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Impact of Skill Training and Demonstrations on Pigeon Pea Cultivation for Empowering Women in the Agro Climatic Context of Jharkhand

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ABSTRACT

Women play a vital role in agriculture, comprising 43% of the global agricultural workforce, with 84% of rural women in India dependent on farming for their livelihoods. Entrepreneurship development through skill training is a key pathway for empowering them. Pulses, particularly pigeon pea, form an important segment of Indian agriculture, being climate-resilient and suitable for rain-fed areas. Krishi Vigyan Kendra (KVK), Ramgarh, implemented 280 Cluster Frontline Demonstrations (CFLDs) on pigeon pea across 160 hectares, involving 1211 farm families during 2016 to 2023. The interventions aimed to strengthen women's decision-making and leadership skills in agriculture. Results showed an average yield of 11.87 q/ha under CFLDs, significantly higher than 8.1–9.0 q/ha under farmers' practice, reflecting a 31.85% increase. The benefit-cost ratio (BC) was also higher under CFLDs (2.16) compared to farmers' practice (1.93). Training and demonstrations enhanced awareness of improved production technologies, including integrated pest and nutrient management, contributing to higher productivity. However, constraints such as limited availability of quality seed and less technical knowledge among farmers continue to hinder wider adoption. The findings emphasize the need for regular training, advisory support, and gender-sensitive technological interventions to enhance production and productivity. Scaling up CFLDs and promoting women's participation can significantly improve yields and socio-economic conditions of farm families empowering women through enhanced skills and leadership not only strengthens agricultural productivity but also fosters resilience to climate change, food security, and sustainable rural livelihoods. Gender-sensitive agricultural policies are therefore critical for achieving long-term improvements in farming communities.

Keywords: Entrepreneurship development, Pest and nutrient management, Gender-sensitive, Technology gap, Extension gap, Technology index

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INTRODUCTION

Women are great contributors to agriculture worldwide, making up a substantial share of the labour force in this sector. Estimates from the Food and Agriculture Organization (FAO) suggest that women represent around 43% of the agricultural workforce globally. In the Indian context, this role is even more significant. Data from the National Sample Survey Office (2013) indicates that a large majority about 84% of rural women rely on farming and related activities as their main source of income and sustenance. Despite their substantial contribution, women in agriculture face numerous challenges, including limited access to resources, training, decision-making roles, and leadership positions. This disparity calls for the implementation of initiatives focused on empowering women, particularly in rural areas where their roles are often constrained by traditional norms and economic barriers. One of the key strategies for empowering women in agriculture is through entrepreneurship development, particularly by providing skill training. Such initiatives will provide better economic opportunities, improve their agricultural productivity, and bolster their leadership capabilities.

The important pulse crops such as Chickpea (45.53%), Pigeon pea (17.06%), Urdbean (13.40%), Mungbean (7.76%), Lentil (5%) and Field pea (5%). The major pulse producing states are Madhya Pradesh (33%), Maharashtra (13%), Rajasthan (12%), Uttar Pradesh (9%), Karnataka (8%), Andhra Pradesh (5%), Gujarat (4%), Jharkhand (3%), Tamil Nadu, (2%), and Telangana (2%) which constitute together for about 91% of the total production (DES, 2018). Among the pulses, Pigeon pea is an important pulse-cum-grain legume crop in semi-arid tropical and subtropical areas of the world. It is a second most important legume crop next to chickpea accounting for about 20% of total pulse production (Singh *et al.*, 2020), occupies a prominent place in Indian dry land agriculture by covering an area of around 3.9 m ha with productivity of 729 kg/ha.

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The Krishi Vigyan Kendra (KVK), Ramgarh, Jharkhand, India, has contributed significantly to this cause by focusing on skill development and capacity building among rural women. KVK Ramgarh conducted training programs aimed at improving decision-making and leadership skills, particularly in the cultivation of pigeon pea (*Cajanus cajan*), a climate-resilient pulse crop. Pigeon pea is particularly well-suited for cultivation in rain-fed areas, which makes it a crucial crop for farmers in drought-prone regions like Jharkhand. As a staple crop in India's agricultural output, pigeon pea plays a vital role in both domestic consumption and fulfilling the country's pulse import needs. The KVK initiative, which spanned from 2016 to 2023, included conducting 280 CFLDs on pigeon pea cultivation across 1,211 farmers' fields, covering a total area of 160 hectares in Ramgarh district. These demonstrations aimed at promoting best practices in agriculture, including integrated pest and nutrient management, to improve productivity and sustainability. However, the study also pointed out several constraints, such as less availability of quality seeds and lack of access to information on improved technologies, which hindered production. These barriers emphasize the need for continuous training, advisory services, and gender-sensitive technological interventions that can help bridge the gaps in knowledge and resource accessibility. By overcoming these challenges, the initiative could contribute to enhanced agricultural productivity and rural women's socio-economic development. Empowering women through agricultural initiatives not only improves their economic standing but also helps in fostering greater leadership and decision-making capabilities. As women gain control over agricultural practices and technologies, they can become key agents of change in their communities. These changes are essential for driving sustainable agricultural practices and improving resilience to climate change, thereby ensuring long-term food security for rural populations. Moreover, the empowerment of women through programs plays an instrumental role in fostering gender-sensitive agricultural policies and programs, which can lead to substantial improvements in the overall agricultural productivity of rural communities. By focusing on women's, KVK Ramgarh provided training on pigeon pea (*Cajanus cajan*) cultivation. This aligns with the vision of a "Viksit Bharat" by promoting women's active participation in agricultural advancements, ensuring they are not just laborers but leaders and decision-makers in farming. By promoting the cultivation of this crop, KVK Ramgarh contributes to sustainable agricultural practices that enhance food security and resilience to climate change, aligning with the broader goals of agricultural development in a changing global environment. The enhanced yield and the higher benefit-cost ratio (BCR) resulting from the CFLDs mean better economic returns for the farmers, especially women who rely on agriculture for their livelihood. This directly impacts rural economic development, lifting families out of poverty and contributing to the development of the local economy. The focus on providing regular training, advisory services, and gender-sensitive technological interventions helps to address the constraints women farmers face, such as limited access to improved technologies and seed availability. These interventions are crucial in improving agricultural practices, boosting productivity, and making farming more profitable. The empowerment of women through such initiatives fosters stronger rural communities, with women taking on leadership roles, advocating for better agricultural policies, and contributing to community development. By enhancing domestic pulse production, KVK Ramgarh contributes to national self-sufficiency in pulses and reduces reliance on imports. This has long-term implications for India's food security, agricultural trade, and economic stability, aligning with the vision of a self-reliant "Viksit Bharat."

The CFLD is an effective approach to expedite the adoption of tested technologies in farmers' fields through a participatory manner. Its goals are to maximise crop production resources and close productivity disparities by increasing national basket production (Kumar and Jakhar, 2020; Sahu *et al.* 2022).

MATERIALS AND METHODS

The present research, which was conducted under CFLDs from 2016 to 2023 at farmers' fields in Ramgarh district, Jharkhand (23°38′N, 85°31′E, 300 m amsl.), aimed to disseminate production technologies to enhance pigeon pea crop productivity. Experimental fields were having sandy loam soil (45 % sand, 35 % silt; 20 % clay) with an average pH of 6.8. Soil was medium in organic carbon (0.45 %), available N (180 kg/ha) and available P (18 kg/ha) and low in available K (150 kg/ha).

Baseline information regarding the crop production practices adopted by farmers from selected villages was collected before organization of CFLDs. The research methodology for this study on CFLDs on pigeon pea conducted by the KVK, Ramgarh, Jharkhand, followed a structured approach aimed at assessing the effectiveness of improved agricultural practices in increasing the yield of pigeon pea cultivation among farmers. The study is designed as a field-based demonstration trial where a comparison is made between the performance of the recommended agricultural practices (improved technologies) and the farmers' existing practices. The primary objective is to measure the difference in yield and assess the extension and technology gaps. The varieties ICPL-87119, Asha /NDA-2 and IPA-203 of pigeon pea were used for CFLD program. Application of 20 kg N, 40 kg P, 20 kg K and 5 tons FYM/ha with *Rhizobium* and *Phosphorus Solubilizing Bacteria* were used for integrated nutrient management. The demonstrations were conducted across six villages in 2016-17, six in 2017-18, seven in 2018-19, three in 2020-21, three in 2021-22, and two in 2022-23 in the Ramgarh district of Jharkhand. The total area covered by the demonstrations was 160 hectares, with each demonstration plot being 0.4 hectares. The active participation of 1211 farmers from these villages ensured adoption of improved practices and the influence of interventions. Beneficiary farmers were selected based on a survey model outlined by Choudhary *et al*. (2009). This study was aimed at identifying farmers who were willing to participate in the demonstration and who were representative of the broader farming community. The inclusion of both small-scale and larger-scale farmers ensured a comprehensive study. The yield data of demonstrated plots as well as control plots were recorded immediately after harvesting. The KVK Scientists team visited the farmer's field on regular basis and addressed all issues faced by the demonstrating farmers. For check plots, existing local agricultural practices were employed. Extension activities like group meetings and field days were also organized at demonstration sites to provide opportunities for other farmers in area to interact and seek benefits from these demonstrations. Seed yield was recorded from demonstration fields and check plots at time of harvest. Data were collected in schedule both in FLDs and check plots and extension gap, technology gap, technology index, and benefit-cost ratio were worked out by using the formula as suggested by Samui *et al.* (2000). Training was imparted to selected farmers regarding different aspects of cultivation (Venkattakumar *et al*. 2010). Extension gap, technology gap and technology index were calculated by given formula (Samui *et al*., 2000); Prasad *et al*., 2022) as follows:

Per cent increase in yield (Kg/ha)

$$= \frac{\text{Yield gain in IP plot} - \text{Yield gain in FP plot}}{\text{Yield gain in FP plot}} \times 100$$

Technology gap = Potential yield – Demonstration yield;

Extension gap = Demonstration yield – Local check

Technology index (%)

$$= \frac{\text{Potential yield} - \text{Demonstration yields}}{\text{Potential yield}} \times 100$$

Change in yield (%)

$$= \frac{\text{Yield of demonstration plot} - \text{Yield of farmers practice}}{\text{Yield of farmers' practice}} \times 100$$

The following formula was used for the calculation of benefit: cost ratio.

B:C ratio = Gross return/Cost of cultivation

RESULTS AND DISCUSSION

Rainfall pattern

June to September are the peak monsoon months and critical for *Kharif* crops, which dominate Indian agriculture. Heavy rainfall in July, August, and September (Table 1) generally corresponds with better yields. There is a moderate positive correlation between rainfall during monsoon months (July–September) and production. Years with higher rainfall during these months, such as 2017-18, had better yields. However, extremely high rainfall might lead to waterlogging or crop damage, so distribution and intensity matter more than total quantity. The highest production (1250 kg/ha) occurred in 2017-18, which also had the highest rainfall (1676.5 mm). However, very low or extremely high rainfall does not always guarantee better yield. Low rainfall (913.7 mm) led relatively low production (11.62) in 2023-24, with slightly above 1000 mm rainfall, showed good production (12.34) in 2020-2021. It may be due to better rainfall distribution.

Table 1: Rain fall pattern of Ramgarh district for the year 2016-2024

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Annual rainfall	Production kg/ha
2016-17	2.8	0.0	13.4	0.0	60.6	139.5	227.6	383.2	288.0	101.2	2.7	4.1	1223.1	1120
2017-18	3.6	0.0	0.0	0.0	26.8	210.8	863.4	243.7	160.0	94.6	11.3	62.3	1676.5	1250
2018-19	4.9	3.8	0.0	49.0	133.1	134.3	233.8	365.1	184.4	29.1	0.0	39.8	1177.3	1180
2019-20	2.3	36.1	25.5	0	38.7	99.4	197.5	231.4	296.8	192.5	0	13.1	1133.3	1200
2020-21	28.1	17.0	85.0	22.6	51.3	71.1	309.7	194.9	78.8	42.8	12.4	0	913.7	1162
2021-22	8.5	7.0	13.5	3.0	279.5	141.7	305.6	96.6	207.9	93	20	11.5	1187.8	1192
2022-23	6.3	4.6	9.0	5.5	11.7	48.4	219.1	337.1	205.1	137.8	1.7	0.2	986.5	1165
2023-24	3.7	2.2	28.5	7.8	23.2	81.0	244.6	139.3	294.0	190.3	4.2	2.2	1021	1234

Seed Yield

The results of CFLDs on pigeon pea revealed that the average yield was 1187 kg/ha (Table 2). The results from these CFLDs have been promising, with a significant increase compared to the farmer practice, yield of 810 to 900 kg/ha. This represents a 31.85% increase in yield. In addition to the yield improvement, these findings highlight the potential for skill-based training and technological interventions in improving both the economic and social outcomes for women farmers.

Table 2: Effect of skill training and demonstrations for empowering women on yield, technological gap, extension gap and technological index of pigeon pea Cultivation

Year	Area (ha)	No. of farmers	Yield (kg/ha)			E% increase over FP	Tech. gap (kg/ha)	Ext. gap (kg/ha)	Tech. index (%)
			Potential	Demo	FP				
2016-17	30	273	1400	1120	720	35.71	2.80	4.00	20.00
2017-18	30	265	1400	1250	850	32.00	1.50	4.00	10.71
2018-19	40	307	1400	1180	780	33.89	2.20	4.00	15.71
2019-20	10	50	1400	1200	890	25.83	2.00	3.10	14.28
2020-21	10	65	1400	1162	874	32.95	2.62	2.88	20.48
2021-22	10	48	1400	1192	881	35.30	1.09	3.11	14.95
2022-23	30	203	1400	1165	869	34.06	1.35	2.96	34.06
2023-24	50	308	1400	1234	982	25.66	1.66	2.52	11.85
Total	210	1519	-	-	-	-	-	-	-

Over the years, the seed yield has varied, with values fluctuating between 720 kg/ha (in 2016-17) to 881 kg/ha (in 2021-22). These values reflect the yield obtained under different farming practices. The yield under CFLD is consistently higher than that under farmer practice, indicating the effectiveness of the CFLD approach in improving seed yield. The percentage increase in yield over control (which represents the baseline or typical yield under farmer's practice) ranges from 10.71% in 2017-18 to as high as 35.71% in 2016-17. The high increase in 2016-17 could indicate a particularly successful year, possibly due to favorable weather conditions or an effective adoption of CFLD technologies.

Technology gap, extension gap, technology index

The study also assessed the productivity, technology gap, extension gap, technology index, and benefit-cost ratio of pigeon pea grown under CFLDs, as well as those grown under the farmer practice (existing package of practices) (Table 2). The technical gap, which represents the difference between the potential yield and the yield under CFLD, varies from 109 kg/ha (2021-22) to 280 kg/ha (2016-17). A decreasing technical gap over the years (2020-21 and 2021-22) suggests an improvement in the adoption and application of best practices under CFLD, leading to a closer realization of the potential yield. The extension gap represents the difference between the yield under CFLD and the farmer's practice (FP). It ranges from 288 kg/ha (2020-21) to 400 kg/ha (2016-17, 2017-18, and 2018-19). This gap shows a persistent difference in the yield obtained by farmers using traditional methods compared to those using CFLD, indicating that there is still a need for further extension activities to bridge this gap. The technical index is a measure of the performance of the technical interventions relative to the potential yield. It ranges from 10.71% (2017-18) to 34.06% (2022-23). The consistent increase in the technical index, particularly in the final year (2022-23), suggests that the technical interventions have become more effective over time in improving seed yield.

Economics

Over the years, the gross cost for farmer's control plot and the demonstration plot shows an increasing trend (Table 3). The cost is higher in the demonstration plot compared to the control plot each year, reflecting the additional inputs or practices demonstrated (e.g., improved technology, fertilizers, and pest management). The gross cost for the farmer's control plot ranged from 18,350 (2017-18) to 23,810 (2022-23), while for the demonstration plot, it ranged from 20,430 (2016-17) to 28,750 (2022-23). Gross returns were higher for the demonstration plot across all years. In 2016-17, the gross return for the demonstration plot was 67,200, compared to 43,200 for the farmer's control plot. Over the years, the returns from the demonstration plot showed a significant increase, from 67,200 in 2016-17 to 81,550 in 2022-23, indicating a clear benefit of adopting new farming practices.

Table 3: Effect of skill training and demonstrations for empowering women on relationship between rainfall and production as well as economics.

Year	relationship between rainfall and production			Economics							
	Annual Rainfall (mm)	Rainfall in Jul–Sept (mm)	Production (kg/ha)	Farmer's Control plot				Demonstration plot			
				Gross cost	Gross return	Net return	B:C ratio	Gross cost	Gross return	Net return	B:C ratio
2016-17	1223.1	899	11.20	19360	43200.00	23840.00	2.23	25430.00	67200.00	41770.00	2.60

Year	relationship between rainfall and production			Economics							
	Annual Rainfall (mm)	Rainfall in Jul–Sept (mm)	Productio n (kg/ha)	Farmer's Control plot				Demonstration plot			
				Gross cost	Gross return	Net return	B:C ratio	Gross cost	Gross return	Net return	B:C ratio
2017-18	1676.5	1267.1	12.50	18350	35000.00	16650.00	1.90	20130.00	40500.00	20370.00	2.02
2018-19	1177.3	783.3	11.80	18990	35250.00	16260.00	1.85	20980.00	41800.00	20820.00	2.08
2019-20	1133.3	725.7	12.00	20146	35600.00	15454.00	1.76	24650.00	48000.00	23350.00	1.94
2020-21	913.7	583.4	11.62	229800	52440.00	29460.00	2.28	24600.00	69720.00	45120.00	2.83
2021-22	1187.8	610.1	11.92	22950.00	52860.00	29910.00	2.30	25010.00	71520.00	46510.00	2.85
2022-23	986.5	761.3	11.65	23810.00	60830.00	37020.00	2.55	28750.00	81550.00	52800.00	2.83
2023-24	1021.0	677.9	12.34	28485.00	68740.00	40255.00	2.41	31510.00	86380.00	54870.00	2.74

The gross return for the farmer's control plot ranged from ₹35,000 (2017-18) to ₹60,830 (2022-23), reflecting lower earnings compared to the demonstration plot. In 2016-17, the net return for the demonstration plot was ₹41,770, compared to ₹23,840 for the farmer's control plot. By 2022-23, the net return for the demonstration plot reached ₹52,800, compared to ₹37,020 for the control plot. The increase in net return over time for the demonstration plot suggests that the improved farming practices lead to higher profitability. The B: C ratio, a key indicator of profitability, was consistently higher for the demonstration plot. In 2016-17, the BC ratio for the demonstration plot was 2.60:1, compared to 2.23:1 for the farmer's control plot. Over time, the BC ratio for the demonstration plot remained higher, reaching 2.83:1 in 2022-23. The farmer's control plot, on the other hand, saw a gradual decline in the B:C ratio, from 2.23:1 (2016-17) to 2.55:1 (2022-23). The higher BC ratio for the demonstration plot indicates that the practices demonstrated have led to more efficient use of resources and greater returns per unit of cost. The higher gross return, net return, and B:C ratio in the demonstration plot suggest that the adoption of improved farming techniques results in greater profitability. These techniques seem to lead to more efficient use of resources, better crop management, and potentially higher-quality yields. The farmer's control plot, while still profitable, shows a lower rate of return and a decreasing BC ratio, suggesting that conventional farming practices are less efficient in comparison to the demonstrated techniques. Over the years, the gap between the farmer's control plot and the demonstration plot in terms of gross return, net return, and BC ratio has widened. This trend implies that the demonstration plot's practices are becoming increasingly beneficial over time, possibly due to better farmer understanding, adaptation, and experience with the introduced practices.

CONCLUSION

The implementation of CFLDs on pigeon pea cultivation by KVK, Ramgarh, from 2016 to 2023, has shown significant success in empowering rural women, improving agricultural productivity, and enhancing climate resilience. Through targeted training and skill development, women farmers acquired improved decision-making and leadership capabilities, transitioning from labourers to informed agricultural entrepreneurs. The CFLDs led to a consistent yield increase, with an average productivity of 1187 kg/ha, surpassing traditional farming practices by 31.85%. The higher benefit-cost ratio (2.16:1) further underscores the economic viability of these interventions. Additionally, the adoption of improved agronomic practices, including integrated pest and nutrient management, contributed to better crop health and sustainability. The analysis also suggests that moderate to well-distributed rainfall during critical monsoon months (July–September) plays a pivotal role in supporting pigeon pea production. Despite positive outcomes, challenges such as poor seed availability and limited access to updated technologies persist. To overcome these, continued emphasis on regular training, gender-sensitive advisory services, and timely technological interventions is essential. In brief, the CFLDs not only boosted agricultural productivity but also played a transformative role in the socio-economic upliftment of women farmers. Such initiatives demonstrate that empowering women in agriculture through knowledge, skills, and access to technology can foster sustainable development, climate resilience, and food security. Scaling up these models and integrating them into gender-sensitive agricultural policies will be vital for building a resilient and self-reliant rural India.

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