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RESEARCH PAPER

Resource productivity, resource use efficiency and return to scale of small, medium and large *Rabi* jowar growers in Marathwada region

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ABSTRACT

The study attempts to examine the resource productivity, resource use efficiency and return to scale of the small, medium and large sized *Rabi* jowar growers in the Marathwada region of Maharashtra state. A sample of 120 growers was selected through multistage sampling technique from Parbhani and Beed districts for *Rabi* jowar season 2009-10. Growers were categorized on the basis of land holding into small (30), medium (50) and large (40) growers. Cobb Douglas production function approach was used to measure the resource productivity, resource use efficiency and return to scale by calculating and comparing Marginal value products (MVPs) and MVP to factor price. Results depicted that on small farms only area (2.08**) and machine labour (2.04**) were found significant. On medium farms, area (2.161**), human labour (2.13**) and seed (2.067**) were significant, and for large farms, area (2.51**), machine labour (2.03**) and human labour (2.10**) were significant, whereas other inputs were insignificant for respective catagories. In regard to resource use efficiency of small farms, area (4.04) and machine labour (2.84) were underutilized. On medium farm, area (0.09) was over utilized, whereas seed (31.54) and human labour (1.24) were underutilized. On large farms, human labour (0.53) was over utilized, whereas area (1.99) and machine labour (1.86) were underutilized. The result also indicated that return to scale on small, medium and large *Rabi* jowar farms were decreasing (Σbi: 0.417), near to unity (Σbi: 1.103) and decreasing (Σbi: 0.797), respectively.

KEY WORDS : *Rabi* jowar, Resource productivity, Resource use efficiency, Return to scale

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Sorghum is the fifth most important cereal crop globally after wheat, maize, rice and barley in terms of production and utilization and is directly staple of more than 500 million people in 30 countries. It is grown on 40 m ha in 105 countries of Africa, Asia, Oceania and Americans. Africa and India account for the largest share >70% of global sorghum area, while USA, Mexico, Nigeria, Sudan and Ethiopia are the major sorghum producers (FAO, 2011). In India, Sorghum is cultivated over an area of 8 m ha *i.e.* 25% of global area with an annual production of 7 million tonnes of grain (13% of total global production) with a productivity of 911 kg/ ha. The first three largest producing states are Maharashtra, Karnataka and Madhya Pradesh (Anonymous, 2010). Maharashtra state is the largest in respect of area and production under jowar cultivation. In the state, jowar is grown mainly as rainfed crop. It is grown in both season *i.e. Kharif* and *Rabi*.

The *Rabi* jowar is primarily crop of dryland area, where it is taken on residual moisture. It is one of the major *Rabi*

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crops in Marathwada region. Jowar plays important role for alternative uses such as poultry feed, livestock feed, forage sugar, alcohol and low calorie foodstuff. Jowar has got malting properties, it can be used in malt based beverages, jowar grain also popped flake and several local preparation are made like *Bhakari, Chakalya, Chik, Dhapate, Lahya, Thalpit* etc. The product such as starch, glucose, syrup, oil, gluten and feeds can also be manufactured from jowar grain. The plant stem and foliage are used for green chop, hay, silage and pasture. In some area, the stem is used as building material and plant remain may be used as fuel.

Rabi jowar is an important foodgrain crop grown during *Rabi* season in Marathwada region of Maharashtra state. This crop has importance in cropping pattern of Marathwada farmers. The result will be useful to farmers to use the scare resources optimally to earn the highest profit from the crop. The policy maker can consider the suggestion of jowar growers for formulating the welfare scheme for the *Rabi* jowar growers. The result will be useful to the student of agricultural economics on research point of view and also useful to extension workers in relation to transfer the *Rabi* jowar technology on economic point of view.

METHODOLOGY

Sampling technique and data description

Data were collected for *Rabi* jowar season year 2009-10 with multi-stage sampling technique. Parbhani and Beed districts were selected purposively as study area in the first stage; in the second stage one tehsil from each district was selected on the basis of highest area of *Rabi* jowar. In third stage six villages were selected randomly from each tehsil. In fourth stage, ten *Rabi* jowar growers were selected randomly from each villages. Thus, 120 *Rabi* jowar growers were selected for the study. The selected samples were then post classified into three groups *i.e.* small (area upto 02 ha.), medium (area between 02 to 04 ha) and large (area above 04 ha) farmers. Number of respondents in small size group were 30, medium size group 50 and large size group 40. Thus, effective total sample size was 120. Well structured questionnaire was used for personal interviews from samples farmers.

Functional analysis :

The resources productivity and resources use efficiency were analyzed by application of functional analysis. In functional analysis, Cobb-Douglas [power production function] production function was used on the basis of goodness of fit (R^2). Cobb-Douglas production function (non-linear) was used to determine the resources productivity and resources use efficiency of *Rabi* jowar production. The data were, therefore subjected to functional analysis by using the following form of equation :

$$Y = a x_1^{b2} x . X_2^{b2} . x . X_3^{b3} ..... X_n^{bn} e^u$$

For fitting the production function for input out-put data of *Rabi* jowar crop, eight inputs were considered as important factor, by considering the problem of multi-collinerarity in estimating production function. The equation fitted was of the following form :

$$Y = a\, x_1^{b1} . x_2^{b2} . x_3^{b3} . x_4^{b4} . x_5^{b5} . x_6^{b6} .$$

where,

y = Estimated yield of the crop in quintals

a = Intercept of production function

bi= Partial regression co-efficient of respective independ variable

x_1 = Area of crop in ha. (per farm)

x_2 = Human labour in men equivalent days (per farm)

x_3 = Bullock labour in pair days per farm

x_4 = Machine labour in hours per farm

x_5 = Nitrogen in kg per farm

x_6 = Seed in kg per farm

Marginal value product (MVP) :

The marginal value productivity of resources indicate the addition of gross value of farm production for a unit increase in the i^{th} resources with all resources fixed at their geometric mean level. The MVP of various input is worked out by the following formula :

$$MVP = bi \frac{\bar{Y}}{\bar{X}} Py$$

where,

bi = Partial regression co-efficient of particular independent variable.

X = Geometric mean of particular independent variable [input].

Y = Geometric mean of dependent variable [output].

Py = Price of dependent variable.

Testing of regression co-efficients :

Each regression co-efficient was tested for its significance by applying 't' test at n-k-1 degree of freedom as under :

$$t_{n-k-1} = \frac{bi}{SE_{bi}}$$

where,

bi = Regression co-efficient of particular variable.

SE = Standard error of that variable.

Return to scale :

It refers to the summation of bi values, return to scale=Σbi

If, Σbi = 1, Constant return to scale.

Σbi = < 1, Decreasing returns to scale.

Σbi = >1, Increasing returns to scale.

ANALYSIS AND DISCUSSION

The effect of various resources on *Rabi* jowar production

has been studied by employing Cobb-Douglas production function in order to determine resource productivity and resource use efficiency of *Rabi* jowar farm. Cobb-Douglas production function gives elasticities of production directly. The sum of regression co-efficient indicate the return to scale. Also these regression co-efficient can be used to determine the resource productivity and resource use efficiency directly.

Resources productivity and resource use efficiency on small *Rabi* jowar growers farm in Marathwada region :

Regression co-efficient with relation to various explanatory variables were calculated with 't' values and are presented in Table 1. It was observed that, regression co-efficient of area was 0.51 which was positive and significant at 05 per cent level. It was inferred that if 01 per cent increase in use of area, over its geometric mean level, production would lead to increase of *Rabi* jowar by 0.51 per cent. Similarly, machine labour indicated, positive regression co-efficient *i.e.* 0.146, which was also found significant at 05 per cent level. It was inferred that, use of machine labour increased by 01 per cent over its geometric mean, it would lead to increase the production of *Rabi* jowar by 0.146 per cent. Seed, human labour and nitrogen were non-significant. Co-efficient of multiple determination (R^2) was 0.71 which indicated that 71.00 per cent variation in *Rabi* jowar production was explained because of variables (independent) included in the model 'F' value was significant (5.26), it mean that model has statistical fit. It was clear that each explanatory variable on its own was not very important but together they explained significantly part of variation in *Rabi* jowar production. The sum of regression co-efficient was 0.417 which indicated decreasing return to scale.

In regard to resource use efficiency, it was evident from Table 1 that, use of area in *Rabi* jowar production indicated that highest MVP to price ratio (04.04) followed by machine labour (02.84). If MVP to price ratio was greater than one, the use of resource could be increased to inverse the level of profit.

Resources productivity and resources use efficiency on medium *Rabi* jowar growers farm in Marathwada region :

Regression co-efficient with relation to various explanatory variable were calculated with 't' values and presented in Table 2. It was observed that regression co-efficient of area was 0.214 which was positive and significant at 05 per cent level. It was inferred that one per cent increase in use of area, over its geometric mean, it would lead to increase *Rabi* jowar production by 0.214 per cent. Similarly, human labour and seed are having positive regression co-efficient of 0.515 and 0.589, respectively. These regression co-efficient were found significant at 05 per cent level. It was inferred that, if use of human labour increase by 01 per cent, it would leads

Table 1 : Estimates of Cobb-Douglas production function of small *Rabi* jowar growers in Marathwada region

Sr. No.	Variables	b_i	SE of b_i	't' value	G.M.	MVP of input	Price of the input	MVP to PR
1.	Constant	1.135	0.397	2.860	–	–	–	–
2.	Area	0.51	0.245	2.08**	0.59	11002	2722.88	04.04
3.	Human labour	0.088	0.266	0.33^{NS}	34.71	–	–	–
4.	Bullock labour	-0.39	0.363	-1.07^{NS}	03.96	–	–	–
5.	Machine labour	0.146	0.071	2.04**	02.10	854.76	300	02.84
6.	Seed	0.03	0.322	0.093^{NS}	06.99	–	–	–
7.	Nitrogen	0.034	0.036	0.095^{NS}	19.15	–	–	–

Intercept (log a) = 1.135, 'F' value = 05.26, Return to scale (Σbi) : 0.417, R^2 = 0.71
*, ** and *** indicates significance of values at P=0.1, 0.05 and 0.01, respectively

Table 2 : Estimates of Cobb-Douglas production function of medium *Rabi* jowar growers in Marathwada region

Sr. No.	Variables	b_i	SE of b_i	't' value	G.M.	MVP of input	Price of the input	MVP to PR
1.	Constant	-0.047	0.420	-0.114	–	–	–	–
2.	Area	0.214	0.099	2.161**	0.98	277.77	2894.77	0.09
3.	Human labour	0.515	0.242	2.13**	43.82	148.83	120	1.24
4.	Bullock labour	-0.32	0.309	-1.04^{NS}	06.61	–	–	–
5.	Machine labour	0.131	0.084	1.56^{NS}	03.32	–	–	–
6.	Seed	0.589	0.285	2.067**	11.80	630.81	20	31.54
7.	Nitrogen	-0.026	0.031	0.909^{NS}	26.76	–	–	–

Intercept (log a) = -0.047, Return to scale (Σbi) : 01.103, 'F' value = 08.27, R^2 = 0.734
*, ** and *** indicates significance of values at P=0.0, 0.05 and 0.01, respectively

to increase the production of *Rabi* jowar by 0.515 per cent like wise use of seed was increase by 01 per cent, it would lead to increase production by 0.589 per cent. Machine labour and bullock labour were non-significant. Co-efficient of multiple determination (R^2) was 0.734 which indicated that 73.40 per cent variation in *Rabi* jowar production was explained due to independent variables include in the model. 'F' value was highly significant (08.27) means that model is statistically best suited. It was clear that each explanatory variable on its own was not very much important but together they explained significant part of variation in *Rabi* jowar production. The sum of regression co-efficient was 01.10 which is nearer to unity.

Maximum MVP to price ratio was found for seed (31.54) followed by human labour and area. Farmers were using optimum dose of seed that's why they were getting highest MVP to price ratio. The results also revealed that extended use of human labour and area will increase the profitability of the *Rabi* jowar business.

Resources productivity and resource use efficiency on large *Rabi* jowar growers farm in Marathwada region :

Regression co-efficient of various explanatory variable were calculated with 't' values and are presented in Table 3. It was observed that, regression co-efficient of area was 0.584 which was positive and significant at 05 per cent level. It was inferred that it 01 per cent increase in use of area, over its geometric mean, it would lead to increase *Rabi* jowar production by 0.584 per cent.

Similarly, human labour and machine indicated, positive regression co-efficient *i.e.* 0.215 and 0.206, respectively, which were also found significant at 05 per cent level. It was inferred that use of human labour and machine labour if increase by 01 per cent over their geometric mean level, it would lead to increase the production of *Rabi* jowar by 0.215 per cent and 0.206 per cent, respectively. Bullock labour and seed were non-significant. Co-efficient of multiple determination (R^2) was 0.694 which indicate that 69.40 per cent variation in *Rabi* jowar production was explained by the variables included in the model. The model was statistically significant as 'F' value was 04.17. It was clear that each explanatory variable on its own was not very important but together they explained significantly part of variation in *Rabi* jowar production. The sum of regression co-efficient was 0.797 which indicated decreasing return to scale.

In regard to resource use efficiency, it was evident from Table 3 that use of area in *Rabi* jowar production indicated that highest MVP to price ratio (01.99) followed by machine labour (01.86) and human labour (0.53). If MVP to price ratio was greater than one that the resource could be increased for increasing the profitability of the enterprises. Similar observation were also made by Thakur *et al.* (1990), Nagraj *et al.* (1998) Kumar and Kumar (2004) and Haque (2006).

Conclusion and recommendations :

This study has examined the resource productively, resource use efficiency and return to scale among small, medium and large *Rabi* jowar farms in Marathwada region of Maharashtra state. The result indicated that on small farms only area and machine labour were found significant, whereas other inputs were found insignificant. Medium farms showed that area, human labour and seed were significant, whereas other inputs were insignificant. And for large farms area, machine labour and human labour were significant, whereas other inputs were insignificant. In regard to resource use efficiency of small farms, area and machine labour were underutilized. On medium farm, area was over utilized, whereas seed and human labour were underutilized. And on large farms human labour was over utilized, whereas area and machine labour were underutilized. The result also indicate that return to scale on small, medium and large *Rabi* jowar farms were decreasing, near to unity and decreasing, respectively.

Based on the findings from this study, it is recommended that *Rabi* jowar production should be based on the technique that will utilize all farm inputs in effective and efficient manner so that farm can earn more profit.

Table 3 : Estimates of Cobb-Douglas production function of large *Rabi* jowar growers in Marathwada region

Sr. No.	Variables	b_i	SE of b_i	't' value	G.M.	MVP of input	Price of the input	MVP to PR
1.	Constant	0.934	0.527	1.77	–	–	–	–
2.	Area	0.584	0.232	2.51**	1.44	5162.56	2589.92	1.99
3.	Human labour	0.215	0.102	2.10**	42.18	63.96	120	0.53
4.	Bullock labour	-0.027	0.441	-0.062^{NS}	07.99	–	–	–
5.	Machine labour	0.206	0.101	2.03^{**}	04.68	560.32	300	1.86
6.	Seed	-0.275	0.538	-0.511^{NS}	15.76	–	–	–
7.	Nitrogen	0.094	0.158	0.598^{NS}	51.07	–	–	–

Intercept (log a) = 0.934, Return to scale (Σbi) : 0.797, 'F' Value = 04.17, R^2 = 0.694
*, ** and *** indicates significance of value at P=0.1, 0.05 and 0.01, respectively

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