Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 2491-2494
Received: 01-03-2019
Accepted: 03-04-2019

KY Khairnar
Junior Research Assistant, Department of Agricultural Economics, MPKV Rahuri, Maharashtra, India

VG Pokharkar
Agriculture Research Officer, Department of Agricultural Economics, MPKV Rahuri, Maharashtra, India

SA Kadam
Senior Research Assistant, Department of Agricultural Economics, MPKV Rahuri, Maharashtra, India

DB Yadav
Head of Department, Department of Agricultural Economics, MPKV Rahuri, Maharashtra, India

Correspondence
KY Khairnar
Junior Research Assistant, Department of Agricultural Economics, MPKV Rahuri, Maharashtra, India

Green gram production technology: An economic analysis

KY Khairnar, VG Pokharkar, SA Kadam and DB Yadav

Abstract
Green gram is the third important pulse crop of India grown in nearly 8 per cent of the total pulse area of the country. it is designated as "poor man's meat." The present study attempted to estimate the extent of adoption of improved production technology, impact of the green gram technologies on employment and income pattern, the yield gap of green gram crop. Total 144 growers from 13 clusters were selected for the study. The result showed that the recommended land use was adopted by green gram growers to the extent 95.83 per cent. sowing distance contributed 99.31 per cent at the highest level followed by sowing time (90.97 per cent), preparatory tillage (80.09 per cent) and seed rate (73.96 per cent) were the highest in case of green gram growers but the irrigation was almost negligible.
The employment was increased by 21.28 and 31.58 per cent in low to medium and medium to high level of adoption while, the income increased by 13.08 and 20.19 per cent. The results concluded that the employment and income was increased from low to high adopters. The returns of Rs. 5332.54 were added in medium adopters as compared to low adopters, while the returns of Rs. 9307.83 were added in high over medium adopters. The IBCR was estimated to 1.26 and 1.73 for medium and high adopters, respectively. There exists a yield gap of 48.73 per cent in green gram production.
Bullock labour, machine power, P fertilizers in case of green gram were highly positively significant at 1 per cent level of significance indicating that these are the important variables for which output is responsive. Therefore, it is recommended that farmers may adopt these technologies at the maximum level to improve the productivity of green gram.

Keywords: Green gram, impact, productivity, employment and income

Introduction
India is the highest producer as well as consumer of pulses in the world. Pulses play a vital role in Indian Agriculture. In India, total production of pulses is 23.95 million tons (Anonymous, 2017-18) [2]. Pulses are the major source of dietary proteins in the vegetarian diet of our country. Besides being the source of proteins, they maintain soil fertility through biological nitrogen fixation and thus play a vital role in furthering sustainable agriculture (Kannaiyan, 1999) [2].
Green gram is the third important pulse crop of India grown in nearly 8 per cent of the total pulse area of the country. Its seed contains 24.7% protein due to its supply of cheaper protein source, it is designated as "poor man's meat" (Potter and Hotchkiss, 1997) [4]. Every100 g of mungbean seeds contains 132 mg calcium, 6.74 mg iron, 189 mg magnesium, 367 mg phosphorus and 124 mg potassium and vitamins (Haytowitz and Matthews, 1986). Green gram has high digestibility and palatability, its pods are used as green vegetable. Its whole grains and split grains are used as dal and curry. Being highly digestible, its curry is generally recommended for patients. Its flour is used in various preparations like, halwa, savoury dishes, snacks, pakoras and fried dal, to get very delicious and nutritious products. Its green plants, chopped and mixed with other fodders are palatable feed for animals. It is also used as green manuring crop, which adds nitrogen in addition to humus to the soil. It is a soil protecting crop in rainy season. Cooked dal of green gram is a very digestive food for invalid and sick persons. Its regular use during childhood, pregnancy and lactation helps one to get the required nutrition and promote health. It is an aperients i.e. a laxative. When given in large quantities. The soup made from it is best article of diet after recovery from acute illness.
Green gram attained its commercial importance in Indian agriculture and also in Maharashtra. In India, Green gram occupies 43.26 million ha area with the production of 21.65 million tones.
In this context, the present study was undertaken with following objectives:

Objectives
1. To study the extent of adoption of green gram improved production technology.

2. To study impact of the green gram technologies on employment and income pattern.
3. To estimate the yield gap of green gram crop.
4. To study the resource use productivities of major inputs of green gram.
5. To estimate the contribution of technology in yield of green gram.

Materials and Methods

The random sampling design was adopted with tahsil as a primary unit, village as the secondary unit and the green gram grower as an ultimate unit of sampling. This study has been carried out in 13 tahsils which were selected on the basis of crop complex approach i.e. the proportionate area under green gram crop, from ten districts of western Maharashtra. From each selected tahsil, a village having the highest area under green gram was considered for the study. On the basis of operational holding, Total 144 green gram growers from 13 clusters were selected for the study.

The data pertaining 2017-18 was collected by cost accounting method with the help of specially designed schedules for the purpose. The analysis was carried out by using tabular method as well as functional approach.

Technology Adoption Index (T. A. I.)

To assess the extent of adoption of improved crop production technology of green gram, the concept of technology adoption index was used. The score was assigned to each technology separately.

Technology Adoption Index (TAI) was worked out as per Kiresur *et. al*. (1996) with the help of following formula,

TAI = (Ai / Mi) x 100

Where,

Ai = Average adoption score registered by the farmer for particular component

Mi = Maximum adoption score registered for the particular component.

After estimating the TAI, the TAI was arranged by ascending order and then the adopters were categorized into low, medium and high adopters on the basis of mean and standard deviation i.e. below mean – S.D.(low adopters), mean-S.D. to mean +S.D. (medium adopters) and higher than mean + S.D. (high adopters).

Functional Analysis

I. Resource Productivity

In order to know the factors influencing resource use productivity of different green gram crop, the functional analysis was carried out by using Cobb-Douglas type of production function,

$$Y = a X1^{b1} X2^{b2} X3^{b3} X4^{b4} X5^{b5} X6^{b6} X7^{b7} X8^{b8} eu$$

Where,

X_1 = Human labour (Man days/ha.)
X_2 = Bullock labour (Pair days/ha.)
X_3 = Machine power (Hrs./ ha)
X_4 = Manure (q/ha)
X_5 = N (Kg. /ha.)
X_6 = P (Kg. /ha.)
X_7 = Irrigation (numbers/ ha)
X_8 = Adoption Index (%)
a = Constant
u = Error term
bi's = Regression coefficients or output elasticities

II. Yield gap of green gram

The yield gap was estimated by using the methodology developed by International Rice Research Institute (IRRI), Manila, Philippines. The yield gap was estimated as below.

$$\text{Yield Gap} = Yd - Ya$$

Where,

Yd = Potential Farm Yield (Yield realized on demonstration plot)

Ya = Actual Yield (Yield realized on sample farm)

Results

1. Distribution of sample cultivators

The selected sample cultivators were grouped as low, medium and high adopters on the basis of estimated Technology Adoption Index and shown in Table 1.

The sample cultivators were grouped as low (below Mean - SD), medium (Mean – SD to Mean + SD) and high adopters (higher than Mean + SD) on the basis of mean and standard deviation of Technology Adoption Index.

Table 1: Distribution of green gram cultivators according to Adoption Index

Particulars		Adopters			Total
		Low	Medium	High	
Green gram	TAI	Below 43.49	43.50 - 64.11	Above 64.11	144 (100.00)
	Number	22 (15.28)	92 (63.89)	30 (20.83)	

(Figures in the parentheses are the percentages to the respective totals)

The mean and standard deviation for green gram were 53.80 and 10.31 respectively. The total 144 sample was distributed as 15.28, 63.89 and 20.83 per cent, respectively. The similar approach for classifying group of farmers on the basis of Technology Adoption Index (TAI) for bajra crop was used by Nirgude and Sonawane (2017) [3, 7, 8].

2. Extent of adoption

The recommended technology wise adoption index is very important to know the technology wise extent of adoption. The detailed technology wise extent of adoption is depicted in Table 2.

Table 2: Extent of technology adoption

S. No.	Particulars	Green gram			
		Adopters			Overall
		Low	Medium	High	
1	Land use	86.36	96.74	100.00	95.83
2	Preparatory tillage	74.24	86.23	65.56	80.09
3	Manure	4.55	17.12	28.33	17.53
4	Variety	9.09	33.70	96.67	43.06

5	Sowing time	68.18	93.48	100.00	90.97
6	Sowing distance	100.00	98.91	100.00	99.31
7	Seed rate	64.77	79.35	64.17	73.96
8	Seed treatment	18.18	60.87	100.00	62.50
9	N	20.45	22.28	44.17	26.56
10	P	14.77	21.74	47.50	26.04
11	Inter culturing	9.09	60.87	53.33	51.39
12	Irrigation	1.52	1.45	14.44	4.17
13	Plant protection	31.82	42.39	76.67	47.92

It is revealed from the Table that the recommended land use was adopted by green gram growers to the extent 95.83 per cent. At the overall level, the adoption level of technology *viz*; sowing distance contributed 99.31 per cent at the highest level followed by sowing time (90.97 per cent), preparatory tillage (80.09 per cent) and seed rate (73.96 per cent) were the highest in case of green gram growers but the irrigation was almost negligible. In case of high adopters, 100 per cent adoption of technologies viz; land use, sowing time, sowing distance and seed treatment for green gram were observed.

At the overall level, the level of use of manure was 17. per cent in, green gram. The similar type of adoption for wheat crop were studied by Sonawane *et al.*, (2017) [3, 7, 8]

3. Impact of technology adoption on Income and Employment generation

The impact on employment among different adopter levels are presented in Table 3. It is revealed from the Table that the employment was increased by 21.28 and 31.58 per cent in low to medium and medium to high level of adoption, respectively. The results concluded that the employment was increased from low to high adopters.

Table 3: Impact of technology adoption on employment generation (Days/ha)

Employment	Adopters		
	Low	Medium	High
Total employment	47.00	57.00	75.00
Added employment	-	10.00	18.00
% Increase in employment	-	21.28	31.58

4. Impact of technology adoption on income generation

The impact on income among different adopter levels are presented in Table 4.

It is revealed from the Table that the income was increased from low to medium and medium to high adopters. The income increased by 13.08 and 20.19 per cent in low to medium and medium to high level of adoption, respectively.

The income was observed to be increased with increase in the level of adoption. These results are in consonance with the findings of Sonawane *et al.* (2017) [3, 7, 8]. The income increased with increase in the level of adoption in case of rabi Jowar.

Table 4: Impact of technology adoption on income generation (Rs/ha)

Income	Adopters		
	Low	Medium	High
Total income	40777.58	46110.12	55417.95
Added income	-	5332.54	9307.80
% Increase income	-	**13.08**	**20.19**

5. Costs effectiveness of technology adoption

The cost effectiveness of the technology adoption cannot be understood only by analyzing the increase in the yield levels of the green gram crop but also with the addition of cost with increasing levels of adoption followed by reduction in the unit cost. Thus, the Incremental Cost-Benefit Ratio (IBCR) actually denotes the effectiveness of the increase in the level of adoption of technology. The estimates of cost effectiveness for green gram crop under study are depicted in Table 5.

Table 5: Cost effectiveness of technology adoption

S. No.	Particulars	Adopters		
		Low	Medium	High
1	TAI	< 43.49	43.50- 64.10	> 64.11
2	No. of sample growers	22	92	30
3	Yield (q/ha)	5.85	7.31	9.90
4	Added yield (q/ha)		1.46	2.59
5	Per cent increase in yield		24.96	35.43
6	Cost C (Rs/ha)	36413.09	40656.70	46044.62
7	Added cost (Rs /ha)		4243.61	5387.92
8	Cost (Rs /q)	6224.46	5561.79	4650.97
9	Unit cost reduction (Rs /q)		662.67	910.82
10	Per cent reduction in cost		10.65	16.38
11	Returns (Rs /ha)	40777.58	46110.12	55417.95
12	Added Returns (Rs /ha)		5332.54	9307.83
13	IBCR ratio		1.26	1.73

The per cent increase in green gram yield levels in medium adopter over low adopters was observed to be 24.96 per cent, while it was 35.43 per cent in high over medium adopters. The increase in yields have increased the per hectare cost of cultivation by Rs. 4243.61 in medium and Rs. 5387.92 in high adopters. The increase in the cost was at the total costs level but in per unit analysis it was noticed that the costs were actually reduced by 10.65 and 16.38 per cent in medium over low and high over medium adopters, respectively. The returns of Rs. 5332.54 were added in medium adopters as compared to low adopters, while the returns of Rs. 9307.83 were added in high over medium adopters. The IBCR was estimated to 1.26 and 1.73 for medium and high adopters, respectively. The findings were in consonance with Angadi and Patil (2018) [5] where B: C Ratios for green gram was 1.77.

6. Yield gap

The gap between the potential and actual yield levels of green gram and their per cent magnitude were worked out and the results are depicted in Table 6.

Table 6: Yield gap in Green gram production (q/ ha.)

S. No.	Output (q)	Adopters			
		Low	Medium	High	Overall
1	Potential farm yield	15	15	15	15
2	Actual yield	5.85	7.31	9.90	7.69
3	Gap	9.15	7.69	5.10	7.31
4	Per cent gap	61.00	51.27	34.00	48.73

At the overall level, it was observed that there exists a gap of 48.73 per cent. The non-adoption of production technology was not the sole reason for such a huge gap in the production levels but the imbalanced application of inputs was also associated with the same. That can be observed among the different adoption levels, which indicates that as the level of adoption increased the percentages of gap between potential and actual yields has decreased considerably.

7. Functional analysis of Green gram production

The results of Cobb-Douglas type of production function are presented in Table 7. It is observed from the table that the variables explained 49 percent variation in the yield of green gram.

Table 7: Results of Cobb-Douglas production function

Particulars		Green gram (N= 144)
Constant	(a)	-0.2267
Human labour (Man days/ha.)	X_1	0.0834 (0.0769)
Bullock labour (Pair days/ha.)	X_2	0.1369*** (0.0485)
Machine power (Hrs./ ha)	X_3	0.1755*** (0.0465)
Manure (q/ha)	X_4	0.0219 (0.0262)
N (Kg. /ha.)	X_5	-0.0953*** (0.0272)
P (Kg. /ha.)	X_6	0.1024*** (0.0272)
Number of irrigations	X_7	-0.1207 (0.4245)
Adoption Index (%)	X_8	0.3363* (0.1885)
R^2		0.49

(Figures in the parentheses indicate the standard error of respective regression coefficient)

***, **, & * indicates level of significance at the 1, 5, & 10 per cent, respectively.

It was observed from the table that bullock labour, machine power, P fertilizers in case of green gram were highly positively significant at 1 per cent level of significance indicating that these are the important variables for which output is responsive. Further, the variable such as adoption index was significant at 10 per cent level of significance.

On the contrary, N fertilizers was negatively significant at 1 per cent level stating that there would be decrease in the output of with any increase in N fertilizers.

Conclusions

1. The employment and income was increased with increase in level of adoption for green gram crop.
2. The productivity gap of green gram 34.00 to 61.00 per cent Thus, there is potential for expansion of the productivity.
3. The per quintal savings in costs for high adopters as compared to medium adopters were Rs. 910.82 for green gram, This indicated that the adoption of improved crop production technology helps to reduce the cost and increases the returns**.**
4. Human labour, bullock labour, machine power, manure, chemical fertilizer components, number of irrigations and per cent adoption index has influences the output by 49per cent in green gram.

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