CHAPTER V

RESOURCE – USE EFFICIENCY AND MEASUREMENT OF CAPITAL PRODUCTIVITY OF MANGO ORCHARD

5.1 INTRODUCTION

In this chapter, an attempt has been made to estimate the relationship between various input factors and gross income received from the mango. For this, a multiple log linear regression model is used. In this regression model, gross income in rupees is treated as a dependent variable and input factors viz., (i) human labour in rupees ($X_1$), (ii) cost of tillage practices in rupees ($X_2$), (iii) cost of plant protection in rupees ($X_3$), (iv) age of orchard ($X_4$) and (v) number of bearing trees on the orchard ($X_5$) are taken as independent variables.

5.2 THE ANALYTICAL MODEL

A multiple log linear regression model of Cobb-Douglas type \(^1\) is used to estimate the relation between various input factors and gross income from the mango.

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mango. This type of production function has been found to be the best fit \(^2\) for such perennial tree study and the variables chosen. In the linear regression model, one dependent variable and six independent variables are included in the form given below:

\[
\text{Log } Y = B_0 + B_1 \log x_1 + B_2 \log X_2 + B_3 \log X_3 + B_4 \log X_4 \\
+ B_5 \log X_5 + u \quad \text{.........}(5.1)
\]

Where,

- \(Y\) = Gross income in rupees from mango production,
- \(X_1\) = Human labour in rupees,
- \(X_2\) = Cost of tillage practices in rupees,
- \(X_3\) = Cost of plant practices in rupees,
- \(X_4\) = Age of the orchard,
- \(X_5\) = Number of bearing trees in the orchard and
- \(u\) = Disturbance term.

\(B_0, B_1, B_2, \ldots \ldots \ldots B_5\) are the parameters to be estimated.

5.2.1 Structural Differences in Production Relations

Prior to the measurement of the resource use efficiency, the structural differences in production relation between Shenkottai and Tenkasi taluks were tested. For this, the above model (5.1) was fitted separately for each taluk and for pooled data of two taluks.

In order to test the structural differences between two taluks, the analysis of Co-variance (Chow’s F Test) \(^3\) was carried out.

\[
F^* = \frac{\sum e^2 - (\sum e_1^2 + \sum e_2^2) / K}{\sum e_1^2 + \sum e_2^2 / n_1 + n_2 - 2K} \tag{5.2}
\]

Where,

\[
\sum e^2 = \text{Unexplained or Residual sum of squares of the pooled sample of both taluks.}
\]

\[
\sum e_1^2 = \text{Unexplained or Residual sum of squares of the sample corresponding the taluk Shenkottai,}
\]

\[
\sum e_2^2 = \text{Unexplained or Residual sum of squares of the sample corresponding the taluk Tenkasi,}
\]

\[ n_1 = \text{Number of observations in Shenkottai}, \]
\[ n_2 = \text{Number of observations in Tenkasi} \]
\[ K = \text{Number of the parameters included in the regression equation.} \]

If the computed value of \( F^* \) is less than table value of \( F \) at appropriate level of significance for \((n_1 + n_2 - 2K)\) degrees of freedom, one can accept the hypothesis that there is no structural differences in production relation between the two taluks. In case, the structural differences are found to exist in their production relation between two taluks, dummy variables may be introduced both at the intercept and slope levels to find out whether the structural differences occur at the intercept level or the slope level or both.\(^4\)

The following form of regression model is used to study the structural differences in production relation between two taluks.

\[
\log Y = \alpha_0 + \alpha_1 D + \sum B_i \log X_i + \sum \partial_j D \log x_j + u
\]

\[............ (5.3)\]

In equation (5.3) \( D \) is the dummy variable representing 0 and 1 for Shenkottai and Tenkasi taluk respectively.

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The regression equations (5.1) and (5.3) are estimated by using the principle of least squares.

5.2.2 Estimation of Marginal Value Productivities

The marginal value product of a factor is defined as the change in gross income resulting from a change of this factor, keeping all other factors constant. Marginal value productivity varies directly with corresponding input-output ratio. Marginal value product of the inputs are measured from the following formula which can be derived from the equation (5.1)

\[
\begin{align*}
Y_{MVPx_1} &= B_1 \frac{Y}{X_1} \\
Y_{MVPx_1} &= B_2 \frac{Y}{X_2} \\
Y_{MVPx_1} &= B_3 \frac{Y}{X_3} \\
Y_{MVPx_1} &= B_4 \frac{Y}{X_4} \\
Y_{MVPx_1} &= B_5 \frac{Y}{X_5}
\end{align*}
\] 

\[\text{............... (5.4)}\]
Where, $Y$ and $X_1 \ldots X_5$ are the geometric mean level of gross income and input factors respectively.

### 5.2.3 Size - Productivity Relationship

To examine the nature of relationship between farm size and productivity, the regression equation is fitted in the following form.

\[
\log Q = \log C + B \log A \quad \text{.......(5.5)}
\]

Where,

- $Q$ = Gross value of output in rupees at individual farm level,
- $A$ = Size of the operational holdings in acres, and
- $C$ and $B$ are parameters to be estimated.

The above equation (5.5) has been estimated by the method of least squares. For the existence of inverse or positive relationship between farm size and productivity the requisite condition is that the coefficient of $\log A$ i.e., $B$ should be less than or greater than unity. In order to examine whether the coefficients are statistically different from unity, the $t$– test has been used.
5.2.4 Measurement of Capital Productivity

In crop like mango, capital invested now yields a stream of returns in future. The economic viability of the investments on such a crop has to be evaluated taking into consideration the life period of the crop. In the present study, productivity of capital was measured by using (i) Net Present Value (NPV), (ii) Benefit-Cost ratio (B-C), (iii) Interest Rate of Return (IRB) and (iv) Payback period.\(^5\)

(i) Net Present Value

It is the difference between the present worth of benefits and present worth of costs. This can be expressed as follows:

\[
NPV = \sum_{t=1}^{50} \frac{B_t - C_t}{(1 + i)^t} \quad ........(5.6)
\]

Where,

\[
NPV = \text{Net Present value},
\]

\[
B_t = \text{Benefits in } t^{th} \text{ year},
\]

\[
C_t = \text{Cost in } t^{th} \text{ year},
\]

t = Number of years (1 to 50 years) and 

i = Discount rate (12 per cent).

The positive net present value indicates economic viability of mango crop.

(ii) Benefit – Cost Ratio

The benefit – cost ratio is the ratio of the sum of discounted net benefits with sum of discounted capital costs. The benefit cost ratio is mathematically expressed as

\[
\frac{\sum_{t=1}^{50} \frac{B_t}{(1 + i)^t}}{\sum_{t=1}^{50} \frac{C_t}{(1 + i)^t}}
\]

\[
B - C = \frac{\sum_{t=1}^{50} \frac{B_t}{(1 + i)^t}}{\sum_{t=1}^{50} \frac{C_t}{(1 + i)^t}} \quad \text{(5.7)}
\]

Where the benefit – cost ratio exceeds one the investment is considered viable.
(iii) **Internal Rate of Return (IRR)**

It is the discount rate which just makes the net present worth of the cash flow equal to zero. IRR is calculated thus

$$\sum_{t=1}^{50} \frac{B_t - C_t}{(1 + i)^t} = 0 \quad \text{...............(5.8)}$$

When the calculated IRR is more than that of the market rate of interest then the investment is considered viable.

(iv) **Pay – Back Period**

Pay-back period is an undiscounted measure if worthiness of an Endeavour which measured the efficiency of cultivation by indicating the period within which returns offset the investment.

5.3 **ESTIMATED RESULTS OF REGRESSION EQUATION – TALUK-WISE**

The results of the linear regression equation (5.1) estimated for Shenkottai and Tenkasi taluks are given in Table 5.1. The results of pooled data of both Shenkottai and Tenkasi taluks are given in Appendix Table 5.1.
<table>
<thead>
<tr>
<th>Taluks</th>
<th>Size of the Sample</th>
<th>Regression Coefficients and t-values</th>
<th>$\Sigma e^2$</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\beta_0$</td>
<td>$\beta_1$</td>
<td>$\beta_2$</td>
</tr>
<tr>
<td>Shenkottai</td>
<td>150</td>
<td>1.76</td>
<td>0.18*</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.74)</td>
<td>(0.16)</td>
<td>(0.98)</td>
</tr>
<tr>
<td>Tenkasi</td>
<td>150</td>
<td>0.99</td>
<td>0.14</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.18)</td>
<td>(0.22)</td>
<td>(0.21)</td>
</tr>
</tbody>
</table>

Figures in parentheses are t-values. * Indicates that the coefficients are significant at 5 per cent level.
In Shenkottai, all the size regression coefficients of independent variables are positive and the value of $R^2$ indicate that all the explanatory variables jointly account for about 93 per cent of variations in gross income from mango. The coefficients of human labour, plant protection and number of bearing trees are statistically significant at 5 per cent level. It implies that by one per cent increase in these variables, the gross income could be increased by 0.18, 0.018 and 0.49 per cent respectively. Among these three influencing input factors, number of bearing trees in the mango orchard has greater influence on gross income determination. As per F-value given in Table 5.1, the regression model is found to be significant at one per cent level.

In the case of Tenkasi taluk, the coefficients of all variables are positively related to the gross income. The value of $R^2$ indicates that nearly 94 per cent of variations in gross income from mango were enplaned by the variables included in the regression model. The coefficients of plant protection and number of bearing trees are found to be significant at 5 per cent level. It means that one per cent increased in these variables is capable of increasing gross income by 0.026 and 0.36 per cent respectively. The F-value shows that the regression model is statistically significant at 1 per cent level.
5.4 TESTS FOR STRUCTURAL DIFFERENCE

In order to test the null hypothesis that there is no structural difference in production relation between two taluks, Chow’s test (5.2) has been applied and its results are given in Table 5.2.

**TABLE 5.2**

**EQUALITY TEST BETWEEN SHENKOTTAI AND TENKASI PRODUCTION RELATION**

<table>
<thead>
<tr>
<th>$\Sigma e^2$</th>
<th>$\Sigma e_1^2$</th>
<th>$\Sigma e_2^2$</th>
<th>$n_1 + n_2 - 2K$</th>
<th>$F^*$</th>
<th>$F(6,288)$ at 1% level</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.329</td>
<td>0.089</td>
<td>0.079</td>
<td></td>
<td>24.46</td>
<td>2.64</td>
<td>Structural difference exists between Shenkottai and Tenkasi production relation</td>
</tr>
</tbody>
</table>

It is clear from the Table 5.2 that the computed $F$-value ($F^*$) is found to be greater than its table value $F$ one per cent level with (6,288) degrees of freedom. The computed and table $F$ values are 24.46 and 2.65 respectively. Therefore, a **null hypothesis (2)** is rejected. Hence, it can be concluded that

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there are structural differences in production relation between Shenkottai and Tenkasi taluks.

Further, the regression equation (5.3) is fitted to find out whether the structural differences in production relation between two taluks existed at a slope level and/or the intercept level. The estimated results of the regression model are given in Table 5.3.
<table>
<thead>
<tr>
<th>Size of the Sample</th>
<th>Regression Coefficients and t-values</th>
<th>( R^2 )</th>
<th>F</th>
<th>( \Sigma e^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \alpha_0 )</td>
<td>( \alpha_1 )</td>
<td>( \beta_1 )</td>
<td>( \beta_2 )</td>
<td>( \beta_3 )</td>
</tr>
<tr>
<td>300</td>
<td>1.58</td>
<td>1.19</td>
<td>0.13</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Figures in parentheses are t-values.

* Indicates that the coefficients are significant at 5 per cent level.
It is observed from the above Table 5.3 that coefficient of dummy variable at the intercept level is not significant; it means that there is no difference with regard to technical change in production relation between two taluks.

In Shenkottai, all the explanatory variables are positively related to the gross income. The coefficients of plant protection and number of bearing trees are statistically significant at 5 per cent level. It indicated that an additional percentage of these variables could increase gross income by 0.14 and 0.34 per cent respectively. The structural differences in relation between two taluks at the slope level in production caused by the variable, number of bearing trees in the orchard. It shows that the addition made to this variable is capable is increasing the gross income by 0.34 per cent in Shenkottai and 0.21 per cent in Tenkasi orchard. It has been observed from sample orchards that the number of bearing trees per acre in Shenkottai orchards were in the range between 33 and 38 trees whereas in Tenkasi orchards it was between 22 and 26 trees.

5.5 MARGINAL VALUE PRODUCTIVITIES OF THE FACTORS

Marginal Value productivity of an input would indicate the addition to the gross income from an increase by one more unit of the input variable
concerned. The computed marginal value productivities by using the formula (5.4) for the input variables are given in Table 5.4.

TABLE 5.4

MARGINAL VALUE PRODUCTIVITIES OF THE FACTORS INPUTS AT THE GEOMETRIC MEAN LEVEL

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Variables</th>
<th>Shenkottai</th>
<th>Tenkasi</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Human labour</td>
<td>9.17</td>
<td>8.63</td>
</tr>
<tr>
<td>2.</td>
<td>Cost of tillage practices</td>
<td>5.75</td>
<td>6.62</td>
</tr>
<tr>
<td>3.</td>
<td>Plant protection</td>
<td>9.15</td>
<td>11.35</td>
</tr>
<tr>
<td>4.</td>
<td>Age of the orchard</td>
<td>941.16</td>
<td>381.62</td>
</tr>
<tr>
<td>5.</td>
<td>Number of bearing trees</td>
<td>198.15</td>
<td>145.75</td>
</tr>
</tbody>
</table>

The results of the above Table 5.4 show that the marginal value of all factor products input was positive in both Shenkottai and Tenkasi taluks. It implies that income could be raised by employing an additional unit in these variables. A comparison of marginal productivities of inputs between Shenkottai and Tenkasi orchards reveal that marginal value productivities of the variables human labour, age of the orchard and number of bearing trees are higher in Shenkottai orchards than in Tenkasi orchards whereas the marginal value productivities of other two variables namely, cost of tillage practices and
plant protection are higher in Tenkasi orchards than in Shenkottai orchards. In general, the marginal value productivity analysis indicates the scope for further increasing the inputs with profit.

In order to examine the resource use efficiency, the marginal value products of the input variables are compared with their respective factor costs. The basic condition to be satisfied to obtain efficient resource use is the equality of marginal value product to factor cost.\(^7\) Resource use efficiency has been calculated only for controllable variables such as human labour, tillage practices and plant protection. As there are conceptual problems in the case of age of the orchard and number of bearing trees, the factor inputs such as human labour, tillage practices and plant protection alone have been taken into consideration for examining the resource-use efficiency.

The cost of human labour was calculated at the price of Rs.460 and Rs.230 per man-day which was the prevailing wage rate in Shenkottai and Tenkasi taluk respectively during the period of the study. Regarding the cost of tillage practices, the cost of bullock labour per pair per day of Rs.450 and Rs.225 in Shenkottai and Tenkasi taluks respectively have been taken into consideration for examining the resource-use efficiency.

account. The actual amount spent by the orchardists towards the cost of plant protection was considered.

Table 5.5 shows the ratios of marginal value products to the respective cost of the factor inputs.

**TABLE 5.5**

**RATIOS OF MARGINAL VALUE PRODUCTS TO FACTOR COSTS**

<table>
<thead>
<tr>
<th>Taluks</th>
<th>Human labour</th>
<th>Tillage cost of Practices</th>
<th>Plant Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shenkottai</td>
<td>0.45</td>
<td>0.11</td>
<td>9.36</td>
</tr>
<tr>
<td>Tenkasi</td>
<td>0.54</td>
<td>0.19</td>
<td>11.42</td>
</tr>
</tbody>
</table>

The above table 5.5 indicates that the marginal value productivity and factor price ratio of plant protection is greater than unity in both taluks. It implies that the mango orchardists in both taluks are found to be rational in the use of plant protection. In the case of other variable inputs namely, human labour and cost of tillage practices, the ratio of marginal value productivity of these two variables to its cost are less than unity in both taluks. It implies that these variables are not being used efficiently by the orchardists in these taluks. Comparing two taluks namely, Shenkottai and Tenkasi, Tenkasi orchardists are
found to be rational in the use of all the three input factors than in Shenkottai orchardists.

5.6 SIZES-PRODUCTIVITY RELATIONSHIP

For over three decades, Economists have debated on the relationship between farm size and productivity. According to Saini, the inverse relationship between farm size and productivity is a confirmed phenomenon in Indian agriculture. The observed relationship between farm size and productivity provoked Economists to offer several explanations. Among them, the following seem to be more relevant.

1. Labour-based explanation,
2. Social, institutional factor-based explanation,
3. Intensive cultivation based explanation,
4. Irrigation based explanation,
5. Tenancy-based explanation, and

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But some Economists have challenged the statistical validity of inverse relationship between farm size and productivity. The study of Rao\textsuperscript{9} has revealed that productivity has remained constant for all sizes of holdings and thus he has indicated that the size of holdings is neutral on this issue. Bhattacharya\textsuperscript{10} has indicated that the inverse relationship between farm size and productivity observed in Indian agriculture could be a spiral statistical relationship arising due to the process of aggregation.

In this context, an attempt is made to examine, the relationship between farm size and productivity of the perennial crop of mango orchard. The equation (5.5) has been estimated and the results are given in the Table 5.6.


TABLE 5.6

ESTIMATED REGRESSION RESULTS OF THE SIZE-PRODUCTIVITY RELATIONSHIP IN THE MANGO CULTIVATION

<table>
<thead>
<tr>
<th>Taluk</th>
<th>Sample size</th>
<th>Regression Coefficients</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>log C</td>
<td>B</td>
</tr>
<tr>
<td>Shenkottai</td>
<td>150</td>
<td>4.25</td>
<td>1.39*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3.19)</td>
</tr>
<tr>
<td>Tenkasi</td>
<td>150</td>
<td>4.09</td>
<td>1.14*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(2.45)</td>
</tr>
</tbody>
</table>

Figures in parentheses are t-values.
* Indicates that the coefficients are significant at 5 per cent level.

The results of the Table 5.6 indicate that the coefficients are statistically; significant for both Shenkottai and Tenkasi taluks and the t-test also reveal that the coefficients are significantly different from unity which confirms the existence of direct relationship between farm size and productivity. In other words, the productivity of mango increases whenever the size of the orchard increases. The reason for the existence of such a relationship may be attributed to the economics of large scale operations.
5.7 DETERMINATION OF CAPITAL PRODUCTIVITY (RETURN ON INVESTMENT)

Measurement of productivity assumes importance as it facilitates studying the efficiency of resource-use. Unlike the annual crops, the problems of investment on such perennial crops demand consideration in depth as its economic life spans more than a generation and once investments are made and resources are committed no retrieval is possible. Further, the magnitude of the problem demands vast resources and the flow of income spreads over a number of years. Therefore, the costs and returns from those investments have to be analysed to test the worth wholeness of these projects. In this section, productivity of capital was measured by using (i) Net present Value (NPV), (ii) Benefit-Cost (B-C) Ratio, (iii) Internal Rate of Return (IRR) and (iv) Pay-Back Period.

(i) Net present Value

For this, future annual margins may be discounted to their present value by using the formula (5.6). It may be noted that the estimated annual margin will depend upon the discount rate used in the calculation. The discount rate should be equal to the opportunity cost of capital, that is, the rate of interest which could be obtained in the best alternative or the rate of interest on
borrowed capital. In the present study, 12 per cent interest rate which was
given for fixed deposits by commercial banks was used as the discount rate.
The discounted value of net benefits was calculated with the help of published
tables of the present worth of an annuity of Rs.1 payable for 50 future years
at 12 per cent interest rate.

The net present value of the stream of returns from one acre of mango
orchard worked to Rs.31,724.90 for Shenkottai and Rs.19849.00 for Tenkasi at
a discount rate 12 per cent which indicated the soundness of investment of
mango orchard in both taluks. Comparing these two taluks, investment on
mango orchard in Shenkottai is economically more feasible than in Tenkasi.

(ii) Benefit-Cost Ratio

The other indicator used to test the worthiness of the investment is the
benefit-cost ratio. This shows how much benefit can be generated per rupee of
cost. The benefit-cost ratio was worked out with 12 per cent discount factor by
using the formula (5.7).

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11 M.V.George and P.T.Joseph, “Cost-Benefit Analysis of Investment in Tree

12 Jr.Harold Birman and Seymour Smidt, The Capital Budgeting Decision,*
The total cost worked out to Rs.10,677.56 and Rs.8,385.64 whereas the total benefits were Rs.31,724.90 and Rs.19,849.00 for Shenkottai and Tenkasi respectively. The benefit-cost ratio for Shenkottai was 2.97 and it was 2.37 for Tenkasi. This indicated the profitability of mango orchards in both Shenkottai and Tenkasi taluks.

(iii) Internal Rate of Return (IRR)

This rate of discount (r which will equalise the stream of net benefits (B) and the stream of capital costs (K) i.e., the rate of discount which will satisfy the relationship \( B - K = 0 \) is known as the Internal Rate of Return.\(^{13}\)

Unlike the Net Present Value (NPV) method, calculating the value of IRR is more difficult. It involves a trial and error procedure. In the case when NPV is found to exceed zero, a rate of interest higher than the rate initially selected would be tried. Conversely, when the NPV is less than zero, a lower rate would be used. This procedure will go on till the rate which gives zero for the NPV.\(^{14}\)


Internal rate of return for Shenkottai and Tenkasi were 25.63 per cent and 20.36 per cent respectively which are greater than the prevailing interest rate i.e., 12 per cent. It revealed that the investment made in mango cultivation is profitable. The higher rate of return in Shenkottai compared to Tenkasi taluk indicated the high pay off nature of the investment in Shenkottai than in Tenkasi taluk.

(iv) Pay-Back Period

The pay-back period is the length of time required to pay itself out. The pay-back period for the investment made in Shenkottai and Tenkasi mango orchards were worked out. They are 13.72 years and 15.22 years in Shenkottai and Tenkasi orchards respectively. It indicated that the investment made in Shenkottai will take 13.72 years to pay itself out whereas the investment made in Tenkasi orchard will yield back in 15.22 years. This indicated that the Shenkottai mango orchard will recoup the investment earlier than the Tenkasi grove.
The findings of the chapter may be summarized as follows:

The results of Table 5.1 revealed that among five variables, three variables namely. Human labour, plant protection and number of bearing trees have influence on the gross income of mango orchard in Shenkottai whereas in Tenkasi only two variables namely, plant protection and number of bearing trees have influence on the gross income. The influence of the number of bearing trees has been greater in both taluks compared to other factor inputs. The Chow’s test showed that there is a structural difference in production relation between two taluks. Table 5.3 indicated that the structural difference existed at slope level and not at the intercept level. At the slope level, the difference was caused by variable number of bearing trees.

Regarding the marginal value productivity, the marginal value productivities of all factor inputs were found to be positive on both taluks. Hence, it indicated that the scope for further increasing the input with profit.

Regarding the resource-use efficiency, the ratio of marginal value products to their respective cost, the variables human labour and cost of tillage practices are underutilization whereas in the case of plant protection, orchardists in both taluks are found to be rational in its use.
Regarding the return on investment of capital, the net present value indicated the soundness of investment on mango orchards in both taluks. In two taluks, investment on mango orchard in Shenkottai is economically more feasible than in Tenkasi taluk. The benefit cost ratio indicated the profitability of mango orchards in both taluks. The ratios are 2.73 and 2.52 in Shenkottai and Tenkasi respectively. In the case of Internal Rate of Return, both taluk give higher rate of return and it indicated the high pay off nature of the investment in mango orchards in these taluks. Regarding the pay-back period, Shenkottai mango orchard will recoup the investment earlier than the Tenkasi grove.