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Impact Assessment of CFLD Pulses on Pigeonpea Productivity and Profitability in Farmer's Field

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ABSTRACT

Front line demonstration is the most appropriate method to transfer improved technology in farmer's field. The study was conducted by ICAR-ATARI, Patna (Bihar and Jharkhand) on pigeon pea during crop season from 2019-2021. Study was conducted in 5520 number of demonstrations, altogether covering 1708.80 ha land area during the three years. Among the different varieties assessed it was observed that cv. NDA-1 and IPA-203 were outperformed in Bihar and Jharkhand respectively. The findings with respect to technology gap, extension gap and technology index of different cultivars grown were varying from 0.121 to 1.49 t/ha; 0.309 to 0.673 t/ha and 6.72 per cent to 49 per cent, respectively in Bihar and Jharkhand. The overall demonstration yield varied between 1.04 to 1.78 t/ha which is 22.55 per cent to 71.68 per cent more than the farmer's practices prevailing. Improved technology used under demonstration plot promoted higher yield than the local check with respect to highest net return from demonstration plot was Rs. 70365/ha and Rs. 47037.50/ha and the B:C ratio ranged from 1.33 to 2.82 and 1.02 to 2.43 in Bihar and Jharkhand respectively. Productivity and profitability can be enhanced by appropriate use of critical inputs and newer technological intervention.

INTRODUCTION

Pigeon pea is the second most important pulse crop in India after gram on production and consumption basis and commonly known as red gram or tur or arhar in different parts of the countries. It is mainly used as dehulled split peas; green seeds and pods used as fresh as well as green vegetables. India occupies first position in the world with respect to area and production and mainly cultivated in the state of Maharashtra, Madhya Pradesh, Karnataka, Uttar Pradesh, Gujarat, Jharkhand, Bihar, etc. which contributes more than 80 per cent of total production. Pigeonpea (*Cajanus cajan* L.) belongs to the family *Fabaceae* is an often-cross pollinated crop with diploid chromosome number of 2n= 22. Plant root helps in releasing soil-bound phosphorus for plant growth in available form. Pigeon pea is hardy, widely adopted and drought tolerant in nature which allow its cultivation in wide range of environmental conditions and cropping systems. Pigeonpea fixes atmospheric nitrogen of about 40 kg/ha. Majority of cultivars and landraces are long duration type and grown as an intercrop with other early maturing cereals and crops. Due to low investment cost, it has become an ideal crop for sustainable agriculture in dry land and rainfed areas. By adopting improved technology and agronomic package of practices yield of pigeonpea can be obtained from 25-30 q/ha in irrigated condition and 15-20 q/ha under un-irrigated condition depending upon varieties and soil fertility climatic condition. Along with grain yield, it also gives 50-60 q/ha of dry stem which is used mainly for fuel and thatching purpose in rural areas. The main objective of this study was to enhance the productivity and profitability of pigeon pea under farmer's field by using high yielding cultivars with good quality seed, pest management and improved production technology. It is observed that the technology should be such that the farmers

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could get the net returns equivalent to that they get from the other crops they mainly grow then only the farmers will go for cultivation of pulses (Kumar et al., 2010).

METHODOLOGY

Cluster frontline demonstration (CFLD) is one of the most powerful tools of extension because farmers' perception is driven by "seeing is believing". The main purpose and objectives of CFLD is to demonstrate newly released technologies (variety, INM, IPM, other practices, etc.) in bunch of packages rather than individual technology. In this study a cluster of 10 ha area has been selected which will give more accurate performance of the technology under assessment covering across the agro-climatic zone for the study. The year wise yield data from 2019 to 2021 was collected from farmers filed through KVKs as authority of ICAR-ATARI, Patna (Bihar and Jharkhand) of Cluster Front Line Demonstration on pigeonpea. Each cluster had minimum 10ha of land areas and 20-25 farmers were selected for demonstration. During three years period total 5520 demonstrations were conducted covering 1708.80 ha land with eight varieties in Bihar and seven varieties in Jharkhand. Four cultivars of pigeonpea viz; IPA-203, LRG-41, Rajendra Arhar-1 and Rajeev Lochan were demonstrated in both Bihar and Jharkhand and other cultivars in only one states based on the seed availability and suitability.

Required critical inputs for demonstration at farmer's site were provided by KVKs from the project centrally sponsored fund of CFLD provided ICAR-ATARI Zone IV. Concerned KVKs SMS implemented demonstrations and recorded needful data periodically. The basic information pertaining to pigeon pea package of practices of were collected by the KVKs before conducting demonstrations (Choudhary, 1999). Farmer itself maintained the control plot (farmer's field) by with their own acquired knowledge. Yield data were recorded immediately threshing and cleaning from both demonstration plot and farmer's field. Calculations of extension gap, technology gap and technology index of different cultivars were done as suggested by Samui et al., (2000). To assess the impact of cluster front line demonstration values were determined on yield, per cent increase over control. Economic analysis was done on the basis of crop value and used inputs in local market. To check the economic feasibility Benefit cost ratio of demonstration and farmer's field were calculated using suitable statistical tools for different parameters as given below:

Technology gap = Potential Yield (Py) - Demonstration Yield (Dy)

Extension gap = Demonstration Yield (Dy) - Farmer's Yield (Fy)

$$\text{Percent increase in yield} = \frac{\text{Extension gap}}{\text{Farmer's yield}} \times 100$$

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

$$\text{Benefit-cost ratio} = \frac{\text{Gross return}}{\text{Gross cost}}$$

RESULTS AND DISCUSSION

Technological adoption gaps

Full technological gap in respect of using high yielding improved variety, appropriate seed rate, method of sowing, seed treatments, etc have been observed whereas partial gap up to 50 per cent has been recorded in nutrient application, weed management, irrigation and plant protection measures. In case of land preparation and time of sowing no adoption, gap was noticed (Table 1). Farmers in general sow un-descript or old variety instead of recommended improved varieties with disease resistance of the region may be attributed due to unavailability of quality seed in time and lack of awareness were the main reasons. Farmers of the region generally applied higher seed rate than the recommended and they are not using seed treatment techniques for wilt and collar rot management and to better nodulation for biological N fixation of plants because of lack of knowledge and awareness and sometimes due to use pest infested seed. In general farmers give more weightage to land preparation and sowing time and less

Table 1. Differences between technological interventions and farmers practices under CFLD in pulses

Particulars	Technological interventions	Existing practices	Technological gap
Land preparation	Ploughing with cultivator (2) and levelling	Ploughing with cultivator (2) and levelling	No gap
Variety	High yielding	Non-descript/ too old var	Full gap Full gap (100%)
Time of sowing	2nd fortnight of June to 1st week of July	2nd fortnight of June to 1st week of July	No gap
Seed rate (kg/ha)	20	30-40	Full gap (100%)
Seed treatment	Trichoderma powder & Rhizobium culture	No seed treatment/carbendazim	Full gap (100%)
Sowing method	Line sowing	Broadcasting	Full gap (100%)
Fertilizer application and dose (kg/ha)	20N, 40P_2O_5 and 20 K_2O	Improper use	Partial gap (50%)
Weed management	Pendimethalin 30% EC @ 3.3 lit/ha + 01 hand weeding if required	Improper weed control measures	Partial gap (50%)
Irrigation	In absence of rain	Rainfed/ untimely	Partial gap (50%)
Plant protection	IPM	Indiscriminate use	Partial gap
Intercultural operations	One Nibbling at 40-50 days crop	01 Nibbling at 35-60 days crop/ improper	Partial gap

on the critical inputs. Similar type of results has been obtained by Burman et al., (2010) & Singh et al., (2020) reported that there is a gap in adoption of technologies in major pulse crop both in irrigated and rainfed cropping system.

Positive impact of critical inputs and technological interventions were observed on the both demonstration and farmer's field with respect to grain yield and related data i.e., extension gap, technology gap, percentage increase over control and technology index were depicted (Table 2). Average demonstration yield in Bihar varied between 1.42 to 1.78 t/ha and 1.04 to 1.34 t/ha in Jharkhand whereas farmer's field yield varied from 0.85 to 1.13 t/ha and 0.710 to 0.98 t/ha respectively. Higher yield under demonstrated conditions were due to use of recent technological inputs and improved package of practices in both the states. Similarly, higher average yield of different pulses (pigeon pea, chickpea, field pea and lentil) than farmer's practices were also reported by Kumbhare et al., (2014); Tomar et al., (2021) & Kumar et al., (2022). Slightly more demonstrations plot yield and farmer's field were recorded in Bihar than the Jharkhand may be due to soil fertility and climatic condition particularly retention of moisture for longer duration.

Demonstration yield of varieties

In Bihar highest demonstration yield (1.78 t/ha) was recorded in var. IPA-203 and lowest (1.46 t/ha) in cv. Bahar (Table 2). However, in Jharkhand maximum demonstration yield to tune of (1.34 t/ha) was recorded in cv. LRG-41 and lowest (1.40 t/ha) in var. Birsa Arahar-1. Higher demonstration yield in this variety is attributed to its genetic potential and congenial environmental condition. Similar result had been obtained by Singh et al., (2022) & Raju et al., (2015) also recorded yield increment under cluster front line demonstration of pigeon pea. Singh et al., (2020a) also reported overall higher demonstrations yield of pigeon pea (1.28 to 1.73 t/ha) than the local practices in different varieties/ location.

Technology gap and impact over farmers practices

The technology gap refers to difference between potential yield and demonstration plot yield. In Bihar, maximum technology gap 1.21 t/ha was in var Rajendra Arhar-1 and lowest 0.12 t/ha in var. Rajeev Lochan with overall cumulative technology gap of 0.58 t/ha among the different varieties (Table 2). Similarly in Jharkhand maximum technology gap (1.49 t/ha) was recorded in var Rajendra Arhar-1 and minimum (0.46 t/ha) in varieties Birsa Arhar-1. These results are in agreement with the findings of Mukherjee (2003). Percent increase in yield over control is another powerful tool for impact analysis. In Bihar state percent change in yield over control was varied from 22.55 to 71.68 per cent whereas, in Jharkhand 36.14 to 61.13 per cent. Percent increase in yield is the ratio of extension gap and farmer's yield expressed in percentage were analysed and the values ranged from 36.70 per cent to 42.55 per cent over the local practices in Bihar and Jharkhand respectively. Similarly, percentage increase in yield was also reported by Singh et al., (2020a).

Extension gap

Extension gap refers to yield difference between demonstration plot and control plot. This gap can be minimised by applying different extension activities such as cluster demonstration, farmer's awareness training programme and *kisan gosthis*, etc. (Kumar *et al*., 2022). In Bihar, highest extension gap (0.67 t/ha) was recorded in the cv. Malviya-13 and lowest (0.31 t/ha) in cv. Rajeev Lochan. However, in Jharkhand extension gap of 0.50 t/ha was observed

Table 2. Impact of technological interventions and varietal performance on yield of pigeon pea and gap analysis

State	Variety	Year of release	Area (ha)	Demo	Yield (t/ha)			Technology gap (t/ha)	Extension gap (t/ha)	Increase over control (%)	Technology index (%)
					Poten-tial	Demons-tration	Farmer's field				
Bihar	Rajendra Arhar-1	2015	130.00	398.00	2.80	1.59	1.08	1.21	0.52	48.00	43.07
	NDA-1	1997	330.00	944.00	2.00	1.57	1.13	0.43	0.44	38.92	21.65
	Malviya 13	2005	20.00	53.00	2.70	1.69	1.02	1.01	0.67	65.98	37.30
	Pusa 9	1993	20.00	69.00	2.20	1.58	0.94	0.63	0.64	67.55	28.41
	LRG-41	2006	200.00	675.00	2.00	1.42	1.03	0.58	0.40	38.73	28.90
	IPA-203	2014	213.16	651.00	1.94	1.78	1.13	0.17	0.66	58.31	8.62
	Bahar	1980	15.00	44.00	2.00	1.46	0.85	0.54	0.61	71.68	26.95
	Rajeev Lochan	2011	10.00	34.00	1.80	1.68	1.37	0.12	0.31	22.55	6.72
	Total		938.16	2868.00	12.77	8.55	4.69	4.25	411.72	201.62	201.62
	Average				2.18	1.60	1.07	0.58	0.53	51.47	25.20
Jharkhand	IPA- 203	2014	365.10	1214.00	1.95	1.29	0.83	0.66	0.46	54.82	34.07
	NDA-2	2008	160.00	517.00	2.50	1.28	0.88	1.23	0.39	44.39	49.00
	Rajendra Arhar-1	2015	50.00	146.00	2.80	1.31	0.81	1.49	0.50	61.13	53.21
	Birsa Arahar-1	1992	40.00	107.00	1.50	1.04	0.71	0.46	0.33	46.48	30.67
	VLArhar-1	2006	90.00	278.00	1.80	1.25	0.90	0.55	0.35	38.40	30.72
	LRG-41	2006	50.00	323.00	2.00	1.34	0.99	0.66	0.36	36.14	32.95
	Rajeev Lochan	2011	15.54	67.00	1.80	1.08	0.73	0.72	0.35	47.95	40.00
	Total		770.64	2652	14.35	8.59	5.85	5.77	2.74	329.31	270.62
	Average				2.05	1.23	0.84	0.82	0.39	47.04	38.66

Table 3. Economic analysis of demonstration and farmer's plot of pigeon pea

State	Variety	Demonstration plot				Farmer's field			
		Gross cost (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C	Gross cost (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C
Bihar	Rajendra Arhar-1	21783.33	61271.67	39488.33	2.10	19133.33	38166.67	19033.33	1.33
	NDA-1	22019.90	78987.90	56867.85	3.46	20116.90	56516.35	36720.45	2.71
	Malviya 13	25635.00	96000.00	70365.00	3.25	23657.50	57300.00	33642.50	1.93
	Pusa 9	22160.00	80203.50	58043.50	3.73	19912.50	54097.50	34185.00	2.82
	LRG-41	26596.00	80173.15	53577.15	2.91	24614.46	60471.31	35856.85	2.33
	IPA-203	21790.53	79674.00	57883.47	3.63	21620.76	59954.21	38333.45	2.08
	Bahar	22595.00	80355.00	57760.00	3.56	16564.00	44825.00	28261.00	2.71
	Rajeev Lochan	34600.00	104098.00	69498.00	2.01	30850.00	84940.00	54090.00	1.75
Jharkhand	IPA-203	25588.34	67655.66	42094.90	2.25	22559.93	44298.76	21738.79	1.57
	NDA-2	23219.50	66546.00	43326.50	2.82	20868.75	46266.38	25526.38	2.16
	Rajendra Arhar-1	17400.00	40600.00	23200.00	1.33	13500.00	27300.00	13800.00	1.02
	Birsa Arahar-1	24500.00	58678.00	34178.00	1.90	20000.00	39962.50	19962.50	1.50
	VL Arhar-1	19845.00	66039.04	46194.04	2.22	18987.50	44658.50	25825.75	1.88
	LRG-41	29847.50	76885.00	47037.50	2.09	28810.00	56488.75	27678.75	1.49
	Rajeev Lochan	21000.00	64800.00	43800.00	3.08	18000.00	43800.00	25800.00	2.43

in var. Rajendra Arhar-1 and minimum 0.33 t/ha invar. Birsa Arhar-1 (Table 2). These findings are in line with findings of Singh et al., (2020c). Similarly, the yield gap minimization in pulses was reported by Nain et al., (2014); Nain et al., (2015); Dubey et al., (2018) & Dubey et al., (2022).

Technology index

Technology index is another important tool for judging the adoption and impact of different technologies. It is derived as the ratio between technology gap and potential yield in terms of percentage. Lower value of technology index means better performance of technological intervention. In the present study, technology index varied from 6.72 to 37.30 per cent in Bihar and 30.67 per cent to 53.21 per cent in Jharkhand (Table 2). From the data it can be seen that the technology index in Bihar was lower than Jharkhand means demonstrated varieties showed better result in Bihar than Jharkhand. Likewise, variation in technology index (41.96 to 69.75%) in Bundelkhand region of UP was reported by Singh et al., (2020c). Similar results were also obtained by Kumar et al., (2010) and Jha et al., (2020). Large variation in technology index might be due to variation in existing weather condition, soil fertility status and insect-pests infestation.

Economic analysis

Data related to economic analysis of demonstration and control plot are presented as gross cost, gross return, net return and benefit cost ratio (B:C) in (Table 3). In Bihar, on the basis of performances of different varieties, the highest net return (Rs. 70365.00/ha) was recorded in Malviya-13 followed by Pusa-9 (Rs. 58043.50/ha) and the lowest net return Rs. 39488.33/ha in cv. Rajendra Arhar-1. Similarly, demonstrated varietal trend was recorded for benefit cost ratio and lowest values (1.33) observed in cv. Rajendra Arhar-1 and highest in cv. Pusa-9 (2.82) under agro-climate of Bihar. In Jharkhand, the highest net return (Rs. 47037.50/ha) from demonstration plot was recorded in cultivar LRG-41 followed by VL Arhar-1 (Rs. 46194.04/ha) and lowest net return (Rs. 23200.00/ha) from the cv. Rajendra Arhar-1. However, the highest benefit cost ratio (2.43) in cv. Rajeev Lochan and lowest (1.02) from the cv. Rajendra Arhar-1. High benefit cost ratio under demonstration plot as compared to farmer's field was due to higher yield under demonstration plot which is in agreement with the findings of Mokiduee et al., (2011). Likewise, front line demonstration on red gram, Dwivedi et al., (2011) and on other pulses Singh et al., (2020b); Singh & Singh (2020) also reported higher net returns as well as benefit cost ratio as compared to farmer's practices.

CONCLUSION

Cluster front line demonstrations conducted in 5520 demonstrations covering 1708.80 ha showed that productivity and economic return of pigeonpea can be increased by appropriate use of critical inputs or resources and new technological interventions. It is also seen that CFLD programme were much more helpful in conveying technical message and changing the attitude of other farmers toward adopting new and improved farming and management practices that also helps in doubling the farmer's income. Higher demonstration yields not only reduced the technology gap but also created interest among farmers in adopting demonstrated technology which ultimately bridges the extension gap. Lower technology index value showed better performance of technological interventions. This will also enhance the relationship and built confidence between farmers and extension worker. Thus, it can be advocated that adoption of improved package of practices particularly in pigeon pea production technology may result in higher productivity per unit area.

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