Resource use efficiency of maize in Telangana state

Bandi Srikanth, KV Deshmukh and SS More

Abstract
Agriculture is an important sector to fuel in economic growth and it needs to be made more attractive. The present study will help farmers to improve economically profitable eventually leading to more inclusive development. Enabling policies for access to inputs, credit, markets and innovations will result in increased productivity, profitability and growth. Telangana is one of the large maize producing states in India; the maize production in the state has been largely influenced by increasing demand from the feed industries and various industrial uses, by calculating recourse use efficiency farmers can understand where he can improve his expenditure as well as efficiency to increase productivity, the present study explains regression coefficients with relation to various explanatory variables, geometric mean of inputs, marginal products, marginal value product, price of input, MVP to price ratio, and optimum recourse efficiency were calculated in present study. Cobb-Douglas type of Production Function was used to find the results. The results in elasticity of maize productivity examines that coefficient of multiple determination (R²) was 0.908 which indicated that 90.80 percent effect of all independent variables together in maize productivity, and Return scale was 1.00 which indicated constant return to scale of maize farming of Telangana state. Some critical resources like Manure, Plant protection chemical and Nitrogen fertilizer are not used properly and there is a greater chance to increase these inputs in maize farming.

Keywords: MVP, regression coefficients, geometric mean, marginal products, marginal value product, optimum recourse efficiency

Introduction
Agriculture is an important sector in economic growth and it needs to be made more remunerative, by creating necessary framework for strengthening the entire agriculture value chain, the present study will help farmers to improve economically profitable eventually leading to more inclusive development. Enabling policies for access to inputs, credit, markets and innovations will result in increased productivity, profitability and growth. With the globalization, the agricultural sector is opened up with new avenues, especially for agricultural enterprises. The cereals are of significant importance not only in providing nutritional support but also in earning additional income. Among the cereals, maize is a multifarious crop used as food and industrial crop globally grown extensively throughout the world and has the highest production role among all the cereal crops throughout the India and world.

The importance of maize lies in its wide industrial applications besides serving as human food and animal feed. As the demand for maize is growing globally due to its multiple uses for food, feed, and industrial sectors, Among cereals and millets, oil is extracted only from maize; a strong demand for ethanol production has resulted in increased maize prices and has provided incentives to increase maize acreage. Every part of the maize plant has economic value; the grains, leaves, stalk, tassel, and cob can all be used to produce a variety of food and non-food products

Methodology
The study was undertaken on a macro framework based on primary data collected from personal interview, multi stage sampling design was adopted for selection of districts, mandals, and villages and selected 120 maize growers from major maize growing districts of state.

To examine the resource use efficiency in the production of maize was achieved by Cobb Douglas and functional analysis. The production function approach was used to examine the productivity of resources used in the cultivation of Maize. For this purpose, the Cobb-Douglas production function was employed.
The single most advantage of this production function has been that the input coefficients constituted the respective elasticity. The Cobb-Douglas type of Production Function was used and is usually defined as follows.

\[ Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} \cdots \cdots \cdots X_n^{b_n} e^u \] ........................ (1)

Where,

\[ Y = \text{Output of Maize crop including main produce and by-products (qts./ha).} \]
\[ a = \text{Intercept.} \]
\[ X_1, X_2, X_3, \ldots \ldots \ldots X_n = \text{Different variables used or independent variables.} \]
\[ e^u = \text{Error term.} \]
\[ b_n = \text{regression coefficient of the respective resource variables.} \]

The function given in equation (1) can be expressed as,

\[ \log \hat{Y} = \log a + b_1 \log X_1 + b_2 \log X_2 + \ldots b_n \log X_n + u \log e \] ........................ (2).

For fitting the production function in the Maize crop, eleven input variables were considered as important factors by considering the problem of multicollinearity in estimating production function. Multicollinearity refers to a situation where because of storing interrelationship among the independent variables, it becomes difficult to disentangle their separate effects on the dependent variables. Some of the independent variables are not important just because the standard errors are high. It might be due to the presence of multicollinearity.

The main consequences of multicollinearity are (a) the sampling variances of the estimate coefficients increase as the degree of collinearity increase between the explanatory variables, (b) estimated coefficients may become very sensitive to small changes in some of the estimates of variables, (c) an apparent change in the variables, (d) if the independent variables are not important just because the standard errors are high. It might be due to the presence of multicollinearity.

i. Elasticity of production (EP)
The elasticity’s of the respective variables are equal to the regression coefficient of the resource in Cobb-Douglas production function. The elasticity of production can be calculated as follows.

\[ EP = \{ baX^{b-1} \} \frac{X}{Y} = \frac{bAX^b}{X} = \frac{bY}{X} = b \]

ii. Testing of the regression coefficient
Partial regression coefficients are tested for significance by applying ‘t’ test at n-k-1 degree of freedom as under:

\[ t_{(n-k-1)} = \frac{bi}{SE(bi)} \]

Where,
\[ bi = \text{Partial regression coefficient of particular variable} \]
\[ SE = \text{Standard error of } bi \]
\[ n = \text{No. of observations} \]
\[ k = \text{Dependent variables} \]

iii. Marginal product (MP)
Cobb-Douglas production function allows either constant, increase or decrease marginal productivity. In other words, resource productivity refers to a marginal product for the added unit of input. The marginal product equation is as:

\[ MP = \frac{dy}{dx} = biaX^{b-1} = \frac{biax^b}{X} = \frac{bY}{X} \]

Where,
\[ bi = \text{Elasticity of production} \]
\[ Y = \text{Geometric mean of output} \]
\[ X = \text{Geometric mean of the respective input} \]

iv. Marginal value product (MVP)
It refers to the product of MP and Py, where MP is marginal productivity and Py is the price of Maize per quintal. The MVP for the input factor is worked out by the following formulae

\[ MVP = \frac{bY}{X} Py \]

Where,
\[ bi = \text{Partial regression coefficient of a particular independent variable} \]
\[ X = \text{Geometric mean of a particular independent variable} \]
\[ Y = \text{Geometric mean of the dependent variable} \]
\[ Py = \text{Price of the dependent variable} \]

v. Optimum resource use efficiency
Optimum resource use efficiency was calculated by the following formula

\[ \text{Optimum resource use} = \frac{biYPy}{Px} \]

Where,
\[ bi = \text{Partial regression coefficient of a particular independent variable} \]
\[ Y = \text{Geometric mean of the dependent variable} \]
\[ Py = \text{Price of the dependent variable} \]
\[ Px = \text{Price of an independent variable} \]
vi. Returns to Scale
It refers to the summation of bi values. Return to scale = ∑bi
If ∑bi = 1, constant return to scale
If ∑bi < 1, decreasing return to scale
If ∑bi > 1 increasing return to scale
Its significance is tested by ‘F’ test as
\[ F = \frac{(\sum bi - n)(n-k)}{\sum var (bi)(k-1)} \]

Results and Discussion
Regression coefficients with relation to various explanatory variables, geometric mean of inputs, marginal products, marginal value product, price of input, MVP to price ratio, and optimum recourse efficiency were calculated and presented in Table 1.

Elasticity of productivity
The result revealed that coefficient of multiple determinations (R²) was 0.908 which indicated 90.80 per cent effect of all independent variables together in maize productivity. ‘F’ value was highly significant that was 97.59. Return to scale was 1.003 which indicated constant return to scale. It was clear that partial regression coefficient of area under maize was 0.68 which was positive and highly significant at 1 per cent level of significance. It inferred that one per cent increased in area under maize crop over its geometric mean it would lead to increase the Maize production by 0.68 per cent. Similarly, partial regression coefficient of plant protection was 0.22 which also positive and significant at 5 per cent level. It inferred that 1 per cent increased in plant protection over its geometric mean it would lead to increase the Maize production by 0.22 per cent. Further, with respect to manure (0.02) is positive and significant at 5 per cent level it shows one increased in manure over its geometric mean it would lead to increase the maize production by 0.02 percent and regression coefficient of nitrogen was 0.25 which was positive and significant at 5 percent level. It inferred that one per cent increased in nitrogen over its geometric mean it would lead to increase maize production by 0.25 percent. On the contrary partial regression coefficient of hired labour, family labour, bullock labour, machinery, total seed, phosphorus and potash was -0.04, -0.01, 0.03, -0.03, -0.09, -0.04 and 0.003 respectively having negative and non-significant.

Marginal productivity
It was observed that marginal product with respect to area under maize was 35.26 which means that in addition of one hectare of land to geometric mean which resulted to give 35.26 quintals of yield. Marginal product of manure was 0.22 it indicated that when there was addition of one quintal of manure which resulted to give additional product of maize by 0.22 quintals. Marginal product of plant protection used was 4.85 litres which mean that when there was addition of one litre used of plant protection chemical it gives additional product by 4.85 quintals respectively. Similarly marginal product of nitrogen was 0.124 kg. It was clear that when there was additional use of one kg nitrogen, it could give additional product of maize by 0.124 quintals. On the contrary the negative marginal product observed in hired labour, family human labour machinery, phosphorous and seed i.e. -0.14, -0.17, -0.70, -0.01 and -0.23 quintals which indicated that due to addition of one man day of hired labour and family human labour caused to reduce the product of maize up to 0.14 and 0.17 quintals. Similarly the marginal product of machinery, phosphorous and seed caused to reduce the product, potash was positive which inferred that with every one kg use of and potash caused to increase the product up to 0.002 quintals. It can be concluded that hired labour, family human labour, machinery, phosphorous and seed were used excess in maize production. Thus marginal product of potash shows that there was a positive increasing production of maize. Thus manure, nitrogen, Plant protection and potash were underutilized resources in maize production.

Resource use efficiency
Results revealed that marginal value product (MVP) due to area under maize were found to be Rs. 50042.13 and price of input of land under maize was Rs. 16450.37 per hectare hence MVP to price ratio was 3.04. MVP to price ratio of Nitrogen was found to be 14.01 followed by plant protection (13.25), and bullock labour (1.86). MVP to price ratio of hired human labour, family human labour, machinery, phosphorus and total used was negative. It was cleared that higher the MVP to price ratio there was greater chance to increase these resources. So the results inferred that there was greater chance to increase plant protection, nitrogen and bullock labour. When MVP to price ratio tends to unity at that point, there would be efficient utilization of resource.

Optimum resource use
Results showed that optimum resource use of production under maize area was found to be 3.07 hectares which inferred that there was good chance to increase production under maize area up to 3.07 hectares. With respect to production there was chance to increase manure to 0.29 quintals, plant protection to 9.93 liters and nitrogen to 515.87 kg per hectare.

Work out resource use efficiency in maize productivity
Regression coefficients with relation to various explanatory variables, geometric mean of inputs, marginal products, marginal value product, price of input, MVP to price ratio, and optimum recourse efficiency were calculated and presented in Table 1.

Elasticity of Productivity
The result revealed that coefficient of multiple determinations (R²) was 0.908 which indicated 90.80 per cent effect of all independent variables together in maize productivity. ‘F’ value was highly significant that was 97.59. Return to scale was 1.003 which indicated constant return to scale. It was clear that partial regression coefficient of area under maize was 0.68 which was positive and highly significant at 1 per cent level of significance. It inferred that one per cent increased in area under maize crop over its geometric mean it would lead to increase the maize production by 0.68 per cent. Similarly, partial regression coefficient of plant protection was 0.22 which also positive and significant at 5 per cent level. It inferred that 1 per cent increased in plant protection over its geometric mean it would lead to increase the maize production by 0.22 per cent. On the contrary partial regression coefficient of hired labour, family labour, bullock labour, machinery, total seed, phosphorus and potash was -0.04, -0.01, 0.03, -0.03, -0.09, -0.04 and 0.003 respectively having negative and non-significant.
would lead to increase maize production by 0.25 percent. On the contrary partial regression coefficient of hired labour, family labour, bullock labour, machinery, total seed, phosphorus and potash was -0.04, -0.01, 0.03, -0.03, -0.09, -0.04 and 0.003 respectively having negative and non-significant.

Marginal Productivity
It was observed that marginal product with respect to area under maize was 35.26 which means that in addition of one hectare of land to geometric mean which resulted to give 35.26 quintals of yield. Marginal product of manure was 0.22 it indicated that when there was addition use of one quintal of manure which resulted to give additional product of maize by 0.22 quintals. Marginal product of plant protection used was 4.85 liters which mean that when there was addition of one litre used of plant protection chemical it gives additional product by 4.85 quintals respectively. Similarly marginal product of nitrogen was 0.124 kg. It was clear that when there was additional use of one kg nitrogen, it could give additional product of maize by 0.124 quintals. On the contrary the negative marginal product observed in hired labour, family human labour machinery, phosphorous and seed i.e. -0.14, -0.17, -0.70, -0.01 and -0.23 quintals which indicated that due to addition of one man day of hired labour and family human labour caused to reduce the product of maize up to 0.14 and 0.17 quintals. Similarly the marginal product of machinery, phosphorous and seed caused to reduce the product, potash was positive which inferred that with every one kg use of and potash caused to increase the product up to 0.002 quintals. It can be concluded that hired labour, family human labour, machinery, phosphorous and seed were used excess in maize production. Thus marginal product of potash shows that there was a positive increasing production of maize. Thus manure, nitrogen, Plant protection and potash were underutilized resources in maize production.

Resource Use Efficiency
Results revealed that marginal value product (MVP) due to area under maize were found to be Rs. 50042.13 and price of input of land under maize was Rs. 16450.37 per hectare hence MVP to price ratio was 3.04. MVP to price ratio of Nitrogen was found to be 14.01 followed by plant protection (13.25), and bullock labour (1.86). MVP to price ratio of hired human labour, family human labour, machinery, phosphorus and total used was negative. It was cleared that higher the MVP to price ratio there was greater chance to increase these resources. So the results inferred that there was greater chance to increase plant protection, nitrogen and bullock labour. When MVP to price ratio tends to unity at that point, there would be efficient utilization of resource.

Optimum Resource Use
Results showed that optimum resource use of production under maize area was found to be 3.07 hectares which inferred that there was good chance to increase production under maize area up to 3.07 hectares. With respect to production there was chance to increase manure to 0.29 quintals, plant protection to 9.93 liters and nitrogen to 515.87 kg per hectare. And by results plant protection chemical usage was very poor during study period 2016 - 17 year there was no severe attacks of pest and diseases in maize fields but after that fall army attack was severe on maize fields causes increased uses of plant protection chemical was observed in Telangana state. Similar results were quoted by Faruq Hasan (2008) [6], Pawar and Vijaykumar (2012) [5], Ochi et al. (2015) [4], Dadson et al. (2016) [3] and Srikanth et al. (2017) [2].

Summary
Statistically significant and positive values of the estimated coefficients which were having higher the MVP to price ratio indicated that farmers could increase per hectare yield by applying more units of these inputs. In elasticity of maize productivity examines that coefficient of multiple determination ($R^2$) was 0.908 which indicated that 90.80 percent effect of all independent variables together in maize productivity. F value is highly significant that was 97.59 and Return scale was 1.00 which indicated constant return to scale of maize farming of Telangana state. Some critical resources like Manure, Plant protection chemical and Nitrogen fertilizer are not used properly it indicated that bringing in more quantity of Manure, Plant protection chemical and Fertilizers results high yield in maize farming would bring out the economies of scale and would result in higher productivity. However, using less quantity of these resources under maize in the state has been used very low and highly fragmented in maize cultivation.

<table>
<thead>
<tr>
<th>S.NO</th>
<th>Variables</th>
<th>partial regression coefficient (bi)</th>
<th>Standard Error (SE)</th>
<th>t' value</th>
<th>Geo mean</th>
<th>MP</th>
<th>MVP</th>
<th>Price(X)</th>
<th>MVP to Price ratio</th>
<th>Optimum resource use efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Land ha</td>
<td>0.683</td>
<td>0.211</td>
<td>3.240**</td>
<td>1.144</td>
<td>35.266</td>
<td>650042.135</td>
<td>50450.368</td>
<td>3.042</td>
<td>3.071</td>
</tr>
<tr>
<td>2</td>
<td>Total hired Labour</td>
<td>-0.036</td>
<td>0.034</td>
<td>-1.037</td>
<td>14.975</td>
<td>0.141</td>
<td>-199.406</td>
<td>350,000</td>
<td>-0.570</td>
<td>0.393</td>
</tr>
<tr>
<td>3</td>
<td>Family labour</td>
<td>-0.007</td>
<td>0.036</td>
<td>-0.186</td>
<td>2.237</td>
<td>-0.176</td>
<td>-250.292</td>
<td>350,000</td>
<td>-0.715</td>
<td>0.014</td>
</tr>
<tr>
<td>4</td>
<td>Bullock labour</td>
<td>0.032</td>
<td>0.053</td>
<td>0.615</td>
<td>3.025</td>
<td>0.630</td>
<td>894.599</td>
<td>478.580</td>
<td>1.689</td>
<td>0.236</td>
</tr>
<tr>
<td>5</td>
<td>Machinery</td>
<td>-0.030</td>
<td>0.047</td>
<td>-0.642</td>
<td>2.527</td>
<td>-0.706</td>
<td>-1002.108</td>
<td>586.250</td>
<td>-1.709</td>
<td>0.169</td>
</tr>
<tr>
<td>6</td>
<td>Total Seed</td>
<td>-0.095</td>
<td>0.153</td>
<td>-0.618</td>
<td>23.649</td>
<td>0.236</td>
<td>-335.532</td>
<td>240.250</td>
<td>-1.397</td>
<td>4.038</td>
</tr>
<tr>
<td>7</td>
<td>Manure</td>
<td>0.024</td>
<td>0.010</td>
<td>2.339*</td>
<td>6.214</td>
<td>0.226</td>
<td>320.809</td>
<td>208.500</td>
<td>1.539</td>
<td>0.294</td>
</tr>
<tr>
<td>8</td>
<td>Plant protection</td>
<td>0.218</td>
<td>0.086</td>
<td>2.535*</td>
<td>2.658</td>
<td>4.851</td>
<td>6883.345</td>
<td>519.200</td>
<td>13.258</td>
<td>9.938</td>
</tr>
<tr>
<td>9</td>
<td>N</td>
<td>0.245</td>
<td>0.096</td>
<td>2.564*</td>
<td>116.302</td>
<td>0.124</td>
<td>176.598</td>
<td>12.600</td>
<td>14.016</td>
<td>515.868</td>
</tr>
<tr>
<td>10</td>
<td>P</td>
<td>-0.035</td>
<td>0.099</td>
<td>-0.354</td>
<td>163.441</td>
<td>0.013</td>
<td>-17.972</td>
<td>41.560</td>
<td>-0.432</td>
<td>3.199</td>
</tr>
<tr>
<td>11</td>
<td>K</td>
<td>0.003</td>
<td>0.019</td>
<td>0.015</td>
<td>84.119</td>
<td>0.002</td>
<td>2.787</td>
<td>19.330</td>
<td>0.144</td>
<td>0.044</td>
</tr>
</tbody>
</table>

** Intercept (log a) --------- 1.47
** F value ----------- 97.59**
** R² --------------------- 0.908
** Return to scale (2bn) ------ 1.003
** Significant at 5 per cent level
** Significant at 1 per cent level

Note: Geometric mean ($\bar{Y}$) of maize productivity was 59.06 q/farm and price was Rs. 1419/q

Table 1: Estimates of Cobb Douglas productivity function in maize production
Conclusion
In elasticity of maize productivity examines that coefficient of multiple determination (R²) was 0.908 which indicated that 90.80 percent effect of all independent variables together in maize productivity, and Return scale was 1.00 which indicated constant return to scale of maize farming of Telangana state. Some critical resources like Manure, Plant protection chemical and Nitrogen fertilizer are not used properly it indicated that bringing in more quantity of Manure, Plant protection chemical and Fertilizers results high yield in maize farming would bring out the economies of scale and would result in higher productivity. However, using less quantity of these resources under maize in the state has been used very low and highly fragmented in maize cultivation.

References