rural Appraisal (PRA) by the active participation of farmers with the objective to show and popularize the improved technologies of lentil production potential developed at Bihar Agricultural University Sabour, Bhagalpur (Bihar). The improved technologies in cluster front line demonstrations consisting use of improved variety (Arun and HUL-57), seed treatment with *Tricoderma* @ 5 g/kg seed, Chloropyriphos 20% EC @8.0 ml/kg seed, *Rhizobium* culture @ 20 g/kg seed and PSB culture @ 20 g/kg seed, recommended dose of fertilizer application, weed management and integrated pest management along with integrated crop management (ICM). Cluster front line demonstrations with improved technologies recorded higher yield as compared to farmer's practice (check). The improved technology recorded higher average yield of 12.2 q/ha in comparison to farmer's practice *i.e.* 8.16 q/ha. In spite of increase in yield of lentil, extension gap and technology index existed. The improved technologies in cluster front line demonstrations gave higher net return with maximum benefit cost ratio as compared to farmer's practices.

Keywords: Economics, extension gap, lentil, technology gap, technology index and yield and yield attributes

Introduction
Lentil (*Lens esculenta* Moench) is a widely grown rabi legume mainly sown in October-November and harvested in February-March, belongs to the family *Leguminoseae* and assumes considerable importance from the point of food and nutritional security in the world. It is best suited to areas having low to moderate rainfall and a mild cold weather. It has the potential to cover the risk of dryland agriculture. In India, lentil is grown on about 1.6 m ha area with production of 1.07 million tonnes and the average productivity is 678 kg/ha. In Bihar, lentil occupies a major position in terms of area, production and productivity among the pulses. In Bihar, lentil is generally grown under rainfed conditions after flood/rice with a very low productivity *i.e.* 706 kg/ha (2017-18, Directorate of Economics & Statistics, Bihar). However, productivity is low due to lack of awareness in farming community regarding improved package and practices of pulse crops. Production of major pulses is constrained by both biotic and abiotic stresses. The major constraints to productivity in lentil are biotic stresses such as *fusarium* wilt, coller rots, dry root rots aphids, cutworm, Bihar hairy caterpillar, powdery mildew and rust, are the major pests and diseases as well as weeds affecting lentil production in India. Weeds are serious negative factor responsible for reduction in the yield to a tune of 84%. Availability of quality seed of improved varieties and other inputs is one of the major constraints in increasing the production of grain legumes (David *et al.*, 2002) [3].

India is the largest importer, producer and consumer of pulses. Net daily pulses availability for Indians has increased slightly from 32g per capita in 2000 to 43.3g per capita in 2013 as against WHO recommendation of 80 g/day. Thus, Indian government imports large quantity of pulses to fulfill domestic requirement of pulses. In this regard, to sustain this production and consumption system, the Department of Agriculture, Cooperation and Farmers Welfare had sanctioned the project "Cluster Frontline Demonstrations on rabi pulses from 2015-16'' to ICAR-ATARI, Kolkata through National Food Security Mission. The basic strategy of the Mission is to promote and extend improved technologies, *i.e.* seed, micro-nutrients, weed

management, soil amendments, integrated pest management, farm machinery and implements, irrigation devices along with capacity building of farmers. This project was implemented by Krishi Vigyan Kendra, Bhagalpur of Zone-IIIB in Bhagalpur district with main objective to boost the production and productivity of pulses through CFLDs with latest and specific technologies.

It is therefore, necessary to assess the technological gap in production and also to know the problems and constraints in adopting modern lentil production technologies. KVK an innovative science based institution plays an important role in bringing the scientist face to face with farmers. The main aim of KVK is to reduce the time lag between generations of technology at the research institution and its transfer to the farmers for increasing productivity and income. KVKs are grass root level organizations meant for application of technology through assessment, refinement and demonstration of proven production technologies under different micro farming situations in a district (Das *et al.* 2010) [2]. The main objective of front line demonstration was to show the worth or value of the technology. The present study was undertaken to response of cluster front line demonstrations (CFLDs) on productivity and profitability of lentil in district of Bhagalpur, Bihar.

Materials and Method

The cluster front line demonstration was conducted during *Rabi* season from 2015-16 to 2017-2018 (3 consecutive years) by the Krishi Vigyan Kendra Sabour, Bhagalpur of Bihar to study the technology gap between the potential yield and demonstrated yield, extension gap between demonstrated yield and yield under existing practice and technology index. The demonstrations were conducted in 100 ha at farmer's field of 18 villages (2015-16), 10 villages (2016-17) and 7 villages (2017-18) of Bhagalpur district. During study 250 beneficiaries were selected *i.e.* 91, 93 and 106 in 2015-16, 2016-17 and 2017-18 respectively.

The selection of farmers was done village wise. Only interested farmers were purposely selected for cluster front line demonstration and type of farmer was large, medium and small holding size included in the study. A group of co-operative farmers were identified based on their participation and feedback received during the preliminary survey and interactive meeting. Through preliminary discussion with selected farmers, causes for low crop yield of lentil were identified and prioritized.

Table 1: Differences between improved technologies under CFLD and farmers' practices

S. No.	Particular	Application improved technologies	Farmer's practice	Gap
1	Variety	Arun, KLS 218 and HUL 57	Tituwa, Desila, Titki Mallika (old)	Full gap
2	Seed treatment	Seed treatment with *Trichoderma* @ 5.0 g/kg seed, Chloropyriphos 20% EC @8.0 ml/kg seed, *Rhizobium* culture @ 20g/kg seed, PSB culture @20 g/kg seed	Without seed treatment	Full gap
3	Land preparation	Three ploughing	Three ploughing	Nill
4	Sowing time	15th October to 20th November	Last week of October to end of November	Partial gap
5	Sowing in residual moisture	Yes	Yes/no	Partial gap
6	Seed rate	40 kg/ha	70-75	Higher seed rate
7	Fertilizer dose	Balance dose of fertilizers in INM manner	imbalance/ No use of fertilizer	Full gap
8	Weed control	Pendimethalin @ 1.0 kg a.i./ha applied as pre-emergence	No weeding	Full gap
9	Irrigation	Nill	Nill	Nill
10	Plant protection	Insect control-Profenophos+cyper - Post-emergence application @ 0.7 lit/ha Disease control- Thiophanate methyl - post-emergence application @1.0 kg/ha	No control	Full gap

Based on the major causes, technological interventions were finalized. All the technological interventions were taken as per prescribed package and practices for improved variety of lentil crop (Table 2). Before conducting CFLDs, specific skill trainings were organized involving the selected farmers and local extension functionaries in their villages/KVK center. In case of local check, the traditional practices were followed by using existing varieties. Critical inputs in the form of improved variety seed, bio-fertilizers, *Tricoderma,* fungicide, herbicide and insecticide were provided to the farmers by KVK after the training.

Table 2: Technology Demonstrated

Variety-	Arun, KLS 218 and HUL 57
Technology -	Seed treatment with *Trichoderma* @ 5.0 g/kg seed, Chloropyriphos (20%) @ 8.0 ml/kg seed, *Rhizobium* culture @ 20g/kg seed, PSB culture @20 g/kg seed
Weed control-	Pendamethaline - pre-emergence application @1.0 1.0 kg a.i./ha
Disease control-	Thiophanate methyl - post-emergence application @1.0 kg/ha
Insect control-	Profenophos+cyper - Post-emergence application @ 0.7 lit/ha

In general, soils of the area under study were greyish red in colour, medium to heavy in texture with medium to low fertility status, cracks during summer. The average rainfall of this area was 1208 mm with 992 mm rainfall received in 3rdweek June to 3rdweek of October. The yield data were collected from both the demonstration and farmers practice by random crop cutting method and analyzed by using simple statistical tools. For the study, technology gap, extension gap and technology index were calculated as suggested by Samui *et al*. (2000) [10].

$$\text{Percent increase yield} = \frac{\text{Demonstration yield - farmers yield}}{\text{Farmers yield}} \times 100$$

$$\text{District yield gap (\%)} = \frac{\text{Demonstration yield - district yield}}{\text{District yield}} \times 100$$

$$\text{State yield gap (\%)} = \frac{\text{Demonstration yield - state yield}}{\text{State yield}} \times 100$$

$$\text{Potential yield gap (\%)} = \frac{\text{Potential yield –Demonstration yield}}{\text{Demonstration yield}} \times 100$$

Extension gap = Demonstrated yield – Yield under existing practice (Farmer's Practice)

Subsequently demonstrated crops were visited during different crop growth stages by the KVK scientists. The beneficiaries under the programme were facilitated by KVK scientists in performing field operations like sowing, spraying, weeding, harvesting etc. during the course of training and visits. Finally field day/crop cutting was conducted involving demonstration holding farmers, other farmers in the villages and local extension functionaries to demonstrate the superiority of the technology for the disseminating the message at large scale. Crop yield was recorded from the demonstration and control plots at 3-5 plots in each cluster. The data on incidence of disease, population of insects, seed yield, cost of cultivation and gross monetary return were collected from improved technologies plots and farmer's practice plots. The following formulae were used to calculate the parameters:

1. Insect incidence/plant = Number of damaging stage of the insect/plant
2. Increase in grain Yield=Grain yield form Improved Technologies (IT) plot– Grain yield from farmer's practice plot
3. Net Return = Gross Return – Cost of cultivation
4. Benefit/Cost Ratio= Gross Return / Cost of Cultivation

Results and Discussion

Yield and yield attributes

Results of CFLDs conducted during 2015-16 to 2017-18 in different villages of Bhagalpur district showed that the highest yield and their attributes in improved technology comprised under CFLD *viz* (1.) use of improved variety, (2.) seed treatment with *Trichoderma* @ 5.0 g/kg seed, Chloropyriphos 20% EC @ 8.0 ml/kg seed and *Rhizobium* culture @ 20g/kg seed, PSB culture @ 20 g/kg seed, (3.) weed control with Pendamethaline as pre-emergence application @ 1.0 kg a.i./ha, (4.) *fusarium* wilting control with seed treatment with *Trichoderma* @ 5.0 g/kg seed and Thiophanate methyl as post-emergence application @1.0 kg/ha (5.) balanced application of fertilizers and (6.) control of pest through insecticide at economic threshold level.

Three years mean data showed the progressive response of improved technology under CFLDs on yield. The highest mean yield (12.2 q/ha) was recorded under the demonstrated plots, comparatively much higher than the farmer's practice (8.16), which was 49.5% higher than farmer's practice. Whereas, 15.3 q/ha *i.e.* maximum and 9.7 q/ha *i.e.* minimum yield was recorded under demonstration (CFLDs). The results clearly indicate the positive effects of CFLDs over the existing farmer's practices toward enhancing the yield of lentil Bhagalpur, Bihar with its positive effect on yield attributes (Table 3). The results were in conformity with the findings of Saikia *et al.* (2018) [9] and Meena *et al.* (2012) [6].

District, state and potential yield gap analysis

District yield gap percentage was ranged from 59.6 to 95.5 during the three years of study (mean of three years 76.9). On the basis of mean data, 29.2% state yield gap was calculated in lentil crop. Whereas, 44.9 % potential yield was calculated on the basis of three years mean (Table 3). It might be mainly due to timely improved variety sowing with recommended seed rate, Seed treatment with *Trichoderma*, Chloropyriphos, *Rhizobium* and PSB culture, optimum fertilizer application, proper weed management and wilt control. The results indicated that the cluster front line demonstrations have given a good impact over the farming community of Bhagalpur district as they were motivated by the new agricultural technologies applied in the cluster front line demonstration plots. The results were in conformity with the findings of Raju Teggelli *et al.* (2015) [8] and Meena *et al.* (2012) [6].

Technology and extension gaps

The yield of demonstrations and potential yield of the crop/variety was compared to estimate the yield gaps which were further categorized namely technology and extension gaps. On the basis of three years data, the extension gap was recorded between 2.7-5.0 q/ha. This Extension gap should be assigned to adoption of improved technology in CFLDs which outcome in higher grain yield than the farmer practices. These agreements are with the findings of Bairwa *et al.*, (2013) [1], Kothyari *et al.*, (2018) [5] and also Hiremath and Nagaraju (2010) [4].

The perusal of three years mean data indicated that technology gap for the technological interventions was found to be 9.95 q/ha (Table 1). This gap might be attributed to the differences in soil fertility status, biotic factors, environmental conditions and adaptability of the demonstrated interventions under the field conditions. The similar result also recorded in Oats by Paul *et al.*, (2018) [7] likewise *et al.*, (2018) in black gram.

Economic

The inputs and outputs prices of commodities prevailed during the study of CFLDs were taken for calculating gross return, cost of cultivation, net return and benefit: cost ratio (Table 2). Improved technologies of CFLDs gave higher gross return, net return and benefit cost ratio as compared to farmer's practices. The similarly findings was also obtained by Kothyari *et al.*, (2018) [5] in black gram.

Table 3: Impact of improved technologies under CFLDs on yield and Gap in grain yield production of lentil

year	Farmer's varieties	CFLDs Varieties	Farmers No	Demo Area (ha)	CFLDs yields (q/ha)			Farmer's practice yield (q/ha)	Yield gap (%)			Extension gap (q/ha)	Technology gap (q/ha)
					Max.	Min.	Av.		District	State	Potential		
2015-16	Tituwa, Desila, Titki Mallika	Arun	91	30	10.6	9.1	9.8	7.1	59.6	5.2	55.4	2.7	12.2
2016-17	Tituwa, Desila, Titki Mallika	HUL 57	53	25.7	16.4	9.6	12.4	7.7	75.6	23.4	43.6	4.7	9.6
	Tituwa, Desila, Titki Mallika	KLS 218	40	14.3	17.1	9.5	12.7	7.7	79.9	26.4	43.5	5.0	9.8
2017-18	Tituwa, Desila, Titki Mallika	HUL 57	66	30	17.3	10.8	13.8	10.2	95.5	29.2	37.3	3.6	8.2
Total / mean		-	250	100	15.3	9.7	12.2	8.16	76.9	29.2	44.9	4.0	9.95

Table 4: Impact of improved technologies under CFLDs on economics of lentil

Year	Variety	Farmer's practice				Demonstration plot			
		Gross Cost (Rs/ha)	Gross return (Rs/ha)	Net Return (Rs/ha)	B:C ratio	Gross Cost (Rs/ha)	Gross return (Rs/ha)	Net Return (Rs/ha)	B:C ratio
2015-16	Arun	16000	55950	39950	3.49	17500	66200	48700	3.78
2016-17	HUL 57	16490	37800	21310	2.29	18100	54400	35300	3.01
	KLS-218	16490	37800	21310	2.29	18100	56000	37900	3.09
2017-18	HUL 57	16404	37671	21267	2.3	17896	51171	33276	2.86
Mean		16346	42305	25959	2.59	17899	56943	38794	3.19

Conclusion

Based on three years study, it may be concluded that there exists a wide gap between the potential and demonstration yields in lentil mainly due to technology and extension gaps and also due to the lack of awareness about new technology in lentil growing community of Bhagalpur. Knowledge level and adoption level of the farmers were amplified after imparting training and conducting CFLDs by KVK scientists. The CFLDs conducted on Integrated Pest Management, Integrated Nutrient Management as well as Integrated crop Management in lentil at farmer's fields revealed that the farmers could increase lentil production and profitability significantly. The productivity and profitability gain under CFLDs over farmer's practice created awareness and motivated the other farmers to adopt these improved technologies which involve in CFLDs.

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