An Economic Analysis of Technical Efficiency in Rice Cultivation in Mandya: Some Issues in Resource Pricing

Rice is an important crop grown in Karnataka, where its consumption is widespread and increasing at a rapid rate both in the urban and rural areas alike, due to its high income elasticity of demand. The growth of production in the state, however, is seriously constrained by lack of irrigated areas to cope with the growing requirement. Rice is a water intensive crop and given the restricted availability of irrigation potential in the state, increasing the area under the crop is not feasible. Hence, the increase in production would have to come from a breakthrough in productivity and increased efficiency in production.

Subsidies in Indian agriculture are pervasive. They consist of implicit and explicit subsidies which amount to approximately Rs. 1,000 crores in Karnataka alone. Pricing of irrigation water, credit, etc., are examples of the former while fertiliser and electricity charges are examples of the latter. From a macro angle subsidies are criticised on the ground that they lead to a misdirection in resource allocation and thereby considerable wastage, notwithstanding the crowding out effect it has on development expenditure.

Farmers in general have a tendency to use resources inefficiently particularly when they are priced low. Further, when endowed with rich natural resources, they use other inputs also in excess, expecting to reap higher yield. The excessive cost thereby included in the production process brings down their profit and leads to the wastage of resources. Subsidised agricultural inputs stimulate the extensive use of these inputs. For instance, if irrigation water is available in plenty and at subsidised rates, farmers are tempted to use the other resources like fertilisers, labour, plant protection chemicals, etc., indiscriminately to get higher yields. Thus it builds a high cost structure into the production process.

Objective

This study is an attempt to understand the extent to which in a region well endowed with man-made infrastructure, farmers are exploiting their resources in the production of rice. Mandya district in Karnataka accounts for about 64 thousand hectares of area under rice with a total production of about 170.5 thousand tonnes annually. It has an irrigated area of about 99.9 thousand hectares, out of a net sown area of about 267.4 thousand hectares. The district is served by the Visveswarayya irrigation canal system and is one of the first Intensive Agricultural District Programme (IADP) districts of the country. Rice is the major crop grown in the district as the water resource is plenty.

It is difficult to assess the level of efficiency of a farmer in his production process unless one is sure of the prevailing conditions in which he operates. For instance, a farmer may not be allocating his resourcesoptimally due to resource constraints or the prevailing uncertainty with regard to price/yield and perhaps due to the lack of ready access to resources. Under such circumstances, he cannot be termed inefficient merely because he does not operate at the point where profit is maximised; profit maximisation may not be his final objective. On the other hand, a farmer may be using all the inputs in required quantities, but may not be realising the potential output due to improper management. In such cases, a comparison of output in relation to the level of inputs used reveals the true picture of efficiency. This is referred to as ‘technical efficiency’ which is the maximum possible yield achievable with a given level of input use.
**Analytical Framework**

The Cobb-Douglas production function does not distinguish between technical efficiency and allocative efficiency (Sampath, 1979). It ignores the problem of technical efficiency by assuming that all the techniques of production (and thereby the isoquants) are identical across farms and as such it assumes that each farmer is technically efficient, which many a time is untrue.

The Frontier production function is built around the concept of efficiency adduced by Farrell (1957). Timmer (1971) operationalised the concept by imposing a Cobb-Douglas type specification on the frontier and evolved an output based measure of efficiency. This takes the general form:

\[ Y = f(x)e^\mu, \quad \mu \leq 0 \]

which, in the Cobb-Douglas framework, is

\[ \ln Y = \alpha + \sum_{j=1}^{n} \beta_j \ln x_j + \mu \]

The intercept is then adjusted by shifting the function until no residual is positive and one is zero. This is done by adding the largest error term of the fitted model to the intercept, thus yielding the frontier production function. The Timmer measure of technical efficiency is then obtained as the ratio of the actual output to the potential output on the frontier production function given the level of input use on farm ‘i’. Thus \( Y/Y^* \leq 1 \), where \( Y^* \) is the maximum value of output obtainable for given levels of inputs, derived from the frontier production function.

Kopp (1981) suggests an alternative approach within the Farrell framework. Here the measure of technical efficiency compares the actual level of input used to the level at which it would be used, by farm ‘i’, to obtain the same output \( Y \), but at the efficient level. This level of input to realise the same output \( Y \) is calculated as follows:

If \( \ln Y = \alpha + \beta_1 \ln x_1 + \beta_2 \ln x_2 + \ldots + \beta_n \ln x_n + \epsilon \)

Let \( R_1 = X_1/X_1, \quad R_2 = X_2/X_2 \quad \ldots \quad R_{n-1} = X_n/X_2 \)

and \( x_1^*, x_2^*, \ldots, x_n^* \) denote the optimum use of inputs.

Then

\[ \ln x_i^* = (\ln Y - \alpha + R_1 \beta_1 + R_2 \beta_2 + \ldots + R_{n-1} \beta_{n-1}) + \sum_{i=1}^{n} \beta_i \]

\( \ln x_1^*, \ln x_2^* \ldots, \ln x_n^* \) are calculated in a similar fashion.

\( x_1^*, x_2^*, x_3^*, \ldots, x_n^* \) indicate the frontier values of the corresponding inputs used. Then the ‘technical efficiency’ of the i-th farm would be:
\[
\text{TE}_t = \frac{X'_2}{X_2} = \frac{X'_1}{X_1} = \frac{X'_3}{X_3} = \ldots = \frac{X'_n}{X_n}
\]

**Sampling Procedure**

For analysing the technical efficiency among the rice growing farmers, Mandya district was purposively selected as it is one of the leading rice producing districts of Karnataka. A sample of 100 farmers was selected randomly using the stratified random sampling procedure. The farmers were first grouped into large (> 5 ha) and small (< 5 ha) and a sample of 50 was drawn from each group. The data pertained to the period kharif 1987. The model estimated was of the form:

\[
Y = a \sum_{i=1}^{7} X'_i \cdot e^h
\]

where

- \(Y\) = total output (yield/ha),
- \(X_1\) = seed rate (kg/ha),
- \(X_2\) = farmyard manure (tonnes/ha),
- \(X_3\) = nitrogen (kg/ha),
- \(X_4\) = phosphorous (kg/ha),
- \(X_5\) = potassium (kg/ha),
- \(X_6\) = plant protection chemicals (Rs./ha),
- \(X_7\) = total labour employed (Rs./ha),
- \(a\) = intercept,
- \(b_i\) = regression coefficients and
- \(e^h\) = error term.

**Results and Discussion**

The results of the regression are presented in Table I. It is interesting to note that farmers were operating at constant returns to scale as indicated by the sum of the regression coefficients not being significantly different from unity. The regression coefficient for seeds (at 1 per cent level), plant protection chemicals and labour (both at 5 per cent level), were found to be significant in the case of large farmers while for small farmers, the coefficients for farmyard manure, nitrogen and labour (all at 5 per cent) were significant. The \(R^2\) values of 0.51 and 0.69 in the case of large and small farmers respectively testified to the adequacy of the model used.

The efficiency of production was measured in terms of the physical maximum attainable by each farmer, based on Timmer measure of technical efficiency. The level of output efficiency was in general high. The average for the large farmers was 97.60 per cent and for small farmers it was almost the same at 97.54 per cent. The analysis thus reveals that the farmers achieved relatively higher levels of physical efficiency in growing rice. This
high level of output efficiency implies that most farmers in the region are familiar with the production techniques and employed it to the best possible advantage. The average yield achieved by the large farmers was 57 quintals/ha., whereas the small farmers achieved an yield level of 55.91 quintals/ha. The potential farm yield achieved with respect to the same in the region was 58.4 quintals and 57.4 quintals per hectare respectively. These levels are comparable with the 62.45 quintals/ha. indicated for the region as potential yield or research station yield.

### TABLE I. FRONTIER FUNCTIONS FOR RICE

<table>
<thead>
<tr>
<th>Farm category</th>
<th>Intercept</th>
<th>Seeds</th>
<th>Farmyard manure</th>
<th>Nitrogen</th>
<th>Phosphorous</th>
<th>Potassium</th>
<th>Plant protection chemicals</th>
<th>Labour</th>
<th>$\Sigma b_i$</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>0.1297</td>
<td>0.4211**</td>
<td>0.0069</td>
<td>0.0987</td>
<td>0.0826</td>
<td>0.0085</td>
<td>-0.0124*</td>
<td>0.4707*</td>
<td>1.08</td>
<td>0.5142</td>
</tr>
<tr>
<td></td>
<td>(2.310)</td>
<td>(0.797)</td>
<td>(0.830)</td>
<td>(1.106)</td>
<td>(1.018)</td>
<td>(2.765)</td>
<td>(2.897)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>0.2713</td>
<td>0.0206</td>
<td>0.0235*</td>
<td>0.1917*</td>
<td>0.0082</td>
<td>0.0003</td>
<td>0.0010</td>
<td>0.5710*</td>
<td>0.82</td>
<td>0.6882</td>
</tr>
<tr>
<td></td>
<td>(0.434)</td>
<td>(3.356)</td>
<td>(4.268)</td>
<td>(0.741)</td>
<td>(0.050)</td>
<td>(0.264)</td>
<td>(4.697)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Significant at 5 per cent level.
** Significant at 1 per cent level.

Note: Figures in parentheses are 't' values.

But in striking contrast, the input use was highly inefficient. The efficiency indices, derived using the Kopp measure of technical efficiency, indicate the degree of inefficiency in the use of selected factors in the production of rice. This index is presented in Table II. There was a higher level of input use efficiency among large farmers compared to small farmers. About 46 per cent of the large farmers used inputs at the rate of 86 per cent and above efficiency level, whereas only 8 per cent of small farmers could achieve this level of efficiency. A majority of the small farmers (i.e., about 72 per cent) operated at an efficiency level of 75 per cent and below. However, a comparatively small percentage of large farmers (i.e., about 30 per cent) operated at this level of efficiency.

### TABLE II. TECHNICAL EFFICIENCY RATING OF THE FARMERS IN THE PRODUCTION OF RICE

<table>
<thead>
<tr>
<th>Technical efficiency rating</th>
<th>Large farmers</th>
<th>Small farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>High (86 per cent and above)</td>
<td>23 (46)</td>
<td>4 (8)</td>
</tr>
<tr>
<td>Medium (76 to 85 per cent)</td>
<td>12 (24)</td>
<td>10 (20)</td>
</tr>
<tr>
<td>Low (75 per cent and below)</td>
<td>15 (30)</td>
<td>36 (72)</td>
</tr>
<tr>
<td>Total</td>
<td>50 (100)</td>
<td>50 (100)</td>
</tr>
</tbody>
</table>

Figures in parentheses are percentages to the total.

Further, a perusal of actual and frontier usage of inputs in the production of rice (Table III) indicated that all the factors under consideration were used at levels higher than the frontier level by both the large and small farmers. The small farmers in the study area are apparently not faced with the problem of lack of access to resources. This is evident from the average level of resource used by the small farmers vis-a-vis large farmers presented in
Table III. The table reveals that the small farmers used resources at levels comparable with those of the large farmers. The quantum of excess use of inputs in the production of rice was 15 per cent in the case of large farmers, while among small farmers, it was 30 per cent. In other words, the existing level of productivity on an average could be achieved by reducing input use by 30 per cent in the case of small farmers and by 15 per cent by large farmers.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Large farmers</th>
<th>Small farmers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frontier</td>
<td>Actual</td>
<td>Quantum of excess (%)</td>
</tr>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>1. Seeds (kg)</td>
<td>66.69</td>
<td>79.85</td>
<td>16.48</td>
</tr>
<tr>
<td>2. Farmyard manure</td>
<td>13.78</td>
<td>16.04</td>
<td>14.08</td>
</tr>
<tr>
<td>(tonnes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Nitrogen (kg)</td>
<td>123.38</td>
<td>149.38</td>
<td>17.40</td>
</tr>
<tr>
<td>4. Phosphorous (kg)</td>
<td>35.79</td>
<td>42.90</td>
<td>16.57</td>
</tr>
<tr>
<td>5. Potassium (kg)</td>
<td>36.68</td>
<td>41.22</td>
<td>15.86</td>
</tr>
<tr>
<td>6. Plant protection</td>
<td>57.24</td>
<td>66.96</td>
<td>14.51</td>
</tr>
<tr>
<td>chemicals (Rs.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Labour (Rs.)</td>
<td>2,373.50</td>
<td>2,836.74</td>
<td>16.33</td>
</tr>
</tbody>
</table>

From the foregoing analysis it is apparent that the resource use in rice cultivation in the study area leaves ample scope for improvement. By a better organisation of resources, about 30 per cent and 15 per cent resource conservation per hectare can be accomplished. The total amount of saving could be considerable. The fact that most of the farmers have realised the potential output is perhaps due to the excessive targeting of the physical output by the extension agencies. Thus there is a need to advocate resource use efficiency among the farmers by the extension system. Further, resource pricing will play a crucial role in the better utilisation of resources. While we do not have evidence on the excessive use of water, fertiliser is clearly over-used in the cultivation of rice as evidenced by non-significant coefficient.

Implications

The study indicates the existence of glaring over-use of resources in the production of rice in Mandya, one of the richly endowed districts of Karnataka with good infrastructural development. The high output efficiency coupled with the high inefficient use of resources, particularly in the case of small farmers is suggestive of improper pricing of resources, which induces non-judicious use of these resources, such as fertiliser and irrigation, leading to wastage. The high subsidy, both implicit and explicit, accorded to these resources induces inefficiency in their use. This is likely to affect the sustainability of agriculture in the long
run. Hence, steps should be initiated to rationalise the prices of resources used in production so as to improve the efficiency of their use and prevent degradation of the production capacity of agriculture. Extension effort should address the problem of resource conservation explicitly.

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REFERENCES


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This paper is a part of the M.Sc. (Ag.) thesis submitted by the first author to the University of Agricultural Sciences, Bangalore in 1988.

The authors are thankful to the anonymous referee for his useful suggestions.