

# Performance evaluation of improved cultivars of pigeonpea under cluster front line demonstration in changing climatic condition of Samastipur District, Bihar

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Received: June 13, 2022  
Accepted: October 04, 2022

Handling Editor:  
Dr. Amarendra Reddy,  
ICAR-CRIDA, Hyderabad

## ABSTRACT

A study was conducted for two years using P-9 and NDA-1, new cultivars of pigeonpea, in an area of 20 and 10 ha for 50 & 25 clusters, respectively with the objective to demonstrate the potential of improved technologies for pulse production. The improved technologies consist of modern varieties, seed treatment with *Bavistin/Rhizobium*, balanced fertilizer application and integrated pest management. These Cluster Frontline Demonstration (CFLD) studies recorded higher average grain yield (17.49 and 16.43 q/ha) as compared to average yield obtained from farmer's practice (10.20 and 11.45 q/ha) which computed to increase in yield by 41.68 % and 30.31% during the years under observation, respectively. The technology gap (q/ha), extension gap (q/ha) and technology index (%) were 2.51, 7.29 and 12.55 during 2016-17 and 3.75, 4.98 and 17.85 in 2017-18 respectively. The significant increase in yield is attributed to introduction of new varieties in cluster mode. This mode facilitated better crop management resulting in better crop production.

**Key words:** B:C ratio, CFLD, Pigeon Pea, Technology index, Yield

## INTRODUCTION

Pigeon Pea (*Cajanus cajan* L.) is an affordable and major vegetarian source of protein, vitamins and important amino acids for large population to support their dietary requirement in India. Being a legume crop, pigeon pea enriches soil through symbiotic nitrogen fixation (Kumar *et al.* 2018). The major pigeon pea growing states are Maharashtra, Uttar Pradesh, Jharkhand, Odisha, Bihar and Rajasthan contributing 88.20 % in the total pigeon pea production basket. At present, pigeon pea is cultivated in about 4.0 m ha with more than 3.5 m tones production with average productivity from 850-900 kg/ha (Singh, 2020). Acreage under pigeon pea in Bihar did not increase much in previous years. The area and production in Bihar are 0.22 lakh ha and 0.34 lakh tones respectively. In order to address this short coming the Government of India has devised a programme to promote pulse cultivation in cluster mode under National Food Security Mission through KVKs.

Pigeon pea is *kharif* crop of Samastipur, Bihar that is generally grown in small and marginal land holdings with minimal inputs and mostly grown in rainfed condition. In addition to it, many of the farmers still use their own saved old seeds of the

variety that are grown year after year and that too through traditional practice of broadcasting, resulting in sub-optimal plant population and low yields. The main objective of CFLD was to demonstrate production technology and its management practices on farmer's field under different farming situations. These demonstrations were carried out under the supervision of agricultural scientists and feedbacks from the different farmers were to be generated on the demonstrated technology. Keeping the importance of CFLD the KVK, Samastipur conducted demonstrations on pigeon pea at farmer's field under irrigated system. The present study has been undertaken to increase the per capita availability of pulses and popularization of new production technology amongst the farming community for pigeon pea.

## MATERIALS AND METHODS

The study was carried out in operational area of Krishi Vigyan Kendra, Samastipur during 2016-17 and 2017-18. The total area allotted by ATARI, Patna for this demonstration were 20 ha and 10 ha during 2016-17 and 2017-18 respectively. The wheat harvested fields were marked from selected villages/clusters (each of 0.4 ha) of the district

(Table 1). The soil was sandy loam/loam in texture. Soil samples were collected from different farmer's field of the village/district (Table 2). The soil sample were air dried, crushed and passed through 2 mm sieve and initial soil properties were determined as per standard methods (Jackson, 1973). The critical inputs were supplied to the farmers by the KVK, other inputs like balanced fertilizers, additional agro-chemicals, weedicides, irrigation facility were managed by farmers himself as per recommendation of scientists of KVK. The pigeon pea varieties Pusa-9 and NDA-1 were sown during third week of July in each year using a seed rate of 20 kg/ha in furrow at 60 cm row spacing and 20 cm plant to plant distance. It was maintained by thinning at 2 weeks after sowing. Before sowing seed was treated with Bavistin (2 gm/kg) and inoculated with bio-fertilizer (*Rhizobium* and Phosphate solubilizing bacteria) @ 20 g/kg seed. Then the treated seeds were dried in shade for an hour, there after seed was used for sowing. The full doses of fertilizer were applied at the time of sowing. Recommended package of practices were followed for raising the crop along with need-based weed control and plant protection measures. The crop received 1067.7 mm of mean rainfall during the crop growth period. Many farmers grow this crop by their own methods that is kept as local broadcasting standard check but farmers should adopt crop rotation. The compost is applied once in three years by the farmers. The soil of farmer's field was medium in organic carbon, available nitrogen (except Samastipur, Kalyanpur and Dalsinghsarai blocks), available phosphorous (except Samastipur, Shivajianagar and Ujijapur blocks) and available potassium in Samastipur block. The available potassium was low in other blocks. However, the available phosphorus was high in Samastipur, Shivajinagar and Ujijarpur. All the farmers were trained for improved package of practices through training programme. Materials for the present study with respect to CFLD and farmers practices are given in Table 3. At Samastipur and Shivajinagars blocks (variety NDA-1) the plant height, days to 50% flowering, no. of branches/plant, leaf area, no. of pods/plant, pod length, no. of grains/pods and 100 seed weight were recorded at harvest whereas, at other blocks data on only grain were recorded.

In case of local check plots, existing practices being adopted by farmers were followed. Regular visit by the KVK scientists to demonstration fields were ensured to guide the farmers. These visits were also helped to collect feedback from different

farmers for further improvement in research and extension programme. Field days, awareness camps and group meetings were also organized at the demonstration plots to provide the opportunities for vicinity farmers to witness themselves the benefits of these demonstrated technologies the improved technology included quality seed, seed treatment and maintenance of optimum plant population etc. Recommended weed control measure and irrigations were applied according to requirement of the crops. The crop was harvested at perfect maturity with suitable method. Gross return was calculated by multiplying yield into prevalent local market price of the crop obtain by the farmers.

For cost estimating the Cost A1 has been followed incorporating input cost, the sum of expenditure on land preparation, planting method, fertilizer, insecticide, fungicide, herbicide, irrigation cost, labour harvesting cost etc. were calculated from each demonstration (Reddy and Reddy, 2010). Further, net return and benefit-cost ratio were calculated from these data.

To estimate the technology gap, extension gap and technology index following formula used were (Samui *et al.*, 2000).

Technology gap = Potential yield - Demonstration yield,

Extension gap = Demonstration yield - Farmers yield,

Technology index = Technology gap / Potential yield x 100.

## RESULTS AND DISCUSSION

The result of 75 demonstrations conducted during *kharif* 2016-17 and 2017-18 at farmers' field in Samastipur district presented in Table 4, as per the proforma prescribed by ICAR Agricultural Technology Application Research Institute (ATARI), Patna (Zone-IV). Results indicated that use of high yield varieties, balance use of fertilizers and micronutrients and control of insect and disease during 2016-17 motivated the famers to take up pigeon pea during 2017-18. The data revealed that the CFLD reflects good impact over the farming communities.

A comparison of productivity levels between local check and demonstrated varieties are shown in Table 4. The grain yield of pigeon pea obtained during 2016-17 and 2017-18 for demonstration were (17.49 and 16.43 q/ha) as compared to grain obtained from farmers field (10.20 and 11.45 q/

ha) respectively. Increase in grain yield from demonstration fields were calculated at 71.47% and 43.49% over that of from local check plots during the 2016-17 and 2017-18 respectively. Similar findings have also been observed by Sandhu and Dhaliwal (2016), Jain (2016) and Keshavareddy *et al.* (2018) where results from demonstration plots observed to be higher in summer green gram and pigeon pea crop. The major differences were observed between demonstration package and farmers' practices are introduction of seed treatment, method and time of sowing, fertilizer doses and method of its application and plant protection measures. It is evident from the results that the yield of demonstration was found better than the local check (farmer's practice) under the similar environmental conditions. Farmers were motivated by results of demonstration and agro-technologies applied in the cluster front line demonstration and they would adopt all these new technologies in their fields. This finding is in corroboration with the findings of Sandhu and Dhaliwal (2016), Meena and Singh (2017) and Kumar *et al.* (2018). Also one reason may be the fallen leaves which can also be used as mulch and thus help to enhance the water holding capacity of the soil. The decreasing yield during 2017-18 is due to weather condition and early termination of rains.

The technology gap is the gap between demonstration yield and potential yield and it was 2.51 and 3.57 q/ha in 2016-17 and 2017-18 respectively. The observed technology gap resulted from Table 4 is due to various constraints such as soil fertility, availability of low moisture content, sowing time and climatic hazards etc. Hence, to reduce the yield gap the location specific recommendations for varieties, soil testing and timely and maintained space sowing appears to be necessary. The 7.29 q/ha extension gap found in 2016-17 whereas 4.98 q/ha was in 2017-18. There is a need to decrease this wider extension gap through latest techniques. The findings are similar to the findings of Kumbhare *et al.* (2014), Jain (2016) and Sandhu and Dhaliwal (2016). The technology index showed the feasibility of evolved technology at farmer's field. Lower technology values indicated that feasibility of variety among the farmers is more. The technology indexes were 12.55 % and 17.85 % in 2016-17 and 2017-18 respectively. This finding is in corroboration with the findings of Sandhu and Dhaliwal (2016) and Kumar *et al.*, (2018). Data (Table 5) clearly revealed that growth and yield parameters like plant height, days to 50% flowering, pods/plant and seed yield were significantly influenced by

improved cultivation practices and nutrient levels. Seed inoculation with *Rhizobium* and PSB proved its superiority over untreated control with respect to plant parameters. The overall improvement of this crop was owing to its pivotal role in early root formation, its proliferation, photosynthesis, increased microbial activity in root nodules, symbiotic nitrogen which in term resulted in greater transformation of photosynthesis towards the sink development. Similar results have been reported by Kumar *et.al.* (2020) and Pawar *et al.*, (2021). The economics of pigeon pea production under CFLD have been presented in Table 6. Economics analysis of the yield performance revealed that CFLD recorded higher gross return (Rs 139920/ha during 2016-17 and Rs. 82150/ha during 2017-18) and net whereas the return (Rs. 115050/ha during 2016-17 and Rs 59000/ha in 2017-18) with higher benefit-cost ratio 5.62 and 3.52 compared to 3.77 and 2.31 in case of local check. The net return increased by 91.84 % and 81.14 % during 2016-17 and 2017-18 respectively. The rate of pigeon pea in local market during 2016-17 was @ Rs. 80/kg due to the low production/market crisis but in the during 2017-18 due to no short fall in the local market the rate was @Rs. 50/kg. The higher cost benefit ratio in demonstrated plot is because of higher yield obtained under improved technologies compared to farmers practices during the experimental years. Similar results were corroborated with Kumar *et al.* (2018) and Keshavareddy *et al.* (2018).

## CONCLUSION

It is concluded from the study that through CFLD of recommended technologies, yield of pigeon pea can be increased to its potential yield in Samastipur district. This will substantially increase the income as well as livelihood of the farming communities. It has also been observed that the recommended technologies employed with improved varieties has the ability to sustain the non-linear climatic changing scenario. Judicious application of fertilizers and irrigation under lined sown and treated seeds crop would attributed to this aspect. Major attention to be made on development of module on area specific technology for enhancing the productivity of pulses in varied agro-ecosystems.

## ACKNOWLEDGEMENT

This project was mandated by ICAR-ATARI, Patna (Zone-IV) and supported by Dr. Rajendra Prasad Central Agricultural University, Pusa (Bihar)

Table 1. Details of farmers and cluster in different blocks of Samastipur district under CFLD programme

Year	No of farmers	Selected Blocks of Samastipur District						
		Samastipur	Bibhutipur	Shivajinagar	Kalyanpur	Ujiyarpur	Dalsinghsarai	Tajpur
2016-17	50	22 (3)	17(03)	11(02)	-	-	-	-
2017-18	25	-	-	-	02(01)	05(01)	12(02)	06(01)

Parenthesis indicates number of clusters in each block

Table 2. Soil analysis of demonstrated plots in different blocks (Pooled data of farmers)

Parameters	Selected Blocks of Samastipur Districts						
	Samastipur	Bibhutipur	Shivajinagar	Kalyanpur	Ujiyarpur	Dalsinghsarai	Tajpur
pH (1:2)	7.7-8.2	8.0-8.1	7.7-8.3	8.0-8.2	7.9-8.1	8.0-8.3	8.0-8.2
EC (dsm <sup>-1</sup> )	0.72	0.69	0.74	0.59	0.72	0.74	0.77
Organic carbon (%)	0.64	0.59	0.56	0.66	0.68	0.62	0.63
Avail. N (kg/ha)	274	284	301	259	284	269	288
Avail. P <sub>2</sub> O <sub>5</sub> (kg/ha)	52	47	51	42	51	47	39
Avail. K <sub>2</sub> O (kg/ha)	127	108	96	139	127	136	141

Table 3. Comparison of cultural practices adopted by farmers and CFLD

Cultural operations	Prevailing Practices	CFLD employing improved cultivation practices
Use of seed	Local seed	Pusa-9, Narendra Arhar-1
Seed quality	Small ungraded seed	Bold graded seed
Seed treatments	-	Treated with Bavistin followed by <i>Rhizobium</i>
Method of sowing	Broadcasting	Line sowing by seed planter
Fertilizer application	-	100 kg DAP + 33 kg MOP + 125 kg Phospho-gypsum per ha
Control measures	Single spray of pesticide when severe problem occurs	Two sprays of insecticides to control of insects and application of micronutrients for more branches and healthy plants as well as grains

Table 4. Yield, technology gap, extension gap and technology index of pigeon pea in Samastipur

Year	Name of variety	No of demo	Potential	Yield (q/ha)						Yield increase (%)	% increase over check	Technology gap (q/ha)	Extension gap (q/ha)	Technology index (%)
				Demonstration			Check							
				Max	Min	Average	Max	Min	Average					
2016-17	P-9/NDA-1	50	20	18.69	16.29	17.49	10.55	9.85	10.20	41.68	71.47	2.51	7.29	12.55
2017-18	NDA-1	25	20	18.20	14.65	16.43	11.85	11.05	11.45	30.31	43.49	3.57	4.98	17.85

Table No. 5. Agronomical Indices of Check and demonstrated plots at Samastipur and Shivajinagar blocks of Samastipur.

Parameters	Samastipur				Shivajinagar			
	Check	Demonstrated	SEM ±	CD (P = 0.05)	Check	Demonstrated	SEM ±	CD (P = 0.05)
Plant height (cm)	171	189	4.89	14.68	174	190	4.83	14.50
Days to 50% flowering	162	153	4.20	12.62	161	154	4.18	12.60
No. of primary braches/plant	12.9	14.2	0.37	1.09	12.6	13.9	0.35	1.06
No. of secondary branches/plant	21.6	27.4	0.67	2.02	21.3	26.4	0.65	1.94
Leaf area (cm <sup>2</sup> )	20.7	24.14	0.60	1.82	20.8	24.17	0.59	1.80
No. of pods/plant	201	221	6.19	18.54	202	223	5.67	17.03
Pod length (cm)	4.1	4.8	0.13	0.39	3.8	4.9	0.12	0.35
No. of grains/pod	3.4	4.0	0.11	0.32	3.5	4.1	0.10	0.31
100 seed weight	11.2	12.7	0.32	NS	11.3	12.6	NS	11.7

Table 6. Gross cost, gross return, net return and B: C ratio of pigeon pea in Samastipur

Year	Expenditure and return (Rs/ha)								Net return increase (%)
	Check				Demonstration				
	Gross cost (Rs/ha)	Gross Return (Rs/ha)	Net return (Rs/ha)	B:C ratio	Gross cost (Rs/ha)	Gross Return (Rs/ha)	Net return (Rs/ha)	B:C ratio	
2016-17	21630	81600	59970	3.77	24870	139920	115050	5.62	91.84
2017-18	24680	57250	32570	2.31	23150	82150	59000	3.52	81.14

Prevailing sale rate of pigeon pea during: 2016-17@Rs. 8000/q; 2017-18@Rs. 5000/q

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