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CHAPTER SIX

YIELD GAP

Among the districts in Tamil Nadu, Tirunelveli Kattabomman district occupied the third position in area under banana cultivation during the year 1993-94. But, the forecaste estimate of average yield of banana per hectare in this district was far below the average yield estimated in other districts for the same year (see Appendix II). Further, the yield achieved, on an average, by banana growers in the selected regions was also lower than the estimate of average yield of banana in this district.
Besides, yield difference or variation or gap was found among the sample farmers due to variations in factor endowments, managerial ability of the banana growers and exogenous natural factors. Hence, quantification of the yield difference or yield gap and identification of factors responsible for limiting the yield of banana at micro level assume importance.

Yield gap in the present study is defined as the difference between the forecast estimate of average yield and actual yield achieved by the farmers in the study area and the difference between the yield of best farmers and backward farmers within the sample.

The yield gap is analysed considering the difference in yield between forecast estimate of average yield and actual yield for different varieties of banana and different size-groups of farm. Further, the yield gap between the best farmers and backward farmers as intra-farm yield gap is also analysed. The estimate of average yield is taken from government report 'Forecast Estimate of Area and Production of Important Crops, 1993-94' issued by the Department of Statistics, Madras (see Appendix II). The actual yield is obtained from sample banana growers who had cultivated different varieties of banana.
1. YIELD GAP BETWEEN FORECAST ESTIMATE OF AVERAGE YIELD AND ACTUAL AVERAGE FARM YIELD

i. FOR DIFFERENT VARIETIES OF BANANA

A comparison of forecast estimate of average yield and actual farm yield with different varieties is presented in Table No.6.1. A perusal of this Table shows that the estimated yield is observed to be 26,444 kgs. per hectare. The average farm yield for the sample as a whole is 23612 kgs. per hectare whereas the average yield for Thozhuvan, Kadali, Peyan and Nendran is 20,111, 28,664, 23063 and 23237 kgs. respectively.

The yield gap between the estimate of average yield and overall average farm yield is negative with 2832 kgs. per hectare (-11.99 per cent). This gap is 6333 kgs. per hectare (-31.49 per cent) with Thozhuvan, 2220 kgs. per hectare (7.74 per cent) with Kadali, 3381 kgs. per hectare (-14.66 per cent) with Peyen and 3207 kgs. per hectare (-13.80 per cent) with Nendran.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Average Kgs/ha.</th>
<th>Yield Gap Kgs/ha.</th>
<th>Percentage gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Forecast Estimate of Average Yield</td>
<td>26,444</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Farm Average Yield with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Overall Farms</td>
<td>23,612</td>
<td>(-) 2,832</td>
<td>(-) 11.99</td>
</tr>
<tr>
<td></td>
<td>ii. Thozhuvan</td>
<td>20,111</td>
<td>(-) 6,333</td>
<td>(-) 31.49</td>
</tr>
<tr>
<td></td>
<td>iii. Kadali</td>
<td>28,664</td>
<td>(+) 2,220</td>
<td>(+) 7.74</td>
</tr>
<tr>
<td></td>
<td>iv. Peyen</td>
<td>23,063</td>
<td>(-) 3,381</td>
<td>(-) 14.66</td>
</tr>
</tbody>
</table>

The average farm yield of different varieties of banana except Kadali is below the forecast estimate of average yield and the yield of Thozhuvan is far below the estimated yield. But the net revenue accrued from Thozhuvan is greater than that accrued from Kadali and Peyen (see Chapter IV, Table No. 4.6.).

ii. FOR DIFFERENT SIZE-GROUPS OF FARM

Yield gap also exists within the size-groups of farm even under the same agro-climatic conditions. This yield gap occurs due to variations in resource position and managerial ability of the farmers. The yield gap within the size-groups of farms is presented in Table No. 6.2.
TABLE NO. 6.2.  YIELD GAP BETWEEN FORECAST ESTIMATE OF AVERAGE YIELD AND ACTUAL (FARMER'S) YIELD (AVERAGE PERFORMANCE) FOR DIFFERENT SIZE-GROUPS OF FARM PER HECTARE.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Average Yield</th>
<th>Yield Gap</th>
<th>Percentage gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Forecast Estimate of Average Yield</td>
<td>26,444</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2.</td>
<td>Farm Average Yield with</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i. Overall Farms</td>
<td>23,612</td>
<td>(-) 2,832</td>
<td>(-) 11.99</td>
</tr>
<tr>
<td></td>
<td>ii. Group-I</td>
<td>25,959</td>
<td>(-) 485</td>
<td>(-) 1.89</td>
</tr>
<tr>
<td></td>
<td>iii. Group-II</td>
<td>23,492</td>
<td>(-) 2,952</td>
<td>(-) 12.57</td>
</tr>
<tr>
<td></td>
<td>iv. Group-III</td>
<td>22,368</td>
<td>(-) 4,076</td>
<td>(-) 18.22</td>
</tr>
</tbody>
</table>

A perusal of Table No. 6.2. indicates that the average yield of each group is below the forecast estimate of average yield. The average yield of Group-I is highest as compared to the average yield of the remaining groups, and this group has negative yield gap of 485 kgs. per hectare (-1.89 per cent). The yield gap is negative by 2952 kgs. per hectare (-12.57 per cent) and 4076 kgs. per hectare (-18.22 per cent) for Group-II and Group-III respectively. The yield gap in Group-I is narrow, in Group-II wide and in Group-III wider.
2. YIELD GAP BETWEEN BEST FARMERS AND BACKWARD FARMERS WITHIN THE SAMPLE FARMS PER HECTARE

The sample banana growers are classified as best farmers and backward farmers. This classification is made on the basis of the standardised average yield of the growers for each variety. Standardisation of yield is the conversion of the actual yield into yield for one hectare. This yield is ranked in ascending order. The standardised average yield for each variety is worked out dividing the total yield by the respective sample of each variety. The banana growers who are above the average yield are termed as best farmers and the growers who are below the average yield are termed as backward farmers.

As the best farmers fall in the first group and the backward farmers fall even on the first group by 17.34 per cent and exclusively on the second and third groups of farm, group-wise analysis of yield gap between these classes is not essential. Therefore, only variety-wise analysis of yield gap between best farmers and backward farmers is carried out.

To test the significance of the difference in mean yield between best farmers and backward farmers, t-test is applied, framing a hypothesis that there is no significant difference in the mean yield between
these two classes per hectare. The t-test runs as follows:

\[ t = \frac{\bar{X}_1 - \bar{X}_2}{S} \times \sqrt{\frac{n_1 \times n_2}{n_1 + n_2}} \]

Where,

\( \bar{X}_1 \) = Standardised mean yield of the first sample (best farmers)

\( \bar{X}_2 \) = Standardised mean yield of the second sample (backward farmers)

\( n_1 \) = number of observations in the first sample.

\( n_2 \) = number of observations in the second sample.

\( S \) = Combined standard deviation

\[ S = \sqrt{\frac{\sum(x_1 - \bar{X}_1)^2 + \sum(x_2 - \bar{X}_2)^2}{n_1 + n_2 - 2}} \]

A comparison of yield gap between best farmers and backward farmers for different varieties is exhibited in Table No.6.3.
TABLE NO.6.3. YIELD GAP BETWEEN BEST FARMERS AND BACKWARD FARMERS FOR DIFFERENT VARIETIES OF BANANA PER HECTARE.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Number of farmers</th>
<th>Average Yield in Kgs. per hectare</th>
<th>Yield gap (in kgs.)</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Best farmers</td>
<td>Backward farmers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thozhuvan</td>
<td>49</td>
<td>51</td>
<td>23018</td>
<td>20072</td>
</tr>
<tr>
<td>Kadali</td>
<td>43</td>
<td>40</td>
<td>33302</td>
<td>27937</td>
</tr>
<tr>
<td>Peyen</td>
<td>43</td>
<td>31</td>
<td>25309</td>
<td>23112</td>
</tr>
<tr>
<td>Nendran</td>
<td>18</td>
<td>28</td>
<td>25165</td>
<td>22363</td>
</tr>
</tbody>
</table>

A persual of Table No.6.3. shows that the yield gap between best farmers and backward farmers ranges from 5365 kgs. in Kadali to 2197 kgs. in Peyen. The yield gap of Thozhuvan as well as Nendran lies in between these two. This means that the backward farmers in Peyen cultivation have maintained their banana garden well when compared to the backward farmers of the remaining varieties. In the cultivation of Kadali the backward farmers have not looked after their banana garden well, hence wide gap in the yield exists between the best farmers and backward farmers in this variety.

This yield gap on backward farmers holds the promise for an increase in banana production without
adding pressure on banana hectareage.

The t-value for each variety is calculated and presented in Table No.6.3. The calculated t-value is greater than the table value at the respective \( n_1 + n_2 - 2 \) degrees of freedom for each variety. Therefore, the already framed hypothesis is rejected and it is concluded that the difference in mean yield per hectare between best farmers and backward farmers for different varieties is significant at 1 per cent level of statistical significance.

The backward farmers should be advised to make use of the required inputs to increase the yield and to narrow down the yield gap in order to get higher revenue from banana cultivation.

3. REASONS FOR THE YIELD GAP

Besides the extension services, resource position and managerial abilities physical, institutional, economic and social factors prevent farmers from achieving the estimated yield, contribute to yield gap. They also influence the yield achieved by best farmers. Moreover, though the banana growers are aware of the available modern technology, they can not practise the available technology in its totality due to monetary constraints. The important reasons for the yield gap are summerised thus:
i. Quality of suckers: The quality of suckers influences the yield of banana. Farmers report that they make use of the suckers available from the nearest garden irrespective of their quality. This often gives room to easy pest attack and the weak stems become vulnerable to wind damages. As a result, the yield is affected.

ii. Cultural operations: The cultural operations especially number of hoeings are inadequate due to higher human and machine labour cost. Large farms under Groups II and III had spent comparatively less amount on labour than the small farms in Group-I. There is also variation in the deepening of soil by hoeing. The suckers which are planted in less deepened soil would have been in a difficult condition to take water and food through their roots from the soil. This affects the growth of banana tree and ultimately yield.

iii. Application of manures and fertilizers: The reasons reported by the farmers for the inadequate use of manures and fertilizers include higher prices of manures and fertilizers, scarcity of chemical fertilizers to be applied in appropriate time and the fear of loss in case of crop failure due to natural calamities.
iv. **Plant protection:** The plant protection measures are generally inadequate due to high cost of plant protection materials like bamboo and casuarina poles, pesticides and insecticides, lack of knowledge of application of pesticides and insecticides at proper stage and lack of appliances.

V. **Number of irrigations:** Normally banana crop requires irrigation once in every five to seven days for one year. But, due to frequent power cut, low amount of rainfall and shortage of water in deep dug wells during summer in backward dry areas, farmers are able to irrigate the banana crop once in every eight to ten days. This affects the growth of banana tree and ultimately the yield.

VI. **Defective watch and ward:** Once the agreement with the pre-harvest contractors is made, the banana growers are reluctant to take care of their banana garden on par with the care taken before the agreement. They do not pluck off the flower from the banana bunch on the eve of its quarter to half maturity. This affects the fruit development. Further, as they want to sell the suckers, they allow all the suckers to grow by taking food and water from the mother plant. This also affects the growth and size of banana tree leading to low yield.
Banana production is constrained by many factors. These factors are classified into agro-biological and economic and institutional factors. In consultation with research and extension personnel ten factors were identified, five representing agro-biological and five representing economic and institutional. The respondents were asked to rank, on the basis of their opinion, the agro-biological and economic and institutional factors which are responsible for limiting banana production.

i. Agro-biological factors: The identified agro-biological factors are severity of wind, disease, Pests, soil condition and amount of rainfall. These factors are ranked by the sample respondents. The ranks given by them are transmuted into scores with the aid of table given by Garret. These scores are added together and presented in Table No.6.4.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Factors</th>
<th>Total Score</th>
<th>Mean Score</th>
<th>Rank</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Severity of disease.</td>
<td>19274</td>
<td>73.29</td>
<td>I</td>
<td>86.80</td>
</tr>
<tr>
<td>2.</td>
<td>Severity of Wind</td>
<td>12250</td>
<td>54.44</td>
<td>II</td>
<td>73.93</td>
</tr>
<tr>
<td>3.</td>
<td>Amount of rainfall</td>
<td>3317</td>
<td>41.46</td>
<td>III</td>
<td>26.40</td>
</tr>
<tr>
<td>4.</td>
<td>Soil condition</td>
<td>1034</td>
<td>39.77</td>
<td>IV</td>
<td>8.58</td>
</tr>
<tr>
<td>5.</td>
<td>Severity of pests.</td>
<td>3845</td>
<td>25.46</td>
<td>V</td>
<td>49.83</td>
</tr>
</tbody>
</table>

A perusal of Table No. 6.4. shows that diseases are considered as the major limiting factor as reported by 86.80 per cent of the banana growers with a mean score of 73.29. Bunchy top and leaf spot are the major dreaded diseases. They spread slowly. The affected banana trees become dwarf in size and they do not put forth any fruit. This will affect the banana production and revenue of the growers.

Next to diseases, wind is considered to be an important factor. During the month of August, severe wind causes extensive damage to the banana trees by completely uprooting them. This was reported by 73.93 per cent of the respondents with the mean score of
54.44. Amount of rainfall, soil condition and severity of pests come next in order in limiting banana production.

ii. Economic and Institutional factors: Five economic and institutional factors identified are higher labour cost, higher cost of manures and fertilizers, higher propping cost, higher pesticides cost and non-availability of credit. The ranks given by the sample respondents for these factors are converted into percent position and this percent position of each respondent is transmuted into scores. These scores are added together and exhibited in Table No.6.5.
TABLE NO. 6.5. ECONOMIC AND INSTITUTIONAL FACTORS LIMITING BANANA PRODUCTION.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Factors</th>
<th>Total Score</th>
<th>Mean Score</th>
<th>Rank</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Higher cost of manures and fertilizers</td>
<td>22821</td>
<td>75.32</td>
<td>I</td>
<td>100.00</td>
</tr>
<tr>
<td>2.</td>
<td>Higher propping cost</td>
<td>11946</td>
<td>54.55</td>
<td>II</td>
<td>72.28</td>
</tr>
<tr>
<td>3.</td>
<td>Higher pesticide cost</td>
<td>2375</td>
<td>43.18</td>
<td>III</td>
<td>18.15</td>
</tr>
<tr>
<td>4.</td>
<td>Higher labour cost</td>
<td>4512</td>
<td>40.29</td>
<td>IV</td>
<td>36.96</td>
</tr>
<tr>
<td>5.</td>
<td>Non-availability of credit</td>
<td>2981</td>
<td>25.48</td>
<td>V</td>
<td>38.61</td>
</tr>
</tbody>
</table>

From the perusal of Table No. 6.5., it is understood that as reported by all the farmers, higher cost of manures and fertilizers is considered as the foremost economic and institutional factor with a mean score of 75.32. Higher cost of propping is ranked second with a mean score of 54.55 and 72.28 per cent of the respondents reported this factor. Next come in order the higher pesticide cost, higher labour cost and non-availability of credit.
5. DETERMINATION OF MAXIMUM YIELD WITHIN THE SAMPLE FARMS

The determination of maximum yield or product within the sample farms can be done with the help of marginal analysis. A rational banana producer will maximise his product at a stage where the marginal product is equal to zero. At this stage, the utilisation of factor inputs is optimum. The maximum product is determined by following derivative technique.

A functional relationship between the yield and inputs used by the sample farmers on an overall basis is established in the form of quadratic equation viz.,

\[ Y = a + bX + cX^2 \]

where,

\[ Y = \text{total product or yield in kgs.} \]
\[ X = \text{total cost of inputs used} \]
\[ a = \text{constant} \]
\[ b = \text{co-efficient of the total cost of inputs} \]
\[ 2c = \text{the derivative of} \, X^2\, \text{showing the rate of change of output with respect to the cost of inputs} \, X. \]
The estimated functional relationship in quadratic form runs as follows:

\[ Y = 0.26 + 0.92X - 0.02X^2 \]

From the above estimated equation, the equation for marginal product could be formed by using the derivative technique. Marginal product (MP) is nothing but the ratio between the change of output to a given change in inputs.

Symbolically,

\[ MP = \frac{\Delta Y}{\Delta X} \]

and by definition it is \( dy/dx \) which reveals the rate of change of \( y \) with respect to \( x \).

Therefore,

\[ MP = \frac{dY}{dx} = 0.92 - 0.04X. \]

It is the first order derivative.

Total product gets maximum at a stage where the marginal product is equal to zero. At this stage the inputs used become optimum.

If

\[ \frac{dy}{dx} = 0.92 - 0.04X = 0, \]

then,

\[ -0.04X = -0.92 \]

\[ X = \frac{-0.92}{-0.04} = 23 \]

\[ X = 23 \text{ (Rupees)} \]
This means that when the marginal product is equal to zero, the farmers has to spend Rupees 23 as optimum inputs.

To determine whether the estimated function gives maximum or minimum value, the technique of second order derivative is used. If the second order derivative \( \frac{d^2y}{dx^2} \) is less than zero, the estimated function will get maximum value. The second order derivative runs as follows:

\[
\frac{d^2y}{dx^2} = -0.04 < 0
\]

Since
\[
\frac{d^2y}{dx^2} < 0,
\]
the estimated function gives maximum product when \( X = 23 \). Substituting \( X = 23 \) in the estimated equation, the value of \( Y \) (total product) would be:

\[
Y = 0.26 + 0.92(23) - 0.02(23^2)
\]
\[
Y = 0.26 + 21.16 - 10.58
\]
\[
Y = 10.84 \text{ (kgs.)}
\]

The estimated maximum yield within the sample farms would be 10.84 kgs. of banana using Rupees 23.00 as input. This means that if a farmer spends Rupees 23 as
input cost, he will produce 10.84 kgs. of banana. This will become clear from Table No.6.3 on the basis of the estimated quadratic function:

\[ y = 0.26 + 0.92x -0.02x^2. \]

<table>
<thead>
<tr>
<th>Total Cost (in '000 rupees)</th>
<th>Total Product (in '000 kgs.)</th>
<th>Marginal Product (in '000 kgs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.00</td>
<td>4.36</td>
<td>0.72</td>
</tr>
<tr>
<td>10.00</td>
<td>7.46</td>
<td>0.52</td>
</tr>
<tr>
<td>15.00</td>
<td>9.56</td>
<td>0.32</td>
</tr>
<tr>
<td>20.00</td>
<td>10.66</td>
<td>0.12</td>
</tr>
<tr>
<td>23.00</td>
<td>10.84</td>
<td>0.00</td>
</tr>
<tr>
<td>25.00</td>
<td>10.76</td>
<td>-0.08</td>
</tr>
<tr>
<td>30.00</td>
<td>9.86</td>
<td>-0.28</td>
</tr>
<tr>
<td>35.00</td>
<td>7.96</td>
<td>-0.48</td>
</tr>
<tr>
<td>40.00</td>
<td>5.06</td>
<td>-0.68</td>
</tr>
</tbody>
</table>

A perusal of Table No.6.6 shows the fact that the total product of banana gets a gradual increase at a diminishing rate with an increase in the cost of cultivation until the reach of Rupees 23 thousand and
after that level the total product starts declining and goes on diminishing at an increasing rate. But, the marginal product (MP) is diminishing at a uniform rate until the use of Rupees 23 thousand as cost and the MP is zero at this level. And after this level of input cost, the marginal product will become negative.

From the above analysis, it is concluded that a farmer may spent Rupees 2.12 for producing 1 kg. of banana. And, if he spends one rupee as additional cost, he would reap 472 gms. of banana as additional product until the reach of maximum product.

On the basis of the above analysis the following findings are drawn:

1. All the selected banana varieties except Kadali have yielded less than the forecast estimate of average yield in Tirunelveli Kattabomman district. This is not due to the efficiency in Kadali cultivation but due to the big size of Kadali bunch, number of hands in the bunch and the number of fruits in the hands. As the gross revenue and net revenue accrued from this variety is comparatively lower than those accrued from the remaining
varieties, the cultivation of Kadali is not strongly recommended on the basis of per hectare yield. The farmers cultivating the varieties except Kadali must try to utilise the available resources and known technology optimally to reach the forecast yield in order to narrow down the yield gap.

ii. Considering the mean yield of different size-groups of farm, the farms in Group-I have negative but narrow yield gap. In Group-II the yield gap is negative but wide and in Group-III the gap is negative and wider.

Group-II should be advised to utilise the inputs rationally and Group-III, to make use of required inputs to increase the yield and to reduce the yield gap.

iii. The mean yield gap between the best farmers and backward farmers is statistically significant. Backward farmers should be advised to use adequate input resources and available technology to increase their yield in order to reach the yield of best farmers.
iv. In the agro-biological factors severity of diseases and wind are the foremost and important factors playing a major role in limiting banana production.

v. Higher cost of manures and fertilizers and higher propping cost are important among the economic and institutional factors which limit the banana production in the study area.

vi. On an average, a banana grower spends Rupees 2.12 for producing 1 kg. of banana.