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Yield gap minimization of Lentil var. HUL 57 under CFLD conducted in Bishnupur district, Manipur, India

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Abstract
Cluster front line demonstration effectively promotes recommended technologies among farmers. Krishi Vigyan Kendra, Bishnupur district conducted 55 lentil demonstrations in 9 villages in 2016-17, 2021-22, and 2022-23. The study reveals improved practices (IP) yield 520-952 kg/ha, while farmer practices (FP) yield 375-680 kg/ha. IP yield was increased upto 16.81-27.28% compared to FP, indicating a significant yield boost. Extension gap ranged from 145-190 kg/ha. Extension gap trend indicates farmers' cooperation in demonstrations, encouraging results in years to come, and KVK scientist training's impact. Demonstration yielded a cost-benefit ratio of 1.81-2.94, while control plots yielded 1.37-2.59. Cluster front line demonstration of proven technologies can significantly enhance lentil crop yield with increased income in farming communities.

Keywords: Cluster front line demonstration (CFLD), lentil var. HUL 57, yield, net return, extension gap, technology gap, economics

Introduction
India dominates global pulse production, accounting for 33% of the world's area and 25% of pulse production. It also dominates pigeon pea, chickpea, and lentil production, accounting for 90%, 65%, and 37%, respectively, according to FAOSTAT (2012) [3]. Pulses are crucial in Indian agriculture as they are high protein foods (17-25%), surpassing cereal crops' 6-10% protein contribution (Veeramani *et al.*, 2017) [21]. Pulse is crucial in daily food habits, contributing 11% of India's total protein intake and being consumed more frequently than other sources, highlighting its importance (Reddy, 2010) [16]. North-eastern India's uplands primarily grow pulses, producing 209.3 thousand tonnes in 2013-14. However, the region faces an 82% deficit in pulse production, exceeding the ICMR recommendation, despite an average productivity of 828 Kg/ha. (Roy *et al.*, 2017) [17]. Pulse production in India has increased significantly in the last decade, but its rapid growth presents challenges for researchers, extension workers, and policymakers to meet the growing demand. (Raj *et al.*, 2013) [15]. Lentil, an ancient Indian pulse crop, is nutritionally superior to other rabi pulses and is a top choice. India tops the global output and acreage under pulses, but its average productivity is extremely low (714 kg/ha), far behind the global average productivity of 1008 kg/ha. (Afzal Ahmad *et al.*, 2012) [1]. Lentil is a widely traded pulse crop with numerous benefits, including crop rotation, weed control, and soil fertility. Widespread adoption of low-cost technology in pulse crops is crucial to meet increasing domestic and global demand. The study aimed to promote improved technologies, seed varieties, micro-nutrients, soil amendments, pest management, farm machinery, and irrigation devices for farmer capacity building. Krishi Vigyan Kendra, Bishnupur district aims to increase lentil production and productivity using FLDs with advanced technologies, promoting rapid spread of new lentil technology in Manipur.

Material and Method
The current study was conducted in the villages of Manipur's Bishnupur district in the years 2016–17, 2020–21, and 2022–23 (Kumbi, Saiton, Salankonjil, Oinam, Leimaram, and Irengbam). A hundred and fifty demonstrations were conducted in villages to identify yield gaps, input cost differences, and monetary returns in lentil crop practices. These demonstrations aimed to assess farmers' practices and improve yields. Critical inputs were provided according to recommended scientific package of practices. Front-line technology

demonstration in lentil includes improved variety HUL-57, line sowing, proper seed rate, fertilizer dose, seed treatment, irrigation, weed management and plant protection measures. (Table 1). Data on production cost and monetary returns were collected from frontline demonstration plots for three years to assess the economic feasibility of improved lentil cultivation. Local checks and farmers' practices were also analysed. Extension gap was calculated as given by (Samui *et al*., 2000) [18] as:

Extension gap = Demonstration yield - Yield from farmers practice (Local check)

$$\text{Percent increase yield} = \frac{\text{Demonstation yield} - \text{Farmer yield} \times 100}{\text{Farmer yield}}$$

Table 1: Difference between technology intervention and farmers practice under CFLD on lentil

Particulars	Technology intervention	Existing practice	Gap
Variety	HUL-57	Non-descript	Full gap
Seed rate	12-16 kg/ha	15-20 kg/ha	Higher seed rate
Sowing method	Line sowing (30 cm)	Broadcasting	Full gap
Seed treatment	Carbendazim @ 2g/kg	No seed treatment	Full gap
Seed inoculation	Rhizobium @ 50g+ 10g sugar per kg of seed	No seed inoculation	Full gap
Fertilizer dose	(20:40:20:20 kg NPKS/ha)	Improper and imbalance use of fertilizer	Full gap
Weed management	Weed management Pre-emergence application of Pendimethalin @ 1.0 kg a.i./ha	One or two hand weeding	Full gap
Plant protection	Integrated Pest Management	Used different pesticides	Uneven use of pesticide

Table 2: Lentil production, extension gap, technology gap and technology index (%) of CFLDs and local check

Year	Area	Demo	Average yield (kg/ha)		Percent increase in yield over local	Potential yield (kg/ha)	Extension gap (kg/ha)	Technology gap (kg/ha)	Technology index (%)
			Improved practice	Farmer practice					
2016-17	30	75	520	375	27.88	1070	145	550	51.40
2021-22	10	25	952	815	16.81	1070	137	118	11.02
2022-23	20	50	870	680	25.84	1070	190	200	18.69
Mean	60	150	780.7	623.3			157.3	289.3	

Table 3: Economics of cluster frontline demonstrations on lentil under CFLDs (average over years)

Year	Gross cost (Rs. / ha)		Gross return (Rs. / ha)		Net return (Rs. /ha)		Additional gain (Rs. /ha) in CFLD's	B:C ratio	
	Improved practice	FP	Improved practice	FP	Improved practice	FP		Improved practice	FP
2016-17	23000	21900	41600	31000	18600	8100	10500	1.81	1.37
2021-22	30000	29500	66640	48900	36640	19400	17240	2.22	1.66
2022-23	29600	26200	87000	68000	57400	41800	15600	2.94	2.59
Mean	27533	25867	65080	49300	37547	23100	14447	2.32	1.87

Results and Discussion

Technology intervention and farmers practice under CFLD on lentil.

Table 1 shows gap between existing and recommended lentil technologies in Bishnupur district. Full gaps were seen in the cases of variety use, sowing technique, seed treatment, fertilizer dosage, and weed control. These are the reason of not achieving potential yield. Farmers struggle to achieve potential yield due to lack of awareness about recommended technologies, improper spacing and fertilizer use, and uneven pesticide use, leading to increased costs in plant protection measures.

Productivity and Economic impact of front-line demonstrations

During the period of study, benefit cost ratio using input and output commodity prices for each year of demonstrations was calculated (Table 2). When compared to local check practices, front line demonstrations of improved practices (IP) produced higher productivity and B:C ratios in each year. These may result from awareness of and adherence to a whole set of practices, such as the use of the most recent, high-yielding, disease-resistant varieties sown with the appropriate spacing, the improvement of nutrient management techniques, and the adoption of enhanced weed and disease control methods. Padmaiah *et al*. (2012) [13] reported similar results. Yearly yield fluctuations mainly result from soil fertility, climate, and moisture availability. The study revealed that whereas the yield of lentils varies between 375 and 815 q/ha in farmer practices, it varies between 520 and 952 kg/ha in improved practices. The range of 16.81 to 27.88% was found for the yield improvement with IP over FP. Under demonstration, the cost-benefit ratio was 1.81 to 2.94, but under control plots, it was 1.37 to 2.59. With a rise in the income level of the agricultural community, the yield potential of the lentil crop might be greatly increased by undertaking cluster front line demonstrations of proven technologies.

Extension gap

In 2016–17, there was an extension gap of 137 kg/ha as opposed to 2016–17 (145 kg/ha). In order to reverse the trend of a large extension gap, it was highlighted that farmers needed to be educated through a variety of extension methods, such as front-line demonstration for the adoption of improved cultivation and protection technologies. We may inform farmers about the increasing usage of cutting-edge agricultural technology with high yielding varieties by horizontally disseminating improved practices through front-line demonstration, which would subsequently reverse this frightening trend of an accelerating extension gap. According to Padmaiah *et al.* (2012) [13] certain interventions may have stronger effects on improving system productivity depending on how farming situations are identified and used.

Technology Gap

Over the course of the three years, a very significant technical gap was seen, with the lowest level (118 kg/ha) and highest level (550 kg/ha) occurring in rabi 2021–2022 and 2016–17, respectively. On a three-year average basis, it was discovered that the technology gap for all 290 demonstrations was 1325 kg per hectare (Table 1). Technology gap observed in agriculture is due to soil fertility, rainfall distribution, disease, pest attacks, and annual changes in demonstration plot locations. The suggested technologies' increased feasibility in some years may be the reason for the variation in the technological gap between years. Technological gaps in agricultural output, according to Raj *et al*. (2013) [15], are brought on by changes in soil fertility and weather.

Technology index (%)

All of the demonstrations throughout the course of several years had technological indices that were in line with the technology gap. The years with the greatest and lowest technology indices were rabi 2021–2022 and rabi 2016–17, respectively. The highest was 54.1%, while the lowest was 11.02%. The technology index indicates whether advanced technology is practical for use in agricultural areas, and the lower its value, the more practicable the technology is (Table 1).

Economic return

For the purposes of calculating gross return, cost of cultivation, net return, and benefit cost ratio, the input and output prices of the commodities that were in demand during the demonstrations were used. The primary causes of the higher cost of cultivation in demonstration fields than local check are the use of expensive seeds for crop planting, seed treatment, prescribed dosage of chemical fertilizers, effective pest management, etc. As a result, compared to local check (27543 Rs/ha), the average cost of cultivation during a three-year period increased in the demonstration practice (28762 Rs/ha). In comparison to farmers' practices, which were Rs. 30580/ha with an additional net return of Rs. 13999/ha, the cultivation of field pea under improved technologies produced a greater net return of Rs. 44574/ha (45.76% more). Field pea's benefit-cost ratio increased from 2.14 under farmers' practices to 2.63 under improved technologies. The difference between local check (farmers' practice) and improved technologies' grain yields and sale rates determines which incremental benefit-cost ratio is lowest and largest. An previous researcher had noted the same outcomes. This result is consistent with the results from Mokidue *et al*. (2011) [11] (Table 2).

Conclusion

The results indicate that integrating improved technology and farmer active participation positively impacts grain yield and economic return in field pea crop production. Conducting demonstrations and promoting suitable technology can improve farmers' productivity and empowerment. These demonstration trails also boost farmers' confidence and knowledge. The FLD program is a successful tool for enhancing field pea crop production and productivity by changing farmers' knowledge, attitude, and skills.

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