J. Rubb. Res. Inst. Malaysia, **30(3)**, 117 – 122

Harvesting of Shoots for Rubber Extraction in Hevea

S.K. LEONG, W. LEONG and P.K. YOON

It is possible to extract rubber from shoots harvested from source bushes of Hevea. *The rubber content varies with clones, maturity of shoots and cultural practices.*

Though the method gives slightly lower yield than that obtained from conventional tapping, it has its potential uses. By breeding and selection and improved cultural practices, it is likely that dry matter production and rubber content can be increased in clones of Hevea. *The harvesting of shoots from source bushes for extraction of rubber may become a promising method in the rubber industry.*

The current method of harvesting rubber from the *Hevea* tree is developed from Ridley's invention of excision tapping[1]. Extensions of this method, which include the different lengths of tapping cut and frequencies of tapping, are many[2,3,4]. More recently, puncture tapping has regained interest and is being researched on actively[5-8]. This method is incision tapping and involves making punctures on the bark with a needle. Both methods of harvesting are non-destructive and the tree is tapped for twenty to thirty years before being replaced.

This paper presents work carried out to investigate the harvesting of rubber by a destructive method. Rubber in the guayule shrub *(Parthenium argentatum* Gray) is extracted by destructive harvesting and grinding of the plant[9,10]. One method is to dig up the shrub including the roots for extraction in the mill. Alternatively, guayule can be harvested by the 'pollarding method' whereby the bushes are pollarded off at about 5 cm above the ground so that only the stem, branches and leaves are harvested for rubber extraction. The stumps are left to regenerate new growth. Similarly, source bushes of *Hevea* may be pollarded back and the shoots harvested for the extraction of rubber.

MATERIALS AND METHODS

Source bushes were pollarded back to brown wood and shoots were obtained from them for the determination of dry matter and rubber content. Shoots of several clones at various stages of maturity were taken and separated into the component parts of leaves, petioles and stems. These were dried to constant weight in the oven for dry weight determination. Samples of the dried materials were analysed for rubber content.

The rubber extraction method used in this study is a laboratory method of Middleton and Westgarth[11] based on an iodimetric procedure. The efficiency with which rubber in plant tissue is determined depends on the effectiveness of the extraction process, on the extent to which interfering substances are removed, and in the way in which the sample is prepared for analysis. The rubber impregnated tissues have to remain in contact with the

COMMUNICATION 699

solvent 16-24 h before the extraction of rubber.

RESULTS AND DISCUSSION

Rubber Content

A study of the rubber content of *Hevea* material shows that it varies with maturity of shoots, different vegetative components and different clones.

Maturity of shoots. Initial analysis of the rubber content of one-whorl, two-whorl and three-whorl shoots from a mixture of clonal materials showed that two-whorl shoots had the highest rubber content *(Table 1).* Middleton and Westgarth[11] have found that brown stems had about 50% less rubber than green stems. Since the three-whorl shoot would have greater amount of brown tissues than the two-whorl shoot, the reduction of rubber content in the older material could be due to the higher percentage of brown tissues.

TABLE 1. RUBBER CONTENT OF ONE-, TWO- AND THREE-WHORL SHOOTS

Shoot	Rubber (%)	
	Leaves	Stem
1-whorl	0.12	0.74
2-whorl	0.60	2.10
3-whorl	0.41	0.91

Vegetative components. Subsequent analysis of the component parts of two-whorl shoots from the mixture of clonal materials showed that the percentage rubber content was highest in the petiole. This was followed by the stem with the lowest rubber content in the leaves *(Table 2).* Except for the stem, other values agreed with those obtained by Middleton and Westgarth[11].

TABLE 2. PERCENT RUBBER CONTENT OF VEGETATIVE PARTS

Vegetative part	Present study	Middleton & Westgarth[11]
Leaves	0.38	0.44
Petioles	1.80	1.93
Stem	1.32	0.60

Clonal variation. Results of analysis of two-whorl shoots of RRIM 600, RRIM 623, RRIM 712, PB 86 and PB 5/51 show clonal variation in the rubber content *(Table 3).* Working on petioles only, Fernando and Samaranayake[12] had indicated there were clonal differences which ranged from 1.81% to 2.31%.

TABLE 3. CLONAL VARIATION IN RUBBER CONTENT

Clone	Rubber (%)		
	Petioles	Leaves	Stem
RRIM 600	2.05	0.43	1.31
RRIM 623	2.02	0.43	1.23
RRIM 712	1.50	0.38	1.70
PB 86	1.37	0.26	1.07
PB 5/51	2.08	0.39	1.31

Dry Matter Production

Since the rubber harvested is dependent on the percentage rubber content and dry matter production, the dry weights of two-whorl shoots of several clones were studied.

Clonal variation. Results showed there were variations in dry weight among the clones RRIM 600, RRIM 623, RRIM 712, PB 86 and PB 5/51 *(Table 4).* In addition, the distribution of dry weight to the leaves, petioles and stems of the shoot varied with clones.

TABLE 4. CLONAL VARIATION IN DRY WEIGHT PRODUCTION AND DISTRIBUTION

Clone	Dry weight of 100 shoots (g) Petioles	Leaves	Stem	Total
RRIM 600	1 130 (20.5)	2 770 (50.2)	1 620 (29.3)	5 520 (100)
RRIM 623	840 (14.9)	3 460 (61.6)	1 320 (23.5)	5 620 (100)
RRIM 712	1 520 (18.1)	4 250 (50.7)	2 610 (31.2)	8 380 (100)
PB 86	760 (15.6)	2 930 (60.0)	1 190 24.4)	4 880 (100)
PB 5/51	1 000 (22.6)	2 300 (51.9)	1 130 (25.5)	4 430 (100)
Mean	1 050 (18.2)	3 142 (54.5)	1 574 (27.3)	5 766 (100)

Figures within brackets indicate percentages.

Density of planting. The total rubber production is a function of the amount of shoots produced per unit area of land per year. For destructive harvesting, shoot production is influenced by the planting density as shown in *Table 5.* Within each density, the number of shoots per bush also varies as shown in the frequency distribution of shoots scored *(Figure 1).* The probable number of shoots per bush for each planting density is obtained from the modal values of these distribution curves.

The frequency of pollarding also influenced the number of shoots produced. Our experience suggests that harvesting at four times a year would be likely to produce the number of two-whorl shoots given in *Table 5.*

Rubber Production

Rubber production per unit area per year is the total dry matter harvested multiplied by the appropriate rubber content of the component parts. Based on the mean value of percent dry weight distribution given in *Table 4* and the mean rubber content of the component parts from *Table 2,* the possible rubber produc-

TABLE 5. DRY WEIGHT PRODUCTION OF SHOOTS

Planting distance (cm)	Density per hectare	No. of shoots per bush	No. of shoots per harvest	No. of harvests per year	Dry weight[a] (kg/ha/year)
120 × 90	8 970	4.3	38 571	4	8 796
120 × 60	13 455	4.8	64 584	4	14 896
120 × 30	26 910	3.9	104 949	4	24 205
90 × 90	11 960	3.6	43 056	4	9 930
90 × 60	17 940	3.5	62 790	4	14 482
90 × 30	35 880	3.5	125 580	4	28 964
60 × 60	26 910	3.6	96 876	4	22 343
(60 × 30) 4+90	47 950	4.4	210 976	4	48 660
60 × 30	53 820	4.4	236 808	4	54 617

[a]Calculations based on 100 shoots = 5766 g (from *Table 4*).

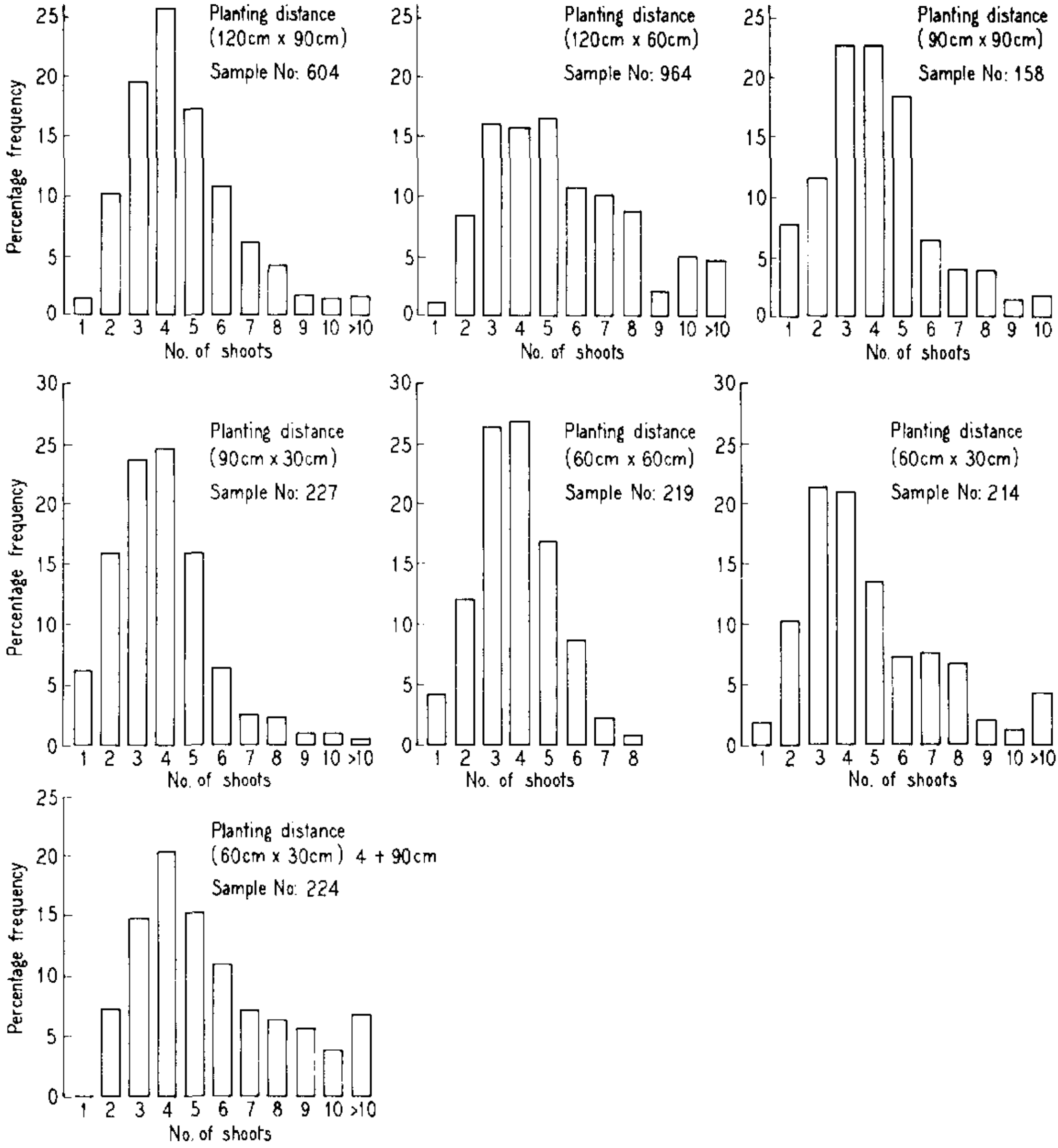

Figure 1. Frequency distribution of shoots.

tion can be calculated for various plant densities *(Table 6)*. It is seen that the rubber production ranged from 80 kg per hectare per year to 492 kg per hectare per year. An indication of the highest yield possible may be obtained from the highest values for rubber content, dry matter and shoot production of the best clones. One such value estimated is a yield of 952 kg per hectare per year.

TABLE 6. TOTAL RUBBER PRODUCTION

Planting distance (cm)	Dry weight (kg)			Rubber production[a] (kg/ha/year)			
	Petioles	Leaves	Stem	Petioles	Leaves	Stem	Total
120 × 90	1 619.1	4 848.3	2 428.6	29.1	19.4	31.6	80.1
120 × 60	2 711.1	8 118.3	4 066.6	48.8	32.5	52.9	134.2
120 × 30	4 405.3	13 191.7	6 608.0	79.3	52.8	85.9	218.0
90 × 90	1 807.3	5 411.9	2 710.9	32.5	21.6	35.2	89.3
90 × 60	2 635.7	7 892.7	3 953.6	47.4	31.6	51.4	130.4
90 × 30	5 271.4	1 578.5	7 907.1	94.9	63.1	102.8	260.8
60 × 60	4 066.4	12 176.9	6 099.6	73.2	48.7	79.3	201.2
(60 × 30) 4 + 90	8 856.1	26 519.7	13 284.2	159.4	106.1	172.7	438.2
60 × 30	9 940.3	29 766.3	14 910.4	178.9	119.1	193.8	491.8

[a]*Yield calculated based on the following assumptions*

Percentage dry weight distribution : petioles 18.2; leaves 54.5; stem 27.3 (from *Table 4*)

Percentage total rubber content : petioles 1.8; leaves 0.4; stem 1.3 (from *Table 2*)

CONCLUSION

The present investigation has shown that rubber production by extraction from shoots ranged from 80 kg to 492 kg per hectare per year. This is below the average yield of 1200 kg per hectare expected of modern *Hevea* clones from conventional tapping[13]. However, using the highest values for rubber content, dry matter production and shoot production from the best clones, a yield of 952 kg per hectare per year can be obtained. This indicates that a reasonable yield can be obtained from this method of destructive harvesting of rubber.

Even if the method does give slightly lower yield than that obtained from conventional tapping, it has its potential uses in the planting industry which is facing an increasing shortage of skilled labour. The harvesting of rubber from source bushes can be carried out earlier than conventional tapping, producing a return to capital investment from the second year of planting. This method can also be considered for use in locations where normal tapping is often hindered by the high frequency of rainy days. The destructive method by source bush harvesting, which can be mechanised, can be a suitable alternative to tapping. By breeding and selection and improved cultural practices, it is conceivable that rubber content, dry matter production and shoot production can be increased and the harvesting of rubber from source bushes may become a promising method in the rubber industry.

ACKNOWLEDGEMENT

The authors wish to thank the Director of Rubber Research Institute of Malaysia, Dato' (Dr) Haji Ani bin Arope for permission to publish this paper. Thanks are also due to Messrs Gerard Sta Maria and Leong Hing Tong for their technical assistance. The Analytical Group of the Engineering and Testing Services Division is gratefully acknowledged for carrying out the rubber analysis.

Rubber Research Institute of Malaysia
Kuala Lumpur *September 1981*

REFERENCES

1. WYCHERLEY, P.R. (1959) The Singapore Botanic Gardens and Rubber in Malaya. *Gdns' Bull. Singapore,* **17(2)**, 175.

2. RUBBER RESEARCH INSTITUTE OF MALAYA (1940) The International Notation for Tapping Systems. *J. Rubb. Res. Inst. Malaya,* **10**, 26.

3. RUBBER RESEARCH INSTITUTE OF MALAYA (1954) Tapping Systems. *Plrs' Bull. Rubb. Res. Inst. Malaya No. 15,* 103.

4. ABRAHAM, P.D., P'NG, T.C., LEE, C.K., SIVAKUMARAN, S. AND LEONG WING (1973) R.R.I.M. Ethrel Trials on Estates : Further Results. *Proc. Rubb. Res. Inst. Malaysia Plrs' Conf. Kuala Lumpur 1973,* 74.

5. LEONG, T.T. AND TAN, H.T. (1977) Results of Chemara Puncture-tapping Trials. *Proc. Rubb. Res. Inst. Malaysia Plrs' Conf. Kuala Lumpur 1977,* 111.

6. ABRAHAM, P.D., ANTHONY, J.L., GOMEZ, J.B., SIVAKUMARAN, S. AND ISMAIL HASHIM (1979) Towards Automated Micro Tapping of *Hevea. Proc. Rubb. Res. Inst. Malaysia Plrs' Conf. Kuala Lumpur 1979,* 182.

7. ISMAIL HASHIM, P'NG, T.C., CHEW, O.K., ABRAHAM, P.D. AND ANTHONY, J.L. (1979) Micro Tapping and the Development of Micro-x System. *Proc. Rubb. Res. Inst. Malaysia Plrs' Conf. Kuala Lumpur 1979,* 128.

8. RAMACHANDRAN, P. AND LEE, T.P. (1979) Preliminary Results of Socfin Puncture Tapping Trials. *Proc. Rubb. Res. Inst. Malaysia Plrs' Conf. Kuala Lumpur 1979,* 166.

9. HAMMOND, B.L. AND POLHAMUS, L.G. (1965) Research on Quayule (*Parthenium argentatum*) 1942-1959. *U.S. Dep. Agric. Tech. Bull. 1327.*

10. BAIRD, L.E. (1975) Guayule – the Viable Second Source of Natural Rubber. *Rubb. Wld.,* **44**.

11. MIDDLETON, K.R. AND WESTGARTH, D.R. (1963) Determination of Rubber in the Vegetative Parts of *Hevea brasiliensis. Analyst,* **88**, 544.

12. FERNANDO, D.M. AND SAMARANAYAKE, P. (1968) The Deterioration of Rubber in Samples of *Hevea* Tissues. *Q. Jl. Rubb. Res. Inst. Ceylon,* **44**, 31.

13. RUBBER RESEARCH INSTITUTE OF MALAYSIA (1976) Performance of Clones in Commercial Practice. Tenth Report. *Plrs' Bull. Rubb. Res. Inst. Malaysia No. 144,* 60.