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(6): 1794-1798
Received: 16-09-2019
Accepted: 18-10-2019

A Vijaya Preethi
Department of Agricultural Economics, Agricultural College, Bapatla, Andhra Pradesh, India

Dr. K Uma Devi
Department of Agricultural Economics, Agricultural College, Bapatla, Andhra Pradesh, India

Dr. D Vishnu Sankar Rao
Department of Agricultural Economics, Agricultural College, Bapatla, Andhra Pradesh, India

Dr. V Srinivasa Rao
Department of Agricultural Economics, Agricultural College, Bapatla, Andhra Pradesh, India

Corresponding Author:
A Vijaya Preethi
Department of Agricultural Economics, Agricultural College, Bapatla, Andhra Pradesh, India

Resource use efficiency of redgram and redgram based cropping systems in Prakasam district of Andhra Pradesh

A Vijaya Preethi, Dr. K Uma Devi, Dr. D Vishnu Sankar Rao and Dr. V Srinivasa Rao

Abstract
The resource use efficiency of redgram and redgram based cropping systems have been computed using primary data collected from 120 farmers in Prakasam District of Andhra Pradesh during the year 2014-15. A sample size of 120 farmers were selected using multiple stage random sampling method. The Cobb-Douglas type of production function was used to evaluate the resource use pattern and resource use efficiency in redgram and redgram based cropping systems. The results indicated that production elasticities of farm size, labour charges and seed were found to influence the productivity significantly in redgram sole crop. In case of redgram + bajra cropping system, the regression coefficient of farm size had a positive and significant influence on productivity. In pooled cropping systems regression coefficients of farm size and labour charges were found to be positive and significant influence on productivity. Cropping system dummy variables CS_2, CS_3 and CS_4 (redgram + greengram, redgram + castor and redgram + sorghum (fodder) cropping systems) were found to be positive and significant.

Keywords: Redgram, cropping systems, cobb-douglas production, resource use efficiency

Introduction
Redgram is an important pulse crop, commonly known as pigeon pea. Globally pigeonpea (*Cajanus cajan* (L.) Millsp) is the fifth most important pulse crop. It is mainly grown in developing countries by resource-poor farmers in drought prone areas and on degraded soils. Redgram crop is a multipurpose leguminous crop used as food, fuel wood and fodder for the small-scale farmers in subsistence agriculture (Tabo *et al.*, 1995; Egbe, 2005) [5, 3]. Because of having versatile, compatable and stable nature of redgram, it is suitable for inter-cropping with different crops *viz.*, cotton, sorghum, pearl millet, greengram, blackgram, castor, maize, soyabean, groundnut and it increases production and maintains soil fertility. In AP, most of the area is cultivated as rainfed monocrop as well as with intercrop in black soils. Intercropping is an old cropping practice, possibly as old as the settled agriculture, and is widespread especially in low – input cropping systems. Intercropping can provide numerous benefits to cropping systems through increasing total yield and land use efficiency (Dhima *et al*., 2007) [2] and improving yield stability of cropping systems (Lithourgidis *et al*., 2006) [4]. The present study was undertaken to examine how the farm resources are used in redgram and redgram based cropping systems.

Materials and Methods
Sampling and Data Collection
Prakasam district of Andhra Pradesh state was selected purposively as redgram is extensively grown in the district covering an area of 53,000 ha and 48,000 tonnes of production during the year 2013-2014. A pretested schedule was used to collect the requisite information from the sample farmers through survey method. Secondary data was collected from different resources of the district. In Prakasam district, all the mandals were listed out in the descending order of magnitude of the area under redgram cultivation and top three mandals were selected purposively. Similarly, top four villages with maximum area under redgram cultivation from each of the selected mandals were selected. From each village, 10 farmers were selected randomly with five farmers cultivating redgram as sole crop and another five farmers practicing redgram based cropping systems making 40 farmers from each selected mandal. Thus in Prakasam district, three mandals, twelve villages and 120 farmers constituting 60 farmers cultivating redgram sole crop and 60 farmers practising redgram based cropping systems were selected for the study.

The 60 farmers systems practising redgram based cropping systems were classified into four identified redgram based cropping viz., redgram + bajra, redgram + greengram, redgram + castor and redgram + sorghum (fodder) cropping systems with 30, 10, 10 and 10 farmers respectively.

Analytical frame work

Cobb-Douglas production function was used to know the resource use efficiency and returns to scale in redgram in different cropping systems. It can measure the contribution of each input factor in combination with other resources influencing the level of output.

Cobb-Douglas production function was fitted with five independent variables namely farm size, labour, seed quantity in Kgs, FYM & fertilizers and plant protection chemicals.

The model for the study was

$Y=ax_1^{b1}x_2^{b2}x_3^{b3}x_4^{b4}x_5^{b5}.....u_t$

U_t =Error term.

For convenience in estimating the parameters in the function, following log linear form adopted.

Redgram sole cropping system:

$\text{Log } Y = \text{Log } A + b_1 \text{ Log } x_1 + b_2 \text{Log } x_2 + b_3 \text{Log } x_3 + b_4 \text{ Log } x_4 + b_5 \text{ Log } x_5 + u_t$

Where: (A=Intercept, b_1 to b_5 = elasticity co-efficients)

Y = Yield (qtls /ha)

X_1 =Farm size (ha)

X_2 = labour charges (Rs /ha)

X_3= Seed rate (kg/ha)

X_4 = FYM&fertilizers expenses (Rs/ha)

X_5 = Plant protection chemicals expenses (Rs /ha)

Redgram + Bajra cropping system

$\text{Log } Y = \text{Log } A + b_1 \text{ Log } x_1 + b_2 \text{Log } x_2 + b_3 \text{Log } x_3 + b_4 \text{ Log } x_4 + b_5 \text{ Log } x_5 + u_t$

Where: (A=Intercept, b_1 to b_5 = elasticity co-efficients)

Y = Yield (qtls /ha)

X_1 =Farm size (ha)

X_2 = labour charges (Rs /ha)

X_3= Seed cost (Rs/ha)

X_4 = FYM &fertilizers expenses (Rs/ha)

X_5 = Plant protection chemicals expenses (Rs /ha)

Pooled cropping systems

Redgram based cropping systems like redgram + greengram, redgram + castor and redgram + sorghum (fodder) cropping systems were identified with only 10, 10 and 10 farmers respectively. For this much sample size, production function analysis could not be possible for estimating resource use efficiency and returns to scale in these cropping systems. Hence, pooled data (including all cropping systems with 120 sample farmers) was taken for the production function analysis.

$$\text{Log } Y = \text{Log } A + b_1 \text{ Log } x_1 + b_2 \text{Log } x_2 + b_3 \text{Log } x_3 + b_4 \text{ Log } x_4 + b_5 \text{ Log } x_5 + \sum_{i=1}^{n} CS_i + u_t$$

Where: (A=Intercept, b_1 to b_5 = elasticity co-efficients)

Determinants	Cropping System Dummy=(0,1) $\sum_{i=1}^{n} CS_i$
Farm size (ha)	Redgram sole crop (control)
Labour charges (Rs /ha)	Redgram + bajra cropping system
Seed cost (Rs/ha)	Redgram + greengram cropping system
FYM&fertilizers expenses (Rs/ha)	Redgram + castor cropping system
Plant protection chemicals expenses (Rs/ha)	Redgram + sorghum(fodder) cropping system

Y = Yield (qtls /ha)

X_1 =Farm size (ha)

X_2 = Labour charges (Rs /ha)

X_3= Seed cost (Rs/ha)

X_4 = FYM and fertilizer expenses (Rs/ha)

X_5 = Plant protection expenses (Rs /ha)

Cropping system dummy=0,1) $\sum_{i=1}^{n} CS_i$ i=1,2,3,4.

CS_1= Intercrop with bajra (dummy variable; 1=yes, 0=no)

CS_2=Intercrop with greengram (dummy variable; 1=yes, 0=no)

CS_3=Intercrop with castor (dummy variable; 1=yes, 0=no)

CS_4= Intercrop with sorghum (fodder) (dummy variable; 1=yes, 0=no)

U_t =Error term

In the production function analysis of pooled data, cropping system dummies were introduced into the model to identify impact of dummy variable on the dependent variable (yield in qtls). With the introduction of these dummies, we can safely attribute the differences in yield to the changes in the cropping system.

Production function was fitted for redgram based cropping systems. The elasticities of production factors along with their standard errors for redgram sole cropping system, redgram + bajra cropping system, redgram + greengram cropping system and redgram + castor cropping system and redgram + sorghum (fodder) cropping system are presented in tables 1, 2 and 3.

Production Elasticities (or) Regression Coefficients

For testing the regression coefficients or production elasticities ‘t’ test was employed by using the formula.

t = |bi |/ S.E of bi

Where, bi = Regression coefficient or production elasticity.

S.E of bi = Standard error of bi.

Returns to Scale

Returns to scale refers to how much additional output can be obtained when we change all inputs proportionately. It indicates the type of production process that exists in a particular firm. It is measuring the relationship between the scale (size) of a firm and output. The sum of regression coefficients or production elasticities (Σbi) indicates the nature of returns to scale.

The formula for “t” value is

$$t = \left| \Sigma b_i - 1 \right| / \text{SE of } b_i$$

Marginal Value Product

The marginal value product is computed by multiplying the regression coefficients of the given resource with the ratio of geometric mean of resource and output. In Cobb-Douglas production function, marginal value product (MVP) of x_i, the i^{th} input factor is given by the following formula.

The marginal value product would be

$$MVP \text{ of } x_i = b_i \times \bar{Y} / \bar{X}_i$$

Where $\bar{X}_i$ and $\bar{Y}$ are geometric means and b_i is regression coefficient of the variable x_i.

In order to evaluate the efficiency of the resource, the marginal value products of the input factors were compared with their respective acquisition costs. A ratio that is equal to unity, indicates the optimum use of factors, more than unity implies that the returns can be increased by using more of that resource and less than unity warrants uneconomic and to minimize the losses.

To test the significance of the difference between marginal value product to factor costs, 't' value was calculated.

$$t = \frac{|MVPxi - FC|}{S.E \text{ of } MVPxi}$$

where, FC = factor cost and

S.E of MVPxi = Standard error of MVPxi

Here S.E of MVPxi is given by

$\bar{Y} / \bar{X}_i \times$ S.E of b_i

Where $\bar{Y}$ and $\bar{X}_i$ are the geometric means, b_i is the regression coefficient of variable i and S.E. of bi is the standard error of the regression coefficient of xi.

Results and Discussion

Redgram sole cropping system

From the Table 1. it could be revealed that farm size, labour charges and seed were found to influence the productivity significantly in redgram sole crop. Regression coefficient of FYM & fertilizers and plant protection chemicals were found to be non-significant, even though the coefficients showed positive sign in sole cropping system. They did not contribute significantly to increase in the productivity. This might be due to the fact that farmers have already applied these inputs to a point beyond which the additional input will not contribute additional returns significantly. It is precisely due to this reason that the farmers are handicapped to optimise the use of plant protection chemicals for increasing the productivity.

The coefficient of multiple determination (R^2) indicated that 94 percent of variation in productivity was explained by the explanatory variables included in the respective production function. The elasticity coefficients for farm size, labour charges and seed were statistically significant at 5 per cent level. In other words, every one per cent increase in farm size, labour charges and seed increased the productivity to the tune of 0.37, 0.28 and 0.22 percent respectively.

The sum of output elasticities (1.02) was more than one, indicating an increasing return to scale which was mainly due to the significant influence of farm size, labour charges and seed inputs.

Table 1: Cobb-Douglas production function estimates for redgram sole cropping system: (n=60)

S. No.	Variables	Coefficient (Σ b_i)	Standard Error (SEb_i)
Yield (qtls/ha) **Y**			
	Constant	-3.08	1.22
1.	Farm size (ha) X_1	0.37**	0.17
2.	Labour charges (Rs/ha) X_2	0.28**	0.14
3.	Seed rate (Kg/ha) X_3	0.22**	0.10
4.	FYM & fertilizers (Rs/ha) X_4	0.12	0.07
5.	Plant protection chemicals (Rs/ha) X_5	0.03	0.03
	Sum of elasticities (Ep)	1.02	
	R^2	0.94	

Redgram+bajra cropping system

In case of redgram+bajra cropping system, table 2. shows that the regression coefficient of farm size had a positive and significant influence on productivity at 10 per cent level. In other words, every per cent increase in farm size would increase the productivity to the tune of 0.78 per cent.

The resources like plant protection chemicals had negative coefficients and no significant influence on productivity. This may be due to the indiscriminate use of this input factor in this cropping system.

The regression coefficients of labour charges, seed and FYM & fertilizers had positive coefficients and not significantly influencing the productivity. This may be due to the fact that these inputs have not reached to the level where they start influencing the productivity.

The coefficient of determination (R^2) value of 0.84, indicated that, 84 per cent of variation in productivity was explained by the variables considered in the production function. The sum of elasticities of coefficients was (1.20) found to be more than unity, which indicated increasing return to scale.

Table 2: Cobb-Douglas production function estimates for redgram +bajra cropping system: (n=30)

S. No.	Variables	Coefficient (Σ b_i)	Standard Error (SEb_i)
Yield (qtls/ha) **Y**			
	Constant	2.97	3.38
1.	Farm size (ha) X_1	0.78*	0.45
2.	Labour charges (Rs/ha) X_2	0.43	0.41
3.	Seed cost (Rs/ha) X_3	0.04	0.14
4.	FYM & fertilizers (Rs/ha) X_4	0.23	0.22
5.	Plant protection chemicals (Rs/ha) X_5	-0.28	0.19
	Sum of elasticities (Ep)	1.20	
	R^2	0.84	

Pooled cropping systems

Table 3. presents the pooled production function results for all cropping systems with yield in quintals per hectare as dependent variable. The coefficient of determination (R^2) was 0.40 for this model. It indicates that the explanatory variables included in the model were explaining 40 percent variation in productivity.

The regression coefficients of farm size and labour charges were found to be positive and significant at 1 percent and 10 percent probability level. It indicates that every 1 percent increase of these input factors by keeping all other inputs constant at their geometric mean levels would increase the system productivity by 0.08 and 0.18 percent respectively. The coefficients of seed and plant protection chemicals were found to be positive whereas coefficient of FYM & fertilizers was negative and non-significant. This may be due to the fact that these inputs have not reached to the level where they start influencing the productivity. Cropping system dummy variables CS_2, CS_3 and CS_4 (redgram + greengram, redgram + castor and redgram + sorghum (fodder) cropping systems) were found to be positive and significant at 5 percent, 1percent and 1 percent level respectively. It indicates farmers in the redgram intercropping systems were better off in terms of obtaining redgram yield than redgram sole cropping system. Similar method followed by Agahiu *et al* (2011) [1] in the study of Assessment of weed management strategies and intercrop combinations on cassava yield in middle belt of Nigeria.

Table 3: Cobb-Douglas production function estimates for pooled cropping systems: (n=120)

S. No.	Variables	Coefficient (Σ b_i)	Standard Error (SEb_i)
Yield (qtls/ha**) Y**			
	Constant	-0.422	1.181
1.	Farm size (ha) X_1	0.084***	0.033
2.	Labour charges (Rs/ha) X_2	0.183*	0.122
3.	Seed cost (Rs/ha) X_3	0.017	0.048
4.	FYM & fertilizers (Rs/ha) X_4	-0.005	0.062
5.	Plant protection chemicals (Rs/ha) X_5	0.035	0.021
6.	CS_1= Intercrop with bajra (dummy variable; 1=yes, 0=no)	-0.427	0.080
7.	CS_2= Intercrop with greengram (dummy variable; 1=yes, 0=no)	0.322**	0.137
8.	CS_3= Intercrop with castor (dummy variable; 1=yes, 0=no)	0.368***	0.135
9.	CS_4= Intercrop with sorghum (fodder)(dummy variable; 1=yes, 0=no)	0.361***	0.126
	Sum of elasticities (Ep)	0.31	
	R^2	0.40	

Note: *, ** and *** denotes 10, 5 and 1 percent respectively.

Resource Use Efficiency

Resource use efficiency can be seen with the computation of marginal value products (MVPs) and opportunity cost (OC) ratios. The ratio helps in suggesting suitable resource adjustments for the rational employment of resources and profit maximization.

From table 4. it could be observed that in redgram sole cropping system, the ratios of MVP to OC were greater than unity for resources like farm size (1.09), labour charges (1.20) and seed (2.28), which suggests that farm size, labour and seed inputs use can be increased in this cropping system. The ratio was less than unity for FYM & fertilizers (0.27) and plant protection chemicals (0.54).The utilization of FYM &fertilizers and plant protection chemicals was not at optimum levels. Hence, these inputs were used excessively than required by this group. There is a need to reduce these inputs to achieve higher productivity in sole cropping system.

The MVP to OC ratios of resources like farm size (1.51), labour charges(1.11) and seed cost (1.44) more than one, indicating that these inputs can be increased sufficiently in redgram + bajra cropping system. The ratio was negative in plant protection chemicals (-2.18) and less than one in FYM & fertilizers (0.56) indicating the excessive and indiscriminate use of this input factor. Hence usage of plant protection chemicals should be reduced considerably.

In pooled cropping system, the ratios of farm size (1.07), labour charges (1.03) and seed cost (1.68) were more than one indicating that these inputs can be increased sufficiently in all cropping systems. The ratio was less than one in FYM & fertilizers (0.36) and plant protection chemicals (0.30) which might be due to excess and indiscriminate use of these inputs. Hence usage of these inputs should be reduced considerably.

Table 4: Marginal value products and opportunity costs (in ₹.) of resources and Marginal value product to opportunity cost ratios in redgram, redgram+bajra and pooled cropping systems

	Particulars	MVP at G.M	OC	MVP/OC
I	**Redgram sole Cropping system (n=60)**			
1.	Farm size (ha) X_1	8016.40	7294.20	1.09
2.	Labour charges (Rs/ha) X_2	1.20	1.00	1.20
3.	Seed rate (Kg/ha) X_3	1627.56	713.37	2.28
4.	FYM & fertilizers (Rs/ha) X_4	0.27	1.00	0.27
5.	Plant protection chemicals (Rs/ha)X_5	0.54	1.00	0.54
II	**Redgram+bajra Cropping system (n=30)**			
1.	Farm size (ha) X_1	9333.55	6146.00	1.51
2.	Labour charges (Rs/ha) X_2	1.11	1.00	1.11
3.	Seed cost (Rs/ha) X_3	1.44	1.00	1.44
4.	FYM & fertilizers (Rs/ha) X_4	0.56	1.00	0.56
5.	Plant protection chemicals (Rs/ha) X_5	-2.18	1.00	-2.18
III	**Pooled cropping systems (n=120)**			
1.	Farm size (ha) X_1	8061.00	7500.00	1.07

2.	Labour charges (Rs/ha) X_2	1.03	1.00	1.03
3.	Seed cost (Rs/ha) X_3	1.68	1.00	1.68
4.	FYM & fertilizers (Rs/ha) X_4	0.36	1.00	0.36
5.	Plant protection chemicals (Rs/ha) X_5	0.30	1.00	0.30

MVP: Marginal Value Product G.M: Geometric mean OC: Opportunity cost

Conclusions
The Production function analysis revealed that production elasticities of farm size, labour charges and seed were found to influence the productivity significantly in redgram sole crop. In case of redgram + bajra cropping system, the regression coefficient of farm size had a positive and significant influence on productivity. In pooled cropping systems regression coefficients of farm size and labour charges were found to be positive and significant influence on productivity. The cropping system dummy variables (redgram + greengram, redgram + castor, redgram + sorghum (fodder) cropping systems) were found to be positive and showing significant influence on productivity. This indicates that farmers in the redgram intercropping systems were better off in terms of obtaining redgram yield than redgram sole cropping system. Sum of elasticities of production function revealed that there was increasing returns to scale in redgram sole cropping system and redgram + bajra cropping system while it was decreasing returns to scale in pooled cropping systems. This clearly showed that production of redgram and redgram based cropping systems could be increased by increased use of inputs viz., farm size, labour charges and seed in the study area. The MVP to OC ratios of farm size, labour charges and seed cost were more than one indicating that these inputs can be increased sufficiently in all cropping systems.

References
1. Agahiu AE, Udensi UE, Tarawali G, Okoye BC, Ogbuji, RO Baiyeri KP. Assessment of weed management strategies and intercrop combinations on cassava yield in the middle belt of Nigeria. African Journal of Agricultural Research. 2011; 6(26):5729-5735.
2. Dhima KV, Lithourgidis AS, Vasilakoglou IB, Dordas CA. Competition indices of common vetch and cereal intercrops in two seeding ratio. Field Crops Res. 2007; 100:249-256.
3. Egbe OM, Evaluation of some agronomic potential of pigeonpea genotypes for intercropping with maize and sorghum in Southern Guinea Savanna. Ph.D. Thesis, University of Agriculture, Makurdi, Nigeria, 2005.
4. Lithourgidis AS, Vasilakoglou IB, Dordas CA, Yiakoulaki MD. Forage yield and quality of commen vetch mixtures with oat and triticale in two seeding ratios. Field Crop Res. 2006; 99:106-113.
5. Tabo R, Ezueh MI, Ajayi O, Asiegbu JE, Singh L. Pigeonpea production and utilization in Nigeria. International Chickpea Pigeonpea News letter. 1995; 2:47-49.