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Enhancing Productivity and Profitability of Green Gram through Cluster Front Line Demonstration in Tribal Area of North Gujarat, India

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ABSTRACT

Pulses occupy an important position in food and nutritional security in India. Though, country is largest producer and consumer of pulse in world, productivity of pulses is very low due to yield gap between research outcome and its adoption on farmer's field. For improving productivity and profitability of green gram in tribal areas of North Gujarat, Krishi Vigyan Kendra, Banaskantha-I organized 335 cluster front line demonstrations (FLD's) in 134 ha area covering 20 villages of Danta taluka of Banaskantha district under the National Food Security Mission. Improved variety of green gram (GM-4), proper seed rate, spacing, nutrient management, and pest and disease management practices were demonstrated. The average yield recorded in the demonstration and local check plots was 804 kg/ha and 568 kg/ha, respectively. There was 41.50% yield increment observed in the demonstrated plot as compared to existing farmers' practices. The gross return, net return, and BCR ratio of the demonstration plot were USD 543/ha, USD 328.8/ha, and 2.40, respectively. The Overall yield gap analysis indicated that the technology gap was observed more than the extension gap. Three is the scope to enhance green gram productivity levels with suitable location-specific strategic research and policies to bridge the existing yield gap between actual farmers' fields and maximum potential yield.

Keywords: *Green gram, Economics, Impact of Interventions, Yield, Yield gap*

INTRODUCTION

Green gram is one of the richest sources of protein, minerals, and fiber for animals and human beings and plays an important role in the food and nutritional security of people in developing countries. As a leguminous crop, it has a great role in improving soil fertility through biological nitrogen fixation. India is the largest producer and consumer of pulse in the world, accounting for 25 percent of global production and 15 percent of consumption. Despite the record production of 23.01 MT of pulses in 2020-21, 3 MT of pulses were imported. Still, there is gap between the requirement and production of pulses in the country [4]. Since, India is leading importer of pulses in the world; production of pulse crops has been stagnant at between 11 and 14 million tonnes over the last two decades. Consequent upon this there is widening gap between demand and supply. Still India is far behind in pulses production. About 20% of the total pulse demands are met by imports only [6]. The low productivity of pulse crops at farmers' fields is one of the reasons for this gap. Many factors, have been identified for low productivity of pulse in India. Partial adoption of recommended practices is one of the major factors. Govt. of India has taken initiatives since 2007 to enhance the production and productivity of pulses by implementing National Food Security Mission Project (NFSM).

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Danta taluka of Banaskantha district predominantly a tribal area is well known for pulse production situated in North Gujarat. Among all the pulses, Green gram (Vigna radiate L.) is one of the most important pulse crop of cultivated in both kharif and summer seasons and covering nearly 65% of the total pulse area. However, the yield potential of green gram in tribal area is very low because of the fact that the crop is mainly grown with poor management practices, water scarcity, use of local quality seed, and also due to various physiological, biochemical as well as inherent factors associated with the crop. For improving the productivity and socio-economic condition of tribal farmers, Krishi Vigyan Kendra, Banaskantha-I identified 20 villages of Danta Taluka and cluster front-line demonstration program demonstrated under National Food Security Mission. The main aim of the project was to full fill the identified gap and constraints for higher production, creating awareness among the farmers about new technology, their adoption, up-scaling, and improving the socio-economic condition of the tribal community.

MATERIAL AND METHODS

Cluster front-line demonstration of green gram conducted by Krishi Vigyan Kendra, Banaskantha-I during the summer season of 2014-15 to 2021-22. The demonstrations were conducted on

335 farmers' field covering 134 ha of the area on twenty villages of Danta taluka. The region is characterized by sub-tropical and semi-arid weather and comes under IV- North Gujarat Agro-climatic zone. A survey to get information on summer green gram cultivation practices were undertaken before conducting the demonstrations. Selection of farmers and improved practices for demonstrations were done based on survey information. The necessary steps for the selection of the site and farmers, the layout of the demonstration etc. were followed as suggested by [2]. The plot size for demonstration of each plot was kept 0.4 ha. The demonstrations were conducted with the active participation of KVK scientists and farmers. Critical inputs viz., improved quality seed (GM-4) 8.0 kg, secondary nutrient sulfur (10 kg), biofertilizer (Rhizobium and PSB – 500 ml each) for seed treatment, and Bio-pesticide (Neem oil – 500 ml) for pest management were demonstrated to identified farmers. Other technological information like balanced fertilizer uses, weed management, irrigation scheduling etc. also given from time to time and comparison has been made with existing farmers' practices. Before conducting the demonstration, soil samples were collected to know the nutrient status of the soil. The farmers' plot (FP) were maintained as a local check for comparison study. The data obtained from demonstration practices (DP) and farmers practices (FP) were analyzed for extension gap, technological gap, technological index, and benefit-cost ratio study suggested by [8,3] by using the following formulae:

$$\text{Extension gap (kg/ha)} = \text{Demonstration yield} - \text{Farmers' yield}$$

$$\text{Technology gap(kg/ha)} = \text{Potential yield} - \text{Demonstration yield}$$

$$Technological\ index\ or\ YG\ (I)(\%) = \frac{Potential\ yield - Demonstration\ yield}{Potential\ yield} \times 100$$

$$Yield\ gap\ (II)\ (\%) = \frac{Demonstration\ yield - Farmers'\ yield}{Demonstration\ yield} \times 100$$

RESULTS AND DISCUSSION

Assessment of gaps: Before conducting the demonstration, a field survey was carried out in different villages to know adoption of technology on the farmer's field. The survey revealed that there was a huge gap between farmers' practices and recommended practices (Table 1). The majority of tribal farmers were not using improved varieties of seed for cultivation and they are traditionally being cultivating locally available seed which is the major factor responsible for low yield. Farmers sown seed by the broadcasting method as they were not aware of line sowing method with proper spacing. On average, 30-35 kg/ha seed used in broadcasting methods which was more than recommended seed rate (20 kg/ha). The information further revealed that all the green gram-grown farmers' do not adopt seed treatment practices with fungicides for root rot disease management, therefore there was gap of 100%. The fertilizer used pattern was not common in farmers, as they are using more quantity of nitrogen fertilizer which was more than recommended rate, more than 50% of farmers adopted recommended phosphorus dose while use of secondary nutrient sulfur was unaware by farmers. Bio-fertilizer plays important role in green gram production. The information in bio-fertilizers usage revealed that use of biofertilizers was almost negligible (5-8%) and the majority of farmers were unaware about biofertilizer importance in pulses. The incidence of sucking pests viz. thrips, white fly, jassid, etc. was another major factor affecting crop yield adversely. The practices for management of sucking pests were adopted only by 8-10% of the farmers resulting in sever attack of yellow mosaic virus.

Impact of interventions on seed yield: Yield under FLD, farmers check plot, district, state and national average yield was presented in table 4, and existing yield gaps were furnished in table 1 indicating that demonstration fetched more yield under recommended practices in comparison to yield of farmers practices. Demonstrated plot (DP) of integrated crop management (ICM) in green gram recorded higher seed yield ranging from 647 to 890 kg/ha with an average of 804 kg/ha as compared with the farmers' practices (568 kg/ha), respectively. The percent increase in seed yield was 22.08 to 55.19 with an average of 41.50 percent during the demonstration period. The above trend of successively increased in seed yield of a green gram over the year was obtained due to integrated crop management approach (ICM) through the adoption of an improved variety of green gram (GM-4), recommended seed rate (20 kg/ha) and spacing which maintains optimum plant population and reduced the competition for nutrient, moisture and sunlight. Seed treatment with biofertilizer i.e., rhizobium for increased root nodules formation for atmospheric nitrogen fixation and reduced the dose of nitrogen fertilizer and PSB improved the phosphorous uptake from soil [1]. Further, the Application of secondary nutrients i.e., sulfur @ 25 kg/ha in basal dose along with chemical fertilizer application had an impact on better growth and improved the quality and boldness of the seed [9]. Similar trends were also noticed by [5] on chickpeas, [7] on groundnut and [10] on the green gram.

The seed yield of green gram in the demonstration plot compared with district, state and national level productivity which are mentioned in Table 4. The demonstrated technology of green gram recorded 35.45, 33.27 and 61.08% higher over district, state and national level productivity, respectively which indicated feasibility, acceptability and adaptability of demonstrated technology over farmers practices. [10] also reported similar findings in green gram crop.

Overall yield gap analysis: The difference between the yield of the demonstration plot and the local check plot was determined to know the extension gap. A small extension gap indicates the available technologies are almost fully used. The average extension gap was 236 kg/ha with the maximum value of 308 kg/ha during 2016-17 and a minimum value of 117 kg/ha during 2014-15 (Table 2). This gap was attributed due to poor management of key factors such as quality seed, nutrient management, biofertilizers use, management of sucking pests, etc. In this study, technology gap shows a maximum value of 853 kg/ha during 2014-15 and a minimum value of 610 kg/ha during 2018-19 with an average of 696 kg/ha. The technology gap reflects the farmers' cooperation in carrying out such demonstrations with encouraging results in subsequent years (Table 2). Data indicated that there is gap in technology demonstration as a result of which the potential yield of the improved practices could not be reaped by the participating farmers. These findings are in line with those of [11].

In case of the technological index (YP-I), lower the value of the technology index indicates more is the feasibility of the technology. The wider gap in the technology index ranging between 40.67 – 56.87 per cent with a mean value of 46.40 percent i.e. yield realized at the research station is 46.40 percent higher than demonstration plots although FLD's are conducted under direct supervision of scientists in farmers' field using same technology as applied in the research station. Huge gap in technology might be due to the dissimilarity in soil fertility status, agricultural practices, non-congenial weather conditions, non-availability of irrigation water, and insect pests attack in the crop. This is in the tune of results recorded by [7] and [11]. In the case of yield gap (II), farmers of demonstration plot realized 28.90 percent higher yield in comparison to their counterparts growing green gram by traditional systems. The overall yield gap analysis in summer green gram found technology gap was observed more than the extension gap.

The present study indicated that there exists a wide gap in potential yield, demonstrated yield, and farmers' yield of summer green gram (Figure 1). Cluster front-line demonstration reduced this yield gap by 236 kg/ha through the adoption of improved practices and still there is an unattainable gap of 696 kg/ha as compared to potential yield and it might be depending on several environmental factors, water scarcity, soil texture and structure, crop phonology, and non- transferable factor.

Economic returns: Gross return, net return and Benefit-Cost ratio were recorded higher under demonstration plots against farmers' plots in all the years of study. Average gross returns of USD 543.0 and 360.8/ha were obtained in the demonstrations and local check plots, respectively. Higher gross monetary returns realized by farmers indicate the economic feasibility of the technology. Similarly, average net returns of USD 328.8 and 155.8/ha were obtained in demonstrations and local check plots (Table 3), respectively due to the difference in cost of cultivation and higher market price. Investment of an additional USD 21.3/ha on the purchase of important critical inputs in demonstrations provided additional net returns of USD 172.9/ha with average effective gain of USD 151.6/ha, respectively. A similar trend was noted by [10]. The Benefit-Cost ratios were ranges from 2.08 – 2.71 with an average of 2.40 in the demonstration plot against 1.62 – 1.98 with average of 1.76 in the farmers' plot (FP) (Table 3). Higher benefit cost ratio under the demonstration plot was self-explanatory indicating the economic viability of the technology and convincing the farmers for the adoption of technology imparted.

CONCLUSION

From the above findings, it can also be concluded that the use of scientific methods demonstrated under cluster front-line demonstration of green gram enhanced yield of summer green gram, created greater awareness, motivated the farmers and reduced the technology gap to a considerable extent thus leading to increased profitability and economic status of tribal farmers in the district. The technology gap in summer green gram is more than the extension gap at the farmer's field, thus suitable extension interventions are needed to reduce the technological as well as extension gap at farmers' field for the benefit of farmers. Moreover, extension agencies in the district need to identify the attainable and unattainable factors, and develop suitable location-specific research strategies and policies to bridge the existing yield gap between actual farmers' field and district average.

Conflict of interest: The authors declares that there is no Conflict of Interest and the authors take complete responsibility for the integrity of the data and accuracy of the data analysis.

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Table 1: Assessment of gap

Technology	Farmers' practices	Recommended practices	% Gap
Variety	Local seed	GM-4	100
Sowing method	Broadcasting	Line sowing	100
Seed rate (kg/ha)	30 kg/ha	20 kg/ha	50
Seed treatment	-	Thirum or captan	100
Fertilizer use (NPKS kg/ha)	40:40:0:0	20:40:0:20	50 (N) 100 (S)
Biofertilizers	5-8%	Rhizobium, PSB, NPK Bacteria	92-95
Insect pest management (Thrips, aphids, Jassid) and Disease management (Yellow mosaic virus)	12-15% Indiscriminate use of plant protection measure	Neem oil, Dimethoate, Chloropyriphos	85-88

Table 2: Performance and gap analysis of cluster front line demonstrations of summer green gram at farmers' field

Year	Area (ha)	No. of demo	Seed yield (kg/ha)			% increase over FP	Technology gap (kg/ha)	Extension gap (kg/ha)	Yield gap (%)	Technology index (%) or Yield gap-I	Yield gap-II (%)
			Potential	Demo	FP						
2014-15	8	20	1500	647	530	22.08	853	117	18.08	56.87	18.08
2015-16	16	40	1500	743	550	35.09	757	193	25.98	50.47	25.98
2016-17	30	75	1500	872	564	54.61	628	308	35.32	41.87	35.32
2017-18	20	50	1500	838	540	55.19	662	298	35.56	44.13	35.56
2018-19	20	50	1500	890	626	42.17	610	264	29.66	40.67	29.66
2019-20	20	50	1500	826	608	35.86	674	218	26.39	44.93	26.39
2021-22	20	50	1500	812	558	45.52	688	254	31.28	45.87	31.28
Average			**1500**	**804**	**568**	**41.50**	**696**	**236**	**28.90**	**46.40**	**28.90**

(Note : DP: Demonstration plot and FP: Farmers' plot)

Table 3: Economics analysis of cluster front line demonstration on summer green gram at farmers' field

Year	CoC (USD/ha)		CoC increased over FP (%)	GMR (USD/ha)		GMR increased over FP (%)	NR (USD/ha)		NR increased over FP (%)	ACoC (USD/ha)	ANR (USD/ha) DP	BCR	
	DP	FP		DP	FP		DP	FP				FP	FP
2014-15	208.3	189.4	10.00	432.6	324.4	33.38	224.3	135.0	66.18	18.9	89.3	2.08	1.71
2015-16	219.9	199.2	10.43	487.4	336.0	45.07	267.5	136.8	95.47	20.8	130.6	2.22	1.69
2016-17	211.3	198.5	6.40	559.7	336.3	66.42	348.4	137.7	152.95	12.7	210.7	2.65	1.69
2017-18	221.1	204.6	8.06	547.0	341.2	60.32	325.9	136.6	138.59	16.5	189.3	2.47	1.67
2018-19	227.3	205.6	10.52	615.5	406.1	51.54	350.7	200.5	74.89	21.6	150.2	2.71	1.98
2019-20	232.3	202.9	14.45	583.3	394.5	47.88	401.9	191.5	109.85	29.3	210.4	2.51	1.94
2021-22	263.9	234.6	12.50	575.4	387.2	48.59	382.8	152.7	150.77	29.3	230.2	2.18	1.65
Average	**226.3**	**205.0**	**10.34**	**543.0**	**360.8**	**50.46**	**328.8**	**155.8**	**112.67**	**21.3**	**172.9**	**2.40**	**1.76**

CoC = Cost of cultivation; DP = Demonstration practices; FP = Farmers' practices; GMR = Gross monetary returns; NR = Net return; ACoC = Additional cost of cultivation; ANR = Additional net return; BCR = Benefit cost ration
(Market price of Green gram seed: USD 57.12 to 65.29 per quintal)

Table 4: Impact of demonstrated practices in terms of productivity enhancement

Years	Seed yield (kg/ha)		District yield (kg/ha)	State yield (kg/ha)	National yield (kg/ha)	Impact (% change over FP)	Impact (% change over DY)	Impact (% change over SY)	Impact (% change over NY)
	Demo plot yield (DP)	Farmers plot yield (FP)							
2014-15	647	530	622	498	498	22.08	4.02	29.92	29.92
2015-16	743	550	386	508	416	35.09	92.49	46.26	78.61
2016-17	872	564	462	526	500	54.61	88.74	65.78	74.40
2017-18	838	540	301	641	472	55.19	178.4	30.73	77.54
2018-19	890	626	818	566	516	42.17	8.80	57.24	72.48
2019-20	826	608	760	772	544	35.86	8.68	6.99	51.84
2021-22	812	558	806	712	548	45.52	0.74	14.04	48.18
Average	**804**	**568**	**594**	**603**	**499**	**41.55**	**35.45**	**33.27**	**61.08**

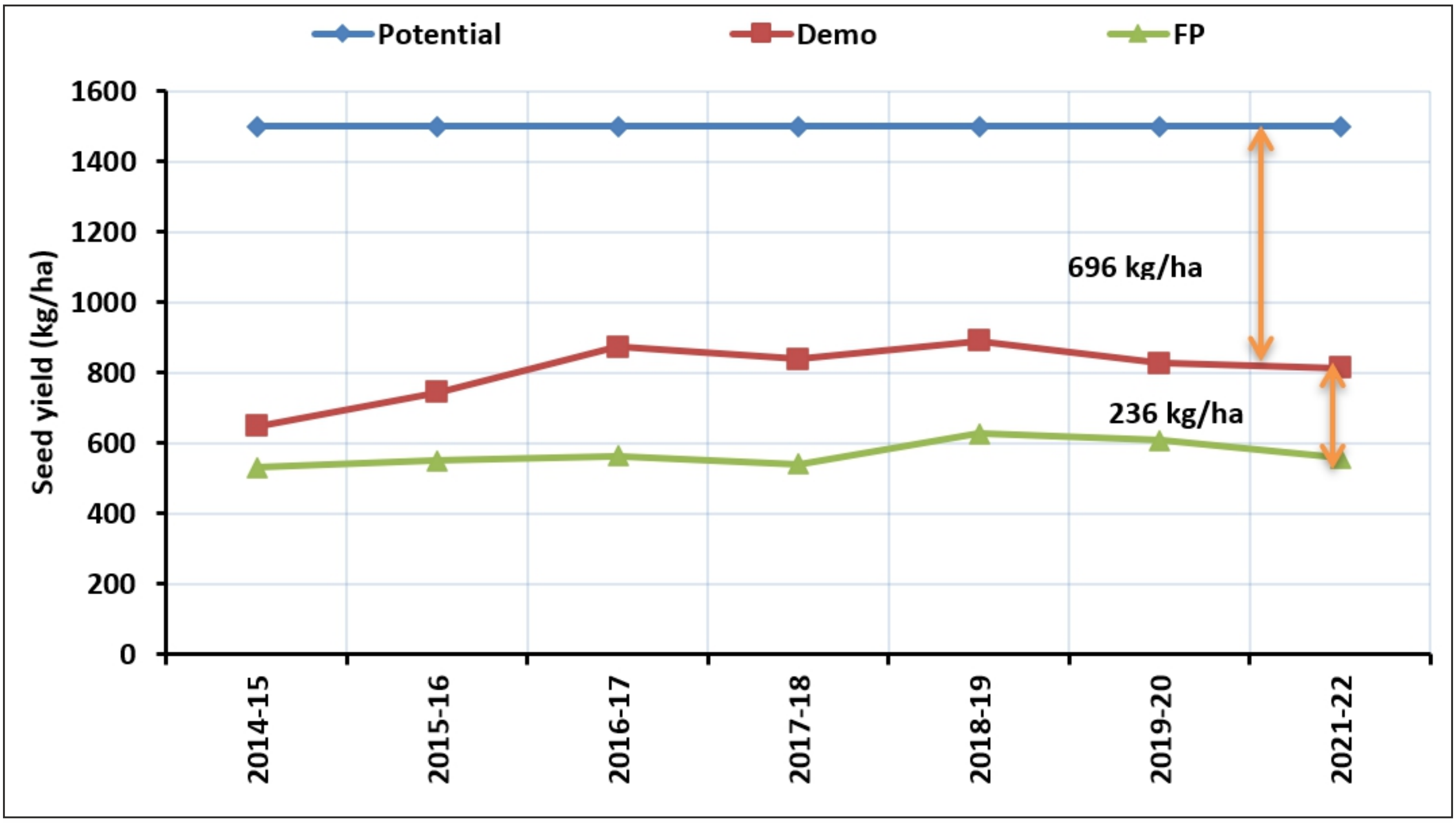

Figure 1: Year wise yield in demonstration plot and farmers' check plot and yield gaps

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