An assessment of extension, technological gaps and income augmentation through participatory cluster front line demonstrations on chickpea (*Cicer arietinum*) in Rajasthan

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ABSTRACT

From 2015 to 2020, 13134 Cluster Front Line Demonstrations (CFLDs) on chickpea were conducted in 5417.45 ha area by Krishi Vigyan Kendras (KVKs) of the Rajasthan state under National Food Security Mission (NFSM). The data were solicited from partner farmers in the participatory approach. The study shows a higher yield of 17.94q/ha over farmers' practice (13.71q/ha). The technology gap of 5.75q/ha, extension gap of 4.23q/ha, and technology index of 24.27% observed. An average, additional yield of 4.23q/ha was observed in CFLDs. Consequently, Rs. 15337/ha has been added through CFLDs during the five years. In a nutshell, it constituted a total of Rs. 8.38 crores in the economy of Rajasthan. The yields of CFLDs surpassed the results of Rajasthan by 7.02q/ha and national yield by 7.53q/ha. The identified technology gaps attributed to the dissimilarity in soil fertility status and weather conditions. Hence, the adoption of the integrated crop management practices could fulfill these extension gaps. Scientists of KVKs should adopt location-specific extension methodologies for approaching partner farmers. Moreover, a lower value of the technology index indicates greater technology feasibility in the particular district.

Key words: Chickpea, Cluster front line demonstrations, Gap, Income, Yield.

INTRODUCTION

In India, food security is one of the prominent issues. However, scientists are thinking beyond food security viz. nutritional security wherein pulses play a vital role. They have high protein content and therefore play a crucial role in diet of the vast majority of India's low-income and vegetarian population (Kumar *et al.* 2019). Pulse crops were reported to grow on more than 29 million hectares of land and yield just 25.23 MillionTonnes (MT) with average productivity of 841kg/ha during 2017-18. Under pulses, Chickpea contributes maximum with the production of 11.23 MT at a record productivity level of 1063 kg/ha in an area of 10.56 million hectares. More than 90% of Chickpea production contributed by Madhya Pradesh (4.60 MT), Maharashtra (1.78 MT), Rajasthan (1.67 MT), Karnataka (0.72 MT), Andhra Pradesh (0.59 MT), Uttar Pradesh (0.58 MT), and Gujarat (0.37 MT). Among pulses, the Chickpea plays a vital role in improving soil fertility since it can survive in drought conditions. Rajasthan is among the significant contributors to Chickpea production. Despite the large area, the full potentials of improved varieties and technologies are yet to be harnessed. Farmers' methods are no longer viable because they demonstrate a considerable yield difference instead of scientific production technologies. Hence, there is a need to increase the adoption of scientific production technology. A constant effortis needed to bridge this gap by showing improved production technology (Sumathi, 2012). The CFLDs area modern approach to having a direct interface between the researcher and the farmer to transmit their existing technology to gain immediate feedback from the farming community. The study shows that in 2015-16, the average results of CFLDs in Rajasthan were 14.87q/ha, which was 2.91q/ha higher than farmers' practices. The yield of Chickpea was enhanced by 3.76q/hawas observed in 2016-17, where CFLDs yield was 16.30q/ha (Meena *et al.*, 2017). However, in 2017-18, the CFLDs yield was 19.91q/ha, which shows a higher yield of 4.59q/ha. However, during 2018-19, the average result of CFLDs was 18.45 q/ha,which offers an increaseof 4.04q/ha yields(Annual Report, ATARI, Jodhpur, 2017-18 and 2018-19). Therefore, a study was undertaken to delineate the technological intervention gap, economics, and income augmentation from 2015 to 2020.

MATERIALS AND METHODS

The KVKs of Rajasthan laid out the CFLDs on Chickpea from 2015 to 2020. The CFLDs were conducted in cluster mode by following a participatory approach. Critical inputs, i.e., the seed of improved varieties, bio-fertilizers, soil ameliorates, herbicide, micro-nutrients, integrated pest & disease management,etc., of maximum Rs.9000/ha provided by KVKs. Many extension activities, i.e., organization of field days, monitoring for crops, etc.,for creating the informal contact so that learnings can take place for acceptance and broader adoption among other farmers. Partner farmers themselves applied fertilizers to attain the potential yields. The scientists from KVKs have frequently visited the fields to resolve the problems in the fields. An area of 0.40 ha for each CFLD was allocated for partner farmers.Hence, a complete package of the practicesof Chickpea was demonstrated in the farmers' fields. The data were collected from 13134 partner farmers. The yield data collected from established technology and farmers' practices by random crop cutting method. The technology gap, extension gap, and technology index of Chickpea were computed. Data were analyzed using simple statistical tools.The gross return, the net return, cost of cultivation, and benefit-cost ratio were also calculated. The methodology used by Yadav et al. 2004, was adopted for computing extension gaps, technology gaps, and technological index.

Extension gap = Demonstration yield-Farmer yield

Technology gap = Potential yield-Demonstration yield

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

RESULTS AND DISCUSSION

Chickpea yields and gap optimization

Study shows (Table 1) an average yields of Chickpea under CFLDs, which was observed in the range from 13.46 q/ha (Barmer I) to 23.41q/ha (Baran) in Rajasthan state. However, the range of yields under farmers' practices was from 9.51 q/ha to 18.95 q/ha. In a nutshell, the average grain yield of Chickpea under CFLDs was 17.94 q/ha in the demonstrated fields compared to farmers' practice (13.71 q/ha). This yield was 36.81 % higher than the farmers' yields. Figure-1 clearly shows that percent yield under CFLD was higher during 2015-16. Since the CFLDs were conducted by KVKs during 2015-16 under NFSM. Farmer were growing old varieties hence a significant enhancement in yield was depicted (52.60 %) by introducing new varieties in the area. In addition to CFLDs, KVK also organized field days and extension activities in the cluster of villages to make farmers aware to grow improved chickpea varieties or to purchase from reliable sources. Some farmers kept the seed for the next year hence the yield of even under control was higher than 2015-16 in the forthcoming years. KVKs were classified based on the results observed in the fields in five years (Table 2). Out of 43 KVKs in Rajasthan state, 6 KVKs, namely Sirohi, followed by Banswara, Baran, Ajmer, Bhilwara, and Jodhpur-II, had increased yield more than 5.42 q/ha. However, 7 KVKs, namely Hanumangarh II, followed by Bikaner II, Pali,Sriganganagar, Bharatpur, Hanumangarh I and Udaipur II, were identified where yields were increased, but below 3.04 q/ha. The remaining 30 KVKs were in the range of 3.04 to 5.42q/ha compared to the local (Tables 1 and 2).

Extension gap, technology gap, and technology index in chickpea

The extension gap is defined as the difference between demonstration yield and the yield of farmers' practice. The extension gap was found as 4.23 q/ha.The highest extension gap was reported in the Sirohi district (8.09 q/ha) of Rajasthan, followed by Banswara (6.73 q/ha) and Baran (6.44 q/ha) district. Relatively, a high extension gap was showed in Ajmer (6.24 q/ha), Bhilwara (5.74 q/ha), Jodhpur-II (5.6 q/ha), and Jhalawar (5.21 q /ha) district. Similar findings are also reported by Kumar (2021). To reduce the extension gap, we need to educate and motivate partner farmers to implement the improved production technologies of Chickpea. Much effort needs to be made by ICAR, Government institutes, SAUs, and KVKs through various extension programs to disseminate the improved practices. More extension gaps indicate the high acceptance of advanced technologies. The technology gap is the output of differences between potential yield and demonstration yield. From 2015 to 2000, the technological gap was observed as 5.75 q/ha. The technology gap may be attributed to the dissimilarity in the soil fertility status and weather conditions, and similar findings were found by Kumar (2021) and Mitra &Samajdar (2010). Less technology gap revealed better adaptability of crop variety in a particular area; among all CFLDs in Pali (- 0.39) and Tonk (- 0.52), a negative gap was observed. These KVKs demonstrated the varieties like RSG-895, RSG-974, and GNG-1581, GNG-1958 performed well and showed lesser technological gaps. The primary reason behind relatively high yield performance was good rainfall in the last week of September or 1st week of October. It means in that area, demonstration yield was more than potential yield and variety shows better adaptability.InSirohi, a significantly less technology gap (0.13 q/ha) was observed, followed by Nagore-II

Table 1. Chickpea yield and gaps minimized during 2015-2020 in Rajasthan, India (n=13134).

Sl. No.	KVKs	Number of CFLDs	Yield gap minimized (q/ha)						
			Farmers practices (q/ha)	CFLDs (q/ha)	Yield increase (q/ha)	Yield increase (%)	Extension gap (q/ha)	Technology gap (q/ha)	Technology index (%)
1.	Jodhpur-I	199.00	13.80	18.39	4.59	32.71	4.59	8.41	31.38
2.	Jodhpur-II	74.00	15.60	21.20	5.60	35.94	5.60	2.80	11.66
3.	Barmer-I	177.00	9.51	13.46	3.95	46.16	3.95	8.87	39.72
4.	Barmer-II	92.00	10.95	14.50	3.55	32.53	3.55	12.30	45.89
5.	Hanumangarh-I	400.00	16.40	18.85	2.45	14.99	2.45	5.22	21.68
6.	Hanumangarh-II	150.00	15.17	18.20	3.03	20.01	3.03	8.60	32.08
7.	Sriganganagar	414.00	14.23	17.01	2.78	20.76	2.78	8.67	33.76
8.	Churu-I	425.00	9.93	14.27	4.34	50.59	4.34	10.29	41.89
9.	Churu-1I	125.00	11.38	14.54	3.16	28.77	3.16	10.86	42.75
10.	Bikaner-I	350.00	13.94	17.99	4.05	29.46	4.05	6.21	25.66
11.	Bikaner-II	125.00	13.25	16.14	2.89	21.81	2.89	7.86	32.75
12.	Jaisalmer-I	135.00	10.13	14.06	3.93	41.45	3.93	9.54	40.42
13.	Jaisalmer-II	50.00	12.52	16.86	4.34	34.66	4.34	5.94	26.05
14.	Sikar	415.00	14.50	17.80	3.30	24.99	3.3	5.96	25.08
15.	Nagaur-I	332.00	12.97	16.27	3.30	25.89	3.3	6.49	28.51
16.	Nagaur-II	125.00	14.32	18.92	4.60	26.32	4.6	0.58	2.97
17.	Jhunjhunu	425.00	11.15	14.29	3.14	31.62	3.14	9.47	39.85
18.	Jalore	150.00	11.73	16.13	4.40	37.89	4.4	4.87	23.19
19.	Pali	252.00	12.00	14.89	2.89	23.81	2.89	-0.39	-2.68
20.	Sirohi	359.00	10.38	18.47	8.09	96.57	8.09	0.13	0.69
21.	Tonk	325.00	15.99	20.92	4.93	31.72	4.93	-0.52	-2.54
22.	Jaipur-I	388.00	14.65	19.11	4.46	30.76	4.46	3.09	13.91
23.	Jaipur-II	200.00	15.33	19.41	4.08	26.62	4.08	4.59	19.12
24.	Ajmer	305.00	11.62	17.86	6.24	67.51	6.24	6.14	25.58
25.	Dausa	590.00	15.06	19.07	4.01	39.12	4.01	5.25	21.58
26.	Alwar-I	239.00	14.77	18.77	4.00	29.56	4	5.23	21.79
27.	Alwar-II	102.00	18.95	22.88	3.93	20.80	3.93	2.52	9.92
28.	Dholpur	454.00	16.32	20.43	4.11	28.17	4.11	5.81	22.14
29.	Karauli	415.00	14.27	18.90	4.63	36.70	4.63	6.22	24.76
30.	Bharatpur	350.00	12.32	15.08	2.76	22.62	2.76	4.17	21.66
31.	Bhilwara	400.00	14.04	19.78	5.74	46.50	5.74	4.78	19.46
32.	Chittorgarh	481.00	16.42	20.95	4.53	27.86	4.53	0.81	3.72
33.	Rajsamand	363.00	14.47	19.32	4.85	35.20	4.85	5.80	23.08
34.	Pratapgarh	350.00	13.84	18.02	4.18	30.76	4.18	6.68	27.04
35.	Udaipur-I	389.00	11.84	16.21	4.37	37.07	4.37	6.35	28.14
36.	Udaipur-II	50.00	14.80	16.90	2.10	14.19	2.1	9.90	36.94
37.	Banswara	325.00	11.04	17.77	6.73	62.95	6.73	5.79	24.57
38.	Dungarpur	669.00	9.92	14.24	4.32	46.38	4.32	10.32	42.01
39.	Kota	455.00	16.90	20.51	3.61	21.83	3.61	5.81	22.07
40.	Bundi	345.00	16.60	20.25	3.65	25.24	3.65	5.39	21.02
41.	Jhalawar	475.00	14.05	19.26	5.21	39.01	5.21	3.14	14.01
42.	Sawai Madhopur	390.00	15.43	20.15	4.72	31.86	4.72	5.53	21.53
43.	Baran	300.00	16.97	23.41	6.44	37.71	6.44	1.79	7.10
	Total	**13134**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
	Average	**-**	**13.71**	**17.94**	**4.23**	**34.12**	**4.23**	**5.75**	**23.53**

Source: Primary data collected from 2015 to 2020.

(0.58 q/ha) and Chittorgarh (0.81 q/ha). The technology index indicates the level of feasibility of demonstrated technology in farmers' fields. The lowest value (-2.68 %) of the technology index was observed in the Pali district, followed by Tonk (-2.54 %). In Sirohi, Nagur-II, and Chittorgarh district, low indexes were observed and reflect high feasibility on farmers' fields. These KVKs obtained the yield more than the potential yields. The highest value of the technology index was

Table 2. Ranking of KVKs based on the yield enhancement through CFLDs on Chickpea (in q/ha).

Sl.No.	Yield (q/ha)	*f*	%
1.	>5.42	6	13.95
2.	3.04 to 5.42	30	69.77
3.	<3.04	7	16.28

Table 3. Economics of Chickpea production in Rajasthan, India (n=13134).

Sl. No.	KVKs	Area (ha)	CFLDs	Economics of FP (Rs/ha)				Economics of CFLDs (Rs/ha)				Total income enhancement
				Gross cost	Gross return	Net return	B.C. ratio	Gross cost	Gross return	Net return	B.C. ratio	
1.	Jodhpur-I	80.00	199.00	23,741.67	60,431.25	36,689.58	2.53	26,450.00	84,674.04	58,224.04	3.20	16,64,192.50
2.	Jodhpur-II	40.00	74.00	24,222.50	74,035.50	49,813.00	3.06	26,355.00	99,929.06	73,574.06	3.79	9,50,442.50
3.	Barmer-I	127.40	177.00	24,800.50	44,907.50	20,107.00	1.82	27,566.50	57,817.63	30,251.13	2.12	13,27,617.90
4.	Barmer-II	60.00	92.00	27,897.33	50,758.79	22,861.46	1.80	30,635.00	66,799.75	36,165.25	2.17	7,98,227.50
5.	Hanumangarh-I	160.00	400.00	25,347.80	72,680.20	47,332.40	2.87	27,135.20	83,218.70	55,883.50	3.07	14,41,000.00
6.	Hanumangarh-II	60.00	150.00	17,708.67	63,700.00	31,414.33	3.60	20,551.00	76,447.00	38,026.00	3.72	3,96,700.00
7.	Sriganganagar	178.00	414.00	24,134.70	57,216.10	33,081.40	2.42	26,592.17	69,331.10	42,738.93	2.69	15,72,449.60
8.	Churu-I	170.00	425.00	20,565.00	45,316.00	27,050.20	2.19	24,350.40	71,405.40	47,254.80	2.91	31,83,810.00
9.	Churu-1I	50.00	125.00	22,060.00	55,948.56	33,888.56	2.51	23,960.00	71,497.25	47,537.25	2.95	6,53,427.50
10.	Bikaner-I	140.00	350.00	26,460.00	56,326.58	29,866.58	2.21	28,200.00	73,435.42	45,235.42	2.69	21,07,400.00
11.	Bikaner-II	50.00	125.00	28,430.00	62,936.25	34,506.25	2.21	30,492.50	76,668.00	46,175.50	2.51	5,81,380.00
12.	Jaisalmer-I	58.00	135.00	21,296.67	58,450.00	36,630.42	2.84	21,966.67	70,732.50	48,765.83	3.28	7,81,157.50
13.	Jaisalmer-II	20.00	50.00	24,060.00	61,010.63	36,950.63	2.54	28,228.00	82,192.50	53,964.50	2.91	3,40,277.50
14.	Sikar	166.00	415.00	28,200.00	76,123.87	47,923.87	2.68	30,830.00	87,870.47	57,053.80	2.84	13,73,035.33
15.	Nagaur-I	148.80	332.00	23,139.00	64,998.75	41,859.75	2.82	23,959.60	82,131.57	58,171.97	3.43	21,79,817.60
16.	Nagaur-II	50.00	125.00	27,991.67	77,866.75	49,875.08	2.78	30,448.60	1,00,953.03	70,504.43	3.31	10,32,760.00
17.	Jhunjhunu	170.00	425.00	28,725.00	52,089.20	23,364.20	1.82	30,454.00	59,441.60	28,987.60	1.95	10,00,640.00
18.	Jalore	60.00	150.00	22,500.00	52,560.25	29,766.50	2.34	24,283.33	73,707.38	49,424.05	3.03	11,39,384.00
19.	Pali	109.00	252.00	19,860.50	44,246.25	24,385.75	2.23	19,980.06	56,196.43	38,716.37	3.06	15,74,124.10
20.	Sirohi	138.00	359.00	23,165.90	64,528.50	32,882.60	2.81	25,414.00	85,488.30	60,074.30	3.37	35,06,570.00
21.	Tonk	140.00	325.00	21,049.60	81,418.50	60,368.90	3.64	23,920.00	1,05,695.90	81,775.90	4.18	29,92,600.00
22.	Jaipur-I	160.00	388.00	22,501.07	68,659.90	46,158.83	3.05	24,486.67	89,528.37	65,175.03	3.65	30,74,843.33
23.	Jaipur-II	80.00	200.00	23,020.00	66,599.17	43,579.17	2.90	26,146.00	83,950.08	57,804.08	3.22	11,27,325.00
24.	Ajmer	150.00	305.00	23,277.73	60,951.47	37,670.13	2.66	26,054.20	84,294.90	58,240.70	3.25	25,32,996.67
25.	Dausa	260.00	590.00	33,382.00	72,122.87	38,740.87	2.20	33,039.20	83,745.15	50,705.95	2.54	35,41,176.67
26.	Alwar-I	146.25	239.00	19,864.90	69,244.40	51,887.40	2.97	21,771.00	88,023.90	66,252.90	3.43	17,86,433.75
27.	Alwar-II	50.00	102.00	22,470.17	89,539.71	67,069.54	3.99	24,702.82	1,08,539.10	83,836.29	4.39	8,29,803.46
28.	Dholpur	176.00	454.00	25,403.00	78,925.05	53,522.05	3.11	28,062.40	93,511.00	65,448.60	3.33	22,16,695.00
29.	Karauli	166.00	415.00	25,992.20	70,657.25	44,665.05	2.77	29,250.60	89,674.38	60,423.78	3.14	24,47,718.75
30.	Bharatpur	140.00	350.00	20,143.75	55,667.75	35,524.00	2.78	22,218.75	67,219.35	45,005.30	3.06	12,65,152.00
31.	Bhilwara	160.00	400.00	22,060.00	69,530.60	47,470.80	3.21	25,180.00	93,342.20	68,262.20	3.77	32,92,710.00
32.	Chittorgarh	190.00	481.00	24,155.72	76,625.20	52,469.28	2.98	28,006.67	97,750.70	69,641.33	3.28	32,90,520.00
33.	Rajsamand	150.00	363.00	19,400.00	71,223.00	51,823.00	3.64	21,657.00	82,649.97	66,992.97	3.72	22,49,843.33
34.	Pratapgarh	140.00	350.00	20,959.00	56,479.50	35,520.50	2.71	23,609.50	73,468.00	49,858.50	3.11	21,75,490.00
35.	Udaipur-I	170.00	389.00	22,755.00	51,484.40	28,729.40	1.77	26,341.80	70,447.00	44,105.20	2.11	26,00,280.00
36.	Udaipur-II	20.00	50.00	31,000.00	66,600.00	35,600.00	2.15	32,500.00	87,880.00	55,380.00	2.70	3,95,600.00
37.	Banswara	130.00	325.00	28,320.00	46,498.55	18,178.55	1.63	31,560.00	74,341.80	42,781.80	2.35	31,66,525.00
38.	Dungarpur	140.00	669.00	23,616.00	43,300.00	19,684.00	1.89	26,867.00	69,191.00	42,324.00	2.71	29,80,450.00
39.	Kota	188.00	455.00	26,207.60	81,613.60	55,406.00	3.14	28,164.80	98,720.70	70,555.90	3.51	24,75,450.00
40.	Bundi	160.00	345.00	27,281.20	80,269.20	52,988.00	2.92	29,608.80	97,367.20	67,758.40	3.27	23,16,290.00
41.	Jhalawar	190.00	475.00	24,165.40	61,573.48	37,025.28	2.58	25,746.90	83,619.75	57,472.76	3.26	39,48,510.60
42.	Sawai Madhopur	156.00	390.00	23,949.84	76,503.94	52,553.90	3.19	26,451.00	96,621.64	70,170.64	3.66	28,16,527.05
43.	Baran	120.00	300.00	24,129.50	87,229.56	63,099.94	3.45	25,020.04	1,14,697.90	89,677.86	4.37	27,51,316.40
	Total	**5417.45**	**13134**	-	-	-	-	-	-	-	-	**83878670.54**
	Average	-	-	**24,172.34**	**64,624.37**	**39,999.63**	**2.68**	**26,470.17**	**73,586.54**	**56,194.86**	**3.14**	-

Source: Primary data collected from 2015 to 2020.

reported in CFLDs under Barmer-II (45.89 %). CFLDs under Barmer-II, irrigation was not available hence showed lesser yields. The observed technology difference can be attributed to dissimilarity in soil fertility status, rainfall distribution, disease, insect, pest infestations, and weed intensity and the change in cluster front line demonstration sites' locations. The technology index demonstrates the viability of the variety at the farmer's field; lowering the technology index's value indicated greater technology feasibility. It shows the efficacy of good performance of relevant interventions or technologies demonstrated in farmer's field. As a result, this could increase in yield of Chickpea under the different agro-ecological situation of Rajasthan. These findings corroborate the findings reported by Meena (2017) and Lakshmi *et al.* (2017).

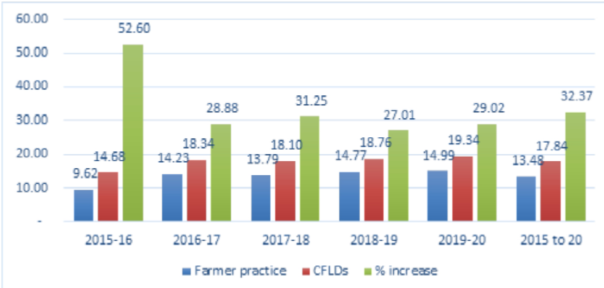

Fig. 1. Yields of Chickpea (q/ha) during 2015-2020 in Rajasthan, India (n=13134).
Source: Primary data collected from 2015 to 2020.

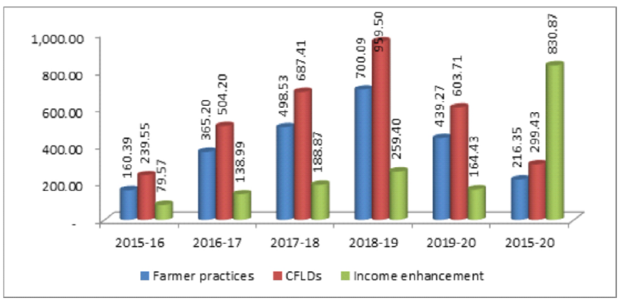

Fig. 2. Income enrichment by conductance of CFLDs on Chickpea in Rajasthan, (in lakh).
Source: Primary data collected from 2015 to 2020.

Economics of chickpea production

The economic performance of Chickpea under CFLDs is depicted in table-3. During the five years, itrevealed that the Chickpea recorded a higher net return from recommended practices. Under CFLDs, net return was Rs 56,194.86 /ha than farmers' practices (Rs. 39,999.63 /ha).Hence, a total of Rs.8.38 crores have been added through these CFLDs in the states' economy in the last five years (2015-2020). Nevertheless, average of the previous five years under all KVKs, the benefit-cost ratio of CFLDs was 1:3.14 while 1:2.68 in farmers' practices was. The higher net returns and B:C ratio in chickpea demonstration might be due to the higher grain yield and better market pricing.

CONCLUSION

The cluster front line demonstrations on Chickpea showed asignificant and positive result, which provided opportunities to the KVKs for demonstrating the latest production technologies. The productivity gained under CFLDs over existing Chickpea cultivation practices has created greater awareness and motivation amongst other fellow farmers to adopt suitable production technology of chickpea. There exists a wide gap in the potential yields, demonstration yields & farmers' plot yields due to technological (5.75 q/ha) and extension gaps (4.23 q/ha). The study emphasizes the dissemination of location-specific crop management, improved technologies embedded with high-yielding varieties to minimize these gaps and improve pulse productivity & profitability in Rajasthan. Moreover, the state's extension functionaries strictly focus on disseminating the proven pulse production technologies in chickpea production systems.

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