Print ISSN : 0972-8813
e-ISSN : 2582-2780

[Vol. 22(3) September-December 2024]

Pantnagar Journal of Research

(Formerly International Journal of Basic and Applied Agricultural Research ISSN : 2349-8765)

G.B. Pant University of Agriculture & Technology, Pantnagar

PANTNAGAR JOURNAL OF RESEARCH

Vol. 22(3) September-December 2024

CONTENTS

Economic analysis of improved green gram variety (MH-421) disseminated through farmers' participatory approach in Hisar district of Haryana

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ABSTRACT: Under Indian Council of Agricultural Research (ICAR) funded Farmer FIRST Programme, large-scale farmer participatory field demonstrations on green gram variety (MH 421) were organized at three adopted villages *i.e.,* Gurana, Bure and Dubetta in Hisar district, situated in semi-arid region of Western Haryana during three consecutive years from 2018 to 2020 to evaluate the economic feasibility of technology transfer and adoption in green gram. The results of the study revealed a notable enhancement in the average yield of the demonstrated plot with an increase of 16.33 per cent compared to that of the farmers' plots for green gram crops. The average yield of demonstration plots showed significant increases of 16.91 per cent, 12.10 per cent and 20.33 per cent in the years 2018, 2019 and 2020, respectively. The extension gap measured 1.37 q/ha, 1.08 q/ha and 1.50 q/ha while the technology gap amounted to 2.53 q/ha, 2.00 q/ha and 3.00 q/ha during consecutive years, respectively. Over the span of these three years, the yield increment observed in demonstration plots translating to additional income compared to check plots totaled ₹ 5105/ha, ₹ 4184/ha and ₹ 6479/ha, respectively with corresponding B: C ratios of 2.51, 2.69 and 2.27. The high cost of inputs, lack of government support and non-availability of credit in time were the primary constraints faced by green gram growers in adopting recommended production technologies. Hence, the study recommends that a multi-pronged strategy be implemented which includes enhancing green gram production through horizontal and vertical expansion and productivity improvements through better adoption of improved technology.

Key words: Farmer FIRST Programme, green gram, grain yield, net returns, participatory field demonstrations

Pulses are considered crucial food crops worldwide owing to their high protein content. They play a significant role in India's export industry contributing substantially to its economic gains. India holds the distinction of being both the largest producer and consumer of pulses encompassing various types such as grain legumes, peas and beans. Globally, India leads in terms of both area cultivated (42.6%) and production output (28.34%) of pulses (Chury, 2019). However, over time, a number of improved pulse varieties and production technologies have been created, but due to low rate of adoption and low yields, the full potential of these varieties and technologies has yet to be realized (Raghav *et al.,* 2020 and Reddy *et al.*, 2023).

Green gram (*Vigna radiata L.*), also known as moong bean, fits well into every cropping system due to its short duration, low input with minimum care and drought tolerant nature (Islam *et al.,* 2011). Being a leguminous crop, it has the ability to fix atmospheric nitrogen and add organic matter to the soil, which ultimately improves the fertility status of the soil. It is one of the major pulse crops of Haryana, sown

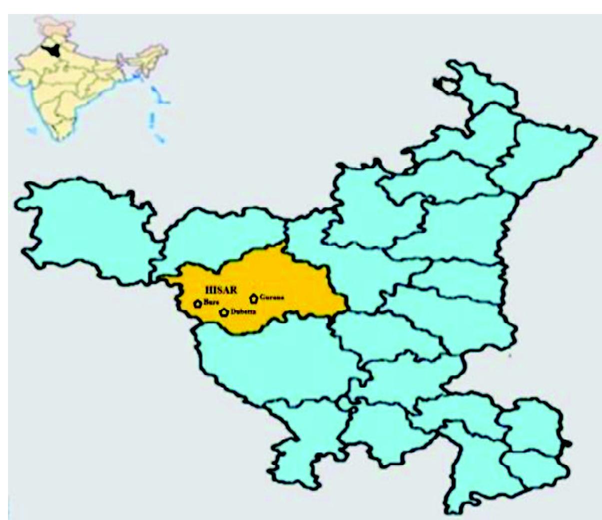

Fig.1. Map of Haryana showing the study area

both in summer and kharif (Debroy *et al.,* 2013). It usually takes about 60 days to mature in the summer and also provides an additional income to the farmers with improved soil fertility (Singh *et al.,* 2019). The land usually remains fallow in the state for about two months after the harvest of wheat and mustard crop. Given this limitation, a high yielding, short duration, medium-dwarf, non-shattering and yellow mosaic virus resistant green gram variety MH-421 has been released by CCS Haryana Agricultural University (CCS HAU), Hisar for commercial cultivation under timely sown irrigated conditions. The average yield of this variety ranges from 10-12 q/ha in summer and 14-15 q/ha in kharif, respectively. Moreover, this timely sown variety would contribute to increasing farmers' income and alleviating the socio-economic poverty of farmers of the north-western plains of India.

The "Farmer FIRST (Farm, Innovation, Research, Science and Technology) Programme" has been initiated by ICAR and is being implemented by CCS HAU, Hisar since October, 2016. It aims to establish a platform for farmers and scientists to foster connections, enhance capacity, facilitate technology adoption and application, manage on-site inputs, gather feedback and foster institution-building endeavors. The project was conducted in three villages of the Hisar district in Haryana, namely Gurana, Bure and Dubetta, which are characterized by limited resources and sandy loam soil. Typically, farmers in these areas rely on locally sourced indigenous seeds for grain production, which exhibit minimal yield potential. Other significant constraints contributing to reduced yield potential include the use of outdated production technologies, such as traditional farming practices, improper crop geometry, imbalanced application of manures and fertilizers, untimely weed management and climatic variability. Considering the above-mentioned facts and nutritional requirement, farmer participatory technological demonstrations on the production of summer green gram (MH-421) were conducted in selected villages with an objective to showcase newly released crop production and protection technologies along with their management practices under different farming conditions and performance was recorded.

MATERIALS AND METHODS

Participatory Technological Demonstration (PTD) is one of the most powerful tools of extension as it ensures the active involvement of the farmers in technology upgradation and refinement (Singh *et al.,* 2020). PTD integrates the development, dissemination and implementation of locally relevant technologies in the field, while also enhancing farmers' experimental skills and knowledge. Under ICAR funded Farmer FIRST Programme, CCS HAU, Hisar conducted PTDs in adopted villages *i.e.* Gurana, Bure & Dubetta in Hisar district of Haryana (Fig.1.) during three consecutive years from 2018 to 2020. Before demonstrations, Participatory Rural Appraisal (PRA) in adopted villages was conducted and technological gaps were identified and calculated using the formulae as described by Katare *et al.* (2011) and Samui *et al.* (2000) and sum-up with the concrete results.

Extension gap = Demonstrated yield – Farmer's practice yield

Technology gap= Potential yield – Demonstration yield

[Potential yield is 'the maximum yield of a given species or cultivar possible achievable under existing conditions of solar radiation flux density with all the other environmental factors considered to be optimal (Reynolds *et al.*, 2011)]

[Demonstration yield is the yield of a crop or product that is recorded in a demonstration plot. (Katare *et al.*, 2011)]

Additional return = Demonstration return – farmer's practice return

$$\text{Technology index} = \frac{(\text{Potential yield - Demonstration yield}) \times 100}{\text{Potential yield}}$$

$$\text{\% increase yield} = \frac{(\text{Demonstration yield - Farmers yield}) \times 100}{\text{Farmers yield}}$$

A total number of 360 participatory technological demonstrations were organized on production of green gram (MH-421) covering 144 hectares using improved variety MH-421 to show case improved production technologies. The farmers' field for conducting PTDs were selected from three adopted villages. Beneficiaries (farmers and farm women) were identified based on their participation and feedback gathered during the preliminary survey, awareness programs and interactive meetings. Each PTD was allocated an area of 0.4 hectares with the farmer's conventional practice serving as the control plot. Continuous monitoring of all demonstrations occurred throughout the entire cropping season and farmers were guided accordingly. Data was collected using a survey method with a pre-tested structured interview schedule administered by field assistants under the direct supervision of the researchers. The yield and economics including gross return, cost of cultivation and Benefit-Cost Ratio (B: C) were assessed at the conclusion of the cropping season. Gross return was determined by multiplying the yield with the prevailing local market price of the grains harvested by the farmers. The cost of cultivation for pulse encompassed expenses for inputs such as seeds, fertilizers and pesticides, either purchased by the farmers (in farmer-managed practices) or provided by the CCS HAU, Hisar (in demonstration plots). Additionally, costs for hired labor (if any), sowing charges for bullocks/tractors (if applicable) and post-harvest operation costs (if any) incurred by the farmers were considered. The study did not account for family labor. The B: C ratio was calculated as the ratio of net returns to the corresponding costs of cultivation following the methodology outlined by Kumari (2007).

RESULTS AND DISCUSSION

Implementation of participatory technological demonstrations

Table 1 indicates that 100, 100 and 160 demonstrations were carried out on 40.0, 40.0 and 64.0 ha area in 2018, 2019 and 2020, respectively. The likely reason for the discrepancy in the number of scheduled demonstrations was the availability of finance/ inputs allocated to CCS HAU, Hisar, provided by ICAR under the scheme. These results were partly supported by the reports of Singh *et al.* (2021), Singh and Sharma (2005) and Jakhar and Kumar (2022).

Technological adoption gaps

Table 2 shows that a full gap was found in the use of improved seed, seed rate, sowing method, seed treatment, bio-fertilizer, weeding and irrigation, all of which contributed to the failure to achieve the potential yield. Farmers primarily used local or old varieties which were accessible in the local market with shopkeepers. Demonstrations were executed adhering to the prescribed sowing period spanning from 20 March to 20 April, strategically chosen to circumvent potential disruptions from pre-monsoon rainfall during the critical harvesting phase. In check plots, farmers typically delayed the sowing of green gram until late April, employed a lower seed rate than recommended, utilized broadcast sowing instead of line sowing, thus complicating intercultural operations and failed to achieve the optimal plant population. Consequently, this led to excessive competition among plants ultimately resulting in decreased yield. Farmers were observed to be applying a higher than recommended dosage of urea in their fields and neglecting the use of herbicides for weed management. Also, they did not use the prescribed pesticides for insect pest management in green gram. Seed treatment and inoculation with bio-fertilizers were implemented to protect the crop against seed-borne diseases. Regrettably, none of the farmers adopted this method, leading to a rise in the number of necessary sprays, disregarding the economic threshold levels and subsequently elevating the cultivation cost per unit area. Time of sowing and plant protection measures revealed a partial adoption gap, as they might be not aware of the potential yield of green gram variety. In addition, farmers were much concerned about importance of land preparation in moong production. This indicates that adoption of green gram production technologies was higher among the beneficiary farmers compared to non-beneficiary farmers. It may be due to the fact that regular interaction of beneficiary farmers with scientists when performing PTDs at their farm has inspired them to gain information and skills for adopting green gram production technologies to optimize their yield and revenue. Kumar and Boparai (2020) and Choudhary *et al.* (2011) also noticed a similar disparity between improved technologies and farmers' practices in the summer moong crop.

Analysis of gaps

Yield gap: It is clear from Table 3 that the average yield of demonstration plots was recorded 9.47 q/ha, 10.00 q/ha and 9.00 q/ha in years 2018, 2019 and 2020, respectively against the potential yield of variety *i.e.*, 12.0 q/ha. Beside this, yield under farmers' practice was 8.10 q/ha, 8.92 q/ha and 7.50 q/ha for the corresponding years The average yield of demonstration plots showed significant increases of 16.91 per cent, 12.10 per cent and 20.33 per cent in the years 2018, 2019 and 2020, respectively. In general, grain yields in PTD plots consistently surpassed those in local checks across all years. This can be attributed to the adoption of superior varieties, seed treatments, recommended fertilizer dosages and diligent plant protection practices implemented by both demonstrators and scientists in the demonstration plots. This stresses the importance of technologically upgrading field agricultural extension personnel's expertise of green gram production technology either through specialized field training or brief in-service training and visits to research stations. Similar findings of yield enhancement of the green gram crop under technological demonstrations were reported by Kumar *et al.* (2018).

Extension gap: An extension gap of 1.37 q/ha, 1.08 q/ha and 1.50 q/ha was observed during 2018, 2019 and 2020, respectively. The average extension gap was 1.31 q/ha (Table 3). Such a gap might be attributed to the adoption of improved technology in demonstrations which resulted in higher seed yield than traditional farmers' practices. The disparity could be narrowed through various extension activities such as training programs focused on the latest advancements in production and protection technologies incorporating high-yielding varieties. Additionally, awareness campaigns, *kisan gosthis* on integrated pest and nutrient management and effective communication via print and electronic media channels can significantly contribute to this goal. These initiatives possess the capacity to empower farmers to adopt innovative and improved crop production techniques thereby facilitating a reduction in the extension gap. The findings are similar to those reported by Kumar *et al.* (2022), Kumar *et al.* (2010) and Dayanand *et al.* (2012).

Technological gap: A gap of 2.53 q/ha, 2.00 q/ha and 3.00 q/ha was observed in years 2018, 2019 and 2020, respectively. It demonstrates that there is still a gap in technology demonstration as a consequence of which the recipient farmers are unable to harvest the potential yield with better practices. The observed technological gap might be attributable to a variety of factors such as soil fertility, low moisture content availability, sowing timing, climate hazards and so on. Hence, it appears that location-specific recommendations for cultivars, soil testing and timely planting are required to close the production gap. Comparable findings were observed by Chandra (2010) in moong bean and Mishra *et al.* (2009) in potato.

Technology index: It varied from 21.08 per cent, 16.66 per cent and 25.00 per cent during 2018, 2019 and 2020, respectively. This highlights a discrepancy between the developed technology for green gram cultivation at research institutions and its distribution to farmers. Similar findings were reported by Islam *et al.* (2011), Saravanakumar (2021), Kumar *et al.* (2019) and Sandhu and Dhaliwal *et al.* (2016) who also reported a significant degree of technology index in case of technologies demonstrated. Nevertheless, this index can be reduced through the effective adoption of demonstrated technical interventions aimed at enhancing the yield performance of the green gram crop.

Economic analysis

The economic analysis of demonstrations has been presented in Table 4. The expenditure incurred on cultivation practices and inputs was slightly higher in participatory technological demonstrations. The average gross return of ₹ 42615, ₹ 48000 and ₹ 45000/ha was calculated in the years 2018, 2019 and 2020 respectively. The average net returns for respective years to the tune of ₹ 25665, ₹ 30200 and ₹ 25180/ha was recorded during the study period. Moreover, it was observed that the additional return varied between ₹ 4184/ha to ₹ 6479/ha, potentially stemming from the utilization of enhanced technologies within the participatory technological demonstration plots. The benefit-cost ratio (BCR)

Table 1: Participatory technological demonstrations implemented during 2018-20.

Particulars	2018	2019	2020	Total
Number of PTDs*	100	100	160	360
Area (ha)	40.0	40.0	64.0	144
Farmers benefitted	100	100	160	360

Note: * PTDs =Participatory technological demonstrations

Table 2: Technological gap in PTDs and farmers' practice of green gram

Technology	Recommended Practice	Existing practice	Technological Gap
Land preparation	Two to three operations by harrow or cultivator followed by planking	Two to three operations by harrow or cultivator followed by planking	No gap
Variety	MH-421	Local variety (available at shop keeper)	Full gap (100 %)
Time of sowing	March, 20 to April, 20	20 April to 5 May	Partial gap
Method of sowing	Line sowing (22.5 cm x 7 cm)	Broadcasting	Full gap (100 %)
Seed rate	20-25 kg/ha	10-12 kg/ha	Full gap (100 %)
Seed treatment	Carbendazim 50 WP @2.5gm/kg seed	No seed treatment	Full gap (100 %)
Fertilizer dose (kg/ha)	35 kg urea + 250 kg SSP/ha as basal dose	Irrational use (only urea)	Partial gap (15-20 % more than recommendation)
Bio-fertilizer	Rhizobium (125 ml/ha seed) and PSB (125 ml/ha seed)	No inoculation	Full gap (100 %)
Irrigation	Two-Three irrigations including the pre-sowing irrigation	Untimely irrigation	Full gap (100%)
Weed management	Pendimethalin 30 EC @ 3.3 l/ha (pre-emergence) used + One hand weeding	Not used	Full gap (100 %)
Plant protection measures	Spray of Dimethoate 30 EC @ 625 ml in 500 litre of water/ha for control of whitefly and aphid.	Indiscriminate use of plant protection measures	Partial gap

Table 3: Yield, extension and technology gap analysis of PTDs and farmers practice of green gram (MH-421)

Year	Yield (q/ha)			Increase over farmers practice (%)	Extension Gap (q/ha)	Technological Gap (q/ha)	Technology Index (%)
	Potential	PTD*	Farmers' practice				
2018	12.0	9.47	8.10	16.91	1.37	2.53	21.08
2019	12.0	10.00	8.92	12.10	1.08	2.00	16.66
2020	12.0	9.00	7.50	20.00	1.50	3.00	25.00
Mean	12.0	9.49	8.17	16.33	1.31	2.51	20.91

*PTD = Participatory technological demonstration

Table 4: Economic analysis of PTDs and farmers' practice of green gram (MH-421)

Year	Average cost of cultivation (₹/ha)		Average gross return (₹/ha)		Average Net return (₹/ha)		Additional return (Rs/ha)	B: C Ratio	
	PTD*	FP**	PTD	FP	PTD	FP		PTD	FP
2018	16950	15890	42615	36450	25665	20560	5105	2.51	2.29
2019	17800	16800	48000	42816	30200	26016	4184	2.69	2.54
2020	19820	18790	45000	37500	25180	18710	6479	2.27	1.99
Mean	18190	22456	45205	38922	27015	21762	5256	2.49	2.27

*PTD = Participatory technological demonstration, ** FP =Farmer practice, B: C = Benefit-Cost ratio

remained at par across all years. PTD participating farmers experienced an approximate additional income of ₹ 5256/ha compared to conventional farming practices. Comparable outcomes were

Table 5: Constraints faced by green gram growers in adopting recommended production technologies (n=360)

Constraints	Number (%)	Rank order
Non availability of seed of improved varieties	224 (62.22)	VII
High cost of inputs	345(95.83)	I
Lack of transportation facilities	289(80.27)	IV
Non-availability of credit in time	310(86.11)	III
Lack of timely technical guidance	261(72.50)	VI
Irregular supply of irrigation	156(43.33)	IX
Lack of market facility	213 (59.16)	VIII
Fluctuations in market rate	286(79.44)	V
Lack of government support	324(90.00)	II

reported by Raghav *et al.* (2021), Singh *et al.* (2017) and Kumar and Boparai (2020) in moong bean cultivation, where the benefit-cost ratio ranged from 1.92 to 2.44 throughout their study duration.

Constraints faced by green gram growers in adopting recommended production technologies

Table 5 indicates a number of constraints that affects the adoption of improved production technologies in green gram crop. It reveals that a great majority of the respondents (95.43%) ranked 'High cost of inputs' as first major constraint followed by 'Lack of government support' (90.00%), 'Non-availability of credit in time' (86.11%), 'Lack of transportation facilities' (80.27%), 'Fluctuations in market rate' (79.44%), 'Lack of timely technical guidance'(72.50%), 'Non-availability of seed of improved varieties' (62.22%), 'Lack of market facility' (59.16%) and 'irregular supply of irrigation' (43.33%) with ranks II, III, IV, V, VI, VII, VIII and IX, respectively. The results of the study highlight the need for developing a robust strategy to address the challenges and provide effective solutions for green gram growers.

CONCLUSION

The study concludes that the participatory field demonstrations conducted by CCS HAU, Hisar under FFP have enhanced the yield of green gram and ensured rapid spread of recommended technologies for green gram production by conducting a range of extension activities such as training programs, field days and exposure visits held in farmers' fields. Nevertheless, a disparity was evident in potential yield, demonstration yield and farmers' practices due to the prevailing technical extension gap. Furthermore, the high cost of inputs, lack of government support and non-availability of credit in time were the primary constraints faced by green gram growers in adopting recommended production technologies. To address these challenges, policymakers should focus on reducing input costs through subsidies or bulk procurement programs, improving access to timely and affordable credit by streamlining loan processes and offering low-interest options and enhancing government support through targeted extension services and financial incentives. Establishing farmer cooperatives and strengthening market linkages can further empower growers to access inputs and credit more effectively. Moreover, interventions showcased necessitate site-specific adjustments to ensure their desired impact on the production and productivity of green gram. District extension agencies must also provide sufficient technical help to farmers using different educational and extension approaches in order to close the extension gap and increase green gram production in the district.

ACKNOWLEGEMENTS

The authors are highly grateful to the Indian Council of Agricultural Research for funding the Farmer FIRST Programme which helped to meet costs of conducting participatory technological demo-nstrations.

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Received: November 13, 2024
Accepted: December 06, 2024