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Resource utilization efficiency of organic farming *vis-à-vis* conventional farming in indian food legumes

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ABSTRACT

In a study conducted among organic and conventional pigeonpea growers of Gulberga district of Karnataka, an attempt was made to assess the resource use efficiency of pigeonpea cultivation in three pigeonpea based cropping systems. The results revealed that human labour, land, seeds, plant protection measures have contributed significantly to the production elasticities. The co-efficients of multiple determination for all three production functions fitted ranged between 0.96 and 0.98 indicating that the production function fitted was sound and could help explain the variation in gross returns in pigeonpea based cropping systems. The returns to scale in all the pigeonpea based cropping systems were superior in organic farming compared to conventional farming.

Key words: Black Gram, Cobb Douglas Production Function, Green Gram, Organic farming, Pigeon pea, Resource utilization efficiency

India is an agricultural country. In a country where sizable proportion of the population is dependent on agriculture, the development of agricultural sector becomes a prerequisite. The agriculture sector has a direct impact on the level of farm income as well as national income of the country. If farmers can increase their production, they shall improve the national economy as well as their own economy. Therefore, it has become an urgent need to increase agricultural production.

There are two feasible options available for increasing the agricultural production in a country. The first option is: through extension of area under cultivation by reclamation of wastelands and by external land augmentation without shrinking of the area and productivity of any activity. The second one is: increasing the productivity of land by cultivating normal soils through optimal allocation of available resources and utilizing the full potential of existing technology. The adoption of new agricultural technology is necessary for the development of agricultural sector, which depends on the availability of various inputs and resources in the region.

The agricultural growth is affected by the various resources such as seeds, manures, fertilizers, irrigation facilities, labour, bullock labour, working capital, farm implements, machinery, crop protection inputs, etc. The rationality in the allocation of resources by the farmers is a crucial issue in agricultural production. Here the focus need to be on the resource use efficiency. The farm income is determined by the efficiency with which all farmers are able to utilize the resources at their own command. If farmers are efficient in the use of scarce resources, then farmers can surely increase agricultural production and their income.

The optimum allocation of available resources is necessary for the growth of agricultural production. The crux of the problem of increasing agricultural production in any area is: how to increase the output per unit of an input. In general, agricultural production continues to be at lower level despite the use of critical inputs. Sometimes, the crucial inputs are either under-utilized or over-utilized in the crop production. Resource use inefficiency exists on the farms. If resource use is inefficient, production can be increased by making adjustment in the use of factors of production in the optimal direction.

The cost of agricultural resources is increasing by quantum jumps, thereby making agriculture a losing proposition. Increasing costs of cultivation has made agriculture vulnerable and exposed to greater risks, thus making it an unviable option of one's livelihood. Efficient resource use is the only option available now. Hence, it is necessary that the available resources should be used economically and efficiently.

To drive home this crucial issue, many researchers have worked on assessing the resource use efficiency in various crops: paddy (Suresh and Reddy 2006), onion (Sankhayan and Sirohi 1971, Naik *et al.* 1998, Verma 2002), mesta (Sunanda and Narender 2003), redgram based cropping systems (Biradar and Rajkumar 2007) and cropping systems and farming systems (Ganesh 2000, Wadear 2003, Rajeshwari 2004, Saikumar 2005). Mixed cropping systems: potato and maize (Sankhayan and Sirohi 1971), maize-sunflower (Nagraj *et al.* 1996).

Resource use efficiency was measured in terms of partial 'b' coefficients contributing to the significant variation in production function. The contribution of land and human labour was positive (Muralidharan 1987) and that of land and farm yard manure was positive (Naik *et al.* 1998). The ratio of Marginal value product (MVP) to Marginal factor cost (MFC) of land was greater than one, and MVP of labour was less than one. It was negative for seeds, fertilizers and pesticides in conventional farms. In

case of farm practicing IPM, this ratio was greater than one for land, labour, and seeds, but negative for fertilizers. (Vishweshwar 1994).

Hence, it has been attempted in this study to assess and compare resource use efficiency of organic and conventional farming in three pigeonpea based cropping systems, with an objective of comparing organic farming and conventional farming in pigeonpea based cropping systems.

MATERIALS AND METHODS

Gulberga district is considered the pulse bowl of India. Pigeonpea is predominantly grown in Aland and Gulbarga taluks. So, district and taluks were purposively selected and two villages from each taluk were randomly selected for the study. Accordingly the study was conducted in the four villages of Gulbarga district in Karnataka state and survey approach was used for the present study. Sixty farmers who were actively involved in organic farming and sixty conventional farmers formed a random sample of one hundred and twenty respondents. The data were collected through personal interviews from both organic and conventional farmers with the help of a specially designed semi-structured schedule.

Data on resource use were collected from forty farmers (20 organic farmers and 20 conventional farmers) form each group of cropping system: (i) sole crop of pigeonpea, (ii) intercropping of pigeonpea with black gram and (iii) intercropping of pigeonpea with green gram. A specially designed semi-structured schedule was used.

Cobb-Douglas production function is used to estimate resource use efficiency and returns to scale in pigeonpea and pigeonpea based cropping system. The resource factors like land, human labour, manures and fertilizers, seeds and plant protection measures were used in both organic and conventional farming and hence they are considered in the present study. The operational definition of resource factors chosen in the study are as follows:

Output: The output has been defined as the sum of gross value output of the crops (pigeonpea, black gram and green gram) evaluated at the prevailing market price during the year 2010-11, irrespective of being consumed, sold or maintained in the stock.

Land: In the present study, the actual area for the particular crop (pigeonpea, black gram and green gram) was considered as the land resource. The land was taken in hectares.

Human Labour: The labour force on a farm consists of farmer's labour and hired labour.

Family Labour: Family labour is one of the most important factors in the growth of economic factor. Family labour considered with the actual work carried out by family members for crop production was evaluated at the prevailing wage rates for hired labour.

Hired Labour: It included the hired labour employed for crop production. The hired labour was evaluated at actual amount paid in cash. Human labour was also divided into male and female labour with varying wage rates. The work turn out of a male or female adult for a period of 8 hours is taken in to consideration.

Manures and Fertilizers: Manures made from the wastes of plant materials and animals are used as sources of plant nutrients. Farm produced manures (farm yard manure, vermi-compost) were charged at prevailing local rates. Chemical fertilizers and other manures purchased were charged at the rates actually paid.

Seeds: For the production own seeds or market seeds have been used in the farm. The farm produced seed was charged at the market price and purchased seed was charged at the rates actually paid.

Plant protection measures: Labour costs incurred in mechanical measures and cultural measures were computed. The purchased pesticides for the use of plant protection were evaluated at the actual price paid in market and the value of bio-pesticides/insecticides produced in bio-digesters on the farm were evaluated as per costs incurred in making them.

Cobb-Douglas Function

The functional model adopted is of the following form,

$$y = a.\ x_1^{b1}.\ x_2^{b2}.\ x_3^{b3}.\ x_4^{b4}.\ x_5^{b5}.\ u$$

y = Value of output (in rupees)

x_1 = Land area (in hectares)

x_2 = Value of human labour used (in rupees)

x_3 = Value of Manures and Fertilizers (in rupees.)

x_4 = Value of seeds (in rupees)

x_5 = Value of Plant Protection (in rupees)

u = Error term

b_1 to b_5 are production elasticities of factors x_1 to x_5 respectively and 'a' is the intercept. The above equation can be transformed into log form as follows:

$$\text{Log } y = \text{Log } a + b_1 \text{Log } x_1 + b_2 \text{Log } x_2 + b_3 \text{Log } x_3 + b_4 \text{Log } x_4 + b_5 \text{Log } x_5 + \text{Log } u$$

In the present study, the above function was fitted in log term with output (y) as dependent variable and five inputs as independent variables.

RESULTS AND DISCUSSION

The collected data was subjected to statistical data analysis using the Cobb Douglas production function. The results of the analysis: coefficients of production elasticities

and returns to scale (sum of production elasticities) are presented below.

Pigeonpea (sole crop) : The production elasticities and other related statistics for pigeonpea are presented in Table 1. It was observed from the results that in organic farming, the co-efficient of multiple determination (R^2) is 0.97 indicating that the explanatory variables included in the function such as land, human labour, manure and fertilizers, value and seeds and plant protection, have explained 97 percent of total variation in gross returns.

In organic farming, it was observed from the results that among the variables included in the function, the production elasticity of human labour was positive (1.09) and significant. It means that 1 percent increase in human labour would increase output by 1.09 percent, when other variables are kept constant. In case of seeds and plant protection, the production elasticities were positive but insignificant. The production elasticities of land, manure and fertilizers were turned out to be negative and insignificant. It was also observed that resource utilization was excessive in organic farming.

The sum of production elasticities (returns to scale) for organic farming in pigeonpea was 1.48, which was more than one, indicating increasing returns to scale.

In case of conventional farming, it was observed from the results that explanatory variables included in the function have explained 98 percent of total variation in gross returns. Among the variables selected in the function, the production elasticity of fertilizers was positive and significant at 10 percent level. The elasticity co-efficients of land, human labour and plant protection were positive and insignificant and elasticity co-efficient of seeds was negative and insignificant. The study was supported by Asmatoddin *et al.* (2009).

The sum of production elasticities which is an indicator of the return to scale was more than one (1.38) indicating increasing returns to scale, but less compared to organic farming which was clearly revealed by the analysis.

Pigeonpea + Black gram : The production elasticities and other related statistics for pigeonpea are presented in Table 2. It was observed from the results that in organic farming, the co-efficient of multiple determination (R^2) is 0.97 indicating that the explanatory variables included in the farmer such as land, human labour, manure and fertilizers, value and seeds and plant protection, have explained 97 percent of total variation in gross returns.

In organic farming, it was observed from the results that among the variables included in the function, the production elasticity of human labour was positive and significant at 1 per cent level of probability. The production elasticity of land, manure and seeds was positive and insignificant. For plant protection, it turned out to be negative and insignificant and it was also observed that resource utilization was excessive in organic farming.

The sum of production elasticities (returns to scale) for organic farming in pigeonpea+ Black gram was 1.54, which is more than one, indicating increasing returns to scale.

In case of conventional farming, it was observed from the results that explanatory variables included in the function have explained 96 percent of total variation in gross returns. Among the variables selected in the function, the production elasticity of fertilizers was positive 1.42 and significant. It means that 1 percent increase in fertilizer would increase output by 1.42 percent, when other variables are kept constant. The elasticity co-efficient of land, seeds and plant protection were positive and insignificant and elasticity co-efficient of human labour was negative and insignificant.

Table 1. Resource Utilization Efficiency of organic and conventional farming practices in Pigeonpea (Sole crop)

Types of farmers	No of observations	Degree of freedom	Constant	Land	Human labor	Manures and fertilizers	Value of seeds	Plant protection	Return to scale	R^2 value
Organic	20	19	-7.61	-0.85	1.09	-0.16	0.63	0.77	1.48	0.97
			(5.61)	(0.36**)	(0.55**)	(0.33)	(0.15*)	(0.27**)		
Conventional	20	19	0.43	0.20	0.15	0.56	-0.24	0.71	1.38	0.98
			(9.78)	(0.14)	(0.21)	(0.17*)	(0.28)	(0.96)		

Note: figure in parenthesis are standard errors of the regression co-efficient. *Significance at 10 per cent level; ** Significance at 5 per cent level; ***Significance at 1 per cent level

Table 2. Resource Utilization Efficiency of organic and conventional farming practices (Pigeonpea + Black gram)

Types of farmers	No of observations	Degree of freedom	Constant	Land	Human labor	Manures and fertilizers	Value of seeds	Plant protection	Return to scale	R^2 value
Organic	20	19	0.54	0.28	0.81	0.86	0.50	-0.91	1.54	0.97
			(8.27)	(0.36)	(0.40***)	(0.73)	(0.40)	(1.09)		
Conventional	20	19	4.02	0.36	-0.82	1.42	0.22	0.05	1.23	0.96
			(8.61)	(0.52)	(0.94)	(0.49**)	(0.49)	(0.76)		

Note: figure in parenthesis are standard errors of the regression co-efficient. *Significance at 10 per cent level; ** Significance at 5 per cent level; ***Significance at 1 per cent level

Table 3. Resource Utilization Efficiency of organic and conventional farming practices (Pigeonpea + Green gram)

Types of farmer	No of observations	Degree of freedom	Constant	Land	Human labor	Manures and fertilizers	Value of seeds	Plant protection	Return to scale	R^2 value
Organic	20	19	-2.18	0.06	1.24	0.30	-0.10	0.12	1.62	0.98
			(3.91)	(0.13)	(0.57**)	(0.23)	(0.13)	(0.15)		
Conventional	20	19	1.11	-0.01	0.32	-0.37	0.26	0.94	1.14	0.98
			(1.56)	(0.05)	(0.31)	(0.21)	(0.20)	(0.22*)		

Note: figure in parenthesis are standard errors of the regression co-efficient. *Significance at 10 per cent level; ** Significance at 5 per cent level; ***Significance at 1 per cent level

The sum of production elasticities which is an indicator of the return to scale was more than one (1.23) indicating increasing returns to scale, but less compared to organic farming which is clearly revealed by the analysis.

Pigeonpea + Green gram : The production elasticities and other related statistics for pigeonpea+Green gram cropping systems are presented in Table 3. It was observed from the results that in organic farming, the co-efficient of multiple determination (R^2) is 0.98 indicating that the explanatory variables included in the farmer such as land, human labour, manure and fertilizers, value and seeds and plant protection, have explained of percent of total variation in gross returns.

In organic farming, it was observed from the results that among the variables included in the function, the production elasticity of human labour was positive 1.24 and significant. It means that 1 percent increase in human labour would increase output by 1.24 percent, when other variables are kept constant. The production elasticities of land, manure and plant protection was positive and insignificant. The production elasticity of seeds was negative and insignificant and it was also observed that resource utilization was excessive in organic farming.

The sum of production elasticities (Returns to scale) for organic farming in pigeonpea was 1.62, which is more than one, indicating increasing returns to scale.

In case of conventional farming, it was observed from the results that explanatory variables included in the function have explained 98 percent of total variation in gross returns. Among the variables selected in the function, the production elasticity of plant protection was positive and significant at 10 per cent level. The elasticity co-efficient of human labour and seeds were positive and insignificant and elasticity co-efficient of land and fertilizers was negative and insignificant.

The sum of production elasticities which is an indicator of the return to scale was more than one (1.14) indicating increasing returns to scale, but less compared to organic farming which was clearly revealed by the analysis. The study was found in harmony with Ghosh et al., (2007).

On comparing the organic farming with conventional farming in sole crop of pigeonpea cultivation, the elasticity coefficients for land, human labour, seeds and plant protection measures were positive and significant in organic farming situation, while only one input, manures and fertilizers was positive and significant in conventional pigeonpea cultivation.

In pigeonpea+black gram cropping system, elasticity coefficient of human labour was positive and significant in organic farming situation, but in conventional farming situation, elasticity coefficient of manures and fertilizers was positive and significant in conventional farming situation. Similar results were also found in case of pigeonpea+green gram cropping system.

It can be concluded that human labour was the sole contributor in all pigeonpea based cropping systems, as pigeonpea is a long-duration (160-180 days) dryland pulse crop demanding more labour use. In case of sole crop, however, other inputs: land, seeds and plant protection measures have contributed in addition to human labour. Resource use efficiency was observed to be more in organic farming.

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