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Green gram (*Vigna radiata)* yield, technology index and extension gap analysis with soil health management in the district Sultalpur (U.P.)

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Abstract

Background: At present there are 731 out of which 66 under ICAR Institute the major mandatory activity of KVKs are OFTs, FLDs and trainings soil testing laboratory is neglected due to unavailability of any funds from any sources myself taken soil samples from farmers fields from 2009-2022 maximum samples were analysed by me in my laboratory at sultanpur. Green gram is one of the important crops among the pulses. Kharif green gram proved to be an effective crop are the restorer of soil fertility as fixing atmospheric nitrogen in the soil, cover crops, reduces soil erosion by winds in summer and by water in rainy season, used as green manure crops in rice-wheat cropping systems providing additional income to the farmers, provide dietary proteins to the large vegetarian population of the country and its works as catch crop and fits in Paddy-Wheat crop rotation in Sultanpur region of India. This crop holds the key to increase the income of the farmers and to achieve self-sufficiency in pulse production. Physically soil texture is clay loam to sandy loam soil fertility status regarding major and micronutrients very low to high in the Sandila and in case of biological properties excellent to very poor population of earthworms and fungi were recorded due to energy source in soil is organic carbon and salinity. Soil colour varried from white to grey measured by Munsell colour soil chart. Soil health cards regarding information given among farmers among farmers on the occassion of World Soil Day 5 th December.

Methods: A total 25 trials on green gram (IPM 02-03) were carried out by scientist at farmers field in 5 ha area during *kharif* season 2016-17 to 2019-20 to study was on performance of green gram in sultanpur district Prevailing farmer's practices were treated as control for comparison with demonstrated technology.

Result: The result of trials conducted by SMS in green gram (IPM 02-03) crop shows a better impact on farmer's livelihood due to significant increase in yield (961.3 kg ha^{-1}) over local check (772.7 kg ha^{-1}) with average 24.54% increased yield. The technology gap ranged between 218 kg to 270 kg ha^{-1} and the extension gap trend of ranged between 166 to 202 kg ha^{-1}. The economics of improved practices was revealed, the viability of enhanced technology, with a net return of Rs.61960 ha^{-1} and a benefit-cost ratio (BCR) of 2.95, compared to Rs. 40814 ha^{-1} and 2.61 for farmers practices**.** A wide range of technology gaps and extension gaps had a detrimental influence on yield output and net return. The results revealed that the adoption of high yielding variety IPM 2-3 with full package of practices increased green gram productivity with a significant reduction in extension and technology gap.

Keywords: Green gram, Trials (OFTs), Impact, Net return, Technology index, Technology gap and Extension gaps.

Introduction

Pulses are an important ingredient in the vegetarian diet of Indian masses. These are important because these have a high value for maintaining the optimal blood sugar levels and also restoring energy over a long period of time after the meals because the carbohydrates provided by pulses are released slowly as compared to cereals. Green gram is excellent source of high quality protein. Moong is consumed as whole grains, sprouted form as well as dhal in a variety of ways in homes. It is also used as green manuring crop for increased soil fertility and carbon source. It can be nitrogen fixation through atmospheric environment. Moong can be used as a feed for cattle even husk of the seed can be soaked in water and used as cattle feed. Mungbean (*Vignaradiata*) is one of the most important pulse crops. It is grown in almost all parts of the country. Mungbean is primarily a crop of rainy season; however, with the development of early maturing varieties, it has proved to be an ideal crop for spring and summer seasons. Indian contributions around 25% in global pulses production, it however, consumes 30% and imports around 14% of its pulses requirements (Singh *et. al*.2017a)[9]. India is one of the largest producer as well as consumer of a wide variety of pulses that is dominated by the tropical and sub-tropical crops such as chickpea, black gram, pigeon pea, green gram and lentil. Pulses play an important role in sustaining food and nutritional security as well as environmental sustainability in India. India occupies an area under Moong crop 428.81 MH with production of 212.24 Mt. and productivity495 kg/ha. (Anonymous 2020-21)[3]. In India's major ten states are growing Moong namely, Rajasthan (190.25 MH), Maharashtra (42.2 MH), Karnataka (39.4MH), Madhya Pradesh (36.8 MH), Odisha (26.2 MH), Tamil Nadu (18.6 MH) Bihar (17.1 MH), Andhra Pradesh (14.3 MH), Gujarat (13.6 MH) and Telangana (9.9 MH) respectively. The highest productivity was higher of

Nagaland State (1060kg/ha). (Anonymous 2020-21) [3]. It advocates the need to diversify from cereal–based cropping systems to pulses-based cropping system with certain policy decisions like crop diversification, improving seed replacement rate, improved crop production techniques etc. During the same period population grew at faster rate than the rate of increase in pulses production. Consequently, the per capita availability of pulses declined from 60.54 grams in 1950-51 to 43.83 grams in 2015-16 against the minimum requirement (based on ICMR norms for sedentary activity) of 68.49 grams. Further, slow growth in production of pulses is accompanied by wide regional variations, temporal fluctuations and unfavorable revenue terms of trade with fine cereals and oilseeds. The poor production performance of pulses coupled with lack of assured market creates imbalance in demand and supply, and results in soaring import bills and unpredictable changes in prices. India is the world's largest producer of pulses. Although the production of pulses is increasing, its level remained insufficient to meet the growing demand. The deficit between domestic demand and production is, therefore, met through the import. During the past two decades, import of pulses has increased from less than one million tonnes during biennium ending (BE) 1996-97 to 6.66 million tonnes in 2016-17.

The level of buffer stock of pulses to be maintained in the country for supply stabilization during the next five years is estimated as under: 2017-18: 15.37 lakh tonne 2018-19: 15.76 Lakh tonne 12 2019-20: 16.15 lakh tonne 2020-21: 16.53 lakh tonne 2021-22: 16.92 lakh tonne. India is the world's largest producer of pulses. Although the production of pulses is increasing, its level remained insufficient to meet the growing demand. The deficit between domestic demand and production is, therefore, met through the import. During the past two decades, import of pulses has increased from less than one million tonnes during biennium ending (BE) 1996-97 to 6.66 million tonnes in 2016-17.

Table 1

S. No.	Operation	Demonstrated improved technology	Farmer's practice
1.	Variety	IPM 02-03	Unknown variety
2.	Soil & Seed treatment	Bavstin @ 2 g/kg, *Rhizobium spp* @ 250 g per =8 kg seeds and Thiomethoxam @ 8g/kg seed before one day sowing	Generally, not practiced
3.	Date of Sowing	1nd week of June	3th week of July
4.	Method of sowing and spacing	Line sowing, 40 x 20 cm	Broadcasting
5.	Fertilizer N-P-K-S and Application time	25 tonnes FYM, N-18kg+35kg P+S-15kg+ 15kg Sulphar/ha	15 tonnes N-40kg+P-70kg
6.	No. of Irrigation	3-5	2-7
7.	Weed management	Fluchloralin or Pendimethalin of 1.0kg a.i. at pre-emergence stage	Hand weeding at 40-60 days after sowing
8.	Plant protection	Seed treatment with Thiomethoxam 30 FS @ 6.0g/kg seed and Bavistin @2.2g/kg seed With the appearance of pod borer and whitefly foliar spray with Chloropyriphos + cypermethrin @ 1.25ml/liter and Thiomethoxam 7.2g/liter water at 20 days interval	Generally, not practiced

The study was carried out by the scientist during *kharf* season 2016-17 to 2019-20. The FLDs were conducted in the adopted villages for randomization of conducted front line demonstrations (FLDs) in adopted villages under two talukas of district. The materials and methods taken for the frontline demonstrations are given in Table 1. A total of 48 front line demonstrations were organized in a 15 ha area at different locations. Locally cultivated varieties were used as local check. Before conducting FLDs, we were collected information basic data on crop production techniques, soil characteristics, suitable high yielding varieties and the occurrence of insect-pests through field surveys and farmer meetings to determine the current condition in green gram production and as a result, necessary information's use in cultivation practices were implemented. Improved package and practices have used in farming technology, including a high yielding variety of green gram and a whole package of operations were demonstrated in various locations over 15 hectare area. The soils in the study are were primarily sandy loam to clay loam with pH, EC, (Jackson, M.L. 1967). OC, (Walkley, A. and Black, C.A. 1934) P_2O_5, (watanabe, F.S. and Olsen, S.R. 1956). values ranging from 7.60 to 8.20, 0.15 to 0.58 dSm^{-1}, 0.2 to 0.5%, 9 kg/ha to 25 kg/ha, respectively.

Optimum time of sowing of *kharif* moong is second fortnight of July, however, farmers usually sowing it after third fortnight of July, which resulted in less productivity due to humid conditions during maturity time, While the harvest took place between the last September and first fortnights of October. The harvested crop and dried was Threshing or manual when the pods became black and a few pods dry out. As shown in Table 1, farmers got important inputs such as seed, fertiliser, and plant protection chemicals. Farmers who were chosen for FLDs were instructed and provided detailed information on how to properly cultivate green gram using the recommended package. Farmers, on the other hand, were permitted to carry out their own practises in a farmer's practise or a local check. Field days and farmer meetings were conducted so that other farmers could learn about the benefits of the varieties and technologies on display. For comparison study, data on several parameters such as seed yield and percent insect-pest and disease incidence were gathered separately from both improved practise (IP) and farmer's practise (FP). Furthermore, data were tabulated and analysed by using statistical tools like frequency and percentage.

Cost of cultivation was calculated for both practices *viz*., improved practices and farmers' practice which include cost of inputs namely seed, fertilizers (chemical and bio-fertilizer), pesticides and herbicides as well as hired labour except family members, field preparation and sowing cost, harvesting and transportation cost. Average gross and net returns were calculated on the basis of sale price of grain in local market. Benefit: cost ratio was also calculated as a ratio of net-return with corresponding cost of cultivation, Singh, *et al*., (2019) [11]. Following formula were used to calculation for extension gap, technology gap and technology index for improved practices and local check (Yadav *et al*., 2004 & Samui et.al., 2000).

Technology gap (Eg) = Potential yield (Py)– Demonstration plot yield (Dy)
Extension gap (Eg) = Demonstration yield (Dy) – Farmers practices (Fp)
Technology index (Ti in %) = [(Py – Dy)/Py] x 100
Additional cost in improved technology (ACIT in Rs/ha) = Cost of improved technology (Cit) - Cost of farmers practice (Cfp).
Additional returns (Ar in Rs/ha) = Net returns of improved technology (Nrit) -Net returns of farmers practice (Nrfp).
Effective gain (Eg in Rs/ha) =Additional returns of improved technology (Arit) -Additional cost of improved technology (Acit)
Benefit cost ratio (BCR) = Gross monetary returns in Rs/ha (GMR) /Gross monetary expenditure in q/ha (GME).
Incremental cost benefit ratio (ICBR) = Additional net returns in Rs/ha (Anr)/ Additional cost of improved technology (Acit) in Rs/ha.

Results and Discussion

Front Line demonstration is a new concept of field demonstration evolved by ICAR New Delhi. The main objective of frontline demonstrations is to demonstrate newly released crop variety, production technologies and its management, practices in the farmer's field.

Analysis of yield gap

The grain yield of green gram was higher in the demonstration field than in the local practise in t throughout *kharif*, 2016-17 to 2019-20, according to the data presented in table-2. Following data analysis, it was shown that better technical intervention led in a 24.54% greater green gram seed production of 961kg/ha compared to 772.7kg/ha recorded with existing techniques (farmers practise) as shown in Table-2. Similar results was reported by *Jogender Singh, et al.* (2021) [10].

Table 2: Seed yield, extension gap, technology gap, technology index of green gram as grown under improved practices and local check:

Year	Yield (kg/ha)			% increased yield over FP	Technology Gap (kg ha^{1})	Extension Gap (kg ha^{1})	Technology Index (%)
	Potential	Demo	Local Check				
2016-17	1200	937	748	25.53	263	191	21.92
2017-18	1200	941	775	21.42	259	166	21.58
2018-19	1200	982	780	25.96	218	202	18.17
2019-20	1200	985	788	25.23	270	196	21.50
Mean	1200	961	772.7	24.54	252.5	188.75	20.79

Analysis of extension gap

The extension gap is a metric used to analysis of the yield difference between an improved practices and local practice. During the *kharif* season, 2016-17 to 2019-20, a extension gap of between demonstration plot 166 kg ha^{-1} to 202 kg/ha and average gap was recorded (table 2). In the improved practices plot, the average extension gap was observed 188.75 kg ha-^{1}, which has to be minimized via various extension approaches like adoption of high yielding varieties, training programmes, kisan gosthies, and better agro technologies to reverse this trend of broad extension gap. This finding is in corroboration with the findings of Singh, *et al.,* (2019) [11].

Analysis of technology gap

The technology gap is the key indicator of the efficacy, efficiency and performance of any technology in location specific of the agro-ecological condition. This technology gap in the present investigation wide ranged from 218 kg ha-1 in 2018-19 to 270 kg ha^{-1} in 2019-20. Under the four-year FLD study, the average technology gap was 252.5 kg/ha as shown in table-2. It is shown that there is still gap in technology demonstration as a result of which the potential yield of improved practices could not be achieved by the adopting farmers, variation in soil fertility, weather conditions at maturity of mung crop management practices *etc*. Therefore, there is an urgent need to recommend location specific technology package are necessary to reduce the technology ga crop management practices to pass over the potential demonstration yield. The similar findings were recorded by Dhillin (2016) and Malik *et al*., (2021) [7].

Technology index

The ratio between technology gap and potential yield expressed as percentage is technology index. The technology index shows the feasibility of the evolved technology at the farmers' field. It also demonstrates the viability of advanced technologies in farmers' fields. According to the results (Table 2), the highest technology index value of 21.92% was recorded in *Kharif*, 2016-17, while the lowest technology index value of 18.17% was recorded in *Kharif*, 2018-19. The period of four consecutive years of front line demonstrations on pulse programme, the average technology index in castor crop was 20.79%. This variation indicates that the result difference according soil fertility condition, weather condition and mismanagement of crop. With adoption of improved practices, the technology gap can be reduced as a result technology index will be reduced. Similar findings were reported by Singh, *et al.*, 2019 and Singh T. and Tetarwal (2022) [13].

Economic analysis

The data show in Table-3 show the cost of cultivation, gross return, net return, and benefit cost ratio (BCR) of green gram crop in improved practise under front line demonstration and existing farmers' practise. The average cost of cultivation in enhanced practise (Rs.21,153 ha^{-1}) compared to conventional methods (Rs.19,288 ha^{-1}). On an average an additional investment of 1903.5/ha was made under demonstration on green gram. The average cost of cultivation increased by 9.90 per cent in green gram with improved technological interventions as compared to farmers practice. The demonstration plot (Rs.61960 ha^{-1}) recorded considerably greater average gross returns than farmers' practises (Rs.50,049 ha^{-1}). were higher.
The average net returns was in demonstration in green gram Rs.40,814/ha as compare to farmers practices of Rs.30, 721/ha. The study found average additional net returns of 10,137/ha from the demonstrated plots of green gram and

this was due to differences in cost of cultivation and higher cost in marketable price.

In consequence, average gross monetary return increased by 24.54 per cent in green gram indicating the importance of improved technologies. The higher gross monetary return realized by the farmers indicate the economic feasibility of the technology.

The data presented in Table 3 also revealed the expenditure involved in the demonstrated plot is higher than the farmers' field due to additional cost of cultivation but the yield obtained is also higher in the demonstrated plot that is Confirmed by the comparative result obtained by calculating the cost benefit ratio.

The effective average gain was received as Rs.8219/ha and whereas BC ration was found in farmer's practise (2.61) and in demonstration plot (2.95) in green gram respectively, The average incremental cost benefit ratio was 5.53 green gram, indicating a good return of each additional rupee invested on IT in all the pulse crops. Similar findings were also reported in frontline demonstrations on pulse crops by Dwivedi *et al.*, 2014 and Singh T. and Tetarwal, A.S. (2022) [13] also reported higher yield and net returns as well as benefit cost ratio as compared to local practices.

Table 3: Impact of technological interventions on green gram in relation to gap on economics during 2016-17 to 2019-20

Year	CoC (Rs/ha)		CoC increase over FP (%)	GMR (Rs/ha)		GMR increase over FP (%)	NR (Rs/ha)		NR increase over FP (%)	ACoC in IP (Rs/ha)	ANR (Rs/ha)	BCR		ICBR	Effective gain (Rs/ha)
	IT	FP		IT	FP		IT	FP				IT	FP		
2016-17	22610	20000	13.05	65611	52265	25.53	43001	32265	33.27	2610	10736	2.90	2.61	4.11	8126
2017-18	20000	18500	8.11	65870	54250	21.42	45870	35750	28.31	1500	10120	3.29	2.93	6.75	8620
2018-19	20500	18900	8.47	54010	42900	25.96	33510	24000	39.63	1600	9510	2.63	2.27	5.94	7910
2019-20	21500	19750	9.95	62350	50780	25.23	40870	30870	33.00	1904	10180	2.98	2.64	5.32	8218
Average	21153	19288	9.90	61960	50049	24.54	40814	30721	33.55	1903.5	10137	2.95	2.61	5.53	8219

CoC= Cost of cultivation; IT= improved technological interventions; FP= Farmers' practice GMR= Gross monetary returns; ACoC= Additional cost of cultivation; NR= Net Returns; ANR= Additional net returns; BCR= Benefit cost ratio; ICBR=Incremental cost benefit ratio.

Technical Feedback on the demonstrated technologies (IPM 02-03): Fine seeded, medium branching, YVM, SMD and Pod borer resistant. At lower topography of soil, if soil dig for bricks purposes YMV occures. KVK, Kushinagar assessed the technology on Mungbean and found best one is raised bed sowing over others practices of farmers like broad casting and flat bed sowing. As compared to conventional planting, growing of Mungbean on beds not only save fuels and labour but also water, seed, fertilizer and pesticides, besides maintaining the same or higher crop productivity. It also improves soil physical conditions as evident from the reduction in soil bulk density and increase in root growth of Mungbean. Weed control very effective within 15 days of application of Imazethapyr 10% SL, 1.0 L./ ha. + 0.2 L./ha. Quizalofop ethyle 5% EC. It also improves soil physical conditions as evident from the reduction in soil bulk density and increase in root growth of Mungbean.

Demonstrated technologies Green gram at farmers field (IPM 02-03)

Farmers' reactions on specific technologies (IPM 02-03) High yielding, Fine seeded, medium branching, YVM, SMD and Pod borer resistant and field suitable for paddy in kharif. Weeds like hoorhur (*Cassia spp*.) control very easly by use of weedicide Imazethapyr 10% SL, 1.0 L./ ha. + 0.2 L./ha. Quizalofop ethyle 5% EC.

Conclusions

The present study comprehensively showed that green gram proved to be an effective crop are the restorer of soil fertility as fixing atmospheric nitrogen in the soil, cover crops reduces soil erosion by winds in summer and by water in rainy season, there is a gap in potential yield, demonstration yield and farmers' practice due to existing technological extension gap and FLDs had positive effect towards increase in yield of green gram. The two advantage of this technology i.e. enhancing farmers' income and enhance soil health. Therefore, front line demonstration (FLD) being an good approaches for changing in knowledge, skills and attitude of farmers and enhances production and productivity of kharif green gram in the district. It is helpful to minimizing the yield gap and contributes towards increase in area under kharif green gram in the district. The demonstration's economic feasibility was explained by the significant benefit-cost ratio, which persuaded the farmers to implement the intervention. Frontline demonstrations are a good proven technology of mass awareness and motivate farmers to adopt improved kharif green gram cultivation.

The horizontal distribution of improved technologies may be achieved by the successful execution of front-line demonstration and different extension activities such as training, field days, and exposure visits arranged through FLDs programmes in farmers' fields. We can concluded that green gram is used as soil health manager in the district sultanpur. Farmers assessed soil health by feel methods and told that the improvement of soil health is recorded afterv harvesting of green gram.

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