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Crop wise Production Function and Resource Use Efficiency in Agriculture

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Abstract: *In this study an attempt has been made to study the resource use efficiency of input factors of production of paddy, bajra, and groundnut. The unrestricted Cobb- Douglas production function has been utilized for the study. The data were collected with the help of from survey method through personal interviews from the farmers. The analysis shows the pattern of resource use need some modification, particularly, the application of HYV seeds and chemical fertilizers and pesticides should be increased in the case of paddy and Bajra whereas in the case of groundnut, the application of human- labour, irrigation, chemical fertilizers and pesticide to obtain more yield.*

Keywords: *Technological Parameters, Resource Use Efficiency, Cobb-Douglas Production, HYVSeeds.*

I. Introduction

Production is a process, thereby some goods and services called inputs and transformed into other goods and services called outputs. Many types of activities are involved in the production including changes in farm location and the time of use of products. Each of these changes involves the use of inputs to produce the desire outputs.

The farms output depends upon the quantities of inputs used in production. Thus the relation between input and output can be characterized by a production function. A production provides information concerning the quantity of output that may be expected when particular inputs are combined in a specific manner. The chemical, physical and biological properties determine the kind and amount of output which will be received from particular combination of inputs.

Crop production by and large can be increased by increasing area under cultivation, double cropping and raising the yields of crops per hectare by the application of new agricultural technology and by the reorganization of institutional factors. Crop- wise desegregation becomes important because the use and the effect of mechanized techniques vary between operations in the cultivation of a given crop, but it can also vary from crop to crop and region to region.

II. Review Of Literature

Debnarayan Sarker and Sudpita De [2004] made an attempt to examine the extent of efficiency under different types of nature and different farm sizes in two types of villages – Technologically Advanced villages and Technologically Backward villages. This study analysis shows that the use of high technological inputs in agriculture is not so important in improving the efficiency level of the farms.

Pandey and shanty[6] (1989) sarup discussed the level of output and input use as well as estimation of productivity equation of rice. Yadav and Gangwar[8] (1986) made an attempt has been made to determine empirically the parameters of chage form old to new rice technology in Dharbhanga district of Bihar State. Rathore (1984) studied the contribution of various factors such as neutral technology, non-neutral technology and other inputs to the overall productivity differences and / or the overall efficiency differences between small and large farms of Himachal Pradesh and Maharashtra. The study reveals that while applying neutral technology the farm productivity will be less on small farms on the other hand applying non-neutral technology, small farms have an advantage over the large ones..

David Hopper (1965) investigated the problem of allocation efficiency with the help of Cobb-Douglas production function using data relating to a village, which he collected specially for his study. Parikh Ashok (1964) combines cross- section and time- series data for ten district of Tamilnadu for paddy, groundnut, cholam, cambu and ragi. Adinarayana (1985) studied the comparative economics of high- yielding and local varieties of rice in coastal Andhra Pradesh.

Sharma and Sharma (2000) study found that the existence of inverse relationship between productivity and farm size in the production of wheat and paddy. The results showed that the small farms used higher amount of human labour and fertilizer as compared to higher farm size categories. Eswara prasad, srirama murthy,

satyanarayana, chennarayudu and Lalitha Achoth (1988) were studied the extent of resource use efficiency of various resources in cotton farms in Guntur district.

In this study an attempt has been made to study the crop- wise production function for staple crops paddy, bajra and groundnut. Further, it is proposed to study the resource use efficiency in agriculture of Cuddapah district of Andhra Pradesh.

III. Data And Methodology

The study extends over Cuddapah district of Andhra Pradesh and is a part of Rayalaseema region of Andhra Pradesh. It is also one of the least rainfall districts. In the state and bulk of the area is under rain fed crops except Kurnool – Kadapa canal, it has no major irrigation source. Groundnut is the dominant with half of the cropped area to its credit. However paddy and Bajra are also the prominent crops under cultivation. In order to analyze, the nature and significance of technological parameters of paddy, Bajra and Groundnut crops, it is necessary to analyze the parameters of different factors of crop production. For this purpose a multistage random sampling design was used to collect the data for the selected crops. At first fifteen villages were selected at random from the district. After the selection of villages a complete list of cultivators prepared. Further, the data were collected with the help of farm survey method through personal interviews with the farmers selected through mixed sampling of three crops paddy, Bajra and Groundnut, which are grown in our study area. The data on bullock- labour (X_1), human- labour, (X_2), HYV seeds (X_3) ,traditional seeds (X_4),irrigation (X_5), natural fertilizers (X_6) , chemical fertilizers and pesticides (X_7), all in rupees.

To study the crop- wise production function based on entire sample of farms, we considered the following Cobbb-Douglas production function for different selected crops.

$$y_i = a_{i0} X_{i1}^{a_{i1}} X_{i2}^{a_{i2}} X_{i3}^{a_{i3}} X_{i4}^{a_{i4}} X_{i5}^{a_{i5}} X_{i6}^{a_{i6}} X_{i7}^{a_{i7}}$$

Where I = P,B and G present Paddy , Bajra and Groundnut

Y= Gross output including by- products	(in rupees)
a_0= intercept	
x_1= Bullock- Labour	(in rupees)
x_2= Human- Labour	(in rupees)
x_3= HYV seeds	(in rupees)
x_4= Traditional seeds	(in rupees)
x_5= Irrigation	(in rupees)
x_6= Natural fertilizers	(in rupees)
x_7= Chemical Fertilizers and pesticides	(in rupees)

a_1, a_2, a_3 - - - - - - - - - - a_7 are elasticities.

Marginal Value Productivity:

By studying the marginal value productivity of factors of production, we can asses their relative importance. Marginal Value Productivity of X_i , the i^{th} input is estimated by the following formula:

$$\text{MVP } (X_i) = a_i \frac{G.M.(Y)}{G.M.(X_i)}$$

Where

G.M.(Y) and G.M. (x_i) represent the geometric means of output and input respectively and a_i is the regression co- efficient of i^{th} input.

IV. Results And Analysis

The functions are estimated by the method of ordinary Lease Squares. The estimated parameters and other relevant statistics were presented in a Table 3.1. Before analyzing the Table 3.1, we should examine the presence of multi- collinearity. Multi collinearity test on the basis of **Klein**[5](1965) **and Heady – Dillon**[4](1961) was carried out and results were given in Table 3.2, 3.3 and 3.4. witch are indicating, the absence of multi-collinearity.

The table 3.1 shows the value of R^2 for different crop functions. The included variables explained 90 per cent of variation in output for paddy; 93 percent in bajra and 92 percent in groundnut. F-test was carried out and it was found significant at 5 percent probability level for all the crops. Thus the fit is good and the estimated equations shows true relationship between output and inputs.

Table 3.1 Estimated parameter and other related statistics

Items	Paddy	Bajra	Groundnut
a_0	2.4887	3.1424	3.7929
X_1 Bullock – Labour	0.0829 (0.0865)	0.2716* (0.0831)	0.0791 (0.0946)
X_2 Human – Labour	0.1515 (0.0973)	– 0.0245 (0.0701)	0.4046* (0.0953)
X_3 HYV Seeds	0.2816* (0.0917)	0.5549* (0.0842)	0.2206* (0.0649)
X_4 Traditional Seeds	---	---	0.2127* (0.0653)
X_5 Irrigation	– 0.0200 (0.0627)	0.0600 (0.0376)	0.2127* (0.00603)
X_6 Natural Fertilizers	– 0.0079 (0.049)	---	0.0011* (0.0032)
X_7 Chemical Fertilizers & Pesticides	– 0.0200 (0.0627)	0.0600 (0.0376)	0.2127* (0.00603)
R^2	0.9048	0.9307	0.9193
Multiple R	0.9512	0.9647	0.9588
F	270.9057*	411.1313*	271.7386
Sum	0.9988	0.9596	1.2581

*Significant at 5% probability level.
Figures in Parentheses are standard errors.

Paddy: From Table 3.1 we observed that the regression coefficients of irrigation and natural fertilizer are negative and they are –0.0200 and –0.0079 respectively. The regression coefficients of bullock- labour, HYV seeds and chemical fertilizers and pesticides are positive and are 0.0829, 0.1515, 0.2816 and 0.5107 respectively. The regression coefficients of HYV seeds and chemical fertilizers and pesticides are statistically significant at 5 per cent probability.

Bajra: From Table 3.1 we found that the regression co- efficient of human –labour is negative and it is – 0.0245. The regression co- efficients of bullock- labour, HYV seeds, irrigation and chemical fertilizers and pesticides are positive and they are 0.2716, 0.5549, 0.600 and 0.0976 respectively. The co- efficients of bullock – labour and HYV seeds are found to be statistically significant at 5 per cent probability level.

Groundnut: From Table 3.1 we observed that the regression co- efficient of natural fertilizer is negative and it is –0.0011. The regression co- efficients of bullock- labour, human- labour, HYV seeds, traditional seeds, irrigation and chemical fertilizers and pesticides are positive and they are 0.0791, 0.4046, 0.2206, 0.2157, 0.2127 and 0.1265 respectively. The co-efficients of human- labour, HYV seeds, traditional seeds, irrigation and chemical fertilizers and pesticides are statistically significant at 5 per cent probability level.

The coefficients of irrigation and natural fertilizers are negative in the case of paddy, the co- efficient of human- labour is negative in the case of Bajra and the co- efficient of natural fertilizers is negative in the case of groundnut. These negative coefficients call for some explanation. One possible explanation is that the input is applied in excess of what is normally required for production. Another explanation is that there may be large fluctuation in the inputs of the crop- wise data.

Returns to scale: Unrestricted Cobb- Douglas production function was estimated. The sum of the regression coefficients are represents returns to scale in this function.

In the case of paddy and Bajra from Table 3.1 we observed that the sum of co-efficients is less than one and hence it indicates decreasing return to scale. Whereas in the case of groundnut the sum of the co-efficient is found to be more than one and hence it indicates increasing returns to scale.

Table 3.2 Correlation Matrix Related to Paddy

1.0000	0.9382	0.9274	0.8632	0.1057	0.8793	0.8913
	1.0000	0.9136	0.8724	0.1298	0.8976	0.9120
		1.0000	0.8735	0.1381	0.9014	0.9189
			1.0000	0.0587	0.8525	0.8422
				1.0000	0.1938	0.1530
					1.0000	0.9319
						1.0000

Table 3.3 Correlation Matrix Related to Bajra

1.0000	0.8324	0.8163	0.6617	0.8487	0.8370
	1.0000	0.8279	0.6676	0.8320	0.7966
		1.0000	0.5963	0.8567	0.8314

Table 3.4 Correlation Matrix Related to Groundnut

1.0000	0.9381	0.2055	-0.0944	0.8847	-0.3599	0.7714	0.9205
	1.0000	0.1931	-0.0816	0.8986	-0.3149	0.7952	0.9208
		1.0000	-0.8926	0.1649	-0.0115	0.0708	0.2205
			1.0000	-0.0583	-0.0380	0.0196	-0.1105
				1.0000	-0.3172	0.7526	0.9007
					1.0000	-0.3930	-03577
						1.0000	0.8098
							1.0000

Resource use efficiency

Economic adjustment of resource is examined with the help of the ratios of marginal value product (MVP) of inputs and their marginal cost (MC). The calculated ratios of MVP and MC are given in Table 3.5.

Paddy:

From Table 3.5 we observed that the ratios of MVP and MC of bullock- labour, HYV seeds, chemical fertilizers and pesticides are 1.2879, 0.8909, 8.6955 and 4.6930 respectively. These ratios call some explanations. The possible explanation is that, keeping all other variables constant at their respective geometric mean level, with the increase of one rupee (Marginal Cost) in bullock- labour , human- labour and chemical fertilizers and pesticides, the amount of gross output including by- products of paddy would tend to increase by Rs. 1.29, Rs.0.89, Rs.8.70 , and Rs.4.70 respectively. Therefore the pattern of resource use in paddy crop need some modification, particularly the application of HYV seeds and chemical fertilizers and pesticides should be increased, to get more yield of paddy.

Marginal Value Product of Input Factors to their Marginal Cost

Input	Paddy			Bajra			Groundnut		
	MVP	MC	Ratio	MVP	MC	Ratio	MVP	MC	Ratio
	1.2879	1.0000	1.2879	1.2879	1.0000	1.5134	1.3715	1.0000	1.3715
X_2	0.8909	1.0000	0.8909	-0.1185	1.0000	-0.1185	3.4658	1.0000	3.4658
X_3	8.69551	1.0000	8.6955	22.2518	1.0000	22.2518	1.9869	1.0000	1.9869
X_4	----	----	----	----	1.0000	----	2.3390	1.0000	2.3390
X_5	-0.3948	1.0000	-0.3948	0.6505	1.0000	0.6505	4.0137	1.0000	4.0137
X_6	-0.0950	1.0000	0.0950	-----	-----	-----	-0.0140	1.0000	-0.0140
X_7	4.6930	1.0000	4.6930	1.2503	1.0000	1.2503	3.4859	1.0000	3.4859

Source: Author's calculations based on collected data

Bajra:

From Table 3.5 we find that the ratios of MVP and MC of bullock- labour, HYV seeds and chemical fertilizers and pesticides are 1.5134, 22.2518, 0.0140 and 1.2503 respectively. These ratios call some explanation, the possible explanation is that, keeping all other variables constant at their geometric mean level, with the increase of one rupee (Marginal Cost) in bullock- labour, HYV seeds, irrigation and chemical fertilizers and pesticides the amount of gross output including by- products of Bajra would tend to increase by Rs.1.21. Rs. 22.25, Rs.0.65 and Rs.1.25 respectively. Therefore the pattern of resource use need some modification, particularly, the application of HYV seeds, bullock- labour and chemical fertilizers and pesticides should be increased to obtain more yield of Bajra.

Groundnut:

From Table 3.5 we observed that the ratios of MVP and MC of bullock- labour, human- labour, HYV seeds, traditional seeds, irrigation and chemical fertilizers and pesticides are 1.3715, 4658, 1.9869,2.3390, 4.0137 and 3.4859 respectively. These ratios call some explanation. The possible explanation is that keeping all other variables constant at their respective geometric mean level, with the increase of one rupee (Marginal Cost) in bullock- labour, human- labour, HYV seeds, traditional seeds, irrigation and chemical fertilizers and pesticides, the amount of gross output including by- products of groundnut would tend to increase by Rs.1.37, Rs.3.47, Rs.1.99, Rs.2.34, Rs.4.04 and Rs.3.49 respectively. Therefore the pattern of resource use need some modification particularly, the application of human- labour, traditional seeds and chemical fertilizers and pesticides should be increased to get more yield of groundnut.

In the case of paddy, the ratios of MVP and MC of irrigation and natural fertilizers are negative. In the case of Bajra, the ratio of human- labour is negative. In the case of groundnut the ratio of natural fertilizers is negative. Negative sign shows the excess usage of inputs. Hence, the use of additional quantity will lead to decrease the quantity of yield.

V. Conclusions And Suggestions

In the case of paddy and Bajra the technological parameters are appear to be relatively important whereas in the case of groundnut both traditional and technological factors are appear to be important. The results of production functions analysis of paddy, bajra and groundnut are clearly indicating that the need of resource adjustments. In the case of paddy farms, particularly, the application of HYV seeds and chemical fertilizers and pesticides should be increased to obtain more yield and natural fertilizers and irrigation should decrease to avoid excess utilization of these inputs. In the case of bajra, application of HYV seeds should be increased to obtain more yield of output and human- labour should be decreased to avoid excess utilization. In the case of groundnut, the application of HYV seeds, chemical fertilizers and pesticides, human- labour and traditional seeds should be increased to obtain more yield of output.

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