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Performance of Cluster Front Line Demonstrations on Integrated Crop Management in Red Gram (*Cajanus cajan*) Using Variety PRG-176 in Peddapalli District under North Agroclimatic Zone of Telangana State in India

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Authors' contributions

This work was carried out in collaboration among all authors. Authors YV, BBR and AS designed the study and wrote the protocol. Author RV performed the statistical analysis, wrote the first draft of the manuscript and managed the analyses of the study. Author BN managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The present study was conducted under CFLD at the farmers' fields under the Krishi Vigyan Kendra (KVK), Ramagirikhilla, Peddapalli District operational area for three kharif seasons during 2016-17 to 2019-20 covering 169 locations. The demonstrated technology delineated the practices of improved selection (PRG-176), seed treatment with *Rhizobium* @ 250 g acre^{-l}, soil application of *Trichoderma viridii* @ 2kg acre^{-l} mixing with FYM @ one hundred kilo acre^{-l} and plant protection measures with installation of pheromone traps @ four per acre, spraying of neem oil @one liter acre^{-l} and Profenofos 50 EC @ 400ml acre^{-l}. The result of demonstration showed higher productivity notably as 15.91 q ha^{-l} compared to the farmers practice (13.42 q ha^{-l}) with a mean increase of 19.50%. Technology index and technology gap values were 59.57 per cent and 4.08 q ha^{-l} respectively. The results conjointly unconcealed that the typical increase within the net return with demonstration was 55248 Rs. ha^{-l} and 40651 Rs. ha^{-l} over farmers practice respectively.

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Similarly, mean benefit cost ratio was recorded with demonstration as 2.63 compared to farmers practice (2.18) throughout the years of trial. Adoption of improved technology as well as new selection, timely supply of essential inputs with correct steering by the human, frequent watching visits to fields diagnose the issues and take applicable corrective measures, field days etc., can be the contributive factors for prime yield with smart quality in all told demonstration plots.

Keywords: Red gram; FLD; ICM; PRG-176; BC ratio.

1. INTRODUCTION

Pulses are important crops in Indian farming system, both ecologically and in terms of human nutrition. Pulses are a common food crop used for both human and animal consumption. Being a leguminous crop in nature, it is considered as an important components of cropping systems because it has the ability to fix atmospheric nitrogen, add significant amounts of organic matter to the soil, and produce viable yields with modest inputs, even in difficult climatic and soil conditions [1]. Pulses are predominantly cultivated in Asian countries particularly in the Indian Sub-continent. In India, pulses are grown under different agro-climatic conditions. India is the world's greatest producer, importer, and consumer of pulses, accounting for 25% of global output from a 35% global area. [2]. Pulse production in India is 24.51 million tonnes during 2017-18, which is highest in the country [3]. Among the different pulses, red gram (*Cajanus Cajan*) is the 2nd most important grain legume after chick pea with a mean cultivated area of 4.05 million hectares recorded a total production and productivity of 3.27 metric tonnes and 799 kilograms per hectare [4]. Red gram has a significant presence in Indian dry land agriculture, by covering an area of around 3.9 million hectares with productivity of 729 kilograms per hectare. It is an important component of the country's various dry land systems, which are primarily intercropped with cereals, pulses, oilseeds, millets, and commercial crops. [5]. It's worth noting that the red gram remains the most popular pulse for both domestic and industrial use, accounting for over half of all pulse production in India [6]. In Telangana state, Red gram is a major pulse crop occupies of an area of 251121 hectares in kharif season, In Peddapalli district, Red gram occupies an area of 1138 hectares with an average production of 20 q ha^{-1} during kharif. Due to the importance of crop there have been developed few high yielding varieties (HYVs) and location specific package of practices by the research institutes but a proper demonstration to improve adaptability is lacking. Hence, there is an urgent need to study the impact of the HYVs and also to identify the key factors influencing adoption of HYVs to realize increased production in Telangana. The reasons for influencing the farmers decision to adopt improved practices also need to be explained. The variety demonstrated in the present trial is PRG-176 which is developed by PJTSAU, Hyderabad. This variety is a bold seeded with 110-115 days duration. Department of Agriculture, Cooperation and Farmers Welfare, Government of India had sanctioned the project “Cluster Frontline Demonstration on Pulses” to ICAR-ATARI, Zone-X, Hyderabad through National Food Security Mission (NFSM) which is a novel approach to providing a direct interface between researchers and farmers for the transfer of technologies developed by them and to receive direct feedback from the farming community, as well as to reduce the amount of pulses imported from other countries and to sustain pulse production and consumption. CFLD is a farmer-centric strategy used to carry out the plan in a mission mode. KVKs are grass-roots organizations tasked with applying technology by assessing, refining, and demonstrating proven technologies in a district's micro farming environment [7]. The PRG-176 variety was demonstrated by Krishi Vigyan Kendra, Ramagirikhilla, Peddapalli District, with the goal of increasing pulse production and productivity through CFLDs by incorporating HYVs with a better package of practices.

2. METHODOLOGY

The cluster frontline demonstrations on integrated crop management of red gram was conducted during rainy/kharif seasons of 2016-17, 2017-18, 2018-19 and 2019-20 by Krishi Vigyan Kendra (KVK), Ramagirikhilla, Peddapalli district in 3 blocks namely Kamanpur, Ramagiri and Kalvasrirampur covering 169 farmers with an area of 80 hectares. The farmers are selected based on their economic condition and the degree of adoptability. The ICM practices viz., land preparation, seed treatment, spacing, intercultivation, integrated nutrient management,

Table 1. Differences between farmers practice and technology demonstration for red gram

Practices	Demonstrated practice	Farmers practice
Variety	PRG-176	LRG-41
Year of Release	2015	2006
Seed treatment	Rhizobium @ 250 g ac^{-l}	No seed treatment
Land preparation	Soil application of *Trichoderma viridii* @ 2 kg $acre^{-l}$ along with 100kg FYM	No application of *Trichoderma viridii* and FYM
Intercultivation	Application of Pendimethalin @ 1 lit $acre^{-l}$	Manual weeding
IPM practices	Installation of pheromone traps @ 4 $acre^{-l}$, Spraying of Profenofos 50EC@ 400 ml $acre^{-l}$ and Neem oil @ 1 lit $acre^{-l}$	Indiscriminate use of sole Chloropyrifos 50EC @ 2 ml lit^{-l} water

integrated pest and disease management were demonstrated at the farmer's field. The remaining cultivation practices were followed as per the package of practice of the State Agricultural University, Telangana and need based input material were provided to the farmers by the KVK (Table 1). All the engaging farmers were educated on copious aspects of red gram production technologies. For control plot, farmers followed conventional methods with existing local variety LRG-41. The yield data was collected from both CFLD and farmers practice plots for all the years of study and compiled (Table 2). In the present study, technology index was operationally defined as the technical feasibility obtained due to implementation of Cluster Frontline Demonstrations in red gram following procedure the employed to analyze the performance of demonstration as per the formula used by [8,9] and [10].

Benefit cost ratio: Gross return (Rs./ha)/cost of cultivation (Rs./ha)

Technology gap: Potential Yield (Pi)-Demonstration Yield (Di)
Extension gap: Demonstration Yield (Di)-Local check Yield (Li)

Technology Index: (Potential Yield-Demonstration Yield/ Potential Yield) × 100

3. RESULTS AND DISCUSSION

3.1 Performance of FLD

The crop production of demonstration plots was greater than farmers' practices, which might be attributable to a complementing impact of high yielding varieties and different components of ICM techniques, as evidenced by the data. Table 2 shows the difference in yield between demonstrated practices and farmer practices. When comparing the yield of the PRG-176 variety using ICM methods to the farmers' practice of the LRG-41 variety, the PRG-176 variety produced a greater yield. The average seed yield with the demonstration was 15.91 q ha^{-l}, compared to 13.42 q ha^{-l} with the farmers' practice. When compared to farmers' practice, the cumulative mean over four years revealed an average increase of production with demonstration (19.50%). [11] and [12] have demonstrated similar yield improvement through frontline demonstrations in a variety of crops. According to [13], the improvement in yield with demonstrations might be attributable to closing the technological gap in FLDs by implementing recommended agro-technologies. The yield of frontline demonstrations and the variety's projected yield were used to assess yield gaps, which were further divided into technological and extension gaps [14]. Similarly, [15] said that selecting high-quality seed is essential for increasing pulse crop yields.

3.2 Technology Gap

According to a typical yield data study (Table 2), the average technology gap is 4.08 q ha^{-l}. Variations in the fertility status of land, adoption levels of IPM practices, weather fluctuations, and local specific crop management problems in order to harness the yield potential of demonstrated cultivars under the differential ability of farmers to follow management practices may be attributed to the technology gap recorded in the current study [16]. As a result, it appears that locality-specific solutions are required to close the yield gap. These findings are very comparable to those of [17] and [18].

3.3 Extension Gap

The refinement of the data presented in Table 2 divulged that 2.49 q ha-1 as the average extension gap between demonstration and farmer practice. The current study's larger extension gap highlights a pressing need to raise public awareness and urge farmers to adopt improved farm technologies over localized existing practices. Another alternative for research scientists is to refine local farmer practices in order to increase acceptance of certain enhanced farm technology in order to maintain crop productivity [19]. Extension yield gaps are evidence of farmers' lack of information about the benefits of adopting new farm technologies [20]. The findings are consistent with those of [17] and [18], who claimed that location-specific problems and treatments could have a huge impact on crop output.

3.4 Technology Index

Because the technology index indicates the distance between research farm technology and farmer's field technology, the lower the technology index, the more practicable the technology [21]. Following up on the data, it was discovered that the average technology index was 59.57 percent (Table 2). This number represents the practicality of doing a demonstration and illustrates that there is a significant gap between technology developed and technology adopted in farmers' fields. During the demonstration years, however, farmer perceptions of the technology, which involved large initial costs and unfavorable meteorological conditions, resulted in a radical trend of increasing and lowering technology index values (Fig. 1). The social context, in terms of irrational mindsets, ignorance, and perplexing attitudes regarding the adoption of new technologies, is also a significant limiting factor in agricultural production increase [15]. It emphasizes the importance of promoting improved technologies for a longer period of time over time with greater field penetration to achieve a decreasing trend in the technology index with more precise use of demonstrated technologies in the field that are more suitable for the climatic conditions during the demonstration period. In terms of technology index, the current findings are very similar to [22] and [23].

3.5 Economics of Front-Line Demonstration

Table 3 shows the analyzed data for the red gram's economic analysis. We discovered that the mean cost of cultivation with demonstration was Rs. 33773 ha^{-1}, which is less than what farmers pay (Rs. 34433 ha^{-1}). According to the data, gross monetary returns and net monetary returns were increased as a result of the technology exhibited over farmers' practices throughout the study. The results show that the demonstration over farmers practice yielded mean gross capital returns of Rs. 89021 ha^{-1} and average net monetary returns of Rs. 55248 ha^{-1}, with average gross returns of Rs. 75084 ha^{-1} and average net returns of Rs. 40651 ha^{-1}. Similarly, the average benefit-to-cost ratio of the demonstration plot was 2.63, which was higher than the farmers' average (2.18) (Fig. 2). The better variety, seed treatment with Rhizobium, soil application of *Trichoderma viridii* together with FYM, effective intercultivation, and integrated pest control approaches may have contributed to the improvement in yield and monetary returns with demonstration. Non-adoption of cutting-edge technologies due to farmers' inability to afford pricey inputs, resulting in low returns and low earnings, and ultimately

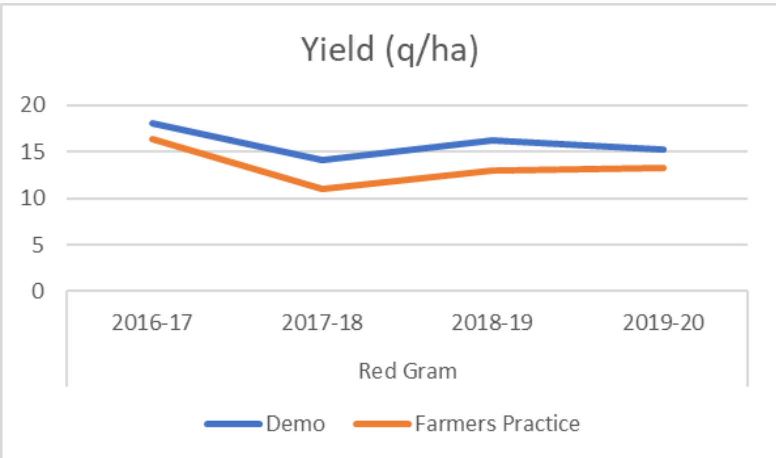

Fig. 1. Radical trend of increasing and decreasing yield of Red gram in demonstration and farmers practice over four years

Table 2. Production, extension gap, technology gap and technology index in CFLD red gram

Crop	Year	Area (ha)	Yield (q ha^{-l})			% Increase in yield	Technology gap (q ha^{-l})	Extension gap (q ha^{-l})	Technology Index (%)
			Potential	Demonstration	Farmers practice				
Redgram	2016-17	20	20	18.05	16.42	9.90	1.95	1.63	70.25
	2017-18	20	20	14.11	11.02	28.1	5.89	3.09	50.55
	2018-19	20	20	16.25	13.01	25.0	3.75	3.24	61.25
	2019-20	20	20	15.25	13.25	15.0	4.75	2.00	56.25
	Average		20	15.91	13.42	19.5	4.08	2.49	59.57

Table 3. Average economics of red gram under CFLD

Crop	Year	Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Benefit to Cost Ratio
Redgram	2016-17	Demonstration	45840	99275	53435	2.16:1
		Farmers practice	45200	90310	45110	1.99:1
	2017-18	Demonstration	27802	76140	48338	2.73:1
		Farmers practice	29560	59400	29840	2.00:1
	2018-19	Demonstration	28950	92218	63268	3.18:1
		Farmers practice	29220	73775	44555	2.52:1
	2019-20	Demonstration	32500	88450	55950	2.72:1
		Farmers practice	33750	76850	43100	2.27:1
	Average	Demonstration	33773	89021	55248	2.63:1
		Farmers practice	34433	75084	40651	2.18:1

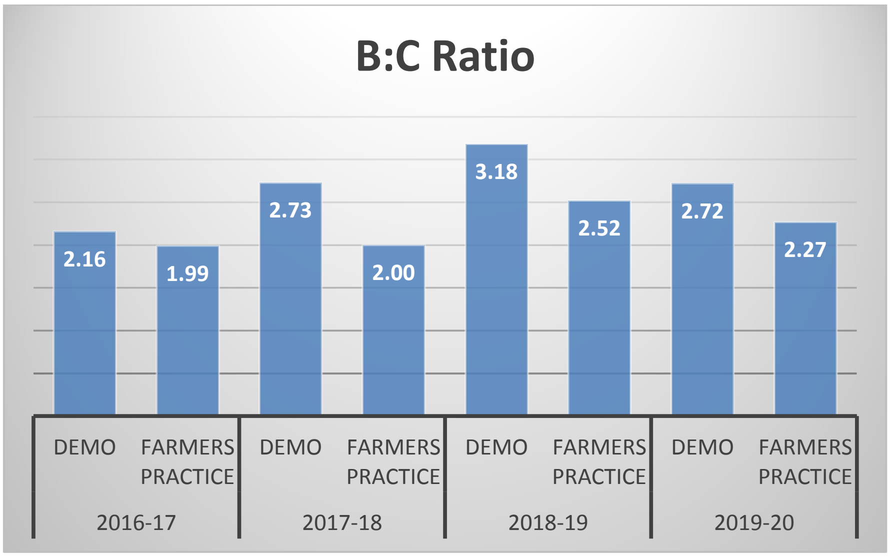

Fig. 2. Benefit Cost Ratio of red gram in demo and farmers practice during the period of study

low monetary advantages to farmers [15]. The findings in regards to the eventual monetary gains are consistent with the findings of [24]. However, when compared to farmers' practices during the trial, the showcased technology yielded higher results. Higher returns and effective gains were attained in the demonstration, which may be attributed to the use of enhanced varieties, recommended technologies, timely crop cultivation operations, and scientific monitoring by KVK scientists. [25] reported a same set of findings.

4. CONCLUSION

During the years 2016-17, 2017-18, 2018-19, and 2019-20, cluster frontline demonstrations on red gram yielded the best yields of 18.05 q ha-I, 14.11 q ha^{-l}, 16.25 q ha^{-l}, and 15.25 q ha^{-l}, followed by 16.42 q ha^{-l}, 11.02 q ha^{-l}, 13.01 q ha^{-l}, and 13.25 q ha^{-l} with farmers practice. Similarly, when compared to farmers' practice, financial gains were similarly overstated with demonstrations. The average increase in red gram production of 19.50 percent in demonstration above the farmers' methods raised awareness and encouraged additional farmers to adopt the enhanced red gram package of activities. Farmers and KVK scientists developed a stronger bond as a result of these demonstrations. It has been concluded that the Cluster Front Line Demonstration programme is a valuable tool for increasing red gram production and productivity while also changing farmers' knowledge, attitude, and ability. This has not only provided socioeconomic stability to the neighborhood, but it has also aided in achieving food and nutrition security. The demonstration's benefit-cost ratio is clearly in accordance with the government of India's goal of doubling farmers' income by 2022, as proposed by the Ashok Dalwai Committee on Increasing Farmers' Income.

CONSENT (WHERE EVER APPLICABLE)

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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