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Economic impact of red gram production technology on farm productivity and income in Western Maharashtra

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Abstract

Red gram is an important pulse crop in India. Red gram accounts for about 20 per cent of the total production of pulses in the country. The present study attempted to estimate the extent of adoption of improved production technology, impact of the red gram technologies on employment and income pattern, the yield gap and contribution of technology in yield of red gram crop. Total 97 red gram growers from 13 clusters were selected for the study. The result showed that that the recommended land use was adopted by red gram to the extent of 92.78. The adoption level of seed treatment technology was highest (86.60 per cent) followed by preparatory tillage (79.04 per cent) and sowing distance (77.32 per cent) at the overall level.

The employment was increased by 20.90 and 27.16 per cent while the income increased by 14.30 and 22.77 per cent in low to medium and medium to high level of adoption, respectively. The results concluded that the employment and income was increased from low to high adopters. The additional returns of Rs.7093.10 were added in medium adopters as compared to low adopters, while the additional benefits of Rs.12906.90 were added in high over medium adopters. There exists a gap of more than 41.15 per cent between the potential farm yield and actual yield level of red gram.

P fertilizers was positively significant at 1 per cent level of significance while, number of irrigations were positively significant at 5 per cent level of significance. The variables such as human labor was significant at 10 per cent level of significance. On the contrary, N fertilizers were negatively significant at 1 per cent level.

The inter culturing technology contributes 29.95 per cent in yield of red gram production followed by nutrient management (N, P & manures) 24.67 per cent and irrigation management contributes to 22.64 per cent. Therefore, it is recommended that farmers may adopt these technologies at the maximum level to improve the productivity of red gram.

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

Introduction

India is the largest producer and consumer of pulses in the world, accounting for 33 per cent of the world area and 22 per cent of world production of pulses. The domestic demand and consumption, however, are much higher than production, mainly because, pulses are a major source of protein for a large section of the vegetarian population in the country. The area under total pulses in India during 2017-18 was 29.28 million ha with 22.40 million tons of production and 765 kg/ha productivity. India is largest producer (25 per cent of global production), consumer (27 per cent of world consumption) and importer (14 per cent) of pulses in the world (Chavan *et al*., 2 2017) [4].

Red gram is an important pulse crop in India. Red gram is also known as Tur, Arhar and Pigeon pea. It is largely cultivated and consumed in developing countries and this crop is widely grown in India. India ranks first in the production and consumption of red gram in the world. Red gram accounts for about 20 per cent of the total production of pulses in the country. Red gram is a staple food and rich in protein. It contains about 22 per cent of protein, which is almost three times of cereals. Red gram is consumed in the form of split pulse as dal, which is an essential supplement of cereal diet. It also plays a crucial role in sustaining soil fertility by improving physical properties of soil and fixing atmospheric nitrogen. It is resistant to drought and suitable for dry land farming and predominately grown as an intercrop with other crops. In India, red gram contributes 53.37 million ha area with the production of 48.73 million tones. (Source: Directorate of Economics and Statistics.)

In this context, the present study on “Economic Impact of red gram production technology on farm productivity and income in western Maharashtra’’ was undertaken with following objectives:

Objectives

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

Materials and Methods

The random sampling design was adopted with Tahsil as a primary unit, village as the secondary unit and the red 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 red gram crop, from ten districts of western Maharashtra. From each selected tahsil, a village having the highest area under red gram was considered for the study. On the basis of operational holding, Total 97 red 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 red 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

1. Resource Productivity

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

Y= a X1b1 X2 b2 X3 b3 X4 b4 X5 b5 X6 b6 X7 b7 X8 b8eu

Where,

X_1 = Human labor (Man days/ha.)

X_2 = Bullock labor (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

Yield gap of red 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.

Yield Gap = YD – YA

Where,

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

YA=Actual Yield (Yield realized on sample farm)

Path analysis

Path analysis is a form of multiple regression statistical analysis used to evaluate causal models by examining the relationships between a dependent variable and two or more independent variables. Using this method one can estimate both the magnitude and significance of causal connections between variables.

Yield was regressed on standardized value of indicators and best fit was obtained. Fitting linear regression between the level of adoption of each technologies and yield.

$$Z_{ij} = \frac{[X_{ij} - X_j]}{S_j}$$

Z_{ij} Denotes the matrix of standardized indicators.

Results

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 red gram cultivators according to Adoption Index

Particulars		Adopters			Total
		Low	Medium	High	
Red gram	TAI	Below 50.53	50.54 - 68.97	Above 68.97	97 (100.00)
	Number	17 (17.53)	70 (72.16)	10 (10.31)	

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

The mean and standard deviation for red gram were (59.75 and 9.22), respectively. The total number of sample for red gram was 97 farmers, out of which 17.53, 72.16 and 10.31 per cent were distributed as low, medium and high adopters, 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) [7, 9, 10].

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

Sr. No.	Particulars	Red gram			
		Adopters			Overall
		Low	Medium	High	
1	Land use	58.82	100.00	100.00	92.78
2	Preparatory tillage	84.31	78.57	73.33	79.04
3	Manure	17.65	12.14	40.00	15.98
4	Variety	41.18	77.14	100.00	73.20
5	Sowing time	52.94	60.00	70.00	59.79
6	Sowing distance	52.94	80.00	100.00	77.32
7	Seed rate	73.53	68.21	80.00	70.36
8	Seed treatment	47.06	94.29	100.00	86.60
9	N	35.29	33.93	40.00	34.79
10	P	10.29	26.79	35.00	24.74
11	Inter culturing	35.29	65.71	60.00	59.79
12	Irrigation	15.69	50.95	70.00	46.74
13	Plant protection	64.71	54.29	70.00	57.73

It is revealed from the Table that the recommended land use was adopted by red gram to the extent of 92.78. The adoption level of seed treatment technology was highest (86.60 per cent) followed by preparatory tillage (79.04 per cent) and sowing distance (77.32 per cent) at the overall level.

In case of high adopters, 100 per cent adoption of technologies viz; land use, variety, sowing distance and seed treatment were observed. The level of use of manure was 15.98, 17.53 and 16.33 per cent, respectively. The inter-culturing operations were followed above 60 per cent in red gram. In case of low adopters, the technology viz; preparatory tillage were adopted at 84 per cent level. The similar type of adoption for wheat crop were studied by Sonawane *et al.*, (2017) [7, 9, 10].

Impact of technology adoption on 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 20.90 and 27.16 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	67.00	81.00	103.00
Added employment	-	14.00	22.00
% Increase in employment	-	20.90	27.16

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 14.30 and 22.77 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) [7, 9, 10]. 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	49595.86	56688.96	69595.86
Added income	-	7093.10	12907.00
% Increase income	-	14.30	22.77

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 red 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 red gram crop under study are depicted in Table 5.

Table 5: Cost effectiveness of technology adoption

Sr. No.	Particulars	Red gram		
		Adopters		
		Low	Medium	High
1	TAI	< 50.53	50.54-68.96	> 68.96
2	No. of sample growers	17	70	10
3	Yield (q/ha)	8.72	11.10	15.48
4	Added yield (q/ha)		2.38	4.38
5	Per cent increase in yield		27.32	39.44
6	Cost C (Rs/ha)	41795.72	48051.54	55329.28
7	Added cost (Rs /ha)		6255.82	7277.74
8	Cost (Rs /q)	4793.09	4328.22	3574.24
9	Unit cost reduction (Rs /q)		464.87	753.97
10	Per cent reduction in cost		9.70	17.42
11	Returns (Rs /ha)	49595.86	56688.96	69595.86
12	Added Returns (Rs /ha)		7093.10	12906.90
13	IBCR ratio		1.13	1.77

The per cent increase in red gram yield levels in medium adopter over low adopters was observed to be 27.32 per cent, while it was 39.44 per cent in high adopter over medium adopters. The increase in yields have increased the per hectare cost of cultivation by Rs. 6255.82 in medium adopter and Rs. 7277.74 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 9.70 and 17.42 per cent in medium over low and high over medium adopters, respectively. The additional returns of Rs.7093.10 were added in medium adopters as compared to low adopters, while the additional benefits of Rs.12906.90 were added in high over medium adopters. The IBCR was estimated to 1.13 and 1.77 for medium and high adopters, respectively. It indicates that the net returns were increased with unit cost reduction as per the increase in adoption levels.
The similar results were found by Sachin Kumar and Dinesh Kumar (2017) [5]. Total cost of cultivation of Red gram for small, medium and large size farms were (Rs.39792.2/ha, Rs.38504/ha and Rs.37003.8/ha) respectively.

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

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

Sr. No.	Output (q)	Adopters			
		Low	Medium	High	Overall
1	Potential farm yield	20	20	20	20
2	Actual yield	8.72	11.10	15.48	11.77
3	Gap	11.28	8.90	4.52	8.23
4	Per cent gap	56.40	44.50	22.60	41.15

At the overall level, it was observed that there exists a gap of more than 41.15 per cent between the potential farm yield and actual yield level of red gram. 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.

Functional analysis of Red 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 69 percent variation in the yield of red gram.
It was observed from the table that P fertilizers was positively significant at 1 per cent level of significance indicating that this is the important variable for which output is responsive. While, number of irrigations were positively significant at 5 per cent level of significance. Further, the variables such as human labor was significant at 10 per cent level of significance. On the contrary, N fertilizers were negatively significant at 1 per cent level stating that there would be decrease in the output of with any increase in N fertilizers case of red gram.

Table 7: Results of Cobb-Douglas production function

Particulars		Red gram (N= 97)
Constant	(a)	0.2804
Human labor (Man days/ha.)	X_1	0.2168* (0.1164)
Bullock labor (Pair days/ha.)	X_2	0.0437 (0.0587)
Machine power (Hrs./ ha)	X_3	0.0145 (0.0618)
Manure (q/ha)	X_4	0.0445 (0.0388)
N (Kg. /ha.)	X_5	-0.1833*** (0.0466)
P (Kg. /ha.)	X_6	0.1768*** (0.0399)
Number of irrigations	X_7	0.3254** (0.1272)
Adoption Index (%)	X_8	0.1431 (0.3844)
R^2		0.69

(Figures in the parentheses indicate the standard error of respective regression coefficient) ***, **, & * indicates level of significance at the 1, 5, & 10 per cent, respectively.

Contribution of technology in yield of red gram
The contribution of technologies in the yield of red gram was studied and indicated in Table 8.

Table 8: Contribution of technology in yield of red gram

Sr. No.	Technology	Contribution (%)	Group of technology	Contribution (%)	
1	Land use	0.03		0.03	
2	Preparatory tillage	29.94	Inter culturing	29.95	I
3	Sowing time	0.003			
4	Variety	0.88	Variety & Seed application	16.43	IV
5	Seed rate	3.17			
6	Seed treatment	2.32			
7	Sowing distance	10.06			
8	N	2.54	Nutrient management	24.67	II
9	P	12.79			
10	Manures	9.33			
11	Irrigation	22.64		22.64	III
12	Plant protection	6.29		6.29	V

From the above table, it is revealed that the inter culturing technology contributes more i.e. 29.95 per cent in yield of red gram production followed by nutrient management (N, P & manures) 24.67 per cent and irrigation management contributes to 22.64 per cent. The variety and seed application technology was observed to play an important role in red gram productivity by contributing 16.43 per cent while plant protection contributes 6.29 per cent.

Conclusions

1. The employment and income was increased with increase in level of adoption for red gram crop.
2. There exists a gap of more than 41.15 per cent between the potential farm yield and actual yield level of red gram. Thus, there is potential for expansion of the productivity of the red gram crop.
3. The per-quintal savings in costs for high adopters as compared to medium adopters were Rs. 753.97 for red gram, This indicated that the adoption of improved crop production technology helps to reduce the cost and increases the returns**.**
4. P fertilizers were highly significant at 1 per cent level of significance.
5. The inter culturing technology contribute more i.e. 29.95 per cent in yield of red gram production followed by nutrient management (24.67 per cent).

Recommendation

The Preparatory tillage, nutrient management, Protective irrigation, Variety and plant protection contributes around 30, 25, 16 and 6 per cent in yield of red gram. Therefore, it is recommended that farmers may adopt these technologies at the maximum level to improve the productivity of red gram.

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