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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; SP-12(9): 30-32

www.thepharmajournal.com
Received: 12-07-2023
Accepted: 16-08-2023

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Analysis of yield gap and economics of cluster frontline demonstration (CFLDs) on field pea in Bishnupur district, Manipur

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Abstract
Krishi Vigyan Kendra in Bishnupur, Manipur, conducted cluster front-line demonstrations on field pea from 2015-16 to 2022-23 in eleven villages. The study involved 290 farmers, focusing on Prakash (IPFD 1-10) variety and Aman (IPF5-19). The eight-year study found that the demonstration plots yielded 11.07 q/ha, compared to 8.58 q/ha in traditional farmer practices. The technology gap, extension gap, and technology index were 13.25 q/ha, 2.49 q/ha, and 54.50 percent, respectively. The investment of Rs.1,218/ha, combined with scientific monitoring, resulted in an additional return of Rs.17,768/ha. The economic returns per unit area were influenced by fluctuating field pea sale prices. The average incremental benefit cost ratio was 2.63.

Keywords: Field pea, yield gap, technology gap, extension gap, technology index, KVK

Introduction
Pulses, also known as "poor man's meat" and "rich man's vegetable," are essential sources of proteins, vitamins, and minerals. India is the largest producer and consumer of total pulse production, with high consumption frequency. India's domestic output of 23 million tonnes in 2016–17 is anticipated to fall short of the future predicted demand of 29–30 million tonnes. Precision farming, high-quality inputs, INM based on soil test results, robotic agriculture, and growing pulses in new niches can all lead to targeted production and productivity.

ICAR-Indian Institute of Pulses Research (IIPR), Kanpur's Vision-2030 statement states aims for 4.2% growth in pulses to meet 32 million tonnes demand by 2030. This requires paradigm shifts in research, technology, crop management practices, commercialization, and stakeholder capacity building. (Tiwari and Shivhare, 2017) [9]. India's pulses receive consumer and government support for production. To address this significant concern, under the National Food Security Mission-Pulses (NFSM-Pulses), the Ministry of Agriculture and Farmers Welfare of the Government of India launched cluster frontline demonstration (CFLD) campaign on pulses in 2015–16. Mission aims to enhance technology, including seed, micronutrients, pest control, agricultural machinery, irrigation devices, and farmer capacity training.

In order to boost pulse yield and productivity through improved varieties and location-specific technologies, Krishi Vigyan Kendras (KVKs) around the nation have been carrying out this CFLD program on a variety of pulse crops. Despite the wider range and better prospects for producing pulses, the Northeast region of India experiences low pulses growth because of soil, climatic, and technology limitations, which affect rice fallow niche areas. Key constraints include soil health issues, population pressure, land shrinking, and food demand. (Praharaj *et al*. 2018) [6].

The district grows green gram and black gram pulses during kharif season, while chickpea, lentil, and field pea are grown during rabi season. Krishi Vigyan Kendra, Bishnupur successfully implemented a program since 2015-16, demonstrating the value of new/proven varieties and technological packages for enhancing field pea production and productivity. The investigation assesses CFLD's performance on field pea, focusing on grain yield, extension gap, technological gap, and economic gains for farmers. The findings will help policymakers and stakeholders improve pulses production in the region, both vertically and horizontally.

Methodology

The current study was conducted by the KVK, Bishnupur (Manipur) throughout the Rabi seasons in the farmers' fields of eleven villages in the Bishnupur district from 2015-16 to 2022-23. CFLD on Prakash (IPFD 1-10) variety was taken in 2015-16, 2016-17, 2022-23, and Aman (IPF5-19) variety was taken in 2017-18, 2018-19, 2019-20, 2020-21, 2021-22 with entire package of practices. In eleven villages, all 290 cluster front line demonstrations on 130 hectares of land were held. In the current CFLD study, the following technologies were employed viz. use of improved varieties Prakash and Aman, scientific cultivation of field pea after rice harvesting such as liming @ 500 kg $CaCO_3$/ha, line sowing with 30 cm X 10 cm, seed treatment with Carbendazim (2 g/kg) and Rhizobium (10g+ 10g sugar/ kg seed), application of NPKS @ 20:40:20:20 kg/ha and timely sowing in the first two weeks of November. In general, the soils in the study area were clayey loam with high nitrogen, medium available phosphorus, and high available potassium. Data collected from farmers' field interactions was analyzed using statistical tools like percentages, calculating technology gap, extension gap, and technology index, as suggested by Samui *et al*. (2000) [8].

Extension gap = Demonstration yield- farmers' yield (control)

Technology gap = Potential yield- Demonstration yield

Technology index (%) = $\frac{\text{Technology gap}}{\text{Potential yield}} \times 100$

Results and Discussion

Grain yield

Grain yield improved by 16.81-51.78% compared to local practices with a 29.99% yield advantage over eight years. Cluster front line demonstrations impacted rural communities in the Bishnupur district, spurred up by new agricultural technologies. (Table 1). Drought during the flowering and pod formation stages caused reduced seed yield in CFLDs. According to Dahmardeh *et al*. (2010) [1], seed rate and cultivar have a substantial impact on grain legume production and quality. According to Kumar *et al*. (2011) [3], rhizobium inoculation enhances seed germination and growth and may be a cost-effective alternative. Mukherjee (2016) [4] obtained similar results, reporting that RDF, rhizobium, and PSB significantly improve field pea height and branches. Similarly, Diwedi *et al*. (2010) [2] discovered that boosting crop productivity necessitates the deployment of new technology.

Gap analysis

Extension Gap

Comparing farmer practices and the demonstrated technology in the eight years of the study, it was observed that, there was an extension gap ranging from 137 to 483 kg per hectare, with an average of 249 kg per hectare (Table 1). The extension gap was lowest in rabi 2021–22 (137 kg/ha) and highest in rabi 2017–18 (483 kg/ha) (Table 1). The variations may have been caused by the demonstrations' use of modern technology, which resulted in higher grain yield than that achieved by conventional agricultural methods.

Technology Gap

A very large technology gap has been observed over a period of 8 years, with the lowest (1019 kg/ha) being recorded in rabi 2018–19 and the maximum (1665 kg/ha) coming in rabi 2016–17. On an eight-year average, it was observed that the technological difference among all 290 demos was 1325 kg per hectare (Table 1). Differences in soil fertility, rainfall patterns, pest and disease outbreaks, and the yearly relocation of demonstration plot locations can all be attributed to the observed technological gap. The difference in the technology gap across years could be due to the suggested innovations' increased viability in certain years. According to Raj *et al*. (2013) [7], differences in soil fertility and weather conditions cause a technological yield gap in crops.

Technology index

The technological gap was reflected in the technology index for all demonstrations over the years. The highest technology index percentage was 68.39 in rabi 2016-17, and the lowest was 41.97 in rabi 2018-19. The technology index represents the viability of evolving technology in agricultural fields; the lower the value of the technology index, the greater the feasibility of the technology (Table 1).

Economics

The gross return, cost of cultivation, net return, and benefit cost ratio were calculated using the input and output prices of the commodities that were in demand during the demonstrations. The use of costly seeds for crop sowing, seed treatment, the appropriate dosage of chemical fertilizers, effective pest management, etc. are all the key causes of the demonstration fields' higher cultivation costs than local check. As a result, compared to local check (27543 Rs/ha), the average cost of cultivation during an eight-year period increased in the demonstration practice (28762 Rs/ha). In comparison to farmers' practices, improved technologies for field pea had a benefit-cost ratio of 2.63 as opposed to 2.14. The lowest and highest incremental benefit cost ratio depends on grain yields obtained and sale rates under improved technologies compared to local check (farmers' practice). The results from Mokidue *et al*. (2011) [5] are supported by this finding (Table 2).

Table 1: Grain yield and gap analysis of Cluster front line demonstrations on Field pea at farmers field from 2015-16 to 2022-23.

Year	No. of Demonstration	Area (ha)	Variety	Potential yield (kg/ha)	Demonstration yield (kg/ha)	Farmer practice (kg/ha)	% increase over FP (check)	Extension gap (kg/ha)	Technology gap (kg/ha)	Technology Index (%)
2015-2016	25	10	Prakash (IPFD 1-10)	2420	1025	820	25.00	205	1395	57.64
2016-2017	50	20	Prakash (IPFD 1-10)	2420	765	556	37.59	209	1655	68.39
2017-2018	40	20	Aman (IPF5-19)	2440	1416	933	51.77	483	1024	41.97
2018-2019	25	10	Aman (IPF5-19)	2440	1421	1225	16.00	196	1019	41.76
2019-2020	50	20	Aman (IPF5-19)	2440	1112	756	47.09	356	1328	54.43
2020-2021	50	20	Aman (IPF5-19)	2440	986	812	21.43	174	1454	59.59
2021-2022	25	10	Aman (IPF5-19)	2440	952	815	16.81	137	1488	60.98
2022-2023	25	10	Prakash (IPFD 1-10)	2420	1180	950	24.21	230	1240	51.24
Mean	290	130			1107	858	29.99	249	1325	54.50

Table 2: Economics of cluster frontline demonstrations on pulses under CFLDs (average over years)

Year	Gross returns (Rs./ ha)		Gross cost (Rs./ ha)		Net return (Rs./ha)		Additional gain (Rs./ha) in CFLD's	B:C ratio	
	CFLD	FP	CFLD	FP	CFLD	FP		CFLD	FP
2015-2016	56000	51250	25392	25392	30608	25858	4750	2.20	2.01
2016-2017	38250	27800	28000	25000	10250	2800	7450	1.81	1.37
2017-2018	99120	65310	25000	25000	74120	40310	33810	3.96	2.61
2018-2019	99410	85750	27500	26500	71970	59250	12720	3.61	3.23
2019-2020	66720	45360	30500	28700	35220	17660	17560	2.19	1.58
2020-2021	66720	45360	28400	31000	50480	33960	16520	2.78	2.09
2021-2022	66640	57050	30000	28000	36640	29050	7590	2.22	2.03
2022-2023	82600	66500	35300	30750	47300	35750	11550	2.29	2.16
Mean	71933	55548	28762	27543	44574	30580	13994	2.63	2.14

Conclusion

The study found that Aman and Prakash yields higher in recommended practice (CFLD) than farmers' practices in Bishnupur District of Manipur. However, a wide yield gap exists between research station and farmers' technology, affecting yields. Extension agencies should showcase new technology's impact on pulse production and encourage farmers' adoption. he study indicates that districts should implement state-specific research and extension initiatives to bridge their technology and extension gaps by carrying out the tasks assigned to them, such as providing skill-oriented training and other extension programs with enough technical help, KVKs in this region can play a vital role in passing improved pulse growing practises to farmers. The availability of high-quality seed of improved varieties and farmer awareness of new technology through various creative extension activities such as ICTs, FPOs, CIGs, FIGs, farmers' fairs/field days, etc. are essential for enhancing pulse yield. The identified yield-enhancing technology must be funded in order for farmers to use it in their local farming methods, hence increasing the region's pulse crop production and productivity.

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