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Impact of cluster frontline demonstrations (CFLD) pulses on yield enhancement of pigeon pea (*Cajanus cajan* L.) in aspirational district of Bhadradri Kothagudem, Telangana

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Abstract
The present investigation was carried out to study the impact of cluster front line demonstrations (CFLD) conducted by Krishi Vigyan Kendra, Kothagudem during Kharif season for five years i.e., 2017-18 to 2021-22 in selected villages of four mandals in aspirational district of Bhadradri Kothagudem for increasing the average yield, productivity and profitability of Pigeon pea farmers. The demonstrations focused on promoting improved agricultural technologies, including high-yielding and wilt-tolerant varieties, proper seed treatment, balanced fertilizer application, integrated pest management, and other recommended practices. The technologies for demonstrations were selected based on on-farm trials and recommendations from research institutes. The results showed consistent increase in grain yield, ranging from 15.9% to 47.6% over farmers' existing practices. The extension gap, representing the yield difference between potential and demonstrated yields, decreased over the years, from 5.3 q/ha. to 3.00 q/ha indicating successful technology adoption by farmers. The technology index, which represents the CFLD's performance as a percentage of the potential yield, averaged 24.73%, indicating reasonable technology adoption. The economic analysis also revealed that the recommended practices consistently generated higher total returns of Rs. 73,800 per hectare (ha), net returns of Rs. 41,845 per ha, and benefit-cost ratio of 2.74: 1 compared to farmers' existing practices.

Keywords: Cluster frontline demonstrations, pigeon pea, adoption gap, productivity, economic analysis, benefit-cost ratio**,** aspirational district

1. Introduction

India is the largest producer of pulses in the world, with 24% share in the global production. The important pulse crops grown are chickpea (48%), pigeon pea (15%), mung bean (7%), urd bean (7%), lentil (5%) and field pea (5%). However, it is projected that in order to achieve self-sufficiency in pulses, the overall production should be increased to 26.5 million tonnes by 2050 and to achieve this target, productivity needs to be enhanced to 978 kg/ha, and an additional area of about 3.0 million hectares has to be brought under pulses. (Ali, M., and Gupta, S., 2012) [1].

Pigeon pea (*Cajanus cajan* (L.) Mill sp.) also known as Redgram, Arhur, Tur is one of the major pulses produced in India. It is an important rainfed legume crop for millions of smallholder farmers in India and in many other countries of the tropical and subtropical regions of the world. In India, it is cultivated in about 3.6 M ha. and contributes about 20% to the total pulses production of the country. Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh and Karnataka are the top five pulses producing States. Its pods contain 21–25% protein which is sufficient enough nutrition for the poor when it supplied along with other cereals and legumes. The crop has soil rejuvenation qualities such as release of soil-bound phosphorous; fixation of atmospheric nitrogen, recycling of soil nutrients, and addition of organic matter and other nutrients make it an ideal for sustainable agriculture in the tropical and sub-tropical regions of India. However, its average yield has remained strikingly low at is 764 kg/ha. It is identified that there are several factors responsible for extremely low pulses productivity and high yield gap, which are mostly related to inputs and their efficient management (Ali M., and Gupta, 2012; Reddy, 2009) [1, 2]. Besides, poor soil and agro-climatic conditions not only compel late sowing of legumes, leads to reduced length of growing period but also necessitate to sustain cold injuries at early vegetative phase which freeze all biological activities for prolonged period. (S.K. Dubey, 2021) [3]. Dissemination and adoption of high yielding varieties have been instrumental in increasing the yield and production in field conditions. (Rao *et al.*, 2016) [5].

Bhadradri Kothagudem is a one of the aspirational districts of the Indian state of Telangana and is the largest district with an area of 7,483 km^2 (2,889 sq. m) in the state. The district shares boundaries with Khammam, Mulugu and Mahabubabad and with state boundary of Chhattisgarh and Andhra Pradesh and the population is predominately tribal. The district gets the benefit of rainfall mostly from South-West monsoon and receives normal annual rainfall of 1033mm and have a total cultivable area is 1.3 lakh ha. The pre-dominant soils in the district are chalka (43%), black soils (29%) and dubba soils (28%) of total area. Pigeon pea crop is cultivated in an average area of 44,500 acres in the district and farmers are cultivating traditional varieties which are susceptible to various pest and diseases and giving low productivity. Hence, Krishi Vigyan Kendra, Bhadradri Kothagudem, Since, five years has been conducting Cluster front line demonstrations under Nation Food security Mission for promotion of pulses among tribal areas. The front-line demonstration underlying the basic principle of extension education "learning by doing" and "seeing is believing" are the backbone of transfer of new/improved agricultural technology. KVK, Kothagudem has demonstrated the performance of high yielding, wilt tolerant varieties like LRG-65, WRG-65 and WRGe-97 for increasing the realised yield productivity among the farmers.

2. Material and Methods

The present investigation of cluster front line demonstrations conducted for five years i.e., from 2017-18 to 2021-22 during kharif season by the Krishi Vigyan Kendra, Garimellapadu, Bhadradri Kothagudem in adopted villages of four distinguished Mandals *viz.* Sujathanagar, Laxmidevipally, Palvoncha, Tekulapally of Bhadradri Kothagudem district, Telangana. It was observed that the average yields and acreage of Pigeonpea was under continuous decline due to use of traditional varieties, incidences of Fusarium wilt and shifting of farmers to commercial crops like cotton and chilli. Potential technologies for sustainable pulse production were selected from the On- farm trails results reported by DAC, PJTSAU and Research Institutes. The demonstrations were conducted in an area of 20 ha. every year and the procedure of selection of beneficiary farmers, villages and mandals were identified by conducting a detailed baseline survey using PRA tools. Package of technologies for cluster front line demonstration include Selection of High yielding varieties like LRG- 41, WRG-65 and wilt tolerant varieties like WRGE-93; demonstration of cultivation methods like Block plantation and intercropping with cotton at 1:4 ratio; demonstration on seed treatment with rhizobium and PSB (@ 250 g per 4 kg seed) along with increased dose of phosphorus, application of *Trichoderma viride* and 2%; foliar spraying of Neem seed kernel Extract (NSKE) 5% (at flowering and pod formation stage, practice of nipping of terminal buds and IPM (seed treatment with carbendazim 25% WS @ 2.5g/kg seed, yellow sticky trap @ 16/ha & spraying of Emamectin benzoate 5%. lt for chemical management of sucking pest) was carried out in Redgram. Farmers were trained to follow the recommended practice as illustrated in Table 1. In case of local check, the traditional practices followed by the farmers and observations of agronomic parameters and pest diseases and respective yield was recorded from both CFLD and non CFLD farmers plots. Field days were conducted for involving the farming community in accessing the results of the demonstration. Socio-economic parameters, their perceptions about the technology and feedback and suggestion were also noted from the farmers via personal interview. Local print and electronic media were also involved for large-scale adoption of the package of practices by farmers in the villages.

Table 1: Particulars showing farmer's existing practices and technological intervention by KVK under CFLD on Pigeon pea

Particulars	Farmers existing practices	Technological recommendations under CFLD	Adoption Gap
Variety	local varieties	LRG-41, WRG-65, WRGE-93	Full gap
Seed rate and spacing	10-12 kg/ha, 120 x 30 cm	8 kg/ha, 120 x 45 cm or 180 x 45 cm, Block planting & Intercropping	Partial gap
Wilt	Wilt Susceptible	Wilt tolerant	Full gap
Time of sowing	15th June to 15th July	1st June to 30th June	Partial gap
Seed Treatment	No seed treatment	Seed treatment was done with 2.5 gm of Carbendazim, 5 ml of Imidachloprid per kg seed and with Rhizobium culture and *Trichoderma viride* @ 5gm/ kg seed.	Full gap
Weed management	Manual weeding at 45-60 DAS	Application of Imazethapyr 10 SL 75 g a.i. ha^{-1} at 15-20 DAS	Full gap
Manures & Fertilizer	Imbalanced use of fertilizer, 50 kg/ ha of DAP as basal dose & 50 kg/ ha urea as top dressing	Balanced fertilizer application as per soil test values, 50 kg of urea as basal dose, 250 kg of SSP and 34 kg of MOP as basal dose/ha	Full gap
Bio- fertilizers	Not applied	Applied *Trichoderma viride* (80 kg decomposed FYM + 20kg neem cake + 2 kg *Trichoderma viride* incubated for 25-30 days in shade)	Full gap
Plant Protection	Injudicious use of insecticides and fungicides based on advice of input dealers	Spraying of Neem seed kernal Extract (NSKE) 5% at 50% flowering stage and Emamectin benzoate5% SG@ 220 g/ha for control of sucking pest.	Partial gap with high cost
Harvesting	Manual harvesting	Manual & Mechanical Harvesting	Partial gap

The basic information was recorded from the demonstration and control plots and analyzed for comparative performance of the cluster frontline demonstrations (CFLDs) and farmer's practice. The yield data were collected both from the demonstration and farmers practice by random crop cutting method and analysed by using simple statistical tools. The technology gap and technological index (Yadav *et al.*, 2004) [6] along with the benefit cost ratio (Samui *et al.*, 2000) [7] were calculated by using following formula as given below.

Extension Gap = Potential Yield – Demonstration Yield

Additional Return = Demonstration Return – Farmer's Practice Returns

$$\text{Technology Index} = \frac{\text{Potential Yield} - \text{Demonstration}}{\text{Potential Yield}} \times 100$$

$$\text{Percentage increase in Yield} = \frac{\text{Demonstration Yield} - \text{Farmer's Practice Yield}}{\text{Farmer's Practice Yield}} \times 100$$

3. Result and Discussion

The study taken up to analyse the performance of Cluster Front line demonstrations in increase the productivity and profitability of Pigeon Pea farmers, revealed in Table 2 that the average grain yield of the CFLD has ranging from 12.75 to 15.5 quintals per hectare (q/ha), which was significantly higher than farmer's practice with the average yield of 10.38 q/ha. The CFLD resulted in a consistent increase in yield, ranging from 15.9% to 47.6% over farmer's existing practices.

Table 2: Grain yield and Gap analysis of cluster frontline demonstration on Pigeon pea

Year	Sample Area (ha)	Sample No. of farmers	Average yield (Q/ha)			% Increase over FP	Extension gap (q/ha)	Technology Index (%)
			Potential	CFLD	FP			
2017-18	10	25	19.5	14.2	12.3	22.5	5.30	27.18
2018-19	20	50	18.5	13.5	11.5	17.5	5.00	27.03
2019-20	20	50	18.5	12.75	10.1	15.9	5.75	31.08
2020-21	20	50	18.5	14.4	10.2	42.5	4.10	22.16
2021-22	10	25	18.5	15.5	10.5	47.6	3.00	16.22
Average	-	-	18.7	14.07	10.92	29.20	4.63	24.73

Moreover, the extension gap, representing the yield difference between the potential and demonstrated yields, decrease over the years from 5.3 q/ha. to 3.00 q/ha. suggesting a successful adoption of technology by the farmers. The technology index, representing the CFLD's performance as a percentage of the potential yield, averaged 24.73%, signifying reasonable technology adoption.

Table 3: Economic analysis of the cluster frontline demonstrations on Pigeon pea

Year	Total return (Rs. ha^{-1})		Input cost (Rs. ha^{-1})		Net return (Rs. ha^{-1})		Additional return (Rs. ha^{-1}) CFLD	B:C ratio	
	Recommended Practice (RP)	Farmer's Practice (FP)	Recommended Practice (RP)	Farmer's Practice (FP)	Recommended Practice (RP)	Farmer's Practice (FP)		Recommended Practice (RP)	Farmer's Practice (FP)
2017-18	72,300	63,900	38,000	34,000	34,300	29,900	4,400	1.90: 1	1.88: 1
2018-19	74,250	63,250	32250	32500	42,000	30,750	11,250	2.30: 1	1.95: 1
2019-20	75,950	62,700	35,025	31,950	40,925	30,750	10,175	2.17: 1	1.96: 1
2020-21	72,500	51,000	27,500	25,500	45,000	25,500	19,500	2.64: 1	2.00: 1
2021-22	74,000	50,500	27,000	26,000	47,000	24,500	22,500	2.74: 1	1.94: 1
Average	73,800	58,270	31,955	29,990	41,845	28,280	13,565	2.35: 1	1.95: 1

Note: MSP of Pigeon Pea @ Rs 5,450 qt^{-1} in 2017-18, Rs 5,675 qt^{-1} in 2018-19, Rs 5,800 qt^{-1} in 2019-20, Rs 6,000 qt^{-1} in 2020-21 and Rs 6,300 qt^{-1} in 2021-22

The data in the Table 3 revealed that the recommended practice consistently generated higher total returns compared to the farmer's practice during the five years. The average total return for the recommended practice was Rs. 73,800 per hectare (ha), while for the farmer's practice, it was Rs. 58,270 per ha. Similarly, the recommended practice yielded higher net returns, with an average of Rs. 41,845 per ha, compared to Rs. 28,280 per ha for the farmer's practice. The additional return, representing the profit obtained by adopting the recommended practice instead of the farmer's practice, consistently favoured the recommended practice. The benefit-cost (B:C) ratio, was higher for the recommended practice during 2021-22 i.e., 2.74:1, indicating the increased profitability for the farmers. The average B:C ratio for the recommended practice was 2.35:1, while for the farmer's practice, it was 1.95:1. These findings show the positive impact of CFLD on pigeon pea productivity, economic analysis underscoring the significance of disseminating improved farming technologies. The above results are in conformity to the findings by Meena and Singh (2017) [4], Jayalakshmi *et al.* (2018) [8] and Jha *et al.* (2020) [9].

4. Conclusion

The socio-economic impact of the adoption of recommended technologies among farmers, unambiguously conclude that the cluster front line demonstrations in Pigeon pea have showcased significant improvements in yield, profitability, and adoption of recommended practices. The consistent efforts by the KVK for a five years duration has helped in reducing the extension gap and hasten the dissemination and adoption of improved production technologies among pigeon pea farmers. These results can guide policymakers, agricultural extension agencies, and farmers in adopting and implementing these recommended practices to enhance pigeon pea productivity and farmers' income. Further research and extension efforts are warranted to scale up these successful demonstrations and ensure wider adoption of improved technologies in pulse cultivation.

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