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Assessment of productivity and profitability of pigeon pea var. TJT 501 through cluster front line demonstration in Sidhi district of Madhya Pradesh

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Abstract
Pigeon pea is a popular kharif crop in the Sidhi district. From 2016-17 to 2018-19, the Krishi Vigyan Kendra (Farm Science Center) set up a Front Line Demonstration, introducing new and high producing varieties and applying scientific procedures to their cultivation. FLDs were conducted in several villages in the Sidhi district. During these years of research, a total of 90 ha of land were covered by package demonstrations on pigeonpea against their own challenges, with 225 farmers benefiting from the technology. Under scientific technology, the highest average yield, net return, and lowest wilt incidence and pod borer damage were achieved at 13.45 q/ha, Rs 38679 / ha, and 0.27 percent and 7.1 percent, respectively, compared to farmers practices at 7.88 q/ha, Rs 20103 and higher wilt incidence 0.44 percent and pod borer damage 14.3 percent. Under recommended practices, the highest number of pods/plant (87.7), number of grain/pod (3.4), Test weight (82.6g), and grain yield (13.48 q/ha) were observed when compared to farmers' conventional practices, which had the lowest number of pods/plant (74.3), number of grain/pod (2.7), Test weight (78.7g), and grain yield (7.66 q/ha). Improved technology yielded a maximum average cost-benefit ratio of 3.10, compared to 2.58 for farmers' technology. The demonstration's economic viability was demonstrated by a favorable cost-benefit ratio, which persuaded farmers to embrace improved technology practices. The method was acceptable for increasing the production of the pigeonpea crop, and it is recommended that similar demonstrations be conducted as part of the technology transfer programme by KVKs or other TOT institutes.

Keywords: yield, C: B, wilt incidence, pod borer damage technology gap and relative spread index

Introduction
Pigeon pea is farmed across India, with the exception of the coldest places. Gujarat (1059 kg/ha), Uttar Pradesh (916 kg/ha), and Madhya Pradesh (780 kg/ha) are the top three states in terms of productivity in the country. When compared to varietal potential, national production of this crop is quite low (780 kg/ha). However, in comparison to their own yield potential of 1500-2000 kg/ha for short-duration varieties and 2000-2500 kg/ha for medium- to long-duration types, their output is rather low. However, if attention is paid to the specific problem in its region, such as a lack of high yielding varieties, an imbalanced use of fertilizers, a low seed replacement rate, and the use of untreated seed due to a lack of knowledge about package and pigeon pea cultivation practices, there is tremendous potential for increasing production levels even further. Pigeon pea production can be boosted when more comprehensive productive technology is accessible. However, no practical and widely adopted technique has yet reached growers. In such cases, KVK considers systemic and concerted efforts to fix the major concerns, such as the use of better varieties, balanced fertilizer use, and seed treatment. Its agro approach is designed to enhancing production under the current agricultural system by demonstrating at farmers' fields in the presence of concerned SMS for attaining the full yield potential of pigeon pea.

Methods and Material
During the Kharif season from 2016-17 to 2018-19, Krishi Vigyan Kendra, Sidhi (MP) conducted a study in selected farmers' fields of adopted villages in five blocks of Sidhi district. During three years of research, a total of 90 acres of land was covered by the Front Line Demonstration, benefiting 225 farmers. Before performing FLDs, a list of farmers was compiled from a group gathering, and particular skill training in several elements of cultivation was given to the selected farmers.

A control plot was also retained in the demonstration, where farmer practice was carried out. Under FLDs, KVK produced and distributed crucial input modules to chosen farmers based on soil test results. The crop was planted in the second to final week of June. Row to row and plant to plant distances of 75 and 30 cm were maintained, and the selected field was fertilized according to the NPK recommendations of 20:60:20 kg/ha. Plant protection measures and other agronomical treatments were followed as recommended in addition to the full dose of NPK sprayed at the time of planting. To ensure wilt incidence and pod damage observation were taken on five randomly selected plants in each replication till harvesting the crop and percent pod damage and wilt incidence calculated by using following formula-

Wilt Incidence (%) = No. of infected plant /Total No. plant examined × 100

Pod damage (%) = No. of damage pod/plant /Total No. of pods/plant examined × 100

Data were collected from both the demonstration and farmer's practices with the help of personal contact and observations on yield data was also recorded at the time of separate threshing and cost benefit ratio also computed in accordance to market support price of the pigeon pea and their technology gap, extension gap and technology index were worked out. To estimate the technology gap, extension gap and the technology index the following formulae have been used (Sagar *et al*. 2004 & Singh 2007) [7].

Technology gap = Potential yield – Demonstration yield
Extension gap = Demonstration yield – Farmers yield
Technology index = [(Potential yield - Demonstration yield)/ Potential yield] x 100

Result and Discussion
The production of pigeon pea in demonstration plots grew steadily over time, according to the results. The average demonstration yield was 13.48 q/ha from 2016-17 to 2018-19, with the greatest yield of 15.85 q/ha in 2016-17. During the study period, the percentage increase in yield ranged from 55.95 to 85.38, with an average increase of 70.60 percent (Table-2). The outcome clearly demonstrates the advantages of FLDs over existing techniques in terms of increasing pigeon pea production in Sidhi district, as well as their favorable impact on yield attributes (Table-3). Under recommended practises, the highest number of pods/plant (87.7), number of grain/pod (3.4), test weight (82.6 g), and grain yield (13.48 q/ha) were observed, compared to farmers' conventional practises, which had the lowest number of pods/plant (74.3), number of grain/pod (2.7), test weight (82.6 g), and grain yield (7.66 q/ha). Biofertilizers and inorganic nutrient combinations may be synergistic, improving the physical and biological health of the soil. The addition of biofertilizer improved nutrient retention capacity and aeration, which was validated by previous data (Aulakh and Malhi 2005) [1]. Because of their additive action, as well as solubilization from non-exchangeable to labile form and fixation of atmospheric nitrogen, they result in a significant boost in growth and yield qualities as compared to single or un-inoculated plots. Combination inoculation favoured increased nitrogen and phosphorus availability in the root zone of pigeon pea, according to literature (Singh and Yadav, 2008) [6].

Cost Benefit ratio
During 2016-17 to 2018-19, an economic analysis of yield performance revealed that the cost benefit ratio of demonstration plots was significantly higher 3.68, 2.49, and 3.14 than control plots (Farmer practice) 3.07, 1.71, and 2.96, respectively, while the average cost benefit ratio was 3.10 in recommended practices and 2.58 in farmers practice. As a result, favorable cost-benefit ratios demonstrated the economic sustainability of the demonstration intervention and persuaded farmers of its utility. Similar findings in moth bean and sorghum were reported by (Sharma 2003 and Singh *et al*. 2018) [5, 9].

Extension Gap
The extension gap has been widening in recent years. During the study period, the extension gap ranged from 4.61 to 7.30 q/ha, emphasizing the necessity to educate farmers through various means in order to adapt to better agricultural production techniques and reverse the trend of vast extension gaps (Singh *et al*. 2016 & Singh *et al*. 2018) [8, 9].

Technology gap
The farmer's cooperation in carrying out such demonstrations with good outcomes in the next year was respected by the trend of technology gap ranging from 4.15 to 8.8q/ha. The observed technology disparity could be attributable to differences in soil fertility and climatic conditions (Singh *et al*. 2016 & Singh *et al*. 2018) [8, 9].

Technology index
The technology index demonstrated the viability of advanced technology on the farm. The lower the technology index value, the more feasible the technology is. From 2016-17 to 2018-19, the technology index increased from 20.75 to 44.25 percent, demonstrating the viability of the exhibited technology in this region (Singh *et al*. 2016 & Singh *et al*. 2018) [8, 9].

Wilt Incidence
Table 4 reveals that wilt affected plant/m^2 (0.27) and damage percent (0.27) in recommended practices as compared to farmers' practices (0.44 & 7.9). The damage reduction percentage was found to be 36.9%. It's possible that this is due to seed treatment. Thiram is particularly efficient in preventing the pathogen's mycelial growth, lowering wilt incidence, and increasing seed output when used alone or in combination with Carbendazime (Nikam *et al.* 2007). Because the combination provides stronger disease protection and resulted in a disease control rate of 29.3 percent above check, This could be explained by the fact that seed treatment in the early stages of the disease may have reduced the original inoculums present in the soil, hence limiting the disease's secondary spread.

Pod borer
During the *kharif* season from 2016-17 to 2018-19, control of pigeon pea pod borers with insecticides was carried out according to prescribed crop production practices. Quinolphos was the most effective treatment for protecting the crop from pod borers, with a 54.1 percent reduction in pod damage as compared to farmer's technology. Because ecofriendly management options were efficient in lowering *Helicoverpa*

armigera pod damage in these areas, the superiority of chemical insecticides in reducing larval population and pod damage under this treatment is likely related to their faster impact against the target pest. The discrepancy in pod damage in yield in the untreated plot could be attributed to the bug being killed slowly or not at all. It has been noted that the benefits of minimizing pod damage and increasing yield should be evaluated against the negative effects of synthetic chemical pesticides on larval populations. These findings contradict Sharma *et al.* finding's from 2011 [4].

Level of use and gap in adoption of pigeon pea technologies

Farmers in usually prefer local varieties to the recommended improved varieties because better varieties' quality seed is difficult to get by (Table-1). Only a small percentage of farmers were able to obtain better variety seed. Farmers used the broadcast way of sowing instead of the recommended line sowing approach, and as a result, they used a larger seed rate than recommended. As indicated, no NPK fertilizer was used. In the case of pigeon pea irrigation and plant protection, there existed a complete gap.

Table 1: Level of use and gap in adoption of pigeonpea technologies in Sidhi.

Crop Operations	Recommended technologies	Existing technologies	Gap
Variety	TJT 501 (Medium duration)	Local (Chaiti)	Full gap
Land Preparation	One cultivator ploughing and 2 ploughings	One cultivator ploughing and 2 ploughings	Nil
Seed rate	20 Kg/ha (TJT 501 with line sowing)	25 – 30 Kg/ha (broadcast tor without line sowing)	Use of higher seed rate and avoid line sowing
Seed Treatment	2 g Carbendazim with @1 g Thaiaram/kg seed	No use of fungicides for seed treatment	Full gap
Fertilizers	DAP @ 125 Kg/ha with dual inoculation of Rhizobium and PSB@ 10g/ Kg seed	DAP @ 30-35 Kg/ha without inoculation of culture	95-90 Kg DAP/ha, and No inoculation of culture
Weed Management	Two mechanical weeding or Pendimethelin @ 3.3 litre/ha	Two mechanical weedings	Chemical weeding is not done
Irrigation	One irrigation in October last to November 1st fortnight (medium duration)	Nil	Full gap
Plant protection	Propenophos + Cypermetrin 2 ml/ liter water	Nil	Full gap

Table 2: Yield and Economical parameter as influenced with package demonstration in pigeon pea.

Year	No. of demo	Area (ha)	Variety	Yield Potential (q/ha)	Yield		Increase yield (%)	Cost of cultivation (Rs.)		Grass return (Rs.)		Net return (Rs.)		B:C ratio	
					RP	FP		RP	FP	RP	FP	RP	FP	RP	FP
2016-17	75	30	TJT 501	20.0	15.85	8.55	85.38	17215	11108	63400	34200	46185	23092	3.68	3.07
2017-18	75	30	TJT 501	20.0	11.15	6.54	70.48	19700	16800	49060	28776	29360	11976	2.49	1.71
2018-19	75	30	TJT 501	20.0	13.35	8.56	55.95	18916	12850	59408	38092	40492	25242	3.14	2.96
Mean	75	30			13.45	7.88	70.60	18610	13586	57289	33689	38679	20103	3.10	2.58

Table 3: Effect of package on yield attributing characters of pigeon pea

Yield attributing characters	Years						Average	
	2016-17		2017-18		2018-19			
	RP	FP	RP	FP	RP	FP	RP	FP
Plant population	5.3	5.5	5.3	5.5	5.3	5.6	5.3	5.5
No. of pods/plant	82.0	73.0	79.0	72.0	81.0	78.0	80.7	74.3
No. of grains/pod	3.2	2.7	3.1	2.6	3.8	2.9	3.4	2.7
Test weight (gm)	83.0	78.0	82.0	78.0	83.0	80.0	82.6	78.7
Yield (q/ha)	15.85	8.55	11.15	6.54	13.45	7.88	13.48	7.66

RP-Recommended practices, FP-Farmers practices

Table 4: Effect of complete package on extension gap and technology index and wilt & pod borer incidence.

Year	Extension gap	Technology gap	Technology index	Wilt affected plant/m^2		Damage %		Reduction damage %	Damaged pods by borer/plant		Damage%		Reduction damage%
				RP	FP	RP	FP		RP	FP	RP	FP	
2016-17	7.30	4.15	20.75	0.23	0.41	4.3	7.5	42.7	7.7	14.3	9.4	19.6	52.0
2017-18	4.61	8.85	44.25	0.31	0.48	5.8	8.7	33.3	6.5	15.4	8.2	21.4	61.7
2018-19	5.57	6.55	32.75	0.26	0.42	4.9	7.5	34.7	7.1	13.3	8.8	17.1	48.5
Average	5.83	6.52	32.58	0.27	0.44	5.0	7.9	36.9	7.1	14.3	8.8	19.4	54.1

Conclusion

Based on the data, it can be inferred that using scientific methods of pigeon pea cultivation can significantly reduce the technological gap, resulting in enhanced pigeon pea yield in the District. Furthermore, district agencies must provide proper technical support to farmers through various educational and extension methods in order to close the extension gap and improve pulse production in the district. The results of front-line trials conclusively shown that by combining balanced nutrition with insect pest management in the Sidhi district, pigeonpea yields may be enhanced by 55.95 to 85.38 percent. The demonstration's economic viability was demonstrated by a favorable cost-benefit ratio, which persuaded farmers to implement the intervention. The technology is suitable for increasing the production of the pigeon pea crop and necessitates demonstrations by KVKs or other TOT centers as part of the technology transfer programme.

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