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Resource productivity and optimum resource allocation in cereal crops on medium farm in Marathwada

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ABSTRACT

The study of resource productivity; resource use efficiency and optimum resources used with respect to various explanatory variables in cereal crops *viz*. bajara, *rabi* jowar and wheat was undertaken on medium farm during agriculture year 2005-06 in Marathwada region of Maharashtra. The data was taken from cost of cultivation scheme Marathwada Agricultural University, Parbhani the sample of 100 medium farm size farmers throughout the zone was tabulated and analyzed by appropriate statistical tools. The result revealed that, in case of bajara area was positive and significant at 1 per cent level. Coefficient of multiple determination was (R^2) 0.707 which indicate 70.70 per cent variation in independent variable, the sum of elasticity was 0.86 which was indicated that decreasing return to scale. In regard to *rabi* jowar area and bullock were positive and highly significant on 1 and 5 per cent level, respectively, the sum of elasticity was 0.89 per cent which indicate decreasing return to scale coefficient of multiple determination was 0.93 which indicate that 93 per cent variation in explanatory variable. In case of wheat area and nitrogen were positive and significant at 1 and 5 per cent level, respectively the coefficient of multiple determination R^2 was 0.90 which was showed 90 per cent variation in explanatory variable.

Key words : Production function, Medium farm, Resource use efficiency, Optimum resources.

INTRODUCTION

Agriculture has prime as well as pride position in the Indian economy. Agriculture's Share in National income was 17.4 per cent in 2006-07 with agricultural growth of 2.4 per cent in year 2007-08. The sector provides employment to 58.4 per cent of country's workforce which is the single largest private sector occupation. About 38 per cent share in total export of country contributed by agriculture and allied sectors. The geographical area of India is 329 million hectares. The area under medium farm was 83.40 million hectare *i.e.* 23.35 per cent and number of medium farmers in country is 6.14 per cent. Geographical area of Maharashtra State and Marathwada region are 30.8 million hectares and 6.44 million hectares, respectively. Area under medium farm are 32.74 per cent and 27.70 per cent, respectively and number of medium farmers in Maharashtra and Marathwada are, 12.36 per cent and 12.50 per cent, respectively. Farm, means a piece of land where crops and livestock enterprises are taken under a common management. Farm management covers aspects of farm business which have a bearing on economic efficiency of the farm. Now a days farmers doing farming as business point of view. So as to analyze the various concepts of farm business income like return to scale, net worth statement, income statement, farm ratio etc; singly or combinely has discussed. Farm business management means a science which deals with judicious decision or use of scarce farm resources having alternative uses to obtain the maximum profit. Thus the overall profit level of farm depends upon income gained on farm. Keeping these points infront "Economic analysis of medium farm in Marathwada region of Maharashtra has been undertaken with the objective is resource productivity and resource use efficiency in cereal crops at medium farm.

MATERIALS AND METHODS

Marathwada region of Maharashtra was purposively selected in order to study the farm business analysis. Multiple stage sampling design was used for selection of zone, tehsils villages and farms. Twenty eight tehsils under the assured rainfall zone were selected from the eight districts of region because of their involvement in cost of cultivation scheme. From each cluster villages the two farmers of medium categories were selected. Thus, total 100 sample farms were selected. Data pertains to the year 2006-07.Technique like tabular analysis, budgeting technique, non-linear and multiple regression analysis, frequency and percentage method were used to analyze the data.

Strong inter-correlations among independent variables were identified for solving problem of collinearity in estimating production function. The variables which had non-significant correlation significant with respect to bajara, *rabi* jowar and wheat production were also dropped in estimating production function. Thus for bajara seven, for *rabi* jowar six and for wheat eight independent variables were included in both linear and Cobb-Douglas production functions. On the basis of goodness of fit (R^2),Cobb-Douglas production function was found to be

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the best fit to the data to estimate the resource productivity, resource use efficiency and optimum resource use. The fitted equation was as follows.

$$Y = aX_1^{b1}. X_2^{b2}. X_3^{b3} ——— X_n^{bn}. e^u$$

where, Y = production of bajara, *rabi* jowar and wheat (kg/ha), a=intercept, b_i = partial regression coefficient of specific resource (i=1,2,…..,8),X_1=area of crop(ha/farm), X_2=Hired labour (man day/farm), X_3=seed(kg/farm), X_4=nitrogen(kg/farm), X_5=phosphorus (kg/farm), X_6=potassium(kg/farm), X_7=family labour(man day/farm), X_8=irrigation and e= error term. The function was transformed into log-linear form as follows.

$$LogY = log\ a + b_1 logX_1 + b_2 log\ X_2 + b_3 log\ X_3 ——— b_n logX_n + uloge$$

RESULTS AND DISCUSSION

Linear and Cobb-Douglas production functions were used in analysis of eight crops on the basis of goodness of fit (R^2). Cobb-Douglas production function was found to fit to the data. Production of various crops, the variable used in production function, the correlation matrices were developed. It was clear that the correlation coefficients of independent variables with respect to production were observed and on the basis of non significant correlation coefficients some of the variables were dropped. Similarly in order to solve problem of multicollinearity. The correlation coefficients among dependent variables which had less than the value of multiple determination were dropped. Thus the remaining dependent variables were lastly used in Cobb-Douglas production function which gives elasticity of production directly. Here the regression coefficients are the elasticity of production and used to determine the return to scale in crops production.

Estimates of Cobb-Douglas production function in bajra production:

Regression coefficient with respect to various explanatory variables were calculated with 't' values and are presented in Table 1. It was observed that regression coefficient of area was 0.873 which was positive and significant at 1 per cent level. It was inferred that if 1 per cent increase in area, over its geometric mean, it would lead to increase bajra production by 0.873 per cent, phosphorus indicated negative but significant at 5 per cent level. So it indicates excessively use of phosphorus in cultivation of bajra. Hired human labour and nitrogen were positive but non significant. Phosphorus and seed were negatively non significant. Coefficient of multiple determination (R^2) was 0.70 which was implied that 70.70 per cent variation in bajra production was explained due to variation in all independent variables 'F' value was highly significant (8.602). It was clear that each explanatory variable units own was not very important but together they explained significantly part of variation in bajra production. The sum of regression coefficients was 0.86 which indicated decreasing return to scale.

Resource use efficiency, resource productivity and optimum resource use with respect to various explanatory variables were estimated and are presented in Table 1. It

Table 1: Estimates of Cobb-Douglas production function for partial regression coefficients in returns to resource productivity, resource use efficiency and optimum resource use in bajra production

Sr. No.	Independent variable	Partial regression coefficient (bi)	Standard error bi (SE)	't' value	Geometric mean of input (xi)	Marginal product (q)	Marginal value product (Rs.)	Price of input (Rs.)	MVP to price ratio	Optimum resource use
1.	Area of bajra (ha/farm)	0.873	0.231	3.78**	0.872	12.42	7454.53	2075.86	3.59	3.13
2.	Hired labour (man day/ farm)	0.0628	0.123	0.509	20.98	0.037	22.28	60.00	0.37	7.79
3.	Seed (kg/farm)	-0.0275	0.173	-0.159	3.162	-0.107	-64.75	70.00	-0.925	--
4.	Nitrogen (kg/farm)	0.0675	0.046	1.461	31.62	0.026	15.89	11.30	1.40	44.47
5.	Phosphorus (kg/farm)	-0.0642	0.032	-1.987*	6.165	-0.129	-77.53	20.00	-9.12	--
6.	Potassium (kg/farm)	0.00480	0.020	0.236	0.441	0.135	81.04	8.50	4.052	4.20
7.	Family labour (man day/ farm)	-0.0412	0.034	-1.214	8.79	-0.058	-34.90	60.00	-0.58	--

Intercept (log a)	1.067
F value	8.60**
R2	0.707
Return to scale (Σ bi)	0.86

NOTE : Geometric mean (Y)of bajra production was 19.678 q per farm and price was Rs.600/q

* and ** indicates significance of values at P=0.05 and 0.01, respecltively.

is obvious from the table that marginal productivity with respect to area of bajra was highest as 12.42 quintals followed by potassium, hired human labour and nitrogen were 0.135, 0.037, 0.026q, respectively. It was inferred that if area of bajra was increased by one hectare, over its geometric mean level, it would lead to increase the production of bajra with 12.42 quintals. Similarly, per unit of potassium, hired human labour and nitrogen were increased; it would cause to increase the production of bajra 0.135, 0.037 and 0.026 quintals, respectively.

In case of resource use efficiency, it was evident from Table 1, that area in bajra production indicated the highest MVP to price was 3.59.The MVP and price ratio of potassium was highest (4.052) followed by nitrogen (1.40). Which were greater than unit and this ratio hired human labour was 0.37, which was less than one where as this ratio greater than one that resources could be increased.

In case of optimum resource use, it was observed that area optimum as 3.13 hectares. On contrary, the optimum resource use with respect to potassium (4.20 kgs) followed by nitrogen (1.40 kgs) and hired human labour was 7.79 man days. It was implied that optimum resource uses with respect to these variables were less than existing resource level.

Estimates of Cobb-Douglas production function in rainfed rabi jowar production:

Regression coefficient with relation to various explanatory variables were calculated with 't' values and are presented in Table 2. It was observed that regression coefficient of area was 0.87 which was positive and significant at 1 per cent level. It was inferred that if 1 per cent increase in area, over its geometric mean, it would lead to increase rainfed *rabi* jowar production by 0.87 per cent. Similarly, bullock labour indicated positive regression coefficient as 0.041 which was also significant at 5 per cent level, it would lead to increase of production of rainfed *rabi* jowar by 0.041 per cent. Seed and phosphorus were positive but non significant. Coefficient of multiple determination (R^2) was 0.93 which was indicted that 93.00 per cent variation in rainfed *rabi* jowar production was explained due to variation in all independent variables. 'F' value was highly significant (85.30). It was clear that each explanatory variable units own was not very important but together they explained significantly part of variation in rainfed *rabi* jowar production. The sum of regression coefficients was 0.89 which indicated decreasing return to scale. The elasticity of hired human labour and nitrogen was negative and non significant it indicates that there is no scope to increase.

Resource productivity, resource use efficiency, and optimum resource use with respect to various explanatory variables were estimated and are also presented in Table 2. It is obvious from the Table 2 that marginal productivity with respect to area of rainfed *rabi* jowar was highest as 8.21 quintals followed by bullock labour, seed and phosphorus were 0.066, 0.0112 and 0.0105q, respectively. It was inferred that if area of rainfed *rabi* jowar was increased by one hectare at its geometric mean level, it

Table 2 : Estimates of Cobb-Douglas production function for partial regression coefficients in returns to resource productivity, resource use efficiency and optimum resource use in rainfed r*abi* jowar production

Sr. No.	Independent variable	Partial regression coefficient (bi)	Standard error bi (SE)	't' value	Geometric mean of input (xi)	Marginal product (q)	Marginal value product (Rs.)	Price of input (Rs.)	MVP to price ratio	Optimum resource use
1.	Area of rainfed *rabi* jowar (ha/farm)	0.870	0.171	5.08**	1.035	8.21	8787.33	2567.67	3.42	3.54
2.	Hired labour (man day/farm)	-0.021	0.068	-0.317	54.95	-0.0037	-3.99	60.00	-0.066	--
3.	Bullock labour (pair day/farm)	0.0410	0.017	2.38*	6.025	0.066	71.13	150.00	0.474	2.85
4.	Seed (kg /farm)	0.0109	0.158	0.069	9.50	0.0112	11.99	30.00	0.39	3.79
5.	Nitrogen (kg/farm)	-0.0099	0.10	-0.973	-0.43	-0.224	-103.49	11.30	-9.15	--
6.	Phosphorus (kg/farm)	0.0041	0.10	0.413	-3.81	0.0105	11.24	20.00	0.56	2.14

Intercept (log a)	0.978
F value	5.30**
R2	0.93
Return to scale (Σ bi)	0..89

NOTE : Geometric mean (Y)of rainfed *rabi* jowar production was 9.77 q per farm and price was Rs.1000/q

* and ** indicates significance of values at P=0.05 and 0.01, respectively

would lead to increase the production of rainfed *rabi* jowar with 8.21 quintals. Similarly, per unit of bullock labour, seed and phosphorus was increased it would cause to increase the production of rainfed *rabi* jowar 0.066 q, 0.0112 q, and 0.0105 q, respectively.

In regard to resource use efficiency, it was also evident from table that area in rainfed *rabi* jowar production indicated the highest MVP to price ratio (3.42) which is greater than unity. On the contrary MVP to price ratios with respect to bullock labour, seed and phosphorus were less than unit. Whereas the MVP to price ratio was greater than one that resource could be increased and less than one that resource not have scope to increase.

In regard to optimum resource use, it was observed that area was optimum as 3.54 hectares followed by, bullock labour 2.85 pair days. On contrary, the optimum resource use with respect to seed (3.79 kgs) followed by phosphorus (2.14 kgs). It was implied that optimum resource uses with respect to these variables were less than existing resource level.

Estimates of Cobb-Douglas production function in wheat production:

Regression coefficient with relation to various explanatory variables were calculated with 't' values and are presented in Table 3. Elasticity of area is positive and significant at 1 per cent level *i.e.* a scope to increase land resource. Hired human labour is positive but non significant and from MVP to price ratio (0.23) indicates the resource was not efficient means there is no scope to increase hired human labour. As in case of area MVP to price ratio is 4.11 which is highly efficient as increase area by 1 per cent. over geometric mean, increase wheat production by 0.77 per cent. Elasticity of nitrogen was 0.129 which was positive and significant at 5 per cent level and the resource has scope to increase which indicated by MVP to price ratio which was 3.69. Seed also has a scope to increase, its MVP to price ratio was 1.60. Elasticity of seed was 0.135, which was positive but non significant indicates that there is scope to increase seed for maintain plant population. In case of phosphorus, potassium, family labour and irrigation were negative and non significant, which implies that there is no scope to increase the amount of these resources.

Resource productivity, resource use efficiency and optimum resource use with respect to various explanatory variables were estimated and are presented in Table 3. It is obvious from the table that marginal productivity with respect to area was highest as 14.82 quintals followed by hired human labour, nitrogen and seed were 3.26 man days, 0.041 kg and 0.025 kg, respectively. It was inferred that as area under wheat increased by one hectare production of wheat increased by 14.82 quintals. Similarly per unit of hired human labour, nitrogen and seed were increase, it would cause to increased production by 3.26, 0.041 and 0.0215 quintals, respectively.

In regard to optimum resource use, it was observed that area was optimum as 2.87 hectares followed by

Table 3 : Estimates of Cobb-Douglas production function for partial regression coefficients in returns to resource productivity, resource use efficiency and optimum resource use in wheat production

Sr. No.	Independent variable	Partial regression coefficient (bi)	Standard error bi (SE)	't' value	Geometric mean of input (xi)	Marginal product (q)	Marginal value product (Rs.)	Price of input (Rs.)	MVP to price ratio	Optimum resource use
1.	Area of wheat (ha/farm)	0.77	0.232	3.34**	0.70	14.82	14828.03	3607.49	4.11	2.87
2.	Hired labour (Man day/ farm)	0.016	0.054	0.30	15.13	3.26	14.25	60.00	0.23	3.59
3.	Seed (kg/farm)	0.135	0.21	0.62	70.79	0.025	25.70	16.00	1.60	113.73
4.	Nitrogen (kg/farm)	0.129	0.057	2.25*	41.68	0.041	41.72	11.30	3.69	143.15
5.	Phosphorus (kg/farm)	-0.006	0.13	-0.48	6.02	-0.013	-13.48	20.00	-0.67	--
6.	Potassium (kg/farm)	-0.012	0.008	-1.59	0.103	-1.57	-1570.48	8.50	-184.76	--
7.	Family labour (man day/farm)	-0.017	0.014	-1.31	5.37	-0.04	-42.67	60.00	-0.71	--
8.	Irrigation	-0.033	0.059	-0.57	1174.89	-0.0003	-0.37	2.50	-0.14	--

Intercept (log a)	0.87
F value	47.05**
R2	0.90
Return to scale (Σ bi)	0.98

NOTE : Geometric mean (Y)of wheat production was 13.48 q per farm and price was Rs.1000/q

* and ** indicates significance of values at P=0.05 and 0.01, respectivelhy

nitrogen 143.15 kgs. On contrary the optimum resource use with respect to seed (113.73 kgs) followed by hired human labour (3.59 man days). Coefficient of multiple determination (R^2) was 0.90 which indicates that in production of wheat, 90.00 per cent variation due to these independent variables. 'F' value was highly significant (47.05). The sum of regression coefficient was 0.98 which represents decreasing return to scale. It was implied that optimum resources use with respect to these variables were less than existing resource level.

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