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Impact of Cluster Front Line Demonstration (CFLD) on Production and Productivity of Chickpea (*Cicer arietinum* L.) under Shivalik Foot Hills of District Reasi, Jammu and Kashmir, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

One of the major *rabi* pulse crops grown mostly in the country's north is chickpea (*Cicer arietinum* L.). Its cultivation begins at 0 in Jammu. However, it is transplanted at 0 in Srinagar. Massive 11 Mha have been planted, yielding zero in total productivity. The yield, to 11 M tons, was 1028 kg/ha. After six years, an attempt was undertaken as part of the ongoing NFSM to combine many strategies for pulse productivity and production, which would result in productivity per unit area. By starting to perform Cluster Front Line Demonstrations (CFLDs) across the nation through KVKs and outscaling agricultural innovations through FLDs, ICAR may take a significant step in the right direction and highlight the unique advantages and value of technology on farmers' fields. The yield that was displayed and the real possible yield based on chickpeas are contrasted using the technological gap. The average extension gap was 692 kg/ha; the maximum was 762 kg/ha in 2019–20 and the minimum was 611 kg/ha in 2021–2022. These data further emphasize the necessity of educating farmers via a variety of channels to encourage the adoption of improved agricultural production technologies in order to reverse the extension gap and it can be concluded that integrated crop management technology in chickpea has been found more productive, profitable.

Keywords: Pulse crops; chickpea; front line demonstration; crop productivity; nutritional security.

1. INTRODUCTION

In terms of area, productivity, and economic value, pulses are the second most important agricultural crop in India after cereals and oilseeds [1]. According to Laishram et al. [2], pulses are a staple in vegetarian diets and are also the most affordable source of protein for resource-constrained farmers in the Indian subcontinent. This makes them truly remarkable crops. India is a consumer and producer of pulses alone, accounting for over 35% of the global market for both area and output. India is the world's leading producer of chickpeas, contributing 64 per cent of the crop produced annually worldwide [3]. In India, nine lands were used to grow the chickpea crop 9.50 million tons and a yield of 960 kg/ha [4]. In northern India, one of the most significant rabi pulse crops grown is chickpea (*Cicer arietinum* L.). It is grown on 0.11 Mha in Jammu, with a total yield of 0. In Indonesia, the market for solar thermal systems is still in its infancy but already exhibits the following traits: to achieve a yield of 1028 kg/ha and a production level of 11 M tons. It is the most affordable producer of minerals, proteins (18–22%), carbs (52–70%), lipids (4–10%), and carbohydrates worldwide. Additionally, it plays a significant part in a branch of sustainable agriculture that improves soil fertility through biological nitrogen fixation. Animals are also fed with its straw [5,6]. The result of a high population growth rate and low chickpea crop productivity and production was consumption per unit.

Over the past six years, the NFSM has been maintained and applied on top of several strategies to increase the nation's production and productivity of pulses, hence increasing the yield of pulses per hectare. This image from 2017–18 shows that pulse production increased to 25.23 million tons. 2018 was a year of success, revolution, and transformation for pulses in India's journey toward self-sufficiency in pulses. The nation is currently working toward achieving 35 million tonnes annually by 2030 for "difficult" reasons. According to Singh et al. [7], the scientists' innovative technology for producing chickpeas was thought to increase both the overall production and hectare yield output. In order to give farmers access to the benefits of chickpea technology, it is crucial to show how productivity has increased using chickpea technology and technique [8-11]. Determining the availability of pulses for the country's growing population will therefore be useful for extension scientists, policy makers, and the farming community as a measure of nutritional security per household. Furthermore, some initiatives were introduced by the government [12-14]. However, there is still a larger imbalance between production and demand, which is being attempted to close by importing pulses. In lieu of recurrent Front Line Demonstrations (FLDs), the Indian Council of Agricultural Research conducted Cluster Front Line Demonstrations (CFLDs) through Krishi Vigyan Kendras (KVKs) around the country. This was a significant step toward addressing the nation's thirst for pulses. These demonstrations showcased the potential value and advantages of technologies for farmers' fields [15-19]. Therefore, the primary objective of the Front Line demonstration is to demonstrate on a broad scale the most recent agricultural production technology and management strategies under a range of climatic conditions and farming scenarios in order to close the yield gap in percentage terms. Therefore on the basis of the above experiment at the Trikuta hills of Jammu region in the state of Jammu and Kashmir the demonstration regarding the production and productivity of chickpea crop under Front Line demonstration has been explored.

2. MATERIALS AND METHODS

Chickpea was the subject of a cluster front line demonstration (CFLD) by Krishi Vigyan Kendra, Reasi, in different cluster at Dadura (N32^0 59.172 E 74-58.289 with elevation of 3061 m), Arli Hansali (N32^0 58-90 E 74-56.41 with elevation of 2699 m), Maghal (N32^0 57.97E 74-55.79 with elevation of 2460 m), Chak Bhagta (N32^0 57.78 E 74-57.45 with elevation of 2465 m), Kotli Bajalian (N32^0 58.902 E 74-54.69 with elevation of 2591 m), Slal Khad (N33^0 09.410 E 74-48.869 with elevation of 2540 m) and Gran Morh (N33^0 05.167 E 74-52.38 with elevation of 2237 m) during the year 2017 to 2020 in 28 villages. The zone receives 360 mm of rainfall on average. The soils in the research area were predominantly sandy loam to clay loam, with an average pH of 7.7, high levels of phosphate, potassium, and nitrogen, and organic carbon ranging from 0.58 to 0.65. Choudhary [20] was followed in the cluster selection, farmer selection, problem diagnosis, and demonstration layout processes. Before laying out FLDs, a personal discussion with a selected group of farmers was used to assess the gap in the adoption of recommended technology (Table 1). There were scheduled trainings on complete technology intervention with improved package and practices for successful pulse cultivation. The exhibited FLDs followed the recommended package of agricultural cultivation practices, and the farmer's actions were compared with them (Table 1). Farmers followed the established practices when it came to their practice plots. Scientists frequently visited farmer's fields and fields for demonstration. In order to develop research and extension programs even more, the farmers' comments was also noted. The cluster Front Line demonstration sites hosted the extension activities, which included field days, farmer interactions, and trainings. Basic data from the farmer's field was collected and examined to compare the displayed plot's performance with that of the local check. Using a random crop cutting technique, data on yield characteristics from various plots and farmer practices were gathered. The following formulas provided by [21] were used to determine the technology gap, extension gap, and technology index.

Table 1. Technology showcased under FLDs for pulses and agricultural practices

Components	Demonstration of recommended technology	Farmer's practices	Gap analysis (%)
*Variety(s)	GNG-1581, (Ganguar)	Local/old variety	70-80
*Seed rate	75 kg/ha	90-95 kg/ha	50-55
*Seed treatment	PSB+*Rhizobium* culture @ 500 gm/ha, *Trichoderma viride* @ 6–8 gm/Carbendazim 50WP @ 2 gm/kg seed	10-20 % farmers do seed treatment with Carbendazim	80-79
Sowing method	Sowing in lines (30 x 10 cm)	Broadcasting/ line sowing	70-80
*Nutrients	FYM @ 2.5 tons/ha; N-18 kg/ha; P-46 kg/ha	Improper use of fertilizers	70-80
*IPM measures	Emamectin Benzoate 5 SG @ 250 gm/ha for pod borer control, manual weeding @ 30-35 DAS, and pendimethalin @ 0.6 kg/ha as pre-emergence are all recommended.	60-70 % farmers use irrelevant IPM measures	30-40
Trainings	Audio-visual instruction both on and off campus	No training	35

**Demonstrate the technology/ input provided*

Potential yield - Demonstration yield is the technology gap.

Demonstration yield minus yield under current practice is the extension gap.

{(Potential yield - Demonstration yield)/Potential yield} x 100 is the technology index.

It was also examined how satisfied participating farmers and nearby farmers were with the upgraded variety's performance. A total of 160 farmers were chosen as participants in order to gauge their degree of satisfaction with the upgraded variety's performance. A pre-tested standard interview schedule was used for in-person interviews with the chosen respondents. The following formula was used to determine the "Client Satisfaction Index."

Client satisfaction index = [Individual score obtained ÷ Maximum score possible] x 100

The collected data were compiled and statistically analyzed in order to assess the outcomes. The input and output minimum support prices and current market prices were utilized to compute the economic parameters, which include the gross return, net return, and C-B ratio.

3. RESULTS AND DISCUSSION

In order to evaluate the yield trend and the difference between the yield from better technologies and the actual yield from extension, the yield, technology index, and extension gap of the chickpea crop were estimated for the period of 2018–2022, and the results are displayed in Tables. 2 and 3. The data's economics with reference to cultivation costs, net returns, gross returns, additional costs, and benefits: The cost ratio numbers previously given were computed and tabulated, as shown in Tables 4 and 5.

The gap analysis (%) of the technologies used for chickpea as compared to the recommended technologies in district Reasi is presented in the Table 1. These practices included HYV's sowing methods, seed treatment fertilizer dose and plant protection measures, and, as the average 70-80% lacuna stands in this account to bring actual yield in line with the potential yield, it was not possible. The farmer had no idea of the recommended technology. For instance instead of using high yielding resistant varieties as prescribed farmers relied most on local or own age varieties. It was due to this that lack of awareness and unavailability of seed in time made the farmers to practice line sowing whereby instead of practicing recommended line sowing they practiced what they called broadcast method and therefore used higher seed rate than recommended.

3.1 Effect on Grain Yield

Table 2 presents an estimation of the chickpea crop's grain yield over a five-year period resulting from the implementation of advanced technology. With regard to the average 17.08 q/ha grain yield of chickpea, which is 34% more than the previous record, FLDs effectiveness demonstrated front line created intervention practices, i.e., line sowing, optimal seed rate, balanced fertilizer application, use of better kinds, seeds, and soil treatments, timely control of weeds, insects, and disease 6% higher than the 12.74 q/ha average that farmers typically use. The use of high yielding cultivars and other ICM techniques was credited with the increased grain output from the plots that were on display. Similarly, Kumar et al. [22] noted the but the stated mean value was zero. grain yields of many pulse crops under demonstration ranged from 83 to 14 q/ha as opposed to 0. Additional methods observed among farmers involve the application of 40 q/ha. It was discovered that there had been a 28% rise in the chickpea crop's production. According to Kumar et al. [12] and Choudhary et al. [23], was also discovered to be 28% in comparable arid places.

3.2 Impact on Technology Index, Technology Gap, and Extension Gap

Table 3 illustrates the extension yield gap, which is the discrepancy between farmers' behaviors and the technology used in demonstrations for the individual crop. During the demonstration period, the extension gaps varied from 359 to 509 kg/ha, with an average of 433.4 kg/ha. As a result, it became popular to educate farmers about the application of improved agricultural production technologies with the goal of reducing the large extension gap. Using the newest production technology in conjunction with high-yielding cultivars will eventually buck the unsettling trend of the widening extension gap. Finally, farmers equipped with new equipment will be able to phase out outdated varieties thanks to the new technologies.

Table 2. Performance of chickpea output under FLDs and farmer practices

Year	Area of demo. (ha)	No. of demo.	Variety(s)	Potential yield (q/ha)	Demo. yield (q/ha)	FP yield (q/ha)	% yield increase over FP
2017-18	10	50	GNG-1581	24.0	17.35	12.49	38.91
2018-19	10	50	GNG-1581	24.0	17.28	13.35	29.43
2019-20	10	50	GNG-1581	24.0	16.38	12.79	28.06
2020-21	10	50	GNG-1581	24.0	16.50	12.30	34.14
2021-22	10	50	GNG-1581	24.0	17.89	12.80	39.76
Total	**5 0**	**250**	**Average**	**24.0**	**17.08**	**12.74**	**34.06**

Table 3. Extension gap, technology gap and technology index of chickpea production under FLDs

Year	Variety(s)	Extension gap (kg/ha)	Technology gap (kg/ha)	Technology index (%)
2017-18	GNG-1581	486	665	27.70
2018-19	GNG-1581	393	672	28.00
2019-20	GNG-1581	359	762	31.75
2020-21	GNG-1581	420	750	31.25
2021-22	GNG-1581	509	611	25.45
Average		433.4	692	28.83

Table 4. Chickpea cultivation's economic performance under farmers' practices and front-line demonstrations

Year	Cost of Cultivation (Rs./ha)		Gross Return (Rs./ha)		Net Return (Rs./ha)		Benefit: Cost ratio	
	Demo.	**FP**	**Demo.**	**FP**	**Demo.**	**FP**	**Demo.**	**FP**
2017-18	27,853	26,000	104100	74940	76247	48940	2.73	1.88
2018-19	26,545	25,495	103680	80100	77135	54605	2.91	2.1
2019-20	23,740	22,100	97680	76740	73940	54640	3.11	2.47
2020-21	24,500	22,250	98280	73800	73780	51300	3.01	2.30
2021-22	24,800	23,600	99000	76800	74200	53200	2.99	2.25
Average	**25487**	23889	100548	75060	75060	52537	2.94	2.19

3.3 Technology Gap & Technology Index

Table 3 presents estimated front line demonstrations and potential production of several chickpea varieties. As a result, the yield gap was computed and split into two categories: technology gap and technology index. The disparities in soil fertility and weather patterns could be the cause of this technical gap. Therefore variety wise location specific recommendation seems to be required to reduce this technology gap for yield level in various circumstances.

The discrepancy between the chickpea's demonstrated production and prospective yield is represented by the technological gap. Technology gaps ranged from 692 kg/ha on average to 762 kg/ha at their highest and 611 kg/ha at their lowest in 2019–20 and 2021–2022, respectively. The observed technology gap may result from a variety of factors, including variances in the region's natural weather patterns, inconsistent and insufficient rainfall, and farmer management abilities. The findings align with the findings of Parihar et al. [24] and Kumar et al. [22], who showed that there was a nine-point technology gap in the chickpea crop. Table 3 displays the data indicating that the technology index has a minimum value of 25, 45 in 2021–2022 and a maximum value of 27.70 percent to 70 percent in 2017–18. The data also shows that the technology index has a maximum value of 31. almost 75% in 2019–20, with an average score of 28. Naturally, this is related to erratic rainfall and mysterious weather patterns, which makes the area the least dependable. The possibilities of the entire technological package at the farmer's field are also shown by the technology index. The feasibility is higher when the technology index number is lower.

3.4 Effect on Economics of Chickpea

The economics (cost of cultivation, gross & net return, and B: Agronomic efficiency (A), apparent recovery efficiency (B), and Rome III C ratio) were calculated for the chickpea under front line demonstrations, which are described in detail in Table 4. Farmers' techniques resulted in a slightly greater investment for cultivation expenditures (Rs. 25487/ha), but the B-C ratio (2. 94) and average gross returns (Rs. 100548/ha) were higher than those of the front-line demonstrations. In comparison to the expense of cultivation, a C/V coefficient ratio of 25 was attained as a result of the average growth in gross return, net return, and B.

Additionally, 62% of households, 48% of farmers, and 62% of households practice over. The outcomes provide evidence in favor of enhanced interventions and technology that are being used in demonstrations. Given the complexity of the district vulnerable to drought, he might adopt proven technologies to increase the financial gains from his farms and move up the socioeconomic ladder.

Growing in benefits and monetary returns: This trend in the cost-to-income ratio of pulse crops has also been noted in several previous studies [25-27]. Similarly, it was discovered that evidence pertaining to the application and adoption of enhanced technologies in conjunction with farmers' field geometry was more successful in raising chickpea productivity and output [28,29].

3.5 Farmer's Satisfaction

The Client Satisfaction Index (CSI) was used to gauge the respondents' farmers' perceived degree of satisfaction with the displayed technology's performance. The results are shown in Table 5. Evidently, 64% of the farmers that responded gave a high rating, while a small percentage gave a medium rating.

Here's a detailed breakdown of the impediments the projects face: First, constraints in the availability of water affect the ability of project to produce yields, Currently, sufficient water for crop production is limiting for food production projects hence restraining the project. However, just 03.60% of the respondents indicated a low degree of satisfaction. The farmers' total mean score, which is moderately high based on their self-reported performance of the technology displayed, indicates greater conviction and

Table 5. The degree of farmer satisfaction with the proven technology's performance

Satisfaction level	Number	Per cent
High	160	64.00
Medium	81	32.40
Low	09	03.60

mental and physical involvement in the FLd, which would lead to higher take off. These outcomes agree with the well-established conclusions of Vijayaragavan and Kumaran [30].

4. CONCLUSION

Thus, we can draw the conclusion that integrated crop management technology—specifically, the use of chickpeas—has shown to be more viable, productive, and profitable in the Trikuta hills of Jammu and Kashmir than the old farming methods. In addition to increasing chickpea crop productivity by up to 34% over farmer practices, this approach has helped build trust and cordial ties between farm scientists and the agricultural community. Farmers will use these technologies in the upcoming years after being persuaded by the chickpea integrated crop management strategies' results. Pulses used to be produced in extremely low quantities in Jammu's Reasi area. The National Food Security Mission, a government program, aims to create a connection to enhance the same since farmers' fields are increasingly using enhanced technologies through KVKs. Nonetheless, there is still a significant discrepancy between potential and practical output, necessitating additional extension services to provide farmers with improved facilities for producing pulses, increasing productivity, and focusing on higher net monitory returns.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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