



UNIVERSITI PUTRA MALAYSIA

**EFFECT OF PUNCTURE TAPPING SYSTEMS ON YIELD
AND SELECTED PHYSIOLOGICAL LATEX PARAMETERS
OF RUBBER (*HEVEA BRASILIENSIS* MUELL. ARG.)**

SALVADOR RUIZ ARROYO

FP 1996 6

**EFFECT OF PUNCTURE TAPPING SYSTEMS ON YIELD
AND SELECTED PHYSIOLOGICAL LATEX PARAMETERS
OF RUBBER (*HEVEA BRASILIENSIS* MUELL. ARG.)**

By

SALVADOR RUIZ ARROYO

**Thesis submitted in Fulfilment of the Requirements
for the Degree of Master of Agricultural Science
in the Faculty of Agriculture
Universiti Pertanian Malaysia**

September 1996



ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the Vocal of the Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP) of México Ing. Jorge Kondo Lopez for the scholarship award and support.

I would like to thank Dr. Heriberto Roman Ponce Director del Centro de Investigacion Regional del Golfo Centro for his approval, support and encouragement on these studies.

I would like to thank Dr. Abdul Azis b. Sheikh Abdul Kadir, Director of the Rubber Research Institute of Malaysia (RRIM) for all the facilities to do the research project.

I am particularly grateful to Associate Professor Dr. Wong Kai Choo (UPM), Chairman of Supervisory Committee, Dr. S. Sivakumaran (RRIM) and Dr. Yeang Hoong Yeet (RRIM), members of Supervisory Committee, for their valuable guidance, encouragement and support throughout the research and preparation of the thesis. My thanks are also given to Dr. Sheikh Awadz Abdullah (UPM), member of Supervisory Committee, for his valuable discussions and comments on the thesis.



My special thanks are given to Mr. Mohd Akbar b. Md., Dr. Chong Kewi and Dr. H. Ghandimati for their valuable discussions and comments on the research project. Mr Mohd Akbar is also thanked for the translation of the abstract to Bahasa Malaysia.

I would like to thank to all staff of Crop Management Division, specially to Mrs. Parameswari, Mr. Tharmalingam, Mr. R. Surendran, Mr. Sukumaran as well as Mrs. Latifah and Mr. A. S. M. Zamri of Biotechnology Division for their technical guidance and support on this project.

I would like to thank Mr. Tajjudin b. Ismail, Manager of RRIES for provision of accommodation.

This thesis is specially dedicated to the memory of my youngest brother Nicolás Ruiz Arroyo who passed away in August 1994.

I am indebted to my parents, brothers and sisters for their infinite love, encouragement and support.

Finally I would like to thank my wife Teresa de J. Buccio García firstly for helping me on the typing of the thesis and secondly for her encouragement and understanding during the two years of these studies. My love and appreciation are given to my sons Galo Raymundo and Jesus Salvador Ruiz Buccio for their great sacrifices throughout these studies.



TABLE OF CONTENTS

	page
ACKNOWLEDGEMENTS	ii
LIST OF TABLES	ix
LIST OF FIGURES	xii
LIST OF ABBREVIATIONS	xiii
ABSTRACT.....	xv
ABSTRAK.....	xviii
CHAPTER	
I INTRODUCTION.....	1
II REVIEW OF LITERATURE.....	4
Exploitation of <i>Hevea brasiliensis</i>	4
Bark anatomy.....	6
Ontogeny of latex vessels	7
Soft inner bark and hard outer bark.....	8
Number, density and diameter of latex vessels	9
Bark regeneration.....	10
Drainage area.....	11
Physiological factors influencing yields	13
Composition of <i>Hevea</i> latex	14
Definition of latex.....	14
Function of latex	14
Latex components.....	15



Main limiting factors of latex flow	19
Flow	20
Regeneration.....	20
Physiological latex parameters.....	21
Total solid content (TSC).....	21
Bursting index (BI).....	24
Thiols (R-SH)	24
Sucrose.....	24
pH.....	25
Inorganic phosphorus.....	25
Tapping systems	26
International notations of exploitation systems.....	28
Puncture tapping.....	32
Historical background.....	32
Performance of puncture tapping as a commercial practice	33
Parameters influencing the performance of puncture tapping	35
Bands (number, width and length).....	35
Number of punctures per tapping	36
Latex stimulation	36
Tapping panel (virgin and renewed bark, high and low panel).....	37
Clonal response.....	38
Seasonal variation.....	39
III MATERIALS AND METHODS.....	41
Location and physical conditions of the experiment site	41
Experimental procedure	42
Rubber plantation	42
Clones evaluated.....	42

Tapping tools	43
Tapping and stimulation method.....	44
Guidance of latex and lace removal	44
Management of tapping panels.....	45
Sampling of latex (Experiment 3)	47
Recording of parameters	47
Rubber yield.....	47
Physiological latex parameters (Experiment 3).....	48
Experimental	56
Experiment 1: Effect of punctre tapping on yield of rubber clone RRIM 600.....	56
Sub-experiment 1.1: Effect of number of punctures on yield	56
Sub-experiment 1.2: Effect of number of punctures and strips on yield	57
Sub-experiment 1.3: Effect of number of strips and times of tapping on yield	58
Experiment 2: Effect of puncture tapping on yield of rubber clone PR 261.....	59
Sub-experiment 2.1: Effect of number of punctures on yield	59
Sub-experiment 2.2: Effect of number of punctures and strips on yield	60
Sub-experiment 2.3: Effect of number of strips and times of tapping on yield	60
Experiment 3: Effect of puncture tapping on yield and selected physiological latex parameters of rubber clone RRIM 600 tapped on different panels	61
Experimental design.....	62
Statistical analysis	63
IV RESULTS.....	66
Experiment 1: Effect of puncture tapping on yield of rubber clone RRIM 600.....	66

Sub-experiment 1.1: Effect of number of punctures on yield	66
Sub-experiment 1.2: Effect of number of punctures and strips on yield	69
Sub-experiment 1.3: Effect of number of strips and times of tapping on yield	71
Experiment 2: Effect of puncture tapping on yield of rubber clone PR 261.....	73
Sub-experiment 2.1: Effect of number of punctures on yield	73
Sub-experiment 2.2: Effect of number of punctures and strips on yield	75
Sub-experiment 2.3: Effect of number of strips and times of tapping on yield	77
Experiment 3: Effect of puncture tapping on yield and selected physiological latex parameters of rubber clone RRIM 600 tapped on different panels.....	79
Mean dry rubber yield (g/t).....	79
Physiological latex parameters	81
Effect of different seasons on physiological latex parameters and production of rubber	91
V DISCUSSION	97
Yield performance in puncture tapped trees as influenced by number of punctures and strips on basal panels (Experiment 1 and 2).....	99
Yield performance of punctures tapped trees as influenced by number of times of tapping (Experiment 1 and 2)	99
Influence of panel position and number of strips on yield performance in clone RRIM 600 (Experiment 3).....	100
Influence of panel position and number of strips on selected physiological latex parameters (Experiment 3).....	101
Correlationship among physiological latex parameters	106
Seasonality effect on physiological latex parameters and yield of rubber of clone RRIM 600	108
VI SUMMARY AND CONCLUSION	112

VI SUMMARY AND CONCLUSION	112
BIBLIOGRAPHY	116
APPENDICES	124
VITA	142



LIST OF TABLES

Table		Page
1	Physiological parameters of latex and their relation with the production mechanism: Flow (F) and, or Regeneration (R).....	23
2	Mean dry rubber yield in (g/t/t) and (kg/ha/year) over five years of puncture tapping with number of punctures.....	67
3	Mean dry rubber yield (g/t/t) and (kg/ha/year) over five years of tapping with different number of punctures and strips.....	69
4	Mean dry rubber yield in (g/t/t) and (kg/ha/year) over five years of tapping with number of strips and times of tapping.....	71
5	Mean dry rubber yield in (g/t/t) and (kg/ha/year) over six years of puncture tapping with number of punctures (clone PR 261).....	73
6	Dry rubber mean in g/t/t and (kg/ha/year) over six years of tapping with number of punctures and strips (clone PR 261).....	75
7	Mean dry rubber yield in (g/t/t) and (kg/ha/year) over six years of tapping with number of strips and time of tapping (clone PR 261).....	77
8	Mean values of dry rubber yield (g/t/t) and (kg/ha/year) over one year of tapping with puncture tapping (clone RRIM 600).....	80
9	Effect of puncture tapping on yield (g/t/t) and physiological latex parameters related to latex flow (clone RRIM 600).....	82
10	Effect of puncture tapping on yield (g/t/t) and physiological latex parameters related to latex regeneration (clone RRIM 600).....	84
11	Simple correlation coefficients between latex physiological parameters and yield (g/t/t) with puncture tapping.....	88
12	Simple correlation coefficients between latex physiological parameters and yield (g/t/t) with excision tapping.....	90
13	Analysis of variance of mean dry rubber yield (g/t/t) over five years as influenced by number of punctures (clone RRIM 600).....	124



14	Summary of ANOVA tables of mean dry rubber yield (g/t/t) at each tapping year with different number of punctures (clone RRIM 600).....	125
15	Analysis of variance of mean dry rubber yield (g/t/t) over five years with different number of punctures and strips (clone RRIM 600).....	126
16	Summary of ANOVA analysis of mean dry rubber yield (g/t/t) at each tapping year with different number of punctures and strips (clone RRIM 600).....	127
17	Analysis of variance of dry rubber yield (g/t/t) over five years with number of strips and times of tapping (clone RRIM 600).....	128
18	Summary of ANOVA tables of mean dry rubber yield (g/t/t) at each tapping year, with different number of punctures and times of tapping (clone RRIM 600).....	129
19	Analysis of variance of dry rubber yield (g/t/t) over six years with number of punctures (clone PR 261).....	130
20	Summary of ANOVA tables of mean dry rubber yield (g/t/t) at each tapping year with number of punctures (clone PR 261).....	131
21	Analysis of variance of dry rubber yield (g/t/t) over six years with number of punctures and strips (clone PR 261).....	132
22	Summary of ANOVA tables of mean dry rubber yield (g/t/t) at each tapping year with number of punctures and strips(clone PR 261).....	133
23	Analysis of variance of dry rubber yield (g/t/t) over six years with number of strips and time of tapping (clone PR 261).....	134
24	Summary of ANOVA tables of mean dry rubber yield (g/t/t) at each tapping year with number of strips and time of tapping (clone PR 261).....	135
25	Analysis of variance of mean dry rubber yield (g/t/t) of puncture tapping over one year (clone RRIM 600).....	136
26	Results of analysis of variance on rubber yield and physiological parameters related to latex flow.....	137
27	Results of analysis of variance on rubber yield and physiological parameters related to latex regeneration.....	138
28	Results of analysis of variance from seasonal effect on rubber yield and physiological latex parameters related to latex flow.....	139



29	Results of analysis of variance from seasonal effect on rubber yield and physiological latex parameters related to latex regeneration.....	140
----	--	-----



LIST OF FIGURES

Figure		Page
1	Three dimensional diagram of <i>Hevea</i> bark (Adapted from Gomez et al., 1972).....	12
2	Ultracentrifugation of <i>Hevea</i> latex (Adapted from Moir, 1959).....	18
3	Graphic description of exploited panels with puncture tapping.....	46
4	Graphic description of exploited panels with puncture tapping (RRIM 600).....	65
5	Yield trend with different number of punctures over five years (RRIM 600).....	68
6	Yield trend with different number of punctures and strips over five years (RRIM 600).....	70
7	Yield trend with different number of strips and times of tapping (RRIM 600).....	72
8	Yield trend over six years with number of punctures (PR 261).....	74
9	Yield trend over six years with number of punctures and strips (PR 261).....	76
10	Yield trend over six years with number of punctures and time of tapping (PR 261).....	78
11	Seasonal effect of yield (g/t/t) and physiological latex parameters related to latex flow of RRIM 600. Values bearing the same letter are not significantly different at $p < 0.05$	93
12	Seasonal effect on yield (g/t/t) and physiological latex parameters related to latex regeneration of RRIM 600. Values bearing the same letter are not significantly different at $p < 0.05$	96
13	Map of Peninsular Malaysia showing the study area in R.R.I.E.S. Sungai Buloh.....	141



LIST OF ABBREVIATIONS

a. i.	Active ingredient
ANOVA	Analysis of variance
BF'	Bottom fraction
BI	Bursting index
CRD	Completely Randomized Design
DMRT	Duncan Multiple Range Test
DRC	Dry rubber content
DTNB	Dithiobis 2-nitrobenzoic acid
EDTA	Ethylenediaminetetraacetic acid
g/t/t	Grams of dry rubber yield per tree per tapping
kg/ha/year	Kilograms per hectare per year
mM	Milimoles per litre
Mw	Molecular weight
Na ₂ HPO ₄	Sodium dihydroxide phosphate
NaOH	Sodium hydroxide
nM	Nanometers
P _i	Inorganic phosphorus
PROL	Proline
R-SH	Thiols group



RCBD	Randomized Complete Block Design
rpm	Revolution per minute
RRIES	Rubber Research Institute Experiment Station
RRIM	Rubber Research Institute of Malaysia
SAS	Statistical Analysis System
SSA	Sulfosalicylic acid
SUC	Sucrose
TCA	Trichloroacetic acid
TSC	Total solid content



Abstract of thesis submitted to the Senate of
Universiti Pertanian Malaysia in fulfilment of
the requirements for the degree of Master of
Agricultural Science

**EFFECT OF PUNCTURE TAPPING SYSTEMS ON YIELD
AND SELECTED PHYSIOLOGICAL LATEX PARAMETERS
OF RUBBER (*HEVEA BRASILIENSIS* MUELL. ARG.)**

By

SALVADOR RUIZ ARROYO

September, 1996

Chairman: Associate Professor Dr. Wong Kai Choo

Faculty: Agriculture

These studies were carried out to evaluate the effect of puncture tapping system on yield performance of clone RRIM 600 and PR 261 and selected physiological latex parameters of clone RRIM 600. Three main experiments were carried out. The first and second experiments studied the effect of number of punctures, puncture strips and times of tapping on yield performance of clones RRIM 600 and PR 261 during the last five and six years respectively. The third experiment studied the effect of number of puncture strips and panel position on



yield as well as on selected physiological latex parameters of RRIM 600 over one year duration.

The rubber yield of clones RRIM 600 and PR 261 was not affected by the number of punctures (3, 6, 9 and 12), puncture strips (single and triple) and times of tapping (7:00, 9:00, 11:00 am and 1:00 pm). However the yield of puncture tapped trees was comparable to that of 1/2S d/2 tapped excision unstimulated control.

Yield performance of clone RRIM 600 was also not affected by either high or low panel position. All puncture tapped trees with three strips produced similar yield as 1/2S d/2 tapped unstimulated control.

Among the physiological latex parameters related to latex flow affected by puncture tapping system were bottom fraction (BF) and thiol (RS-H), while no significant effects were noted on bursting index (BI) and dry rubber content (DRC). Trees puncture tapped with three strips on high panels HO-1 and HO-2 recorded the highest percentage of BF while trees puncture tapped with single strip on panel BO-2 recorded the lowest percentage of BF. However puncture tapping treatments did not result in higher percentage of BF than 1/2S d/2 and 1/4S ↑ d/2 tapped unstimulated controls. Among puncture tapped trees the highest RS-H was recorded with three strips tapped on panel BO-2. The other puncture tapped treatments recorded similar RS-H to that of 1/2S d/2 and 1/4S ↑ d/2 tapped unstimulated controls.

Most of the physiological latex parameters (pH, proline, inorganic phosphorus (P_i) and sucrose) related to latex regeneration were affected by puncture tapping, with the exception of total solid content (TSC). On the high panels the values for all these parameters under puncture tapping were higher than those of 1/4S \uparrow d/2 tapped unstimulated control. However on basal panel BO-2 only proline and sucrose under puncture tapping recorded higher values than 1/2S d/2 tapped unstimulated control. Among puncture tapping treatments the panel position did not affect the mean values of these parameters.

There were better correlations between yield and physiological latex parameters in puncture tapped trees. Among these correlations observed were the positive correlations of yield with proline, P_i , thiol and sucrose. Sucrose was related positively with proline and P_i .

Comparative studies between different seasons in a year show that there were no significant seasonal effects on yields. However in contrast the majority of the physiological latex parameters with the exception of BI were affected by different seasons. High values were recorded for DRC, TSC, RS-H, P_i and sucrose during the high yielding season in the year.



Abstrak tesis dikemukakan kepada Senat
Universiti Pertanian Malaysia Sebagai Memenuhi
Keperluan Untuk Ijazah Master Sains Pertanian

**KESAN SISTEM TOREHAN
PENGHASILAN DAN PARAMETER FISILOGI LATEKS
TERPILIH (*HEVEA BRASILIENSIS* MUELL. ARG.)**

oleh

SALVADOR RUIZ ARROYO

September, 1996

Pengerusi : Professor Madya Dr. Wong Kai Choo

Fakulti: Pertanian

Kajian dijalankan untuk menilai kesan sistem torehan cucuk ke atas prestasi hasil klon-klon RRIM 600 dan PR 261 dan beberapa parameter fisiologi lateks terpilih ke atas klon RRIM 600. Tiga percubaan telah dilaksanakan. Percubaan pertama dan kedua mengkaji kesan bilangan cucukan, jalur cucukan dan masa menoreh ke atas prestasi hasil klon-klon RRIM 600 dan PR 261 masing-masing untuk tempoh selama lima ke enam tahun. Percubaan ketiga ialah untuk mengkaji kesan bilangan jalur cucukan dan kedudukan panel ke atas hasil dan juga ke atas



beberapa parameter fisiologi lateks terpilih bagi klon RRIM 600 untuk jangkamasa selama satu tahun.

Pengeluaran hasil getah klon-klon RRIM 600 dan PR 261 tidak dipengaruhi oleh bilangan cucukan (3, 6, 9 dan 12), jalur cucukan (satu jalur dan tiga jalur cucukan) dan waktu menoreh (7:00, 9:00, 11:00 pagi dan 1:00 petang). Walau bagaimanapun, hasil dari pokok-pokok yang ditoreh secara cucukan adalah setanding dengan hasildari kawalan (sistem torehan 1/2S d/2 tanpa rangsangan).

Prestasi hasil klon RRIM 600 juga tidak dipengaruhi oleh paras panel torehan sam ada di paras tinggi atau rendah. Kesemua pokok-pokok yang ditoreh secara cucukan pada tiga jalur cucukan memberikan hasil yang setanding dengan hasidari kawalan (sistem torehan 1/2S d/2 tanpa rangsangan).

Di antara parameter fisiologi lateks yang dikaitkan dengan pengaliran lateks dan dipengaruhi oleh sistem torehan cucuk ialah Bottom Fraction (BF) dan Thiol (RS-H), manakala parameter-parameter Bursting Index (BI) dan Kandungan Getah Kering (KGK) didapati tidak dipengaruhi oleh sistem torehan cucuk. Pokok-pokok yang ditoreh pada panel di sebelah atas HO-1 dan HO-2 merekodkan nilai peratus BF yang tertinggi. Sungguhpun demikian, rawatan sistem torehan cucuk tidak menghasilkan peratus BF yang lebih tinggi berbanding dengan kawalan iaitu sistem torehan 1/2S d/2 dan sistem torehan 1/4S \uparrow d/2 tanpa rangsangan. Nilai RS-H yang tertinggi direkodkan oleh pokok-pokok yang ditoreh dengan sistem torehan cucuk pada tiga jalur cucukan di panel BO-2. Rawatan dengan sistem torehan cucuk yang

lain merekodkan nilai RS-H yang setanding dengan kawalan sistem torehan iaitu 1/2S d/2 dan sistem torehan 1/4S ↑ d/2 tanpa rangsangan.

Kebanyakan parameter fisiologi lateks yang dikaitkan dengan pengeluaran lateks dipengaruhi oleh sistem torehan cucuk kecuali parameter Total Solid Content (TSC). Untuk panel sebelah atas, nilai-nilai parameter itu adalah lebih tinggi dari kawalan iaitu sistem torehan 1/4S ↑ d/2 tanpa rangsangan. Walau bagaimanapun, pada panel di sebelah bawah BO-2, hanya “proline” dan “sucrose” mencatatkan nilai yang lebih tinggi dari kawalan iaitu sistem torehan 1/2S d/2 tanpa rangsangan. Bagi rawatan-rawatan torehan cucuk, kedudukan panel torehan tidak mempengaruhi nilai-nilai parameter tersebut.

Bagi pokok-pokok yang ditoreh dengan sistem torehan cucuk didapati korelasi perkaitan di antara hasil dan parameter fisiologi lateks adalah lebih baik. Keputusan yang diperolehi menunjukkan perkaitan yang positif di antara hasil dengan “Proline”, P_i , Thiol dan “Sucrose”. Korelasi yang positif juga ditunjukkan di antara “Sucrose” dengan “Proline” dan juga P_i .

Kajian perbandingan di antara musim yang berlainan dalam setahun menunjukkan bahawa musim tidak mempunyai kesan yang ketara ke atas hasil. Sungguhpun demikian, kecuali BI, keputusan yang bertentangan diperolehi ke atas majoriti parameter fisiologi lateks. Ini kerana parameter-parameter tersebut dipengaruhi oleh musim yang berlainan. Nilai yang tinggi direkodkan untuk KGK, TSC, RS-H, P_i dan “Sucrose” ketika musim hasil tinggi dalam tahun tersebut.

CHAPTER I

INTRODUCTION

Natural rubber *Hevea brasiliensis* (Muell. Arg.) is classified as strategic material because it is an important raw material used in the manufacture of a wide range of industrial products such as tyres, engineering components and latex products, which are considered to be the essential ingredients of modern life. In fact among the few economic plants, rubber trees have had the greatest influence on industrial development and human life.

In the early days of the rubber history, rubber trees were exploited for latex by different methods of extraction. These methods, though involving many instruments and complicated techniques, gave poor yields, poor bark regeneration and shortened the economic life of the trees. These methods of latex extraction were improved when Ridley (1890) introduced the continuous excision method of tapping which is considered as one of the most important scientific and economic contributions to the success of the rubber industry (Abraham, 1976).

Excision method is still the main tapping system of latex extraction used by the rubber industry. This technology was developed when labour was plentiful and cost

of production was negligible. It is, therefore, evident that this technology is grossly ill equipped and no longer appropriate to overcome the current serious constraints of the rubber industry such as high production cost, shortage of skilled labour and low rubber prices (Sivakumaran, 1991a).

An alternative to excision tapping system is puncture tapping introduced by Tupy (1973), which is an incision method whereby tapping is done by using a special needle mounted on a wooden holder to puncture a vertical strip which has been previously scraped and stimulated. This new technique of latex extraction was only possible with the discovery of ethephon (2-chloroethyl-phosphonic acid) as a yield stimulant (Abraham, 1977). Puncture tapping has the potential to be developed as an alternative system to conventional tapping, with higher yields and less risk of tree exhaustion (Leong and Tan, 1977).

Puncture tapping system with conventional methods of stimulation can be adopted for specific purposes such as exploitation of young rubber trees, allowing longer periods of maturity for bark renewal on tapped panels and prolonging the economic life of a given tapping panel (Sivakumaran, 1991b). In addition, yields obtained with this technique are reported to be similar or higher than that of the unstimulated conventional $1/2S d/2$.

However the adoption of puncture tapping systems by the Natural Rubber Industry has not been encouraging although puncturing is a simple and easy method

of latex extraction and does not require skilled tappers, because the bark of the tree is not shaved as is the case with excision methods.

Research conducted on puncture tapping has mainly emphasized on mechanical and agronomic aspects such as number of punctures, number of strips, clonal response and puncture tools. There is a lack of adequate information on effect of puncture tapping on the physiological latex parameters with regard to panel position and tapping times. In addition there is insufficient comparisons between conventional and puncture tapping with regard to physiological latex parameters.

Certain physiological latex parameters are correlated to yield (Jacob et al., 1989). These parameters may control production directly or indirectly, and may contribute to a better understanding of the physiological status of the trees, favoring optimization of exploitation by avoiding the exhaustion of the laticiferous system, thus enabling maximum production potential.

In view of this background, this project was initiated with objectives to study the effect of puncture tapping on yield of rubber and physiological latex parameters. It is hypothesized that this technique does not adversely affect latex physiology and rubber yield when compared to conventional excision tapping methods.

CHAPTER II

REVIEW OF LITERATURE

Exploitation of *Hevea brasiliensis*

The history of exploitation of *Hevea brasiliensis* started in Brazil in the 19th century when latex was extracted from wild rubber trees by excision methods. These methods consisted of making a series of cuts on the bark with a long machete. However these methods of tapping damaged the cambium, thus shortening the economic life of the trees. These methods were improved when Ridley (1890) discovered the continuous excision method that was based on the specific characteristic of *Hevea* bark (Abraham, 1975).

Tapping methods have been continuously modified since *Hevea* was introduced in the Far East at the beginning of this century, and today when rubber trees are planted in millions of hectares, exploitation methods are far different from the original one practised in the Amazon jungle.

The tapping cut itself has displayed a whole range of geometrical forms. The earlier system were V cuts vertically under one another, followed later by the half of full herringbone system. In the early part of the 20th century new approaches to tapping were introduced, involving so many factors such as number, type and length