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Enhancement of Green Gram Productivity through Cluster Front Line Demonstrations in Northern Agroclimatic Zone of Telangana, India

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Authors' contributions

This work was carried out in collaboration among all authors. Authors YV, BBR, and AS contributed to the conceptualization. Authors KP, YV, and BBR were involved in the investigation. Authors KP, YV, and TVK handled data curation and analysis. Authors KP and YV contributed to the writing. Authors KP, YV, BBR, TVK, BN, KA and BN participated in the writing, review, and editing. Author DV supervised the work. All authors read and approved the final manuscript.

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ABSTRACT

India is the world's biggest producer, importer, and consumer of pulses. About 7% to 10% of the nation's overall food grain production comes from pulses, which make up roughly 5% of the area used for pulses production. The production of green grams accounts for around 8–10% of all pulses. The productivity of pulses is currently 892 kg/ha, which requires further improvement. In Telangana due to increase in the irrigation facility most of the farmers are growing crops like paddy, maize and the pulses cultivation is drastically decreasing. To bring awareness and to improve the pulses cultivation the present study was carried out by KVK, Ramagirikhilla, Kharimnagar-II, ICAR-ATARI, Zone-X in *rabi* season for five successive years from 2018 to 2022. A total of two hundred and twelve cluster frontline demonstrations were conducted in the farmers' field of Peddapalli district of Telangana. Improved varieties MGG-295 and WGG-42 were demonstrated with integrated crop management practices viz., seed treatment with rhizobium, chemical weed control, timely management of pest and diseases management. The outcomes of the experiments shown the improved green gram varieties MGG-295 and WGG-42 produced a greater yield (11.77 q/ha) than the farmers' practices (8.46 q/ha) that is revealed an extension gap of 3.70 q/ha, technology gap 1.43 q/ha and 10.88% Technological Index. Cumulative results over five years when compared to farmers' practices, the demonstration yield was increased by 40.62%. The benefit cost ratio was recorded 3.06 with an increased net return of Rs. 14,640.11 and 51.11% higher net returns than farmers' practices (2.46). The propagation of improved practices was the reason for the increase in green gram crop productivity under the demonstration plot. This could be replicated in northern agroclimatic zones of Telangana as well as the other parts of state which are having the similar climatic conditions.

Keywords: Green gram; cluster front line demonstrations; improved varieties; extension gap; technology gap; technological index; benefit cost ratio.

1. INTRODUCTION

Legumes are recognized for providing essential food proteins and are typically grown in risk-prone, marginal lands with minimal inputs. Pulses can grow in a variety of soils, but they do best in well-drained loam with a pH of around 6.7. They also prefer soils with lots of microorganisms and that are tolerant to moderate drought stress. Pulses grow best in temperatures between 25° and 30° Celsius. Pulses grow well in areas that receive 500 – 750 mm of rainfall. Pulses are typically sown from September to November and harvested in February, March, and April. Pulses can be grown in a variety of cropping systems, including sequential, mixed, inter, relay, catch, and ratoon cropping.

Among the grain legumes, Green gram [*Vigna radiata* (L.) Wilczek], commonly known as Moong bean; belongs to the family Fabaceae. It is believed that moong bean is originated from India and mainly cultivated in East, Southeast and South Asia (Tridge, 2020). As a leguminous plant, it has well developed root system and contains root nodules. Root nodules form symbiotic association with Rhizobium bacteria and fix atmospheric nitrogen into the soil around 58-109 kg/ha. Mung beans produce large amount of biomass around 7.16 tonnes per hectare and can fix around 30-50 kg/ha nitrogen into soil (Feedipedia, 2021). The nitrogen fixation ability not only enables it to meet its own nitrogen requirement, but also benefits the succeeding crops. It can be used as a cover crop before or after cereal crops in rotation, which makes a good green manure (Feedipedia, 2021). It is a short duration legume crop grown mostly as a fallow crop in rotation with rice.

It is an excellent source of high-quality protein (25%). In India Rajasthan, Maharashtra, AP, Bihar, Karnataka and Gujarat are the major growing states of green gram (Sumitra et al., 2022). India contributes more than 70% of world's green gram production (Green gram Outlook 2023).

In India, the uncertainty in area and production of green gram was observed as it is recorded 33.69 lakh ha with 2.46 million tonnes of green gram production in 2018-19 (Green gram Outlook, 2019); during 2019-20, about 31.15 lakh ha are covered under green gram with 2.51 million tonnes of green gram production (Green gram Outlook, 2020); 2020-21, about 35.79 lakh ha are covered under green gram with 3.09 million tonnes of green gram production (Green gram Outlook, 2021); 2021-22, about 34.80 lakh ha are covered under green gram with 3.15 million tonnes of green gram production (Green gram Outlook, 2022); 2022-23, about 33.45 lakh ha are covered under green gram with 3.74 million tonnes of green gram production (Green gram Outlook, 2023).

As per data of year 2022-23, in India Rajasthan state is the lead producer of green gram with 20.54 lakh ha, followed by Karnataka with 4.14 lakh ha, Maharashtra 2.78 lakh ha, Odisha 2.03 lakh ha, Madhya Pradesh 1.58 lakh ha and Telangana 0.27 lakh ha are the major producers of green gram. Though Telangana is one of the major green gram growing state with Sangareddy, Vikarabad, Mahbubabad, Kamareddy, Khammam, Suryapet and Asifabad are the major green gram producing districts (Green gram Outlook, 2019).

The government of India, started a new scheme under National Food Security Mission by providing new technology packages in pulses cultivation in collaboration with the Indian Council of Agricultural Research and Krishi Vigyan Kendra's aims to achieve self-sufficiency in pulses production by deploying Cluster Front Line Demonstrations (CFLDs) in all the states of India (Gautam et al., 2023).

Cluster Front Line Demonstrations (CFLDs) aim to boost the production of Pulses by filling the gaps with demonstrating popular and improved new agricultural technologies on farmers field (Gautam et al., 2019). These types of demonstrations play a crucial role in extending the new technologies to farmers (Tankodara et al., 2018), helps in introducing suitable agricultural practices in real farming conditions (Deka et al., 2021), and are supported by extension programs for widespread technology dissemination (Venkatarajkumar et al., 2000).

Aiming with these objectives, In Peddapalli district Krishi Vigyan Kendra, Ramagirikhilla carried out a study that focused on Cluster Front Line Demonstrations of Green gram in farmer's field in Rabi season from 2018-19 to 2022-23.

2. METHODOLOGY

Krishi Vigyan Kendra, Ramagirikhilla, Peddapalli district has conducted Cluster Front Line Demonstrations (CFLDs) on Green gram in different mandals/clusters of Peddapalli district, Telangana, during the Rabi seasons of 2018-19 to 2022-23. Each year (2018-19 to 2022-23) 20 hectares were allocated to these demonstrations under irrigated situation during Rabi season, contrasting with local farming practices. The soils in the selected villages were sandy loam, red chalka and black soils. A total of 212 demonstrations were conducted covering an area of 100 hectares were implemented to showcase advanced green gram technologies with the view to promote improved cultivation practices and increase the area and production of green gram in the district.

Krishi Vigyan Kendra-Ramagirikhilla has conducted training programmes on Integrated Crop Management in green gram cultivation and also provided with necessary need based critical inputs (Table 1). Various technological parameters and procedures for demonstrations and farmers practices were provided in Table 2. Scientist are regularly visited to ensure the effective implementation of the methodology and facilitate the systematic collection of farmers' feedback on the recommended varieties and technologies. The performance of the varieties and associated technologies were evaluated both visually and quantitatively. To showcase the benefits of the demonstrated technologies, field days were organized by gathering active participation from local farmers, neighboring communities and officials from the State Department of Agriculture.

Yields from the demonstration plots were meticulously recorded and compared with those obtained through farmers' practices at harvest, highlighting significant performance disparities. The data analysis also included cultivation costs, net income, and benefit-cost ratios, demonstrating the advantages of advanced green gram technologies. The Yield Gap, Technology gap, Extension Gap, and Technological Index were calculated using the following formulas:

Extension gap(q/ha.) = Demonstration yield – Farmers' practice yield

Technology gap = Potential yield – Demo yield

$$\text{Technology Index (\%)} = \frac{\text{Potential Yield} - \text{Demo yield}}{\text{Potential Yield}} X\ 100$$

Additional Yield Increase (q/ha.) = Demonstration yield – Farmers' practice (or) State (or) National yield

$$\text{Yield increase (\%)} = \frac{\text{PDemonstration yield} - \text{Farmers}' \quad \text{practice (or) State (or) National yield}}{\text{Demonstration yield} - \text{Farmers}' \quad \text{practice (or) State (or)National yield}} X\ 100$$

Table 1. Details of critical inputs used under CFLD in Greengram

Year	No. of Demos	Variety	Technology demonstrated	Critical input
2018-19	32	MGG-295	Integrated Crop Management	Seed, Rhizobium for Seed treatment, Herbicides, Need based Pesticides, Trainings and Group meetings
2019-20	40	MGG-295	Integrated Crop Management	Seed, Rhizobium for Seed treatment, Herbicides, Need based Pesticides, Trainings and Group meetings
2020-21	42	WGG-42	Integrated Crop Management	Seed, Rhizobium for Seed treatment, Herbicides, Need based Pesticides, Trainings and Group meetings
2021-22	48	WGG-42	Integrated Crop Management	Seed, Rhizobium for Seed treatment, Herbicides, Need based Pesticides, Trainings and Group meetings
2022-23	50	WGG-42	Integrated Crop Management	Seed, Rhizobium for Seed treatment, Herbicides, Need based Pesticides, Trainings and Group meetings

Table 2. Difference between Demonstration and Farmers' practice under CFLD on Greengram

Particulars	Recommended practices	Farmers' practice
Variety	MGG-295, WGG-42	Local varieties or own seed
Seed treatment	Rhizobium400g/acre	No seed treatment done
Seed rate	6 kg/ha.	8 kg/ha
Fertilizer dose	Balance fertilization:10 kg N, 30 kg P_2O_5 & 40 kg S/ha at sowing time. Spray of 2% NPK (18:18:18) at flowering time.	Imbalance use of fertilizers and 50 kg DAP at sowing.
Plant protection	Neem oil @ 5ml/lit and Imidacloprid @ 0.5 ml/lit for control of sucking pest. Need based Plant protection chemicals (Emmamectin benzoate 100 grams per acre, Chlorontrinilprole 80 ml per acre. Spraying of Acephate@1.5 g, Dichlorvos 1ml, spraying of dicofol@5ml/lit. (Maruca pod borer, Pod fly))	Indiscriminate use of chemicals, without following any recommendations
Weed management	Pre emergence herbicides Pendimethalin @1.2 lit per acre and post emergence herbicide Imazethapyr @ 250 ml acre at 15-20 Days after sowing (DAS)	Manual weeding

3. RESULTS AND DISCUSSION

Technology demonstrated through Cluster Front Line Demonstrations showed tremendous impact on yield and other parameters in Green gram cultivation in Peddapalli District. However, it was clearly observed that farmers often deviate from the recommendations, particularly regarding the application of seed treatment, weed management practices, recommended fertilizers and plant protection chemicals. This issue is addressed and results were presented as follows.

3.1 Green Gram Yield

Improved varieties and technologies in green gram cultivation under cluster front line demonstrations resulted in average grain yield of 10.25, 11.08, 12.00, 12.50 and 13.00 q/ha as compare to 7.75, 8.06, 7.50, 8.20 and 10.80 q/ha, respectively recorded in farmer's practice and average yield increase of 32.26, 37.4, 66.67, 46.34 and 20.37 per cent during 2018, 2019, 2020, 2021 and 2022, respectively. Over the five years (2018, 2019, 2020, 2021 and 2022) of green gram cultivation recorded a mean yield of 11.77 q/ha, which is 40.62 percent higher than farmers' practice (8.46 q/ha), 39.79 percent higher than state yield (8.42 q/ha) and 33.04 percent higher than national yield (33.04 q/ha) (Table 3). The increased grain yield with improved technologies was mainly because of quality seed, weed management, improved package and practices and timely management of pest and diseases. Meena and Dudi (2018) also reported that demonstrations with improved technology recorded a mean yield of 982 kg/ha which was 35.5 per cent higher than farmers' practice (755 kg/ha). The above findings were also in line with the findings of Venkanna and Bhaskar (2020) in red gram crop, Sumathi (2012), Ganesh (2010) and Laxmi et al. (2017) in green gram crop.

3.1.1 Extension gap, technology gap and technology index

The discrepancy in productivity between farmers' practice and demonstration may be explained by the extension gap. The extension gap of 2.50, 3.02, 5.00, 3.80 and 2.20 q/ha, technology gap 1.75, 0.92, 2.00, 1.50 and 1.00 q/ha and technology index 14.58%, 7.67%, 14.29%, 10.71% and 7.14% was recorded during 2018, 2019, 2020, 2021 and 2022, respectively (Table 3). It is revealed 3.70 q/ha extension gap, 1.43 q/ha technology gap and 10.88% technology index (Table 3). The adoption of the extension gap should be attributed to improved dissemination process in recommended practices which outcome in higher grain yield than the farmer's practice. Meena and Dudi (2018) also reported an extension gap of 284 to 320 kg/ha in their studies and also reported that there is a wide technology gap during different years. Similar findings were also obtained by Patil et al. (2015) in green gram and by Sahare et al. (2018) in black gram and by Venkanna and Bhaskar (2020), Chaitanya et al. (2020) in red gram crop.

3.1.2 Economic analysis

Economic returns varied annually due to variations in grain yield and Minimum Support Price (MSP) set by the Government of India. According to the results shown in Table 4, from the CFLD demonstrations, the maximum gross returns were Rs. 81,505.85 with net returns and highest benefit-cost ratio were observed in the demonstration plots than the farmers' practices. The mean of gross returns were Rs. 71899.51 with net returns of Rs. 44619.57 in the demonstrations with gross cost of Rs. 23480.00. Whereas, farmers' practice recorded gross returns Rs. 56379.46 with net returns of Rs. 29979.46 and with a gross cost Rs. 23040.00. The increased net returns in demonstration fields were attributed to the adoption of advanced technologies, timely crop management practices, conducting field days and consistent field visits. A mean benefit-cost ratio of 3.06 was recorded in demonstrations with an increase of Rs. 14,640.11 net returns and with 51.11% increase of net returns than farmers practices (2.46). The benefit-cost ratio increased from least 2.87 in 2018-19 to 3.26 in 2022-23, reflecting the positive impact of CFLD on both grain yield and profitability. Meena and Dudi (2018) also obtained a mean net income of Rs. 46030.00 /ha with a benefit cost ratio of 4.3 with demonstrations in comparison to farmers' practices (Rs. 38775/ha). These findings align with earlier studies conducted by Venkanna and Bhaskar (2010) in red gram crop, Chaudhary, (2012) and Patil et al. (2015) in green gram crop.

Conducting the Cluster Front Line Demonstrations (CFLDs) with improved technologies in our study increased the yields, reduced the extension gap and enhanced the net returns per ha throughout all years of study. Sumitra et al. (2022) also reported in their study that in India, over the last few years, green gram area of cultivation and production increased due to inception of Cluster Front Line Demonstrations (CFLDs) through Krishi Vigyan Kendra's at farmers' fields.

Table 3. Yield, Extension gap, Technology Gap (q/ha), Technology Index (%) and Percent increase (%) in yield over farmers' practice, state yield and national yield of Greengram as influenced by CFLD in Peddapalli District

Year	Variety demonstrated	no. of Demos	Yield (q/ha)					Extension gap (q/ha)			Technology Gap (q/ha)	Technology Index (%)	Percent Increase (%) over		
			Potential	Demo	FP	State	National	FP	State	National			FP	State	National
2018-19	MGG-295	32	12.00	10.25	7.75	8.00	8.25	2.50	2.25	2.00	1.75	14.58	32.26	28.13	24.24
2019-20	MGG-295	40	12.00	11.08	8.06	8.00	8.25	3.02	3.08	2.83	0.92	7.67	37.47	38.5	34.3
2020-21	WGG-42	42	14.00	12.00	7.50	8.50	9.00	5.00	3.50	3.00	2.00	14.29	66.67	47.06	38.89
2021-22	WGG-42	48	14.00	12.50	8.20	8.00	8.08	3.80	4.50	4.42	1.50	10.71	46.34	50	48.51
2022-23	WGG-42	50	14.00	13.00	10.80	9.61	10.90	2.20	3.39	2.10	1.00	7.14	20.37	35.28	19.27
Average			**13.20**	**11.77**	**8.06**	**8.42**	**8.90**	**3.70**	**3.34**	**2.87**	**3.34**	**2.87**	**40.62**	**39.79**	**33.04**

Table 4. Cost of cultivation, Gross return, Net return and Benefit cost ratio of Greengram under CFLD compared to farmers' practice in Peddapalli District

Year	Demo			FP			Net returns (Rs./ha) increase over FP	% increase of Net returns over FP	B:C Ratio	
	Gross cost (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	Gross cost (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)			Demo	FP
2018-19	21300.00	61000.00	39700.00	20000.00	48000.00	28000.00	11700.00	41.79	2.86	2.40
2019-20	25500.00	78992.00	53492.00	27000.00	59644.00	32644.00	20848.00	63.86	3.10	2.21
2020-21	23300.00	68000.00	44700.00	20000.00	53800.00	33800.00	10900.00	32.25	2.92	2.69
2021-22	22300.00	70000.00	48700.00	23200.00	55000.00	35000.00	13700.00	39.14	3.14	2.37
2022-23	25000.00	81505.85	36505.85	25000.00	65453.32	20453.32	16052.53	78.48	3.26	2.62
Average	**23480.00**	**71899.57**	**44619.57**	**23040.00**	**56379.46**	**29979.46**	**14640.11**	**51.11**	**3.06**	**2.46**

4. CONCLUSION

It is concluded from the study that there is a significant disparity between farmer practices and demonstration methods due to lack of extension and technology dissemination in the Peddapalli District of Telangana. We can conclude that the introduction of enhanced varieties and technology led to a higher yield in the demonstrations. The percentage increase in green gram production in the demonstrations over the farmers' practices raised awareness and encouraged other farmers' to follow the better management practices in green gram production. Additionally, these cluster front line demonstrations increased the bond and trust between KVK scientists and farmers'. The farmers' who are adopting the KVK technologies are playing crucial role in spreading of the varieties or new technologies to other local farmers. Through cluster front line demonstrations, Krishi Vigyan Kendra (KVK) play a crucial role in helping farmers make the switch from conventional to improved farming practices. These programs have demonstrated a remarkable potential to increase farmers' incomes by generating more money per unit of land and input. The success of CFLDs shows how effective they are at promoting the long-term and significant adoption of improved agricultural technologies.

5. FUTURE SCOPE OF STUDY

This study lays the groundwork for the dissemination of technology to boost output in other pulses. There is also a need to improve extension methods for spreading such technologies, which will be understand and apprehended by this study.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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