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The technological impact of production and farmers' income of vegetable pigeon pea growers under the rainfed situation in Panchmahal of Gujarat

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Abstract

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is a key pulse crop cultivated primarily for grain, though it is also harvested as a vegetable when the pods are immature. In Gujarat, pigeonpea often substitute for green pea [*Pisum sativum* (L.)]. However, the district's pigeonpea productivity remains low. Efforts to boost yields and expand pigeonpea cultivation have focused on adopting high-yielding varieties (HYVs), such as the Vaishali variety. To compare the performance of traditional pigeonpea varieties with HYVs, the KVK conducted 225 front-line demonstrations from 2017 to 2021 on farmers' fields, aiming to showcase the benefits of improved varieties over local ones and encourage farmers to adopt enhanced production practices. These demonstrations, which involved scientifically backed and practical farming techniques, resulted in an average yield of 81.6 q/ha and a net return of Rs. 99,250/ha, compared to 50.32 q/ha yield and Rs. 40,980/ha under traditional farming methods. The cost-benefit ratio for the improved technology reached 4.08, significantly higher than the 2.17 ratio from farmers' practices. This favorable cost-benefit ratio highlights the economic benefits of adopting the improved technology, which successfully motivated farmers to incorporate the recommended interventions. This technology is well-suited to increasing the productivity of summer green gram crops and demonstrates the effectiveness of KVK's technology transfer initiatives.

Keywords: Pigeonpea, production technology, frontline demonstration

Introduction

Among subtropical legumes, pigeonpea or red gram [*Cajanus cajan* (L.) Millspaugh] holds significant importance in rainfed agriculture. Globally, pigeonpea is cultivated on 4.67 million hectares, with India accounting for 3.30 million hectares of this area. While primarily grown as a pulse crop, pigeonpea also has versatile uses as a fresh or canned vegetable, which is popular in many parts of India, including Gujarat. Vegetable pigeonpea, with its large pods and easy-to-shell seeds, can thrive in various conditions, including slightly degraded soils, backyards, field borders, and uneven terrain. The fresh green seeds are suitable for freezing and canning, making them viable for commercial and export markets. When cooked, they are easily digestible and provide a rich source of protein, vitamins (A, C, B-complex), minerals (Ca, Fe, Zn, Cu), carbohydrates, and dietary fiber. Compared to pulses, vegetable pigeonpea has five times the beta-carotene content, triple the amounts of thiamine, riboflavin, and niacin, and twice the vitamin C content. It also boasts a higher shelling percentage (70%) than green peas (52%), underscoring its nutritional value and suitability for daily cuisine.

Despite these benefits, farmer adoption of vegetable pigeonpea remains low, primarily due to the inferior pod and seed characteristics of traditional varieties. A survey aimed at understanding farmers' preferences found that they favor pigeonpea plants with high pod counts, large seeds, and good flavor—characteristics that make pigeonpea pods appealing for vegetable harvesting. Consumers preferred pods that are long (5-7 cm), wide (1.5-2.0 cm), and contain a high seed count (4-7 seeds per pod). Given these preferences, varieties specifically bred or suited for vegetable production should be recommended for cultivation in regions where pigeonpea is used in cooking. Consequently, varieties like Shavani, Vaishali, Mahima, and Ganesh have been recommended for commercial cultivation in Central Gujarat.

Materials and Methods

An extensive survey was conducted from 2016-17 to 2021-22 to gather information on various uses of vegetable pigeonpea in Panchmahal District, Gujarat. Data was collected from 150 farming families across seven villages in three Talukas—Goghamba, Kalol, and Godhra—that cultivate pigeonpea. In the demonstrations, a control plot was maintained where traditional farming practices were followed. The improved practice module included balanced fertilizer application (20:40:20 N: P2O5kg/ha), adjusted according to soil test results; use of a disease-resistant pigeonpea variety; seed treatment with fungicides (Carbendazim and Thiram at 2+1 g/kg seed); and seed inoculation with *Rhizobium leguminosarum* and phosphorus-solubilizing bacteria (PSB) at 5 g/kg seeds.

Additionally, one spray of Carbendazim (0.1%) and a spray of chlorpyriphos 50% combined with cypermethrin 5% EC at 750 ml/ha were applied during pod initiation and development. The crop's performance under these practices was compared with the traditional method at the same locations.The farmer's practice involved using 50 kg of DAP per hectare, a higher seed rate (15 kg/ha), and closer spacing (90 cm x 30 cm) without seed treatment or inoculation with *Rhizobium leguminosarum* and PSB. Pigeonpea was sown in the second to last week of July. Farmers were also asked to rank perceived constraints affecting vegetable pigeon pea production, prioritizing those they saw as most limiting. The quantification of data was done by first ranking the constraints and then calculating the Rank Based Quotient (RBQ) as given by Sabarathnam (1988), Production and economic data for FLDs and local practices were collected and analyzed. The technology gap and technology index were calculated using the following formulas as given by Samui *et al.* (2000) [11]:

$$R.B.Q = \frac{\sum fi\ (n + 1 - ith)}{N\ x\ n} \times 100$$

Wherein,
fi = Number of farmers reporting a particular problem under ^{the} rank
N = number of farmers
n = number of problems identified

Extension gap= Demonstration yield-Farmers 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

This study documented the challenges faced by farmers in pigeonpea production. A preferential ranking method was used to identify the constraints experienced by the farmers surveyed. The rankings providedby different farmers are shown in Table 2. A review of the table reveals that the highest-ranking constraint, cited by 29 farmers, was the lack of suitable high-yielding varieties (HYVs). As part of the front-line demonstrations (FLD), participants received HYV seeds as essential inputs. Rank-based quotients were calculated based on the farmers' rankings for each constraint, and the results are presented in Table 2.

Table 2: Ranks given by farmers for different constraints (n=150)

S. No.	Constraints	Ranks									
		I	II	III	IV	V	VI	VII	VIII	IX	X
1.	Lack of suitable HYVs	29	16	12	08	05	05	00	00	00	00
2.	Low technical knowledge	14	08	16	10	08	05	02	06	04	02
3.	Low soil fertility	13	12	16	17	05	06	03	03	00	00
4.	Weed infestation	18	15	11	07	03	06	07	08	00	00
5.	Intercropping	00	00	05	08	05	10	20	35	00	00
6.	Wild animals	05	05	04	07	07	02	10	13	10	12
7.	Wilt	06	04	15	11	13	26	00	00	00	00
8.	Pod borer infestation	10	10	09	06	07	05	08	10	05	05
9.	Pod fly infestation	09	14	10	11	09	07	04	06	05	00
10.	Leaf hopper infestation	08	14	17	15	13	00	05	00	00	03

The data analysis in Table 3 shows that the main challenges to pigeonpea production were the lack of suitable high-yielding varieties (HYVs), low soil fertility, weed infestation, and leaf hopper infestation. Additional constraints impacting production included limited technical knowledge, wilt disease, pod fly and pod borer infestations, intercropping, damage from wild animals, and unpredictable rainfall. Similar issues have been reported by other researchers, such as Saxena *et al.* (2010) [12] and Joshi *et al.* (2005) [1], in maize production.

Table 3: Frequency distribution of RBQ values given by farmers (n=150)

S. No.	Problems	R.B.Q	Overall rank
1.	Lack of suitable HYVs	88.46	I
2.	Low technical knowledge	71.2	V
3.	Low soil fertility	76.26	II
4.	Weed infestation	75.6	III
5.	Intercropping	49.13	IX
6.	Wild animals	46.2	X
7.	Wilt	67.8	VI
8.	Pod borer infestation	59.73	VIII
9.	Pod fly infestation	67.46	VII
10.	Leaf hopper infestation	73.06	IV

Performance of FLD

The results showed a steady increase in pigeon pea yields in the demonstration plots over the years. From 2017 to 2021, the average yield in these plots was 81.62 q/ha, with the highest recorded yield being 50.32 q/ha during the study period. Yield improvements ranged from 26.2% to 42.5% over the five years, highlighting the effectiveness of CFLDs in enhancing green pod yields of pigeonpea in the Panchmahal district of Gujarat. Table 3 illustrates this positive yield impact. Yearly fluctuations in yield and cultivation costs can be attributed to varying social, economic, and microclimatic conditions in each village. Mukherjee (2003) [6] has also opined that depending on the identification and use of farming situation, specific interventions may have greater implications in enhancing systems productivity. Yield enhancement in different crops in Front Line Demonstration has been documented by (Padmaiah *et al* 2009, Rai et. al. 2012, Tiwari *et al*, 2003 and Tomer *et al*, 2003 Singh *et al*, 2019) [7, 9, 13, 14, 10]

Table 2: Impact of a demonstration on yield of vegetable pigeonpea

Year	No. of demo	Area ha.	Variety	Potential Yield q/ha (Green Pod)	Yield		Increase yield %
					RP	FP	
2017	50	20	Vaishali	125	80.5	48.9	39.2
2018	25	10	Vaishali	125	85.4	45.8	46.3
2019	50	20	GT+101	110	81.2	51.4	36.2
2020	50	20	AGT-2	95	79.6	58.7	26.2
2021	50	20	AGT-2	95	81.4	46.8	42.5
Average	-	-	-	110	81.62	50.32	38.08

Technology gap

The technology gap, which ranged from 13.6 to 44.5 q/ha, reflected the farmers' cooperation in implementing the demonstrations, yielding encouraging results in the following years. This observed gap can be attributed to differences in soil fertility and weather conditions.

Extension Gap

The extension gap exhibited an upward trend, ranging from 20.9 to 34.6 q/ha throughout the study period. This highlights the importance of educating farmers through various approaches to encourage the adoption of improved agricultural techniques and help narrow the existing extension gap.

Technology index

The technology index demonstrated the practicality of the introduced technology on farmers' fields, with lower values indicating greater feasibility. A reduction in the technology index, from 14.2% to 35.6% between 2017 and 2021, highlighted the suitability and effectiveness of the demonstrated technology in this region. The findings of the present study is in consonance with the findings of Hiremath and Nagaraju (2009) [2] and Kushwaha (2007) [4]. in the case of an onion crop.

Table 5: Extension Gap, Technology Gap and Technology Index of FLD on vegetable pigeonpea

Year	Technology gap- (qha^{-1})	Extension Gap (qha^{-1})	Technology index (%)
2017	44.5	31.6	35.6
2018	39.6	39.6	31.6
2019	28.8	29.8	26.1
2020	15.4	20.9	16.2
2021	13.6	34.6	14.3
Average	28.38	31.3	24.76

Economics of frontline demonstrations

The economics of pigeonpea production under front-line demonstrations were analyzed, and the findings are presented in Table 5. The economic analysis of yield performance showed that front-line demonstrations achieved average gross returns of Rs. 131,640/ha and net returns of Rs. 99,280/ha, with an average benefit-cost ratio of 4.08 compared to local practices. These results are in line with the findings of Rai et.al. (2015) [8], Kumar et.al. (2015) [3], and Hiremath and Nagaraju (2009) [2] in case of pigeon pea, okra, potato, and onion crop.

Table 4: Economics of frontline demonstrations on vegetable pigeonpea

Year	Cost of cultivation (Rs ha^{-1})		Gross return (Rs ha^{-1})		Net return (Rs ha^{-1})		Benefit cast ratio	
	RP	FP	RP	FP	RP	FP	RP	FP
2017	30400	24500	132400	58100	102000	33600	4.35	2.37
2018	31500	26500	124500	67100	93000	39800	3.95	2.13
2019	30200	25800	136700	71200	106500	45400	4.52	2.35
2020	34500	27300	126200	68400	91700	41100	3.65	1.98
2021	35200	27500	138400	72500	103200	45000	3.93	2.05
Average	32360	26320	131640	67460	99280	40980	4.08	2.17

RP-Recommended practices, FP-Farmers practices

Impact of technology

The achievements and outcomes from the organized CFLD programs have proven highly rewarding. Pigeon pea productivity and the benefit-cost ratio have seen significant improvements. Across 225 Front Line Demonstrations (FLDs), yield increased by 26.2% to 46.3% at various locations compared to traditional farmer practices. This success is largely attributed to the introduction of high-yielding varieties and advanced techniques. As a result, an additional 2,500 hectares have adopted this technology, producing 58,000 additional quintals of yield and generating Rs. 650,00,000 in revenue. The swift adoption of this technology among practicing farmers, farm women, and Rural Agricultural Extension Officers (RAEOs) has been facilitated through targeted training sessions and distribution of literature on the package and practices for vegetable pigeonpea.

Conclusion

The study, conducted with 225 CFLD participants at KVK Panchmahals, aimed to assess the economics of pigeonpea production using high-yielding varieties (HYVs) and to evaluate the level of adoption and constraints influencing this adoption. The findings indicated that the five key factors limiting the adoption of HYVs of pigeonpea in Panchmahals were a lack of knowledge about suitable HYVs, soil fertility issues, weed infestations, wilt disease, and low technological awareness. The yield of pigeonpea in the demonstrations was 81.62 q/ha compared to 50.32 q/ha for local checks, which has shifted farmers' perspectives, leading to increased adoption of the improved production technologies showcased through the front-line demonstrations.

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