CHAPTER - VI

RESOURCE USE EFFICIENCY OF SAMPLE FARMERS
6.1 INTRODUCTION

Productivity improvement in agriculture is an index of agricultural development. Higher productivity indicates the efficient use of resources. Technological change in agriculture in the form of increased use of modern inputs made the agricultural sector move along the production surface by increasing productivity per hectare. This induced upward shift in the production function. However, this is not uniform among different size-groups, crops and regions. Further, mere increase in application of different resources is not enough to raise agricultural output, especially in developing countries like India. The crux of the problem lies in the efficient utilization of resources and most economic combination of the factors of production. This chapter makes an attempt to examine how efficiently various input factors have been utilized under new agricultural technology in the area under study.

6.2 Factors Influencing Area under the Crops under Study

The agricultural technology plays a vital role in determining the cropping pattern under changed scenario of agriculture. The new agricultural technology generally influences cropping pattern mainly in two ways: firstly by shifting from less remunerative crops to more remunerative crops, and secondly, by shifting from mono cropping to multiple cropping. Besides new technology, cropping pattern is also influenced by agro-climatic conditions, soil type, irrigation, level of investment, availability of resources, prices of farm products and inputs and size of holding. One of the important aspects of new agricultural technology is the efficient utilization of available resources. The resultant increase in yield has a bearing on the area allotted to different crops. In the following lines, the factors influencing the area under important crops grown by the sample farmers are studied using Cobb-Douglas production function.

6.2.1. Rice

A log-linear regression model was performed to estimate area function in order to study the influence of irrigation, farm harvest price, yield, and fertilizers on area allocated for rice cultivation. The estimated results of the regression analysis are shown in table 6.1.
Table 6.1
Estimated Elasticity Co-efficients of Cobb-Douglas Area Function for Rice
(Mandal-I)

<table>
<thead>
<tr>
<th>Season</th>
<th>Constant</th>
<th>Irrigation Hectares ($X_1$)</th>
<th>Farm Harvest Price in Rupees (ha) ($X_2$)</th>
<th>Yield Per Hectare (Kgs) ($X_3$)</th>
<th>Fertilizers Per Hectare (Kgs.) ($X_4$)</th>
<th>$R^2$</th>
<th>$F$ (Statistics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kharif</td>
<td>5.268</td>
<td>0.2986</td>
<td>0.2321</td>
<td>0.2779</td>
<td>0.3169</td>
<td>0.6710</td>
<td>69.6640</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.5154)*</td>
<td>(4.1851)**</td>
<td>(4.7171)**</td>
<td>(5.9846)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabi</td>
<td>7.892</td>
<td>0.5434</td>
<td>0.6900</td>
<td>-0.0424</td>
<td>0.1574</td>
<td>0.8036</td>
<td>76.7035</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.2441)**</td>
<td>(3.6637)*</td>
<td>(0.2402)*</td>
<td>(3.5215)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5.163</td>
<td>0.3554</td>
<td>0.2658</td>
<td>0.3028</td>
<td>0.2149</td>
<td>0.6935</td>
<td>111.4581</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.1699)**</td>
<td>(5.4556)**</td>
<td>(5.9309)*</td>
<td>(6.0004)**</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*(' Values are Shown in Parentheses)

Note

** : Significant at 0.01 Per cent Level
* : Significant at 0.05 Per cent Level
@ : Not Significant
$R^2$ : Co-efficient of Multiple Determination
$F$ : Statistics (obtained from Analysis of Variance)

Dependent Variable – Y : Area under Rice
Independent Variables : $X_1$ to $X_4$

Source : Computed from Field Data

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Table 6.1 shows that during kharif season, fertilizer use ($X_4$) had highest effect on rice area with 0.32 per cent, followed by irrigation ($X_1$) with 0.30 per cent, yield per hectare ($X_2$) with 0.28 per cent and farm harvest price ($X_3$) with 0.23 per cent in Mandal-I. The $R^2$ co-efficient was 0.67 and this indicates that 67 per cent variation in rice area was explained by the independent variables. The Cobb-Douglas Production function employed turned out to be the best model to the given data as revealed from ‘F’ statistics (69.66).

During rabi season, the farm harvest price ($X_3$) had highest impact (0.69), followed by irrigation ($X_1$) with 0.54 per cent and fertilizer use ($X_4$) 0.16 per cent. Yield per hectare ($X_2$) had negative and insignificant impact on rice area. The $R^2$ co-efficient, which was 0.80, explained that 80 per cent variation in the rice area was due to change in independent variables. The Cobb-Douglas Production Function Analysis turned out to be the best model to the given data as revealed by the ‘F’ statistics (76.70).

It we take both kharif and rabi seasons together, among the input variables, irrigation $X_1$ had the highest impact with 0.36 per cent on rice area, followed by yield per hectare ($X_2$) with 0.30 per cent, farm harvest price ($X_3$) with 0.27 per cent and fertilizer use ($X_4$) with 0.21 per cent for every one per cent increase in the respective independent variables. The estimated $R^2$ co-efficient was 0.69, indicating 69 per cent variation in the rice area as explained by the independent variables. The F-statistics (111.46) reveal that Cobb-Douglas Production Function employed turned out to be the best model to the given data.
Table 6.2

Estimated Elasticity Co-efficients of Cobb-Douglass Area Function for Rice
(Mandal –II)

<table>
<thead>
<tr>
<th>Season</th>
<th>Constant</th>
<th>Irrigation (Hectares) (X₁)</th>
<th>Farm Harvest Price (Rs.) Per Hectare (X₂)</th>
<th>Yield Per Hectare (X₃)</th>
<th>Fertilizers Per Hectare (Kgs.) (X₄)</th>
<th>R²</th>
<th>F (Statistics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kharif</td>
<td>4.879</td>
<td>0.3940 (2.3396)*</td>
<td>0.3065 (3.8697)**</td>
<td>0.3566</td>
<td>0.1918 (4.6206)**</td>
<td>0.7122</td>
<td>58.7678</td>
</tr>
<tr>
<td>Rabi</td>
<td>6.744</td>
<td>0.0395 (2.2061)*</td>
<td>0.6407 (3.4505)**</td>
<td>0.3790</td>
<td>-0.0182 (0.2967)*</td>
<td>0.9875</td>
<td>295.1017</td>
</tr>
<tr>
<td>Combined</td>
<td>5.142</td>
<td>0.2603 (2.4702)*</td>
<td>0.3091 (4.2258)**</td>
<td>0.3389</td>
<td>0.2035 (5.4294)**</td>
<td>0.7504</td>
<td>86.4311</td>
</tr>
</tbody>
</table>

(‘*’ Values are Shown in Parentheses)

** : Significant at 0.01 Per cent Level
*  : Significant at 0.05 Per cent Level
# : Not Significant
R² : Co-efficient of Multiple Determination
F : Statistcs (obtained from Analysis of Variance)

Dependent Variable = Y : Area under Rice
Independent Variables = X₁ to X₄

Source : Computed from Field Data
Table 6.2 suggests that in mandal-II during kharif season the co-efficient of irrigation \((X_1)\) was highest (0.39 per cent) indicating maximum impact on the rice area. It was followed by yield per hectare \((X_1)\) with 0.36 per cent, farm harvest price \((X_2)\) with 0.31 per cent and fertilizer use \((X_4)\) with 0.19 per cent effect. The \(R^2\) co-efficient was 0.71, indicating that 71 per cent variation in the rice area was explained by the independent variables. The Cobb-Douglas Production Function Analysis, as revealed by 'F' statistics (58.77) turned out to be the best fit to the given data.

During rabi season. Farm harvest price \((X_2)\) had the maximum impact (0.64 per cent) on rice area, followed by yield per hectare \((X_1)\) with 0.38 per cent, and irrigation \((X_1)\) with 0.34 per cent. Fertilizer use had negative effect (-0.02 per cent), which is not significant statistically. The \(R^2\) co-efficient was 0.99, suggesting that 99 per cent variation in the rice area was due to variation in independent variables. The 'F' statistic value (295) indicates suitability of model to the data.

When both kharif and rabi seasons are taken together, the area function for mandal-II shows that among the independent variables, yield per hectare \((X_1)\) had the highest impact (0.34 per cent), followed by farm harvest price \((X_2)\) with 0.31 per cent, irrigation \((X_1)\) with 0.26 per cent and fertilizer use \((X_4)\) with 0.20 per cent, on rice area. The \(R^2\) co-efficient was 0.75, implying that 75 per cent variation in the rice area was explained by the independent variables. The 'F' statistic value (86) indicated the suitability of the model to the data.

6.2.2 Groundnut

Estimated Elasticity co-efficients of Cobb-Douglas area function in the case of groundnut crop are set-out in table 6.3.
Table 6.3

Estimated Elasticity Co-efficients of Cobb-Douglass Area Function (Groundnut)

<table>
<thead>
<tr>
<th>Mandal</th>
<th>Season</th>
<th>Constant</th>
<th>Irrigation (Hectares) (X₁)</th>
<th>Farm Harvest Price (Rs.) Per Hectare (X₂)</th>
<th>Yield Per Hectare(Kgs) (X₃)</th>
<th>Fertilizers Per Hectare (Kgs) (X₄)</th>
<th>R² (Statistics)</th>
<th>F (Statistics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandal</td>
<td>Kharif</td>
<td>5.045</td>
<td>0.6468 (5.5284)**</td>
<td>0.3788 (2.4019)*</td>
<td>0.4320 (2.7315)**</td>
<td>0.1327 (3.0051)**</td>
<td>0.8886</td>
<td>93.7461</td>
</tr>
<tr>
<td>Mandal</td>
<td>Rabi</td>
<td>4.060</td>
<td>0.6204 (3.6553)**</td>
<td>0.2480 (3.3044)**</td>
<td>1.0005 (12.3579)**</td>
<td>0.0213 (0.4891)@</td>
<td>0.8637</td>
<td>53.8788</td>
</tr>
<tr>
<td>Mandal</td>
<td>Total</td>
<td>2.0523</td>
<td>0.5701 (5.6605)**</td>
<td>0.1903 (3.0705)**</td>
<td>0.7659 (11.5187)**</td>
<td>0.0805 (2.4160)*</td>
<td>0.8505</td>
<td>122.3081</td>
</tr>
<tr>
<td>Mandal</td>
<td>Kharif</td>
<td>2.969</td>
<td></td>
<td>0.1574 (1.6372)@</td>
<td>0.3352 (4.1415)**</td>
<td>0.1829 (3.6970)**</td>
<td>0.5635</td>
<td>44.7465</td>
</tr>
</tbody>
</table>

(‘T’ Values are Shown in Parentheses)

Note
** : Significant at 0.01 Per cent Level
* : Significant at 0.05 Per cent Level
@ : Not Significant
R² : Co-efficient of Multiple Determination
F : Statistics (obtained from Analysis of Variance)

Dependent Variable = Y : Area under Groundnut
Independent Variables : X₁ to X₄

Source: Computed from Field Data
The estimated elasticity co-efficients of area function relating to groundnut crop in mandal-I during kharif season suggests that irrigation ($X_1$) had highest effect (co-efficient = 0.65 per cent) and it was followed by yield per hectare ($X_2$) with 0.43 per cent, farm harvest price ($X_3$) with 0.38 per cent and fertilizer use ($X_4$) with 0.13 per cent on the area allotted to rice. The $R^2$ co-efficient was 0.89, which suggests that 89 per cent variation in groundnut area was explained by the independent variables. The ‘F’ statistics is 93.75 and shows the suitability of the model to the data.

During the rabi season, the effect of irrigation ($X_1$) with 0.62 per cent was highest, followed by farm harvest price ($X_2$) with 0.25 per cent and yield ($X_3$) 1.00 per cent on area under groundnut. Fertilizer use ($X_4$) had insignificant impact. The $R^2$ co-efficient was 86 and implies that 86 per cent variation in the rice area was explained by the independent variables. The ‘F’ statistic value (53.88) showed suitability of model to the data.

For both seasons taken together, the area function suggests that yield per hectare ($X_3$) with 0.77 per cent had the highest impact on groundnut area, followed by irrigation ($X_1$) with 0.57 per cent, farm harvest price ($X_4$) with 0.19 per cent and fertilizer use ($X_2$) 0.08 per cent. The $R^2$ co-efficient was 0.85, which indicates that 85 per cent variation in the groundnut area is explained by the independent variable. The ‘F’ statistic value (122.31) showed suitability of model to the data.

In mandal-II, yield per hectare ($X_3$) had the highest and significant effect (0.34 per cent) on groundnut area and it was followed by fertilizer use ($X_1$) 0.18 per cent. Farm harvest price ($X_4$) had insignificant effect. The $R^2$ co-efficient is 0.56 and indicates that the independent variables explain 56 per cent variation in the groundnut area. The ‘F’ statistic value (44.75) indicates suitability of model to the data.

6.2.3. Sugarcane

Estimated elasticity co-efficients of Cobb-Douglas area function for sugarcane crop are presented in table 6.4.
Table 6.4
Estimated Elasticity Co-efficients of Cobb-Douglass Area Function (Sugarcane)

<table>
<thead>
<tr>
<th>Mandal</th>
<th>Constant</th>
<th>Irrigation (X₁)</th>
<th>Farm Harvest Price Per Hectare (X₂)</th>
<th>Yield Per Hectare (Kgs.) (X₃)</th>
<th>Fertilizers Per Hectare (Kgs.) (X₄)</th>
<th>R²</th>
<th>F (Statistics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandal - I</td>
<td>8.214</td>
<td>0.2189 (2.0502)*</td>
<td>0.2344 (3.1072)**</td>
<td>0.5452 (4.7391)**</td>
<td>0.3493 (3.0061)**</td>
<td>0.9623</td>
<td>146</td>
</tr>
<tr>
<td>Mandal - II</td>
<td>3.965</td>
<td>0.2448 (2.6978)**</td>
<td>-0.0272 (0.2187)**</td>
<td>0.5023 (3.2539)**</td>
<td>0.2187 (2.7427)**</td>
<td>0.7022</td>
<td>30.0568</td>
</tr>
</tbody>
</table>

(*' Values are shown in Parentheses)

**Note**:  
**: Significant at 0.01 Per cent level  
*: Significant at 0.05 Per cent level  
/: Not Significant  
R² : Co-efficient of Multiple Determination  
F : Statistics (obtained from Analysis of Variance)  
Dependent Variable - Y : Area under Sugarcane  
Independent Variables : X₁ to X₄

Source : Computed from Field Data

It is noticed that all the four variables included in the model influenced significantly the area under sugarcane in mandal-I. R² co-efficient shows that 96 per cent variation in the area is explained by the independent variables and 'F' statistics was 146. RTS co-efficient is more than one and indicates increasing returns to scale.

In mandal-II the influence of yield per hectare (X₃) was maximum (co-efficient 0.5023 per cent) and it was followed by fertilizer use (X₄) and irrigation (X₁). Farm harvest price (X₂) had negative effect on area under sugarcane. While the positive effect of all the three variables was highly significant, the negative effect was not significant. The estimated R² co-efficient indicates that 70 per cent variation in sugarcane area is explained by 4 independent variables. 'F' statistic (30.06) indicates suitability of model to the data.
6.3 Factors Influencing Yield

Yield of particular crop is influenced by number of factors. Besides soil, irrigation extent of area and climatic conditions, the yield levels in any area are determined by the resource like chemical fertilizers, pesticides and mechanical implements. Size of holding is also one of the determinants of yield. An attempt is made in this section to examine the effects of various factors on yield of rice, groundnut and sugarcane in the area under study using regression analysis. Log-Linear model is fitted, taking yield per hectare as dependent variable and proportion of irrigated area under the crop, extent of area under the crop, fertilizer per hectare, pesticides per hectare and tractor use per hectare as independent variables.

6.3.1 Rice

Rice is the most important crop grown in the area under study. In order to study the factors influencing the yield of rice, Cobb-Douglas production function has been employed and the results are set out in table 6.5.
Table 6.5

Estimated Elasticity Co-efficients of Cobb-Douglas Yield Function for Rice

(Mandal-I)

<table>
<thead>
<tr>
<th>Season</th>
<th>Constant</th>
<th>Irrigation (Hectares) (X₁)</th>
<th>Area (Hectares) (X₂)</th>
<th>Fertilizer Use Per Hectare (Kgs) (X₃)</th>
<th>Pesticide Use Per Hectare (X₄)</th>
<th>Tractor Use Per Hectare (X₅)</th>
<th>R² Co-efficient</th>
<th>F Statistics</th>
<th>RTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kharif</td>
<td>2.530</td>
<td>0.2267</td>
<td>0.4546</td>
<td>0.1437</td>
<td>0.1391</td>
<td>0.1094</td>
<td>0.9089</td>
<td>235.4206</td>
<td>1.0735</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.6527)**</td>
<td>(9.3785)**</td>
<td>(3.9872)**</td>
<td>(2.9508)*</td>
<td>(3.6287)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabi</td>
<td>3.363</td>
<td>0.4170</td>
<td>0.6688</td>
<td>0.2233</td>
<td>-0.0071</td>
<td>0.2005</td>
<td>0.8772</td>
<td>104.2941</td>
<td>1.5025</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.7002)**</td>
<td>(9.6799)**</td>
<td>(2.1362)*</td>
<td>(0.3274)*</td>
<td>(4.6664)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>3.207</td>
<td>0.3585</td>
<td>0.5723</td>
<td>0.0461</td>
<td>0.0120</td>
<td>0.1415</td>
<td>0.8802</td>
<td>289.3824</td>
<td>1.1304</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.1086)**</td>
<td>(14.5218)**</td>
<td>(2.5929)**</td>
<td>(0.8239)*</td>
<td>(5.4256)**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(‘t’ Values are shown in Parentheses)

Note: ** Significant at 0.01 Per cent Level
* : Significant at 0.05 Per cent Level
@ : Not Significant
R² : Co-efficient of Multiple Determination
F : Statistics (obtained from Analysis of Variance)
RTS : Returns to Scale

Dependent Variable - Y : Yield of Sugarcane
Independent Variables : X₁ to X₅

Source: Computed from Field Data

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The effect of area ($X_2$) was highest (0.46 per cent) and it was followed by irrigation ($X_1$) 0.23 per cent, fertilizers ($X_3$) 0.14 per cent, pesticide ($X_4$) 0.14 per cent and tractor hours ($X_5$) 0.11 per cent on yield of rice. The estimated co-efficients indicate that rice yield would increase by 0.46 due to area effect, 0.23 per cent due to irrigation, 0.14 per cent due to fertilizer use and 0.14 per cent due to pesticides and 0.11 per cent on account of tractor use. The $R^2$ co-efficient was nearly 0.91 and this would imply that nearly 91 per cent variation in the rice yield is due to variation in independent variables. The $F$ statistic which was (235.42) indicates suitability of model to the data. The RTS value indicates the operation of increasing returns to scale.

During rabi season, the effect of area ($X_2$) under rice on yield was highest (0.67 per cent). It was followed by Irrigation ($X_1$) 0.42 per cent, fertilizer ($X_3$) 0.22 per cent and Tractor use ($X_5$) 0.20 per cent in influencing rice yield. The pesticide ($X_4$) impact on rice yield in rabi was negative and not significant. $R^2$ coefficient for production function was nearly 0.90. This implies that 90 per cent variation in rice yield was explained by the independent variables. The $F$ statistic (104.29) indicates suitability of model to the data. The RTS coefficient indicates the operation of increasing returns to scale.

For both seasons taken together, area ($X_2$) with 0.57 per cent had maximum impact, followed by irrigation ($X_1$) 0.37 per cent, tractor use ($X_5$) 0.14 per cent, fertilizer use ($X_3$) 0.05 per cent. The pesticides ($X_4$) had insignificant impact on rice yield. $R^2$ coefficient, which was nearly 0.9 indicated that 90 per cent variation in rice yield was explained by the independent variables. The $F$ statistic was 289.38 and indicates suitability of model to the data. The RTS value indicates the operation of increasing returns to scale.

Estimated elasticity co-efficients of Cobb-Douglas yield function for rice in mandal-II are furnished in table 6.6.
Table 6.6
Estimated Elasticity Co-efficients of Cobb-Douglass Yield Function for Rice
(Mandal-II)

<table>
<thead>
<tr>
<th>Season</th>
<th>Constant</th>
<th>Irrigation (Hectares) (X1)</th>
<th>Area (Hectares) (X2)</th>
<th>Fertilizer Use Hectare (Hours) (X3)</th>
<th>Pesticide Use Per Hectare (X4)</th>
<th>Tractor Use Per Hectare (X5)</th>
<th>R² Co-efficient</th>
<th>F Statistics</th>
<th>RTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kharif</td>
<td>3.732</td>
<td>0.6016</td>
<td>0.2192</td>
<td>0.3072</td>
<td>0.4591</td>
<td>-0.0422</td>
<td>0.8465</td>
<td>94.0186</td>
<td>1.5494</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.5619)*</td>
<td>(2.3278)*</td>
<td>(3.0307)**</td>
<td>(2.1453)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabi</td>
<td>3.754</td>
<td>0.2721</td>
<td>0.8923</td>
<td>-0.0971</td>
<td>0.5973</td>
<td>-0.2346</td>
<td>0.9991</td>
<td>2947.5393</td>
<td>1.4300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.9397)**</td>
<td>(17.6226)**</td>
<td>(1.4119)@</td>
<td>(4.7058)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>3.511</td>
<td>0.4328</td>
<td>0.3634</td>
<td>0.4165</td>
<td>0.3951</td>
<td>-0.0826</td>
<td>0.6314</td>
<td>35.9743</td>
<td>1.5252</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.2372)*</td>
<td>(2.4706)*</td>
<td>(3.0737)**</td>
<td>(2.8751)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(‘t’ Values are Shown in Parentheses)

Note:
** : Significant at 0.01 Per cent Level
* : Significant at 0.05 Per cent Level
@ : Not Significant
R² : Co-efficient of Multiple Determination
F : Statistics (obtained from Analysis of Variance)
RTS : Returns to Scale
Dependent Variable Y : Yield of Rice
Independent Variables : X1 to X5
Source : Computed from Field Data

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Production function for kharif season indicates that the co-efficient for irrigation $(X_1)$ was 0.61. This means that one per cent increase in irrigated area would result in 0.6 per cent increase in the rice yield. Similarly, increased use of pesticide $(X_4)$ by 1 per cent would result in 0.46 per cent, fertilizers $(X_3)$ 0.31 per cent and area $(X_2)$ 0.22 per cent increase in the yield of rice. Tractor use $(X_5)$ had negative and insignificant effect. During rabi season area $(X_2)$ effect is 0.89 per cent, pesticide $(X_4)$ 0.60 per cent and irrigation $(X_1)$ 0.27 per cent. Tractor $(X_5)$ and fertilizer effects were negative. The effect of tractor was highly significant and that of fertilizers was not significant. It we take both the seasons together, irrigation variable $(X_1)$ has 0.43 per cent effect, followed by fertilizer $(X_3)$ 0.42 per cent, pesticide $(X_4)$ 0.39 per cent and area $(X_2)$ 0.36 per cent impact on rice yield. The effect of tractor use $(X_5)$ on rice yield was negative and not significant. $R^2$ for kharif season was 0.85 per cent implying that the variation in the independent variables explains 85 per cent variation in the rice yield. Similarly $R^2$ was 0.99 for rabi season and 0.63 for entire year. This indicates that the independent variables would explain 99 per cent variation during the rabi season and 63 per cent variation during the whole period in rice yield. F statistic in all functions implies that the chosen Cobb-Douglas production function is best suited to data. The estimated RTS co-efficients were more than one in all three cases and they imply the operation of increasing returns to scale.

6.3.2. Groundnut

Estimated elasticity co-efficients of Cobb-Douglas yield function for groundnut crop in mandal-1 and mandal-11 are presented in table 6.7.
<table>
<thead>
<tr>
<th>Mandal</th>
<th>Season</th>
<th>Constant</th>
<th>Irrigation (Hectares) (X₁)</th>
<th>Area (Hectares) (X₂)</th>
<th>Fertilizer Use (Hectare) (X₃)</th>
<th>Pesticide Use Per Hectare (X₄)</th>
<th>Tractor Use Per Hectare (X₅)</th>
<th>R² Co-efficient</th>
<th>F Statistics</th>
<th>RTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandal I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabi</td>
<td></td>
<td>0.662</td>
<td>0.5958</td>
<td>0.4661</td>
<td>0.3639</td>
<td>0.0444</td>
<td>0.1154</td>
<td>0.8242</td>
<td>51.889</td>
<td>1.5856</td>
</tr>
<tr>
<td>combined</td>
<td></td>
<td>0.765</td>
<td>0.2795</td>
<td>0.3442</td>
<td>0.1493</td>
<td>0.0858</td>
<td>0.1100</td>
<td>0.8455</td>
<td>94.1337</td>
<td>0.9688</td>
</tr>
<tr>
<td>Mandal II</td>
<td>Khari¹</td>
<td>1.936</td>
<td></td>
<td>0.5175</td>
<td>0.3120</td>
<td>0.0316</td>
<td>0.2569</td>
<td>0.6873</td>
<td>59.3107</td>
<td>1.1180</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2.3536)*</td>
<td>(3.1144)**</td>
<td>(4.2461)**</td>
<td>(2.9092)**</td>
<td>(2.4075)*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(¹ Values are Shown in Parentheses)

** Note:
** : Significant at 0.01 Per cent Level  
* : Significant at 0.05 Per cent Level  
α : Not Significant  
R² : Co-efficient of Multiple Determination  
F : Statistics (obtained from Analysis of Variance)  
RTS : Returns to Scale  
Dependent Variable – Y : Yield of Groundnut  
Independent Variables : X₁ to X₅  
Source : Computed from Field Data
The above table suggests that during kharif season fertilizer use ($X_1$) had highest impact with 0.36 per cent, followed by irrigation ($X_3$) with 0.32 per cent, area ($X_2$) 0.22 per cent and tractor use ($X_4$) 0.22 per cent on yield rate in mandal-I. The impact of pesticide ($X_5$) was least (0.18 per cent). During rabi season, the effect was highest ($X_2$) 0.67 per cent in the case of area ($X_1$) 0.42 per cent in respect of irrigation and 0.36 per cent in the case of fertilizers. The Tractor use ($X_5$) had 0.12 per cent and pesticide ($X_4$) 0.04 per cent effect. If both kharif and rabi seasons are taken together, the effect on yield was maximum (0.34 per cent) in the case of area and it is followed by ($X_1$) 0.28 per cent, fertilizers ($X_3$) 0.15 per cent and tractor use ($X_5$) 0.12 per cent and pesticides, ($X_4$) 0.09 per cent. The $R^2$ was highest (0.89) for kharif season, and it was followed by pooled period (0.85) and rabi season are (0.82). This indicates that the independent variables included in the model explain 89 variations in kharif season, 82 per cent in rabi and 85 per cent for the period covering both the season. All the co-efficients were highly significant, as revealed by 'F' statistics and this would imply that the Cobb-Douglas Model was the best fit to the given data. The RTS co-efficients indicated the operation of increasing returns to scale during kharif and rabi seasons and decreasing returns to scale prevailed in the combined period.

In mandal-II, the area ($X_1$) had a significant positive effect (0.52 per cent) on groundnut yield, followed by ($X_2$) fertilizer use with 0.31 per cent and tractor use ($X_4$) with 0.26 per cent, pesticide ($X_4$) with 0.03 per cent. The $R^2$ coefficient of the model was 0.69 and this indicates that 69 per cent variation in the groundnut yield was explained by the independent variable. 'F' statistic was 59.31 and it could be inferred that the given Cobb-Douglas production function was the best model to the given data. The RTS co-efficient was more than one and indicates increasing returns to scale.

6.3.3 Sugarcane

Estimated elasticity co-efficients of Cobb-Douglas yield function for sugarcane crop in mandal-I and mandal-II are presented in table 6.8.
### Table 6.8
The Cobb-Douglas Yield for in Mandal-1 and Mandal-II
(Sugarcane)

<table>
<thead>
<tr>
<th>Mandal</th>
<th>Constant</th>
<th>Irrigation (Hectare) (X₁)</th>
<th>Area (Hectare) (X₂)</th>
<th>Fertilizer Use (Hours) (X₃)</th>
<th>Pesticide Litres Per Hectare (X₄)</th>
<th>Tractor Use Per Hectare (X₅)</th>
<th>$R^2$ Co-efficient</th>
<th>F Statistics</th>
<th>RTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandal-1</td>
<td>3.911</td>
<td>0.488</td>
<td>0.5539</td>
<td>0.1997</td>
<td>0.0992</td>
<td>0.1654</td>
<td>0.8312</td>
<td>49.2470</td>
<td>1.5062</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.5543)*</td>
<td>(4.7194)**</td>
<td>(2.2763)**</td>
<td>(2.6537)**</td>
<td>(2.7366)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandal-11</td>
<td>7.016</td>
<td>0.8150</td>
<td>0.6776</td>
<td>0.3101</td>
<td>-0.0605</td>
<td>0.2314</td>
<td>0.6985</td>
<td>38.3395</td>
<td>1.9736</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.1547)*</td>
<td>(3.2971)**</td>
<td>(3.0504)**</td>
<td>(0.3950)**</td>
<td>(2.1394)*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*T Values are Shown in Parentheses

**Note:**
* : Significant at 0.01 Per cent Level
* : Significant at 0.05 Per cent Level
: Not Significant
$R^2$ : Co-efficient of Multiple Determination
F : Statistics (obtained from Analysis of Variance)
RTS : Returns to Scale
Independent Variable-Y : Yield of Sugarcane
Independent Variables : X₁ to X₅

**Source:** Computed from Field Data
In mandal-I, area ($X_1$) with a co-efficient of 0.55 per cent had the highest impact and it was followed by irrigation ($X_7$) with 0.49 per cent, fertilizer use ($X_3$) with 0.20 per cent, tractor use ($X_4$) with 0.17 per cent and (X) pesticide use with of 0.19 per cent on the sugarcane yield as a result of one per cent increase in the respective five input variables. The $R^2$ co-efficient was 0.83 and this indicates that 83 per cent variation in the sugarcane yield was due to independent variables. The ‘F’ statistic was highly significant and indicates the best suitability of the model to the given data. The RTS co-efficient was more than one, implying the operation of increasing returns to scale.

In mandal-II, irrigation ($X_7$) with 0.82 per cent had the highest effect, followed by area ($X_2$) with 0.68 per cent, fertilizer use ($X_3$) 0.31 per cent and tractor use ($X_4$) 0.23 per cent on the sugarcane yield. It is also observed that the ($X_4$) input, viz., pesticide use had negative impact (-0.06 per cent) on yield and its co-efficient was not significant. The $R^2$ co-efficients was 0.70, indicating 70 per cent variation in sugarcane yield due to independent variable. ‘F’ statistic was highly significant and indicated the suitability of the model to the given data. The RTS co-efficient was more than one and it indicates increasing returns to scale.

6.4 Factors Influencing Production

The analysis of costs and returns do not explain fully the efficiency of resource allocation. In fact, production is the simultaneous process of a number of variables. In order to explain the individual contribution of different resources, production function analysis has been used. The determination of efficiency of resources used for producing the output is analyzed using production function techniques. The variables used are fertilizers supplied ($X_1$), tractor use per farm in hours ($X_7$), human labour used in mandays ($X_4$) and size of land holding in hectares ($X_4$). Cobb-Douglas type of production function has been used to derive the elasticities of output with respect to each input factor and returns to scale. Marginal productivities of various inputs are estimated.

Estimated elasticity co-efficients of Cobb-Douglas production function for rice in mandal-II are presented in table 6.9.
Table 6.9
Estimated Elasticity Co-efficients of Cobb-Douglas Production Function in Mandal-I
(Rice)

<table>
<thead>
<tr>
<th>Season</th>
<th>Constant</th>
<th>Fertilizer Kgs (X₁) (Ha)</th>
<th>Tractor Use (Hours) (X₂)</th>
<th>Human Labour (X₃) (ha)</th>
<th>Size of Land Holding (Ha)(X₄)</th>
<th>R² Co-efficient</th>
<th>F Statistics</th>
<th>RTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kharif</td>
<td>5.155</td>
<td>0.3163</td>
<td>0.0178</td>
<td>0.5917</td>
<td>0.2148</td>
<td>0.8519</td>
<td>133.6858</td>
<td>1.1406</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.6600)**</td>
<td>(0.8734)@</td>
<td>(5.6321)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabi</td>
<td>5.925</td>
<td>0.3932</td>
<td>0.1252</td>
<td>0.2915</td>
<td>0.3559</td>
<td>0.9813</td>
<td>236.5012</td>
<td>1.658</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.9054)**</td>
<td>(1.8601)@</td>
<td>(2.2380)*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined</td>
<td>5.108</td>
<td>0.3298</td>
<td>0.0124</td>
<td>0.5832</td>
<td>0.2277</td>
<td>0.8802</td>
<td>213.1187</td>
<td>1.531</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.5922)**</td>
<td>(0.7235)@</td>
<td>(6.8016)**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(‘@’ Values are Shown in Parentheses)

Note:
** : Significant at 0.01 Per cent Level
* : Significant at 0.05 Per cent Level
@ : Not Significant
R² : Co-efficient of Multiple Determinations
F : Statistics (obtained from Analysis of Variance)
RTS : Returns to Scale

Dependent Variable – P : Total Output of Rice
Independent Variables : X₁ to X₄

Source : Computed from Field Data

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The magnitude of elasticity co-efficient for human labour (X₁) was highest at 0.5917 per cent, followed by fertilizer (X₃) at 0.32 per cent. The elasticity co-efficient of size of land holdings (X₄) was 0.2148 which would imply that every one per cent increase in X₄ would result in 0.2148 per cent increase in the dependent variable (Y). Similar interpretation would follow for (X₂) and (X₃) variables the impact of which was highly significant. However, the elasticity co-efficient of tractor (X₅) was not significant. This means that increase in the X₂ variable over and above its geometric-mean would have insignificant impact on the dependent variable 'Y'. The estimated co-efficient of R² for paddy during kharif season was 0.8519. The input variables included in the model explained 85.19 per cent variation in the dependent variable 'Y'. The ‘F’ statistic was also highly significant at 1 per cent probability level. This would imply that the selected Cobb-Douglass model was the best model to the given data. The co-efficient of returns to scale for kharif production was more than one (1.14 per cent) and this indicated increasing returns to scale.

During rabi, fertiliser (X₂) was having highest impact (0.39) on dependent variable (Y), followed by size of holdings (X₄) 0.36 per cent, human labour (X₁) 0.29 per cent on (Y). The efficient tractor use (X₅) was not significant. Increasing returns were also observed for production function for rabi season. Increasing return to scale would imply that one per cent increase in selected impact variable would result in more than one per cent increase in dependent variable.

If we take both the seasons together, the highest impact (0.58 per cent) was found in the case of human labour (X₁) variable and it was followed by (Xₐ) variable (0.33 per cent) and (X₄) variable (0.23 per cent). The tractor hours (X₅) was not significant. All the three production functions were highly significant and explained 85 per cent to 98 per cent and 88 per cent variation in the 'Y'. RTS value implies the operation of increasing returns to scale.

6.4.1 Rice

Table 6.10 shows the estimated elasticity co-efficients of Cobb-Douglass production function in the case of rice.
Table 6.10

Estimated Elasticity Co-efficients of Cobb-Douglass Production Function for Rice

(Mandal-II)

<table>
<thead>
<tr>
<th>Season</th>
<th>Constant</th>
<th>Fertilizer Kgs (X₁) (Ha.)</th>
<th>Tractor Use (Hours) (X₂) (Ha.)</th>
<th>Human Labour (Ha.) (X₃)</th>
<th>Size of Land Holding (Ha.) (X₄)</th>
<th>R² Co-efficient</th>
<th>F Statistics</th>
<th>RTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kharif</td>
<td>6.531</td>
<td>0.1819 (3.6938)**</td>
<td>0.0995 (3.7912)**</td>
<td>0.4725 (7.0220)**</td>
<td>0.1694 (2.4280)*</td>
<td>0.8035</td>
<td>119.6059</td>
<td>0.9233</td>
</tr>
<tr>
<td>Rabi</td>
<td>6.641</td>
<td>0.0971 (2.0457)*</td>
<td>0.4464 (5.3869)**</td>
<td>0.4925 (6.0718)**</td>
<td>-0.00083 (0.1737)@</td>
<td>0.9399</td>
<td>298.3565</td>
<td>1.0360</td>
</tr>
<tr>
<td>Combined</td>
<td>6.199</td>
<td>0.1949 (5.6394)**</td>
<td>0.0967 (4.4533)**</td>
<td>0.5289 (10.2339)**</td>
<td>0.1354 (2.92.8)**</td>
<td>0.8416</td>
<td>260.4406</td>
<td>0.9559</td>
</tr>
</tbody>
</table>

(* Values are Shown in Parentheses)

Note:
** : Significant at 0.01 Per cent Level
* : Significant at 0.05 Per cent Level
@ : Not Significant
R² : Co-efficient of Multiple Determinations
F : Statistics (obtained from Analysis of Variance)
RTS : Returns to Scale
Dependent Variable-P : Total Output of Rice
Independent Variables : X₁ to X₄
Source: Computed from Field Data

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All the Co-efficients of input variables were significant during kharif season. The elasticity co-efficient of human labour input was estimated at 0.47, this would mean that 1 per cent increase in the human labour over and above its geometric-mean would increase the rice production by 0.47 per cent. The co-efficient of fertilizers input was estimated at 0.18 which was significant at 1 per cent probability level. This would imply that 1 per cent increase in fertilizers use over and above its geometric-mean would increase the rice production by 0.18 per cent. Similarly, the size of land holding would bring an additional output of 0.17 per cent and 1 per cent increase in tractor hours would result in nearly 0.1 per cent increase in rice output. R² co-efficient would imply that 80 per cent of the variation in the dependent variable (rice total output per farm) was explained by 4 input variables. The RTS co-efficient implies the operation of diminishing returns to scale as its value is less than unity (0.8035). F-Statistic indicates that the chosen Cobb-Douglas production function was the best model to the data in question.

During rabi season all the input variables, except land holding size, were having significant impact on rice output. The coefficient relating to human labour implies 0.49 per cent increase in the rice output per farm for every one per cent increase in the human labour. Similarly, one per cent increase in tractor hours would result in 0.44 per cent increase in rice production. Fertilizer input would bring about 0.1 per cent increase in rice production. All the regression co-efficients would imply the ceteris paribus assumption. The R² value was higher (0.94) in this production function, implying that 94 per cent variation in the rice output during rabi season was explained by the independent variables included. Based on 'F' statistics (298.36). It could be inferred that the given Cobb-Douglas production function was the best model to given data. In this case, co-efficient of return to scale (1.0360) indicates increasing returns to scale. It means that one per cent increase in all four inputs variables simultaneously would increase the output by 1.04 per cent.

The highest contribution to rice production (0.53 per cent) was made by human labour (X₁) and it was followed by fertilizers per hectare (X₂) at 0.19, size of land holding (X₃) at 0.14 and tractor hours (X₄) at 0.10 and. For example (X₂) input would bring about 0.19 per cent increase in the rice production value for every
1 per cent increase in its use level. For the pooled data, combining the data for both kharif and rabi seasons, 84 per cent variation in rice production value was explained by 4 inputs variables as indicated by $R^2$. The ‘F’ statistic was highly significant (260.44) indicating the best fit of the model to the given data. Co-efficient of returns to scale in this case (0.96) indicated the decreasing returns to scale.

6.4.2. Groundnut

Estimated elasticity co-efficients of Cobb-Douglass production function for groundnut crop in the mandals under study are presented in table 6.11.
Table 6.11
Estimated Elasticity Co-efficients of Cobb-Douglas Production Function for (Groundnut)

<table>
<thead>
<tr>
<th>Mandal</th>
<th>Season</th>
<th>Constant</th>
<th>Fertilizer Kgs ($X_1$) (Ha.)</th>
<th>Tractor Use (Hours) ($X_2$)</th>
<th>Human Labour ($X_3$) (Ha.)</th>
<th>Size of Land Holding ($X_4$) (Ha.)</th>
<th>$R^2$ Co-efficient</th>
<th>F Statistics</th>
<th>RTS Co-efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandal – I</td>
<td>Kharif</td>
<td>6.689</td>
<td>0.3283 (3.6644)**</td>
<td>0.1367 (2.7690)**</td>
<td>0.2797 (2.6789)**</td>
<td>0.2329 (2.3567)*</td>
<td>0.7386</td>
<td>33.2046</td>
<td>0.9776</td>
</tr>
<tr>
<td>Mandal – I</td>
<td>Rabi</td>
<td>6.353</td>
<td>0.6572 (5.8084)**</td>
<td>0.1160 (2.2253)*</td>
<td>-0.0339 (0.2703)*</td>
<td>0.1941 (2.4547)*</td>
<td>0.9120</td>
<td>90.7315</td>
<td>0.9673</td>
</tr>
<tr>
<td>Mandal – II</td>
<td>Total</td>
<td>6.76 0</td>
<td>0.3511 (5.3577)**</td>
<td>0.1189 (3.4373)**</td>
<td>0.2300 (3.0231)**</td>
<td>0.2132 (3.2957)**</td>
<td>0.7926</td>
<td>83.1379</td>
<td>0.9132</td>
</tr>
<tr>
<td>Mandal – II</td>
<td>Kharif</td>
<td>0.5539</td>
<td>0.1496 (2.3003)*</td>
<td>-0.0648 (2.7431)**</td>
<td>0.8302 (8.0504)**</td>
<td>-0.2871 (2.5043)*</td>
<td>0.5539</td>
<td>34.1456</td>
<td>0.9798</td>
</tr>
</tbody>
</table>

(*T Values are Shown in Parentheses)

** : Significant at 0.01 Per cent Level
* : Significant at 0.05 Per cent Level
# : Not Significant
$R^2$ : Co-efficient of Multiple Determination
F : Statistics (obtained from Analysis of Variance)
RTS : Returns to Scale

Dependent Variable-P : Total Output of Groundnut
Independent Variables : $X_1$ to $X_4$

Source: Computed from Field Data
In mandal-I, the elasticity coefficients of inputs suggest that during kharif, fertilizers \((X_1)\) was having maximum impact \((0.33\text{ per cent})\), followed by human labour \((X_1)\) \(0.28\text{ per cent}\), size of land holdings \((X_2)\) \(0.23\text{ per cent}\) and tractor \((X_3)\) \(0.14\text{ per cent}\) in that order on the production of groundnut. During rabi, \(X_1\) input was having maximum impact \((0.33\text{ per cent})\) followed by \((X_4)\) \(0.19\text{ per cent}\) and \((X_2)\) \(0.12\text{ per cent}\). However, \((X_3)\) variable was negative and not significant. For both kharif and rabi seasons taken together (combined), fertilizer has maximum impact \((0.35\text{ per cent})\), while human labour \((0.23\text{ per cent})\), size of land holding \((0.21\text{ per cent})\) and tractor \((0.12\text{ per cent})\) come next in their effect on groundnut production. \(R^2\) was 0.74 during kharif, 0.91 during rabi and 0.79 during the whole period, implying 74 per cent, 91 per cent and 79 per cent variation in groundnut production in kharif, rabi and the combined periods respectively due to variation in the independent variables. All the three production functions implied decreasing returns to scale. This means one per cent simultaneously increase in the input variables \((X_1\) to \(X_4)\) included in model would result in less than one per cent increase in the \(Y\).

In mandal-II, the highest \((0.83\text{ per cent})\) contribution to \(Y\) was made by \(X_1\) variable and it was followed by fertilizers \(X_1\) \((0.15\text{ per cent})\). The effect of \(X_2\) and \(X_4\) variables was negative and in both cases the effect was significant. This would imply that the tractor hours per farm were used more than the required level. This would mean that 1 per cent increase in the tractor use per farm would bring about decrease in production due to variation in independent variables by \(0.07\text{ per cent}\). \(R^2\) \((0.5539)\) shows that 55 per cent of variation in output is due to variation in independent variables. F-statistics indicate that the model is best fit for the data. RTS \((0.9798)\) implies the operation of diminishing returns to scale.

### 6.4.3. Sugarcane

Estimated elasticity coefficients of Cobb-Douglass production function for sugarcane in mandal-I and mandal-II are presented in table 6.12.
Table 6.12
Estimated Elasticity Co-efficients of Cobb-Douglass Production Function (Sugarcane)

<table>
<thead>
<tr>
<th>Mandal</th>
<th>Constant</th>
<th>Fertilizer Kgs (X1) (Ha.)</th>
<th>Tractor Use (Hours) (X2) (Ha.)</th>
<th>Human Labour (X3) (Ha.)</th>
<th>Size of Land Holding (X4) (Ha.)</th>
<th>R^2 Co-efficient</th>
<th>F Statistics</th>
<th>RTS Co-efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandal - I</td>
<td>6.030</td>
<td>0.2091</td>
<td>0.0308</td>
<td>0.7056</td>
<td>0.2598</td>
<td>0.8740</td>
<td>95.3441</td>
<td>1.2053</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.9519)**</td>
<td>(1.2219)*</td>
<td>(1.2219)*</td>
<td>(2.3199)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandal - II</td>
<td>4.558</td>
<td>0.5667</td>
<td>-0.0022</td>
<td>0.5762</td>
<td>0.4673</td>
<td>0.9037</td>
<td>61.0053</td>
<td>1.6102</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.0241)**</td>
<td>(0.0900)@</td>
<td>(4.4687)**</td>
<td>(3.3686)**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

('t' Values are Shown in Parentheses)

Note:
** : Significant at 0.01 Per cent Level
* : Significant at 0.05 Per cent Level
@ : Not Significant
R^2 : Co-efficient of Multiple Determinations
F : Statistics (obtained from Analysis of Variance)
RTS : Returns to Scale
Dependent Variable- P : Total Output of Sugarcane
Independent Variables : X1 to X4
Source : Computed from Field Data
Table 5.12 reveals that in mandal-I, the elasticity co-efficient of human labour (0.71 per cent), was maximum, implying that every 1 per cent increase in human labour would lead to 0.71 per cent increase in the output of sugarcane. This was followed by farm size (0.26 per cent), fertilizers (0.21 per cent) and tractor use (0.03 per cent) in that order. All the coefficients are statistically significant. The Cobb-Douglass production function employed turns out to be the best model to given data as revealed by F statistic (95.34). $R^2$ indicates that over 87 per cent variation in output is due to variation in independent variables. Increasing returns to scale was observed indicated by RTS co-efficient (1.21 per cent).

In mandal-II, elasticity co-efficient of human labour (0.5762 per cent) was highest while that of tractor use was not only least (-0.002 per cent) but also negative. The effects of fertilizers (0.5667 per cent) and size of land holding (0.47 per cent) lay in-between these two variables. All the variables except tractor use had significant effect. $R^2$ (0.9037) indicates that over 90 per cent variation in output of sugarcane has been explained by the variation in the independent variables. F-statistics indicates the suitability of the model for the data. In this mandal also the operation of the increasing returns to scale is indicated by RTS.

6.5 Marginal Productivity

Marginal Productivities of an input show the addition to gross output caused by the addition of one unit of the resource input concerned, holding other inputs constant. The table 6.13 provides marginal productivities of various input factors for rice, groundnut and sugarcane.
### Table 6.13
Marginal Productivity of Input Factors

<table>
<thead>
<tr>
<th>Input Factor</th>
<th>Rice</th>
<th></th>
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<th></th>
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<tbody>
<tr>
<td></td>
<td>Mandal I Kharif</td>
<td>Mandal II Kharif</td>
<td>Mandal I Rabi</td>
<td>Mandal II Rabi</td>
<td>Mandal I Combined</td>
<td>Mandal II Combined</td>
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</tr>
<tr>
<td>Fertilizers</td>
<td>0.1819</td>
<td>0.3163</td>
<td>0.0971</td>
<td>0.3932</td>
<td>0.1949</td>
<td>0.3298</td>
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<tr>
<td>Tractor Use</td>
<td>0.0995</td>
<td>0.0178</td>
<td>0.4464</td>
<td>0.1252</td>
<td>0.0967</td>
<td>0.0124</td>
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</tr>
<tr>
<td>Human Labour</td>
<td>0.4725</td>
<td>0.5917</td>
<td>0.4925</td>
<td>0.2915</td>
<td>0.5289</td>
<td>0.5832</td>
<td></td>
</tr>
<tr>
<td>Size of Land</td>
<td>0.1694</td>
<td>0.2148</td>
<td>-0.0083</td>
<td>0.3559</td>
<td>0.1354</td>
<td>0.2277</td>
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</tr>
<tr>
<td></td>
<td>Holdings</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Fertilizers</td>
<td>0.3283</td>
<td>0.1496</td>
<td>0.6572</td>
<td>-</td>
<td>0.3511</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tractor Use</td>
<td>0.1367</td>
<td>-0.0648</td>
<td>0.1160</td>
<td>-</td>
<td>0.1189</td>
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<tr>
<td>Human Labour</td>
<td>0.2797</td>
<td>0.8302</td>
<td>-0.0339</td>
<td>-</td>
<td>0.2300</td>
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<td></td>
</tr>
<tr>
<td>Size of Land</td>
<td>0.2329</td>
<td>-0.2871</td>
<td>0.1941</td>
<td>-</td>
<td>0.2132</td>
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<td></td>
</tr>
<tr>
<td>Holdings</td>
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</tr>
<tr>
<td>Fertilizers</td>
<td>0.2091</td>
<td>0.5667</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Tractor Use</td>
<td>0.0308</td>
<td>-0.0022</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Labour</td>
<td>0.0756</td>
<td>0.5762</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size of Land</td>
<td>0.2598</td>
<td>0.4673</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

The table presents that the productivity of rice from fertilizer in kharif is low at 0.1819 in mandal-I and high at 0.3163 in mandal-II whereas in rabi it is 0.097 in mandal-I and four folds higher at 0.3932 in mandal-II while in the combined, it is at 0.1949 in mandal-I and 0.3298 in mandal-II. The productivity owing to tractor use in kharif is 0.0995 in mandal-I and 0.0178 in mandal-II whereas in rabi, it is 0.4464 in mandal-I and 0.1252 in mandal-II while in combined, it is 0.0967 in mandal-I and 0.0124 in mandal-II. The human labour productivity in kharif is 0.4725 in mandal-I and 0.5917 in mandal-II, while in rabi, it is 0.4925 in mandal-I and 0.2915 in mandal-II whereas in combined, it is 0.5289 in mandal-II in mandal-I and 0.5832 in mandal-II. The productivity from size of land holdings in kharif is 0.1694 in mandal-I and 0.2418 in mandal-II whereas in rabi, it is negatively at 0.0083 in mandal-I but positively highest at 0.3559 in mandal-II while in combined, it is 0.1354 in mandal-I and 0.2227 in mandal-II.
The groundnut productivity from fertilizers in kharif is at 0.3283 in mandal-I, and 0.1496 in mandal-II whereas in rabi, it is 0.6572 and 0.3511 in combined in mandal-I. The productivity through tractor use in kharif is at 0.1367 in mandal-I and negatively at -0.648 in mandal-II while in rabi, it is 0.1160 and combined 0.1189 in mandal-I. The human labour productivity in kharif is at 0.2797 in mandal-I and 0.8302 in mandal-II while in rabi, it is -0.339 and combined at 0.2300 in mandal-I. The productivity from size of land holdings in kharif is 0.2329 in mandal-I and negatively at -0.2071 in mandal-II whereas, it is 0.1941 in rabi and 0.2132 in combined of mandal-I.

The productivity of sugarcane through fertilizers in kharif is 0.2091 in mandal-I and more than two folds at 0.5667 in mandal-II. From tractor use, the productivity in kharif is 0.0308 in mandal-I and very minutely and negatively at -0.0022 in mandal-II. The productivity through human labour in kharif is 0.7056 in mandal-I and 0.5762 in mandal-II. The productivity from size of land holding in kharif is at 0.2592 in mandal-I and 0.4673 in mandal-II.

6.6 Conclusion

Increasing productivity, which is an index of agricultural development, depends on efficient utilization of resources and the most economic combination of factors of production. The new agricultural technology, which ensures this aspect, shifted production function upwards and made agricultural sector move along the production surface by raising yield or productivity. The area under rice, groundnut and sugarcane grown in the mandals under the study is influenced by yield, irrigation, fertilizers and farm harvest price in both kharif and rabi seasons. Regarding yield the influence of irrigation, fertilizers, area under the crop and pesticides is found to be significant in both the mandals and in both the seasons, with few exceptions. Human labourers, fertilizers, size of land holding and tractor hours are the important factors affecting output of the crops under study in both kharif and rabi seasons in both the mandals.