PERFORMANCE OF RRII 105 IN HIGHER ELEVATIONS OF THODUPUZHA TALUK IN IDUKKI DISTRICT

By

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DISSERTATION

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE POST-GRADUATE DIPLOMA IN NATURAL RUBBER PRODUCTION OF THE FACULTY OF AGRICULTURE KERALA AGRICULTURAL UNIVERSITY

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DECLARATION

I hereby declare that this dissertation entitled '**Performance of RRII 105 in higher elevations of Thodupuzha Taluk in Idukki District**' is a bonafide record of the research work done by me during the course of placement/ training and that the dissertation has not previously formed the basis for the award to me of any degree, diploma, associateship or other similar title of any other University or Society.

Vellanikkara
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CERTIFICATE

Certified that the dissertation entitled '**Performance of RRII 105 in higher elevations of Thodupuzha taluk in Idukki District**' is a record of research work done independently by **Sri.K.Abraham Joy**, under our guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma to him.

We, the undersigned members of the Advisory Committee of Sri.K.Abraham Joy, a candidate for the **Post Graduate Diploma in Natural Production** agree that the dissertation entitled 'Performance of RRII 105 in higher elevations of Thodupuzha taluk in Idukki District' may be submitted by him in partial fulfilment of the requirement for the Diploma.

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INTRODUCTION

INTRODUCTION

Hevea brasiliensis, the para rubber tree is the most important source of natural rubber in the world contributing 99 per cent of the world's natural rubber.

India enjoys a unique position in the field of natural rubber production. The area under rubber in India during 1994-95 was estimated as 5 lakh hectares. The production of natural rubber during 1994-95 was 4.72 lakh tonnes and consumption 4.83 lakh tonnes (Rubber Board, 1995). It is estimated that the national requirement by 2000 AD would be 6.80 lakhs and in 2010 AD it is likely to be 12.8 lakh tonnes (Menon, 1993). This target of production can be achieved only through long term and short term measures. Bringing more area under rubber as well as replanting of old planting with high yielding clones are the long term strategies taken by the Rubber Board. Under the World Bank assisted rubber project, Rubber Board envisages to replant the old and uneconomic rubber in 40,000 hectares in traditional areas. It also envisages new planting in 30,000 hectares consisting of 23,000 hectares in Kerala and Tamil Nadu, 5,000 hectares in Tripura and 2,000 hectares in selected other states/union territories. The period of the project is five years from 1993-94 to 1997-98 (Rubber Board, 1995).

In Kerala, the scope of extending the area under rubber in traditional tracts is limited. Attempts are therefore undertaken to take up rubber cultivation in high elevation areas of Wynad and Idukki districts.

Thodupuzha taluk in Idukki district is considered as an area with peculiar landscape with hills and valleys. The north eastern part of this taluk occupies hilly

areas with high elevation. The total area of the taluk is 861.51 sq.km with a population of 2,99,540. It comprises of 17 villages. Rubber is one of the most important plantation crops in low elevations of the taluk. Since the cultivation of the crop has proved to be profitable, growers in higher elevation also took up rubber cultivation in some areas. Before initiation of steps to popularise cultivation in high elevations, it is necessary to study the performance of the crop in already established plantations. No systematic study has been conducted to analyse the growth and yield of rubber at higher elevations in Kerala. Hence the present study was conducted to assess the growth and yield performance of the clone RRII 105 of *H. brasiliensis* in low and high elevation areas in Thodupuzha taluk of Idukki district. The data gathered from this study will be useful in assessing the feasibility of growing rubber in higher elevations.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Rubber is an important crop in Thodupuzha taluk. It is mainly grown in low elevation areas. However, in high elevation areas also, some growers have taken up cultivation of this crop. The published literature available on rubber in this aspect is only few. Hence, the effect of climatic factors and management practices on the performance of rubber are reviewed in the following pages.

2.1 Effect of climatic factors on the performance of rubber

Cretin (1978) recorded positive correlation between rainfall deficit and cumulative production loss in rubber.

Pushpadas and Karthikakutty Amma (1980) found that for optimum growth and yield, rubber requires an evenly distributed rainfall of 2000-3000 mm in an year. In areas where rainfall was much less, it was found that the tree became stunted in growth with crooked stem and lesser number of branches. The growth of tree was retarded in regions with pronounced drought season.

Temperature is one among the key environmental factors influencing plant growth. Mean monthly temperature of 21 $^{\circ}$C to 35 $^{\circ}$C without wide variations is found suitable for the growth of rubber (Pushpadas and Karthikakutty Amma, 1980).

Transpiration rate is influenced by temperature and relative humidity of the surrounding atmosphere. A humid atmosphere throughout the year without much variations is found to be ideal for successful cultivation of rubber. According to Pushpadas and Karthikakutty Amma (1980), the relative humidity varies from about

70 per cent during January to 95 per cent during August in many of the rubber growing regions of India.

The decrease in yield during the course of the day is related to increased loss of water due to transpiration and the resultant drop in pressure potential in the latex vessels (Devakumar *et al.*, 1988).

Wind and storms adversely affect rubber cultivation. The damage caused varies with the age of the tree and the nature of the wind. Morphological and anatomical deformations are reported to be usually associated with high wind velocities. One of the notable features of the trees in windy areas is the deformation of their canopies leading to an assymmetric architecture in which the branches appear to be swept to the leeward side (Grace, 1977).

Uprooting, trunk snap and branch break are the major effects of wind on old trees. Shallow soil or high water table usually results in uprooting. Unduly heavy development of the canopy makes the trees susceptible to trunk snap and branch break when affected by wind. Rate of girthing on tapping and configuration of branches, both clonal characteristics, influence susceptibility to trunk snap and branch break. Faulty and unbalanced nutrition is another pre-disposing factor causing wind damage (Pillai, 1980).

Young plantations with heavy canopy may show stem bending and require corrective pruning and roping. Susceptibility to wind damage is the greatest at the time of maximum girthing and canopy development. Trees with narrow crotches are more prone to wind damage. Tracts with strong wind should be avoided for cultivation of rubber (Rao and Vijayakumar, 1992).

2.2 Effect of elevation on the performance of rubber

In Sri Lanka, at high elevations high incidence of *Oidium* led to retarded growth and poor bark renewal (Chandrasekhara, 1972). Similar observations have also been made in India.

In an experiment conducted at West Java Experiment Station to compare the performance of *Hevea* at two locations, 515 m and 250 m above mean sea level, it was found that there was considerable retardation of growth at high elevations (Foth and Turk, 1973). The plants at lower elevation reached tappability by the end of fifth year while the plants at higher elevations came into tapping only at the end of the seventh year. Experiments indicated that the immaturity period was increased by six months for every 100 m rise in attitude. Bark thickness was also considerably lesser at high elevation. High yielding clones at lower elevations were not high yielders when planted at high elevations.

Pushpadas and Karthikakutty Amma (1980) reported that growth of rubber has been found satisfactory up to 450 m above mean sea level. At higher elevations, temperature becomes unfavourable for proper growth. At low temperature, the rate of biochemical and physiological processes generally decreases. At very low temperature, dessication or death of tissues may result from freeze injury.

Most of the rubber plantations in Kerala are found in the midland region which has elevations varying from a few meters in the west to about 450 m in the east. Eventhough the performance of rubber is comparatively poor under high elevations, several cases of successful establishment of economic units can be noticed in

some of these areas such as Wynad in Kerala, where distributed rainfall and good soil conditions prevail.

According to Rao and Vijayakumar (1992) in tropical low elevation areas, a mean monthly temperature of 26°C to 28°C with adequate soil moisture and sunshine were associated with high production.

2.3 Effect of management practices on the performance of rubber

Adoption of appropriate agro-techniques has long been recognised as the surest means of sustaining high levels of productivity in rubber.

Joseph and Nair (1984) found that by adopting polybag plants of advanced growth, the trees could be brought into tapping, one year earlier. Ramachandran (1992) reported that polybag plants produced better growth when compared to other methods.

Napitipulu (1977), Ng *et al.* (1979), Satheesan *et al.* (1982) and Webster and Baulkwill (1989) had reported that increased density of planting resulted in lower tree girth, biomass and crown, higher crotch height and lighter branching. Virgin bark and renewed bark also became thinner with high stand per hectare. The reduction in thickness was more pronounced in the renewed bark (Ng *et al.*, 1979). Because of these effects, yield per tree tended to be lower with increased number of trees per unit area. In addition to this, percentage of tappable trees in a field during the initial year of tapping also decreased with increasing density, thus affecting yield per unit area.

In India, the Rubber Board (1995) recommends a maximum population of 500 plants per hectare.

The beneficial effects of establishing leguminous cover crops in immature rubber plantations are reduction in weeding cost, maintenance of moisture, control of soil erosion, fixation of nitrogen, addition of organic matter and reduction in soil temperature (Potty *et al.*, 1980).

Judicious nutrient management is the surest way of increasing yield in rubber. Manurial trials on rubber in different rubber growing countries have confirmed good response of the tree to the application of fertilizers. The mineral composition of *Hevea* was reported to be influenced by soil fertility status (Dijkman, 1951). The effect of various nutrient elements on growth of *Hevea* was also established from the studies conducted in Malaysia (Bolle Jones, 1954).

The nutrient requirement of *Hevea* varies with stages of growth. In India, Nair (1956) suggested a blanket recommendation based on soil fertility status and the observations from fertilizer trials on rubber conducted in different locations. The experiments indicated that the response of rubber is directly related to soil available nutrients and leaf nutrient status (Ananth *et al.*, 1966; Potty *et al.*, 1976). A discriminatory approach was therefore proposed as the most efficient and economic method for optimum fertilizer use (Pushpadas and Ahamed, 1980).

The effectiveness of mulching and lime washing in young rubber to protect the plants from drought during summer were reported by Potty *et al.* (1980).

Rubber tree is susceptible to several diseases but their economic importance and severity vary with climatic conditions, clones and cultural practices adopted.

Abnormal leaf fall caused by *Phytophthora* spp. is an annually recurring disease of rubber in India causing severe yield losses ranging from 38-56 per cent in susceptible clones. Pillai (1977); George *et al.* (1980) and Abraham (1991) found that RRII 105 was tolerant to this disease.

Powdery mildew caused by the fungus *Oidium heveae* attacks the immature leaflets when trees refoliate after the annual wintering, causing secondary leaf fall. Saraswathy Amma *et al.* (1987) reported that RRII 105 and RRIM 600 were showing low disease intensity while PB 235 was highly susceptible.

Pink disease caused by *Corticium salmonicolor* is the only important stem disease of rubber. The fungus attacks the bark of the main stem and branches of 3-7 years old immature trees. The severity of attack varies from one locality to another according to rainfall pattern. A few clones are known to be of above average in susceptibility, but most cultivars are prone to the disease (Liyanage and Jacob, 1992).

Abraham and Hashim (1983) recommended the tapping systems for different cultivars. The schedule covered conventional tapping from opening to felling for clones and seedlings separately over a period of 25 to 28 years.

High intensity of exploitation is known to promote incidence of tapping panel dryness in rubber. The proportion of dry trees increased with tapping intensity

and particularly with tapping frequency (Bealing and Chua, 1972; Paranjothy *et al.*, 1976).

While the growth of trees and production of rubber are satisfactory and economical upto an elevation of 450 m MSL, a few grow rubber at high elevation and claim that it is profitable. However, no systematic attempts were made to analyse growth and yield of rubber trees at higher elevation in Kerala. The present study was taken up in this context.

MATERIALS AND METHODS

MATERIALS AND METHODS

The study was conducted with clone RRII 105 of *H. brasiliensis*, the most popular cultivar in the country. Tree growth and yield were assessed both at low and high elevation locations in Thodupuzha taluk of Idukki district. The management practices adopted by the growers were also studied. The data gathered relate to the period 1994-95.

For collection of data, 30 units planted with RRII 105 during 1981, for which subsidy permits were issued by the Rubber Board, were selected as below.

From low elevation area (Upto 450 m, above MSL)	- 15 units
From high elevation area (Above 450 m, above MSL)	- 15 units

A map showing the villages of Thodupuzha taluk is attached as Annexure-I. List of the units selected for the study is given in Annexure-II.

Details of previous girth increments and cultural practices adopted were collected from the available records kept in the Rubber Board Regional Office, Thodupuzha. The individual holdings were visited and the details regarding management practices adopted, growth, mode of tapping, yield, incidence of pests and diseases were collected based on a pre-tested interview schedule (Annexure-III). The data regarding the present girth and bark thickness (using bark guage) were actually measured. The available meteorological data on mean monthly rainfall and

temperature were collected from the Kerala State Electricity Board, Idukki and Taluk Office, Thodupuzha.

The data thus gathered were tabulated and summarised.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

Thodupuzha taluk of Idukki district represents an area suitable for rubber cultivation. The topography of the area is highly undulating. The main occupation of the people is agriculture and about 85 per cent of the population depend directly or indirectly on agriculture. Apart from lower elevations, rubber cultivation has been now extended to high elevation also. The important clone in this area is RRII 105.

4.1 Climate prevailing in the area

4.1.1 Rainfall

The data on monthly rainfall and number of rainy days in high and low elevation areas of Thodupuzha taluk from 1992 to 1994 are furnished in Tables 1 and 2 respectively. The results indicated that the rainfall received during the three years under high elevation ranged from 3670.60 mm to 4317.60 mm. During the three year period the average annual rainfall was 4089.03 mm and the average number of rainy days 177.99. Compared to this, in low elevation areas, rainfall received during the three years ranged from 2402 mm to 3454 mm. The average annual rainfall during the three year period was 2976.49 mm, the average number of rainy days being 149.32. The data also revealed that the South West monsoon extended from June to August and North East monsoon from October to November. December, January, February and March were the drier months with very few showers. Occasional summer showers were obtained during April and May.

According to Pushpadas and Karthikakutty Amma (1980) rubber growing regions in Kottayam, Idukki, Alappuzha, Ernakulam and Thrissur receive an annual rainfall of 2000-4500 mm where the growth is optimum. The data indicate that

Table 1. Mean monthly rainfall and number of rainy days at high elevation areas of Thodupuzha taluk

Month	1992		1993		1994		Mean	
	Rainfall (mm)	No.of days	Rainfall (mm)	No.of days	Rainfall (mm)	No.of days	Rainfall (mm)	No.of days
January	0.50	1	-	-	60.10	3	20.20	1.33
February	3.40	1	57.70	3	19.80	4	26.97	2.67
March	-	-	26.10	5	5.20	1	10.43	2.00
April	207.68	11	96.50	9	126.00	12	143.06	10.67
May	215.40	14	114.30	14	46.80	7	125.50	11.67
June	1054.10	27	805.00	28	1027.20	29	962.10	28.00
July	1056.65	31	1070.30	31	1129.60	31	1085.50	31.00
August	799.10	29	640.00	30	829.10	30	756.06	29.66
September	525.30	24	265.90	23	333.00	20	374.73	22.33
October	269.30	17	458.10	25	602.60	28	443.33	23.33
November	143.10	15	125.70	14	137.40	10	135.40	13.00
December	3.85	3	12.40	3	1.00	1	5.75	2.33
Total	4278.38	173	3670.60	185	4317.80	176	4089.03	177.99

Table 2. Mean monthly rainfall and number of rainy days at low elevation areas in Thodupuzha taluk

Month	1992		1993		1994		Mean	
	Rainfall (mm)	No.of days	Rainfall (mm)	No.of days	Rainfall (mm)	No.of days	Rainfall (mm)	No.of days
January	-	-	-	-	75.00	4	25.00	1.33
February	-	-	40.00	2	48.00	2	29.33	1.33
March	-	-	30.00	4	15.00	2	15.00	2.00
April	157.00	11	120.00	12	249.00	16	175.33	13.00
May	296.00	16	261.00	10	172.00	11	243.00	12.33
June	554.00	24	527.00	25	731.00	26	604.00	25.00
July	884.50	26	549.00	28	604.00	27	679.27	27.00
August	350.00	24	316.00	21	539.00	22	401.67	22.33
September	256.00	20	96.00	10	293.00	11	215.00	13.67
October	382.00	18	369.00	21	657.00	25	269.33	21.33
November	194.00	14	84.00	10	71.00	5	116.33	3.67
December	Nil	-	10.00	1	-	-	3.33	0.33
Total	3073.50	153	2402.00	144	3454.00	151	2976.49	149.32

Thodupuzha taluk receives sufficient rainfall for rubber cultivation both in low and in high elevations.

4.1.2 Temperature

The data collected on the mean monthly temperature recorded during 1993 and 1994 from high elevation area of Thodupuzha taluk is furnished in Table 3. It could be seen that this area enjoyed a maximum temperature of 34.11°C and a minimum of 20.38°C. The annual variation in temperature was negligible. From the study it was observed that the temperature in this region was ideal for rubber cultivation. The observation made by Pushpadas and Karthikakutty Amma (1980) is in agreement with that of the present study. The data on temperature in low elevation could not be obtained as the same were not available.

4.2 Management practices

Studies were conducted on the adoption of different practices namely population density, weeding, manuring, intercropping, cover cropping and plant protection in immature and mature plantations both in high and low elevations.

4.2.1 Immature plantations in low and high elevations

The data gathered on different management practices in immature area are furnished in Table 4 and 5. In high elevation area, initial planting was done with a density ranging from 487 to 621 with a mean of 560. Rubber Board (1995) recommends an optimum plant population density of 500 plants per ha. As a whole, the planting density observed in the units showed a higher trend and this is mainly because of the smallness of the holding and a trend of planting more plants through

Table 3. Mean, maximum and minimum temperature at high elevation areas of Thodupuzha taluk

Month	1993		1994		Mean	
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
January	30.12	20.38	29.77	21.83	29.95	21.11
February	32.08	22.14	31.27	22.60	31.68	22.37
March	32.85	24.32	33.30	22.63	33.08	23.48
April	34.11	24.88	33.50	24.83	33.81	24.86
May	33.44	24.89	31.90	26.06	32.67	25.48
June	28.33	23.13	26.42	23.35	27.38	23.24
July	26.40	21.77	27.24	22.80	26.82	22.29
August	27.51	22.33	27.06	22.58	27.29	22.46
September	29.35	22.96	28.89	22.63	29.12	22.80
October	29.89	22.60	29.03	23.01	29.46	22.81
November	28.75	22.81	29.20	23.61	28.98	23.21
December	28.80	21.99	29.23	23.35	29.01	22.77
Mean	30.13	20.77	29.73	23.27	29.94	23.07

Table 4. Holding size, population density and extent of adoption of agrotechniques by the growers in high and low elevation areas during mature and immature stages

Practices	High elevation		Low elevation	
	Immature	Mature	Immature	Mature
Holding size				
Mean (ha)	0.39	0.39	0.52	0.52
Range (ha)	0.21-1.1	0.21-1.1	0.26-1.32	0.26-1.32
Population density (No./ha)				
Mean	560	449	475	471
Range	487-621	298-500	446-658	401-573
Weeding				
No. adopted	15	15	15	15
Percentage of adoption	100	100	100	100
Manuring				
No. adopted	15	0	15	0
Percentage of adoption	100	0	100	0
Intercropping				
No. adopted	13	-	13	-
Percentage of adoption	86.6	-	86.6	-
Cover cropping				
No. adopted	15	-	15	-
Percentage adoption	100	-	100	-

Table 5. Extent of adoption of plant protection measures by the growers in high and low elevation areas during mature and immature stages

Practices	High elevation		Low elevation	
	Immature	Mature	Immature	Mature
Protection against drought				
No. adopted	15	-	15	-
Percentage of adoption	100	-	100	-
Spraying				
No. adopted	3	3	4	4
Percentage adoption	20	20	26.6	26.6
Dusting				
No. adopted	1	1	0	0
Percentage of adoption	6.6	6.6	0	0
Protection against pink disease				
No. adopted	15	13	15	15
Percentage of adoption	100	86.6	100	100

the boundaries. Out of the 15 units, only two units (13.3%) followed the recommended density. In low elevation area, initial planting was done with a density ranging from 446 to 658 per ha with a mean of 475. Here, out of the 15 units, seven units (46%) adopted the recommendations of Rubber Board.

Weeding was done regularly by spade weeding, slashing and pulling out. Manuring was adopted as per the recommendations of the Rubber Board. Many scientists reported the advantages of judicious fertilizer application in rubber (Dijkman, 1951; Bolle Jones, 1954; Nair, 1956; Ananth *et al.*, 1966; Potty *et al.*, 1976).

The data furnished in Table 4 indicated that intercropping was followed in 13 units out of 15 (86.66%) in the high elevation area. In six units ~~plantations~~ Plantains and banana were intercropped during first and second year. Brinjal was also planted in one unit along with banana and plantains. In the other five units, banana and plantains were intercropped upto the third year. In three units, pepper was also grown as an intercrop. In one unit, banana and plantains were interplanted during second and third year. In one unit Ginger was interplanted during first and second years along with pepper. In two units, no intercrops were grown. The beneficial effects of intercropping using banana is reported by Rubber Research Institute of Malaysia (1972).

In low elevation area (Table 5), 13 growers adopted intercropping; Elayam units were interplanted with banana and plantains along with ginger, turmeric, colocasia and amorphophallus. In one unit, ginger, turmeric and colocasia were interplanted during the first and second years. In one unit, tapioca was planted during the first year and colocasia in the second year. In two units, there were no intercrops.

Data, furnished in Table 4 indicate that in all the units, the leguminous cover crop *Pueraria phaseoloides* was planted during second, third and fourth year after interplanting. The beneficial effects of establishing cover crops in immature rubber plantations were reported by Potty *et al.* (1980).

It was also found that in both the elevations all the units adopted shade or mulching in the first year and white washing for three or four years (Table 5). The effectiveness of mulching and white washing in young plants to protect from drought during summer were reported by Potty *et al.* (1980).

The results showed that in high elevation, out of the 15 units, only in three units (20%) spraying against abnormal leaf fall was done during the immature period (Table 5). In two units spraying was done only in the first year. In the other 10 units no spraying was carried out.

In low elevation areas, spraying was carried out in four units (26.66%). In four units, spraying was done only in the first three years, in one unit, spraying was done only for the first two years, in three units, it was done for the first year and in three units there was no spraying at all. Pillai (1977), George *et al.* (1980) and Abraham (1991) found that RRII 105 was tolerant to abnormal leaf fall disease.

The data also indicated that in high elevation areas, out of the 15 units only in one unit dusting was adopted against powdery mildew (6.6%). Compared to this in low elevation area, dusting was not at all adopted in any of the units studied. Saraswathy Amma *et al.* (1987) reported that RRII 105 is showing low disease intensity.

The data also show that the plants in both high and low elevations were affected by pink disease which were properly treated with Bordeaux mixture. Liyanage and Jacob (1992) reported that the severity of attack varies from one locality to another according to rainfall pattern and the cultivars.

4.3.2 Mature plantations in low and high elevations

The different management practices adopted by the growers in mature rubber plantations in high and low elevations are furnished in Table 4 and 5.

The stand per hectare ranged from 298 to 500 in the units selected in high elevation with a mean of 449. In low elevation areas it ranged from 401 to 573.

Table 4 indicated that weeds were not a problem since in all the units selected, leguminous cover crops were established. But occasional slashing and pulling out was done. In cover cropped area, the leguminous cover crops reduce weed growth (Rubber Board, 1995).

The data in Table 4 show that manuring was not strictly based on the recommendations of the Rubber Board in all the selected holdings. But in 12 units of high elevation areas, chemical fertilizers were applied. The quantity and type of fertilizer applied varied from grower to grower. In three units, cowdung was also applied along with fertilizers. In the other three units, only cowdung was applied.

The data furnished in Table 4 indicated that 100 per cent of growers did not strictly adopt the recommendations of the Rubber Board. Fourteen growers applied chemical fertilizers and one grower applied cowdung. Adoption of

discriminatory fertilizer usage is the most efficient and economic method of improving productivity (Pushpadas and Ahamed, 1980). The results show that the extension efforts of the Board are to be strengthened in respect of manuring in this area.

The data in Table 5 showed that spraying against abnormal leaf fall was not carried out in 12 units out of 15 in high elevation area. In two units, spraying was done regularly. In another unit, spraying was done in all the years except during 1993 and 1994.

Spraying was carried out only in 26.6 per cent of the holdings in low elevation areas (Table 5). In one unit, spraying was done up to 1992. In one unit, spraying was done for three years after tapping started. Only in two units, spraying was done regularly. RRII 105 is reported to have fair tolerance to the abnormal leaf fall disease (Pillai, 1977; George *et al.*, 1980 and Abraham, 1991).

The data in Table 5 reveal that generally, growers in high elevation did not adopt any control measures against powdery mildew caused by *Oidium* eventhough the attack was severe. Out of the 15 units selected, in one unit dusting was done, that too only in 1990. Pillai *et al.* (1989) reported that leaf fall caused by powdery mildew disease adversely affects the growth and yield of rubber tree.

Dusting was not carried out in any of the holdings selected in low elevation (Table 6) and it is stated that powdery mildew disease is very mild in the low elevation areas.

Sethuraj and George (1980) had reported that the portion of bark tapped off during a year should be treated with wound dressing compound during the period of wintering every year. The data in Table 4 and 5 indicated that when all growers

in low elevation adopted panel protection measures, only 13 growers adopted it, in high elevation.

4.3.4 Girth of the plants

The data on mean girth of the plants during 7th year and 14th year in high elevation areas are furnished in Table 6. Average girth during 7th year after planting in high elevation localities ranged from 30 cm to 45 cm. The mean girth was 38.1 cm. The plants in none of the units attained tappable girth. Thus immaturity period is found elevated at higher elevations. During year 1994-95 i.e., 14th year of field planting the average girth recorded in the 15 selected holdings ranged from 50 cm to 63 cm with a mean of 56.1 cm. The mean girth increment during this period (7th to 14th year) worked out to be 17.93 cm.

The girth during 7th year after planting in the low elevation areas ranged from 43 cm to 55 cm, the average girth being 49 cm (Table 7). During 1994-95, the average girth recorded in the 15 selected holdings was 69.2 cm, the range being 60 cm to 78 cm. The mean girth increment was 20.2 cm during this period. The results indicated that the plants in higher elevation recorded slow rate of growth when compared to those in respect of lower elevation in terms of girth increments. This confirms the findings of Foth and Turk (1973).

4.3.5 Brown bast (Tapping panel dryness)

This is a physiological disorder in most of the high yielding clones. Incidence of tapping panel dryness in high elevation localities is furnished in Table 8. it was found that 5.17 per cent trees were affected by panel dryness under ½ Sd/2 system.

Table 6. Girth of trees during 7th year and girth during 1994-95 in high elevation areas of Thodupuzha taluk

Sl. No.	Name and address	Average girth during 7th year (cm)	Average girth during 1994-95 (cm)	Girth increment 7th-14th year (cm)
1	Anice Jose, Edasseril Maniyaramkudy,P.O.	31	58	27
2	Mathew Kurian, Pottananickal Chalachuvadu,P.O.	45	60	15
3	Varghese Jose, Puthenpurayil Chelachuvadu,P.O.	37	58	21
4	Daivathan Cehallappan Thekkeparampil, Chelachuvadu,P.O.	37	56	19
5	Kuttiamma Mathew, Mylackal Keerithodu,P.O.	37	53	16
6	Aleyakutty Thomas Ayyananickal, Keerithodu,P.O.	40	53	13
7	Joseph Thomas, Thundiyil Churulipathal, Alpara,P.O.	40	53	13
8	Avirah George, Pamparayil Churuli, Chelachuvadu,P.O.	43	63	20
9	Mathai Varghese Karottuthachoor, Alpara,P.O.	30	50	20
10	Joseph Ulahannan, Kallattu Thudanganadu, P.O.	39	58	11
11	Joseph Scaria & Thomas Keemattathil, Chelachuvadu,P.O.	40	58	18
12	Augusthy Varghese Chettaniyil, Thadiyampadu,P.O.	44	55	11
13	Joseph Joseph Naduvethettu Thadiyampadu, P.O.	36	58	23
14	P.V.Varghese, Puthenpurackal Kathiparathadom, Chelachuvadu,P.O.	35	58	23
15	Joseph Mary, Naduvathettu Thadiyampadu, P.O.	38	58	20
	Mean	38.1	56.1	17.93

Table 7. Girth of trees during 7th year and girth during 1994-95 in low elevation areas of Thodupuzha taluk

Sl. No.	Name and address	Average girth during 7th Year (cm)	Average girth during 1994-95 (cm)	Girth increment 7th-14th year (cm)
1	Baby Jacob, Pallickamyalil Elamdesom,P.O.	48	73	25
2	V.M.Chacko & V.M.Jose Varacheril, Vazhithala	52	73	21
3	Mother Superior, Adoration Convent, Muttom, P.O.	45	62	17
4	K.K.Ulahanan, Kadalimattathil Karimkunnam, P.O.	43	70	27
5	P.V.Emmanuel, Pallikunnel Ezhumuttom,P.O.	46	63	14
6	Baby Joseph, Chirackal Nediyasala,P.O.	50	62	12
7	Antony Augusthy A.Augustin (PAH) Inchananiyil, Kuninji,P.O.	55	75	20
8	N.D.Varghese Perumbananiyil, Vazhithala,P.O.	52	74	22
9	Augusthy Antony Inchananiyil, Kuninji,P.O.	55	78	23
10	C.V.Varghese, Chellooparambil Ezhumuttom,P.O.	50	67	17
11	Iype Skaria, Kanjirakombil Puthupariyaram, P.O.	48	69	21
12	Mary Skaria, Kanjirakombil Puthupariyaram,P.O.	48	69	21
13	Johny,M.J., Moolasseril Karimannoor,P.O.	48	69	21
14	V.C.Thomas, Varumgalakudy Mailacombu, P.O.	48	74	26
15	N.V.Johan, Nedumaruthumchailil Arikuzha,P.O.	47	60	13
	Mean	49.0	69.2	20.2

Table 8. Incidence of brown bast in high elevation areas of Thodupuzha taluk during 1994-95

Sl. No.	Name and address	Year of opening	System of tapping	No. of trees tapped	No. of days tapped	No. of plants affected by brown bast	Percent
1	Anice Jose, Edasseril, Maniyaramkudy,P.O.	1988	S2d2	230	96	7	3.04
2	Mathew Kurian, Pottananickal Chelachuvadu,P.O.	1988	S2d2	140	90	7	5.00
3	Varghese Jose, Puthenpurayil Chelachuvadu,P.O.	1989	S2d2	110	98	5	4.55
4	Daivathan Chellappan Theckeparambil, Chelachuvadu,P.O.	1990	S2d2	170	95	8	4.71
5	Kuttiamma Mathew, Mylackal Keerithodu,P.O.	1990	S2d2	100	93	3	3.00
6	Aleyakutty Thomas, Ayyannikkal Keerithode,P.O.	1990	S2d2	110	92	4	3.64
7	Joseph Thomas, Thundiyil Churulipathal, Alpara,P.O.	1980	S2d2	230	124	46	20.00
8	Avirah George, Pamparayil, Churuli	1988	S2d2	100	112	5	5.00
9	Mathew Varghese, Karottuthachoor Alpara,P.O.	1990	S2d2	155	118	6	3.87
10	Joseph Ulahannan, Kallattu, Thadiyampadu	1989	S2d2	150	125	25	16.67
11	Joseph Scaria & Thomas, Keemattathil Chelachuvadu,P.O.	1989	S2d2	200	120	2	1.00
12	Augusthy Varghese, Chettaniyil Thadiyampadu,P.O.	1989	S2d2	135	98	3	2.22
13	Jose Joseph, Naduvathettu Thadiyampadu,P.O.	1989	S2d2	520	86	5	0.96
14	P.V.Varghese, Puthenpurackal Kathiparathadom	1990	S2d2	180	95	4	2.22
15	Joseph Mary, Naduvathettu Thadiyampadu,P.O.	1989	S2d2	180	87	3	1.67
	Mean			180.66	101.93	8.86	5.17

$S_2d_2 = \frac{1}{2} S_4/2$

In low elevation localities (Table 9) 6.23 per cent trees were affected by panel dryness. In serial No.11 and 12, ½ Sd/3 tapping was followed and in serial No.11 only 0.89 per cent of trees were affected by panel dryness. In serial No.12, not even a single tree was affected by panel dryness. The data indicated that the incidence of the disease was not associated with difference in elevation and that it was associated with high intensity of tapping as reported by Sethuraj (1976) and Paardekooper (1989).

4.3.6 Wind damage, drought and wintering

The data on extent of natural calamities and period of wintering in high elevation localities are furnished in Table 10. Out of 2860 mature rubber trees 44 trees were damaged by wind. The extent of wind damage was 2.16 per cent and damage occurred only in three units, out of 15 units selected. The data also reveal that rubber was not affected by drought in high elevation. It is also revealed that the period of wintering was during December.

In low elevation localities (Table 11), out of 3654 mature rubber trees, 38 were damaged by wind and this worked out to 1.04 per cent. Damage was noticed only in three units out of 15 units surveyed. Out of 3654 trees, 90 trees were damaged by drought and was recorded only in two units. Percentage of damage was worked out 2.26. In these two units, drought occurred due to the presence of rock underneath. Wintering took place in January in this area. The results showed that the wind damage was not very severe in both low and high elevations.

Table 9. Incidence of brown bast in low elevation areas of Thodupuzha taluk during 1994-95

Sl. No.	Name and address	Year of opening	System of tapping	No. of trees tapped	No. of days tapped	No. of plants affected by brown bast	Percent
1	Baby Jacob, Pallickamyalil, Elamdesom,P.O.	1987	S2d2	245	128	50	20.41
2	V.M.Chacko & V.M.Jose, Varacheril Vazhithala,P.O.	1987	S2d2+ S2d1	155	134	5	3.45
3	Mother Superior, Adoration Convent Muttom,P.O.	1988	S2d2	300	96	7	2.33
4	K.K.Ulahannan, Kadalimattathil Karimkunnam	1987	S2d2+ S2d1	280	120	20	7.14
5	P.V.Emmannuel, Pallikunnel Ezhumuttom,P.O.	1989	S2d2+ S2d1	250	124	13	5.20
6	Baby Joseph, Chirackal, Nediyasala,P.O.	1987	S2d2	160	128	8	5.0
7	Antony Augusthy, Inchenaniyil, Kuninji,P.O.	1988	S2d2	145	117	15	10.34
8	N.D.Varghese, Perumbanani, Vazhithala,P.O.	1988	S2d2	250	102	6	2.40
9	Augusthy Antony, Inchananiyil, Kuninji,P.O.	1989	S2d2	160	100	2	1.25
10	C.V.Varghese, Chellooparambil Ezhumuttom,P.O.	1988	S2d2	600	120	8	1.33
11	Iype Skaria, Kanjirakompil Puthupariyaram,P.O.	1988	S2d2	225	82	2	0.89
12	Mary Skaria, Kanjirakombil Puthupariyaram,P.O.	1987	S2d2	125	82	Nil	-
13	Johny,M.J., Moolasseril, Karimannoor,P.O.	1988	S2d2	225	106	5	2.22
14	V.C.Thomas, Varangalakudiyil Mailacombi,P.O.	1987	S2d2	200	140	40	20.00
15	N.V.John, Nedumaruthumchalil Arikuzha,P.O.	1987	S2d2	130	142	15	11.54
	Mean			230	114.73	13.6	6.23

$S_2d_2 = 1/2\ S_1d_2$

Table 10. Natural calamities and period of wintering in high elevation areas of Thodupuzha taluk

Sl. No.	Name and address	Year of planting	Area (ha)	Total No.of trees	No. of trees affected by wind	Percent-age	No. of trees affected by drought	Percent-age	Period of wintering
1	Anice Jose, Edaseril Maniyaramkudy	1981	0.47	240	4	1.67	Nil	-	December
2	Mathew Kurian Pottananickal Chelachuvadu,P.O.	"	0.28	140	-	-	-	-	"
3	Varghese Jose, Puthenpurayil Chelachuvadu,P.O.	"	0.34	130	20	15.38	-	-	"
4	Daivathan Chellappan Thecheparambil	"	0.37	185	-	-	-	-	"
5	Kuttiamma Mathew, Mylackal Keerithodu	"	0.24	110	-	-	-	-	"
6	Aleykutty Thomas Ayyananickal	"	0.25	130	20	15.38	-	-	"
7	Joseph Thomas, Thundiyil	'	0.47	230	-	-	-	-	"
8	Avirah George, Pamparayil	"	0.20	110	-	-	-	-	"
9	Mathew Varghese Karottuthachoor	"	0.39	155	-	-	-	-	"
10	Joseph Ulahannan, Kallattu	"	0.31	165	-	-	-	-	"
11	Joseph Skaria & Thomas Keemattathil	"	0.37	205	-	-	-	-	"
12	Augusthy Varghese Chettaniyil	"	0.31	145	-	-	-	-	"
13	Joseph Joseph, Naduviladathu	"	1.10	545	-	-	-	-	"
14	P.T.Varghese, Puthenpurackal	"	0.36	1380	-	-	-	-	"
15	Joseph Mary, Naduviladathu	"	0.41	190	-	-	-	-	"
	Total		5.87	2860	44				
	Mean		0.39	190.66	2.93	2.16			

Table 11. Natural calamities and period of wintering in low elevation areas of Thodupuzha taluk

Sl. No.	Name and address	Year of planting	Area (ha)	Total No.of trees	No. of trees affected by wind	Percentage	No. of trees affected by drought	Percentage	Period of wintering
1	Baby Jacob, Pallickamyalil Elemdesom,P.O.	1981	0.53	245	14	5.71	Nil	Nil	January
2	V.M.Chacko & V.M.Jose Varacheril, Vazhithala,P.O.	"	0.30	155	-	-	"	"	"
3	Mother Superior, Adoration Convent, Muttom,P.O.	"	0.60	325	-	-	"	"	"
4	K.K.Ulahanan, Kadalimattathil Karimkunnan	"	0.72	295	-	-	40	13.56	"
5	P.V.Emmanuel, Pallikunnel Ezhumuttom,P.O.	"	0.54	275	-	-	Nil	Nil	"
6	Baby Joseph, Chirackal Nediyasala,P.O.	"	0.38	175	-	-	"	"	"
7	Antony Augusthy, Inchananiyil Kuninji,P.O.	"	0.33	150	-	-	"	"	"
8	N.D.Varghese, Perumbananiyil Vazhithala	"	0.53	264	14	5.3	"	"	"
9	Augusthy Antony, Inchananiyil Kuninji,P.O.	"	0.44	180	10	5.56	"	"	"
10	C.V.Varghese, Chellooparambil Ezhumuttom,P.O.	"	1.32	615	-	-	"	"	"
11	Iype Skaria, Kanjirakompil Puthupariyaram	"	0.61	245	-	-	90	20.41	"
12	Mary Skaria, Kanjirakompil Puthupariyaram	"	0.30	130	-	-	Nil	Nil	"
13	Johny,M.J., Moolasseril Karimannoor	"	0.41	235	-	-	"	"	"
14	V.C.Thomas, Varungalakudy Mylacombu	"	0.56	225	-	-	"	"	"
15	N.V.Johan, Nedumaruthumchalil	"	0.26	140	-	-	"	"	"
	Total		7.83	3654	38		90		
	Mean		0.52	243.6	2.53	1.04	6	2.26	

4.3.7 Productivity

The data on number of tapping days obtained per year, tapping rest given, time of tapping, system of tapping adopted, depth of tapping and adoption of rainguarding during 1994-95 pertaining to high elevation are furnished in Table 12. It was observed that tapping rest was given during January and February. Number of tapping days obtained ranged from 87 to 125. Tapping rest was not given in two units. In one unit, tapping rest was limited to 35 days. It was also observed that early tapping was done and the system of tapping adopted was ½ Sd/2 in all units. Tapping was found deep in 12 units. Shallow tapping was found in two units and in only one unit optimum depth was noted. Only in two units rainguarding was adopted.

In low elevation area (Table 13), the number of tapping days obtained ranged from 82 to 142. Tapping rest ranging from 30 to 60 days were given in 12 units. Tapping rest was not given in three units. It was also observed that early tapping was followed and the system of tapping adopted was ½ Sd/2 in 10 units, ½ Sd/3 in two units and ½ Sd/2 + ½ Sd/1 in three units. Deep tapping was followed in 10 units and optimum depth was seen in five units. Rainguarding was done only in two units.

The data on total yield from the unit and yield per hectare in high elevation area are furnished in Table 14. The average yield hectare^{-1} ranged from 916 kg to 1482 kg (calculated as yield per tree x 310 trees). In low elevation areas (Table 15) the average yield hectare^{-1} ranged from 1266 kg to 2621 kg. The average yield of rubber in India is 1215 kg hectare^{-1}. In Thodupuzha taluk, the average yield in

Table 12. Tapping details of holdings in high elevation areas of Thodupuzha taluk during 1994-95

Sl. No.	Name and address	Year of planting	Year of opening for tapping	No. of days tapped during 1994-95	Tapping rest given	Time of tapping	Tapping method	Depth of tapping	Remarks
1	Anice Jose, Edasseril Maniyaramkudy,P.O.	1981	1988	96	58 days	Early	S2d2	Deep	
2	Mathew Kurian, Pottananickal Chelachuvadu,P.O.	1988	1988	90	"	"	"	Optimum depth	
3	Varghese Jose, Puthenpurayil Chelachuvadu	1981	1989	98	35 days	"	"	Deep	
4	Daivathan Chellappan Thekkeparampil, Chelachuvadu	1981	1990	95	58 days	"	"	"	
5	Kuttiamma Mathew, Mylackal Keerithodu,P.O.	1981	1990	93	January/ February	"	"	"	
6	Aleykutty Thomas Ayyannanickal, Keerithodu	1981	1990	92	"	"	"	"	
7	Joseph Thomas, Thundiyil Churulipathal, Alpara	1981	1989	124	No tapping rest	"	"	"	
8	Avirah George, Pamparayil Churuli	1981	1988	112	"	"	"	"	
9	Mathew Varghese Karottuthachoor, Alpara	1981	1990	118	60 days	"	"	"	Rain-guarding done
10	Joseph Ulahannan, Kallattu Thadiyampadu	1981	1989	125	January/ February	"	"	"	"
11	Joseph Scaria & Thomas Keemattathil, Chelachuvadu	1981	1989	120	No tapping rest	"	"	"	
12	Augusthy Varghese Chettaniyil, Thadiyampadu	1981	1989	98	January/ February	"	"	"	
13	Jose Joseph, Naduvathettu Thadiyampadu,P.O.	1981	1989	86	"	"	"	Shallow	
14	P.V.Varghese, Puthenpurackal Kathiparathadan	1981	1990	95	"	"	"	Deep	
15	Joseph Mary, Naduvathettu Thadiyampadu	1981	1989	87	"	"	"	Shallow	

$S_2d_2 = \frac{1}{2} S d_2$

Table 13. Tapping details of holdings in low elevation areas of Thodupuzha taluk during '94-95

Sl. No.	Name and address	Year of planting	Year of opening for tapping	No. of days tapped during 1994-95	Tapping rest given	Time of tapping	Tapping method	Depth of tapping	Remarks
1	Baby Jacob, Pallickamyalil Elemdesom,P.O.	1981	1987	128	35	Early	S2d2	Deep	Rain-guarding done
2	V.M.Chacko & V.M.Jose Varacheril, Vazhithala,P.O.	1981	1987	134	40	"	S2d2+ S2d1	"	
3	Mother Superior, Adoration Convent, Muttom,P.O.	1981	1988	96	35	"	S2d2	"	
4	K.K.Ulahannan Kadalimattathil, Karimkunnam	1981	1987	120	40	"	S2d2+ S2d1	"	
5	P.V.Emmanuel, Pallikunnel Ezhumuttom,P.O.	1981	1989	124	40	"	"	"	
6	Baby Joseph, Chirackal Nediyasala,P.O.	1981	1987	128	0	"	S2d2	"	"
7	Antony Augusthy Inchananiyil, Kuninji,P.O.	1981	1988	117	0	"	"	"	
8	N.D.Varghese, Perumbanani Vazhithala,P.O.	1981	1988	102	60	"	"	Optimum depth	
9	Augusthy Antony, Inchananiyil	1981	1989	100	35	"	"	Trees attained tappability in 1988. But tapping started in 1989	
10	C.V.Varghese, Chellooparampil Ezhumuttom,P.O.	1981	1988	120	0	"	"	Deep	
11	Iype Skaria, Kanjirakompil Puthupariayaram	1981	1987	82	30	"	S2d3	Optimum depth. Owner himself is the tapper	
12	Mary Skaria, Kanjirakompil	1981	1987	82	30	"	"	" son of the owner is the tapper	
13	Johny,M.J., Moolasseril Karimannoor	1981	1988	106	30	"	"	Deep	
14	V.C.Thomas, Varangalakudiyil Mylacombu,P.O.	1981	1987	140	35	"	"	Optimum depth	
15	N.V.John, Nedumanathuchalil Arikuzha,P.O.	1981	1987	142	30	"	"	Deep	

$S_2d_2 = 1/2\ S_d/2$

Table 14. Total yield and yield per ha during 1994-95 in high elevation areas of Thodupuzha taluk

Sl. No.	Name and address	Year of planting	Area (ha)	Year of opening	Total years tapped	Total yield	No. of trees under tapping during 1994-95	Yield obtained during 1994-95	Yield per ha during 1994-95 (yield/ tree x 310 trees)
1	Anice Jose, Edasseril Nediyasala,P.O.	1981	0.47	1988	7	4868	230	744	1002
2	Mathew Kurian, Pottananickal Chelachuvadu,P.O.	1981	0.28	1988	7	2501	140	414	916
3	Varghese Jose, Puthenpurayil Chelachuvadu,P.O.	1981	0.34	1989	6	2542	110	471	1327
4	Daivathan Chellappan Thekkeparampil, Chelachuvadu	1981	0.37	1990	5	2199	170	532	970
5	Kuttiamma Mathew, Mailackal Keerithodu,P.O.	1981	0.24	1990	5	2185	100	478	1482
6	Aleykutty Thomas Ayyannickal, Keerithodu	1981	0.25	1990	5	1668	110	364	1026
7	Joseph Thomas, Thundiyil Alpara,P.O.	1981	0.47	1989	6	3785	230	926	1248
8	Avirah George, Pamparayil Churuli	1989	0.20	1988	7	2578	100	419	1298
9	Mathew Varghese Karottuthachoor, Alpara	1981	0.39	1990	5	2667	155	677	1354
10	Joseph Ulahannan, Kallattu Thadiyampadu,P.O.	1981	0.31	1989	6	3126	150	560	1157
11	Joseph Scaria & Thomas Keemattathil	1981	0.37	1989	6	4027	200	772	1196
12	Augusthy Varghese Chetaniyil, Thadiyampadu	1981	0.31	1989	6	3132	135	522	1194
13	Joseph Joseph, Naduvathettu Thadiyampadu,P.O.	1981	1.10	1989	6	7562	520	1668	994
14	P.V.Varghese, Puthenpurackal Kathiparathadan	1981	0.36	1990	5	2992	180	586	1009
15	Joseph Mary, Naduvathettu Thadiyampadu,P.O.	1981	0.41	1989	6	3304	180	678	1167

Table 15. Total yield and yield per ha during 1994-95 in low elevation areas of Thodupuzha taluk

Sl. No.	Name and address	Year of planting	Area (ha)	Year of opening	Total years tapped	Total yield	No. of trees under tapping during 1994-95	Yield obtained during 1994-95	Yield per ha during 1994-95 (yield per tree x 310 trees)	Remarks
1	Baby Jacob, Pallickamyalil Elemdesom,P.O.	1981	0.53	1987	8	8552	206	1138	2013	
2	V.M.Chacko & V.M.Jose Varacheril, Vazhithala	1981	0.30	1987	8	5469	155	794	1588	49 days tapped in 1987
3	Mother Superior, Adoration Convent, Muttom,P.O.	1981	0.60	1988	7	8022	300	1302	1345	
4	K.K.Ulahannan, Kadalimattathil Karimkunnam	1981	0.72	1987	8	9729	280	1491	1650	1987-88 tapping done for 35 days
5	P.V.Emmanuel, Pallikunnel Ezhumuttom, P.O.	1981	0.54	1989	6	5394	250	1226	2621	1987-88 tapping done for 30 days
6	Baby Joseph, Chirackal Nediyasala,P.O.	1981	0.38	1987	8	6705	160	1049	2032	In 1987, 22 days tapped
7	Antony Augusthy, Inchananiyil Kuninji,P.O.	1981	0.33	1988	7	5399	130	852	2046	
8	N.D.Varghese, Perumbanani Vazhithala,P.O.	1981	0.53	1988	7	7875	250	1238	1535	
9	Augusthy Antony, Inchananiyil Kuninji	1981	0.44	1989	6	5277	160	960	1860	
10	C.V.Varghese, Chellooparampil Ezhumuttam,P.O.	1981	1.32	1988	7	19145	600	3628	1874	
11	Iype Skaria, Kanjirakompil Puthupariyaram	1981	0.61	1987	8	8426	225	927	1277	
12	Mary Skaria, Kanjirakompil Puthupariyaram	1981	0.30	1987	8	4589	125	56	1378	During 1987-88 tapping done for 30 days
13	Johny,M.J., Moolasseril Karimannoor,P.O.	1981	0.41	1988	7	5356	225	919	1266	"
14	V.C.Thomas, Varumgalakudiyil Mailacombu,P.O.	1981	0.56	1987	8	8475	200	1226	1900	
15	N.V.John, Nedumaruthumchalil Arikuzha	1981	0.26	1987	8	4321	130	642	1530	During 1987, 40 days tapped

all holdings was well above the national average in low elevation areas and in five holdings lying in high elevation.

4.3.8 Bark thickness

The data collected on bark thickness (virgin and renewed) of plants in high elevation is given in Table 16. Thickness of virgin bark ranged from 9 to 12 mm and the thickness of renewed bark ranged from 5 to 8 mm.

The data on bark thickness of plants in low elevation are given in Table 17. Here, thickness of virgin bark ranged from 9 to 13 mm and the thickness of renewed bark ranged from 6 to 9 mm. From the study, it was found that the rate of growth of renewed bark was not good, in high elevation localities when compared to low elevation area. This confirms the finding of Chandrasekhara (1972).

4.3.9 Period of immaturity

Table 18 indicates the period of immaturity in high elevations. Out of the 15 units selected, in three units, it took eight years for attaining tappability, in seven units it took nine years and in five units it took 10 years.

The immaturity period in low elevation (Table 19) revealed that in eight units, it took seven years for attaining tappability, in six units it took eight years and in one unit it took nine years.

From the study it was found that immaturity period in high elevation areas is eight to ten years and in low elevation areas it is seven to nine years.

Table 16. Bark thickness (virgin and renewed) of trees (April, 1995) in high elevation areas of Thodupuzha taluk

Sl. No.	Subsidy permit No.	Name and address	Year of opening	Thickness of virgin bark (mm)	Thickness of renewed bark (mm)
1	PD/TH/671/81(A)	Anice Jose, Edasseril Maniyarankudy,P.O.	1988	10	7
2	" 363 "	Mathew Kurian, Pottananickal Chelachuvadu,P.O.	1988	9	6
3	" 677 "	Varghese Jose, Puthenpurayil Chelachuvadu,P.O.	1989	10	6½
4	" 365 "	Daivathan Chellappan Thekkeparampil, Chelachuvaru,P.O.	1990	11	7
5	" 259 "	Kuttiamma Mathew, Mylackal Keerithodu,P.O.	1990	10	7
6	" 581 "	Aleykutty Thomas, Ayyannickal Keerithodu,P.O.	1990	10	7
7	" 252 "	Joseph Thomas, Thundiyil Alpara,P.O.	1989	9	6
8	" 490 "	Avirah George, Pamparayil Churili, Chelachuvadu,P.O.	1988	12	7
9	" 253 "	Mathew Varghese Karottuthachoor, Alpara,P.O.	1990	10	5
10	" 402 "	Joseph Ulahannan, Kallattu Thadiyampadu,P.O.	1989	10	7
11	" 321 "	Joseph Scaria & Thomas Keemattathil, Chelachuvadu,P.O.	1989	10	7
12	" 321 "	Augusthy Varghese, Chettaniyil Thadiyampadu,P.O.	1989	10	7
13	" 285 "	Jose Joseph, Naduviledathu Thadiyampadu	1989	10	8
14	" 676 "	P.V.Varghese, Puthenpurackal Kathiparathadam	1990	10	7
15	" 528 "	Joseph Mary, Naduviledathu Thadiyampadu	1989	10	7

Table 17. Bark thickness (virgin and renewed) of tree (May, 1995) in low elevation areas of Thodupuzha taluk

Sl. No.	Subsidy Permit No.	Name and address	Year of opening	Thickness of virgin bark (mm)	Thickness of renewed bark (mm)
1	PD/TH/96/81(A)	Baby Jacob, Pallickamyalil Elamdesom	1987	13	9
2	" 49 "	V.M.Chacko & V.M.Jose Varacheril, Vazhithala	1987	10	9
3	" 274 "	Mother Superior, Adoration Convent, Muttom, P.O.	1988	10	9
4	" 579 "	K.K.Ulahannan, Kadalimattathil Karimkunnam	1987	11	8
5	" 779 "	P.V.Emmanuel, Pallikunnel Ezhumuttom,P.O.	1989	9	6
6	" 52 "	Baby Joseph, Chirackal Nediyasala,P.O.	1987	10	7
7	" 387 "	Antony Augusthy, Inchananiyil Kuninji, P.O.	1988	10	7
8	" 610 "	N.D.Varghese, Perumbanani Vazhithala	1988	11	8
9	" 709 "	Augusthy Antony, Inchenaniyil Kuninji	1989	10	8
10	" 741 "	C.V.Varghese, Chellooparampil Ezhumuttom	1988	10	7
11	" 75 "	Iype Skaria, Kanjirakompil Puthupariyaram	1987	10	8
12	" 87 "	Mary Skaria, Kanjirakompil Puthupariyaram	1987	10	8
13	" 565 "	John,M.J., Moolasseril Karimannoor	1988	11	8
14	" 34 "	V.C.Thomas, Varumgalakudy Mailacombu	1987	13	9
15	" 218 "	N.V.John, Nedumaruthumchalil Arikuzha,P.O.	1987	11	8

Table 18. Period of immaturity in high elevation areas of Thodupuzha taluk

Sl. No.	Name and house name	Year of planting	Year of opening	Immaturity period (years)
1	Anice Jose, Edasseril	1981	1988	8
2	Mathew Kurian, Pottananickal	1981	1988	8
3	Varghese Jose, Puthenpurayil	1981	1989	9
4	Daivathan Chellappan, Thekkeparampil	1981	1990	10
5	Kuttiamma Mathew, Mylackal	1981	1990	10
6	Aleykutty Thomas, Ayyannickal	1981	1990	10
7	Joseph Thomas, Thundiyil	1981	1989	9
8	Avirah George, Pamparayil	1981	1988	8
9	Mathew Varghese, Karottuthachoor	1981	1990	10
10	Joseph Ulahannan, Kallattu	1981	1989	9
11	Joseph Scaria & Thomas, Keemattathil	1981	1989	9
12	Augusthy Varghese, Chettaniyil	1981	1989	9
13	Jose Joseph, Naduvathettu	1981	1989	9
14	P.V.Varghese, Puthenpurackal	1981	1990	10
15	Joseph Mary, Naduvathettu	1981	1989	9

Table 19. Period of immaturity in low elevation areas of Thodupuzha taluk

Sl. No.	Name and House name	Year of planting	Year of opening	Period of immaturity (years)
1	Baby Jacob, Pallickamyalil	1981	1987	7
2	V.M.Chacko & V.M.Jose, Varacheril	1981	1987	7
3	Mother Superior, Adoration Convent	1981	1988	8
4	K.K.Ulahannan, Kadalimattathil	1981	1987	7
5	P.V.Emmanuel, Pallikunnel	1981	1989	9
6	Baby Joseph, Chirackal	1981	1987	7
7	Antony Augusthy, Inchananiyil	1981	1988	8
8	N.D.Varghese, Perumbanany	1981	1988	8
9	Augusthy Antony, Inchananiyil	1981	1989	9
10	C.V.Varghese, Chellooparampil	1981	1988	8
11	Iype Skaria, Kanjirakompil	1981	1987	7
12	Mary Skaria, Kanjirakompil	1981	1987	7
13	Johny,M.J., Moolasseril	1981	1988	8
14	V.C.Thomas, Verumgalakudy	1981	1987	7
15	N.V.John, Nedumaruthumchalil	1981	1987	7

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

An attempt was made to compare the performance of RRII 105 at high elevations and low elevations in Thodupuzha taluk of Idukki district. Primary data were collected through personal visits and interviews with the help of a pretested interview schedule. Secondary data were gathered from the records available at the Rubber Board Regional Office, Thodupuzha.

It is found that the average annual rainfall for three years was 4089.03 mm and the average number of rainy days as 177.99 in higher elevations. In low elevation areas it is 2976.49 mm and the average number of rainy days as 149.32.

For the study, 15 units, each planted with RRII 105 during 1981 for which subsidy permits issued from Rubber Board were selected from low and high elevations ie., up to 450 m above MSL and above 450 m respectively. Units selected in high elevation area ranged from 525 m above MSL to 780 m above MSL. All the growers used RRII 105 budded stumps for planting. Planting density observed in the unit showed a higher trend. The study also revealed that the growth of plants in high elevation was not satisfactory when compared to the plants in low elevations. From the study it was found that immaturity period in high elevation area was eight to ten years and in low elevations it was seven to nine years. The girth increment was also found to be less in high elevation areas. The average yield obtained was little less when compared to the national average in high elevation areas. The study showed that tapping panel dryness is negligible in high elevation localities when compared to low elevation. Wind damage is also very negligible in both the localities. The study

showed that the growers in this area are not strictly adopting the fertilizer recommendations of the Rubber Board in mature area.

The study has also revealed that majority of the growers are not adopting spraying since RRII 105 was found tolerant to abnormal leaf fall disease. Eventhough the attack of powdery mildew was severe in high elevation areas, majority of the growers were not adopting dusting.

The study thus revealed that growth and yield performance of RRII 105 is comparatively poor in high elevation areas.

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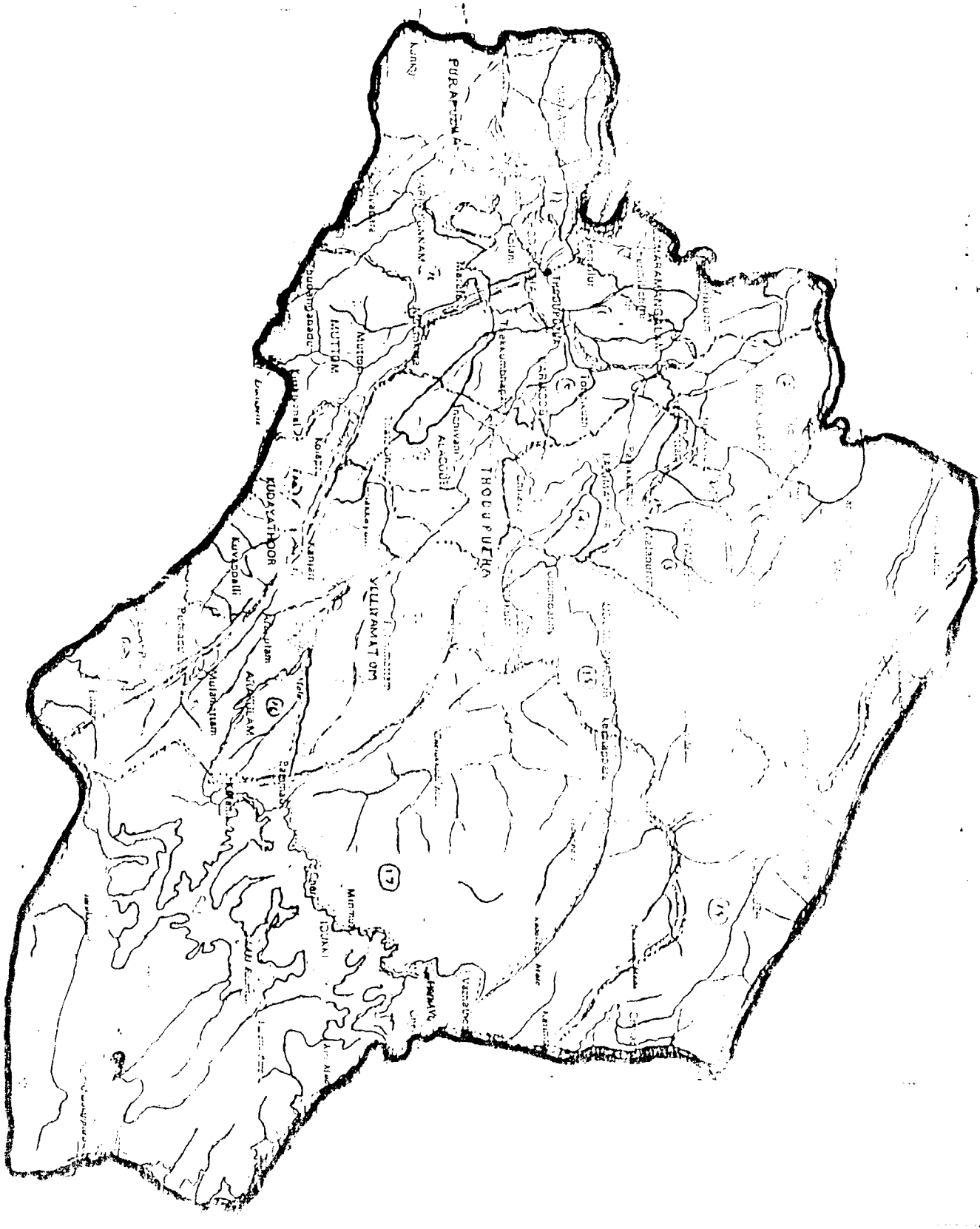
ANNEXURES

ANNEXURE-I
MAP OF THODUPUZHA TALUK SHOWING THE VILLAGES



ANNEXURE-II

List of units selected for the study

Sl. No.	Name and address	Permit No.	Area (ha)	Elevation (metre)
1	2	3	4	5
1	Smt.Anice Joy, Edasseril Maniyarankudy,P.O.	PD/TH/671-81(A)	0.47	660
2	Shri.Mathew Kurian Pottannickal, Chelachuvadu,P.O.	PD/TH/363-81(A)	0.28	525
3	Shri.Varghese Jose Puthenpurayil, Chelachuvadu,P.O.	PD/TH/677-81(A)	0.34	675
4	Sri.Daivathan Chellappan Thekkeparampil, Chelachuvadu,P.O.	PD/TH/365-81(A)	0.37	615
5	Smt.Kuttiamma Mathew Mylackal, Keerithode,P.O.	PD/TH/259-81(A)	0.24	660
6	Smt.Aleykutty Thomas Ayyannickal, Keerithode,P.O.	PD/TH/581-81(A)	0.25	578
7	Sri.Joseph Thomas Thundiyil, Churulipathal Alpara,P.O.	PD/TH/252-81(A)	0.47	750
8	Sri.Avirah George Pamparayil, Churuli Chelachuvadu,P.O.	PD/TH/490-81(A)	0.20	510
9	Shri.Mathew Varghese Karottuthachoor Alpara,P.O., Idukky	PD/TH/253-81(A)	0.39	780
10	Shri.Joseph Ulahannan Kallattu, Thadiyampadu,P.O.	PD/TH/402-81(A)	0.31	660
11	Shri.Joseph Scaria & Thomas Keemattathil, Chelachuvadu,P.O.	PD/TH/318-81(A)	0.37	578
12	Shri.Augusthy Varghese Chettaniyil, Thadiyampadu,P.O.	PD/TH/321-81(A)	0.31	660

Contd.

Annexure-II.Continued

1	2	3	4	5
13	Sri.Jose Joseph Naduvathettu Thadiyampadu,P.O.	PD/TH/285-81(A)	1.10	705
14	Shri.P.V.Varghese Puthenpurackal Kathiparathodom Chelachuvadu,P.O.	PD/TH/676-81(A)	0.36	675
15	Smt.Joseph Mary Naduvathettu Thadiyampadu,P.O.	PD/TH/528-81(A)	0.41	705
16	Shri.Baby Jacob Pallickamyalil, Elamdesom,P.O.	PD/TH/96-81(A)	0.53	60
17	S/s.V.M.Chacko & V.M.Jose Varacheril, Vazhithala,P.O.	PD/TH/49-81(A)	0.30	60
18	Mother Superior Adoration Convent Muttom,P.O.	PD/TH/274-81(A)	0.60	97
19	Shri.K.K.Ulahannan Kadalimattathil Karimkunnam, P.O.	PD/TH/579-81(A)	0.72	60
20	Shri.P.V.Emmanuel Pallikunnel, Ezhumuttom,P.O.	PD/TH/779-81(A)	0.54	75
21	Shri.Baby Joseph Chirackal, Nediyasala,P.O.	PD/TH/52-81(A)	0.38	135
22	Shri.Antony Augusthy Inchananiyil, Kuninji,P.O.	PD/TH/387-81(A)	0.33	75
23	Shri.N.D.Varghese Perumbanani, Vazhithala,P.O.	PD/TH/610-81(A)	0.53	90
24	Shri.Augusthy Antony Inchananiyil, Kuninji,P.O.	PD/TH/709-81(A)	0.44	120

Contd.

Annexure-II Continued

1	2	3	4	5
25	Shri.C.V.Varghese Chellooparampil Ezhumuttom,P.O.	PD/TH/741-81(A)	1.32	90
26	Sri.Iype Skaria Kanjirakompil Puthuppariyaram,P.O. Thodupuzha	PD/TH/75-81(A)	0.61	90
27	Smt.Mary Skaria Kanjirakompil Puthuppariyaram,P.O. Thodupuzha	PD/TH/87-81(A)	0.30	90
28	Shri.Johny,M.J. Moolasseril, Karimkunnam,P.O.	PD/TH/565-81(A)	0.41	105
29	Shri.V.C.Thomas Varumgalakudy Mailacombu,P.O. Thodupuzha	PD/TH/34-81(A)	0.56	45
30	Shri.N.V.John Nedumaruthumchalil Arikkuzha,P.O.	PD/TH/218-81(A)	0.26	60

ANNEXURE-III

PERFORMANCE OF RRII-105 IN HIGHER ELEVATIONS OF THODUPUZHA TALUK IN IDUKKY DISTRICT

INTERVIEW SCHEDULE

1. Name and address of the owner :

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

3. Locations of the estate : District Taluk Village

4. Data of visit :

5. Area under rubber
   a) Mature rubber

Year of planting	Extent	Planting material	No.of plants planted	No.of plants now exist	Spacing

b) Immature rubber

Year of planting	Extent	Planting material	No. of plants	Spacing

6. Elevation of the area :

7. Type of soil :

8. Early historyof the mature area :
   a) Intercropping

	Variety
Ist year	
IInd year	
IIIrd year	
IVth year	
Vth year	

b) Leg cover (year of planting and establishment :

9. Lie of the land

a) Flat :
b) Slopy :
c) Steep :
d) Others :

10. Type of planting

a) Replanting :
b) New planting :

11. Cultural operations

a) Contour line planting :
b) Square planting :
c) Pits size :
d) Soil conservation by contour terraces :
e) Noncontour terraces :
d) Silt pits :

12. Variety of clone used for planting :

13. Type of planting materials used

a) Budded stumps :
b) Polybag planting :
Green bud :
Brown bud :
c) Others

14. Girth increment during immaturity period

3rd year :
4th year :
5th year :
6th year :
7th year :

15. Weeding

a) Clean weeding :
b) Slashing of weeds :
c) Weedicide application :

d) Others :

16. Manuring

a) Pit manuring (compost/cowdung/Mussoriephos etc.) :

b) Type of mixture :

c) Quantity :

d) Method of application :

e) Time of application :

f) Mulching :

17. Other maintenance operations

a) Irrigation :

b) Fire belt :

18. Whether the area is exclusively planted/interplanted :

19. Details of other trees present in the area : 1.

2.

3.

4.

20. Details of plant protection measures adopted

a) Sparaying :
b) Dusting :
c) Pannel protection measures :

21. Disease Incidence

a) Abnormal leaf fall :
b) Powdery mildew :
c) Pink disease :
d) Root disease :
e) Deficiency of nutrients :

22. Natural calamities

a) Wind damage :
b) Drought :

23. Wintering

a) Period :
b) Nature (Partial or complete) :

24. Particulars of mature area and yield

1. Year of planting :
2. Extent :
3. Year of opening for tapping :
4. No. of trees opened :
5. Variety of planting materials :
6. Average girth of the tree :
7. No. of days tapped :
8. Tapping rest given and days :
9. Time of tapping (early or late) :
10. System of tapping :
11. Yield/year of tapping :
12. Sheet (kg) :
13. Scrap (kg) :
14. Latex :
15. Others :
16. Total yield :
17. Yield/ha :
18. Remarks :

25. Rainguarding adopted or not :

26. Whether tapping is done by the owner himself or by paid tapper :

27. Whether tapping done by using headlight :

28. If yes, the time of tapping :

29. Whether yield stimulant is applied or not :

30. If yes, the method of application and its frequency :

31. Which panel is under tapping :

32. Depth of tapping

    a) Deep :
    b) Shallow :
    c) Optimum depth :

33. Brown bast incidence ;

34. Growth of plants, nature of bark renewal and panel diseases :

35. Bark thickness

    a) Virgin :
    b) Renewed :

36. Remarks, if any :

Signature of the student