CHAPTER I

INTRODUCTION

The future of our country lies in the growth of the agricultural sector that ultimately boosts the industrial sector. Nature has bestowed humans with an abundant supply of resources with the help of which they have created the modern world and introduced many valuable things based on these resources for the benefit of mankind. One such unique renewable resource of nature is rubber. Today, a number of rubber products are being produced and utilised in various fields. In the words of Ralph Wolf,

"Civilization as we know it today is wholly dependent on rubber. It is a material that is myriad to uses totally unlike anything the world has previously known. It enters in a thousand ways into the fabric of our daily lives. It is indispensable in transportation, in communication, in cushioning of our bodies and protecting our senses from the fairs and jolts, the noise and tumult of model life. It is a servant that follows, literally from the cradle to the graves."

This is the introductory chapter and as such deals with a brief history of rubber and rubber industry in the world, first. It is followed by a description of the problem of analysis, the objectives of the research reported here, the procedures adopted in the study, and the organisation of the thesis. This chapter also gives a brief description of rubber and rubber industry in retrospect.

A Brief History of Rubber

The caoutchouc aroused little curiosity among the Spaniards when there were no obvious uses for it. Being conquistadores more than colonists, they had shown no scientific curiosity about anything. They were interested in
gold, silver, pearls and souls for Christianity or tobacco, maize, turkey and Indian slaves. It was no wonder then that they had not shown any when they first encountered a ball made of ‘rubber’, which Columbus brought with him on his return from the Indies. This was in fact something the Haitians used in their games.  *Caoutchouc*, which was rubber that came from the Spanish and Portuguese colonies in the Americas, remained for the next two centuries an object of idle curiosity.

It was in 1736, the French mathematician La Condamine went to Brazil and returned to inform about its other uses and about the tall tree from which the Indians extracted it as milky liquid. It was Dr. Joseph Priestly of Birmingham who found that lumps of *caoutchouc* could be used to erase pencil marks. It was then that the substance came to be called ‘rubber’ because it was by rubbing it across a sheet of paper that pencil marks could be erased. Yet another use was found for rubber in the meantime, namely, as a handle for surgeon’s instruments. A third use was found for rubber, to use it in a textile factory to manufacture coated cloth. The Indians had produced waterproof cloaks in this way.

It was the handiwork of Charles Macintosh and his partner Thomas Hancock who developed the processes that first turned rubber into an industrial raw material. It was Macintosh, who shared with Lord Cardigan, the Duke of Wellington the distinction of having an article of clothing named after him. But Hancock was interested in finding more direct uses of rubber. He found, by accident, a way of shaping rubber. Then came Charles Goodyear, an American, who began to experiment with rubber, in the 1830s, with methods of reducing rubber’s reaction to temperature changes.
Small rubber industries had, by this time, become established in the industrialised countries. Goodyear then evolved the idea that if rubber could be combined with sulphur, the desired effect would result. He found it again by an accident in his kitchen, while talking about his idea. He improved the product later by adding a little lead and the product he made he called ‘fireproof gum’. This he later renamed as ‘vulcanised rubber’, after Vulcan, the Roman god of fire. Rubber only brought him misfortune and Goodyear spent long periods in a debtor’s goal, until his death in 1860.

By the end of the nineteenth century, rubber was a material that manufacturers could work with and its uses were multiplying. With the advent of steam power, there was a rapidly growing demand for rubber-coated drive belting. Macadamised roads led to increase in transport and rubber tyres were found to give a better ride than metal ones. The rise in popularity of the bicycle in the last two decades of the century made pneumatic tyres a necessity. J.B. Dunlop developed his version of them, with marked success, in 1888. Finally, the horseless carriage or motor car was gradually being developed into a serious form of transport. From then on, motor cars were to determine the fortunes of the rubber industry. Before the turn of the century, the United States was to become the centre of the motor car industry. Harvey S. Firestone of Detroit, the first to ever ride a buggy on pneumatic tyre, started a factory in 1895 to produce car tyres. His friendship with a car manufacturer, Henry Ford, led to the enormous increase in the demand for rubber.

Where was the increased supply of rubber to come from, in the early years of the twentieth century? Brazil was the first choice, though a certain amount of wild rubber also came from the Gold Coast, Nigeria and the Congo. Brazil doubled her export of rubber between 1890 and 1900. There
were, however, definite limits to any further expansion. There was, in Britain, a growing awareness during the later years of the nineteenth century that *Hevea brasiliensis* was the most productive of all sources of rubber. It was also known that the tree would flourish only in certain well-defined areas of the tropics, 10 degrees north and south of the Equator. Soil type was not a deciding factor but rainfall was. It would only succeed in areas where the rainfall amounted to 100 inches (more than 2,200 mm) per annum. This meant that it was confined to Southeast Asia and some areas of western Africa. For the Colonial Office, rubber would grow in several of the tropical colonies, including Ceylon, Borneo and Malaya as well as Nigeria and Sierra Leone.

But rubber was a Brazilian monopoly and it was illegal to take the seeds out of the country. And H.A. Wickham, the explorer and plant collector, smuggled 70,000 seeds out of Brazil in 1876. The Government was willing to allow them to be planted out in Kew Garden. Only 4 per cent of them germinated and this was enough to allow a large batch of seedlings to be sent to Ceylon (now Sri Lanka) and a few to Singapore. None of those sent to Singapore survived. But 22 seedlings sent out and planted in the Residency garden at Kuala Kangsar in Perak did. The rubber plantation in Malaysia owes its existence to those seedlings.

The seedlings did well in Ceylon and the young trees were eventually distributed to various plantations, for growing on as seed bearers and for testing rubber production in trial plots. The Ceylon planters were willing to experiment with alternative crops to tea, but was also engaged in replacing coffee plantations with tea. Tea showed every sign of succeeding. Rubber was also tried with other crops such as cinchona. Some plantations inter-planted it with tea, hoping to establish it as a shade crop. But as tea did too well for any
alternative crop, Ceylon never developed an extensive rubber plantation industry.

In the early years of the twentieth century, the early plantings in Ceylon and Malaya were coming into full bearing. The demand for rubber, especially from America, was growing. Its price went up and the London Rubber Market was beginning to prefer plantation rubber to wild rubber. The one consequence of the boom was that rubber plantations, even more than tea estates, began to attract the investor. The fact that the American car manufacturers were doubling their car production every two years and their sales increased from 34,000 in 1906 to 187,000 in 1910. The price of rubber could only continue to increase until such time as new plantations coming into production outstripped demand and glutted the market.

The story of *Hevea Brasiliensis* is essentially the story of rubber. The use of rubber has evidently been well established by the Incas of Peru, the Aztecs of Mexico and the Maya of Central and South America even before the discovery of America by Columbus. The early explorers of the new continent recovered protective garments and other coverings, balls for playing games, bottles and syringes. After the voyage, Columbus brought back from Haiti, bouncing balls of rubber with which the natives used to play some primitive games on specially paved courts. Later, Portuguese explorers found Amazonian inhabitants waterproofing their hats, clothes and shoes with rubber latex; and other explorers observed Mexican Indians chewing the hardened latex of guayule shrub.

Not much progress was made during the sixteenth and the seventeenth centuries that are regarded as periods of incubation in the history of rubber. The rubber articles brought back to Europe by Columbus and other explorers
remained as curiosities as the knowledge concerning these valuable plant products was rather scanty. Only a few latex yielding plants were known at that time.

In 1736, a French astronomer and physician, M. de la Condamine dispatched to France samples of the mysterious plant, ‘Caoutchouc’ (a French rendition of the Caribbean word ‘Cahuchu’, meaning weeping tree) with a complete description of the tree, methods of collection and processing which created an ever increasing demand for it. The sample was obtained from a local tree called heve. This vernacular name was later used by Aublet to give the genetic name Hevea.

In 1755, Don Jose of Portugal, who heard of the wonderful waterproofing material used by the American Indians, sent several pairs of his boots with a royal expedition to Para, Brazil, in order to get them coated with this gum. It is reported that the native people of Penang, Malaya used to carry their water and food in vessels and bags made from the hardened latex, in the late eighteenth century.

The year 1770 is memorable in the history of rubber because an English chemist, Joseph Priestly, reported the ability of the hardened latex (caoutchouc) to erase lead pencil marks on paper and since then it still tips millions of lead pencils. Because of the property of caoutchouc to rub off pencil lines, it came to be known as ‘rubber’. By 1780, a great number of erasers were on sale in London shops.

Rapid progress was made in the nineteenth century and quite a large number of botanical sources of rubber were unearthed. Charles Macintosh, a Scotsman, discovered in 1823, that rubber could be dissolved in the solvent naphtha, which offered a new way for producing waterproof articles, such as
raincoats. He established a factory in Manchester and became the founder of the raincoat industry. Another significant achievement in the nineteenth century was the development of *vulcanization* by an American rubber manufacturer, Charles Goodyear, in 1839, which revolutionised the rubber industry overnight.

Factories for the manufacture of rubber articles began to spring up in the principal industrial countries. Solid rubber tyres were first used on road vehicles in 1867.

At the beginning of the twentieth century, the world’s supply of natural rubber came almost entirely from Brazil and as such the plant was shipped into England. Later on, the plant was brought to Malaya, Indonesia and Ceylon and then to India.

The Rubber Plantation Industry in South East Asia dated back to 1876. In India, rubber plantations were first started in Kerala State in 1905. Since then many other areas have been brought under rubber cultivation.

The World War II provided a stimulus to the synthetic rubber industry. Synthetic rubber equalled natural rubber in world output in the early 1960s and moved ahead of natural rubber, thereafter. Despite the competition from synthetic rubber, the natural rubber continues to occupy an important place where *elasticity, resilience and tackiness* are required (Unny, Haridasan, Burger, Smit and Zant, 1995).

**Rubber and Rubber Industry in India: In Retrospect**

The Indian rubber sector has registered a substantial slow down in the demand sector in the last two or three years. Although the production sector
of natural (NR) remained more or less unaffected during 1997-98, the continued slump in the market affected the industry very much during 1998-99. Owing primarily to the mismatch between the demand and the supply, for the first time after the 1970s, a surplus was generated in the market during 1997-98 and it depressed the prices of rubber. The year 1998-99 did not see any change in the situation (Lalithakumari, 1999). 

**Area and Production of Rubber.** There has been a sustained effort at increasing the area under rubber in the last few years. This has resulted in an area of cultivation of rubber on 553,000 ha during 1998-99 and it was 533,000 ha during 1996-97 and increased to 545,000 ha during 1997-98. Increase in cash subsidy for new planting and replanting from Rs. 8,000 to Rs. 18,000 per hectare in traditional regions, and to Rs. 20,000 per hectare in non-traditional regions, during 1997-98 and the effective grassroots extension network of the Rubber Board have been the key factors which helped to sustain the process of area extension despite adverse conditions prevailing in the natural rubber market.

India produced 583,830 tonnes of NR during 1997-98 and 605,045 tonnes during 1998-99. While the growth rate was 8.4 per cent in the year 1996-97, it was only 6.3 per cent during 1997-98 and it declined further to 3.6 per cent in 1998-99 (see Unny and others, 1995, for history, analysis and policy perspectives in the Indian rubber economy). The continuance of the unfavourable conditions prevailing in the market dissuaded the dominant small holders from adopting short-term and yield enhancing measures. The production was affected by the adverse climatic conditions of 1998-99 in the major rubber growing areas of the country during the year. As a result, the average yield during 1998-99 increased only marginally: from 1,549 kg during 1997-98 to 1,563 kg during 1998-99.
The production of synthetic rubber (SR) increased to 71,993 tonnes during 1997-98 from 64,563 tonnes over the previous year. However, 1998-99 witnessed a dip in the production, reaching only 67,590 tonnes and the decline was primarily in Styrene Butadiene Rubber (SBR).

Consumption of NR and SR. The total consumption of NR was 571,820 tonnes during 1997-98 and 591,545 tonnes during 1998-99. Against the demand growth of 8.2 per cent during 1995-96 and 6.9 per cent during 1996-97, the growth was only 1.8 per cent during 1997-98 and 3.4 per cent during 1998-99. The continued lackluster performance of the demand sector was attributable to the slow down in the country's industrial sector and slackness in the automobile industry, the dominant NR consuming sector in India. The consumption of the NR by the industries manufacturing automotive tyres and tubes registered a negative growth of 2.4 per cent during 1997-98. The situation marginally improved during 1998-99 and the NR consumption in the automobile tyre-manufacturing sector increased by 1.2 per cent during the year.

The consumption of SR, which registered an increase of 12.7 per cent during 1997-98 declined by 2.8 per cent during 1998-99. The consumption was 160,915 tonnes during 1997-98 and 156,395 tonnes during 1998-99. The relative use of natural and synthetic rubber by the Indian rubber goods manufacturing industry did not undergo any significant change during the last two years. The composition of the use of NR and SR by the industry was 78:22 during 1997-98 and 79:21 during 1998-99.

Prices. The slump in the demand sector, referred to earlier, resulted in excess supply of NR during 1997-98 and 1998-99. The surplus and the influence of the downtrend prevailed in the international market. NR market
in the country drifted from the end of 1996 and the trend continued unabated throughout, during 1997-98 and 1998-99. The price of RSS-4 grade, which averaged at Rs. 4,901 per 100 kg during 1996-97 declined to Rs. 3,580 in 1997-98 and it fell further to Rs. 2,994 per 100 kg during 1998-99. The trend in the prices from April 1997 to March 1999 was more or less in tandem with the international prices.

As a strategy to save the situation or the receding movement in the domestic market, the Government of India intervened in the market from August 1997 by procuring about 9,600 tonnes of NR. But as there was a further fall in the prices, in May 1998, the Government made arrangements to procure an additional quantity of 20,000 tonnes and the actual procurement up to the end of March 1999 was 11,500 tonnes. Further, in September 1998, Government of India revised the benchmark price of RSS-4 grade of NR from Rs. 2,490 per 100 kg to Rs. 3,405 and that of RSS-5 from Rs. 2,440 to Rs. 3,355. Apart from these short-term measures, a few long-term measures have also been initiated to resolve the crisis. These include the initiatives to popularise road rubberisation in the country and to promote the export of NR by providing incentives and assistance for quality improvement. The production and consumption of NR and SR since 1995-96 is shown in Table 1.1 below (Charts 1.1a and 1.1b).

Table 1.1: Production and Consumption of NR and SR

<table>
<thead>
<tr>
<th>Year</th>
<th>Production in '000 tonnes</th>
<th>Consumption in '000 tonnes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NR</td>
<td>SR</td>
</tr>
<tr>
<td>1995-96</td>
<td>506.9</td>
<td>68.2</td>
</tr>
<tr>
<td>1996-97</td>
<td>549.4</td>
<td>64.6</td>
</tr>
<tr>
<td>1997-98</td>
<td>583.8</td>
<td>72.0</td>
</tr>
<tr>
<td>1998-99</td>
<td>605.0</td>
<td>67.6</td>
</tr>
</tbody>
</table>

Source: Statistics and Planning Department, Kottayam 1999.
Chart 1.1a: Production and Consumption of Natural and Synthetic Rubber in India
Imports and Exports. According to the EXIM Policy of the Government of India, for the period April 1997 to March 2002, NR is a 'restricted item' in the 'negative list' of imports. The import of NR however is allowed only against a license in accordance with a Public Notice. The policy allows exporters of rubber products to import NR against what they call Quantity Based Advance License or Special Import License (SIL). As there was excess availability of NR in the national market, the Government of India did not allow the import of NR against Public Notice during 1997-98 and 1998-99. But the manufacturers imported NR using SIL, entitled as incentives for their export of manufactured goods. The total quantity imported under the scheme was 32,070 tonnes during 1997-98 and 26,413 tonnes during 1998-99. However, as a measure to check the excess availability of NR in the country, the Government of India banned its imports against SIL with effect from February 20, 1999. As an alternate arrangement, the exporters of rubber goods were allowed to purchase locally procured rubber from the State Trading Corporation of India, at the international prices after surrendering import license. Though there is no restriction on the export of NR since April 1992, the export continues to be nominal. The export was 1,415 tonnes during 1997-98 and 1,840 tonnes during 1998-99.

Global Scenario in Rubber and Rubber Industry

It is necessary to look at the global scenario of NR and SR in the light of the Indian situation briefly outlined above. Global production of NR registered an increase of 5.5 per cent during 1996. In the following years however the growth was dismal at 0.2 per cent during 1997 and 4.7 per cent during 1998. The production was 6.38 million tonnes during 1997 and 6.68 million tonnes during 1998. Thailand accounted for as much as 33 per cent of
Chart 1.1b: Growth Rates of Natural and Synthetic Rubber in India
the global output in 1998, and continues to be the largest producer of the world. Indonesia, Malaysia and India were the other three major producers, sharing respectively 26.2 per cent, 13.3 per cent and 8.9 per cent of the global output of NR during 1998 (Barlow, 1978).4

The global consumption of NR was 6.51 million tonnes during 1997 and 6.61 million tonnes during 1998. The growth attained was 5.9 per cent during 1997 and 1.5 per cent during 1998. In respect of the data for the year 1998, the first four major consumers of NR in the world are the USA, China, Japan and India. The relative shares of the consumption of NR during 1998 were 17.5 per cent for the USA, 12.7 per cent for China, 10.7 per cent for Japan, and 8.8 per cent for India.

During 1997, the total consumption of elastomers (that is, of NR and SR) in the world was composed of 39.5 per cent NR and 60.5 per cent SR. During 1998, NR shared 40.2 per cent of the global elastomer consumption. The economic crisis of the Asia-Pacific region adversely affected the global consumption of elastomers. The growth in the consumption declined from 4.6 per cent in 1997 to –0.1 per cent in 1998. The total elastomer consumption was 16.47 million tonnes during 1997 and 16.46 million tonnes during 1998. Table 1.2 summarises the performance of the world rubber economy during the period 1995-1998 (Charts 1.2a and 1.2b).

### Table 1.2: Global Production and Consumption of NR and SR

<table>
<thead>
<tr>
<th>Year</th>
<th>Production (million tonnes)</th>
<th>Consumption (million tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NR</td>
<td>SR</td>
</tr>
<tr>
<td>1998</td>
<td>6.68</td>
<td>9.89</td>
</tr>
</tbody>
</table>

Source: Statistics and Planning Department, Kottayam 1999.
As the local currencies of the crisis-hit Asian countries were substantially devalued, despite a continued decline in the world market in dollar terms, no proportional decline was observed in the prices expressed in the local currencies. The Daily Market Indicator Price (DMIP) used for the operation of buffer stock scheme existing under the third International Rubber Agreement (INRA) 1995 is calculated on the basis of Malaysian and Singapore currencies. As a result, despite a considerable price decline in dollar terms, the DMIP was within the neutral zone and producing countries in the INRA became increasingly unhappy with the fruitfulness of the Agreement. Malaysia, the third largest producer of NR, had given notice of its withdrawal from the INRA in October 1998. This was followed by a similar move by Thailand, the world's largest NR producer, in February 1999. Indonesia, the second largest producer, is planning to stay in INRA. Yet it is unlikely for the organisation to exist without Thailand, which supplies about 40 per cent of the INRA countries. Even if INRA 1995 survives till its scheduled termination date of early 2001, its extension or replacement by a fourth agreement now looks increasingly unlikely.

This is the national and global backdrop against which the present thesis is set and in respect of rubber and rubber industry in Kanyakumari district of Tamil Nadu, which is a traditional area of rubber production.

The Problem of Analysis

Innovative and exploratory research calls for a statement of the problem of study on the industry considered for study. Although the district accounts for more than 90 per cent of latex production in the State of Tamil Nadu, the industries in operation are not producing useful rubber products such as automobile tyres, rubber bushes or numerous other industrial
Chart 1.2b: Growth Rates of Global Production and Consumption of Natural and Synthetic Rubber
accessories as expected from such an industry. The trend in rubber production disproves the basic principles governing the localization of industries. Unless efforts are made to overcome factors impeding the growth of such industries in the district, there is no gainsaying the fact that the growth of the rubber plantations would be in peril, in the days ahead. So this study would focus on this concern of industrial development and identify the factors responsible for non-proliferation of industries manufacturing rubber products. The study would also assess, at the same time, the potential for a steady and abundant supply of latex, which constitutes the major raw material for these products.

The Objectives of the Study

The objectives of the study are:

1. To examine the nature and extent of rubber plantations and subject data pertaining to growth and development of natural rubber, synthetic rubber and reclaim rubber to a simple statistical investigation of the potentials of latex supply in Kanyakumari district;

2. To explore the possibilities for opening up new avenues for the rubber industry in Kanyakumari district, given an understanding of the extent of rubber cultivation and volume of production over the years;

3. To examine the socio-economic characteristics of the plantation and industry owners and managers and the plantation and industrial workers in Kanyakumari district to understand the household economic behaviour of the population studied; and

4. To determine ways and means to get over the problems the estates, industries, workers in them face in their day-to-day operations and to put the rubber industry on rail in the years ahead.
The Methodology

The study is based on both primary and secondary data collection. The primary data are collected using an interview schedule of questions, pre-tested, and reformulated for the purpose of interviews with (a) rubber plantation and industrial workers, and (b) rubber industrialists or industry managers. The sample chosen could only be small, as there are only a small number of workers in a small number of industries. The sample size is 125 for industrial workers and 18 for industry managers or industrialists. In most cases, the industry owners were not available for interviews and so only industry managers could be contacted and interviewed.

The study calls for use of simple statistical techniques, which could help with the explanation of the industry and the production of raw materials (latex, for example) for the industry. They could also provide for different perspectives on the nature of the subject of study. The techniques used are the multiple and stepwise regressions.

Other exploratory techniques, such as frequency and percentage analysis, would be used mostly to study the potentials of growth for the rubber industry in Kanyakumari district and to portray the genesis of some of the deep-rooted problems of the industry. The study is done to determine the ways and means by which the rubber industry in the district can resolve its technical and institutional problems and emerge as the promising and prominent industry in the district:

a. A historic study of the rubber plantations and the growth of latex production in the district ever since the State re-organisation in 1956;
b. A diagnostic study of the basic factors hampering the growth of industries manufacturing rubber products; and

c. A study of the rubber industry in the district, in the absence of measures fostering the growth of the industries manufacturing rubber products in the district.

The primary data are collected using the random sampling technique, in which every willing industrial worker was interviewed. Their number is kept to the minimum so that the industrial workers from some select units in select locations could be interviewed. The secondary data on the other hand have been collected from standard research journals, research monographs and periodicals and publications of the Rubber Board of India, as these are the only reliable sources of information.

The study requires the use of the following and useful statistical techniques. They could be stated as follows:

a. A trend analysis of the growth of the rubber plantations and latex production in the district, using a simple regression and correlation technique; and

b. The fitting of an econometric model of relationships, namely, multiple regression scheme, including the use of a multiple step-wise regression.

The study addresses the following:
a. The ways and means by which Kanyakumari district could be rendered a centre for manufacturing of the major rubber products.

b. Further growth of rubber plantations and the consequent growth of latex production in the district.

c. The path of progress for the rubber industry not only in Kanyakumari district but also in the region in the years ahead.

Techniques of Analysis

The two methods of analysis we use in the study are multiple regression and stepwise multiple regression. The stepwise is to understand the importance of the individual terms that are entered in the analysis. The data however are from the field survey conducted for the purpose. The variables have been item selected for the purpose of analysing the relationships between income and expenditure, which give us an understanding of the intra-household economic behaviour.

The two methods used here are from the group of statistical techniques known as the Multivariate General Linear Hypothesis (MGLH). It can estimate and test any multivariate general linear model including those for multiple regression, analysis of variance and co-variance, and other multivariate procedures. These procedures are minor variants of a single mathematical model (Wilkinson, 1990:115). The intent here is to do more with the field data than draw a line on a picture.

Multiple Regression Analysis

Multiple regression is an extension of the bivariate simple regression and correlation. In fact, multivariate procedures are all such extensions of
bivariate procedures, to account for complexities in real problem situations. The multiple regression equation has the general form:

\[ Y = a + b_0X_0 + b_1X_1 + \ldots + b_nX_n + \epsilon \]

where \( Y \) is the dependent variable, \( X_1, \ldots, X_n \) are the independent variables, \( a \) is the constant, \( b_0, b_1, \ldots, b_n \) are the slope coefficients and \( \epsilon \) is the error term. Once the equation is fit, then it would be possible to determine the multiple correlation value and other related coefficients that could be used in interpretation of results.

The multiple correlation coefficient derived from the multiple regression indexes the goodness-of-fit of the equation relating a dependent variable to a set of independent variables.

The square of the multiple correlation coefficient, multiple coefficient of determination, indicates the proportion of the variance in the dependent variable associated with all of the independent variables. Multiple correlations may be used to describe the goodness-of-fit to a linear trend, or they may be used to infer the probable relationships in a population from a properly selected sample. For the latter purpose, however, Snedecor's F-test can be used.

**Step-wise Multiple Regression**

This method starts with an equation, which includes all independent terms. These are taken in turn and treated as if they were the last to be included and their respective contributions are to be explained after the sums of squares are determined.
The variable with the lowest contribution is eliminated and the process is repeated with other variables until a *statistically significant* variable is found to explain maximum variance. At that point, the process causes the regression model to be optimum. In the absence of the procedural aspects of, for example, forward inclusion, selection focuses often on the R square values and there is a tendency to select models with high R square estimates but which include many variables. By examining the rate at which variance is explained or the regression sums of squares increase, with the number of terms, it is usually possible to determine the scope at which diminishing returns set in. This enables us to decide which combinations of the prescribed number of variables are the best.

**The Organisation of the Thesis**

The thesis is organised in seven chapters.

The first chapter is introductory. It gives a brief history of rubber and speaks of the problem of study and the procedures followed in the analysis of data and interpretation.

The second chapter is a review of relevant literature and it recounts the growth and development of rubber and rubber industry in the world and India.

The third chapter is a description of the study area, that is, Kanyakumari district, in all its geographical, social and economic characteristics, with a view to providing a background for the understanding of the rubber plantations in general and industry in particular.

The fourth chapter is on rubber and rubber industry in India and Tamil Nadu and gives the trends in rubber production and rubber products in the
State and the country. A historical account of rubber and rubber industry is also provided in this chapter.

The fifth chapter is analytical. In this chapter, the data collected from the plantation owners/managers are used in the description of their characteristics. Production and marketing of rubber products from the industries are also described as revealed by the 18 sample plantation owners and managers. The analysis is simple and in frequency and percentage terms only.

The sixth chapter is about the characteristics of plantation and factory workers. The data gathered from 125 workers consisting of field and factory workers, plantation workers and watchmen are analysed in frequency and percentage terms and subsets of data are subjected to multivariate regression methods to bring out their characteristics and relationships.

The seventh chapter summarises the entire thesis and gives the conclusions of the study in a nutshell. The implications of the findings and conclusions are also given in this chapter, with a note on the studies which could be taken to further the understanding of the rubber and rubber industry.

The thesis has an appendage of references and appendices.

Footnotes


3. Statistics and Planning Department, Kottayam 1999
