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Impacts of Cluster Frontline Demonstrations on Yield and Economics of Green Gram in Madhya Pradesh, India

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ABSTRACT

Background: It is a emerging significant legume crop (Green gram) in summer season that plays vital role in the food and nutritional security accomplishment of the country and contributing to protein intake. It is a soil building crop and being a leguminous crop, it fixes atmospheric nitrogen through symbiotic fixation, there by helps in N cycling within the ecosystem.

Methods: Cluster frontline demonstrations of greengram were conducted by Krishi Vigyan Kendra, Kolipura Tappar, Harda (Madhya Pradesh) during summer season from 2018-19 to 2022-23. A total 250 front line demonstrations were conducted on green gram in 100 ha area by the active participation of the farmers with the objective of improved technologies of greengram production potentials.

Result: The results of the demonstrations observed that on an average yield of greengram under improved technology ranged from 12.12 to 16.38 q/ha with a mean of 14.95 q/ha; which was 23.39 per cent more yield as compared to farmer's practices (12.01 q/ha). Moreover, average yield was also recorded higher under demonstration (16.38 q/ha) over district (16.0 q/ha) and State and country (12.09 and 570 q/ha), respectively. The study exhibited mean extension gap of 293.2 kg/ha, technology gap and technology index assessed more than potential yield of demonstrated variety MH-421. The average mean net return of Rs. 87737/ha with mean B: C ratio of 4.78 was obtained with improved technologies in comparison to farmers' practices (Rs. 65061.6/ha). The present study resulted to convincing the farming community for demonstration of new improved technologies, higher productivity and returns.

Key words: Economics, Extension gap, Frontline demonstrations, Green gram, Impact, Technology gap, Technology index.

INTRODUCTION

Green gram or mungbean [*Vigna radiata* (L.) Wildzek] is important pulse crop in India after chickpea and pigeonpea and it has been cultivated in India since ancient times. In India, green gram is one of the most widely cultivated pulse crops grown during kharif, spring and summer seasons. Cultivation of summer green gram is important to increase soil fertility in these areas where paddy wheat crop rotation is used. It is believed that green gram is native to India and Central Asia and since prehistoric times green gram has been grown in these regions. It is widely cultivated through out many countries across Asia, Australia, Africa and the U.S.A recently (Anonymous, 2021). Pulses are the climate resilient crops as they promote sustainable agriculture, decrease greenhouse gases, fix atmospheric nitrogen, improve soil fertility and use less water compared to other crops (Meena and Biswas, 2013). Green gram has excellent source of high-quality protein and consumed as whole grains, sprouted form as well as dhal in a variety of ways in homes. It is particularly rich in leucine, phenylalanine, lysine, valine, isoleucine, *etc*. Green gram (Dal) source of nutrition such as Protein 24% Calcium 140 mg/100 g, Fat 1.3%, Phosphorus 280 mg/100 g, Iron 8.4 mg/100 g, Calorific value 334 Kcal/100 g and Carbohydrate 56%etc reported by Baldev *et al*. (1989).

India is the largest producer, consumer, importer and processor of green gram in the world. It is fast spreading to many other countries of the world. Green gram mainly grown in Rajasthan, Madhya Pradesh, Maharashtra, Karnataka, and Bihar which accounting nearly for 45, 19, 7, 6 and 4 per cent respectively. India has occupied an acreage of 5.15 million hectares with a production of 3.09 million tonnes in Green gram during 2020-21. The area increased from 3.38 million hectares during 2013-14 to 5.15 million hectares during 2020-21, while the production increased from 1.61 million tonnes to 3.09 million tonnes and yield levels increased from 475 kg/hectare to 599 kg/hectare during the same period thereby in parting an overall growth of 106% to this crop in last ten years (Anonymous, 2021).

In Madhya Pradesh, green gram is grown in an area of 0.544 million hectares with an average production of 0.641

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million tons and productivity of 1179 kg/ha; whereas, Harda district of Madhya Pradesh covers total production of 1380 tons of green gram from an area of 1150 hectares with productivity of 1200 kg/ha (Anonymous, 2020-21).It clearly indicates that average productivity of green gram crop (1200 kg/ha) in Harda district is comparatively lower than the State average yield (1209 kg/ha) during 2021-22. However, still it is lower as compared to production potential of the demonstrated variety MH-421 "14.66 q/ha" (Anonymous, 2021a). Although, green gram crop productivity of Harda district has crossed the state productivity and also potential productivity of variety MH-421 (16.00 q/ha) during 2022-23. The productivity of chickpea can be further enhanced by adopting improved high yielding varieties and scientific crop management practices (Kumar, 2014 and Meena *et al*., 2020).

Indian government imports large quantity of pulses to fulfill the domestic requirement of pulses. In this regard, to sustain this production and consumption system, Government of India has initiated cluster frontline demonstrations (CFLDs) under National Food Security Mission. Front line demonstration is the method of field demonstration evolved by the ICAR with the inception of Technology Mission on Oil seed Crops. The main aim of this programme is to demonstrate latest crop production, protection technologies and crop management practices at the farmers' field under different agro-climatic zones and real farming situation under the supervision of Agricultural scientists.

MATERIALS AND METHODS

Cluster frontline demonstrations of greengram were carried out by Krishi Vigyan Kendra, Kolipura Tappar, Harda under the administrative control of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh during summer season from 2018-19 to 2022-23 (five consecutive years). The basic information collected while conducted FLDs (Table 1) shown covered 11 villages from 3 block Harda district *viz.,* Variety, latitude and longitude and partner farmer contributed who belongs different categories as beneficiary. As per the Agro-climatic zones of Madhya Pradesh, Harda district falls under the upper plains are broad and fertile (Deep black (deep) areas, well suited for cultivation and mainly consists of black soils in the Central Narmada Valley Zone-IV.

A total 250 FLDs on green gram were carried out by Krishi Vigyan Kendra, Kolipura Tappar, Harda to harness production potentialities of demonstrated green gram variety MH-421 along with full-fledged cultivation package of practices in 100 ha area and in farmer's practices PDM-139, Hum-12 and un identified local varieties with traditional cultivation practices. The technologies to be demonstrated for green gram were identified based on participatory rural approach (PRA) technique. Under demonstration, 0.4 ha area is allotted for individual partner farmer and adjacent 0.4 ha was considered local check (farmers' practice). Farmers were trained to follow the improved package and practices of green gram cultivation recommended for cultivation and mainly consists of black soils in the Central Narmada Valley Zone-IV. The required critical inputs like improved variety seed MH-421, seed treatment with FIR System and soil application of *Trichoderma* spp and bio-fertilizer like *Rhizobium spp*, Phosphorus Solubilizing Bacteria and *Pseudomonas* spp culture were supplied to the farmers from the scheme budget. Farmers were advised to use seed at the rate 25 kg ha^{-1} with recommended package of practices. The sowing method keeping 30×5-10 cm spacing was demonstrated on their fields. For fertilizer management, application of 20 Kg N+40 Kg P_2O_5+20 Kg K_2O_5 per ha in the form of Urea DAP and MOP as per demonstration were applied by the partner farmers. In addition to N,P and K, N:P:K (19:19:19) @ 2.5 kg/ha was supplied by KVK. The seed was treated before sowing with carboxin+thiram @3 g, Thiamethoxam 30FS @10 ml and *Rhizobium* @ 10 ml kg^{-1} taken with FIR system. Liquid *Trichoderma* spp and biofertilizers such as *Rhizobium* and PSB culture @ 5 L/ha, weed management (manually) and spray of Emamectin benzoate 5% SG@ 180 g/ha and tebuconzazole + sulphur @ 500 g/hawere supplied to the farmers from the scheme budget also as per need for the management of gram pod borer (*Helicoverpa armigera* Hubner) and Spotted pod borer *Maruca vitrata* Fabricius. Regular visits to the demonstration fields by KVK Scientists ensured proper guidance to the partner farmers. At flowering or maturity stage of crop, field days and group meetings were also organized to provide the opportunities for other farmers to witness the benefits of demonstrated technologies. Simultaneously, feedback from the farmers were also taken on the demonstrated technologies. In case of local check, traditional practices were followed by using existing varieties. Data were collected from both the demonstration as well as local check plot of partner farmers through personal contacts and finally extension gap, technology gap and technology index were worked out as suggested by Raj *et al*. (2013) as per formula given as follows:

Increase in yield (%) =

$$\frac{\text{Yield of demonstration - Yield of farmer practice}}{\text{Yield of farmer practice}} \times 100$$

Technology gap =

Potential yield (Kg/ha) - Yield of demonstration (kg/ha)

Extension gap =

Yield of demonstration (kg/ha) -
Yield under farmer practice (kg/ha)

$$\text{Technology index} = \frac{\text{Pi-Di}}{\text{Pi}} \times 100$$

Where:
Pi = Potential yield of the variety.
Di = Demonstration yield of the variety.

Additional cost (Rs./ha.) =

Cost of cultivation of demonstration (Rs./ha.) - Cost of cultivation of farmer practice (Rs./ha.)

Additional return (Rs./ha.) =

Gross return of demonstration (Rs./ha.) - Gross return of farmer practice (Rs./ha.)

Effective gain (Rs./ha)=

Additional return (Rs./ha) - Additional cost (Rs./ha.)

$$\text{B:C ratio} = \frac{\text{Gross return}}{\text{Cost of cultivation}}$$

RESULTS AND DISCUSSION

The data evident (Table 2) shown gap demonstrated between improved technology and farmer's practice of green gram cultivation in Harda district of Madhya Pradesh. Among varying technological component, full gap was observed in the component *viz*., variety and soil application of biofertilizers and *Trichoderma* spp, while, partial gap noticed in seed treatment with fungicide, insecticide and rhizobium culture, seed rate, showing time, fertilizer management and plant protection measures. These gaps observed at the farmers' field are ascribed to delay improved adopted; coupled with unreached extension system, poor accessibility of advanced or improved agro - technologies specially among small holder farmer's (Shivran *et al*., 2020). Under farmer's practice, seed of local/old variety with low yield potential was sown instead of newly recommended varieties for the zone with improper application of improved recommended package technologies. On the basis of observed gap under the demonstration were provided improved variety MH-421, fungicide, insecticide and bio-fertilizer (*Rhizobium* and PSB culture) to the partner farmers by KVK and other component *viz*., chemical fertilizers and all other crop management practices were timely performed by the partner farmer itself funder the supervision of KVK Scientist. Similar findings have also been observed by Meena *et al*. (2021), Saikia *et al*. (2018), Bhargav *et al*. (2017)and Meena and Singh (2017).

Green gram yield

Under National Food Security Mission (Pulses), total of 250 cluster frontline demonstrations of green gram (Pic 1) were demonstrated during 2018-19 to 2022-23 in Harda under Central Narmada Valley Zone. The findings obtained during last five years of demonstrations are presented in (Table 3) which revealed that average yield of green gram through improved technology ranged from 12.12 to 16.38 q/ha as compared to 9.39 to 12.65 under farmer's practice. Average yield of total 250 demonstrations was 14.95 q/ha from improved technology whereas, the average yield from farmer's practices was 12.01 q/ha. During the investigation, demonstrated improved technology variety MH-421 harvested average within 63.8 days in summer season under Harda district climate, where, as compare to farmer's

Table 1: Basic data of FLDs conducted on green gram under cluster frontline demonstrations during summer season.

Year	Variety	Variety release year	Village	Block	Latitude		Longitude		Category of beneficiary	
					From	To	From	To	Area (ha)	No. of demo.
2018-19	MH-421	2012	Dhangoan	Harda	22°04.704	22°46.822	76°51.552	77°16.456	30	75
			Pantalai	Timarni						
			Pahatkalan	Khirkiya						
2019-20			Balagoan	Harda	22°14.647	22°16.193	77°08.544	76°59.787	20	50
			Amasel	Khirkiya						
2020-21			Gola	Harda	22°17.35	22°29.283	76°55.605	77°18.393	10	25
			Pipliyakalan	Timarni						
2021-22			Sarsud	Khirkiya	22°05.16	22°26.997	76°51.31	76°59.629	20	50
			Damodarpura							
2022-23			Heerapur	Harda	22°11.073	22°28.391	76°53.305	77°16.577	20	50
			Singanpur	Timarni						
Average			11	3	-	-	-	-	-	-
Total					-	-	-	-	100	250

practices other local varieties average harvested in 67.4 days. Under improved technology, it recorded 19.18 to 29.48 per cent increased in yield over the local check. Thus, there was on an average 23.39 per cent increase in demonstration yield over local check. Demonstrated greengram variety MH-421 gave the highest yield (16.38 q/ha) during the year 2020-21. The results also revealed that yield under improved technology as well as under farmer's practices were higher than the district and State average yield during all the years of demonstrations. The higher yield greengram could be attributed due to adoption of improved variety with improved production practices of green gram. These results validate the findings of Reager *et al*. (2020) and Meena *et al*. (2020) and Meena and Singh (2017) in green gram, Wadkar *et al*. (2018) in chickpea. However, on an average, 7.31 q/ha higher yield of greengram was recorded under improved technology over district average. Similarly, 4.72 q/ha and 9.36 q/ha higher yield of green gram was recorded under improved technology over State and the country average, respectively. It was due to use of high yielding improved variety, improved agronomic practices and adoption of improved management practices. Meena *et al*. (2021) and Shivran *et al*. (2020) also reported the higher grain yield of chickpea and Indian mustard respectively, under front line demonstrations over district and state average.

Extension gap

Extension gap is considered as a parameter to know the yield difference between the demonstrated improved technology and farmer's practices. Results of the demonstrations (Table 3) stated that the extension gap ranging between 2.36-3.73 q/ha was found between demonstrated technology and farmer's practices. On an average extension gap during period of study was 293.20 kg/ha. So as to enhance the farmers income, there is need to reduce the wider extension gap, therefore, it is necessity to educate the farmers through various means for more adoption of recommended improved high yielding varieties and implementation of latest agro-technique (Reager *et al*., 2020, Meena *et al*., 2020 and Meena and Singh (2017) in green gram and Meena *et al*. (2021) in chickpea.

Technology gap

The data of Table 3 reflected that technology gap was not recorded in demonstration yield against potential yield which ranged from 0.12 to 4.38q/ha more harvested than potential yield harvested during consecutive five years of demonstrations on green gram crop variety MH-421 cultivation in Harda district. This also reflects the excellent extension activities, which resulted in maximum adoption of package of practice by farmer. Hence, extension activities and a location specific technological recommendation appear to be necessary to decline the technology gap. These results corroborate the findings of Meena *et al*. (2021) and Jat *et al.* (2013).

Technology index

The technology index is a parameter to show the feasibility of the improved technology at the farmer's fields. Data on technology index presented in Table 2 shows that technology index assessed more yield harvested than potential yield 1200 Kg/ha that varied from 1 to 36.50 per cent more recorded. During study period of frontline demonstrations, highest technology index 36.5 per cent and lowest 1 per cent was recorded during year of 2018-19 and 2022-23, respectively. Further, on an average technology index 24.58 per cent more than potential yield was observed during four

Pic 1: Field Day celebration on CFLD Farmer 's Field at podding stage of green gram crop during summer 2022-23.

Table 2: Technological gap between FLDs and farmers practices on green gram.

	Technological intervention	Farmers' practices	Gap
Variety	MH-421	PDM-139/Unidentified/local variety	Full gap
Seed rate	25 kg/ha	17-22% higher	Partial gap
Time of sowing	1-25 March	10-30 March	Partial gap
Seed treatment by chemical fungicide	Carboxin+Thiram @3 g+ Thiamethoxam 30FS@3 ML+ Rhizobium @10 ml/Kg Seed	60% farmers used Thiram or Carbendazim+ Mancozeb or other fungicides as seed treatment	Partial gap
Soil application	Trichoderma spp@5 L/ha+ PSB@5 L/ha	Less than 1% farmers used Biofertilizers and *Trichoderma* in Soil application	Full gap
Method of sowing	Line sowing	Line sowing	No gap
Fertilizer dose	Recommended dose of fertilizer (RDF)	Imbalance use of fertilizer	Partial gap
Weed management	Hand weeding	Hand weeding	No gap
Plant protection measures	Tebuconazole+ Sulphur@ 1 kg/ha and Emamectin benzoate 5% SG @ 180 g/ha	Indiscriminate use of insecticide	Partial gap
Irrigation	4 irrigation with 12 days interval	4 irrigation with 12 days interval	No gap

Table 3: Comparative statement of yield and other parameters of frontline demonstrations on Green gram in Harda district of Madhya Pradesh (potential yield of MH-421= 1200 kg per hectare).

Year	Harvesting duration days		Yield of demo (kg/ha)			Average yield under FP	Increase yield over FP	EG	TG	TI	Productivity kg/ha		
	Demo	FP	H	L	Av.	(kg/ha)	%	(kg/ha)	(kg/ha)	(%)	District	State	India
2018-19	61	65	1430	1020	1212	939	22.77	273	MP<12	MP<1	800	963	516
2019-20	66	71	1750	1400	1556	1240	25.48	316	MP<356	MP<29.66	160	741	548
2020-21	63	69	1963	1775	1638	1265	29.48	373	MP<438	MP<36.5	60	1179	601
2021-22	64	64	1645	1203	1466	1230	19.18	236	MP<266	MP<22.16	1200	1209	570
2022-23	65	68	1720	1406	1603	1335	20.07	268	MP<403	MP<33.58	1600	-	-
Average	63.8	67.4	1702	1361	1495	1201.8	23.396	293.2	MP<295	MP<24.58	764	1023	558.75
Total	-	-	-	-	-	-	-	-	-	-	-	-	-

Demo.= Demonstration, H= Highest, L= Lowest, Av.= Average, FP= Farmer's practice (Local check), EG= Extension gap, TG= Technology gap, MP<= More than Potential, TI= Technology index.

Table 4: Economics of the frontline demonstrations on Green gram in Harda district of Madhya Pradesh.

Year	Variety	Cost of cultivation Rs/ha		Gross return Rs/ha		% increase in gross return	Net return Rs/ha		% increase in net return	Additional		Effective gain (Rs./ha)	Benefit-cost ratio	
		Demo.	FP	Demo.	FP		Demo.	FP		Cost (Rs./ha)	return (Rs./ha)		Demo.	FP
2018-19	MH-421	22040	19250	84523	65481	29.08	62483	46231	35.15	2790	19042	16252	3.84	3.4
2019-20		22511	21932	109698	87420	25.48	87187	65488	33.13	579	22278	21699	4.87	3.98
2020-21		23470	22950	129131	92028	40.31	105661	69078	52.95	520	36583	36063	5.5	4
2021-22		22800	23250	106651	89482	19.18	83851	66232	26.6	625	17169	17619	4.68	3.85
2022-23		24800	25250	124303	103529	20.06	99503	78279	27.11	450	20774	21224	5.01	4.1
Average/Total	MH-421	23124.2	22526.4	110861.2	87588	26.822	87737	65061.6	34.988	992.8	23169.2	22571.4	4.78	3.866

experimental years of green gram, which shows the efficacy of good performance of technical interventions. This will accelerate the adoption of demonstrated technological intervention to increase the yield performance of green gram at farmer's field. Similar findings were recorded by Meena *et al*. (2021); Reager *et al*. (2020); Wadkar *et al*. (2018); Bhargav *et al*. (2017) and Jat *et al*. (2013).

Economics of green gram under CFLD

Cluster frontline demonstration economics of improved technology was assessed (Table 4) on the basis of prevailing market rates (Minimum Support Price) which recorded higher gross monetary return (Rs. 129131/ha), additional returns (Rs.36583/ha.) with improved technology demonstration compare to farmer's practice in the year 2020-21 in case of green gram variety MH-421. The higher net returns (Rs. 105661/ha), effective gain (Rs. 36063/ha) and B: C ratio (5.50) with improved technology demonstration compare to farmer's practice in the year 2020-2021 in case of green gram variety MH-421. Seed yield, cost of variable inputs, labour charge and sale price of produce determine the economic return and these vary from year to year. The present investigation showed improved technology fetched higher net return to the tune of Rs. 62483/ha to Rs. 105661/ha with the average of five years (Rs. 87737/ha) and average per cent increase in net return (34.98%) in addition to farmer's practices. However, under farmer's practice, the net return ranged from Rs. 46231/ha to Rs. 78279/ha over the years and its average value fetched to Rs. 65061.60/ha. Although, cost of cultivation average mean with the five years (Rs. 23124.20/ha) in improved technology demonstration compare to farmer's practice (Rs. 22526.40/ha) with average additional cost (Rs. 992.80/ha) was recorded similarly by Meena *et al*. (2022).

Further, on the average, of all five years of study revealed that improved technology demonstration gave higher mean gross return (Rs. 110861.20/ha), mean net return (Rs. 87737/ha), mean additional returns (Rs. 23169.20/ha), mean effective gain (Rs. 22571.4/ha) and mean B:C ratio (4.78) compare to farmer's practice. Similar economic benefits owing to adoption of improved technology interventions were also reported by Meena *et al*. (2021); Reager *et al*. (2020); Meena *et al*. (2020) and Jat *et al*. (2013).

CONCLUSION

The Cluster frontline demonstrations conducted on green gram at the farmer's field revealed that the adoption of improved technologies significantly increased the yield as well as net returns to the farmers. So, there is a need to disseminate the improved technologies among the farmers with effective extension activities like trainings, group meetings, demonstrations and field days. The farmers should be couraged to adopt the recommended package of practices realizing for higher returns. The beneficiary farmers of demonstrations also play an important role as source of information and quality seed for wider dissemination of the high yielding variety of green gram for other nearby farmers.

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Conflict of interest

I ensure that our research was conducted ethically, with relevant guidelines and regulations. I have obtained information consent from research participants, maintain confidentiality, and avoid any form of coercion or deception. We have no conflict of interest on behalf of co-authors of this research article to any includes obtaining ethical approval for the study and disclosing any financial or personal relationships that may have influenced the research.

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