4.1 GENERAL

The hosiery industry in India has shown significant growth, especially in the recent years - not only in the production but also in sophistication of the production technology and export of its products. In the industry, Tiruppur had a place of pride, with a significantly large share in the market of hosiery product. It is characterized by the wide variation in the size of the enterprises and the types of technology from slow hand knitting small units to large amounted units. While the large units are successful in placing hundles for the entry of similar sophisticated units, small units with their low productive, labour intensive technology show significant growth in number and market share. Consequently, the market for hosiery products of Tiruppur has the characteristics of differentiated digopoly. For majority of the small enterprises their success in business demands careful decision making on size and composition of production, use of capital and labour at optimal level and combination. To them mathematical programming appears to be a useful tool for decision making because it allows for several constraints and specified goal. However, the conventional Linear programming (LP) model is inadequate when the goal of the enterprise is not unique: a maximizing or minimizing objective function. Even small hosiery units are observed to operate with multiple goals. A modification of LP is possible and it is the Goal-Programming (GP) model that allows multiple goals and multiple constraints yet remains simple to use an iterative procedure
of the simplex method. This study is interested to evaluate and demonstrate the use of the Goal Programming, decision-making by non-automated hosiery enterprises and to evaluate the performance of the industry in Tiruppur.

**Objectives:**

The overall objectives of the study are

(i) to prepare optimal production plans, size wise with the help of the multi-criteria programming models and to show the scope for progress of the firms,

(ii) to test the usefulness of fuzzy in MCDM paradigm

(iii) to use the WGP with the help of AHP

(iv) to suggest the best method in this for MCDM

4.2 **DATA**

In Tiruppur, there are more than 6000 units. After conducting a pilot study, data are collected from 150 firms, selected by simple random sampling method from the list of all firms arranged in the ascending order of installed capacity. The required informations were obtained from the records maintained in the selected firms and further supplemented by personal enquiry with the administrative heads of the units. Secondary data are also collected from the publications of the Association of Tiruppur Knitwear products for time series analysis of growth and instability and export. Thus both the primary and secondary data were found to be useful in the analysis. The sample firms were kept in the ascending order of their installed capacity and classified into three size groups A, B, C. The group comprised of the first 50 firms in the above list constituted the group A, and
represents the small units. The next 50 firms constituted the group B, represented medium size and the remaining 50 firms constituted group C represents the large firms. The groups were tested for the statistical difference among them in the size of the installed capacity. The differences were all statistically significant and hence, the groups were studied separately.

4.3 THE MODEL

The major thrust of this study was to help the hosiery firms in identifying the product mix that would satisfy their organization goals. All the firms produced more than three varieties of products and their goals were not unique. Hence, the decisions were to be made in multi-product and multigoal context, with constraints in resource supply and market conditions. Necessarily, it was a normative analysis.

There are two mathematical programming approaches to tackle the problem with multiple objectives of goals, viz (i) GP Goal programming and (ii) MOP Multi objectives programming. The focus of this study suggested the choice to Goal Programming. The aim of the Goal Programming (GP) is to minimize the deviations between the achievements (realization) of the goals and their aspiration levels. The goals are included in the model by adding positive($n_i$) and negative($p_j$) deviation variables to the goal equations. They allow for the under achievement and over-achievement of the goals respectively. It was first assumed and then verified in the field that the hosiery firms can explicitly define all the goals that are relevant to a planning situation. Further, it assumes not only that they can attach priorities to those goals but also in a pre-emptive fashion. In other words, the fulfillment of the goals in a specific priority, $Q_j$ is
immeasurably preferable to the fulfillment of any other set of goals situated in a lower priority, \( Q_j \). In LGP, higher priority goals are satisfied first—it is only then that lower priorities are considered. It is the model used.

Application of LGP is done for representative firms, one for each of the three groups A, B, C earlier described. The representative firm is one that has installed capacity closely equal to the mean installed capacity of the fifty firms in the groups. A comparative study of the solutions of the three representative firms would show the differences if any, between firms of different size (installed capacity) and that information would be useful to know the size of effect on business performance. The goals were:

1. Maximizing profit after tax
2. Minimising use of borrowed fund
3. Minimising use of labour

4.4 FINDINGS

The hosiery industry of Tiruppur has grown in number from 3,096 in 1981 to 4,830 in 1985 a significant addition of 57.38 percent. Though the absolute number is steadily increasing and had reached 6,510 in 2005 and to 7012 in 2010, the percentage addition during the successive five-year period is falling. The time series aggregate data shows faster growth of installed capacity than that of the number of enterprises. Thus, the growth of the industry is from the increase in both number of units and their average installed capacity. The value of capital use refers to the operation and maintenance \((0 \text{ and } m)\) costs and also the book value of machines used up (ie) depreciation.
This includes cost of raw material, energy and value of fixed assets used in production. This value has increased from Rs.57.53 crores in 1981 to Rs.690.10 crores in 2005 and to Rs.895.23 crores in 2010. There has been a steady increase in percentage additions the largest being seen during the Eighth plan. The production of hosiery industry requires the use of human labour of various skills. The total number of persons of all categories in roll at the beginning of each year is taken as a measure of employment of labour. By the end of the fourth plan, the hosiery industry of Tiruppur provided employment to 51,120 persons and the employment increased both in absolute and percentage terms in all the five years period, to reach more than 8.5 lakhs in 2010. Thus the hosiery production is labour intensive and any investment in it would contribute to the employment objective also.

Technological progress is measured by the degree of modernization of machines. Hence, the percentage of value of recent investment (less than five years) to the total of the capital stock is taken as a measure of technological progress. There is a steady up-trend in technological progress and more significantly after the Eighth plan period. This explains larger increase in capital use than labour use during that period. There was growth not only in absolute value but also in the rate of growth, so that the value of production (Rs.2014.73 crores) in constant prices was more than 10 times of the values in 1980. As the price variation has been excluded by the use of (1980-81) constant prices the significant growth is a measure of a real output.

The export value at Rs.27.28 crores in 1981 rose to Rs.326.46 crores in 2005 and to 463.87 crores in 2010, all valued at constant (1990-81) prices and in Indian rupee
value. Thus, export has provided an incentive for production. However, the domestic market also is no less important, because it absorbs nearly 80 percentage of the growing production.

Thus, the performance of the hosiery industry is rated high in terms of the number of enterprises, capacity expansion, capital investment, employment of human labour, technological progress, production, export and domestic sales. The substantial increase in the production is more due to capacity expansion than the increase in the number of enterprise. The hosiery industry has responded to the policy stimuli of NEP favourably and successfully with gains to itself and to the country. Its employment benefit is felt locally. Further, the temporal variation in production and also in the export of hosiery products of Tiruppur is secular rather than cyclical. Absence of cyclical variation does not however ensure stability in variables because random or irregular variation may be large.

The instability in production and export of hosiery industry of Tiruppur was studied with the help of Cuddy and Valle Index, separately for the period 1981-95, 1996-2005 and 2006-2010. It is seen that instability in both production and export is larger in the second period than in the first and third periods where as the export shows increases with increasing time, (ie) it is highest in 2006-2010. Thus, the new economic policy has helped in achieving larger instability.

The modernization of production through technological progress and the policy support of NEP have significantly contributed to the rise in capital productivity in hosiery industry of Tiruppur and compound growth rate in it works out to 2.64 percent annum.
Similar results were seen in labour productivity also from Rs.6,510 per person in 1981 to Rs.19250 per person and is Rs.22,427 per person in 2005 and 2010 respectively; all at constant (1980-’81) prices.

Aggregate industry wide production function was studied. It shows that the hosiery industry of Tiruppur has good scope for a more intensive production. The pace of technological progress observed in the industry may help the cause. Hence the future scope of hosiery in Tiruppur is vast.

The result of production function analysis of primary data reveal much scope for improving economic efficiency in resource use. A comparative study of the performance of hosiery units of different sizes among themselves and with the performance of the industry as a whole shows that in every group and for the industry as a whole, the capital is used less than optimally. In labour use, a large scope is seen for the industry as a whole but little scope in small and medium size hosiery enterprises. There is an increasing return to scale in medium and large groups and the industry as a whole, but there are constant returns to scale in small units.

The results of the LGP show that the small units gain by specializing in production of banians (X₂) with limited diversification to children wear (X₈) ladies Nightee (X₁) and T-shirts for male (X₆). The medium sized hosiery units should pay attention to sales promotion to achieve units of at least 40,000 pieces. In large units, there is scope for further expansion of production. But it would require sales promotion, as at present sales limit production and capacity utilization is not full.
The performance efficiency of the hosiery units in three size groups was compared with four specific measures viz., (a) capital productivity (b) labour productivity (c) capacity utilization and (d) the sales realization. It is seen that for the small hosiery units optimal plan has largest values of capital and labour productivity and better capacity utilization and sales realization but the capital labour ratio is marginally smaller. It means that optimal plan specifies the goals set by the hosiery unit and priority ordering in them and improve performance efficiency of the unit, even while reducing capital intensity.

For the medium sized units, capital productivity ($\pi/K$), labour productivity ($\pi/L$), and factor intensity ($K/L$) increased from existing plan to plan 3. The inference is that, by increasing the sales potential medium sized hosiery units could steadily improve their performance efficiency. However, capacity utilization and sales realization were less. For large units, capital productivity and labour productivity declined, but the factor intensity, capacity utilization improved significantly.

A comparative study of the three size groups shows that optimal plans presented opportunities to improve performance efficiency in all the groups but the gain was larger, larger the size of the units. This was in agreement with increasing returns to scale for medium and large units and constant returns to scale to small units.

An opinion survey of the sample respondents showed that 49.17 percent of the respondents readily accepted the plans as useful to them without any reservation while 39.17 percent of them accepted with condition. The conditions related to adminitative problems only. Hence it may be concluded that the LGP model is really usable by the
hosiery units. Studied size groups wise acceptance rate was highest in the large units, followed by small units and medium units in the order. Hence, the LGP model can be successfully used for decision making with multiple goals and defined priority ordering of them.

4.4.1 Comparative statement of results from all the three methods.

The final optimal results obtained from LGP, Fuzzy GP and the one through AHP GP are presented below in Tables 4.1

Table 4.1

Comparative statements for the small size Firms

(a) Small size hosiery units

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Variable Name</th>
<th>Symbol used</th>
<th>G.P</th>
<th>Fuzzy GP</th>
<th>AHP GP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>One piece ladies nightees</td>
<td>X₁</td>
<td>6,422</td>
<td>6,800</td>
<td>6,856</td>
</tr>
<tr>
<td>2</td>
<td>Banians</td>
<td>X₂</td>
<td>22,500</td>
<td>22,518</td>
<td>22,762</td>
</tr>
<tr>
<td>3</td>
<td>Folding neck, front 3 shades in black T-Shirt for males</td>
<td>X₆</td>
<td>928</td>
<td>922</td>
<td>986</td>
</tr>
<tr>
<td>4</td>
<td>Neutral top and bottom printed children’s wear</td>
<td>X₈</td>
<td>14,970</td>
<td>15,084</td>
<td>15,142</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>44,820</td>
<td>45,324</td>
<td>45,746</td>
</tr>
</tbody>
</table>
(b) **Medium size hosiery units**

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Variable Name</th>
<th>Symbol used</th>
<th>G.P</th>
<th>Fuzzy GP</th>
<th>AHP GP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>One piece ladies nightees</td>
<td>X&lt;sub&gt;1&lt;/sub&gt;</td>
<td>12,060</td>
<td>12,496</td>
<td>13,112</td>
</tr>
<tr>
<td>2</td>
<td>Banians</td>
<td>X&lt;sub&gt;2&lt;/sub&gt;</td>
<td>45,620</td>
<td>44,826</td>
<td>46,314</td>
</tr>
<tr>
<td>3</td>
<td>Chest printed T-Shirts for ladies</td>
<td>X&lt;sub&gt;4&lt;/sub&gt;</td>
<td>8,020</td>
<td>8,470</td>
<td>8,643</td>
</tr>
<tr>
<td>4</td>
<td>Neutral top &amp; bottom printed children’s wear</td>
<td>X&lt;sub&gt;8&lt;/sub&gt;</td>
<td>7,200</td>
<td>7,366</td>
<td>7,465</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td>72,900</td>
<td>73,158</td>
<td>75,534</td>
</tr>
</tbody>
</table>

(c) **Large size hosiery units**

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Variable Name</th>
<th>Symbol used</th>
<th>G.P</th>
<th>Fuzzy GP</th>
<th>AHP GP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Banians</td>
<td>X&lt;sub&gt;2&lt;/sub&gt;</td>
<td>1,24,668</td>
<td>1,25,470</td>
<td>1,25,741</td>
</tr>
<tr>
<td>2</td>
<td>White rib neck, chest printed T-Shirts</td>
<td>X&lt;sub&gt;5&lt;/sub&gt;</td>
<td>21,230</td>
<td>22,432</td>
<td>22,664</td>
</tr>
<tr>
<td>3</td>
<td>Rib-nect T-Shirts for males</td>
<td>X&lt;sub&gt;7&lt;/sub&gt;</td>
<td>54,102</td>
<td>52,098</td>
<td>51,595</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td>2,00,000</td>
<td>2,00,000</td>
<td>2,00,000</td>
</tr>
</tbody>
</table>

A comparative study shows that in all the size groups there is a steady increase in the number of units in the final solution from ordinary GP to Fuzzy GP to AHP GP.

Thus the study helps us to accept the Null hypothesis that the AHP GP is an improvement over the other two irrespective of the size groups.