Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

J P P Journal of Pharmacognosy and Phytochemistry

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(3): 4522-4526
Received: 19-03-2019
Accepted: 23-04-2019

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Estimation of farm level technical efficiency of black gram production in Tirunelveli district of Tamil Nadu

V Swetha, S Senthilnathan, T Rajendran and R Gangaiselvi

Abstract
A study was conducted in a block of Tirunelveli district in which the technical efficiency of cultivation of pulses was studied. Tirunelveli is one among the districts in Tamil Nadu which has a major population of farmers cultivating black gram. But the major drawback of the farmers is the lack of awareness and lack of knowledge about high yielding varieties. Hence study was conducted to find the technical efficiencies and their production capabilities. The study included 120 samples taken from three blocks, from each block two villages were covered. The results showed that in the study area not all the black gram farmers were technically efficient. The Mean technical efficiency of the black gram farmers in the study were 67%, in which there was 33 per cent allowance to improve efficiency. It was observed that for the production of black gram the factors like seed and weedicide are highly positively significant at one per cent level. Similarly, urea and insecticide was found to be positively significant at five per cent level on the yield only four variables affect the yield significantly and other variables such as DAP and labour usage showed non-significance. The determinants of technical efficiency of production using Tobit model was analysed in which the results showed among the socio economic variables (independent variables) experience, education showed significance at 1% and 5% level, and farm size also showed 1% significance. The technical efficiency parameters and the determinants of efficiency of socio economic variables were computed by using the computer software STATA.

Keywords: Technical efficiency, log-likelihood, frontier, black gram, to bit model

Introduction
Tamil Nadu contributes about 10.1% of the total production of black gram (Commodity profile for Pulses – March 2017). Even though climatic factor is a major advantage, the district farmers also tend to face major losses due to lack of rain, as most of the farm lands are rain fed and due to lack of finance and inability to buy pesticides, weedicides and other nutrients for plant health and growth. In this study, the problem focus is on the identification of technical efficiencies and the factors that contribute positive significance to the production.
The study aims at deriving the technical efficiency parameters of black gram growers. Most of the black gram farmers in the study area are rain fed and most of them prefer chemical inputs to enhance their production. Factors such as seed, urea, Di Ammonium Phosphate, labour, weedicide, insecticide were analysed to find the technical efficiency. Since black gram serves as one of the main agricultural produce in Tirunelveli district, it is necessary to test the most influencing factors that affect the production of black gram. Adoption of new technologies and awareness of appropriate techniques for input application can increase the efficiency and consequently increase the production of black gram. However, the evaluation of success of the enterprise in terms of effective use of inputs (land, labour, seeds, chemicals, water, energy, etc. for vegetative production) and maintenance of a sound cost structure lies in the efficiency analysis of the process (Ozkan *et al*, 2009) [9]. According to Farrel's interpretation of technical efficiency it is not feasible to produce by using more inputs than required while valuing these inputs more than the market values. Yet, it is also not efficient to use more inputs than required even if they are priced as the market values (Farrel, 1957) [4].
The Technical Efficiency is the ratio between actual and potential output of a production unit. A few empirical studies provide the estimates of TE of raising a particular crop (mostly rice) within a state/region. Mythili and Shanmugam (2000) [6] estimated the TE of rice farms in Tamil Nadu. Shanmugam (2003) [8] estimated TE of rice, cotton and groundnut growing farms in Tamil Nadu. For achieving productive efficiency, having technical and resource-allocation efficiencies is a must for an enterprise, yet these significances are not solely adequate for productive efficiency. Studies have said that an enterprise can have the best amount of output

in exchange of utilisation of best priced, minimum amount of inputs, but this characteristics may not be enough for productive or economic efficiency (Xu, X., Jeffrey, 1995, Abdulai *et al*, 1998) [9, 1]. The variation of technical efficiency was correlated with agricultural infrastructure, yield per acre, experience and extension services (Rahman, 2003) [7]. The results of these studies are useful for policy makers to rationalise the development policies for a particular crop in region. The objective of this study is to provide empirical information on technical efficiency and its determinants in black gram production in Tirunelveli district.

Materials and Method

The study was conducted in Tirunelveli District having geographical area of 6759sqkms. Which lie in the South eastern portion of Tamil Nadu is triangular in shape. It lies between 8°.05' and 9°.30' of the Northern latitude and 77°.05' and 78°.25' of Eastern longitude. The district is located in the southern part of Tamil Nadu and surrounded by Virudhunagar District in the north, Western Ghats in the West, Kanyakumari District in the south and Tuticorin District in the East. The lifeline of the district river Tamiraparani feeds the district and quenches the thirst of residents of Tirunelveli and Tuticorin district too and also supplying drinking water to Virudhunagar. The District has three Revenue Divisions consisting of 16 Taluks, as per GO.No.273, dated.25.07.2018 the Kovilpatti Taluk was newly created.

A Multi stage random sampling technique was adopted for the selection of sample respondents. Firstly, Tirunelveli district was selected as the study area, which forms the universe of the study. The district consists of nineteen blocks in which three blocks with the largest area under black gram were selected. Kuruvikulam, Melaneelithanallur and Sankarankoyil blocks were selected based on their production. At the third stage, two villages from each of the three blocks were selected at random. Twenty farmers were selected at random from each of the selected village to conduct the study. Total sample population of 120 farmers were taken for the study.

Table 1: Distribution of Sample Blocks, Villages and Number of Respondents in each Block

S. No	Blocks	Villages	No. of farmers
1.	Kuruvikulam	Malayangulam	20
		Vadaku kuruvikulam	20
2.	Sankarankoyil	Veerasigamani	20
		Ariyanayagipuram	20
3.	Melaneelithanallur	Gurukalpatti	20
		Keelaneelithanallur	20
		TOTAL	120

A structured interview schedule was used to obtain information from the farmers. Interview schedule was prepared to elicit information on the physical, cultural and socio economic environment of the farming system in the study area. The Interview schedule was finalized by testing it with a 5 per cent sample population in the study area. A Sample population of 120 farmers were taken. The details on family size, age, education, income, Land particulars, and area under crops, cost and returns from crop cultivation were obtained from farmers.

Analytical techniques

The data obtained from the respondents were analysed using descriptive and inferential statistics. Means, standard deviations, percentages, frequencies for input and output and distributions of efficiency levels were used in analysis. A stochastic frontier production function was fitted and estimated using maximum likelihood technique to obtain the farm specific technical efficiencies. The high level of efficiency is an indication that only a small fraction of the output can be attributed to wastage (Idiong, 2006) [5].

Stochastic frontier production function

This study used the stochastic (or econometric) frontier production function model for cross sectional data. We define the frontier production function as the maximum feasible or potential output that can be produced by a production unit such as farm, given level of inputs and technology. The actual production function (corresponding to the production unit's actual output) can be written as:

$$Y_i = X_i\alpha + V_i - U_i \text{..... (1)}$$

Where,

Y_i Is the dependent variable

X_i Is the independent variables

α Is the regression coefficient.

In this model the dependent variable is restricted by the stochastic variable. $V_i - U_i$.

The random error, V_i can be Negative or Positive. It arrests the random shocks away from the control of farmers and measurement errors on the dependent variable.

U_i, the other independent error term is a non-negative term representing farm specific technical inefficiency. It quantifies the output Y_i from its maximum possible value.

In this study the mean technical efficiency parameters have been calculated by using the computer software STATA.

Right after estimating the equation (1), the mean technical efficiency of the farm can be measured. The respective individual technical efficiencies can be estimated by using a proper functional form,

$$Ln(Y_i) = \alpha_0 + \sum_{k=1}^{n} \alpha L_n(X_{ki}) + V_i - U_i \text{..... (2)}$$

(Cobb- Douglas production function)

A Cobb-Douglas function was fitted to the stochastic frontier production function and estimated. This functional form has been consistently used in related efficiency studies [4].

$$\mu_i = \partial_0 \sum \partial_m . Z_m \text{..... (3)}$$

Where,

Y_i = Output of i^{th} crop

X_{ki} = Use of k^{th} input

V_i = Random error to be identically and independently distributed N $(0, \sigma^2 V)$

u_i = Farm specific inefficiency effect.

Z_m = Factors affecting technical efficiency.

α's and ∂'s = regression coefficients to be estimated.

The stochastic frontier production function model specified for crop is given below

$$Ln(Y) = \alpha_0 + \alpha_1 In(X_1) + \alpha_2 In(X_2) + \alpha_3 In(X_3) + \alpha_4 In(X_4) + \alpha_5 In(X_5) + \alpha_6 In(X_6) + \alpha_7 In(X_7) + V_i - U_i$$

(Cobb- Douglas type)

And

$$\mu = \partial_0 + \partial_1 Z_1 + \partial_2 Z_2 + \partial_3 Z_3$$ (Linear type)

Where,
Y =Yield of black gram in Qntls/acre
X_1 = Quantity of seeds in Kgs/acre
X_2 = Quantity of urea in Kgs/acre
X_3 = Quantity of DAP in Kgs/acre
X_3 = Quantity of weedicide in Kgs/acre
X_5 = Quantity of insecticide Kgs/acre
X_6 = Number of human labour in man days per acre

Tobit model (Censored regression)
In this study, Tobit regression was used to estimate the determinants of technical efficiency of sample farmers using the individual efficiency results obtained from the frontier results. The Individual farmer's efficiency was taken as dependent variable and was regressed with socio economic variables such as gender, education, farm size, experience and family size. The outcome value of about 0.5 was fixed and Tobit regression was calculated because below 0.5 level are technically inefficient farmers, whereas our objective is to find out the determinants of technical efficiency of production so that the values under 0.5 were censored.

$$Y_i = Y_i, \quad \text{if } Y_i > 0.5$$
$$= 0, \quad \text{if } Y_i \leq 0.5$$
$$i = 123\ldots.n,$$

Where n is the number of observations, Y is the dependent variable as technical efficiency, X_i is a vector of independent variables listed in Table. β is the vector of parameters to be estimated, and u_i is an independently distributed error term assumed to be normal with zero mean and constant variance σ^2. The model assumes that there is an underlying stochastic index equal to $(X_i*\beta+U_i)$ which is observed when it is positive, and qualifies as an unobserved latent variable, otherwise.

Results and Discussion
Data collected for the study were analysed with reference to the objectives and the results are presented in the Table: 2
The results showed that the mean output per farmer is 7.679 quintals, the mean labour usage is 16.054 man days. The mean usage of seed, urea, Di Ammonium Phosphate, weedicide, insecticide were 32.58kgs, 155.25kgs, 144.25kgs, 3.35 litres, and 1.92 litres respectively.

Table 2: Summary statistics of output and input variables in black gram production in the study area

Variable	unit	mean	Standard deviation	Standard error
Seed(X_1)	Kgs.	32.58	35.086	3.202
Urea(X_2)	Kgs.	155.25	214.87	19.61
Di Ammonium Phosphate (X_3)	Kgs.	144.25	216.57	19.77
Weedicide (X_4)	litre	3.35	8.266	0.754
Insecticide (X_5)	litre	1.92	4.350	0.397
Labour (X_6)	Man days	16.054	11.95	1.091
Output (Y)	quintal	7.679	12.32	1.125

Technical efficiency in black gram production in Tirunelveli district
The stochastic parameter estimates with regard to the black gram is presented in the Table.3. From the table it can be observed that for the production of black gram the factors like seed and weedicide are statistically and positively significant at one per cent level. Similarly, urea and insecticide was found to be positively significant at five per cent level and other variables such as Di Ammonium Phosphate and labour usage showed non-significance.

The estimated lambda (λ) parameter was 1.92, which means that the total error variance is mainly due to the inefficiency and random errors are less important. The percentage of total variation due to variation in efficiency is 78.6%. The estimated variance for the variation in efficiency (sigma^{2}u value) is equal to 0.56 which is considerably larger than the variation due to random errors (sigma ^{2}v value) of 0.29. This Indicates the existing scope to increase the production level of black gram by properly training the farmers in the study area.

Table 3: Maximum Likelihood Estimates for Black gram Production in Tirunelveli District of Tamil Nadu

	Parameters	Standard error	t-value	P r (>|t|)
Seed	0.198986***	.056542	3.52	0.000 at 1%
Urea	.1212604***	.0391972	3.09	0.002 at 1%
DAP	.0106657	.031139	0.34	0.732
Weedicide	.3243892***	.0806974	4.02	0.000 at 1%
Insecticide	.160544**	.0794872	2.02	0.043 at 5%
Labour	.0491492	.0478083	1.03	0.304
Lambda	1.920315			
sigma^2	.4064202			
sigma^{2}v	.2944502			
sigma^{2}u	.5654372			
log likelihood	72.319634			
variation in efficiency	78.6616			

Note: ***- Significant at 1 per cent level, ** - Significant at 5 per cent level

Technical efficiency distribution of black gram farmers
The technical efficiency distribution of black gram farmers in the study area is presented in the Table.4. In the study area the highest technical efficiencies (above 90 per cent) was attained by 1.7 per cent of the farmers. The technical efficiency percentages between 81-90% were attained by 16.7 per cent

of farmers in the study area. The range of percentages between 61-70 per cent and 71-80 per cent was attained by 29.2 per cent and 29.2 per cent farmers respectively. About 12.5 per cent of farmers in the study area attained efficiencies below 50 per cent. And finally about 10.8 per cent of farmers attained efficiency level between 51-60 per cent. Mean level of Technical efficiency attained for the sample as a whole was 68 per cent.

Table 4: Frequency Distribution of Black gram Farmers based In the Technical efficiency:

S.no	Range	Frequency	Percentage of frequency
1	<50	15	12.5
2	51-60	13	10.8
3	61-70	35	29.2
4	71-80	35	29.2
5	81-90	20	16.7
6	>90	2	1.7
		120	100
	MTE	0.6768871	

Note: MTE–Mean Technical Efficiency

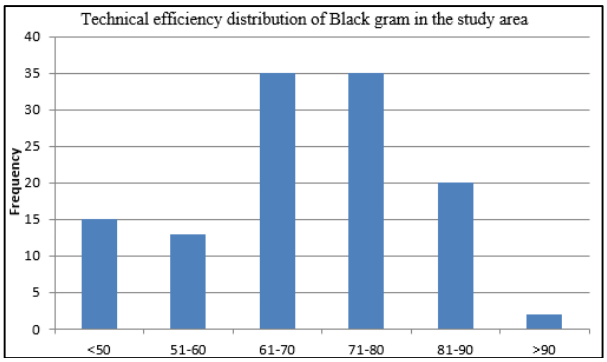

Fig 1: Technical efficiency in cultivation of black gram

Determinants of technical efficiency

In order to study the determinants of technical efficiency, a Tobit model was fitted and the results of its estimation are presented in Table 5.

Table 5: Tobit model results on determinants of technical efficiency

Variables	Coefficient	Standard Error	P> t
Gender	-0.0009	0.0067	0.888
Experience	0.0099***	0.00067	0.000
Education	0.006**	0.0023	0.010
Family size	0.0019	0.00113	0.085
Farm size	-0.0055***	0.00071	0.000

Note: ***Significant at 1 per cent level **Significant at 5 per cent level

From Table 5, it is observed that the socio economic variables like experience, education and family size showed positive significant relationship with the technical efficiency. Gender showed non-significance, which is negatively significant, or does not contribute to the increase in efficiency. Whereas both experience and farm size were statistically significant at one per cent level. But the former had positive and the latter had negative influence. Education parameter was significant at 10 per cent level and all other parameters showed no significant effect. The increase in education and farming experience by one per cent would increase the dependent variable by 0.006 and 0.009 per cent respectively from their mean level. The increase in farm size would decrease the efficiency by 0.005 per cent from the mean level. All changes at *cetaris paribus* condition.

Table 6: Marginal effects of determinants on technical efficiency

Variable	Coefficient	Standard error	P>t
Gender	-0.0013	0.0095	0.888
Experience	0.72***	0.04971	0.000
Education	0.068**	0.026	0.010
Family	0.0126	0.0072	0.085
Farm size	-0.0249***	0.0032	0.000

Note: ***- Significant at 1 per cent level, ** - Significant at 5 per cent level

Marginal effects of the selected variables on the technical efficiency of black gram production were estimated and presented in Table 6. From the table, it could also be seen that the parameters experience, education and farm size are significant at one per cent level. An increase in one year of experience resulted in an increase of 0.72 points of efficiency. An increase in one acre of farm size will lead to a decrease in 0.024 points of efficiency. An increase in a year of education would lead to increase efficiency by about 0.012 points. The other two variables such as gender and family size showed negative significance.

Conclusion

The study was conducted to find out the technical efficiency of black gram producing farmers and to know their input usage efficiency. This study has revealed that among the sample black gram farmers not all the farmers are technically efficient. Among the factors, seed and weedicide are highly significant at one percent level. Similarly, urea and insecticide was found to be significant at five percent level and other variables such as Di Ammonium Phosphate and labour usage showed non-significance. The determinants of technical efficiency of production was analysed using Tobit model in which the results showed among the socio economic variables experience, education and farm size showed significance at one per cent level. The technical efficiency parameters and the determinants of efficiency of socio economic variables were computed by using the computer software STATA.

References

1. Abdulai A, Huffman WE. An Examination of Profit Efficiency of Rice Farmers in Northern Ghana, Staff Paper, Swiss Federal Institute of Technology, Department of Agricultural Economics, 1998; 27.
2. Burhan Ozkan, Figen Ceylan R, Hatice Kizilay. A Review of Literature on Productive Efficiency in Agricultural Production, Journal of Applied Sciences Research. 2009; 5(7):796-801.
3. Commodity profile for Pulses–March, 2017. http://www.commoditiescontrol.com
4. Farrel MJ. The Measurement of Production, Efficiency. Journal of the Royal Statistical Society Series A. 1957; 120:253-290.
5. Idiong IC. Evaluation of technical, allocative and economic efficiencies in rice production systems in cross river state, Nigeria. Unpublished Ph.D. Dissertation. Michael Okpara University of Agriculture, Umudike, 2006.
6. Mythili G, Shanmugam TR. Technical efficiency of rice growers in Tamil Nadu: a study based on panel data. Indian Journal of Agricultural Economics 2000; 55(1):15-25.

7. Rahman S. Profit Efficiency among Bangladeshi Rice Farmers, Paper presented in 25th Conference of International Agricultural, Durban, South Africa, 2003.
8. Shanmugam TR. Technical efficiency of rice, groundnut and cotton farms in Tamil Nadu. Indian Journal of Agricultural Economics. 2003; 58(1):101.
9. Xu X, Jeffrey SR. Efficiency and Technical Progress in Traditional and Modern Agriculture: Evidence from Rice Production in China, University of Alberta, Department of Rural Economy, Staff Paper, 1995.