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Yield gap and economics of Cluster Frontline Demonstrations (CFLDs) on pulses under rain-fed condition of Bundelkhand in Uttar Pradesh

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Abstract

The study aimed at assessing the impact of cluster frontline demonstrations (CFLDs) in terms of grain yield, extension gap, technological gap and economic gains in pulse crops in village Titihara selected for National Innovations on Climate Resilient Agriculture in Districts Chitrakoot during Rabi season of 2014-15 to 2016-17. The data on selected parameters of demonstration fields and control field were collected through experimental designs ('Control-Treatment') of social research. The results reveal that the average grain yield in demonstration fields of all selected pulses crops namely; Field pea, Chick pea, Lentil and Green gram were higher than farmers practice. The PDM -139 var. of green gram was recorded lowest extension gap (3.15 q ha-1), technology gap (1.25q ha-1)and technology index(12.50%) followed by lentil (DPL-62) with5.95 q ha-1, 5.20q ha-1 and 23.64%, respectively. The highest additional income (Rs. 36240 ha-1) in CFLD was recorded in Lentil followed by (Rs. 21225 ha-1) in Chickpea and Field pea (Rs. 19250 ha-1) over control. The results clearly reveal that the use of latest varieties and improved package of practices under cluster frontline demonstration remarkably increase the productivity and profitability of pulses in the region by reducing the technology gaps.

Keywords: Pulses, CFLD, yield gap, economics, technology index

Introduction

Pulses are the important sources of proteins, vitamins and minerals and are popularly known as "Poor man's meat" and "rich man's vegetable", which contribute significantly to the nutritional security of the country. Pulses represent commodity group of crops that provide high quality protein complementing cereal proteins for pre-dominantly substantial vegetarian population of the country. Although, being the largest pulse crop cultivating country in the World, India's production of pulses is relatively lower in comparison to total cereal crops productions. The cultivation of pulses builds-up a mechanism to fix atmospheric nitrogen in their root nodules and thus meet their nitrogen requirements to a great extent.

In India, pulses can be produced with a minimum use of resources and hence, it becomes less costly even than animal protein. In comparison to other vegetables, pulses are rich in protein which are less expensive and can be cultivated as an inter-crop and also as mixed crop. Pulses are mostly cultivated under rainfed conditions and do not require intensive irrigation facility and this is the reason why pulses are grown in areas left after satisfying the demand for cereals/cash crops. Even in such conditions, pulses give better returns. Apart from this, pulses possess several other qualities such as they improve soil fertility and physical structure, fit in mixed/inter-cropping system, crop rotations and dry farming and provide green pods for vegetable and nutritious fodder for cattle as well.

India is the largest producer (26%) of world's production and consumer (30%) of total pulses of the world. The frequency of pulses consumption in the country is much higher than any other source of protein, which indicates the importance of pulses in their daily food habits (Raj *et al.* 2013). The domestic production of about 23 million tonnes during 2016-17 shall be still less than the future estimated demand of 29-30 million tonnes in 2030. The targeted production and productivity is possible by way of harnessing this yield gap by growing pulses in new niches, precision farming, quality inputs, soil test based INM, timely weed management and mechanized method of pulse cultivation complimented with generous governmental policies and appropriate funding support to implementing states/stake holders (Tiwari and Shivhare, 2017). According to the Vision-2030 document prepared by the ICAR-Indian Institute of Pulses Research (IIPR), Kanpur, a growth rate of 4.2% has to be ensured in order to meet the projected demand of 32 million tonnes of pulses by 2030. This will, however, require a paradigm shift in research, technology generation and dissemination, popularization of improved crop management practices and commercialization along with capacity building of the stakeholders in frontier areas of research (Tiwari and Shivhare, 2017)

Addressing this concern of significance, the Ministry of Agriculture and Farmers Welfare, Govt. of India had initiated a nation-wide cluster frontline demonstration (CFLD) programme on pulses under National Food Security Mission-Pulses (NFSM-Pulses). The basic strategy of the Mission is to popularize improved technologies, i.e., seed, micro-nutrients, soil amendments, weed management, integrated pest management, farm machinery and implements, micro irrigation devices along with capacity building of farmers. The ICAR through its Krishi Vigyan Kendras (KVKs) across the country has been implementing this CFLD programme on different pulse crops to boost the production and productivity of pulses with improved varieties and location specific technologies. Despite great scope and better opportunities for pulses production in Bundekhand region of UP. The growth rate is low due to many intricate and interrelated factors right from soil/climate related constraints to technological and extension-oriented tribulations. Besides, shrinkage in land holding, growing population pressure, increasing food/pulse demand and poor soil health are the key constraints (Vijaya Laxmi *et al.* 2017 and Praharaj *et al*. 2018). The major pulses grown in the region are green gram (*Vigna radiata*), black gram (*V. mungo*), pigeon pea (*Cajanus cajan*), chickpea (*Cicer arietinum*), lentil (*Lence culinaris)* and field pea (*Pisum sativum*). The Krishi Vigyan Kendra Chitrakootin this region has been successfully implementing this programme since 2008-09 under the scheme of National Innovations on Climate Resilient Agriculture (NICRA) by conducting cluster frontline demonstrations in a systematic manner on farmers' field under the close supervision of their scientists to show the worth of new/ proven varieties with technological packages for enhancing production and productivity of pulse crops. With this background, the current study was undertaken with the particular objectives to assess the performance of CFLD on pulses in terms of grain yield, extension gap, technological gap and economic gains by the farmers so that the findings the study will be helpful to the concerned policy makers and other stakeholders to focus on the way forward for improving pulses production in the region, vertically and horizontally as well.

Materials and Methods

The study sites: The study was carried out in village Titihara District Chitrakoot under the KVK scheme of NICRA on 335 farmers field which have implemented CFLD programmes on selected crops of pulses namely; field pea, chick pea, lentil and green gram during three years (2014-15 to 2016-17). One variety of each crop namely; Prakash (field pea), DCP 92-3 (chick pea), DPL-62 (lentil) and PDM -139 (green gram) were considered for the study which have paramount significance in terms of production potential and wide acceptance by the farmers in their local farming systems.

Experimental details

Major technological interventions were taken as per prescribed packages of practices for selected crops (Table 1) by the KVK of the Chitrakoot. Knowledge and Skill development of farmers were imparted through trainings at KVK as a part of technological interventions with improved package of practices in demonstration fields at farmers' fields. The farmer practice was considered as control field/local check which was maintained by the farmers according to their own traditional cultivation practices. The KVK as per the mandate of the scheme had provided critical inputs such as seeds, fertilizers, IPM, implements and bio-fertilizers to the farmers for demonstration fields with technical support. The necessary steps for selection of site, selection of farmers, layout of demonstrations etc. were followed as suggested by Choudhary (1999). The KVKs Scientists used to frequent visit to demonstrations fields and farmer's field (control) for intensive supervision and data collection during the entire period of study. The study was conducted in experimental designs ('Control-Treatment') of social research.

Table 1: Details of recommended package of practices for Field pea, Chick pea, Lentil and Green gram

Technological intervention	**Recommended packages of Practice followed in CFLDs**			
	Field pea (*Pisum sativum*)	**Chick pea (*Cicer arietinum*)**	**Lentil (*Lens esculenta*)**	**Green gram (*Vigna radiate* L.)**
Variety	Prakash	DCP 92-3	DPL -62	PDM -139
Seed rate	80 kg ha-1	80 kg ha-1	50 kg ha-1	15 kg ha-1
Seed treatment.	Rhizobium culture @ 40g kg-1, Bavistin @ 2g kg-1 and *Trichoderma viride* @ 4g kg-1 seed.	Rhizobium culture @ 40 g kg-1 , Bavistin @2g kg-1 and *Trichoderma viride* @ 4g kg-1 seed	Rhizobium culture @40 g kg-1 Bavistin @ 2g kg-1 and *Trichoderma viride* @ 4g kg-1 seed	Rhizobium culture @40 g kg-1, Bavistin @ 2g kg-1 and *Trichoderma viride* @ 4g kg-1 seed
Sowing method and Spacing	Line sowing @ 30 X 10 cm	Line sowing @ 30 X 10 cm	Line sowing @ 25 X 10 cm	Line sowing @ 30cm X 10cm.
Time of Sowing	October-November	Mid October-Mid November	Mid October-Mid November	July
Nutrient management	Application of 25kg N, 50kg P2O5 as basal dose	Application of 25kg N, 50kg P2O5 and 2% foliar application before flowering	Application of 25kg N, 50kg P2O5 and 2% foliar application before flowering.	Application of 20kg N, 50kg P2O5 as basal dose
Weed management	Application of weedicide (Pendimethalin @1.0 kgha-1) immediately after sowing	Application of weedicide (Pendimethalin @1.0 kgha-1) immediately after sowing	Application of weedicide (Pendimethalin @1.0 kgha-1) immediately after sowing	1 weeding 30-40 days or use of Pendimethalin @1.0 kgha-1 immediately after sowing.
Irrigation	One light irrigation at flowering stage	One light irrigation before flowering stage	One light irrigation before flowering stage	No irrigation
Insect-pests and disease management.	Seed treatment with Carbendazim @ 2 g kg-1 against infestation of powdery mildew.	Seed treatment with Mancozeb and Carbendazim @2 g kg-1. and two spray of Spinosad 45 SC @0.1 ml/lt to control pod borer at flowering and pod formation stage.	Seed treatment with Mancozeb and Carbendazim @2 g kg-1. In case of aphid infestation, spraying of Monocrotophos (0.04%) .	Seed treatment with Mancozeb and Carbendazim @2 g kg-1 and Indoxacarb 15.8% SC @ 330 mlha-1 at pod filling stage

Data collection and analysis

The data on listed parameters of demonstration fields as well as control fields were collected on fixed interval till harvesting of crops to assess the overall performance of selected pulse crops. The on-spot interaction schedule was also used to record the information from beneficiary and non-beneficiary farmers about adoption pattern, varietal replacement and diffusion in nearby villages of pulse crops etc. The data outputs were also collected from CFLD fields as well as control fields and finally the extension gap, technology gap, technology index, additional return along with the benefits- cost ratio were worked out (Table 3 & 4) as per the formula adopted by (Samui *et al*. 2000)as given below:

Extension Gap = Demonstrated yield-Farmers' practice yield

Technology Gap= Potential yield- Demonstration yield

Additional Return = Demonstration return – Farmers practice return

Technology Index

$$= \frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}} \times 100$$

$$\text{Benefit – Cost Ratio} = \frac{\text{Gross Return}}{\text{Gross Cost}}$$

The basic information from the farmer's field as well as feedback information were chronologically recorded and analyzed to see the comparative performance of cluster frontline demonstrations (CFLDs) and farmer's practice (control).

Results and Discussion

During the period of 3 years, demonstrations conducted by Krishi Vigyan Kendra in the district are shown in Table 2. In each cluster frontline demonstration (CFLD), The latest varieties with scientific package of practice of pulse crops were compared with control/ farmer's practice with traditional cultivation practices. A total of 335 demonstrations on improved varieties of Field pea (90), Chick pea (80), Lentil (90) and Green gram (75) covering 134 ha were conducted by the KVK at farmers' field during 2014-15 to 2016-17 (Table 2).

Table 2: Details of pulses growing under Cluster frontline demonstrations (CFLDs) and farmers Practices

Pulse	Variety		2014-15		2015-16		2016-17		Total	
	CFLD	Farmer Practice	Area (ha.)	No. of farmers	Area (ha.)	No. of farmers	Area (ha.)	No. of farmers	Area (ha.)	No. of farmers
Field pea	Prakash	Rachna	10.0	25	12.0	30	14.0	35	36.0	90
Chick pea	DCP 92-3	Awarodhi	10.0	25	10.0	25	12.0	30	32.0	80
Lentil	DPL – 62	Local	10.0	25	12.0	30	14.0	35	36.0	90
Green gram	PDM-139	Local	10.0	25	10.0	25	10.0	25	30.0	75
Total	**-**	**-**	**40.0**	**100**	**44.0**	**110**	**50**	**134**	**134**	**335**

Grain yield and gap analysis of pulse crops

The observations pertaining to grain yield and gap analysis of pulse crops in demonstrated field's and farmer's practice is presented in Table 3. Data reveals that average grain yield of field pea, chick pea, lentil and green gram in demonstration fields were higher in compare to farmer's practice. Singh *et.al.* (2015) and Patil *et.al*. (2018) also supported that yield in frontline demonstrations was better than that of farmer practices. The results show that average grain yield of field pea(var. Prakash) under CFLD was 16.50q ha-1 compared to 10.50q ha-1 in farmers practice with 36.97averageincreaseoverlocalcheck.Incaseofchick pea (var. DCP 92-3), average yield of 15.32 q ha-1 in demonstration field was recorded against 9.25 q ha-1 in farmers' practice with average increase of 39.62 % over local. Similarly, lentil (var. DPL -62) produced 16.80 q ha-1 average yield in demonstration in compare to farmers practice (10.85 q ha-1) with average increase of 35.41 % over control. While 8.75 q ha-1 average yield was found in CFLD against

5.60 q ha-1 in farmers' practice accounting 36.0 % increase yield over the local check in green gram (var. PDM-139). The results clearly showed positive response of CFLDs over the existing practices toward enhancing the yield of pulses in the region due to technological interventions effect on yield attributes. The above findings are in accordance with Dwivedi *et, al.* (2014), Singh *et al.* (2018), Mitnala *et al*. (2018), Saikia *et al*. (2018) and Singh *et. al*. (2020).

Table 3: Productivity, extension gap, technology gap and technology index of pulses under CFLDs(average over years).

Pulse	No. of demo.	Area (ha)	Average productivity (q ha-1)			% increase over FP (control)	Extension gap (q ha-1)	Technology	
			Potential	CFLD	FP			gap (q ha-1)	Index (%)
Field pea	90	36.0	23.0	16.50	10.40	36.97	6.10	6.50	28.26
Chick pea	80	32.0	22.0	15.32	9.25	39.62	6.07	6.68	30.37
Lentil	90	36.0	22.0	16.80	10.85	35.41	5.95	5.20	23.64
Green gram	75	30.0	10.0	8.75	5.60	36.0	3.15	1.25	12.50
Average			**19.25**	**14.34**	**9.03**	**37.00**	**5.32**	**4.91**	**23.69**

CFLD = Cluster Frontline Demonstration FP=Farmers Practice

The per cent increment in CFLD yield of pulses to the extent of 36.97 %, 39.62%,35.41% and 36.0% in field pea, chickpea, lentil and green gram respectively, over the farmers practice advocated greater awareness and motivated the other farmers to adopt the improved package of practices of pulses. The adopted farmers of demonstrations also played an important role as key personnel of information and quality seeds for wider dissemination of high yielding varieties of pulses for nearby farmers and villages.

The data presented in Table 3 also reveals that PDM-139 variety of green gram was recorded with the least extension gap (3.15 q ha-1), technology gap (1.25q ha-1) and technology index (12.50 %) compared to other pulse crops under study. This was followed by lentil, field pea and chick pea. Field pea (var. Praksh) emerged with the highest extension gap (6.10 q ha-1) while maximum technology gap (6.68 q ha-1) and technology index (30.37 %) was recorded in chickpea (DCP 92-3). This prioritize the need of KVKs to educate the farmers more particularly those non-beneficiaries through various extension means for the adoption of scientific practices in cultivation of all the pulse crops.

Economics analysis of pulse crops

Table 4 represent the results of economic findings of cluster frontline demonstration on pulse crops conducted by KVK. It is summarized from the table that the highest total average return of Rs.80640ha-1 was noticed from CFLD of Lentil (var. Prakash) as compared to Rs. 44400 ha-1 in farmers practice during the period of study. This yielded additional net profit of Rs. 56690 ha-1 in demonstration and Rs.26100ha-1 in farmers practice followed by chick pea, field pea and green gram. Average maximum additional return of Rs.36240ha-1 was recorded in lentil followed by chick pea (Rs.21245 ha-1), field pea (Rs.19520 ha-1) and green gram (Rs.15278 ha-1) in demonstration fields. While pattern of B:C ratio was recorded with 3.37, 2.14, 2.10 and 2.07 in lentil, field pea, chick pea and green gram respectively. While these data under farmers practice was recorded as 2.43, 1.80, 1.63 and 1.61, respectively. The findings are in conformity with those of Kumar *et.al.*(2014) and Singh *et al*. (2019). Singh *et.al* 2015)in their study on impact of FLD on yield of pulses also reported that the improved technology gave higher gross return, net return with higher benefit cost ratio as compared to farmer's practices. Similar findings were reported by Raj *et al.* (2013) and Singh *et al*. (2017) in their study.

Table 4: Economics of cluster frontline demonstrations on pulses under CFLDs (average over years)

Pulse	Gross returns (Rs. / ha)		Gross cost (Rs. / ha)		Net return (Rs. ha-1)		Additional gain (Rs. ha-1) in FLD's	B:C ratio	
	CFLD	FP	CFLD	FP	CFLD	FP		FLD	FP
Field pea	52800	33280	24730	18510	28070	14770	19520	2.14	1.80
Chick pea	53620	32375	25910	20100	27710	12275	21245	2.07	1.61
Lentil	80640	44400	23950	18300	56690	26100	36240	3.37	2.43
Green gram	42438	27160	20250	16620	22188	10540	15278	2.10	1.63
Average	**57375**	**34304**	**23460**	**17883**	**33665**	**15846**	**23071**	**2.42**	**1.87**

CFLD = Cluster Frontline Demonstration; FP=Farmers Practice

The results in Table 4 also clearly indicate higher benefit cost ratio (B:C ratio) of recommended practices in demonstration fields than control field in all the pulse crops under the study. This may be due to higher grain yields recorded under recommended technologies compared to local check (farmers practice). The findings are in the line of that of the study conducted by Udhad *et al.* (2019). These results are also in accordance with the findings of Dhaka *et al.* (2010), Mitnala *et al.* (2018)and Singh *et al.*, (2018). Hence, higher benefit cost ratios proved the economic viability of the technological interventions and convinced the farmers on the utility of interventions. The programme of large-scale cluster frontline demonstrations could be popularized for other pulses crops as well in order to increase farmers' income and to attain self-sufficiency in pulses production in the region.

Conclusion

The findings of above study revealed that all the selected varieties of pulses namely; Praksh (field pea), DCP 92-2 (chick pea), DPL-62 (lentil) and PDM-139 (green gram) produced higher yield in recommended practice (CFLD's) than farmers practice in all the farmers field of Titihra, Chitrakoot. Wide yield gap between research station technology and farmers' technology, has resulted in lower yields in farmers' practices. The advance released technologies have the potential of doubling production at national level without increasing area under pulses if farmers adopt the recommended technological intervention for pulses production system. The extension agencies should demonstrate effects of new technology in pulses production and motivate farmers for adoption of new technology to minimize this wide yield gap and extension gap. Economic findings on selected parameters also revealed that net returns and additional return were recorded higher in recommended practice (CFLD's), which solidate that the CFLD programme is an effective tool for increasing the production and productivity of pulses and changing the knowledge, attitude and skill of farmers. Thus, identified yield enhancing technologies needs to be disseminate for wider adoption among the farming community in their respective farming systems and enhancing production and productivity of pulse crops in the region.

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