A COMPARATIVE STUDY ON THE PERFORMANCE OF RR II 105 UNDER HIGH AND LOW DENSITY PLANTING IN CHIRAYINKEEZH TALUK

By

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DISSERTATION

Submitted in partial fulfilment of the requirements for the

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DECLARATION

I hereby declare that this dissertation entitled "**A comparative study on the performance of RRII 105 under high and low density planting in Chirayinkeezh taluk**" is a bonafide record of original work done by me during the course of placement for training and that this dissertation has not formed the basis for reward of any degree, diploma, associateship or other similar titles of any other University or Society.

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CERTIFICATE

Certified that this dissertation entitled "**A comparative study on the performance of RRII 105 under high and low density planting in Chirayinkeezh taluk**" is a record of research work done independently by **Shri.A.Abdul Hameed** under our guidance and supervision and that it has not previously formed for the basis for the award of any degree or diploma to him.

We the undersigned members of the Advisory Committee of Shri.A.Abdul Hameed, a candidate for the **Post Graduate Diploma in Natural Rubber Production** agree that this dissertation entitled "A comparative study on the performance of RRII 105 under high and low density planting in Chirayinkeezh taluk" may be submitted by Shri.A. Abdul Hameed in partial fulfilment of the requirements of the diploma.

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A. ABDUL HAMEED

CONTENTS

LIST OF TABLES

Introduction

INTRODUCTION

Natural rubber, nature's most versatile vegetable product, is commercially obtained from the tree *Hevea brasiliensis* Muell Arg., native of Amazon valley in Brazil. It was introduced to tropical Asia during the second half of 19th century. Presently it is grown in 22 countries of the world, mostly in tropics.

In India, rubber cultivation is confined to a narrow belt which extends from Kanyakumari district in the south to Coorg district in the north. Besides, non-traditional areas in the States of Goa, Orissa, North-eastern States and Andaman Nicobar Islands have been brought under rubber cultivation.

Thiruvananthapuram, the southern most district of Kerala, originally forms part of the traditional area under rubber. But, until 1980, the cultivation was more concentrated on the eastern part of the district and it was grown only in certain pockets in other parts especially in Chirayinkeezh taluk. A boom in this field could be noticed after 1980, by the launch of Rubber Board's comprehensive scheme covering new plantations also under the subsidy scheme.

Chirayinkeezh taluk consists of 28 villages, wherein rubber forms one of the major crops in 25 villages. The other three villages are in coastal areas (Appendix-I).

Generally, the soils in the rubber growing tracts of the taluk are not so fertile when compared with that of the eastern parts of the district. The rainfall in the Chirayinkeezh taluk is very less ie. only 50 per cent as compared to other major rubber growing areas of the State like Kottayam, Meenachil, etc. (Appendix II).

A notable feature in this new area within the traditional belt is that, over 98 per cent of the new units are planted with a single clone, RRII 105, which is still very popular because of its high initial yield and satisfactory growth during pre-tapping as well as post-tapping periods.

Another peculiarity in this taluk is that all the units under rubber are in small holding sector because of the absence of extensive areas for rubber cultivation. Here a total area of 40893 ha has been brought under various crops, of which rubber accounts for 1915 ha. Influenced by the small size of the holdings, most of the rubber growers in the taluk do follow a higher population density than what is recommended by the Rubber Board.

Both merits and demerits, could be attributed for the high density planting. It is true that cost of cutlivation and maintenance in high density planting is always on the higher side, but in cases where family labour is involved in the up keep and harvest of the crop, it would be more advantageous. There is also a firm belief that high density planting is an intensive way of cultivation, especially where there is high pressure on land in State like Kerala. It is a long term measure to increase rubber production indigenously by bringing more and more area under rubber to meet the national demand in full, avoiding import which has been to the tune of around 30,000 tonnes per year for the last so many years.

In low density planting, better growth of the tree, thicker bark, high per tree yield, etc. are reported. However, there is no conclusive proof to do away with high density planting on situations like scarcity of land, availability of man power and growing demand for the raw material amidst constraints.

In India, only limited studies on planting densities have so far been undertaken. But in Malaysia and Indonesia systematic studies had been made to elucidate the impact of planting density on growth and yield of rubber.

In this study an earnest attempt has been made to find out whether the performance of the most popular clone in the new area within the traditional tract is in accordance with the accepted results and the extent of suitability of high density planting in small holding sector.

Review of Literature

REVIEW OF LITERATURE

During the early period of rubber cultivation, all over the world, it had been the practice to adopt wider spacing, particularly in estate sector. To study the impact of planting density, extensive field trials had been carried out in Indonesia and Malaysia in 1920s and 1930s, respectively. However, in India, the studies in this respect are very meagre.

The earliest report with respect to planting density was that a relatively higher planting density had a marked effect on the growth of the tree if no thinning was done ( ). Under wider spacing, per tree yield was more when compared to that in closer planting (Dijkman, 1951).

Large scale experiments conducted by Buttery and Westgarth (1965) revealed that one or two years after planting there was no competition among young plants, but as the crown develops they began to compete for light, nutrients and water. They had also reported that the percentage of tappable trees decreased with increasing density. At the highest density, a good number of trees never attained tappable girth (Dijkman, 1951). Besides, thickness of virgin bark was reported by decreased with increasing density. At higher densities, the restricted space per tree resulted in smaller crowns (Leong and Yoon, 1982).

In an estate trial with ten clones including RRII 105 and nine popular ones, it was found that RRII 105 was the highest yielder but susceptible to brown bast (15%) under ½S d/2 tapping system. RRII 105 was reported to be a sturdy tree with tall straight trunk with good branching habit (Saraswathiamma *et al.*, 1987). In

general, the clone RRII 105 showed a fair degree of tolerance to abnormal leaf fall and moderate resistance to oidium and high susceptibility to pink disease.

As in Indonesia and Malaysia, the earlier plantations in Sri Lanka and India also followed wider spacing. In Sri Lanka, a stand of 300 per hectare was the standard density (Cheriyan, 1990).

The first attempt to study the impact of planting density in India after the formation of the Rubber Board was by a survey conducted in 120 large estates. The study revealed that the maximum density adopted was only 375-450 per hectare and that too in 19 per cent of the total area of the estates. The remaining area of the estates had further lower densities (Cheriyan, 1990).

Mani *et al.* (1990) reported that density of planting played an important role in the reduction of immaturity period. According to them each clone may have an optimum density and for the clone RRII 105, the density 445-598 tree/ha showed very little variation in girth increment upto 4th year of planting.

Studies have made clear that in rubber, tap root grows upto 2.4 m deep in 6-7 years of age and laterals 6-9 m in young plants and beyond 9 m in mature trees. The maximum root activity is within 3.7 m radius from the tree trunk and the uptake was more from sub soil than in top soil (Krishnakumar, 1993).

Recently, studies on the effect of planting density on growth and yield of rubber were also conducted by Karthikeyan (1993) and Sathishchandran (1994). The results of their studies were in agreement with the earlier observations and findings.

Material and Methods

MATERIALS AND METHODS

The studies reported herein were conducted during the period from April 1996 to June 1996 in Chirayinkeezh taluk of Thiruvananthapuram district. Altogether there are 28 villages in this taluk, of these rubber is grown in 25 villages in a total extent of 1915 hectares. The terrain of the plantation area is mostly either gentle slope or undulating. A revenue map of Chirayinkeezh taluk is given as Appendix-I.

The areas planted in 1990 and 1985 which are covered by Rubber Board's subsidy scheme were selected for the study. The units were grouped into three categories based on the planting densities. ie., (i) 450-500 trees per hectare (ii) 501-600 trees per hectare and (iii) above 600 trees per hectare. Fifty holdings were selected comprising both mature and immature plantations in the above categories as follows:

(i)	450-500 plants per hectare	- 10 units
(ii)	501-600 plants per hectare	- 19 units
(iii)	above 600 plants per hectare	- 21 units
	Total	- 50 units

The holdings planted during 1990 and 1985 which completed five and ten years of growth respectively, were selected. In almost all the 1985 plantings, three years tapping had already been over. The details required for the study were gathered by personal interview with the growers using a pre-tested questionnaire prepared for the purpose (Appendix-III).

The following observations were recorded.

3.1 Size of holdings

The extent of the units selected were assessed from the scheme files kept in the Regional Office, Rubber Board, Thiruvananthapuram. So also, the original planting density and type of planting materials used were collected from the concerned scheme file and verified with the field.

3.2 Extent of vacancy

The present stand in the field was ascertained and the difference from the original population density was calculated and expressed as percentage vacancy.

3.3. Number of weaklings

The number of weaklings in each unit was counted separately and mean percentage for each category computed and tabulated.

3.4 Height at first branching

Ten trees per holding were selected at random and the height of the present living branch from the ground level was found out using a bamboo pole and a measuring tape.

3.5 Crown size

The growth and spread of the canopy were assessed visually and classified into thin, medium and dense.

3.6 Plant girth

For recording the girth, ten trees per holding were selected at random. The girth at 125 cm above bud union of the selected trees were measured using a flexible measuring tape and the average worked out and expressed in centimetres.

3.7 Bark thickness

Bark thickness of three randomly selected trees per holding were measured using Schlieper's gauge. The mean values were calculated and expressed in millimetres.

3.8 Tapping

The details regarding the system of tapping and nature of tapping work were gathered from individual holdings and the number under each item tabulated and percentage worked out.

3.9 Yield

In the case of holdings where estate records are maintained and made available, the annual yield per tree and per hectare were gathered.

With regard to other units, the yield on the day of visit was assessed and mean yield computed taking into consideration that the average number of tapping days will be 200 per year under ½S d/1 and 120 per year under ½S d/2. Discussions were also held with the concerned tappers and growers to arrive at a conclusion with respect to the computation of the yield.

3.10 Disease incidence

The incidence of common diseases such as oidium, pink and abnormal leaf fall was visually assessed by the symptoms and as per growers' statements. The incidence was rated as 'low', 'medium' and 'high' according to intensities.

3.11 Panel diseases

Examined the trees under tapping and counted the number of trees affected by panel diseases, means for each category worked out and recorded in percentage.

3.12 Brown bast incidence

By thorough checking of the individual trees under tapping with the help of the owner/tapper, brown bast cases were identified, counts taken and expressed in percentage.

3.13 Wind damage

During the visit to the units, the number of trees damaged by wind were assessed and expressed in percentage.

3.14 Economic analysis

The cost of maintenance and net income per hectare were calculated on the basis of actual expenditure incurred and revenue realised in 1995-96. For arriving at the actuals, full revenue expenditure plus the proportionate development cost for one year were accounted. An amount of Rs.30,000/- (1985) was taken as

full development cost per hectare during the immaturity period under normal recommended density and for higher densities, provision was given for proportionate increase.

Results and Discussion

RESULTS AND DISCUSSION

The data collected from the study on the various parameters were critically analysed and the results are presented and discussed in the following paragraphs:

4.1 Size of holdings

In the case of mature (1985 planting) and immature (1990 planting) plantations, the holding size is comparatively larger under normal recommended density (450-500/ha). The average holding size is little over 0.60 hectare whereas in higher densities the average extent is around 0.40 hectare (Table 1). Out of the fifty units visited, only 10 units (20%) had larger extent with the recommended density and 80 per cent of the units having smaller holding size adopted closer planting. As the size of holding increases the growers seemed to go for wider spacing as in large estates. This may be due to the reason that when the extent of area is more, family labour may not be sufficient and the grower will have to go for hired labour. Under such circumstances higher density may not be advantageous.

4.2 Trend in the adoption of high density planting

It is seen that a good number of small holdings had normal density in the past. The recent trend in the taluk is to go for high density planting.

The survey revealed that in 1985, normal density was adopted in 22.5 per cent units. By 1990, the units under this category had gone down to 15.7 per

Table 1. Details of holdings selected

Population density (trees/ha)	No. of holdings selected	Total area of the holdings (ha)	Average size of holding (ha)	No. of villages within the taluk in which the holdings are situated
450-500				
Immature	3	1.90	0.63	3
Mature	7	4.50	0.64	3
501-600				
Immature	8	3.81	0.48	5
Mature	11	4.63	0.42	4
601 and above				
Immature	8	3.98	0.50	6
Mature	13	3.99	0.30	4
Grand total	50	22.81	0.46	25

cent. In the case of plantations covered by Rubber Board's subsidy scheme, there were only seven units with optimum density during 1985 whereas it came down to three units in 1990 under the group.

The new areas like Chirayinkeezh taluk where the growers in general have not much experience in a perennial crop like rubber, it is natural to have an impression among small growers that "more trees, more yield". Perhaps the higher initial yield of the clone RRII 105 and the small extent available for rubber planting might have influenced the growers in adopting closer planting.

Cherian (1990) had stated that the recommended stand in Malaysia was 450-500 per hectare while in Sri Lanka it was 350-450 per hectare. It has also been reported that the estates in Kerala follow lower densities as compared to small holdings.

4.3 Extent of vacancy

The studies revealed that planting density did not have any influence on the number of vacancies. The rate of casualities was not in accordance with the planting density (Table 2).

The percentage of vacancy was found to be the highest (5.10%) in normal density, followed by highest density (2.82%) and medium density (0.71%) in the case of immature plantation. The values with respect to mature plantations (1985 planting) were 1.80, 4.08 and 5.46 percentage in low, medium and high densities of planting, respectively. In fact this aspect is controlled by the standard of planting material used, agroclimatic conditions, after care etc.

This observation is in agreement with the reports of Sathischandran (1994).

4.4 Number of weakling

The percentage of weaklings at various densities is furnished in Table 2.

The data reveal that the percentage of weaklings is the least in lower density (5.73%) whereas it is on the higher side in the medium (6.97%) and high (6.92%) densities in mature plantations. No marked difference could be detected in this aspect between medium and high densities under 1985 planting. In the immature plantations (1990 planting) a steady increase in weakling percentage in the order 5.27, 8.4, 12.53 under the three categories of population density could be noticed.

During the initial two to three years of planting, there will not be any competition among young plants, but as the crown develops, competition begins and it is directly related to the population density. Apart from the impact of planting density, it also depends on certain other factors such as type of planting material used, time of planting, adversities in the climate, management etc. These factors are all the more important when the study is conducted on taluk basis at varying agro-climatic conditions and standard of maintenance.

However, the findings are in agreement with earlier results of experiments conducted in Malaysia by Buttery and Westgarth (1965). It revealed that 90 per cent of the plants in the density 110 plants per hectare attained tappable girth three years after planting and 31 per cent trees at 1074 plants per hectare did not attain tappable girth even after 19 years of planting. The study conducted by

Table 2. Morphological features of clone RRII 105 in relation to planting density

Population density (trees/ha)	Weakling (%)	Vacancy (%)	Height at first branching (m)	Girth (cm)	Bark thickness (mm)
Immature (1990)					
450-500	5.27	5.10	2.88	37.83	5.33
501-600	8.40	2.82	2.81	36.31	5.06
Above 600	12.53	0.71	3.13	36.78	5.00
Mature (1985)					
450-500	5.73	1.80	3.74	57.14	7.28
501-600	6.97	4.08	3.07	51.70	7.04
Above 600	6.92	5.46	4.32	52.40	6.65

Sathischandran (1994) also recorded higher percentage of weaklings in closer plantings.

4.5 Branching height

The data on height of living branches in the mature and immature plantations under study are given in Table 2.

In the immature plantations, the branching height varied from 1.92 m to 3.80 m in optimum density and it was above 4 m in close plantings. Similarly, in 1985 planting branching height was at around 4 m in normal recommended density and in higher densities the living branches were noticed above 5 m height. That is, in the immature plantations the height of branching is at lower levels in optimum density and the branching height increased with the increase in density. The same pattern of branching was observed in mature plantations also.

The result is in conformity with earlier observations reported by Leong and Yoon (1982).

4.6 Crown size

The clone RRII 105 has a dense canopy which is determined by the number of branches and leaves, leaf area etc.

In this study the canopy size was mostly dense in normal density and that in medium and high densities, medium to thin crown size was noticed.

The observation is in agreement with the findings of Leong and Yoon (1982), Karthikeyan (1993) and Sathischandran (1994) who all reported that smaller crown is a conspicuous feature under high densities of planting.

4.7 Plant girth

The observations made on the trunk girth in relation to various densities are presented in Table 2.

Both in immature and mature plantations, marked difference in plant girth could be noticed among the normal, medium and high densities. The mean girth in normal population density was found to be 36.93 cm and under medium and high densities it was 36.31 cm and 36.78 cm respectively. In the case of mature plantation, the girth recorded was 57.14 cm, 51.7 cm and 52.42 cm in the three stand groups in the ascending order. In fact, plants in the medium population density showed slightly less growth.

Schmole (1940) reported similar growth rate in an experiment with different spacings. According to him, during second and third year, the girth at stand 625 per hectare recorded slightly higher value than that at 400 per hectare. The difference was 0.1 cm to 0.7 cm. The observations made in Chirayinkeezh taluk also agree to his findings.

4.8 Bark thickness

Table 2 contain the data on bark thickness in relation to planting density.

It was found that the mean bark thickness in 1985 planting was 7.28 mm in optimum density and trees in medium and high densities had 7.04 mm and 6.65 mm, respectively. In the immature (1990 planting) plantations, the bark thickness was found to 5.33 mm, 5.06 mm and 5.00 mm under the first, second and

third category of stand group, respectively. From the above, it could be seen that the bark thickness was the highest in wider spacing and decreased with increase in density.

This result is in agreement with the findings of Schmole (1940) and Sathischandran (1994).

4.9 Tapping

Out of the total 50 units selected for the study, 31 units were mature plantations. Over 80 per cent of the selected holdings (25 Nos.) adopted daily tapping (½S d/1) which seemed to be the accepted practice among small growers in the taluk (Table 3). Alternate daily tapping was practised only in 6 units of which, four units were in low density planting and one each in medium and high densities.

The recommended tapping system for the clone RRII 105 is half spiral, once in third daily (½S d/3) which is not found to be followed anywhere in the 31 mature units selected. In general, higher incidence of brown bast, a physiological disorder, is observed under higher intensities of tapping like 100 per cent or 200 per cent. Most of the growers are well aware of the ill effects of the high intensity tapping but they express their inability to change over to low frequency tapping because of certain practical problems such as difficulty in sharing a tapper among two or three units and providing regular employment for the hired tapper.

Only in two units which are having less than 0.20 ha in extent, self tapping was noticed. In terms of percentage it comes to six. However, self tapping was not at all practiced in units under normal population density (Table 3).

Table 3. System and nature of tapping in relation to planting density

	Population density (trees/ha)			Mean
	450-500	501-600	601 and above	
Tapping system				
½S d/2 (%)	57	9.00	8.00	24.66
½S d/1 (%)	43	91.00	92.00	75.34
Total	100	100.00	100.00	100.00
Nature of tapping				
Self (%)	-	9.00	8.00	5.66
Hired (%)	100	91.00	92.00	94.34
Total	100	100.00	100.00	100.00

The mean tapping task was found to be 394 trees per tapper and the highest task of 438 was noticed in normal density where the extent is comparatively large.

It is encouraging to note that over 57 per cent of the units with normal stand per hectare, have adopted alternate daily tapping (Table 3) which is of moderate intensity (100%).

4.10 Incidence of brown bast

The percentage of brown bast incidence under different tapping systems were assessed and the data provided in Table 4.

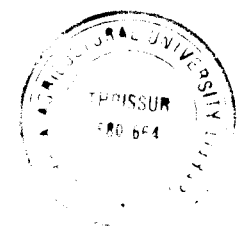
Symptoms of brown bast were noticed in all the mature plantations under study. The intensity of the disorder was the least, 13.61 per cent under the high density whereas it was maximum (15.18%), under medium density. With respect to tapping intensity brown bast incidence recorded was more in ½S d/1 (16.89%) as compared to ½S d/2 system of tapping (11.62%).

Saraswathiamma *et al.* (1987) reported that the clone RRII 105 is susceptible to brown bast. Under ½S d/2 system of tapping the incidence was more (15%) and became lesser (7%) when the system was changed to ½/S d/3.

Mercykutty *et al.* (1995) have reported that RRII 105 has above average occurrence of brown bast under ½S d/3 system, brown bast cases are reported to be at 5.26 per cent and 10 per cent in ½S d/2 system.

Table 4. Incidence of brown bast under different population densities and intensities of tapping

Tapping system	Population density (trees/ha)			Mean
	450-500	501-600	601 and above	
½S d/2 (%)	11.70	12.91	10.27	11.62
½S d/1 (%)	16.28	17.45	16.95	16.89
Mean	13.99	15.18	13.61	14.25



4.11 Yield of dry rubber

The data with respect to yield in relation to planting density are furnished in Table 5.

Yield computation was made on per tree per year basis. The analysis showed that the highest per tree yield of 6.21 kg per annum was obtained under low density planting and it was minimum in high density planting (5.35 kg) followed by medium density planting (6.10 kg).

Thus, it is observed that the per tree yield was the highest in optimum density followed by medium and highest densities. On per hectare basis, the result was the reverse, ie., the dry rubber obtained was found to be the maximum (3360 kg) in high density, followed by medium (3096 kg) and optimum (2855 kg) densities. It is evident from the fact that though the per tree yield is low in higher densities, the number of trees per hectare is more and hence more yield.

This observation agrees with the results of experiments and studies conducted in India and abroad (Schmole, 1940, Cherian, 1990 and Sathishchandran, 1994).

4.12 Disease incidence

The three common diseases affecting rubber trees are powdery mildew, abnormal leaf fall and pink disease. Powdery mildew is a serious disease in Kanyakumari district and in high elevation areas where cool climate, frequent dew formation during night and prevalence of thick mist are existing (Pillai *et al.*, 1980). As the climate condusive for the disease is not prevalent in the taluk, disease

Table 5. Influence of planting density on yield of dry rubber

Item	Population density (trees/ha)			Mean
	450-500	501-600	Above 600	
Mean yield of dry rubber per tree/year (kg)	6.21	6.16	5.35	5.90
Mean yield of dry rubber per hectare (kg)	2855	3096	3360	3103

incidence is not severe. However, mild infection was noticed on leaves (Table 6). Crinkling and shedding of leaves in severe stages of attack could not be detected and the intensity of the attack was assessed as below five per cent and could be rated as 'low'.

Generally, abnormal leaf fall and pink diseases become common during June-July and September-October period, respectively after heavy and continuous downpour. The condusive climatic conditions for these two diseases do not exist in the taluk and only mild attack was noticed. In the case of these two major diseases, depending on growers' statements and left over symptoms, the severity of the attack was only 3 to 5 per cent and rated as low as in the former case.

Because of the above circumstances, large scale, preventive remedial measures against these diseases are not very essential.

4.13 Panel diseases

High humidity coupled with frequent wetting of tapping panel favour panel diseases. The studies revealed that panel diseases were the least (0.74%) in wider spacing and showed an increasing trend of 1.30 per cent to 1.66 per cent in medium and high densities (Table 6).

In wider spacing, there will be better light penetration and air circulation which reduces humidity and results in less panel infection. In the case of higher densities, because of the crowded growth, light penetration and air circulation are adversely affected and thus favour high humidity for panel diseases. This is in conformity with the report of Heubel (1939).

Table 6. Incidence of common diseases and wind damage at different planting densities

Disease/ wind damage	Population density (trees/ha)			Mean
	450-500	501-600	601 and above	
Panel disease (%)	0.74	1.30	1.66	1.23
Pink disease (%)	2.94	3.58	3.79	3.43
Powdery mildew (%)	3.20	4.50	4.98	4.22
Abnormal leaf fall (%)	4.60	4.80	5.01	4.80
Wind damage (%)	1.93	1.90	1.02	1.61

4.14 Wind damage

The trees affected by wind in the units under study are presented in Table 6.

In general, Chirayinkeezh taluk seems to be not prone to heavy wind or cyclone. Wind damage in rubber is influenced by the intensity of wind, depth of soil, clonal susceptibility, elevation, etc. The result on wind damage was found to be more in optimum density. The damage ranged from 1.7 to 2.17 per cent and in higher densities it varied from 1.02 per cent to 1.90 per cent. The difference among the three stand groups in this respect is negligible. However, the increase in the case of wind damage with the increase in density agrees with the findings of Heubel (1939).

Economic analysis

The economics of production consists of three aspects namely:

1. Cost of production
2. Total yield
3. The quality and market value of the produce

The economic analysis showed that the highest net income was obtainable in the order of high, medium and low stand per hectare (Table 7). The major share of the cost of production goes as tapping charges alone. This item of expenditure is 45 per cent of the total cost of production (1995-96) in low density and that at medium and high stand groups, it is 47.90 and 50.00 per cent respectively. The variation is due to the difference in the number of plants per unit area.

Table 7. Impact of planting density on the cost of production and net income per hectare

Item of expenditure and income	Population density (trees/ha)			Mean
	450-500	501-600	601 and above	
Maintenance cost per ha (Rs.)	29074	31935	37176	32729
Gross income per ha (Rs.)	95429	100582	110836	102282
Net income per ha (Rs.)	66355	68647	73660	69554
Benefit cost ratio	1:2.28	1:2.14	1:1.98	1:2.13

The mean total cost of production which is, inclusive of revenue expenditure and development cost comes to Rs.29,074/- for normal density, Rs.31,935/- for medium density and Rs.37,178/- for high planting densities, ie., in last two categories the cost of production is 9.80 per cent and 27.00 per cent more than the first stand group. In other words for every rise in stand over and above the normal density the increase in the cost of production is Rs.55/- per tree in mature plantation and another analysis by dividing the mean total expenditure with the average stand gives per tree cost of production at Rs.60.00 in optimum, Rs.59.13 in medium and Rs.59.67 in higher densities, thus showing no significant difference in the per tree cost of production among the stand groups. But in higher densities it will be slightly on the higher side when the cost of family labour is also added to the total of cost of production. There is no share of family labour in normal density of planting under study.

The analysis on the return from unit area showed that the net income was in proportion to the increase in density. The normal population density recorded a net income of Rs.66,335/- per hectare, whereas it was Rs.68,647/- and Rs.73,660/- per hectare in medium and high densities respectively. The mean per tree net income recorded was Rs.138.81, Rs.127.12 and Rs.118.23 in the three stand group, ie., the per tree profit declined with increase in density. Further analysis also revealed that the BCR with respect to normal planting density was 2.28 whereas it was 2.14 and 1.98 in medium and high densities, respectively.

Regarding the market value of the produce, the price of lot rubber touched an all time record of over R.5,000/- per 100 kg towards the end 1995. However, the average price of the same for the year 1995-96 was Rs.3500/- per kg.

It was observed that the entire rubber produced in the taluk was marketed as lot rubber which usually fetch lower price as compared to graded sheet rubber.

The findings on the economic analysis are:

(i) Harvesting cost (tapping) is a major item of expenditure

(ii) The total cost of production is increasing progressively with the increase in density

(iii) Irrespective of the density, the per tree maintenance cost is more or less the same

(iv) Though the gross profit is in accordance with the rise in density, the net profit is inversely proportional to the increase in density.

Summary and Conclusion

SUMMARY AND CONCLUSIONS

With a view to evaluate the performance of RRII 105 under different planting densities, 25 villages in Chirayinkeezh taluk of Thiruvananthapuram district were selected covering an area of 1915 hectares. Fifty units selected were categorised into three groups based on the number of plants per hectare. Group one comprised of those with 450 to 500 trees per hectare; group two, 501-600 trees per hectare and group three, above 600 trees per hectare. The holdings selected were planted during 1985 and 1990. Observations pertaining to growth, yield, incidence of diseases, wind damage, brown bast, etc. were recorded by periodical visit to the holdings as well as from the records maintained in the Regional Office, Rubber Board.

The results of the present study generally agree with the results of experiments reported earlier. It is a fact that plants under wider spacing will be vigorously growing and is likely to attain tappable girth comparatively earlier.

At lower densities, per tree yield is higher but the per hectare yield is low when compared to high densities of planting.

The effect of close planting can be seen in the net income from a unit area of rubber plantation. Though the per tree yield is low in medium and high densities of planting, the total net income is always high. The high density also leads to high cost of maintenance. For meeting the tapping charge alone, over 45 per cent of the maintenance cost is to be set apart. This item of expenditure goes upto 50 per cent in highest densities of plantation.

The general notion is that if family labour is employed, the closer plantings will be more profitable as there is considerable savings towards labour cost. The peculiarity observed in Chirayinkeezh taluk is that even the smallest units measuring around 0.20 hectare in extent are engaging paid tappers and estate workers. This is because no grower is entirely dependent on rubber or agriculture in particular as a sole source of income.

Under the circumstances it is advisable to recommend an initial stand between 550-600 per hectare subsequently reduced to 500 per hectare at the time of tapping for small holders of Chirayinkeezh taluk as there is not much difference between the stand groups of 450-500 and 501-600 per hectare with respect to yield, net return and on various growth parameters. Keeping in view the recommendation in Malaysia (750 per hectare for small holders), it is suggested to undertake in depth studies in this direction before giving a specific recommendation with regard to high density planting considering the unique local situations. The findings of the study can be summarised as follows:

* Generally, plants in lower planting densities had medium to dense canopy
* Plants under wider spacing were comparatively more vigorous
* Height of branching was at higher level in close planting
* The intensity of common diseases affecting rubber tree could be rated as 'low' and large scale preventive/remedial measures were not warranted
* Daily tapping was the common accepted system of tapping in small holdings
* Brown bast symptoms started appearing notably and would intensify in the coming years

* Though per hectare yield was positively correlated with planting density, the per tree yield recorded a negative correlation. Higher BCR (2.28) was recorded in the case of normal planting density (450-500 trees/ha).

References

REFERENCES

Buttery, B.R. and Westgarth, D.R. 1965. The effect of planting density on the growth yield and economic, exploitation of *Hevea brasiliensis* 1. The effect of growth and yield. *Journal Rubb. Res. Inst.* Malaya, 19(1):62-71

Cherian, P.P. 1990. Impact of initial stand for increasing rubber production. *Planters Conference*, pp.71-73

Dijkman, M.J. 1951. *Hevea - Thirty Years of Research in the far East*. University of Miami Press, Florida, pp.115-142

Heubel, G. Ad. 1939. Voorhoopige resultaten Van cenige plantien band en uitdunning Sproeven bij Hevea in Zuid-Sumatra. De Bergcultures. 13(20):682-695

Karthikeyan, K.V. 1993. Effect of planting density on the growth of rubber in the Vellanikkara estate. P.G. Dip. N.R.P. Dissertation, Kerala Agricultural University, Thrissur.

Krishnakumar, V. 1993. *Rooting Pattern of Tropical Crops* (Ed. Abdul Salam, M. and Abdul Wahid, P). Tata Mcgraw Hill Publishing Company Ltd., New Delhi, pp.237-240

Leong, W. and Yoon, P.K. 1982. Modification of crown development of *Hevea brasiliensis* Mull. Arg. by cultural practices. I. Tree density. *J. Rubb. Res. Inst. Malaysia*. 30(3):123-130

Mani, J., Punnoose, K.I. and Mathew, M. 1990. Agro-management techniques for reducing immaturity period of rubber. Paper presented at the planters conference, Rubber Board, Kottayam.

Mercykutty, V.C., Saraswathiamma, C.K., Sethuraj, M.R. and Annamma Varghese, Y. 1995. Performance of eight popular clones of rubber from certain large estates. *Rubber Board Bulletin*, 27(2):7-13

Pillai, P.N.R., George, M.K. and Rajalekshmy, V.K. 1980. *Leaf and shoot diseases*. Hand Book of National Rubber Production in India, Rubber Board, Kottayam. pp.249-261

Rubber Board. 1996. *Rubber Growers Companion*. Rubber Board, Kottayam, pp.66-68

Saraswathiamma, C.K., 1985. Advanced planting materials, planting density and crown modification. *Training Manual*, Rubber Board, Kottayam

Saraswathiamma, C.K., George, P.J. and Panikkar, A.O.N. 1987. Performance of few RRII clones in the estate trials. *Rubber Board Bulletin*, 23(2):5-9

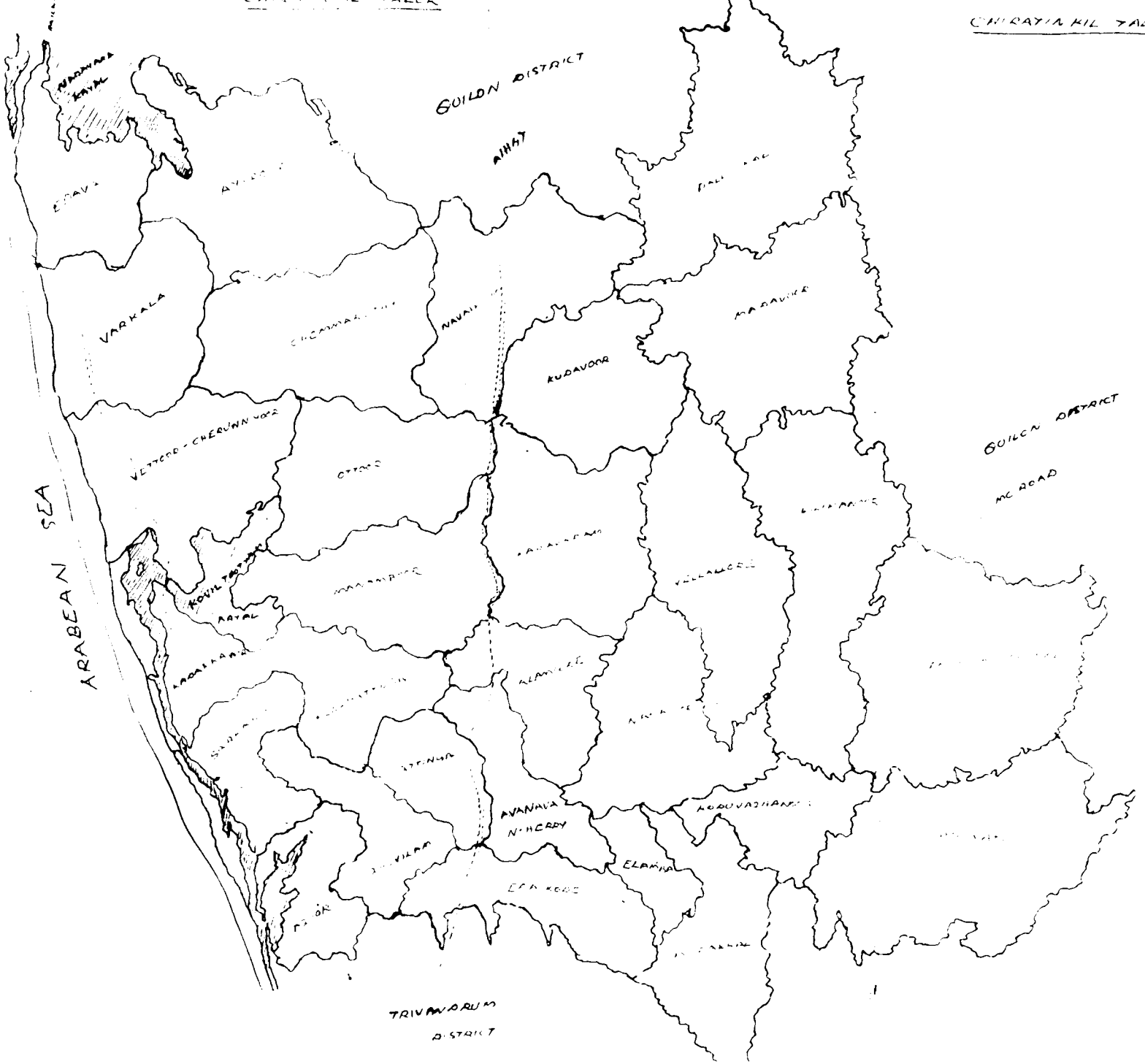
Sathishchandran. 1994. Performance evaluation of rubber under different planting densities. P.G. Dip. N.R.P. Dissertation, Kerala Agricultural University, Thrissur.

Schmole, J.F. 1940. Voorloopige resultaten Van een plant Verband proef met oculaties II. Arch. V.d. Rubber Cult. in Ned-Indie. 24:285-305

Webster, C.C. and Baulkwill. 1989. *Rubber*, Longman, Scientific and Technical, New York, pp.186-191

* Originals not seen

Appendices


CHIRAYIN KIL TALUK
KOLLAM DISTRICT
VARKALA
KUDAVOOR
KOLLAM DISTRICT
NC ROAD
ARABEAN SEA
AVANAVA
N.HERRY
TRIVANDRUM
DISTRICT

APPENDIX-II

Weather data at Thiruvananthapuram district
(temperature °C and rainfall in mm)

Temperature	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1991												
Maximum	34.5	34.0	34.5	34.8	34.5	31.2	32.0	32.0	31.8	31.4	31.7	32.4
Minimum	20.2	19.8	22.4	23.8	23.1	22.1	22.0	21.6	22.5	20.5	22.7	19.6
1992												
Maximum	33.1	33.3	34.7	34.8	32.9	31.5	31.0	31.3	32.8	33.1	33.3	34.0
Minimum	21.1	20.6	22.6	23.1	23.0	22.1	21.6	21.6	22.5	20.5	22.7	19.6
1993												
Maximum	33.5	33.9	33.4	34.0	34.4	31.5	30.8	33.0	32.7	32.3	33.1	33.8
Minimum	20.4	20.0	20.7	22.7	22.3	21.6	22.0	22.3	22.3	20.1	22.1	19.5
1994												
Maximum	33.7	34.9	36.1	35.3	35.3	31.0	31.0	31.7	31.1	31.8	32.6	34.7
Minimum	21.0	20.8	22.6	23.5	22.4	21.4	21.4	21.4	21.9	21.8	20.1	21.1
1995												
Maximum	34.4	33.2	35.5	35.1	34.2	32.8	32.0	31.8	32.6	32.6	34.1	33.4
Minimum	20.6	21.0	21.9	22.5	22.6	22.2	22.1	20.7	22.0	22.7	19.7	21.3
RAINFALL												
1991	40.5	31.4	35.1	121.1	150.8	147.99	174.4	145.8	361.6	300.9	297.0	29.8
1992	-	-	16.1	82.0	284.7	428.60	151.8	109.2	17.1	164.8	131.0	23.3
1993	65.1	128.2	151.0	297.0	135.7	205.50	126.0	21.1	40.2	205.1	71.8	2.7
1994	91.7	40.2	13.6	87.4	223.3	424.3	82.5	61.8	96.8	162.7	170.4	39.5
1995	2.2	28.8	30.1	184.5	150.9	147.7	535.7	210.0	77.5	105.4	110.4	26.6

Source: Meteorological observatory, Thiruvananthapuram

APPENDIX-III
INTERVIEW SCHEDULE FOR THE SURVEY

I. General information

1. Name and address of the owner :

2. Reg.No./Permit No. of the holding :

3. Location :

4. Area under rubber with year/years of planting

	Mature	Immature
Year of planting		
Clone planted		
No. of tress planted/ha		
Present stand/ha		

II. Details of planting/cultural operations

Particulars	Mature	Immature
1. Planting distance		
2. Height at branching		
3. No. of leader branches		
4. Crown size (small/big/medium)		
5. No. of weaklings		
6. Girth at 125 cm		
7. Bark thickness		
8. Pannel disease (%)		

9. Incidence of	Low	Medium	High	Low	Medium	High
Oidium						
Pink						
Abnormal leaf fall						
TDP cases						
Wind damage						
Tapping system						
Tapping task						

10. Yield obtained

Year	Sheet rubber kg	Scrap rubber kg	Total yield kg	Value Rs.

III. COST OF PRODUCTION

A. Labour charges	Mandays	Expenditure (Rs.)
Item of work		
1. Weeding		
2. Manuring		
3. Labour charges for plant protection		
4. Tapping charge		
5. Processing charge		
B. Material Cost		
1. Fertilizer		
2. Chemicals		
3. Tools and implements		
C. Labour benefit		
1. Holiday wages		
2. Bonus		
3. Others		
D. Cost of cultivation		
1. Development cost		
2. Miscellaneous (TA, stationary, etc.)		

IV. General remarks, if any

Place
Date

A. ABDUL HAMEED