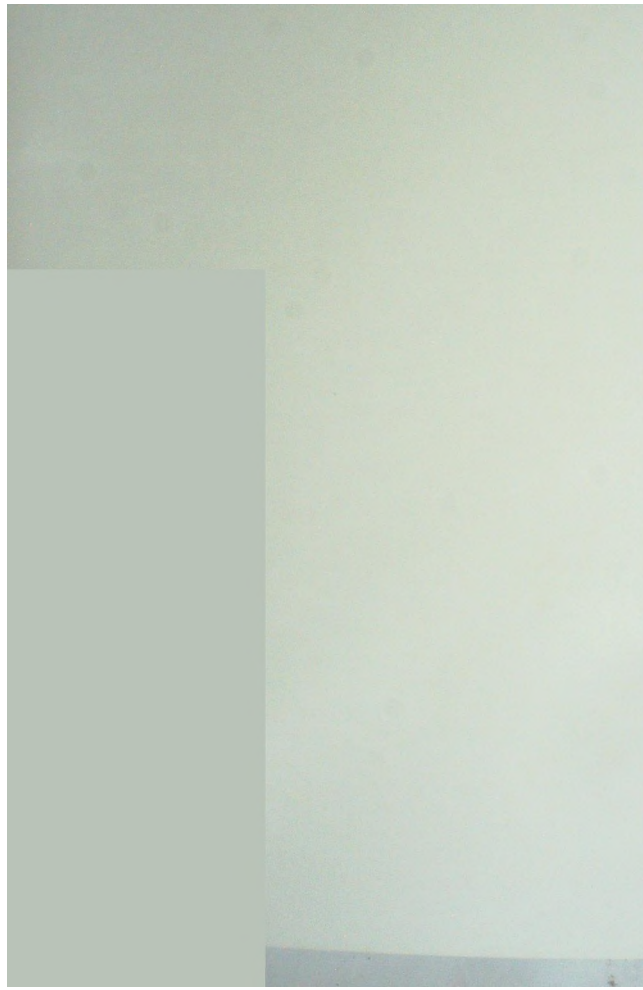
Exploitation Technology of *Hevea*

An Annotated Bibliography

RUBBER RESEARCH INSTITUTE OF INDIA
KOTTAYAM, KERALA



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An Annotated Bibliography

Compiled
N. Latha and Mercy Jose

Library and Documentation Centre
Rubber Research Institute of India
Kottayam 686 009
Kerala, India

December, 2003

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FOREWORD

Research on technological innovations in crop harvesting in rubber plantations has made considerable progress during the last few decades. The development of new exploitation techniques has also helped the world rubber plantation industry in enhancing its productivity in a cost-effective manner. R&D efforts pursued by the IRRDB member institutions have generated valuable information, which need to be organized, and disseminated for the benefit of the entire sector.

In order to keep the scientific community and the rubber plantation industry abreast with the latest R&D developments on exploitation systems in rubber, the Library and Documentation Centre of RRII has brought out an excellent compilation entitled '**Exploitation Technology of *Hevea*: An annotated bibliography**', covering the period 1990-2003. It is expected that this compilation will serve as a valuable source of reference for scientists and others involved in the development of the NR industry.

N.M. MATHEW
Director

2 December 2003

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N.M. MATHEW
Director

2 December 2003

PREFACE

There has been a tremendous progress in exploitation technology of rubber in the recent past. Considerable attention is being paid to research on exploitation systems among the IRRDB member institutes. As a result, there is a virtual information explosion globally. To familiarize with the latest developments in this field the information scattered in different forms such as periodicals, books, monographs, conference proceedings, etc., have been organized here in a systematic manner for the use of NR plantation industry. It is hoped that this compilation would be a good reference material in this direction.

I place on record my appreciation to all concerned in the creditable efforts of bringing this Bibliography *viz.*, '**Exploitation Technology of *Hevea*: An Annotated Bibliography**' at the appropriate time in connection with International workshop on Exploitation Technology in 2003.

K.R. VIJAYAKUMAR
IRRDB Liaison Officer
(Exploitation Technology)

2 December 2003

ABOUT THE COMPILATION

We hereby present the publication entitled '**Exploitation Technology of *Hevea*: An Annotated Bibliography**' in continuation of the two subject bibliographies published in 2001 and 2003 respectively. It provides information on various aspects of exploitation systems and related areas such as tapping system, stimulation, rain guarding, labour productivity, TPD etc. The bibliography, covers the period from 1990 till date, contains a total number of 200 records. The materials were collected from sources like journal articles, conference proceedings, workshops, symposia, books, monographs and agricultural data bases like AGRIS and CAB CD-ROMs.

This compilation has three sections. In Section I, which is the **Bibliography**, articles are arranged alphabetically by title followed by author(s), citation, abstract (in majority of cases) and key words. Section II is the **Key word Index** comprising all the relevant key words from the respective articles. Section III is the **Author Index**. The key word and author indices are suffixed with their entry numbers.

The urgency in bringing out the compilation before the IRRDB Workshop on Exploitation Technology and lack of sufficient time did not permit us to collect an exhaustive range of information. However, maximum efforts have been made to collect relevant references available.

We are grateful to Dr. N.M. Mathew, Director for giving permission to publish this bibliography. Thanks are also due to Dr. K.R. Vijayakumar, Joint Director for providing necessary guidance and keen interest in getting published this compilation on a priority basis.

We appreciate the full support and wholehearted co-operation of our colleagues in the library, without which, perhaps publication of this compilation would not have materialised within a spell of three months. The assistance rendered by Mr. Kurian K Thomas on all matters connected with the printing of this bibliography is also appreciated. Thanks are also due to M/s. Creative Minds, Kottayam, M/s. Alois Graphics, Kottayam and M/s. Colortone Process Private Ltd, Cochin for timely printing of this bibliography in a short notice. Any suggestion for improvement is highly welcome.

2 December 2003

N. LATHA
MERCY JOSE

CONTENTS

BIBLIOGRAPHY

1 **AAR Jacket system: A promising improved system of extracting latex from rubber trees**

Hoong, Chan Weng and San, Ong Tee

The planter, 68(801):1992. 587-596.

Early results of the AAR Jacket System are promising. The method involves tapping short cuts once in three to four days combined with application of a stimulant enclosed in a jacket attached to the bark. Marked increase in yield per tapper was obtained on most ages of rubber. Other benefits of the system are significant reduction in tapper requirement and extension of economic life of trees. The system appears to be able to solve the current woes of the rubber industry subject to evaluation of its long-term effects on trees.

Key words: AAR Jacket system; Latex extraction; Malaysia

2 **Accelerating rubber technology adoption in Indonesian rubber small holdings**

Supriadi, M and Nancy, C

Proceedings of the Indonesian Rubber Conference and IRRDB Symposium, 12-14 September 2000, Bogor, Indonesia, V2. pp.385-398.

Even though some successes have been achieved through various development projects launched by the government, the majority of farmers in Indonesian rubber smallholdings have remained untouched because of some constraints, especially the limitations of government budget. In light of this limited result the government has been promoting a self-help development policy in estate crops development which requires greater self-help community initiatives and broad-based participation of smallholders. This means that the smallholders are encouraged to improve their rubber farming by adopting the recommended rubber technologies using their own efforts and resources. To accelerate achievement of this objective, an adaptive self-help development approach is proposed. In this new approach, development programme is designed based on the characteristics of the village. Self-help rubber development programme for progressive villages include: the improvement of the quality of rubber planting material, the exploration and mobilization of rubber development funds and the provision of intensive extension activities through various media and limited development assistance to the targeted farmers. In addition, the provision of various rubber technology choices for different condition of farmers or users is suggested to accelerate the rate of rubber technology adoption.

Key words: Self-help development; Smallholding; Technology adoption; Indonesia

3 **Advances in exploitation research of *Hevea* in India**

Vijayakumar, K R ;Thomas, K U; Rajagopal, R and Karunaichamy, K

In: *Global Competitiveness of Indian Rubber Plantation Industry: Rubber Planters' Conference, India 2002*. (Ed. C. Kuruvilla Jacob). Rubber Research Institute of India, Kottayam, pp.155-162.

In the field of exploitation research, for the last one and a half decade, Rubber Research Institute of India is focussing on low frequency tapping (LFT), panel change, controlled upward tapping(CUT), mini and reduced spiral tapping cuts, assessment of crop loss due to rain and its recovery through stimulation. Cost of production of natural rubber is highest in India, the reasons being steep slopes, high rainfall, high incidence of diseases and manuring require-

ments. Under these circumstances, extensive research was carried out on LFT for substantial reduction in tapping cost. As a result, optimum schedules of stimulation for getting sustainable yield increase under d/3 or third daily tapping systems (two tappings per week) was evolved for many popular clones. In addition to that, fourth daily (three tappings per fortnight) and weekly tapping (d/7) systems were evolved without any reduction in yield comparable to that under stimulated d/3 system, which is and important and novel achievement. Panel application was found to be the most effective and economical method of stimulation of basal panels. To suit the agro climate of India, modified practice of controlled upward tapping (CUT) was evolved. In the modified practice, basal panel is tapped with rain guarding during monsoon season and CUT is done during the remaining period. The practice was found to result in sustainable yield increase for many years. In clone RRII 105, crop loss due to rainfall could only be partially recovered by stimulation, under d/3 frequency of tapping. Under d/2 frequency of tapping there was no response to stimulation. Tapping of reduced spiral tapping cut with stimulation was found to result in better girthing without any reduction in yield. This might help in early opening of trees. Yearly panel change in the basal panel resulted in significant yield increase and reduced incidence of tapping panel dryness. Low frequency tapping and CUT were extended to large number of estates and medium holdings (more than 100) in Kerala, Karnataka and Tamil Nadu through lab to land programmes. Ladder tapping of 1/2 V cut was completely abandoned as a result of this.

Key words: Controlled upward tapping; Low frequency tapping; Panel change; Yield; India

4 Advances in exploitation technology and adoption by smallholders

Vijayakumar, K R; Thomas, K U; Rajagopal, R and Karunaichamy, K

Paper presented at IRRDB Symposium "Challenges for Natural Rubber in Globalization," 15-17 September 2003, Chiang Mai, Thailand.

In recent times most of the exploitation research in rubber (*Hevea brasiliensis*) focused on addressing local problems such as shortage of tappers, loss of tapping days due to climatic constraints of rain, soil water deficit, low temperature etc. Even though tapping was irregular due to social or climatic reasons alternate daily tapping of semi spiral cuts worked fairly well with medium yielding clones. This system was extensively adopted by smallholders as well. However, with high yielding clones, this system proved counter productive, with high incidence of tapping panel dryness (TPD). Chemical stimulation of yield was not only useful in exploitation of short tapping cuts but also in optimising the intensity of exploitation in combination with frequency of tapping. Third daily tapping with stimulation was found essential to sustain high yield of new clones. Lowering of cost of tapping is an indirect benefit. Though, this system was adopted by estate sector, small holders are yet to take the advantage of the same. With further reduction in frequency of tapping to fourth daily or weekly, more stringent conditions became necessary for complete success with out compromising yield. Thus low frequency tapping (LFT) systems warrant regular tapping without rest periods, more number of stimulations, rainguarding, dispensing of cash tapping and Sunday tapping, additional collections, payment of production incentive to the tappers, etc. In India, majority of the estates have started adopting LFT in a big way. However in the smallholdings lot of problems are encountered for extending the technology. Extensive research has also helped to evolve tapping systems and stimulation schedule to achieve sustainable high yield and longer economic life. Thus, Controlled upward tapping (CUT),

gaseous stimulation (RRIMFLOW) etc. have led to increase the productivity in the later part of economic life. These techniques are also not very popular among smallholders.

Key words: Controlled upward tapping; Low frequency tapping; Yield; India

5 **Application of short cut exploitation system to increase yield of rubber trees**

Lukman and Karyudi

Bulletin Perkaretan, 11(1/3): 1993. 33-36.
(CAB Abstracts 1995)

In order to maximize rubber yield and to prolong the economic life of the trees, the application of Ethrel [ethephon] (ET) combined with a short cut system was investigated in clones and seedlings of GT 1. It was found that the treatments 1/3S d/2.ET2.5% .Ga0.5.20/y (2w) and 1/4 S d/2 (t, t) .ET 5.0%.Ga 0.5.20/y (2w) increased average yield to 129 and 141%, respectively, of that of the control (1/2 S d/2). In addition, the economic life of the trees was extended by 1.5-2.0 times. The treatments did not reduce the dry rubber content of the latex.

Key words: Ethrel; Shortcut system; Yield; Indonesia

6 **Application of upward tapping to increase rubber yield planted in Type-A climatic region of North Sumatra**

Lukman

Indonesian Journal of Natural Rubber Research 14(1):1996. 79-83.

High labour cost, low initial, yield of most rubber planting, and international market competition are as the trigger for the planters to find out the method for increasing yield of rubber. One of the possible methods to achieve the above purpose is assumed by application of upward tapping since BO panel. The results of a three-year experiment on GT 1 clone planted in type-A climatic region of North Sumatra showed that upward tapping could increase yield up to 21-48% above the 1/2 S d/2 control. Upward tapping with 10 cm length of cut could lengthen the economic life of trees more than twice through the minimising of bark consumption with yield 21% above the control. Dry rubber content was not influenced by the direction of tapping, meanwhile the tapping panel dryness(TPD) of upward tapping (=2.2%) was lower than downward tapping (=9.0%). Bark consumption was higher by increasing the height of tapping panel. The shorter the tapping cut, the lower the bark consumption was. Girth increment of upward tapping (=2.5 cm/yr) was slightly more than downward tapping (= 2.1 cm/yr). It is recommended to increase the yield of GT 1 clone planted in type-A climatic region of North Sumatra by applying upward tapping 1/3S↑d/3.ET2.5%.BaO.5(1.5). 9/y(m) or 1/4 S↑d/3.ET2.5%. Ba0.5(1.5).9/y(m). To lengthen the economic life of the trees, it is suggested to use upward tapping Mc10↑d/3.ET5.0%.Ba0.5(1.5).9/y(m).

Key words: Ethephon; Upward tapping; Indonesia

7 **Application of upward tapping (UT) with low exploitation intensity to increase yield and economic life of rubber trees**

Lukman

Indonesian Journal of Natural Rubber Research, 13 (2): 1995. 94-98.

Too long unproductive period, low initial yield and declining yield when tapping approaches

the union foot are unpleasant "inner factors" of rubber trees. Besides, international market competition has forced the planters to increase the yield as highest and earliest as possible to lower cost price of rubber. One of the methods of increasing yield as earliest as possible is assumed by Upward Tapping (UT), started from BO panel. The results of earlier experiments showed that UT did not always show positive response to each clone and each region and there is a tendency of declining yield in consecutive tapping years. Based on that, it is necessary to carry out long-term UT experiments on each clone in different regions, especially by using low exploitation intensity. The results of a two-year experiment on GT1 clone, arranged in a fully randomized design with seven treatments and four replications, showed that UT with "Low" exploitation intensities increased the yield high significantly, about 34-46 above Downward Tapping(DT) control. By "Very Low" exploitation intensity (Mc10_), the yield of UT was still the same as DT control. Lowering the exploitation intensity would minimize the declining yield in the consecutive tapping years. UT could lengthen economic life of the trees although the thickness of tapping cut twice than that of DT and the depth of tapping cut was the same as DT. Renewed bark of UT was thicker than DT, meanwhile, the percentage of Tapping Panel Dryness was lower. The percentage of Dry rubber content of latex was not influenced by the direction of tapping. It was recommended to increase yield and lengthen the economic life of the trees (GT1 clone) by applying UT with "low" exploitation intensity i.e., 1/3S↑d/3.ET 2.5%.BaO.5(1.5).9/y(m) or 1/4 S↑d/3.ET2.5%BaO.5(1.5).9/y(m). To lower bark consumption and to avoid the sharp declining yield in the consecutive tapping years, UT with "very low" exploitation intensity, i.e.: Mc10↑d/3.ET5.0 %.BaO.25(1.5).9/y(m) could be applied.

Key words: Bark consumption; Upward tapping; Yield; Indonesia

8 **Associations of structural traits: Yield, girth and occurrence of tapping panel dryness in *Hevea brasiliensis***

Premakumari, D; Panikkar, A O N; Sethuraj, M R and Marattukalam, Joseph G.

Indian Journal of Natural Rubber Research, 10(1/2): 1997. 27-33.

A correlation study on ten *Hevea brasiliensis* clones showed that the factors detrimental to girth increment on tapping favours the occurrence of tapping panel dryness. Laticifer area index was an exception which has positive association with both. The number of latex vessel rows, the number of intra xylary phloem groups and total volume of latex produced together contributed to 49 percent variation in the occurrence of tapping panel dryness of which the two structural traits alone governed 39 percent variation. The associations of characters indicated that a very high number of latex vessel rows in high yielding clones leads to high incidence of tapping panel dryness. Hence selection based on high girth, good quantity of intra xylary phloem and balanced number of latex vessel rows is suggested for sustainable yield by reducing TPD. The two structural traits mentioned above are useful parameters for early prediction of clonal susceptibility to TPD at least to some extent. The importance of laticifer area index and number of intra xylary phloem groups as selection parameters is discussed.

Key words: Clonal response; Tapping panel dryness; Yield; India

9 **Availability and welfare of tappers in rubber estates: A case study in some estates in South Sumatra and Lampung**

Nancy, C; Anwar,C; Junaidi, Untung and Hendratno, S

Jurnal Penelitian Karet, 15(1):1997, 23-41.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No. 238)

Since the past time, the living standards of estate labour has been difficult to be improved, so it is concerned that there would be a lack of labour, including tappers in rubber estate. The aims of this research were to study the characteristic and welfare level of tapper availability in rubber estates. The research was done in government and private-owned rubber estates in South Sumatera and Lampung in 1997. Total respondents was 180 tappers, chosen by simple random sampling, i.e. about 5-20% of tappers population. Most of tappers in established estates was permanent Daily Worker (89-96%), with working period ranging from 6 to 16 years. The tappers' age were between 33 and 40 years, with education up to primary school (48-57%) and the rest above primary school (42-52%). The tappers could be considered to have a welfare life, as indicated by: 1) the asset ownership (land, TV/radio, house, bicycle, livestock), 2) the income level and percentage of saving, and 3) the child's education. The availability of tappers for the established government and private-owned estates so far has not become a problem. This was reflected by many youths who wish to be tappers, mainly with the following reasons: a). the guaranteed permanent income (including oldage security or pension and health guarantee), b).as tappers, they would still have enough free time because between 13.30 and 14.00 hours they were already back home, c).they received premium and incentives. In new rubber estates, the tappers were relatively young, i.e. about 25 years old, relatively less healthy, and with very low asset ownership. The availability of tappers in isolated new estate was still a problem in terms of the quantity and quality of tappers. Efforts that could be made included employing tapper's family through training, providing public facilities such as and health center, transportation as well as the basic needs at reasonable price through cooperatives.

Key words: Rubber estate; Tapper welfare; Upward tapping; Indonesia

10 **Can D/3 frequency tapping minimize problems related to tapper shortage**

Nugawela, A; Peries, M R C; Wijesekera, S and Wilbert, S

Bulletin of the Rubber Research Institute of Sri Lanka 38:1998. 53-59.

In Sri Lanka the most widely adopted tapping system is 1/2 S d/2. The potential yield from this system is not harvested in the majority of plantations due to vacant tapping blocks and employing of unskilled tappers. With 1/2 S d/3 system of tapping above problems could be minimized and similar yield levels, *i.e.* presently achieved yield levels from 1/2 S d/2 system, can be harvested with a lower cost of production. d/3 frequency tapping will have the added advantages of less bark consumption and improvement in quality of tapping. Also, stimulating the virgin bark [2.5% ET, Ba 1.6(2.5)4/y] when tapped on d/3 frequency do not result in a higher incidence of Tapping Panel Dryness.

Key words: Bark consumption; d/3 frequency tapping; Tapper shortage; Tapping panel dryness; Sri Lanka

11 **Changes in some physiological latex parameters in relation to over-exploitation and the onset of induced tapping panel dryness**

Yusof Faridah; Arija, M A S; Ghandimathi, H; Hamzah, Zainab; Sivakumaran, S and Yeang, H Y

Journal of Natural Rubber Research 10 (3): 1995. 182-198.

As tapping panel dryness of the rubber tree developed in response to various stress treatments, significant changes in invertase and polyphenol oxidase activities, total sugars and total solids in the latex were found to be associated with the intensive tapping and ethephon treatments. These changes appeared to be related more to the exhaustion of the laticifer system (over-exploitation) than to the basic causes of dryness. They were unreliable predictors of dryness in situations where the dryness was not accompanied by increased yield output, as exemplified by the pin-pricking stress treatment. In the early stages of the stress treatments, latex proline and copper content increased with all the experimental treatments attempted, irrespective of whether yield output was increased. These results suggest that an increase in latex proline or latex copper might serve as a warning indicative of incipient or impending dryness.

Key words: Ethephon; Tapping panel dryness; Yield; Malaysia

12 **Chemicals for yield stimulation (Malayalam)**

Vijayakumar, K R

Rubber, 332:1993. 14.

Key words: Stimulation; Yield; India

13 **Clone growth and stimulation: Latex production factors**

Gohet, E; Prevot, J C; Eschbach, J M; Clement, A and Jacob, J L

Plantations-Recherche-Developpement, 3(1): 1996. 30-38.

Variations in tree growth, yields and physiological condition (sugar and mineral phosphorus contents) of the laticifers were studied on five *Hevea* clones AF 261, AVROS 2037, PB 217, GT 1 and PB 235, under the effect of up to 78 stimulations per year. The trial indicated strong competition for assimilate distribution between growth and production and revealed the limits, serious malfunctioning occurred. It was concluded that in order to be effective, stimulation must only be used if the clone typology and physiological condition of the latex-bearing tissue in the topped trees are precisely known.

Key words: Clonal response; Clonal typology; Ethrel; Stimulation

14 **Combination tapping systems to increase yield and save bark**

Kuswanhadi; Junaidi, Untung and Thomas

Bulletin Perkebunan Rakyat, 1991, 7(2): 74-77.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.180)

The aim of this trial was to study the effect of combination tapping system on plant growth and yield. The trial was arranged according to a randomizes block design with 8 treatments and 4 replications. Each plot consists of 25 trees. Results of two tapping years showed that the yield of 5 PG (1/2S)d/3, 1/2S d/3 (t,2t). ET2.5%. Gal. 0.12/y (m) and 10 PG (1/2 S)d/3, 1/2S d/3

(t,2t). ET2.5%. Gal. 0.12/y (m) combination tapping systems were comparable with 1/2 S d/2 but lower than 1/2 S d/3 ET2.5% Gal. 0.12/y(m). The bark consumption was lower in combination system. Plant growth was not affected by tapping system. Based on those results it was recommended to apply 1/2 S d/3 system with stimulation for tapping on BI-1 panel.

Key words: Stimulation; Tapping system; Yield

15 Commercial experience with Less Labour-Intensive Collection System (LELICS) and polybag collection system

Mohd. Norddin Abd. Jalil and Mamat Abas

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry. 5-6 December 1994, Kuala Lumpur, Malaysia. pp.140-150.

LELICS (Less Labour-Intensive Collection System) and polybag collection system were introduced on Ladang Pinang Emas in Dungun to overcome the problems of tapper shortage and high cost of production faced by Kumpulan Ladang-ladang Terengganu Sdn. Bhd. It was observed that with 1/2 S d/2 tapping system, LELICS and polybag collection could reduce tapper requirement by 33 to 50% compared to conventional practice. Under LELICS and polybag collection system, the tapper only taps the tree, collects the polybags once fortnightly and strips off the polybags. With the conventional system, a tapper not only taps the trees but also collects and delivers the latex and scrap daily. It was also observed that under LELICS and polybag collection system yield per tapper increased by 64% to 124 as it was possible to tap more number of trees per day. By tapping a large task of 750 trees instead of the normal task of 450 trees a tapper could bring in more crop and therefore earn a higher wage i.e. 45 to 99% more than the conventional practice. This ensured their continued stay on the property. LELICS and polybag system also reduce transportation cost by 37% as the crop is collected once in two weeks. This paper reports Ladang Pinang Emas experience on the use of LELICS and polybag collection system. To-date, 4159 ha in Kumpulan Ladang-ladang Terengganu Sdn. Bhd. have adopted the system.

Key words: Less Labour Intensive Collection System (LELICS); Polybag collection system (PCS); Tapping system; Tapper shortage; Yield

16 Commercial experience with once-a-week tapping: A case study

Khoo Lian Hong

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry. 5-6 December 1994, Kuala Lumpur, Malaysia, pp.70-79.

Once-a-week tapping system with ethephon stimulation was evaluated on a commercial task size basis on six tasks of 1978 plantings, clones PR 255/PR 261 from 1984 onwards. The average yield per tapper over the last eleven years was 60 kg dry for the d/6-tapped area against 22 kg recorded in the d/2 –tapped (control) area. The average tapper's income, which has been the highest on the estate, was 82% more than that earned by tappers in d/2 tasks. The average tapping and collection cost per kilogramme was 22 sen lower than that of the d/2- tapped and 25 sen lower than that of the average estate cost. The average return per hectare over the eleven years for the d/6-tapped area was better than that of the d/2-tapped area (RM210 more) despite a lower yield per hectare (88% of d/2) largely because of the lower tapping and collection cost. This paper reports the findings established from the commercial experience as well as high-

lights the benefits of using once-a-week tapping, particularly in situations of acute shortage of tappers. Some practical problems associated with the implementation of this system are also indicated and discussed. It is expected that based on the experience gained with this system over the preceding 11 years, it will increasingly be adopted in areas coming into tapping within both the estate and the group.

Key words: Ethephon; Once-a week tapping; Tapping system; Stimulation

17 Comparative effectiveness of different stimulation methods on yield performance of *Hevea brasiliensis*

Rajagopal, R; Vijayakumar, K R and Thomas, K U

In: *Plantation Crops Research and Development in the New Millennium: PLACROSYM XIV.* 12-15 December 2000 (Eds. P.Rethinam *etal.*) Coconut Development Board, Kerala, India. pp. 420-423.

Hevea brasiliensis Muell.Arg is the most important source of natural rubber. Ethephon (2-chloro-ethyl-phosphoric acid) is widely used as an yield stimulant in rubber plantations. Effectiveness of four stimulation methods (lace, groove, panel and bark) at four concentrations (0%, 2.5%, 5% and 10%) were evaluated in clone RRII 118 under 1/2S d/6 frequency of tapping. Among the various treatments, panel application was found to be more effective treatment. This was further confirmed in clone RRII 105 under d/3 frequency of tapping. Results show that, maximum response can be achieved by panel application. The concentration of ethephon can also be reduced to 2.5%

Key words: Stimulation; Yield; India

18 Comparative evaluation of two tapping systems on yield of selected rubber clones in Nigeria

Ibiremo, O S and Aigbekaen, E O

Nigerian Journal of Tree Crop Research, 4(2): 2000. 69-84.

(CAB 2000/08 – 2002/07)

The effect of two tapping systems, *i.e.* half spiral alternate daily tapping (s/2 d/2) and half spiral, tapping every third day (s/2 d/3), on the yield of four rubber clones/ seedlings was evaluated at Iyanomo Benin City in Nigeria between March and September 1998. The clones/ seedlings investigated include RRIN seedling (C1) PB5/51 (C2), RRIM 600 (C3) and mixed clones (C4). These were tapped using the two tapping techniques for seven months. The results showed that the yield obtained from s/2 d/2 system was significantly higher ($P > 0.05$) in terms of dry rubber content (DRC), coagula and latex production than s/2 d/3, which caused 36% average yield reduction for all the yield indices. Among the four clones evaluated, RRIM 600 (C3) and PB5\51 consistently gave higher yield throughout the study period. The economic efficiency of the two tapping systems showed that s/2 d/2 tapping system gave net revenue of N51, 647 while s/2 d/2 gave negative net revenue of 8133 nairas. The net present value (NPV) of s/2 d/3 was 36814 nairas at 10% discount factor with an internal rate of return of 13%. With these results, s/2 d/2 gives better results for latex exploitation in the country, and is therefore suggested for use.

Key words: Clonal response; Tapping system; Yield; Nigeria

19 **Comparison of different methods of yield estimation in *Hevea brasiliensis***

Aniamaka, E E and Olapade, E O

Indian Journal Natural Rubber Research 3(2): 1990. 98-101

Five methods of estimating dry rubber yield were investigated in eleven clones of *Hevea brasiliensis*. The tapping system used was 1/2 S d/2 without stimulation. The conventional method of air-drying of cup-lumps was found to over-estimate yield. The Metrolac method gave values closer to those of the standard method, though not close enough to the required tolerance. Pending identification of an alternative method giving results within acceptable tolerance, the Metrolac method may continue to be used with reservation.

Key words: Air dried cup lump; Dry rubber content; Metrolac method; Yield estimation

20 **Comparison of functional properties of ecosystems for rubber plantations under different tapping systems**

Jusheng, Jiang; Weifu, Lin; Guishui, Xie; Yuekun, Wang; Junming, Chen; Mingdao, Cai and Xianhai, Zeng

Paper presented at IRRDB Symposium, Hainan, China, 1999

The ecosystems of rubber plantations of clone PR 107 under S/2 D/2 (old or traditional tapping system) and S/2 D/4 + ET (new tapping system) were designed for positional observation of soil nutrients, leaf nutrients, physiological parameters of latex, meteorological factors and yield. Comparative analysis of single and multi-factors of the resultant data derived from two years observation manifested that the material recycle and energy metabolism under similar environmental conditions and management were obviously higher in the rubber plantations under new tapping system than under the old system. The plantations under new system consumed more soil organic matter (6.6%), soil nitrogen (9.8%), soil available potassium (2%) and soil water (1091.69 kg/ha) annually than those under old system but less soil available phosphorous. The plantations under new tapping system contained soil available phosphorous 115% higher than those under old tapping system, which was likely due to improved energy metabolism responsible for enhanced utilization efficiency of phosphorous and hence for less soil available phosphorous, or due to improved availability of soil phosphorous by changing root-system ecological environment after ethylene stimulation. The principal factors influencing physiological functions of the two rubber plantation ecosystems (new and old tapping systems) were different in some way. The effect of Mg+2 content of leaf on DRC of latex and the effect of maximum temperature on R-SH of latex were similar in the plantations under both new and old systems, whereas the ecological factors affecting Pi, Mg+2 and sucrose content of the latex were different under both ecosystems. The physio-ecological factors comprehensively influencing the latex producing function of the two ecosystem were different. The main factors affecting average yield per unit area and per tree included Mg+2 content of leaf and raining days per month for the new tapping system, whilst DRC of latex and content of soil organic matter for the old tapping system. The above results suggested that the environmental condition adapted to growth of the rubber tree had changed greatly after the new tapping system was adopted. The control techniques for the rubber plantation ecosystem of the new tapping system should include improvement of components of fertilizer and changing of the frequency and date of fertilizer application, application of organic fertilizer for improvement of soil organic matter,

and establishment of plant covers of rubber plantations for conserving water and increasing fertility. The phosphorous metabolism observed in the rubber plantation under the new tapping system needs further research.

Key words: Ethylene; Functional properties; Rubber plantation ecosystem; Stimulation; Tapping system; China

21 Components of variance for tapping panel dryness in *Hevea brasiliensis*

Mydin, Kavitha K; John, Alice; Marattukalam, Joseph G; Saraswathyamma, C K and Saraswathy, P

Paper presented at IRRDB Symposium, Hainan, China, 1999.

A large scale evaluation trial of 21 clones of *Hevea brasiliensis* was studied with respect to yield, girth and the incidence of tapping panel dryness (TPD) over nine years of exploitation. Tapping panel dryness was confirmed to be a distinct clonal characteristic with high heritability and low genetic advance. A significant positive correlation of TPD with girth and girth increment over nine years of tapping was observed. The distribution of TPD affected trees in the field was non random in most of the clones studied. Nonadditive gene action in the inheritance of TPD as indicated by the genetic parameters and its implications on *Hevea* breeding are discussed.

Key words: Clonal response; Genetic advance; Heritability; Tapping panel dryness

22 Contribution of the dynamics of vegetative growth of *Hevea brasiliensis* to the determination of tapping norms

Obouayeba, S; Boa, D; Gohet, E; Dian, K; Ouattara, N and Keli, Z J

IRRDB Symposium on Natural Rubber(Hevea brasiliensis) V2*: Physiology and Exploitation and Crop Protection and Planting Methods Sessions*, 14-15 October 1997, Vietnam, pp71-79.

A study to determine "norms" for the tapping of *Hevea brasiliensis* is being carried out in Cote d'Ivoire. This is aimed at defining an age and minimum circumference for the opening of *Hevea* which takes into account the notion of physiological maturity. The modelled vegetative growth curve is a sigmoid with a gradient change point at the third phase that is a plausible solution to the problems of this study. Analysis of growth dynamics shows that this point hardly varies, irrespective of the growth class of the clone, and takes place at the sixth year after planting. In addition, several observations on the growth of *Hevea* under different conditions lead to the proposal of a minimum tapping circumference linked with the growth class, thus combining the notion of age and size. This study finally shows that economic objectives are not always adequate for some of the requirements for the development of plants.

Key words: Physiological maturity; Primary and Secondary metabolisms; Tapping norms; Vegetative growth; Cote d'Ivoire

23 Controlled upward tapping

Jayachandran, O T

Workshop on the Latest Trends in Exploitation, Processing and Marketing of Natural Rubber, 1991, UPASI R & D Centre , Kottayam, India, pp.7-20.

Tapping is nothing but controlled wounding of the rubber tree to produce latex. Tapping was carried out in a crude manner and today we have various controlled systems to produce latex in

a sustained manner. Over the years various systems and combinations have been implemented but the growth in yield per ha. per annum has been around 3%. The cost of inputs has been going up drastically and it is absolutely essential that the productivity is improved immediately. The existing systems may not be able to deliver the goods and as such, we have to think of updating an exploitation policy. The Controlled Upward Tapping (CUT) has proved its superiority in production compared to the conventional systems. In the various trials conducted by AVT over the years, the production with CUT increased in the range of 40% to 60% with a cost reduction of about 40%. The response of CUT was best on d2 frequency. There was no adverse secondary affects such as Brown Bast, Dry trees or on DRC. CUT is essentially the reverse of normal downward tapping and is an ideal system for exploitation of the high level virgin bark. The angle of the cut can be 30 degree and length 1/2S, stimulation can be carried as is done on other panels. The problem of latex spillage can be corrected by tilting the knife correctly. Rainguarding can be carried out using shades or 18" plastic. Trials were carried out by AVT on 1/4S, 1/3S, and 1/2S length of cuts. 1/3S was found to be best. Shorter cuts permit the trees to be tapped longer and height increase is also restricted. Extensive trials on CUT has proved it to be a superior system of tapping and the benefits are higher yields and cost reduction, higher tasks, no bark island effect, better drainage area, and ladder can be avoided. It has proved to be better system for the exploitation of higher panels than the 'V' cut. It is also far superior to the tapping of regenerated bark on the low level.

Key words: Controlled upward tapping; Tapping system; India

24 **Controlled Upward Tapping (Malayalam)**

Vijayakumar, K R and Thomas, K U

Rubber, 344: 1994. 7-9; 31

Key words: Controlled upward tapping; India

25 **Correlation between quality of smallholder rubber plantation with tapping pattern used and smallholders income: Case study in Proyek PIR Khusus I (First special Nucleus Estate Project) in Tanjung Santan, East kalimantan (Indonesia).**

Darmandono

Risalah-Penelitian-Pusat-Penelitian-Perkebunan-Getas (Indonesia), 19:1992. 13-29.

(AGRIS 1995-1996)

Key words: Smallholders income; Tapping pattern; Indonesia

26 **Critical need to enhance yield and labour output to assure sustainability of rubber plantations in Malaysia**

Chandran, M R

Proceedings of Seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, Malaysia, pp.3-16.

Natural rubber as a raw material has been facing low prices for over 10 years, and the situation is exacerbated by the current currency crises in the major producing countries. The continuing

low prices of rubber have meant that the capital inflow needed to develop or maintain rubber plantations in Malaysia is less attractive to investors. As a consequence there has been a decline in area under rubber; this to an extent is also applicable to the smallholder sector. Even with a sale price of RM 3.50/Kg (for premium grades of processed rubber) high yielding estates (1500-1600 kg/ha/year) obtain profits which are very much less than obtainable from an average yielding (22 tonnes FFB/ha) oil palm area. An added disincentive is the low labour productivity under the conventional d/2 and d/3 systems of tapping. The newly introduced Low Intensity Tapping System (LITS) is an avenue to increase productivity or more to answer the problem of acute shortage of labour. There is an urgent need to increase production efficiency through improved clones with much higher productivity and improved exploitation systems with more trees tapped and higher productivity per man day.

Key words: Low intensity tapping; Productivity; Yield; Malaysia

27 Current status of trials on AAR Jacket system of exploitation of rubber

Hoong, Chan Weng and San, Ong Tee

In: *Ensuring sustainability and competitiveness of the NR industry: Proceedings of the Rubber Growers Conference*, 1995 (Ed. Abdul Aziz S. A. Kadir). Rubber Research Institute of Malaysia, Kuala Lumpur, Malaysia. Pp.135-144.

This paper reports 22 to 38-months' results from nine experiments on the AAR Jacket System of exploitation of rubber. Most jacket treatments in the nine experiments exceeded their controls in yield per tapper, ranging from 3% to 43% higher. Response in yield per hectare of jacket treatments was more variable than yield per tapper. In the experiments on *Panel Bo-1*, all jacket treatments yielded below their controls. In the experiments on other panels, jacket treatments tapped on a lower frequency than their control mainly yielded below their controls, while those tapped on the same frequency yielded above their controls. Except for the highest stimulation rate of 400 mg a.i. ethephon applied on *Panel BO-2*, which raised tree dryness to 20 compared with 10 for the control, incidence of dryness; of jacket treatments was more or less similar to their controls. Interim jacket systems for various panels are proposed based on the trial results obtained and also on the current exploitation needs of estates.

Key words: AAR Jacket system; Tapping system; Tree dryness; Yield; Malaysia

28 Detection and treatment of tapping panel dryness (TPD) in rubber plantation

Siswanto, Darussamin A

Warta Pusat Penelitian Bioteknologi Perkebunan 01(1): 1995. 10-14

(HORTCD 1989-2001/09)

Tapping panel dryness (TPD) causes losses of about $68 million per year to the rubber industry in Indonesia. In this study, TPD was detected (during the harvest period) by procoagulation on the harvest line. Resting the affected plants for a while did not have any great beneficial effect. The most effective treatment was to scrub the trunk and remove the affected "skin". To avoid fungal infection, a mixture of palm oil and fungicide (95 : 5) was spread over the wound then harvesting was suspended for 2 weeks. This method was found to be effective for clone WR101. The highest percentage of cured plants was obtained with the addition of KCl fertilizer at 1.5

times the recommended dose or 250g/plant, twice a year. TPD diagnosis can be advanced by 3-4 weeks by detecting a reduction in the sucrose concentration and an increase in the phosphate ion concentration in the latex. Blocking index and flow rate also increased during the 4 weeks before TPD was noticed.

Key words: Tapping panel dryness control; Indonesia

29 DOL and enlarged task: Concept, merits and shortcomings

Hassan, Mohd.Johari; Nayagam, James; Sivakumaran, S and Wan,Yong Hing

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, pp.111-121.

Division of labour (DOL) and enlarged task are alternative labour management systems in latex exploitation, geared towards addressing tapper shortage problems presently encountered by the rubber industry in Malaysia. They emanate from the need to reduce labour requirements in the estates. The two approaches adopted together with other less intensive exploitation systems could significantly reduce labour requirement in the tapping and collection operation and contribute towards increasing labour productivity and income. Reduction in estate's margin could be minimized, if not increased, by reducing unit cost of production through adoption of the novel approaches in a labour shortage situation. DOL separates the conventional twin function of tapping and collection. Thus, a tapper only taps the trees and the task of collecting the latex is delegated to any unskilled worker. This enables the management to double the task size allotted to a tapper. Tapping skill is optimised when the experienced tapper is able to tap an extended task using the time otherwise used for collection. The resultant increase in tapper productivity and wages mutually benefits labour and management. In the enlarged task, work allocation to the tapper is maintained as in conventional operation, except that the task size is extended. In this case, the task is not doubled but enlarged, as the individual has to perform both functions of tapping and collection. The obvious advantage of this approach is the reduction in tapper requirement, without necessarily employing additional labour for collection. As in DOL, tapper productivity and wages improve with increase in task size benefiting both labour through increased wages, and management through increased productivity and lower overheads. Investigation was carried out to examine the feasibility and viability of both these approaches. It included determining the task size the labour could handle, yield levels and the extent of crop loss, given the possibility of pre-coagulation with extended tapping time, earnings to labour as well as cost and margin to the estate. Modifications were made to the MAPA-NUPW wage agreement with regard to basic output, crop incentives and tree bonuses to ensure increased income to labour without adversely affecting the estate's margin. It was observed that both approaches were feasible and each had its strengths and weaknesses. In the DOL approach, tappers could tap more than 1000 trees within the normal 7 h of work. Under the enlarged task, task sizes could be increased to 900 trees. Although fatigue was not apparent in tapping, signs were shown during collection. Tappers when given larger tasks were quick to self-adjust by increasing their work speed and reduced rest and slack time in order to complete their work within the specified working hours. There was no marked loss in yield (g/t/t) as tappers were generally able to complete tapping at or before the threshold time of 11.30 a.m. after which tapping is considered uneconomic due to pre-coagulation. Cost of tapping and collection, tapping margin and earnings were favourable to both estates and workers. However, an apparent weakness of both approaches is that during late tapping it was necessary to revert to

conventional task to complete tapping within the threshold time. DOL, while saving and optimising labour on tapping, requires additional labour for collection and hence is not essentially a labour saving method. It is, however, attractive to estates that maintain their scarce tapping labour force and recruit unskilled immigrant labour as collectors. The enlarged task saves on total labour, although there is a narrower range to which task size can be extended. It maintains the conventional system of operation and hence faces less resistance to change and less problems of logistics. One strong point of this approach is the higher wages it offers to tappers compared to DOL. Assisted collection is, however, required for doing both tapping and collection as collection can be taxing. This paper reports results of investigations carried out to determine if these approaches are feasible and viable. It also discusses their theoretical concept as well as the merits and limitations.

Key words: Management systems, alternative; Tapper productivity; Tree productivity; Malaysia

30 Dryness syndrome, spreading and control of tapping panel dryness in suggested clone of rubber trees

Siswanto

Warta Pusat Penelitian Bioteknologi Perkebunan 3(1): 1997. 2-15.

(HORTCD 1989-2001/09)

Key words: Dryness syndrome; Tapping panel dryness control

31 Dynamics of vegetative growth of *Hevea brasiliensis* in determining tapping norms

Obouayeba, S; Boa, D; Gohet, E; Dian, K; Ouattara, N and Keli, Z J

Journal of Rubber Research 3(1): 2000. 53-62.

A study to determine norms for the tapping of *Hevea brasiliensis* was carried out in Cote d'Ivoire. This was aimed at defining age and minimum girth for the panel opening of *Hevea* which takes into account the notion of physiological maturity. The modelled vegetative growth curve is a sigmoid with a change in the gradient at the third phase which is a plausible solution to the problems of this study. Analysis of growth dynamics shows that this point hardly varies, irrespective of the growth class of the clone, and takes place at the sixth year after planting. In addition, several observations on the growth of *Hevea* under different conditions support the proposal of a minimum tapping girth linked with the growth class, thus combining the notion of age and size.

Key words: Tapping norms; Vegetative growth; Cote d' Ivoire

32 Early exploitation with puncture tapping

Leong, T T

In: *Towards Greater viability of the Natural Rubber Industry: Proceedings of the RRIM Rubber Growers' Conference*, 1991, (Ed. Abdul Aziz Bin S. A. Kadir). RRIM, Kuala Lumpur, Malaysia, pp.169-87.

The puncture-tapping (PT) system involves making six punctures at random along a stimulated vertical strip. The latex oozes out of the punctured hole, flows down the vertical strip onto

the spout and into the latex cup. This technique of extracting latex was carried out on young immature rubber trees of several clones. The objective is to reduce the immaturity period by initially puncture-tapping for a short duration and subsequently by the conventional tapping system (CT). Results of five years on clone PB 311 showed that early exploitation of trees opened for tapping one year earlier could result in extra yield and higher net revenue than those trees opened for tapping one year later. Comparing PT and CT on trees less than 45 cm girth and opened for tapping one year earlier, the yields of PT during the first five year were similar to those under CT. Subsequent conventional tappings from second to fifth year showed similar yield performance in both the ex-punctured and non-punctured trees. The net revenue of five years indicated only marginal difference between PT and CT. Since PT had advantage over CT in terms of bark consumption, early exploitation with PT is recommended. The trial on early exploitation with PT on various clones and crown-budded plants indicated that there was clonal response to PT. For example, clones PR255, GT1, PR107 and AV 2037 performed better than clone RRIM 600.Clone PR255, however, showed high incidence of bark 'burst' and early PT of this clone can be problematical for subsequent CT. Another experiment on early PT of clone GT1 showed that subsequent CT should preferably be carried out on virgin bark and not immediately on punctured bark.

Key words: Clonal response; Girth increment; Puncture tapping; Tree dryness; Yield

33 Early opening of trees to improve productivity and profitability

Gan, L T; Chew, J S; Chew, O K and Ho, C Y

In: *Towards Greater viability of the Natural Rubber Industry: Proceedings of the RRIM Rubber Growers' Conference*, 1991, (Ed. Abdul Aziz Bin S. A. Kadir).RRIM, Kuala Lumpur, Malaysia, pp.147-168.

Trial results have reaffirmed that early opening for tapping at 40 cm and 45 cm when 50% of the stand had attained these girth sizes, had no long-term deleterious effects on yields, girthing, dry rubber content (d.r.c.), incidence of dryness and percentage of late drip compared to the conventional 50 cm girth size of opening. It was also shown that the advantage of early yields made possible by early opening, afforded earlier returns on investment and lowered cost to maturity for all three clones evaluated *viz.* RRIM 600, GT 1 and PB 260. Stimulation boosted yields of early opening, thus making it a more attractive proposition. Higher ethephon concentrations increased yield response but also resulted in higher incidence of dryness and percentage late drip. In addition, higher stimulation regimes had an apparent depressive effect on girthing, irrespective of sizes of opening and clonal material. The relative Net Present Values (NPVs), Internal Rate of Return (IRR) and Payback period of all clones were improved with early opening at 40 cm and 45 cm compared to the conventional 50 cm.

Key words: Clonal response; Dry rubber content; Economic analysis; Stimulation; Yield

34 An economic analysis of the commencement time for tapping rubber by smallholders in *Imperata* areas of indonesia

Grist, P G and Menz, K M

Journal of Natural Rubber Research 10(4):1995. 276-282.

A bioeconomic model for estate rubber is modified to apply to conditions facing Indonesian smallholders in low fertility *Imperata* areas. The economic component of the model is updated

using prices and costs prevailing in South Sumarta in 1995. The modifications to the model are briefly described, then used to analyze the decision of when tapping should commence. It is shown that smallholders who tap prior to recommended minimum tapping girths are acting logically. Early commencement of tapping is consistent with maximising economic returns over the life of the plantation, even though there is a sacrifice in terms of total rubber yield. Bioeconomic modelling is a powerful tool for analysing issues of this type, where the undertaking of long run biophysical experiments is prohibitively expensive.

Key words: Ethrel; Shortcut system; Yield; Indonesia

35 Economics of less labour-intensive tapping systems

Nayagam, James; Wan,Yong Hing; Hassan, Mohd.Johari and Sivakumaran,S.

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, Malaysia, pp.183-193.

The conventional methods of tapping and field upkeep are comparatively labour intensive. While the demand for labour is high, the supply has been continuously decreasing. This has resulted in increasing labour shortage and, consequently, larger areas are left untapped. Besides labour shortage, the producers are also facing rising production cost. In spite of the high production cost, wages and fringe benefits of the workers are still comparatively low. This in turn has encouraged increasing number of young workers to migrate to urban centres in search of better paying jobs. Since tapping accounts for 70% of the labour force and about two-thirds of the production cost, extensive adoptive research on labour and cost saving tapping systems is being carried out. This paper outlines and discusses economics of some efficient systems, namely DOLCUP, DOLBAG, enlarged tasks, stimulated periodic and stimulated d/6 (once-a-week). In analysing these systems a two-fold approach was adopted. First, the output, production cost, tapping margin and tapping wages obtained with these systems were compared with that of the conventional system under no tapper-shortage situation; then, the same comparisons were made on the basis of different levels of labour shortage. The data used here were those obtained from the relevant field trials conducted in Selangor, Negeri Sembilan, Perak and Johore. When there were sufficient tappers, the use of the conventional d/2 or d/3 system ensured optimal output/hectare/year. With DOLCUP, DOLBAG and enlarged task systems, comparable output per hectare per year was obtained so long as the tapping was completed well before 11.30 am and recovery tapping carried out properly whenever necessary. The stimulated periodic tapping system showed that it was capable of giving better output. As for the stimulated d/6 system, the crop output (kg/ha) dipped by about 19%. Tapping cost, which also includes the collection cost, was highest for the conventional system, followed by enlarged task, periodic, DOLCUP, DOLBAG and d/6 systems. The reduction in production cost corresponded with the amount of reduction in labour used for the respective systems. For DOLCUP and DOLBAG there was a 50% reduction in tapper usage though additional unskilled workers were engaged to collect the crop. For enlarged task the reduction in tapper requirement varied from 14 to 33% as the task size was increased from 600 to 900 trees. In the periodic and d/6 systems, there was less usage of tappers by 25 and 67% respectively. Tapping margin, i.e. gross revenue less tapping cost (including collection and stimulation costs), obtained from these labour-saving systems as compared with the conventional system differed significantly. The margin for periodic tapping was higher than that of the control because of the comparative increase in output and reduced

tapping cost. DOLCUP's margin was comparable with the control, whereas DOLBAG was 14% lower. This was because latex output for DOLCUP and the control was marketed as SMR CV, while lumps from DOLBAG were sold as SMR 10. Tapping margins of the enlarged task systems varied from minus 8% to plus 18% compared to that of the control, mainly due to the differences in output resulting from the variation in the tapper's turn-up for work. The margin for d/6 tapping was 13% lower because of the 19% dip in output. The lower the tapping frequency and the larger the tapping area, the higher were the tapper's earnings because of the increased output per tapping. For the d/6 system, the tapper's daily earning was RM25.00, about 67% more than the conventional tapper's earning (RM15.00/day.) For the enlarged task, it was higher by 13-53%, depending on the size of the task. DOLCUP, DOLBAG and periodic system gave higher earnings by 17, 8 and 15% respectively. As the supply of tappers fell, the amount of output from the conventional system reduced because of the larger area that was left untapped. It was observed that when there was a 25% shortage in tapper supply a producer who resorted to the use of periodic and enlarged task systems gained in tapping margin by 27 to 45%, compared to the gain if he were to continue to remain with the conventional system. When tapper shortage increased to 33% the use of DOLCUP, DOLBAG and enlarged task system enhanced the margin by 32-50%. With 50% shortage, the introduction of DOLCUP and DOLBAG improved the margin by 75-100% and with 66% shortage, use of the d/6 system improved the margin by 150%. From the above analyses, it is clear that when there is tapper shortage continued use of the conventional system will reduce the estate's overall profit. The producer may even face losses over time. Thus, as the tapper shortage increases the most appropriate less labour-intensive tapping systems should be used to maintain reasonable returns from the rubber area.

Key words: Economic analysis; DOLBAG; DOLCUP; Tapping system; Malaysia

36 Economics of low intensity tapping systems

Hassan, Johari; Sivakumaran, S and Md.Said, Mohd. Akbar

Proceedings of Seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, Malaysia, pp.103-122.

Low intensity tapping system (LITS) emanates from the need to address problems of labour shortage and low land and labour productivity that presently plague the upstream plantation sector. The LIT d/6 system shows promise in reducing labour requirement and increasing labour productivity. The increase in tree productivity on account of stimulation is insufficient to offset the loss in tapping days. Consequently, yield per hectare is expected to reduce. The system is effective in increasing labour productivity and income and in optimizing land and labour utility under labour-shortage situation. The long-flow gaseous stimulation systems of RRIMFLOW and REACTORRIM show promise in substantially increasing yield. Results form trials and monitored development projects confirmed the effectiveness of both gaseous systems of stimulation in increasing tappers' and smallholders' income and profit margin to estates. In terms of returns, owner-operated smallholdings stand to benefit most from these systems if smallholders themselves establish and maintain the exploitation technologies. While the long-flow systems show tremendous potential, there still exist constraints on the ground at the implementation stage that have yet to be addressed if these systems are to be fully commercialized. One such problem is the high start-up cost especially that of REACTORRIM. Further cuts in material cost are in order for the technology to be more affordable to smallholders who are now the

major players in the upstream sector. Another problem requiring urgent attention is that of ensuring uninterrupted gas supply. While successful inroads have been made towards reducing gas leakage and blockage, work at perfecting both technologies must continue if they are to be successfully commercialized.

Key words: Low intensity tapping; RRIMFLOW; REACTORRIM; Yield

37 **Economics of tapping rubber trees once a week**

Sivakumaran, S; Nayagam, James; Kewi, Chong and Wan Yong Hing

Planters' Bulletin. 214:1993. 17-25.

Key words: Tapping system; Tapping cost

38 **Effect of debarking on Rubber trees *(Hevea brasiliensis* Muell. Arg) affected by bark drynes.**

Thomas, Vinoth; Saraswathyamma, C K and Sethuraj, M R

The Planter, 74(867): 1998. 335-337.

An attempt was made to manage TPD in the rubber plantations by removing the unproductive dry bark by successive tapping leaving the residual bark undisturbed. The combined activity of vascular cambium and residual bark lead to the process of bark regeneration. Renewed bark was tapped after two years, and there was a continuous latex flow which indicated that the bark was productive. However the technique needs further refinement before recommendation for wide adoption

Key words: Bark regeneration; Debarking; Tapping panel dryness; India

39 **Effect of ET gas dose on the yield and physiological characteristic of *Hevea brasiliensis* under Micro-cut**

Xianzhou, Xiao; Xiqiao, Lou; Xiaodi, Wei; Shizhong, Liu and Wenxian, Xu

Paper presented at IRRDB Symposium, Hainan, China, 1999.

Adopting micro-cut (Mc) technique, the yields of rubber trees are acceptable while stimulated with 20ml ET gas for PR 107 middle-ages, 20-30 ml for PR107 and RRIM600 old-ages. The result of latex diagnosis shows that, the sucrose, thiols and inorganic phosphorus contents keep in a relatively high level, while the magnesium content decreases. Adopting Mc technique with ET gas stimulation will result in high burst index and excessive latex flow.

Key words: Micro-cut; Physiological parameter; Stimulation; Yield; China

40 **Effect of ethephon concentration on yield and some physiological parameters of *Hevea brasiliensis* latex from controlled upward tapping on clone RRIM 600**

Nghia, Nguyen Anh; Ramlan, Mohd. Fauzi; Ghandimathi, H; Yeang, H Y and Kadir, Mihdzar Abdul

IRRDB Symposium on Natural rubber (Hevea brasiliensis) V2. *Physiology and Exploitation and Crop Protection and Planting Methods Sessions*, 14-15 October 1997 Vietnam, pp.46-60.

A study was carried out to evaluate the effect of several ethephon concentrations (5,10 and 20%) on yield and some of the physiological parameters of latex obtained from the use of

Controlled Upward Tapping (CUT) on clone RRIM 600. A good response to stimulation on yield was observed. The yields in stimulated treatments were from 192.5-267.7 %of the control over the period of study. The influence of the stimulant concentration on the yield varied with the duration of the study. The variation of some physiological parameters under the effect of ethephon was similar to that observed in downward tapping. Total solid content (TSC), cytosolic pH, C serum invertase activity, bottom fraction (BF), thiol content and sucrose content exhibited a transitory change after each stimulation. However, the modification of inorganic phosphorus (Pi) content and Triton X-100 (Tx) serum invertase activity were observed after a few applications of stimulant. Polyphenol oxidase (PPO) activity was not affected by the stimulation. The progressive decrease of an initially higher yield when stimulating with 20% ethephon, compared to stimulation using the lower concentrations of 5 and 10% ethephon, accompanied by some changes in the physiological parameters implied a possible unfavourable effect of a high stimulant concentration.

Key words: Controlled upward tapping; Ethephon; Total solid content; Yield; Malaysia

41 Effect of ethephon on bark wound healing in *Hevea brasiliensis*

Jilin Wu and Bingzhong Hao

Indian Journal of Natural Rubber Research, 04(2): 1991, 91-96.

Wound healing of ethephon-treated and untreated bark of *Hevea brasiliensis* was studied using microscopy. Cell wall lignification of wound margin appears earlier and more lignified cells occur in treated bark. The first cell divisions leading to the formation of callus and wound periderm are postponed by ethephon treatment. The sequent periderm is formed beneath the first periderm around the wound of ethephon-treated bark, while no such periderm occurs in untreated bark. The significance of the results is discussed in relation to the ethephon-induced resistance of *Hevea* bark to black stripe, a wound disease.

Key words: Bark wound; Ethephon; Wound healing; China

42 The effect of intensive tapping on induction of tapping panel dryness and associated biochemical changes in two clones of *Hevea*

Vijayakumar, K R; Sulochanamma, S; Thomas, Molly; Sreelatha, S; Simon, S P and Sethuraj, M R

Proceedings of IRRDB Symposium: Physiology and Exploitation of Hevea brasiliensis, 6-7 October 1990, Kunming, China, pp.103-110.

Randomness in the incidence of Tapping Panel Dryness (TPD) in any field makes it difficult to quantify clonal susceptibility to this syndrome. In a preliminary study, using GT1 as a reference clone, the susceptibility of RRII 105 to the syndrome was quantified by an index based on the period required to induce total dryness of the tapping cut under a high intensity tapping system. The incidence of TPD was more rapid in RRII 105; the rate of incidence of TPD for clone RRII 105 was 1.92 times greater than that found for clone GT 1. The possibility of using this an index to classify clones according to susceptibility to TPD is discussed. Biochemical parameters such as bursting index, total and free acid phosphatase activity, proteins, sugars and lipids were monitored in the experimental trees. The pattern of changes markedly varied between the two clones studied. A lower bursting index and higher levels of sugars and proteins were ob-

served in the initial months in the latex of the intensively tapped trees of the susceptible clone. The possibility of using these parameters also, for early prediction of susceptibility to TPD, is discussed.

Key words: Biochemical change; Clonal susceptibility; Intensive tapping; Tapping panel dryness; India

43 Effect of once in three days tapping with mild ethephon application

Sugunananda, Swami

In: *Global Competitiveness of Indian Rubber Plantation Industry: Rubber Planters' Conference, India 2002*, (Ed. C. Kuruvilla Jacob). Rubber Research Institute of India, Kottayam, pp.82-83

Small growers of Kerala in general are following 1/2 S d/2 frequency of tapping in clone RRII 105 (with or without rainguarding). Majority of growers in Palakkad district also follow d/2 frequency without rainguarding, and hence obtain only low yield. The plantation of the Madom also was not an exception. As a part of Rubber Research Institute of India's 'Lab to Land' programme, the tapping was shifted to d/3 frequency with use of rainguard in the entire area of six blocks with 2400 trees in total. Four blocks were stimulated with 2.5% ethephon (3 application / year on panel) and two were left untreated for comparison. The annual dry rubber yield under d/2 frequency was 1.5 tonnes per ha. This could be increased to 2.1 tonnes/ha under regular d/3 frequency tapping and further increased to 2.8 tonnes/ha by stimulant application. The cumulative yield (40 months) under unstimulated blocks was 7344 kg/ha and that of stimulated blocks was 9419 kg/ha. Throughout the year, yield was higher and sustainable in stimulated blocks. Annual dry rubber content was in the range of 38-40 percent. Higher rubber yield was obtained even in summer months (15.6 to 20 kg/ha/tap) under d/3 frequency of tapping. The DRC remained high and tapping panel dryness (TPD) very low (only 4%). The number of tappers could be reduced from three to two by shifting to d/3 tapping system. The payment for workers is based on number of trees tapped per day and the rate is 30 paise/tree By introducing incentive system for number of sheets (60 paise/standard sheet) and reducing per tree rate to 25 paise, the rubber production per tap could be increased. This resulted in an overall increase in the wages of tapper by Rs 10 and an extra income of Rs 125 per day to the farm. The d/3 system of tapping with stimulation has definite advantage over the conventional d/2 frequency in clone RRII 105.

Key words: Clonal response; Ethephon; Stimulation; Tapping system; India

44 Effect of panel changing on tapping panel dryness in *Hevea*

Krishnakumar, R and Jacob, James

Indian Journal of Natural Rubber Research, 15(1): 2002. 96-99.

Key words: Panel change; Tapping panel dryness; India

45 Effect of recovery tapping on yield potential of rubber *(Hevea brasiliensis)* trees

Silva, T U K; Nugawela, A; Rodrigo, V H L and Serasinghe, P

Journal of the Rubber Research Institute of Sri Lanka, 84: 2001. 25-38.

Wet tapping panels are not tapped as it leads to panel diseases, law yields (drying of panels) and wastage of latex. Therefore depending on the area of the cultivation ca. 15-34% of the crop is lost each year. Amongst the different agrotechnologies recommended to overcome this crop

loss, recovery tapping is frequently done in both plantations and smallholdings. In this study the effect of 0(RT-0), 3(RT-3), 4(RT-4), and 5(RT-5) recovery tappings/tree/month on yield and some yield related parameters of two widely grown clones was tested. Total dry rubber yield per tree per month was highest in RT-5 and lowest in RT-0 during first two months of the study. On the third month the RT-0 gave the highest yield/tree/month in clone RRIC 100 whilst in RRIC 121, RT-5 recorded a marginally high yield. During the initial two months of the study all treatments with recovery tapping recorded a higher g/t/t than from the no recovery tapping treatment in both clones. However, in the third month of the study treatments with recovery tapping recorded a significantly lower g/t/t in clone RRIC 100. In RRIC 121 though the g/t/t was low, the difference was not significant. Excessive recovery tapping continuously for periods more than 2 months resulted in significantly lower latex volumes and DRC. These can be attributed to the lower g/t/t and monthly total yields with excessive recovery tapping. The yield per unit bark consumed also declines when excessive recovery tapping is undertaken. It can therefore be concluded that recovery tapping when done excessively will not result in higher yields than what can be achieved with the recommended number of recovery tappings. Also there is evidence that some clones, e.g. RRIC 121 may withstand relatively more number of recovery tappings a month than others.

Key words: Latex volume; Recovery tapping; Tapping intensity; Yield; Sri Lanka

46 Effect of stimulant application for rubber in small growers field: A case study

Thomas, George and D'Cunha, Bernard

In: *Global Competitiveness of Indian Rubber Plantation Industry: Rubber Planters' Conference*, India 2002, (Ed. C. Kuruvilla Jacob). Rubber Research Institute of India, Kottayam, pp.155-162.

Trees of clone RRII 105 in small growers field at Pookkottupadam in Nilambur were selected for the case study. There were 550 trees in 1.21 ha opened for tapping in 1991 under d/2 frequency with polythene skirt rainguard. BO-1 and BO-2 panels were completed by 2000 (10years) and in 2001, tapping commenced on renewed bark (BI-1). The dry rubber yield obtained during 2000(January to May d/2 and June to December d/3) without yield stimulation was 2418 kg/ha (124 tappings) compared with that in 2001-02 (d/3) with panel application of ethephon at 2.5% twice during the year being 2737 kg/ha (95 tappings). The per tap yield under d/2 was only 10.9kg/ha which increased to 17.5 kg/ha under d/3 (2000) and further to 28.8 kg/ha under d/3 with two stimulations per year, the overall increase being 319 kg (13%). Annual average DRC was 37.8 per cent. From this study it is evident that regular d/3 frequency tapping with recommended method and dose of stimulation can result in good yield even on renewed bark, at lesser cost.

Key words: d/3 frequency tapping; Ethephon; Yield; India

47 Effect of stimulant-cover application combined with HLE tapping system on rubber yield

Lukman

Indonesian Journal of Natural Rubber Research, 13(1): 1995. 17-20.

At present, application of latex stimulant is assumed as an integral part of rubber exploitation system. Stimulant material widely used now in rubber estates is Ethrel Latex Stimulant (ELS)

with its active ingredient 2-chloroethylphosphonic acid or ethephon. Usually, this ELS is diluted with water to have lower concentration before application to the bark of rubber tree. Ethephon decomposes spontaneously in aqueous solution, and in plant tissues yields ethylene which is responsible for yield induction. Due to this reason, it is possible that much of ethylene has already evaporated during Ethrel dilution with water before being applied to the bark of rubber tree, washed by rain after application to the tree or exposed to the night-dew, etc. It is assumed that covering the stimulant after application to the bark will decrease the evaporation of ethylene outside the plant tissues, so, by that way more ethylene will induce the yield of stimulated rubber tree. Based on the above reasons, an experiment was done to see the effect of stimulant-cover application combined with HLE tapping system on the yield of rubber tree. The results of a one-year experiment on GT 1 clone showed that the yield of rubber tree could be increased highly significant by applying stimulant-cover to scraped rubber bark. The highest yield was obtained by stimulation with Ethrel 10.0% a.i. covered by plastic sheet i.e. 133% of the control (= 66.3 g/t/t), followed by vaseline-cover (132%) and coaltar-cover (129%). The average of dry rubber content of treatments stimulated with Ethrel and covered with stimulant-cover were higher (= 37.1%) than that of the control (= 34.0%). The treatments did not influence the percentage of tapping panel dryness.

Key words: Ethephon; Protective coating; Tapping system

48 Effect of stimulants on rubber content of natural rubber latex: Research report

(www.clib.psu.ac.th/acad-43/kpir 1.htm)

The effect of 3 natural rubber latex stimulants {2-chloroethylphosphonic acid (2-CEPA0, 1-napthylacetic acid (NAA), 2,4-dichlorophosphonic acid (2,4-D)} on latex weight, dry rubber content was studied. The experiment was conducted with the 15 years old clone RRIM 600 Hevea trees. Tapping was done every 3 days, and the total number of Tapping was 12 within the 34 days' period. The results showed that the average latex weight and the total rubber content were increased for all 3 stimulants used the average dry rubber content was rather constant but it was lower than the control. 2-CEPA was found to increase the average weight of total rubber content from 18.22 to maximally 37.78g/tree/tapping, while 2,4-D and NAA were responsible for the increase of the average weight of total rubber content from 18.77 to 31.73 g/tree/tapping and from 18.65 to 25.43 g/tree/tapping, respectively.

Key words: Stimulant; Yield

49 Effect of tapping frequency and stimulation on yield and economic performance of rubber tree clones.

Goncalves-P-de-S; de Souza, S R; Brioschi, A P; Virgens-Filho-A-de-C, ; May, A and Alarcon, R S C

Pesquisa-Agropecuaria-Brasileira 35(6) 2000. 1081-1091.

(HORTCD 1989-2001/09)

Key words: Clonal response; Stimulation; Tapping frequency; Yield

50 Effect of upward tapping (UT) on rubber production of recommended *Hevea* clones

Junaidi, Untung and Kuswanhadi,

Indonesian Journal of Natural Rubber Research 13(2): 1995. 109-112.

Upward tapping is expected to be superior tapping system compared with downward tapping system. By upward tapping (UT), latex regeneration is expected better and with broader latex drainage area, plant yield will be increased. This trial was arranged in a randomized block design with 12- 13 treatments of tapping systems and two or three replications. The *Hevea* clone used were GT 1, PR 255, PR 261 and BPM 1. Observations were made on yield, total solid content of latex, bark consumption, plant growth and health. The results showed that tapping system of 1/4S↑d/2.ET2.5%Ga0.5.24/y(2w) increased plant yield of GT 1, PR 255 and PR 261. Upward tapping did not have negative effect on plant growth and health. There were difference responses among clones and plant age to upward tapping.

Key words: Clonal response; Tapping system; Upward tapping; Yield; Indonesia

51 Effect of upward tapping on technical specification quality of two recommended *Hevea* clones

Solichin, M; Junaidi, Untung and Kuswanhadi

Jurnal Agrotropika, 5(1):2000. 49-55.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.324)

The objective of this experiment was to study the effect of upward tapping on the technical specification quality of the latex of two recommended clones. This experiment was arranged in a randomized block design with 12 treatments of tapping systems in two months and two replications. The *Hevea* clone used were PR 261. Observations were made on technical specification quality of Po (initial plasticity), PRI (plasticity retention index), V_R (Mooney viscosity), V_{37}(volatile matter), and as content during two months of tapping. The results showed that different length and frequency of upward tapping and stimulation of ethephon did not effect the value of Po, V_R and ash content compared with the downward tapping. But it decreased the value of PRI. This effect on the PRI value probably due to the changing of the balance of anti and pro-oxidant in the latex with different frequency and month of tapping, where the longer time of tapping frequency tends to increase the pro-oxidant matter in latex.

Key words: Latex quality; Upward tapping; Indonesia

52 Effective and efficient exploitation of higher virgin panels in *Hevea brasiliensis* Muell. Arg.

Nugawela, A and Karunasena, R P

Bulletin of the Rubber Research Institute of Sri Lanka, 40: 1999. 39-44

A study was carried out in 2 plantations in Sri Lanka where tapping had commenced in 1983 and was completed in 1993. Thus 10 yeas of no tapping enabled bark renewal. A diagram is presented indicating year of tapping, tapping system and panel to be tapped. Trees were tapped in the following ways during 1994-96: (1) tapping panel B1-1 downwards commencing at the original height of opening; (2) tapping of virgin bark downwards, commencing 15 cm above

panel B1-1; (3) upward tapping of virgin panels above B1-1; (4) downward tapping of higher virgin panels; and (5) puncture tapping of higher virgin bark. The highest combined yields over 4 years were obtained in treatments 1 and 3, and the lowest combined yield was observed in treatment 5. Tapping method influenced yield of latex

Key words: Bark renewal; Panel change; Tapping system; Virgin bark; Sri Lanka

53 Effects of tapping and intensive stimulation on yield, dryness incidence and some physiological latex parameters of clone RRIM 600

Thanh, Do Kim; Sivakumaran, S and Choo, Wong Kai

Journal of Natural Rubber Research 11(3): 1996. 200-214

A four-year experiment studied the yield responses, dryness incidence and some physiological latex parameters of clone RRIM 600 on two tapping frequencies (alternate daily d/2; fourth daily d/4) of half-spiral tapping system combined with four stimulation frequencies unstimulated control(0/y); 4 applications/year(4/y); 30 applications/year(30/y); 60 applications/year(60/y) of 2.5 ethephon applied by groove method. Low tapping frequency of d/4 gave significantly higher g/t/t but lower kg/ha/year and cumulative kg/ha when compared to d/2 frequency. When very high stimulation frequency of 30/y or 60/y were applied, the bulk of the yield increase in response to stimulation was only recorded in the first year of tapping, with increase thereafter being marginal when compared to the unstimulated control. No significant differences in yield were obtained between stimulations 30/y and 60/y. Incidence of dryness was not affected by stimulation frequency up to 30/y, but was significantly increased when at stimulation frequency of 60/y. Trees tapped on d/2 frequency in contrast to d/4 recorded consistently lower readings of physiological latex parameters such as plugging index(PI), initial flow rate(IFR), total solid content(TSC) and dry rubber content(DRC) but higher bottom fraction(BF), thiol content(R-SH) and inorganic phosphorus content(Pi). Similarly, intensive frequencies of stimulation (30/y and 60/y) produced lower values of PI, IFR, TSC and DRC but higher values of BF and Pi when compared to low stimulation frequency 4/y or unstimulated control. Under our experimental conditions sucrose and pH of latex were not affected by both tapping and stimulation treatment and this finding is at variance with other published reports. The significance of changes in these various physiological latex parameters are discussed in relation to yields obtained with the different combinations of tapping and stimulation frequencies.

Key words: Dryness incidence; Intensive stimulation; Tapping system; Yield

54 Efficient tapping system for rubber estate

Siregar, Tumpal H S; Lukman and Junaidi, Untung

Prosiding Apresiasi Teknologi Peningkatan Produktivitas Lahan Perkebunan Karet, 30-31 July 1997, Medan, pp.33-53.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.275)

The results of study and evaluation on rubber estate indicate that problems of tapping are caused by low yield per hectare. Applications of tapping in the field often deviated so that beside low yield it also shorten the economic life of the rubber plants. The recommendation of clonal potential is not realized. The research results of Indonesian Rubber Research Institute conclude that the normal exploitation systems are exploitation systems with low intensity asso-

ciated with stimulant application. While optimal exploitation systems are recommended with intensive stimulant applications from the beginning of tapping. Optimal yield on BO-2 tapping panel could be obtained by applying 1/3S↑d/3.ET2.5%.Ba0.5(1.5.9/y(m) or 1/4S↑d/3. ET2.5%Ba0.5(1.5).9/y/(m). Exploitation system of Mc10 ↑d/3.ET5.0%.Ba05(1.5).9/y(m) is also an alternative to optimize yield on BO-2 tapping panel. Such exploitation system is mainly applied on GT1 clone which is planted in the area with B-type climate. It is not recommended on BPM 1 clone.

Key words: Rubber estate; Tapping system; Stimulation; Yield; Indonesia

55 Enhancing Rubber Production to meet increasing demand for Natural Rubber

Lim Chin Hock and Sivakumaran, S

Paper presented at IRRDB Symposium "Challenges for Natural Rubber in Globalization" 15-17 September 2003, Chiang Mai, Thailand.

The arrest in decline of rubber prices with gradually improving sentiment coupled with the forecast of shortfall in supply augurs well for Natural Rubber in the foreseeable future. However the declining trend in rubber production noted over the last couple of years with exception of year 2002 in Malaysia and from year 2000 to2002 in Thailand is of concern over the long term. There is already presently inadequate supply of field latex to meet the requirements of several latex concentrate manufactures in Thailand with projected annual production targets not being achieved. There is certainly a need to enhance yield productivity of rubber smallholdings and plantations in Thailand. RRIMFLOW system of exploitation developed in the early nineties and introduced for commercial adoption in Malaysia from mid-nineties has been identified as a suitable system to markedly increase yield productivity of rubber smallholdings and plantations in Thailand. The early data on yield productivity obtained on the RRIMFLOW system (RF) in Thailand shows yield increases of 59 to 79 above respective conventionally tapped trees in evaluations carried out in two smallholdings and in two Thaitex plantations. The DRC values of latex from RF tapped trees with exception of the preliminary trial are comparable or slightly lower than that recorded for latex from control trees. The incidence of tapping panel dryness on the new RF cut has been negligible. Determination of several chemical properties in latex obtained from RF tapped trees confirms that RF latex is very suitable for latex concentrate manufacture. This is very important in Thailand because majority of smallholders sell their latex to concentrate manufacturers. Data from partial economic analysis shows increased profitability per rai for the RF system in both smallholdings and the plantation. The net increase in income ranged from 3343 bahts per rai per year in the smallholding to 738 bahts per rai over six months in the plantations. RRIMFLOW is the ideal system to boost the national production of rubber in Thailand thus satisfying the increasing world wide demand for this commodity. The adoption of this system by smallholders will also ensure adequate supply of field latex for concentrate manufacturers in Thailand. It is projected that if the RF system is implemented on only ten percent of the hectarage in production and yield levels are conservatively increased by twenty percent, there will be a gross turnover of 1.5 billion bahts at prevailing rubber prices.

Key words: RRIMFLOW; Smallholding; Malaysia; Thailand

56 Ethephon-induced myelin-like structures in *Hevea brasiliensis* phloem

Bingzhong Hao and Jilin Wu

Chinese Journal of Botany 6(1):1994. 7-11

(Biological Abstracts 57619, 1994)

Key words: Ethephon; Phloem; China

57 Evaluation of d/3 tapping with stimulation to alleviate problems related to d/2 tapping of *Hevea*

Nugawela, A; Peries, M R C; Wijesekera, S and Samarasekera, R K

Journal of the Rubber Research Institute of Sri Lanka, 83: 2000. 49-61

1/2S d/2 system of tapping of *Hevea* is time tested to harvest economic yields from clones widely grown in Sri Lanka. However, both the plantation and the smallholder sectors do not have sufficient tappers, currently, to adopt this system. It is apparent that in the Plantation Sector ca. 28.5% of the potential crop is lost each year due to ca. 28% unskilled tappers and 21.5% vacant blocks. This situation leads to low land and tapper productivity whilst escalating cost of production. With Low Frequency Tapping (LFT) the tapper requirement is less. Nevertheless yield stimulants need to be used to overcome yield losses due to lesser number of tappings/tree/annum. 1/2S d/3 tapping with 3 rounds of stimulation using 2.5% ethrel has given 86% of yield possible through 1/2S d/2 system. In a situation where 28.5% of the potential crop is lost due to tapper related problems 1/2S d/3 tapping with stimulation gives better returns to the estate. Apart from lower tapping costs due to increased tapper productivity, LFT systems have the advantage of low bark consumption rates. The 30 year replanting cycle possible with 1/2S d/2 tapping can be increased up to 36 years with 1/2S d/3 tapping with stimulation. This results in a higher revenue extent in the plantation and hence a higher total production and a reduced cost of production (COP). LFT with stimulation has not retarded the vegetative growth of rubber trees. Moreover, the incidence of Tapping Panel Dryness (TPD) is similar to that with conventional 1/2S d/2 system. These are expected as 1/2S d/3 tapping system with stimulation does not result in a dry rubber yield higher than with 1/2S d/2 system.

Key words: Low frequency tapping; Productivity; Replanting cycle; Stimulation; Tapper shortage; Sri Lanka

58 Evaluation of rubber tapping systems using stimulants

Aragao, L A P De; Dessaune Filho, N

Pesquisa em Andamento, 55: 1990. 6.

(HOA. 7871, 1992)

Key words: Tapping system

59 Evaluation of the "EMB-RUBBER" model for estimating growth and yield

Bernardes, M S; Goudriaan, J; Castro, PRC; Castro, A M G; Brummer, B M; Borin, M and Sattin, M

Proceedings of the 3rd Congress of the European Society for Agronomy, 18-22 September 1994, Padova University, Abano-Padova, Italy, pp.314-315.

Key words: EMB-rubber model; Yield

60 Evaluation of three types of rainguards

Hoong, Chan Weng; Abdul Rahman Hj. Othman; Choy, Chow Kok; Wooi, Toh Choo and Lim H P Patrick

The Planter, 66(775): 1990. 523-535.

Three types of rainguards were evaluated to compare their effectiveness over time. The economics of one type of rainguard and their possible role in minimising incidence of tree dryness through regularisation of tapping frequency and minimisation of recovery tapping were also evaluated. The results showed that where there was monkey damage, Ebor eaves exhibited the least leakage among the rainguard. RRIMGUD and AA rainguards, both aluminium based rainguards suffered marked damage from monkeys. Where monkey damage was absent, AA rainguards were as effective as Ebor eaves. RRIMGUD was poorest. In the trial evaluating the economics of using AA rainguards, rainguard areas suffered a loss of $95.35 per ha over ten months as a result of premature loss of protection from rain due to monkey damage to the rainguards. Tappers were also unwilling to turn up for work in rainguard areas on days where the balance of the estate which was not fitted with rainguards could not be tapped due to rain interference. Although the above trial showed AA rainguards to be uneconomic in that situation, longer periods of protection against rain interference exceeding one year afforded by Ebor eaves and AA rainguards in some other situations and the ability to persuade tappers to turn out for work by the management may well reverse the position. Observations elsewhere have indicated other rainguards to be economically beneficial. Tasks where recovery tapping was undertaken and which had 10 per cent more tappings mainly carried out on a d/1 frequency showed higher tree dryness than non-recovery tapping tasks. This finding however, appears unrelated to the role of rainguards in minimising tree dryness in the above exercise.

Key words: Ebor eaves; Rainguarding; Recovery tapping; Tapping frequency; Malaysia

61 An evaluation on the exploitation system at rubber smallholder project

Boerhendhy, I; Kuswanhadi and Junaidi, Untung

Risalah seminar hasil penelitian Balai Penelitian Sembawa tahun 1992/1993, pp.167- 177.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.64.)

The development of rubber smallholder, both through PIR (NES) or PPKR (SRDP) systems, basically aims to improved and increase rubber smallholder production. Thus these projects are expected to increase the income of smallholders, state devisa, and work opportunity. The main aspect in rubber cultivation relates to the quality of the stem bark, on which tapping is performed. Thus, the bark consumption needs serious attention since it relates to the economic life of the trees. A study has been conducted at the PIRSUS I Project at Sungei Berau, PIR II Bajubang and UPP PPKR Prabumulih in July, August and October 1992. To evaluate the tree condition in each project, several observations were made. The selection of smallholder in this study was carried out using an imbalanced randomized stratified sampling; planting year was used as a stratum. The results showed that most smallholders at the two PIR sites did not follow the recommended tapping norm, while at the UPP PPKR site smallholders followed the recommended norm.

Key words: Smallholding; Tapping system; Indonesia

62 Evolution of latex physiological parameters of *Hevea* rubber tree over consecutive tapping years

Thanh, Do Kim and Nghia, Nguyen Anh

Proceedings of IRRDB Symposium on Natural Rubber(Hevea brasiliensis) V2. *Physiology and Exploitation and Crop Protection and Planting Methods Sessions*, 14-15 October 1997, Vietnam, pp.18-25.

A study was conducted on ten rubber clones, namely GT 1, RRIM 600, PB 235, VM 515, PB 255, PB 310, PB 217, RRIC 100, RRIC 101 and RRIC 121, over four consecutive tapping years using panel BO-1, to examine the effect of the tapping duration and /or the position of the tapping cut on the rubber yield and some latex physiological parameters. The results showed that yield (g/t/t) gradually increased over the period of the tapping years until the cut reached the stock/scion union when the yield was fell off. Sucrose content decreased slightly. Inorganic phosphorus and total solid content increased whilst the thiols content was more or less stable over the years of tapping. In general, all rubber trees responded in similar ways to tapping and/or the tapping cut position though the absolute values reflected the physiological features of each clone. The acquired understandings could supplement the interpretation of the results of latex physiological analysis.

Key words: Clonal response; Latex physiology; Tapping cut; Tapping duration; Tapping system; Yield

63 Exploitation and stimulation recommendations in Sri Lanka

Tillekeratne, L M K and Nugawela, A

Bulletin of the Rubber Research Institute of Sri Lanka, 34: 1996. 9-11.

This paper describes the current stimulation and exploitation procedures recommended by RRI Sri Lanka together with the reasons behind their adoption.

Key words: Stimulation; Tapping system; Sri Lanka

64 Exploitation of *Hevea* under low temperature stress situations: Studies on exploitation systems giving tapping rests based on drop in minimum temperature

Das, Gitali; Raj, S; Pothen, J; Dey, S K and Varghese, Y Annamma

In: *Recent Advances in Plantation Crops Research: Placrosym XIII*, 1998, Coimbatore, (Eds. N. Muraleedharan and R. Rajkumar). Allied Publishers Limited, India, pp.150-156.

Low temperature being the prime cause for late dripping in non-traditional belt of northeast India. An experiment was conducted incorporating three systems viz. 1/2S d/1, 1/2S d/2 and 1/2 S d/3 with three periods of tapping rests based on minimum temperatures of 20-20 C , 15-15 °C and 10-10°C and compared with a control. Though the 1/2S d/1 system for all the combinations showed a high annual yield, the occurrence of tapping panel dryness (TPD) was found to be relatively high. The 15-15 °C rest covers around 20% of the peak yields in comparison with the continuous tapping systems. Analysis of yield showed a high significant relation between the sub-plot treatments of the temperature regimes. Mean yield was high (30.8 gm/tree/tap) for the continuous system of 1/2 S d/3 tapping system which also registered the same

in the 20-20 °C rest. With a low incidence of TPD (5%), the 15-15 °C minimum temperature regime, for the 1/2S d/2 system of tapping, in general, showed an optimum system for exploitation of latex yield during cold season under this non-traditional agroclimatic condition. Nevertheless, basic knowledge of the effects of rest periods during the cold season with an optimum system of tapping, coupled with a lack of long term deleterious effects, would necessarily render exploitation methods to tackle and overcome several prevailing limitations in the region.

Key words: Tapping rest; Tapping panel dryness; Temperature stress; Yield; India

65 Exploitation of High panel

Vijayakumar, K R

Workshop on the latest trends in Exploitation, Processing and Marketing of Natural Rubber, UPASI R & D Centre for rubber, Kottayam, India, 1991, pp. 21-24.

The paper reports the first experiment in India on Controlled Upward Tapping (CUT) comprising 1/2 S, 1/3S and 1/4 S cuts in the high panel employing long handled modified gauge knife. The study conducted in clone RRIM 600 showed 50% higher yield from high panel compared to that from the renewed bark in the basal panel. Advantages of long handled modified knife for exploitation of high panel are elaborately discussed. Benefits of tapping short cuts in the high panel with stimulation are also brought out. The paper describes possibility of exploitation of high panel for more than 9 years.

Key words: Controlled upward tapping; Tapping, high panel; India

66 Exploitation of Rubber in Sri Lanka: Changes needed

Nugawela, A

In: *Global Competitiveness of Indian Rubber Plantation Industry: Rubber Planters' Conference, India 2002,* (Ed. C. Kuruvilla Jacob). Rubber Research Institute of India, Kottayam, pp. 175-178.

In Sri Lanka the most widely adopted tapping system is 1/2 S d/2. Nevertheless due to the scarcity of tappers nearly 28.7 per cent of the tappers used are unskilled. Further, about 15.9 and 22.8 per cent of the tapping blocks are untapped during normal and late tapping days. The estimated crop loss due to these reasons is about 25 per cent. Further, long-term crop losses will also occur. In the absence of any other perfected alternate latex extraction method, 1/2 S d/2 system needs to be modified to suit current conditions of the rubber plantations. 1/2 S d/3 tapping together with the use of yield stimulants is one such modified system. This system helps to minimize the tapper requirement and by adopting it, increase in both tapper and land productivity which are urgent needs for the further development of the rubber industry in Sri Lanka can be achieved.

Key words: Land productivity; Tapping system; Yield; Sri Lanka

67 Exploitation systems in rubber (*Hevea brasiliensis* Muell. Arg. cv GT 1), in the Piracicaba region, Sao, Paulo state, Brazil

Martins, A N

Escola Superior de Agricultura Luiz de Queiroz, Piracicaba, SP, 1995. 107.

(AGRIS 1995-1996)

Key words: Tapping system; Brazil

68 Exploitation systems to maximise yield productivity and enhance profitability in rubber

Sivakumaran, S

In: *Global Competitiveness of Indian Rubber Plantation Industry: Rubber Planters' Conference, India 2002*, (Ed. C. Kuruvilla Jacob). Rubber Research Institute of India, Kottayam, pp. 163-174.

Yield productivity is a critical element in determining level of profitability in rubber plantations. Increased tapper and land productivity can substantially reduce fixed costs of production and tapping and collection costs thus enhancing margins of profitability despite depressed and stagnant rubber prices. The marked increase in yield productivity can be realized through adoption of appropriate exploitation systems incorporating effective methods of yield stimulation. During the first five years of tapping on panel BO-1 on young mature rubber, moderate levels of fifteen to twenty percent increase in yield productivity can be achieved with mild ethephon stimulation involving application of low concentrations at three to six rounds per year. The frequency of application can be regulated according to the type of clone and its inherent yield potential. The RRIMFLOW Short Cut tapping system which involves tapping of a four inch or one eight the spiral cut on reduced frequencies of d/3 or d/4 in combination with gaseous stimulation can be used to markedly increase both tapper and land productivity on trees above eleven years of age. Data obtained over the long term from intensive field evaluation on a broad spectrum of clones tapped either on basal virgin or high panels has confirmed that the RRIMFLOW Short Cut system is the ideal system to maximize tree, tapper and land productivities in rubber. The absence of marked changes in DRC values of RRIMFLOW tapped trees relative to conventionally tapped trees with low levels of dryness recorded suggest that the rubber trees are able to tolerate this mode of exploitation. Enhanced yield responses on the RRIMFLOW system can be sustained over a long term through appropriate manipulation of drainage areas on the tree. The income of tappers in fields exploited on the RRIMFLOW system has been increased two to three fold due to the increased tapper productivity. Similarly the profitability per hectare per year has been enhanced in RRIMFLOW tapped fields relative to conventionally tapped fields. A ready reckoner on economic viability of the RRIMFLOW system based on actual field evaluation data shows that yield increases of only 14 to 26% or minimum of 9 to 15 tappings are required for break even in profitability.

Key words: Ethephon; RRIMFLOW; Stimulation; Tapper income; Yield; Malaysia

69 Exploitation techniques: Recent developments and recommendations

Vijayakumar, K R; Sulochanamma, S and Thomas, K U

Proceedings of the Planters' Conference 1990, Rubber Board, Kottayam, India, pp. 58-61.

Key words: Ethephon; Low intensity tapping; Tapping recommendation; Tapping rest; India

70 Exploitation technology: Advances and challenges facing the NR industry of Malaysia

Md Said, Mohd Akbar and Abang, Mega Arjuna

Paper presented at IRRDB Joint Workshop on Plant Breeding, Agronomy and Socio Economics, 29 August 2002, Kuala Lumpur, Malaysia.

Key words: Natural rubber industry; Tapper income; Tapping yield; Malaysia

71 **Exploration of the high yield physiological regulation of *Hevea brasiliensis* in Xishuangbanna**

Shuochang, Ao and Yagang, Guo

Proceedings of IRRDB symposium: Physiology and Exploitation of Hevea brasiliensis, 6-7 October 1990, Kunming, China, pp. 83-92.

The paper deals mainly with the relationship between the ecological environment, climate and physiological factors and yield of rubber. The reason for a high yield and seasonal yield variations in Xishuangbanna is examined on a preliminary basis.

Key words: Ecological environment; Physiological parameter; Yield; China

72 **Extension of modern exploitation techniques in smallholdings**

Thomas, K U; Vijayakumar, K R; Rajagopal, R and Karunaichami, K

Paper presented at IRRDB Symposium "Challenges for Natural Rubber in Globalization" 15-17 September 2003, Chiang Mai Thailand.

In India more than 88 percent of rubber is grown in small holdings and their share in NR production is 87 percent. Above 90 area in small holding has the Indian wonder clone RRII 105. Though the tapping frequency recommended for this clone is 1/2 S d/3 6d/7, more than 90 small holders follow higher frequencies. Due to the high frequency of tapping and associated incidence of TPD, economic life in small holdings is restricted to 13-15 years resulting in a very high cost of production. Under d/3 frequency, crop realized from RRII 105 is lower than optimum. Hence, mild yield stimulation (3/y) was recommended to optimize yield. On farm trials and lab to land programs of RRII in various locations are in agreement with the recommendation. Almost all small holders make payment of wages based on number of trees tapped irrespective of production. But, a newly introduced production liked incentive proved to be beneficial for both the tapper and the grower. Prolonged immaturity phase, 6-7 years (to attain trappable girth of 50cm) is also a problem in small growers field. Mini/reduced spiral cuts with appropriate yield stimulation can successfully be adopted for early opening (1-1½ years early), when the trees girth is 43cm or more. The crop realized is more than 80 of standard (1/2 S d/3) tree of 50cm girth, and with better girth increment. Adoption of mini/reduced spiral cuts for early opening, subsequent practice of d/3 frequency tapping with mild stimulation, and high panel exploitation under CUT (with periodic panel change) is ideal for small growers. This enables them to have longer exploitation, better production and to reduce cost of production, considerably. Results of on farm trials, and problems faced in extending the new techniques are discussed.

Key words: Panel change; Smallholding; Tapping system; India

73 **FELDA's experience in the implementation of REACTORRIM system**

Zainuddin, Tormodi Hj

Proceedings of Seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, Malaysia, pp.129-139.

REACTORRIM method of stimulation was introduced to settler of Jengka 22 in 1991. When it was first introduced, the system comprised a reactor bottle with chemicals to generate ethylene gas, combined with puncture tapping system, 3PS d/3. This system underwent several

improvements and in 1996, a canister system was introduced to replace the reactor bottle system. Similarly, the method of latex extraction was changed to 2PI d/3 and subsequently to 1/8S d/3. Results over six years indicated that the average tree productivity ranged from 76.9 to 100.7 g/t/t (g/tree/tapping). A comparison was made by the management of Jengka 22 in 1997 and 1998 between REACTORRIM system and the conventional tapping system. The results indicated that the tree productivity of the REACTORRIM system was consistently higher than that of the conventional tapping system. The yield of 102.9 to 110.5 g/t/t was 345 to 351% of the yield of the conventional tapping system. The average land productivity of the settlers during the period ranged from 1,015 to 2,175 kg/ha/year while income ranged from RM 1,286.14 to RM1,602.86/month. The impact of REACTORRIM system on the productivity of the trees, income and land productivity on the settler was good, and this resulted in rapid expansion of the use of this system by other settlers in Jengka 22 as well as settlers from other schemes. By December 1997, a total of 98,974 trees in four schemes had been fixed with canister system combined with either 2PI d/3 or 1/8S d/3 tapping system. Although the use of REACTORRIM system has been widely accepted by settlers of Jengka 22 and neighbouring schemes, based on feedback by users during the six-year period of adoption of this system in Jengka 22, this system needs further improvement. The experience in the implementation of REACTORRIM by settlers of Jengka 22 shows that this system has a great potential to overcome the prevailing problems faced by the rubber industry, primarily the problem of shortage of labour, low productivity and low income of smallholders.

Key words: FELDA; Land productivity; REACTORRIM; Stimulation; Tree productivity; Malaysia

74 Felcra's experience in the implementation of the RRIMFLOW system

Ragu, P

Proceedings of Seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, Malaysia, pp.123-128.

RRIMFLOW tapping system was initially introduced in FELCRA on a trial basis. The success with the system both in terms of yield and returns to tappers has encouraged its commercial adoption. In 1997 and 1998 (to-date) over 200,000 trees or over 400 tasks are using the RRIMFLOW system. An evaluation showed that those who used the system of tapping for 12 months obtained a yield of over 2,500 kg/ha during this period. The RRIMFLOW system is seen as an appropriate system to enhance productivity in a number of FELCRA schemes with clones GT1, PR 261, PR 255 and RRIM 600, often with poor quality renewed bark. With the adoption of this system the operations in the scheme are expected to obtain substantial benefits.

Key words: RRIMFLOW; Tapping system; Malaysia

75 First panel yield of eight *Hevea* clones in sub-tropical Meghalaya

Reju, M J; Thapliyal, A P; Gopalakrishnan, J; Deka, H K and Soman, T A

Indian Journal of Natural Rubber Research, 15(2): 2002, 190-193.

Key words: Agrometeorological parameters; Clonal response; India

76 Genetic control of growth (girthing) and it's response to tapping in *Hevea brasiliensis*

Jayasekera, N E M; Karunasekera, K B and Herath, S

Proceedings of the IRRDB symposium on Agronomy Aspects of the Cultivation of Natural Rubber, (Hevea brasiliensis), 5-6 November 1996, Sri Lanka, pp.20-24.

Girth data, collected over 15 years, from 9 rubber clones planted in seven agro-climatic areas have been analyzed to study the change in magnitude, over years, of genetic environmental and genotypic x environmental components. Further this study discusses the clone specific growth response to tapping in relation to growth before tapping. Results clearly indicate that at the very early stages the environmental factors influence the growth of young rubber plants. During first five years environmental factors contribute more than 50 to the total variation. But as plants grow older genetic differences take control and by about the 13th year after establishment genetic differences contribute 75 to the total variation while environmental factors contribute only 13. With respect to growth before and after tapping it was found that increase in girth was linear when two phases of growth were considered separately. But the rate of growth slowed down after the commencement of tapping. The magnitude of reduction in growth rate differed among clones indicating that response to tapping varied with genotype.

Key words: Genetic control; G X E interaction; Tapping system

77 Golden Hope's experience with d/6 tapping system

Nasir, Jamaluddin and Ghani, Mohd Noor A

Proceedings of Seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, pp. 97-102.

The rubber industry is still facing the problems of labour shortage and rising cost of production. Lembaga Getah Malaysia (LGM) has recommended few technologies in tackling these problems, and one of them is the Less Intensive Tapping System (LITS). The adoptions of these technologies, as reported by LGM, have not been wide spread. The industry instead has resorted to short term measures, for example, the use of immigrant tappers or abandoning tapping. Golden Hope Plantations Berhad, which is maintaining a substantial area under rubber especially in estates in Selangor, Negeri Sembilan, Malacca and Johor, is also facing these problems. Trials were laid out, some with LGM, to evaluate LITS or d/6 tapping system in some of the areas. This paper evaluates some factors affecting the performance of LITS in these trials. These include drying-up of bark due to long intervals between tappings, pre-coagulation problems occurring on trees tapped on LITS, incidence of dryness due to intensive stimulation applications and higher percentage of late drips or cup lumps in the absence of evening collection. Results obtained from two trials, that is, from Victoria Estate in Kedah and New Rompin Estate in Negeri Sembilan are reported in this paper. The former was conducted with LGM. Trial 1 on Victoria Estate using clone PB 217 has shown that the tapper's yield has increased substantially to 251% during the 26 months period of the trial, while land productivity was reduced to 68%. In terms of yield per tree, the results also showed the increase to 203% as compared to the control 1/2 S d/2 tapping system. There was no significant difference in dry rubber content (drc) between LITS and the control. The second trial (Trial 2) on New Rompin Estate is the commercial trial with LITS using 11 clones including PB 260 as control. The

average yield of these clones varied from 51.2g tree/tapping for clone PM 10 to 104.2g/t/t for clone PB347.

Key words: Low intensity tapping; Yield; Malaysia

78 ***Hevea*** **latex production, relationship with tree growth, influence of clonal origin and Ethrel stimulation**

Gohet, E; Prevot, J C; Eschbach, J M; Clement, A and Jacob, J L

IRRDB symposium on Physiological and Molecular Aspects of the Breeding of Hevea brasiliensis , 6-7 November 1995, Penang, Malaysia, pp.200-211.

The growth of Hevea brasiliensis, reflected by the primary biomass formation, competes directly with latex production which corresponds to secondary biomass synthesis. Five clones with very different growth and yield characteristics were studied as follows: AF 261, AVROS 2037, PB 217, GT1 and PB 235. Several groups of each clone were compared, namely unopened trees, exploited but unstimulated trees and finally exploited trees with the same tapping intensity but with increasing Ethrel stimulation. The results show that the respective primary and secondary biomass products lead to a linear regression which reflects the competition between the two synthetic function; the repartition coefficient between these functions is dependent on the clone and its physiological characteristics. Beyond a certain stimulation intensity, if growth continues to decrease then latex yield also decrease due to disfunctioning of the laticigenous function. The critical level of stimulation is clone dependent. For these five clones, the latex sucrose content and latex Pi content of each group of trees were studied. It appears that the capability of the tree to react with efficiency to stimulation intensity is tightly linked with available sugar in the laticifers; the latex sugar content is a clonal characteristic in relation to laticifer metabolic activity. Latex Pi content effectively reflects the metabolic activity level related to yield. Results are discussed in terms of clonal typology, exploitation level and improvement strategy.

Key words: Stimulation; Latex sugar; Latex production; Yield

79 **High panel exploitation of** ***Hevea brasiliensis*** **(Muell.Arg): A comparative study offive tapping systems**

Ahmad Zarin Mat Tasi

(http:/uru.upm.edu.my/iresearch.nsf)

Key words: High panel; Tapping system

80 **High tapping intensity on several recommended clones for smallholders**

Junaidi, Untung and Kuswanhadi

Risalah Seminar Hasil Penelitian Balai Penelitian Sembawa tahun, 1992/1993, pp.157-166.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No. 163)

Rubber smallholders are generally reluctant to adopt the recommended tapping system inspite of training they once took. Farmers feel that the conventional tapping system does not suit their need. In addition, the discovery of new prime clones also necessitates to further study their capabilities of sustaining tapping burden of intensity higher than 100%. This experiment aimed

to assess the effect of high intensity tapping on several recommended clones for smallholder on yield, growth and health condition of rubber trees. The experiment was carried out using a randomized complete block design involving 11 treatments and 3 replicates. The three recommended clones for smallholders tested (PR 255, PR 261, and PR 300) were treated parallel, comprising 30 trees per plot. The components of yield, growth and percentage of tapping panel dryness. All the treatments involving tapping system gave daily dry rubber yield similar to the conventional tapping system. The long resting period, if properly practiced, gave a good effect on yield. Among the three clones tested, PR 300 showed the highest percentage of groove dryness. Further observations are still needed to achieve conclusive result.

Key words: Clonal response; High intensity tapping; Smallholding; Tapping system

81 High productivity through low frequency tapping

Rubber Asia, 14 (3): 2000. 57-59

Key words: Low frequency tapping; RRIMFLOW; Yield performance; Malaysia

82 Higher productivity – workers' perspective

Navamukundan, A

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry 5-6 December 1994, Kuala Lumpur, pp.3-14.

Productivity is the relationship between the output generated by a production or service system and the input provided to create this output. Higher productivity can be achieved either by producing more with the same input, or by producing the same output with less input. In reality, productivity is influenced by all production-related issues viz. capital, labour, land, technology, energy, consumables, delivery systems, marketing, management, etc. This paper views the policies and programmes for improvement of productivity both at the macro and micro levels. At the macro level 'national economic and social policies are evolved for achieving national targets. At the micro level, which is at the enterprise and industry level, programmes for changes are formulated and implemented to achieve the national targets.

Key words: Peninsular Malaysia

83 Hypodermic extraction of latex from *Hevea brasiliensis*

Guha, M M; Guha, P R ; Mathews, J and Guha, A

Indian Journal of Natural Rubber Research, 5(1&2): 1992. 38-50.

A method and apparatus for using a gaseous unsaturated hydrocarbon, or oxide thereof, as a yield stimulant by its direct absorption into the lie bark tissues of *Hevea brasiliensis* are described. A polythene or rubber jacket sealed to the tree bark is used for holding the stimulant. This prolongs latex flow, when a hypodermic puncture is made in the bark, for upto 40 h. or more at a maximum rate of one ml per minute. The latex is collected by means of a hollow tube or needle (of about one mm internal diameter) that leads into a covered latex collection container, from the hypodermic puncture. The total outflow of latex from one aperture was between 1000 ml and 2000 ml per extraction, compared to only about 150 ml obtainable from conventional half spiral tapping systems. The higher yield realized by this method promises a bright future for the natural rubber industry. Physiological parameters relevant to sucrose trans-

location and its subsequent synthesis into isoprene *in situ* were also monitored over a period. The physiological dynamics of this convertion of sucrose into isoprene is also discussed briefly. Anatomical examination of stimulated bark samples taken from trees under the new method of latex extraction did not indicate any undesirable effects. Microscopic observation of the stimulated bark samples indicated no decrease in the number of healthy latex vessel rings.

Key words: Ethylene; Latex flow; Microtapping; Plugging; Stimulation; Yield; Malaysia

84 Improvement of exploitation system for old rubber trees with the stimulation: Research report

Bamroongrugsa, Noparat

(www.clib.psu.ac.th/acad_41/bnop2.htm)

Key words: Stimulation; Exploitation system; Thailand

85 Implementation of Low Intensity Tapping system amongst smallholders: Issues and problems

Ambia, Aliasak Bin

Proceedings of Seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, Malaysia, pp.91-96.

This paper considers the problems and potential for the introduction of low intensity tapping systems (LITS) in the smallholders sector. A major constraint is that over 80% of the smallholders sector consists of scattered individual holdings. Further, at the time of replanting, with the current stands there was no necessity to give any consideration for clones which respond to low intensity tapping systems. With the current labour shortage experienced and with higher remuneration to be earned by the tapper, LITS may be attractive to smallholders. However, a number of considerations are essential. These include the need for: a change in tapping intervals from d/2 to d/6 over a period of time; initially to d/3, then to d/4 etc., and some system of subsidy or loan as the equipment involves an initial investment of RM800/ha. A concerted, coordinated and dedicated input by the relevant agencies to ensure successful adoption of LITS by smallholders is urgently needed.

Key words: Low intensity tapping; REACTORRIM; RRIMFLOW; Malaysia

86 Improvement of production, processing and marketing systems of rubber smallholdings through implementation of recommended technology and improved institutional mechanism in South Sumatra

Gunawan, A; Hendratno, S; Suwardin, D; Lasminingsih, M and Boerhendhy, I

Proceedings of the Indonesian Rubber Conference & IRRDB Symposium, 12-14 September 2000, Bogor, Indonesia, V2. pp. 508-516.

Until now the productivity of Indonesian rubber smallholding is still low because of various factors such as the existence of old rubber, seedling plant material, improper maintenance, and damaged tapping panel. The low quality of smallholder rubber product and inefficient marketing system have also caused low farm gate price. Research on improvement of production, processing and marketing systems of rubber smallholding has been conducted in South Sumatera.

The aims of this research were to implement, demonstrate, and develop technology packages of rubber technology, processing, and marketing which are profitable and suitable for farmers, as well as to develop technology transfer mechanism from research institution to farmers/farmers group. On-farm trial methods were used in this research. Through survey method, location of trial was chosen at Pagar Dewa and Prabu Menang Villages, Rambang Lubai, Muara Enim District. Field technical supervision and extension were carried out through farmer groups which involved an extension worker who is responsible for these areas. Three types of farmer groups have been established based on type of activities: (1). Nursery groups; (2) Rubber cultivation groups; (3) Tapping, processing and marketing groups. The maintenance of rubber stump on polybag was done properly by most of farmers as recommended. More than 80% of the farmers' field has been planted with clonal rubber planting material. The growth of rubber (1988/1999) was normal although there was significant difference among farmers due to different management by each farmer. Most farmers did not follow recommended tapping technology, mainly tapping frequency since they have to tap everyday in order to fulfill their daily basic needs. In the implementation of processing technology and partnership marketing systems with trader, farmers have been able to process clean thin slab using formic acid coagulant and sell about 4.2 ton/week (72% grade A). Weekly farm gate price of rubber was fluctuated but it was higher 40-50% (grade A) and 17-25% (grade B) per kg DRC than the traditional market.

Key words: Marketing; Productivity; Recommended technology; Smallholding ; Indonesia

87 The Improvement of rubber tapping systems in Southern Thailand

Besson, I. *et al*

In: *Reunion Annuelle du centre Scientifique de la Mission d' Economie at de Sociologie du CIRAD*, 1991. 8p

(ATA 85112, 1993)

Key words: Tapping system; Thailand

88 Influence of alley Management practices on productivity of clone RRIM 901, tapped with LIT D/6 system

Md. Said, Mohd Akbar

Paper presented at IRRDB Symposium "Challenges for Natural Rubber in Globalization", 15-17 September 2003, Chiang Mai, Thailand.

Key words: Alley management; Productivity; Tapping system

89 Influence of judicious methods of stimulation on the long term yield responses of rubber clone RRIM 600

Thanli, Do Kim; Sivakumaran, S and Choo, Wong Kal

Proceedings of IRRDB Symposium: V2. *Physiology and Exploitation and Crop Protection & Planting methods*, 14- 15 October 1997, Ho Chi Minh City, Vietnam, pp.66-70.

The effects of various frequencies of 2.5% Ethephon stimulation on the long-term yield responses of clone RRIM600 tapped d/3 over a fourteen-year duration were examined. Stimulation at eight rounds/year resulted in the highest significant yields (g/t/t, kg/ha/year and cumulative yield) among the treatments. The yields of trees stimulated using 4 and 6 rounds/year

were higher than the unstimulated control though the difference was not statistically significant. The slight difference between the unstimulated control and these stimulated treatments meant that: (i) Judicious stimulation maintained positive yield responses over long-term application; (ii) judicious stimulation could increase yield without harmful effects to long-term yield responses. Thus, judicious stimulation was necessary for a sustained and positive response. The yield performances of various tapping panels are also discussed.

Key words: Clonal response; Low frequency tapping; Stimulation; Yield

90 International notation for exploitation systems

Lukman

In: *Natural Rubber: Biology, Cultivation and Technology*, 1992, (Eds. M.R. Sethuraj and N.M. Mathew). Elsevier publishers, Amsterdam, pp.263-281.

Key words: Tapping notation

91 IO1 patch method of stimulation-preliminary results

Chee, K H and Chiu, S B

The Planter, 69(805): 1993. 149-151

A patch made of resinous Cinnamon wood dust and 2.5 % ethephon in a ratio of 2 g: 8ml applied to scrapped bark increased rubber yield by 36- 41% over that of unstimulated trees with a concurrent 19% fewer number of tappings. Tapped on 1/8 S cut, the task size could be increased to 900 trees. The patch was replaced after seven weeks and the cost of the patch, inclusive of material and labour was 5.3 cents.

Key words: IOI patch method; Tapping stimulation; Malaysia

92 Labour problems and exploitation in the smallholder sector

Shafie, Shahabudin

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, pp.24-32.

The Malaysian rubber industry, in particular the smallholders sector, is currently facing problems associated with a shortage of tappers and unstable rubber prices. Tappers are decreasing in number due to the migration of the rural population to urban areas and also due to a lack of skilled tappers. The younger generation today shows no interest in becoming tappers. Based on the current situation,, the smallholder sector is geared to implement the various technologies available to achieve their own development objectives. In view of the increasing cost of production, decreasing labour supply and the need to increase productivity to enhance competitiveness, the smallholder sector has now become an important issue in the rubber industry. According to the 1992 Census on smallholdings, there were 420 193 smallholders compared to 490 460 recorded in the 1977 Census (a decrease of 14.3%). This indicates exodus of a large number of smallholders from the rubber industry to other sectors. The Census revealed that 300 659 smallholders owned 481 060 rubber lots covering an area of 918 825 ha. Mature rubber accounted for 702 139 ha (76.4%) and the balance were young rubber. About 58% of the mature rubber area or 407 455 ha were tapped regularly – 67 362 ha (10%) were under peri-

various technologies

odic tapping and 227 326 ha (32%) were left untapped. By status, 55.9% of the smallholders were owner operators, while the rest were non-owner operators, trustees, lease holders, beneficiaries, etc. The Census revealed that 72% of the smallholders were Malays, 24% Chinese and the remaining were Indians, Orang Asli, etc. In terms of age group, 41% of the smallholders were above 56 years, 48% were 36-55 years, 9% 26-35 years and 1.6% below 26 years of age. This indicates that 57% of the smallholders were within the very productive age group. The average dependent size was 3.8 persons, far less than the 6.4 persons recorded in the 1977 Census. Owner operators totalled 168 070, out of which 128 434 were from mature rubber areas and 39 636 from immature areas. Thus, to tap the 702 139 ha of mature rubber, an additional labour force of 105 612 is required for the d/2 tapping system and 27 597 for the d/3 system. However, for the d/4 and d/6 tapping there will be a surplus of 11 411 and 50 418 tappers respectively. Besides the smallholdings under the management of RISDA, the rapid development of the industry has also led to a shortage of about 700 tappers in RISDA estates under the management of ESPEK sdn Bhd. The RISDA management is very much aware of the problem and is now actively introducing low-frequency tapping systems (d/3, d/4 or d/6) to overcome the labour shortage. Smallholders are advised and encouraged to adopt the extended task and division of labour (DOL) concepts and the LELICS system of crop collection to increase productivity. RISDA is also introducing the block farming system to further improve the management of labour. For the East Coast states, the daily periodic tapping with ethephon stimulation is recommended. The smallholders' institution, i.e. a total of 64 smallholders' co-operatives at State District levels with a membership of 100 000 smallholders, will be able to provide the human resource to take over the management of the estate and create a well-organised, affluent, dynamic and self-sufficient smallholder community. Meanwhile, RISDA, together with various research institutions, are conducting trials on several novel exploitation methods such as REACTORRIM, RRIMFLOW, AAR Jacket and Guthrie Paste with the objective of increasing rubber productivity, overcoming labour shortage and reducing the cost of rubber production. RISDA Management hopes that the relevant research agencies and the private sector will focus their R & D on the mechanisation of the rubber product sector and transfer the technologies at the lowest cost.

Key words: Ethephon; LELICS; Smallholding; Tapper shortage; Malaysia

93 Labour-saving exploitation systems: Methods to enhance yields

Sivakumaran, S

Planters' Bulletin. No. 208-9: 1991. 92-101.

It is now well established that the yield viability of exploitation systems geared for reducing labour requirements is heavily dependent upon the intensity and efficiency of ethephon stimulation. Thus, reduced frequencies of stimulation, which are less than twelve applications per year or ineffective methods of stimulation which do not facilitate uptake of stimulant due to poor contact with bark tissues, have all been shown to contribute to poor yields from trees tapped on d/4 or d/6 frequencies and on periodic system. It is apparent that the traditional methods frequencies of stimulation currently practiced with moderate to intensive tapping systems (1/2S d/2, 1/2S d/3) are grossly insufficient to ensure viable yields from less labour-intensive exploitation systems. In view of this, several trials were carried out to study alternative and improved methods of stimulation for low-intensity systems, to further enhance yields and to

make these systems economically viable for commercial adoption. This article presents data from these trials and discusses the application of these techniques.

Key words: Labour saving; Low intensity tapping; Yield;

94 Labour-saving technologies: Factors impeding adoption

Sivakumaran, S

Proceedings of Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, RRIM, Kuala Lumpur, Malaysia, pp. 151-175.

Although several labour-saving technologies are currently available to overcome prevailing problems in the industry of acute shortage of skilled tappers and rising cost of production, their adoption by the industry has not been very widespread or extensive. The industry, instead, has resorted to short-term solutions, such as the use of immigrant labour and or abandoning tapping in certain fields, to sustain tapping in others. This paper examines the possible factors that could be impending the uptake of technologies and assesses several approaches that could facilitate greater adoption of the technologies available. The factors examined include the presumed drying up of bark due to long intervals between tapping in low-frequency tapped trees, yield recovery or sluggish flow in trees coming out of rest in periodically-tapped trees, incidence of dryness due to intensive and heavy stimulation employed with low-frequency systems, high percentage of late drip or cup lump in the absence of evening collection because of perceived practical problems, greater tendency for precoagulation on the cut, practical problems associated with field operations and reduction in yield per hectare compared with the more intensive tapping systems. These factors are critically assessed with the support of experimental data wherever relevant. The presumed limitations associated with some of these factors are disproved, while for others appropriate solutions are suggested to overcome the relevant constraints. Approaches currently under study to boost yields per hectare obtained with low frequency systems are identified.

Key words: Labour saving; Low frequency tapping; Stimulation; Yield

95 Land productivity in rubber influenced by three critical parameters

Sivakumaran, S

The Planter, 76(888): 2000. 155-169.

The interrelationships between land productivity and the three critical parameters namely tree productivity, stand per hectare and number of tappings have been elucidated and the impact of new technologies such as clones and exploitation systems on these interrelationships are highlighted. It is apparent that the various technologies recommended for adoption by the industry can markedly increase tree productivity but the translation of this enhanced tree productivity into the desired levels of land productivity is dependent on the other two key parameters namely stand per hectare and number of tappings, which are definitely beyond the scope of these technologies. The stand per hectare cannot be manipulated due to loss of trees over time to wind damage, root disease and brown bast. However, the number of tappings to be achieved according to frequency of tapping falls within the influence of plantation managements and smallholders. Land productivity can be maximized if the extremely high levels of tree productivity achieved with new clones or the novel RRIMFLOW system of exploitation as shown by supporting yield

data given in this article, can be converted into yields per hectare with the maximum possible number of tappings according to the frequency of tapping. It is hoped that this article would enable the industry to have a better appreciation of the scope and potentials of the recommended various new technologies and encourage wider adoption in order as to enjoy the full benefits of these technologies, particularly with regard to realization of higher margins of profitability per hectare under rubber.

Key words: Land productivity; RRIMFLOW; Tapping days; Yield; Malaysia

96 Long flow tapping system

Ahmad Zarin Mat Tasi

Joint Thailand-Malaysia Technical seminar on Rubber 7-9 April 1997, Phuket, Thailand.

(Cited Ahmad Zarin and Mohd. Akbar Bin Said)

Key words: Long flow tapping system; Thailand

97 Long-term effect of tapping and stimulation frequency on yield performance of rubber clone GT1

Thanh, Do Kim; Sivakumaran, S and Choo, Wong Kai

Journal of Natural Rubber Research 11(02): 1996. 96-107.

A fourteen-year experiment was conducted to study the yield responses and dryness incidence of rubber clone GT1 to half-spiral tapping at frequencies d/2 (alternate daily), d/3 (third daily) and d/4 (fourth daily) in combination with stimulation frequencies of 0/y (unstimulated control), 2/y (two rounds/year), 3/y (three rounds/year), 4/y (four rounds/year) and 6/y (six rounds/year) of ethephon at 2.5 concentration applied by groove method. Mean dry rubber yield/tree/tapping (g/t/t) and mean dry rubber yield/hectare/year (kg/ha/year) over 14 years' of tapping were affected by interaction between tapping and stimulation frequencies. Under high stimulation frequencies of 4/y and 6/y there was a progressive increase in g/t/t with reduction in tapping frequencies from d/2 to d/4. This has led to comparable kg/ha/year among the three tapping frequencies. In spite of lesser number of tappings, d/3 tapping frequency produced cumulative yield (kg/ha) comparable to that of d/2 tapping frequency. Positive responses of g/t/t, kg/ha/year and cumulative kg/ha to stimulations 4/y and 6/y were obtained only under low tapping frequencies of d/3 and d/4. Virgin and renewed tapping panels responded in a similar manner to the tapping and stimulation treatments. Dryness incidence was not significantly affected by any of the treatment combinations.

Key words: Clonal response; Ethephon; Stimulation; Yield

98 Low frequency tapping system for reduction in cost of production of natural rubber

Vijayakumar, KR; Thomas, KU; Rajagopal, R and Karunaichamy K

The Planters' Chronicle, 97 (11): 2001. 451-454.

Though India stands first in productivity of Natural rubber cost production is also one of the highest This is mainly due to high slopes in the plantations, high rainfall etc. Extension field

experiments in the research farm of Rubber Research Institute of India and in plantations-have shown that in high yielding clones under third daily tapping 15 to 30% sustainable yield increase is possible with three annual stimulations. The high yielding clones experimented were RRII 105 and PB 217. Similar increase in yield was achieved form clones RRIM600 and GT1 with four stimulation per year under third daily taping. With fourth daily tapping (2 tappings in a fortnight0 same yield as that under third daily tapping could be achieved by increasing stimulation to 5 to 7 applications per year (RRII105 , PB217, RRIM600 and GT1). It was also shown that the same yield obtained under third daily and fourth daily frequencies of tapping with stimulation can be achieved under weekly frequency of tapping (one tapping in 7 days) with increased frequency (12/year) of stimulations from clone RRII105. Cost benefit analysis has shown that both planters and tappers are benefited by adoption of low frequency tapping. It is first report on weekly tapping without any reduction in land productivity

Key words: Clonal response; Cost reduction; Low frequency tapping; India

99 Low frequency tapping to reduce cost of natural rubber production

Vijayakumar, K R

Indian Rubber Journal, 70: 2003. 41-42.

Key words: Cost reduction; Low frequency tapping; India

100 Low intensity tapping systems and early use of CUT

Ahmad Zarin Mat Tasi; Kewi, Chong and Hashim, Ismail

In: *Towards Greater Viability of the Natural Rubber Industry. Proceedings of the Rubber Growers' Conference*, 22-24 July 1991, Kuala Lumpur, Malaysia, pp.189-211.

Low Intensity Tapping systems consisting of low frequency tapping with half spiral and short cut systems were evaluated. The responses of low intensity tapping systems to some clones are discussed in this paper. Significant yield responses from the various low intensity tapping systems were obtained from seven years of trials on clones PB 235, PB 260 and PR 261 and from six years of trials on PB 255 and RRIM 712. Varying responses were obtained from three clones tapped on reduced frequency of 1/2S d/3. Shortening the cut to 1/4S with panel changing had resulted in comparable yield response of 90% and 95% for some clones. Applications of 5.0% ethephon to reduced frequencies of d/3 and d/4 at six rounds per year had resulted in varying responses. Clone PB 260 gave poorer, while clones PR 261 and PB 235 gave comparable responses to d/4 frequency treated with ET 5.0% at fortnightly intervals. Low frequency tapping of d/4 with different levels of ethephon stimulations resulted in lower yield responses for clones PB 255 and RRIM 712.Short cut 1/4S with panel changing and ET 5.0% at six rounds per year showed promising results with clones PR261, PB 255 and RRIM 712. Results from these studies have indicted that several clones such as PB 235, PB 261 could benefit from reduced frequency of tapping when appropriate ethepon stimulation was applied. Short cut, 1/4 S (t,t) with ethephon stimulation was also found to be suitable for clones PR 261, PB 255 and RRIM 712. Early introduction of Controlled Upward Tapping (CUT) after completion of Panel BO-2 tapping on clone RRIM 600, showed better yield than continuous tapping on Panel BI-1.

Quarter cut panel changing gave similar yield as continuous tapping with single quarter cut. Satisfactory yield level were also obtained from low frequency (d/4) CUT system.

Key words: Controlled upward tapping; Ethephon; Low intensity tapping; Stimulation; Yield; Malaysia

101 Low intensity tapping system for rubber clone selection

Junaidi, Untung; Tjasadihardja, A and Kuswanhadi

Buletin Perkebunan Rakyat, 8(1):1992, 27-31.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.161)

Selection of rubber clone according to certain tapping system should be done since response clone to tapping system was variable. This trial was aimed to study the possibility of using low intensity tapping system for clone selection. The trial was a factorial experiment which was arranged according to split plot design with 2 factors and 4 replications. The main plot was 4 rubber clones (GT 1, PR 255, PR 261 and PR 300). Whilst the sub-plot was 3 kinds of tapping system (1/2 S d/3→1/2 S d/2,1/2S d/4 ET 2.5% Gal.24/y (2w) and 1/4 S d/4 (t,t).ET2.5%.Gal.24/y(2w)). Each plot consist of 50 trees. Plant production and growth and DRC of latex were measured. There were no interaction effect of clone with tapping system. The result of selection by low intensity tapping was same as by conventional system. Thus it could be recommended to use those both tapping system for rubber clone selection.

Key words: Clonal response; Tapping system; Low intensity tapping

102 Management inputs for enhancing labour productivity

Audong, Mohamad

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, pp.20-23.

The rubber industry is more than 120 years old. It is, therefore, a mature industry. However, there are inherent problems associated with the industry, including the fact that commodity prices are beyond the control of the producers, unfavorable weather conditions and labour shortage. The rubber industry has to look for a long-term and permanent solution for its continued survival including enhancement of labour productivity through genetic and technological improvements, mechanization, further improvements on housing and amenities, a stable and sound industrial relations climate in the place of employment, creation of a happy working environment and continued investment in human resource development. This paper identifies some inputs or actions that are required by the management in enhancing labour productivity.

Key words: Labour productivity; Labour shortage; Malaysia

103 Marked effects on tapping system reform of China

Wenxian, Xu; Xiaodi, Wei and Xianzhou, Xiao

Science and technology of tropical crops, 3:1993,11-12.

(Cited by Xiaodi, Wei et al. IRRDB Symposium, Hainan, China, 1999)

Key words: Tapping system; China

104 Maximising yields in rubber plantations

Nugawela, A

Bulletin of the Rubber Research Institute of Sri Lanka, 37:1998, 66-70.

Achieving maximum total yields from plantations is vital to reduce cost of production. This will also enable to recover the capital and management costs whilst realizing profits. It appears that only the exploitation systems are considered with regard to maximizing yields. Nevertheless there are many other important factors we need to consider to maximize yields in an estate. In any plantation the total yield per annum depends mainly on: a) mature extent and b) yield per hectare. Both the mature extent and yield per hectare have to be at optimum levels to maximize total annual yields

Key words: Exploitation system; Yield; Sri Lanka

105 Microelement treatment of resting bark dryness *Hevea* trees and theirre-exploitation

Shicong, Li and Zhaomu, Lin

Proceedings of the IRRDB TPD workshop, 26-28 July1994, Hainan, China.

In 1970s we tested an approach of remedying and retapping of resting bark dryness trees, including application of compound micro-elements on the shallowly scraped bark of the resting affected trees and tapping of healthy bark at the upper part of the trees. This approach, integrating bark scraping and chemical treatment with adequate tapping, had come out with better results. In a view of verifying its application efficiency on a commercial scale a study on chemical treatment and re-exploitation of resting bark dryness trees was carried out in 1982 in the whole We-xing State Farm in Hainan Province. The results of 12 years experiments were presented in this paper. A commercial scale pairing method design was arranged in this study with one treatment and the control. For the control, bark dryness trees at resting were not treated but tapped upward on the high panel on the S/2 d/3 system, and the yield and the incidence of bark dryness were observed. For the treatment trees, the hard cortex of the diseased zones was shallowly scrapped and shaved to turn up brown spots from the tapping cut to the base of its panel; compound micro-elements solutions were painted on the scraped bark, and on each side of the trunk one hole was drilled and inserted respectively with small tubes A and B containing microelements. The resting infected trees were puncture tapped on the high panel one week after the treatment. A vertical exploitation strip of 25 x 2 cm was created on the upper bark with the cork cortex removed, smeared with 5% ET and tapped on d/3 (3punctures/tapping). The treated trees were tapped 6 times for one tapping cycle and then rested for one week, in other words 48 tappings per year in 8 tapping cycles.

Key words: Bark dryness; Microelement treatment; Tapping system; Yield; China

106 Mobility of Labour in the Rubber sector

Arikiah, A

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, pp.15-19.

The single most pressing issue facing the plantation industry is shortage of agricultural workers, particularly rubber tappers, oil palm, cocoa, pineapple and tea harvesters and general field workers

for all crops. Statistics for the month of September 1994 indicates the extent of shortage in some plantations. This paper attempts to offer some remedial measures to address the situation of shortage of agricultural workers.

Key words: Tapper shortage; Malaysia

107 **A Modified exploitation system for PB 260 as practiced in an Indonesian plantation**

Karyudi

Paper presented at IRRDB Symposium "Challenges for Natural Rubber in Globalization" 15-17 September 2003, Chiang Mai, Thailand.

Key words: Exploitation system; Indonesia

108 **Modulation of gene expression under ethylene treatment in the latex of *Hevea brasiliensis***

Pujade-Renaud,V

Proceedings of the International Symposium on Cellular and Molecular aspects of Biosynthesis and Action of the Plant Hormone Ethylene, 1992, France, pp.162-163.

(Plant Breeding Abstracts . 10031: 1993.)

The ethylene releaser ethephon is commonly used in rubber tree arming to stimulate latex production. Ethylene treatment extends latex flow and activates general metabolism allowing more efficient regeneration of latex after tapping. Some enzymatic activities in latex have been shown to be modified by ethylene. Results of investigations on ethylene-induced modifications of gene expression in latex cells are reported. It is shown that ethylene regulates several specific genes at the RNA level, probable through transcriptional regulation. Some of these genes, which are involved in various metabolic phenomena such as mechanisms of latex coagulation, protein synthesis and other stress reactions, were identified by northern blotting. Several probes corresponding to potentially ethylene-regulated genes are currently being used to screen a latex cDNA library to provide markers for Hevea genetic improvement as well as to study the genetic mechanisms of ethylene control.

Key words: Gene expression; Stimulation

109 **A new economic approach to assessing profitability of estates under tapper shortage**

Nayagam, James; Wan, Yong Hing; Hassan, Johari and Sivakumaran, S

Planters' Bulletin, 214: 1993, 3-8.

Key words: Profitability; Tapper productivity; Tapper shortage; Yield; Malyasia

110 **Once-a-Week conventional tapping system (1/2S d/6) with ethephon stimulation for young mature rubber.**

Said, Mohd Akbar; Sivakumaran, S; Eusof, Zainol and Atan, Samsudin

Proceedings of seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, Malaysia, pp.17-41.

Low Intensity d/6 tapping system (LIT d/6 system) with commercial ethephon stimulation also known as "Once-a-week tapping" has been recommended for commercial adoption for modern

clones. The recommendation was based on the strength of the LIT d/6 system which is characterized by reduced requirement for tappers, high tree productivity, high productivity of tappers, comparable land productivity and low cost of production compared to the conventional tapping systems with d/2 or d/3 tapping frequencies. Hence, the main emphasis of LIT d/6n system is to overcome problems associated with the use of the conventional tapping system primarily on the problem of shortage of tappers. This paper highlights the impact of LIT d/6 on tree productivity, tapper productivity, land productivity, tappers' income and incidence of dryness. Other parameters such as bark consumption and percentage of bark shaved are discussed as appropriate. The paper also addresses the suitability of LIT d/6 system for adoption by the industry in relation to different categories of young mature rubber. R & D efforts are being geared to simplify the stimulation method, in-field collection and to overcome problem of wintering depression on yield. Other approaches to make LIT d/6 system more attractive for large-scale adoption of this system in conjunction with high density plantings.

Key words: Bark consumption; Low intensity tapping; Once-a week tapping; Productivity; Malaysia

111 Optimizing clone productivity by exploitation system

Junaidi, Untung and Kuswanhadi

Proceedings of the National meeting on Rubber Breeding in 1998 and Discussion of Natural Rubber Prospect in 21st century, 8-9 December 1998, Medan, pp.236-245.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.168)

Production potential of hevea clones depends on environment, plant management and type of clone. In an appropriate and associated with a good management, production potential of hevea clone could be obtained. On the contrary; when the management is bad, plant production will be low and production potential of clones can not be realized. There are some recommended hevea clones, which have various production potential. Grouping of these clones according to its physiological characteristics of growth and production will be valuable. Growth rate of tree, DRC of latex, and other content of latex can be used as indicator to optimize plant production. A high growth rate, high DRC and high sucrose content show a possibility to apply higher exploitation intensity to get higher production. Tapping system combined with stimulation can be applied selectively according to clone characteristics. Thus, optimum production can be obtained by certain exploitation system without giving negative effects t plant. Increasing stimulation frequency or stimulant concentration can be used in the effort to optimize production. Due to different effects of responses of stimulant to each clone stimulation treatment will be effective only if applied to highly responsive clones. Besides, stimulant is only effective in a certain range to a clone, so that only at this range it will be profitable. Stimulation should be used carefully because over-stimulation will give adverse effect to plant and indicated by the increasing trend of TPD intensity. In addition over stimulation will increase cost and unprofitable in the long run. Grouping hevea clones according to its physiological characters is very important and valuable. A different exploitation system should be applied to each group, so that potential production of each clone can attained. Recommended exploitation system should be evaluated annually based on physiological state of the tree, so the ' under' exploitation can be avoided. As the result maximum profit will be obtained.

Key words: Stimulation; Yield

112 **Optimizing yield of mature rubber trees with high intensity exploitation system**
Lukman

Jurnal Penelitian Karet 14(2): 1996. 125-136.

Key words: High intensity exploitation system; Yield

113 **An Overview on labour availability towards year 2000 and beyond**
Ahmad Salimi Haji Ismail and Baharudin, Nazaria

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, pp.33-43.

This paper provides an overview on labour availability towards the year 2000 and some indicators on trends of labour compositions beyond 2000. It also highlights issue pertaining to labour and measures taken by the government in addressing labour problems, as well as the role of labour and the importance of concerted efforts of the public and the private sectors.

Key words: Labour availability; Labour problems

114 **Paradigm shift in assessing estate profitability under labour constraints**
Nayagam, James; Wan, Yong Hing; Hassan, Mohd.Johari and Sivakumaran, S

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, pp.194-199.

Rubber Producers in Malaysia are being confronted with varying levels of labour shortage, which is adversely affecting their profitability. As a result, increasing hectarage of mature rubber is left untapped. Even when there are tappers, the producers are unable to optimise their output (kg/ha/year) because of the tapper's reluctance to perform late tapping and recovery tapping. The current method of profit assessment of a rubber area (RM/ha/year) is based on land productivity (kg/ha/year), rubber price (RM/kg) and production cost (RM/kg). Since producers cannot influence price and cost, particularly labour cost, they resort to increasing land productivity. This paper underlines the need for the growers to change their approach in assessing rubber profitability under labour constraint. With labour shortage the conventional approach of calculating profits from rubber areas using land productivity is not helpful. The emphasis should now be on labour productivity. The anticipated loss in yield/hectare from the reduced frequency can be compensated with the use of stimulant. With this shift in emphasis the producers can resort to the use of the tested less labour-intensive tapping systems that would enable them to fully tap their mature areas in spite of the reduction in labour supply, thus ensuring fair returns. Further, with the increase in tapper productivity the income of the tappers is expected to improve. This in turn will tend to attract and retain some of the workers.

Key words: Labour intensive tapping system; Tapper shortage; Tapper productivity; Malaysia

115 **Performance of Low-Frequency tapping systems**
Kewi, Chong and Sivakumaran,S

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, pp.47-67.

The recent increase in NR price has brought fresh hope to the rubber industry. However, the acute shortage of skilled tappers and the spiraling cost of production in the NR industry remain

critical. Thus, there is a continued pressing need for the adoption of low-frequency tapping systems, which can reduce both the requirement of tappers and cost of production. Most of the reported thousands of hectares of mature rubber trees that remain untapped could become productive with the adoption of low-frequency tapping systems. Recruitment of foreign labour to solve tapper shortage problem without adopting new technologies provides only a temporary solution as its associated social problems eventually negate the intended purpose. A more durable solution requires the adoption of appropriate technologies derived through the process of research and development (R&D). This paper presents available alternative solution that is based on R&D. Results show that low-frequency tapping systems, namely 1/2 S cut tapped on d/3, d/4 and d/6 frequencies, can reduce tapper requirement by 33 to 67% and increase landman ration up to a maximum of 12 ha per man with d/6 tapping. Results from most clones indicated that there was progressive increase in yield in grammes per tree per tapping (g/t//t) as the tapping frequency was decreased from d/2 to d/3, d/4 or d/6. Yields as high as 70, 80 and 100 g/t/t, representing 20 to 126% gain over the d/2 control, have been recorded for the respective stimulated d/3, d/4 and d/6 tappings. During the period of tapper shortage, yield in terms of g/t/t is an important parameter as it can be translated into productivity measure. Higher yield in g/t/t means higher tapper productivity, better income for tapper, and lower production cost to management. Most Class I and Class II clones tapped with the various low-frequency tapping systems yielded more than the national average yield of 1400 kg/ha. The absolute yield of d/3 ET tapping of most clones exceeded 1800 kg/ha, while those of d/4 and d/6 ET tappings exceeded 1500 kg/ha. Some new clones form block and hedge plantings yielded between 1000 and 1500 kg/ha. Yield responses have been used to indicate the viability of low- frequency tapping systems, with the breakeven point around 90%. This criterion was useful when there were enough tappers to maximise land productivity. The d/3 ET tapping was viable for most clones, as their responses were mostly over 90%. However, d/4 and d/6 ET tappings were less viable for most clones as their responses were mostly below 90%. The breakeven percentage may be irrelevant in situation of zero option with absolutely no tappers. A target yield-per-hectare (YPH) concept was developed to assess the performance on absolute yield rather than relative percentage. This target YPH is site-specific and adjustable according to years in tapping, differences in tappable stand, management style and tapper variation. With this site-specific target YPH as the basis, low-frequency tappings, especially the d/4 and d/6 ET systems, will compare more favourably in terms of yield viability. The paper also presents other relevant factors influencing the yield of various low-frequency tapping systems, d.r.c. values and incidence of dryness.

Key words: Ethephon; ET stimulation; Labour reduction; Low frequency tapping; Tapper shortage; Yield; Malaysia

116 Performance of mini and reduced spiral tapping cuts in *Hevea brasiliensis*

Thomas, K U; Vijayakumar, K R; Rajagopal, R and Karunaichamy, K

Plantation Crops Research and Development in the New Millennium: Proceedings of Placrosym XIV, 2000, Hyderabad, India, (Eds. P Rethinam, et al). Coconut Development Board, Kochi, India, pp.126-130.

India is fourth in natural rubber production and area under rubber is around 5.6 lakh hectares of which 87% is in small holdings and only 13% is in estate sector. Rubber plantation industry

in India is facing crisis for the last few years and the present price is not cost effective. Due to high frequency of tapping and associated incidence of Tapping Panel Dryness in the small holdings, economic life is restricted to 13-15 years. At the same time, estates are following medium frequency of tapping. Due to higher wage rates, poor labour efficiency and over heads, cost of production is more in the estate sector. The way out for rubber grower is to make his product more cost effective. Optimum dose and frequency of application of ethephon, an yield stimulant, can help in realizing potential crop from rubber trees. An experiment was laid out to compare the performance of mini and reduced spiral cuts under d/3 frequency of tapping in clone RRII 105, the Indian Wonder Clone, with different frequencies of stimulation. Seven tapping treatments comprising different cut length, frequency and dose of stimulation were imposed with completely randomized design (single tree, single plot). In the present experiment, comparable or better yield could be realized from mini and reduced spiral cuts. Dry rubber content and girth increment were also more and the incidence of TPD was less. These approaches can substantially reduce cost of production of natural rubber through increasing task, economic life and reducing the requirement of skill for tapping. Tapping of short tapping cuts can maximize physiological efficiency with minimum injury to the laticiferous system.

Key words: Ethylene; Low intensity tapping; Spiral tapping cut; Tapping system; Yield; India

117 Performance of previously puncture-tapped panels on the 1/2 S d/6 tapping system

Sivakumaran, S and Hashim, Ismail

Proceedings of IRRDB symposium: Physiology and Exploitation of Hevea brasiliensis, Kunming, China. 1990.pp.111-129.

The performance of previously puncture-tapped virgin panels and renewed panels was evaluated in several trials using the 1/2S d/6 stimulated tapping system. In addition, an assessment has been made of the effects of varying the duration of pre-exploitation stimulation, by methods similar to puncture tapping, on the subsequent yield of 1/2 S d/6 tapped trees. Yield comparisons have also been made between 1/2 S d/6 tapping of normal panels from initial opening and previously puncture-tapped panels and a limited study of the level of endogenous ethylene in puncture tapped bark was carried out. The yield viability of previously puncture-tapped panels on the 1/2S d/6 system with stimulation has been confirmed with few exceptions. It is apparent that stimulation during post-conventional tapping is critical to ensure yield viability irrespective of the past history of stimulation. The subsequent yield on low frequency tapping was not influence by the duration of the preceding puncture tapping or the levels of crop extracted during micro-tapping. Pre-stimulation of trees with ethephon for a short period prior to 1/2S d/6 tapping resulted in a good yield during the first few years, generally comparable to that of previously puncture-tapped panels. This was less marked in trees pre-stimulated for periods of 12-24 months. Data seems to suggest that the residual effects of ethephon on later yield may be restricted to a limited period. The lack of significant difference in the endogenous ethylene level of control bark tissue and puncture-tapped bark tissue stimulated 12-24 months earlier, lend support to the above conclusion. No marked advantage is evident in cumulative yield when 1/2S d/6 puncture-tapped bark is compared with that of normal bark tapped on this system from initial opening. However, this combined approach, of puncture for limited periods

plus conventional tapping on low frequency systems, has applications in specific areas such as a reduction in the period of immaturity and a lengthening of the economic life of virgin panels (thus avoiding tapping of low yielding renewed panels). The absence of any adverse effects from excessive stimulation, as reflected by the average drc values, the low levels of dryness and the absence of any elevation of endogenous ethylene levels, suggests that additional work would be justified on a wider range of clones, particularly the precocious high yielding ones, which would incorporate methods to improve the yield from puncture tapping. The additional data thus generated would confirm if this combined approach could be adopted on a wider scale.

Key words: Low frequency tapping; Puncture tapping; Stimulation; Virgin pouch; Yield; Malaysia

118 Periodic tapping: An approach to tackle tapper shortage

Ahmad Zarin and Sivakumaran, S

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, pp.80-95.

Exploitation systems were evaluated incorporating three months of rest from tapping and stimulation at different times in a year for three to 14 years on panels BO-1 and BO-2 of several clones. These 'periodic' systems were compared with continuous tapping system with and without stimulation. In RRIM small-scale trials, good yield responses were obtained from trees tapped with the periodic system. RRIM 600 tapped on panels BO-1/BO2 and rested for three months during the wintering period, gave cumulative yield 6% above that of the unstimulated control over 14 years. With four combinations of rest months, PR 261 (panels BO-1/BO-2) yielded 93 to 104% of 1/2 S d/2 control. With PB 260 (Panel BO-1), the yield ranged from 85 to 110% of the 1/2 S d/3 control. PB 252, which was rested ruing the months of March, July and November, gave comparable cumulative yield of the continuous system and PB 235 yielded slightly lower. All clones gave much higher yield per tree per tapping under the periodic system compared to the continuous system. Continuous resting period for three months in a year coincided with wintering months; the periodic system on RRIM 600 gave slightly better yield than the unstimulated control. The commercial trail on clone PR 255 (panel BO-1) gave cumulative yield responses of 94 to 112% of the control in six years. With clone PB 235 (panel BO-2) , the cumulative yield as 100 to 115% of the control during the five years of tapping, while clone PB 260 (pabnelBO-1) with only three rounds of stimulation per year yielded 78 to 89% of the control. The mean yield per tree per tapping for the periodic system ranged from 11 to 42% higher than the yield from control trees. The high yield per tapper per tapping brings higher income to tappers and with only slight reduction on the yield per hectare make the system viable for adoption. With the reduction in the number of tapping, the requirement for tappers is reduced. However, the viability of the system depends on the response of individual clone to stimulation, the amount of stimulant applied and the method of stimulant application. There was no marked difference between the d.r.c. values of latex from periodic tapping system and the control. The incidence of dryness was low. The bark consumption was reduced and this resulted in the longer life span of the tapping panels.

Key words: Periodic tapping; Tapper shortage; Stimulation; Yield

119 Periodic tapping system as an effective approach for sustained yield responses on young mature rubber

Chong, K and Sivakumaran, S

Proceedings of the IRRDB symposium on Agronomy Aspects of the Cultivation of Natural Rubber (Hevea brasiliensis), 5-8 November 1996, Beruwela, Sri Lanka, pp.74-86.

Early experiences from stimulation of young mature rubber tapped with the conventional systems, 1/2S d/2 or d/3, produced unfavourable yield trends, in which the initial high yield responses were followed be negative yield responses from the same or subsequent panels. In addition, a higher incidence of dryness and bark consumption were observed. Moreover, the current acute shortage of skilled tappers has precluded the practice of conventional tapping systems which has resulted in the delayed opening of young, mature rubber. Thus, periodic tapping systems, modified forms of conventional systems, were evaluated as an effective approach to sustain yield responses and to solve the tapper shortage. Several clones were tested from the very commencement of opening for tapping using various combinations of tapping, rest and stimulation regimes. Results from these various trials of periodic tapping systems indicated that long term positive response were sustained covering both panels BO-1 and BO-2. Besides enhanced land productivity, tapper productivity, and consequently income, was improved. As the periodic tapping systems incorporate a tapping rest, there is some saving in tapper requirements by 17 – 25%. Coupled with this advantage are reductions in bark consumption, a low incidence of dryness and drc values that are comparable to conventional tapping systems. As a result of the use of these periodic tapping systems, all young mature rubber can be opened for tapping at the correct girth and the problem of the acute shortage of tappers can be alleviated.

Key words: Periodic tapping; Stimulation; Yield; Malaysia

120 Periodic tapping system: A solution to tapper shortage

Sivakumaran, S; Ahmad Zarin Mat Tasi and Kewi, Chong

Planters' Bulletin, 208-209:1991. 111-123.

This article discusses relevant findings from three commercial task-size trials on young mature rubber, established to confirm the yield data and assesses the practical aspects related to the implementation of the system in commercial fields. Periodic tapping system in combination with ethephon stimulation is recommended for immediate adoption in areas with acute shortage of skilled tappers and where tappable young mature trees have been left unopened. The system is also suitable for use in fields that are on panel BO-2 tapping or fields which have just commenced tapping on panel BI-1 (first renewal). Further, periodic tapping system provides avenues for maximum usage of he available pool of tappers over wider areas in a given estate, thus avoiding the need for continuous exploitation of a limited area. This is possible without compromising standards of tapping, while conserving bark and ensuring beneficial effects on growth. Stimulation is critical for the viability of the system and therefore it is necessary to ensure that the method of stimulant application is effective (groove if lace is thick) and the frequency adequate. Clones which respond well to stimulation are expected to perform better on this system than clones with moderate or poor responses.

Key words: Ethephon; Periodic tapping; Tapper shortage; Stimulation; Malaysia

121 Periodic tapping system as a solution to tapper shortage: An economic evaluation

Sivakumaran, S; Nayagam, James; Ahmad Zarin and Wan, Yong Hing

Planters' Bulletin; 214:1993, 9-16.

Periodic tapping systems in combination with ethephon stimulation is an economically viable method of exploitation with comparable crop production and better profit margins per hectare than that obtained from use of continuous tapping systems. Its' use will allow for a 25% reduction n tapper requirements, with lower costs of production per kilogram of rubber and higher income for tappers. The higher yield per tapping is achieved without sacrificing yield per hectare. It is therefore an attractive system for ensuring equitable returns per unit area, while providing higher remuneration for tappers, thus forestalling their movement to other areas of employment.. The economic viability of periodic tapping system can further be enhanced both with clones which respond better to stimulation and in situations where there are shortage of tappers with fields left untapped and consequently with no crop contributions. The economic evaluation of periodic tapping system with stimulation highlighted in this article further strengthens and supports the recommendation that this system should be adopted immediately by the industry to resolve their current pressing problem of tapper shortage and unproductive rubber areas

Key words: Ethephon; Periodic tapping; Stimulation; Tapper shortage; Malaysia

122 Periodic tapping system: Sime Darby's experience

Chew, J.S; Gan,L T; Ho, C Y; Tiong, M D; Sivakumaran,S; Chong, K and Ahmad Zarin Mat Tasi

In: *Ensuring Sustainability and Competitiveness of the NR Industry: Proceedings of the Rubber Growers Conference* 1995,(Ed. Abdul Aziz S. A. Kadir). RRIM, Kuala Lumpur, Malaysia, pp. 145-173.

The availability of skilled tappers is becoming more acute and this trend is expected to get worse with time. In September 1987, Ebor Research, in conjunction with RRIM, initiated a plot-sized trial on 1982/PB 260 using the periodic tapping system on Atherton Estate, near Nilai, Negeri Sembilan. Treatments compared 1/2 S d/3 nil stimulation control with different combinations of periodic rests at 4th monthly intervals (9m/12) and continuous rest of 3 months. Stimulation was applied at ET 1.5% monthly on the groove. Treatments were replicated 4 times on a task basis with core plots of 30 trees per treatment recorded per task. Results after 6 years yield recording on Panel BO-1 showed that yield per ha of the periodic tapping systems gave between 1% and 17% better yield compared with the unstimulated control. Mean yield per tree per tapping and mean yield per tapper per tapping was between 32% and 52% higher than the unstimulated control. Brown bast incidence on stimulated treatments ranged between 4.1% and 8.6% compared with 6.1% in the unstimulated control during the same period. Girth increment of stimulated treatments ranged between 12.6 cm and 16.0 cm compared with 15.2 cm in the unstimulated control over the 6-year –period on Panel BO-1 tapping. In September 1992, the periodic rest system was further evaluated on a pilot commercial scale. This was carried out on a 1986 field (46 ha) planted with PB 235 near Sg. Petani, Kedah. This trial compared 1/2 S d/3 (nil stimulation) control with 1/2 S d/3 (stimulated control) against 1/2 S d/4 (9m/12) and 1/2 S d/4(12m/12). The 1/2 S d/4 frequency in combination with periodic tapping (9m/12) is similar in intensity to 1/2 S d/6(12m/12) tapping or once-a week tapping.

Stimulation for this commercial trial started very conservatively at ET 1.0% 3/y during months following tapping rest. This was subsequently changed to ET 1.5% 6/y in September 1993. This change in stimulation was prompted by the lack of yield response in the month immediately following the rested month. Results todate ($2^1/_2$ years of yield recording) indicated that yield per ha of 1/2 S d/4 periodic tapping treatments expressed as percentage of that of unstimulated d/3 control were 42% in the first year, 53% in the second year and 61 % in the first six months of the third year, respectively. The stimulated d/4 treatment gave about 96% of the unstimulated d/3 control whilst the stimulated d/3 treatment gave 46% more yield than the unstimulated d/3 control. Todate yield per tapper of the periodic tapping treatments is about 22% better than the d/3 unstimulated control. However, it is only about 84% of the d/3 stimulated control and 95% of the stimulated d/4 treatment. The periodic tapping system offers alternative approaches for tackling the problem of tapper shortage. These system relative to unstimulated d/3 systems are attractive because of the higher yields per tapping with consequently better income for tappers and reasonable yields per hectare. Stimulation is critical for ensuring viable yields per hectare for periodic tapping systems. Thus for clone PB 260 with nine applications per year, the yields per hectare for all periodic treatments were higher than the unstimulated d/3 control. In the trial on clone PB 235, the yield per hectare was affected by the very low level of stimulation. Periodic tapping systems could be a viable technique of exploitation for precocious high yielding clones with propensity for development of tapping panel dryness.

Key words: Dry tree incidence; Girth; Stimulation; Yield; Malaysia

123 Periodical tapping system as an alternative for smallholder rubber

Kuswanhadi; Junaidi, Untung and Tjasadihardja, A

Prosiding Konferensi Nasional Karet, 18-20 September 1990 di Palembang: 188-202.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.177)

Periodical tapping system is a tapping system with tapping frequency, which allow to tap the tree for some time and rest it for another time. This system is arranged according to accustom of the farmer and the ability of the tree to be tapped with tapping intensity about 100 percent. There were two experiments conducted at RIEC Sembawa which aimed to invent a new profitable tapping system and acceptable by the farmer. These experiments were arranged according to a randomized block design. In the first experiment three kind of exploitation systems were tested on five rubber clones (GT 1, AV 2037, PR 261, PR 300 and RRIM 600), whilst in the second experiment 14 tapping system were tested on PR 300. The results of the first experiment showed that the periodical tapping system could be applied as alternative to the conventional system, especially on RRIM 600 and PR261. All periodical tapping system tested in second experiment could be expected as alternative to the conventional system on PR 300, except 1/2 S d/1 3d/5 2w/3 system

Key words: Periodic tapping; Smallholding; Indonesia

124 Physiolgical response of PR107 to intensive tapping with stimulation at early exploitation stage

Shaoqiong, Yang; Yeyong, Mo and Siwei, Fan

IRRDB TPD workshop, 26-28 July, 1994, South China Academy of Tropical Crops, Hainan, China.

The present study tried with S/2 d/1 +3% ethrel stimulation on clone PR107 trees under exploitation for three years to cause tapping panel dryness, and observed dynamically some

physiological and biochemical changes possibly related with the tapping panel dryness. BY 36th tapping after three applications of ethrel at a total dosage of 180mg 2-chloroethylphosphonic acid each tree, the tapping panel dryness incidence reached 73%. It was found that in all cases dryness first appeared from upper and lower end of tapping cut. As compared with the control, the treated trees had a lower initial flow rate, dry rubber content and total acid phosphatase activity but higher inorganic phosphorus level. No dropping was noted on the level of ascorbic acid-the cytosolic scavenger during the experiment period, and the decline in thiols content occurred quite late. The total phenol level and peroxidase activity in latex increased, particularly in the latter case. The proline content rose with the increase in water loss with latex extraction, but no accumulation of proline was detected after the appearance of dryness. The present paper discussed these physiological and biochemical changes. It is considered tentatively that the tapping panel dryness in the present experiment may be ascribed to the consequence of extreme physiological fatigue of the treated rubber trees.

Key words: Ethrel; Physiological fatigue; Stimulation; Tapping panel dryness; Yield; China

125 Physiological effects of stimulation and exploitation intensities and tapping patterns on tree dryness

Wenxian, Xu; Xiaodi, Wei; Xianzhou, Xiao; Shiqiao, Luo and Shizhong, Liu

IRRDB TPD workshop, 26-28 July 1994, South China Academy of Tropical Crops, Hainan, China.

Occurrence of tree dryness of *Hevea brasiliensis* was closely related to stimulation and exploitation intensities and even tapping patterns. When exceeding the endurance of the rubber tree, the physiological damages caused by stimulation or tapping would give rise to physiological imbalance between latex production and latex flow in that dry rubber content, total solids, thiols, initial velocity of latex flow and plugging index were remarkably reduced while late drip ratio and the isozymatic activities of peroxidase reflecting degrees of trauma were enhanced significantly. Continuous physiological imbalance resulting from over intense flow o f latex would invoke self-destruction of latex vessel cells, leading to functional failure of latex regeneration and subsequently formation of tree dryness. The commercial scale experiments proved that the dynamic balance between latex regeneration and latex flow could be regulated by stimulation intensity, exploitation intensity or tapping patterns, and hence occurrence of tree dryness is also controllable. This paper puts forward a series of practices for controlling tree dryness initiation.

Key words: Stimulation; Tapping pattern; Tree dryness; China

126 Physiological features of *Hevea* latex under CATASFLOW

Shizhong, Liu; Wenxian, Xu; Shiying, Cai; Xianzhou, Xiao; Wanlin, Ye and Ming, Wu

Proceedings of IRRDB Symposium on Natural Rubber (Hevea brasiliensis) V2. *Physiology and Exploitation and Crop Protection & Planting Methods Sessions*, 14-15 October 1997, Ho Chi Minh City, Vietnam. pp.38-45.

Dynamic changes in physiological and biochemical parameters were tested during the latex flow of *Hevea* trees under the CATASFLOW technique (1PI d/6 + ET (G)) stimulated every 6 days. Latex flow exceeded 36 hours and the flow speed was lower than that of the control (S/2

d/3 + ET). The dry rubber and total solids contents were low compared to the control, and decreased with latex flow to reach their lowest points in 24hrs before rising slowly but they failed to reach the initial levels before flow ceased. Unlike the control, sucrose content rose with flow: it decreased a little after reaching the highest point in 16hrs and then decreased slowly over 12hrs before increasing progressively. Rubber transferase activity was picked up 30-100%over the initial level after an increase in the early stage of flow. Bursting index was higher than the control throughout. The bursting index rose with flow to a new height (28-36%), then fluctuated to some extent although still higher than the initial level. Thiols changed very little during the first 4hrs and then, after a dramatic decrease to the lowest level, rose slowly and accelerated to the initial level. The control was relatively stable. The soluble inorganic phosphorus and magnesium ion contents both decreased slowly with flow, whilst the controls decreased dramatically.

Key words: CATASFLOW; Physiological parameter; Rubber transferase; Tapping system

127 Practical experience and strategies in periodic tapping

Ghani, Mohd Noor A; Hashim, Khairudin and Hai, Teoh Cheng

Proceedings of Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, RRIM, Kuala Lumpur, Malaysia, pp.96-109.

Shortage of rubber tappers in Golden Hope estates has become acute in the last five years with some estates experiencing shortage of 30 to 35% tappers. For this reason, four trials were set up using periodic tapping system (1/2S d/2 2m/3 57%ET 2.5% 8/y) on Sungei Mahang Estate in Nitai, New Rompin Estate in Bahau and Sungei Wangi Estate near Sitiawan on clones PB 217 and RRIM 600. The results from the trials on Sungei Mahang Estate indicated that the periodic tapping system gave yield per hectare over a five-year period ranging from 98 to 107% as compared to the control, tapped on 1/2 S d/2 86% conventional system. Mean yield per tapper ranged from 150% to 15-7% of the control. The trial on New Rompin Estate showed that yield was slightly depressed due to poor canopy. Mean yield per hectare over the five-year period ranged from 78 to 94% and the yield per tapper ranged from 118 to 132% as compared to the control conventional system. The new Rompin Estate trial indicated that there was a slight decrease in the mean annual girth increment for trees in the stimulated periodic tapping system as compared to the control. Mean annual girth increment for trees exploited on periodic system was 1.9 cm, while that of the control was 2.2cm. However, the lower value on girth increment for the periodic system was mainly due to the lower girth increment contributed by Block C, situated on a low-lying soil, which had an initial poor tree tappability compared to Blocks A and B. Periodic-tapping system indicates that besides the reduction in the number of tappers required (33%), there are benefits such as comparable or better yield per hectare, higher yield per tapper and better bark reserve due to reduction in number of tapping. Thus, it is a good system for precocious high-yielding clones. Besides young mature rubber, periodic tapping system can be used on prime-age trees on panels BO-2 and B1-1. It is, however, important to ensure effective stimulant application especially after the resting period, that is on groove if the lace is thick, and to provide adequate frequency.

Key words: Girth; Periodic tapping; Tapper shortage; Yield; Malaysia

128 Preliminary results of hypodermic tapping system on rubber

Karyudi and Chaidamsari, Tetty

In: Prosidings of the Lokakarya Nasional Pemuliaan Tanaman Karet, Medan 1992, pp. 157-161.

Key words: Hypodermic tapping; Tapping system; Indonesia

129 Productivity and economics of enlarged tasks – A case study

Hassan, Johari; Nayagam, James; Sivakumaran, S; Wan, Yong Hing and Muthu, K

Planters' Bulletin; 214: 1993, 26-40.

Key words: Profitability; Tapper shortage; Tree productivity; Yield; Malaysia

130 Prospective solutions to current problems in *Hevea* exploitation in a large group of estates

Hoong, Chan Weng and San, Ong Tee

In : Management for Enhanced Profitability in Plantations : Proceedings of the 1994 International Planters Conference, 1994, Kuala Lumpur, (Ed. Chee Kheng Hoy). The Incorporated Society of Planters, Kuala Lumpur, pp.337-349.

The AAR jacket system was developed to overcome the problems of tapper shortage and high cost of production faced by the group and AAR rainguard, to reduce rain interference especially in young mature areas. Yield per tapper in jacketed fields increased by 15 to 101 per cent. Corresponding increase in yield per ha was however lower. Owing to the higher yield per tapper obtained, tappers' wages were raised by 10 to 57 per cent and cost of tapping reduced by 5 to 22 per cent. Labour for tapping was reduced by 24 to 53 per cent due mainly to lower frequency of tapping and also larger task size in jacketed areas. AAR rainguards were very effective in the experimental scale trials giving protection to more than 90 per cent of panels against rain interference compared with 9 per cent for unguarded control areas. In the commercial rainguard areas, 12 extra tapping days were obtained over a period of 12 months. Cost of rainguarding was fully recovered only two months after installation based on a breakeven yield of 90 kg per task. Overall the AAR rainguard is a practical, economic, and effective device against rain interference.

Key words: AAR jacket system; Rainguarding; Tapper shortage; Malaysia

131 Puncture tapping in combination with low-frequency tapping system: An approach to reduce tapper requirements

Sivakumaran, S

Planters' Bulletin: 208-9:1991. 102-110.

The combined approach of puncture tapping for limited periods followed by conventional 1/2 S d/6 tapping with stimulation can be adopted in areas experiencing acute shortage of tappers and, as a result, mature fields have been left untapped. This method, which uses unskilled labour and limited skilled labour, provides adequate flexibility to tapping operations on the ground, with the limited tappers available fully utilized to exploit large areas. The advantages of this system are numerous and its benefits should be fully exploited. In view of its scope for

further improvement, particularly with regard to yields obtained with puncture tapping, the Institute is prepared to evaluate this approach jointly with interested members of the industry. The evaluation trials will generate additional data for a wide range of clones and, besides confirming the promising results, will facilitate progress towards its commercial implementation, which is exclusively designed to tackle the current serious problems afflicting the industry.

Key words: Ethephon; Low frequency tapping; Puncture tapping; Tapper shortage; Yield; Malaysia

132 Puncture tapping with ethylene stimulant on rubber production and wood quality

Sinthurahat, S; Paechana, P and Peamaroon, A

The 37th Kasetsart University Annual Conference, 3-5 February, 1999. 3-10.

(HORTCD 1989- 2001/09)

Puncture tapping with ethylene stimulant (PTE) is widely used in Thailand under the trade name of 'Agrobase Gassing System' (AG) since its introduction in 1993. AG is used to promote production in non-productive rubber *[Hevea]*-plantations of >15 years of age. AG is applied for 1-2 yeas before the plantations are replanted. A comparison of PTE, conventional tapping (CT), CT with ethrel stimulant (CTE), high level tapping with ethrel [ethephon] stimulant (HTE), and CT with ethrel stimulant and plastic rain guard (CTEP), was carried out using 20-year-old RRIM 600 at Ranong rubber Station, Thailand. PTE gave statistically higher yields (dry rubber sheet) than the other treatments. There were no statistical differences in wood quality between PTE and CT treatments.

Key words: Agrobase gassing system; Ethylene; Puncture tapping; Yield; Thailand

133 Rainfall as a major factor influencing land productivity in rubber plantations

Sivakumaran, S; Md. Said, Mohd Akbar; Kewi, Chong and Choi, Tam Yong

Planters' Bulletin, 2:1998. 3-17.

The potential loss in crop due to lost tappings and crop washouts due to morning or afternoon rains is very substantial as supported by data presented here. This can on the average range from a low of 400kg/ha/year to a high of 700 kg/ha/year with consequently the potential losses at the national level being tremendous if the total hectarage of tapped rubber area in the country is taken into consideration. Thus even without use of newer exploitation systems, the productivity per unit area or land productivity in rubber fields can be maximized by merely adopting appropriate measures to minimize rain interference on tapping operations or crop washout in the morning or afternoons. Rain interference can be overcome to a large extent, with consequently enhanced land productivity. This in turn would result in rubber profitability being maintained with returns per unit area being economically viable. The national average productivity per hectare per year in rubber estates and smallholdings can be maintained on an upward trend with better total national production, without increasing the existing hectarage of tapped rubber in the country.

Key words: Crop loss; Land productivity; Rain interference; Smallholding; Malaysia

134 Rainguarding (Malayalam)

Thomas, K U

Rubber, 348: 1995. 3-5.

Key words: Rainguarding; India

135 Rainguards for the rubber plantation

Tillekeratne, L M K and Nugawela, A

Proceedings of Indonesian Rubber Conference and IRRDB Symposium, 2000, 12-14 September 2000, Bogor, Indonesia, V2. pp. 448-451.

A rain guard is a pleated gauge of 300 polythene apron fix on to the bark of the rubber tree by means of a bitumen based gum, to divert contaminated rain water seeping along the bark of the tree away from the tapping cut. Contamination of freshly tapped panel would result in panel disease called bark rot, thereby causing the wastage and reducing the quality of latex. Annually between 45-55% of the rubber crop available in trees is wasted due to the interference of rain. By using the rain guard, tapping could be continued on over 325 days per year, thereby providing constant work to the tapper as well. Recovery tapping done in plantations to recover crop loses in rainy days is harmful to the rubber plantation. Use of rain guard eliminates the need to conduct recovery tapping as well. In order to simplify the lying of rain guard, a brushable, viscid sealant was introduced by the Rubber Research Institute of Sri Lanka. The rubber production in Sri Lanka dropped to below 100,000 metrics tons in 1999 for the first time since World War II. In order to meet the growing demand for raw rubber for the rubber products industries in the country, the only rapid method available to increase the production over 100,000 metric ton is the use of rain guards in the whole of Sri Lanka.

Key words: Rainguarding; Yield; Sri Lanka

136 Rainguards-only solution for immediate increase in rubber production

Tillekeratne, L M K and Nugawela, A

Bulletin of the Rubber Research Institute of Sri Lanka 32(2): 1995. 70-72.

Key words: Rainguarding; Rubber production; Sri Lanka

137 Rain Gutter: An effective means of improving rubber production

Choi, Tam Yong

Proceedings of Seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, Malaysia, pp.140-159.

This paper identifies the problems of low rubber production and offers solutions to overcome these problems. Data from estates and smallholdings show that rain interferes with tapping, resulting in loss in tapping days and wash outs of late drips. These are the main causes of low yields from rubber planting. The use of a simple device called Rain Gutter has been shown to minimize these problems. The other factor is human problem, which can only be overcome by the management. But more importantly, in large commercial adoption, Rain Gutter has increased yield considerably by 400 to 700 kg/hectare/year and this had in turn led to higher income for the growers. Used on a national basis it has great implications on enhancing Malaysia's

total production of NR by 400,000 to 700,000 tonnes/year. Rain Gutter is meant for all tapping systems and in principle one task per tapper should be fitted to ensure that on any given rain day one task would be still tappable. For the long flow system Rain Gutter is essential because of its high yield per tapper and its long late drip.

Key words: Conventional tapping system; Long-flow tapping system; Rain gutter; Rubber production; Yield; Malaysia

138 Rain gutter as a current tapping aid for enhanced land productivity: Yield and economic performance

Kewi, Chong; Md.Said, Mohd Akbar; Sivakumaran, S and Choi, Tam Yong

Planters' Bulletin, 2:1998. 24-30.

Ever since the introduction of excision tapping systems, rain has been one of the most important factors limiting the productivity of rubber trees. The limitation comes in the form of non-tapping due to wet panel or from crop loss due to washout. Various measures have been practiced by the industry to ameliorate this constraint, such as replacement or 'ganti' tapping, double tapping, late tapping, and the use of different types of rain protecting devices with certain degree of success. Among these devices, Ran Gutter has proven to be one of the most cost effective ways of enhancing crop productivity and return on investment. The prevention of stem flow during and after by Rain Gutter is responsible for increasing actual tappable days and preventing crop loss through washout, both of which would lead to enhanced crop productivity. The small investment per unit and its simplicity in use has rendered the Rain Gutter as a popular device in controlling rain interference on excision tapping systems. The benefits of using Rain Gutter in relation to yield and economic performance, by several estates and plantation agencies are presented in this article.

Key words: Ethephon; Rain gutter; Stimulation; Tapping system; Yield; Malaysia

139 Rain gutter as an effective tapping aid to enhance land productivity; Technical aspects

Md.Said, Mohd Akbar; Kewi, Chong; Sivakumaran, S and Choi, Tam Yong

Planters' Bulletin, 2:1998. 14-23.

Rain Gutter has been accepted by NR industry as an essential and effective device to overcome the problem of rain interference. Presently, Rain Gutter is one of the effective rain guards available in the market. The concept of a gutter, the versatility of Sealant C-200, easy fixing and maintenance work are the key advantages of the Rain Gutter. Fixing of Rain Gutter is highly recommended in high yielding areas, in areas with low turnout of tappers, newly opened rubber areas, rubber areas tapped with LIT d/6 system with ethephon stimulation and areas tapped on either RF or RR techniques. Rain Gutter is designed to overcome loss of tapping days, minimize crop washout, minimize late tapping, recovery tapping and double tapping because of wet tapping panels as a result of rain interference. Trees fitted with Rain Gutter would allow the tapping panels to dry quickly after overnight rain or early morning rain, thus allowing tapping to be carried out normally or only with slight delay in term of commencement of tapping.

Key words: Ethephon; Land productivity; Rain gutter; Stimulation

140 REACTORRIM system of exploitation: Recent improvement and uptake on yield performance

Ahmad Zarin Mat Tasi and Md.Said, Mohd Akbar

Proceedings of Seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, Malaysia, pp.66-78.

REACTORRIM is a method of stimulation of *Hevea* trees by slow release of gaseous stimulant that continuously diffuses into the laticiferous system. It has undergone numerous stages of development and improvement through a continuous process of research and development. Currently, the stimulant gas is compressed in a canister and released through micro-porous membrane into a delivery tube and button diffuser fixed on the bark. Evaluation of the system on mature trees tapped on HO panel using puncture tapping or shortcut 1/8S↑ d/3systems has shown that most clones gave good yield response to the system. Clones PR255, RRIM 703, PR 261, RRIM 600, PB 330, PB311, PB 260 and GT1 are among the good responders. Clone PB 235 showed slightly lower response. With short cut 1/8S↑ d/3, the mean yield for clone PB330 was 166.2 g/t/t respectively over a period of 22 months. With puncture tapping, clone GT1 gave a mean yield of 100.4 g/t/t over a period of 42 months. The tapper productivity increased to 156, 175 and 244% of the normal tapping yield for clones PB 311, PB 260 and PB 330 respectively. The land productivity per year with these clones was 3267 kg/ha/ from PB 311, 3689kg/ha from PB 330, and 3599kg/ha from PB260. The mean dry rubber content (drc) of latex in REACTORRIM area was comparable to the drc of latex in the normal tapping area. The percentage of panel dryness at the end of one year was lower than the percentage dryness in the normal tapping area. The system has increased the income of the tappers. In commercial estate areas the income of tappers per month ranged form RM 459 to RM1,253. In organized smallholdings, the smallholders' income ranged form RM517 to RM1,288/month from tapping 500 trees. The REACTORRIM has a good potential to solve the problem of shortage of skilled tappers. It can increase the productivity of rubber areas as well as income of rubber tappers. The system is recommended to be used on trees above 15 years of age.

Key words: Dry rubber content; Land productivity; REACTORRIM; Tapper income; Yield

141 Recent developments in rubber biosynthesis research

Yusof, Faridah

Paper presented at IRRDB Symposium "Challenges for Natural Rubber in Globalization" 15-17 September 2003, Chiang Mai, Thailand.

Key words: Rubber biosynthesis

142 Re-exploitation of tapping panel dryness trees of *Hevea brasiliensis*

Xiaodi, Wei; Wenxian, Xu; Wanlin, Ye and Chengxu, Wang

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, Hainan, China, 1997. pp.55-62.

Resting trees affected by tapping panel dryness were treated and retapped for 3 successive years by employing vertical puncture tapping, upward tapping plus puncture tapping, and S/4 upward tapping after isolation of the infected patch and application of antibiotic compounds.

Results showed that upward tapping plus puncture tapping of the treated trees gave a dry rubber yield of 1.546 kg/tree/year, 67% of that of the control (healthy trees), but the tapping frequency was only 30% of that of the control. Upward tapping plus puncture tapping gave more yield, consumed less bark and a less recurrent rate of TPD than conventional upward tapping or vertical puncture tapping. The tapping system is practical and easy to use.

Key words: Puncture tapping; Tapping panel dryness; Re-exploitation; Upward tapping; Yield; China

143 Reduced tapping frequency and DCA tapping systems. Research towards improvement of Thailand rubber plantations productivity.

Gohet, E and Chantuma, Pisamai

Paper presented at IRRDB Symposium "Challenges for Natural Rubber in Globalization", 15-17 September 2003, Chiang Mai, Thailand.

Continuous decrease of the size of Thai rubber smallholdings for the last twenty years (from 4 ha in 1980 to 1.7 ha nowadays) has led to general adoption of very intensive tapping systems by most of Thai rubber farmers. Beside 1/2 S d/2 7d/7, systems like 1/2 S d/1 2d/3, 1/3 S d/1 1d/3, 1/3S d/1 3d/4 or even more intensive are quite usual on Thai rubber farms, resulting in possible overexploitation, high TPD (tapping panel dryness) rates, short life-cycle of plantations and rather low productivity. The current report presents the results of a three years experimentation on clone RRIM 600 in Chachoengsao Rubber Research Centre (RRIT-DOA), under the framework of the project "Towards the improvement of the Rubber Tree Productivity" (RRIT-DOA/Kasetsart University/Cirad). Different strategies in order to alleviate the impact of former constraints are studied. Experiments on reduced tapping frequencies (RTF: d/3 7d/7 or d/4 7d/7) with compensation using ethephon stimulation are conducted. Results confirm that reduced tapping frequencies can reach the same yield per tree (kg/tree/year) or per hectare (kg/ha/year) in comparison with a 1/2 S d/2 7d/7 control, leading to an important increase of rubber output per tapper (g/tree/tapping, kg/tapper/day), from +25% to +70% with 1/2 S d/3 7d/7 and from +50% to +90% with 1/2 S d/4 7d/7, depending on stimulation intensity (number of rounds per year, 2.5% ET concentration). Conditions for a possible and successful implementation of reduced tapping frequencies in Thai rubber plantations are discussed (minimal size of farms, production sharing between tapper and owner.) Although rather difficult to implement in the present Thai rubber farming context, study on RTF should be continued in order to prepare a future possible shortage of tappers. A new tapping system (Double Cut Alternative or DCA, 2x 1/2 S d/4 (t,t) 7d/7) is currently under study in comparison with 1/2S d/2 control. Principle of the DCA system is, in case when RTF cannot be implemented, to optimise higher tapping frequencies by tapping two cuts instead of one. The two cuts, each one tapped in d/4 frequency, are opened on opposite panels (BO-1, BO-2) and maintained vertically distant by at least 75-80 cm, in order to minimize competition between their respective latex regeneration areas. The tree is tapped every 2 days, but each cut is tapped every 4 days, increasing regeneration time on each d/4 cut (4 days instead of 2 with 1/2 S d d/2 7d/7 control). After three years of tapping, DCA system shows, on two different experiments, a significant increase in production (+25- 30% for all yield parameters: kg/tree/year, g/tree/tapping and kg/tapper/day) compared to 1/2S d/2 7d/7 control, associated with better latex physiological profiles (latex diagnosis: higher latex sucrose, inorganic phosphorous and reduced thiols). The DCA system does not

alter the competitive relationship between trunk growth and rubber production. Compared to reduced tapping frequencies, which only increase output per tapper, DCA system increases both rubber yield and output per tapper in comparison with 1/2 S d/2 7d/7 conventional tapping system and therefore appears very promising.

Key words: Double cut alternative tapping system(DCA); Latex diagnosis; Physiological parameter; Productivity; Rubber plantation; Reduced tapping frequency (RTF); Smallholding; Stimulation; Thailand

144 A reflection on the new tapping systems with whole course, successive and increased by degrees of PR 107 and RRIM600

Xinzheng, Zhang; Jialian, Wu and Dingyan, Wu

Science and Technology of Tropical Crops, 5:1993.

(Cited by Xiaodi, Wei et al. IRRDB Symposium, Hainan, China, 1999)

Key words: Clonal response: Tapping system; China

145 Relationship between stimulating paste quantity and production of *Hevea brasiliensis* rubber in the south-east of the Cote d'Ivoire

Obouayeba, S; Boa, d and Keli, Z J

Tropicultura, 14(2): 1996. 54-58.

(AEDR. 105527, 1997.)

Key words: Stimulant; Rubber production; Cote d' Ivoire

146 Respond of GT 1 rubber clone to combination tapping systems

Kuswanhadi and Junaidi, Untung

Risalah seminar hasil peelitian Balai Penelitian Sembawa tahun 1992/1993: 127-145.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No. 187)

The aim of this trial was to find combination of tapping systems suitable for GT 1 Rubber clone in term of yield and bark consumption. This trial was arranged according to a randomized block design with 6 treatments and 4 replications. Plant yield and growth were assessed. The result showed that combination tapping systems increased yield about 11-33 percent and save bark about 30-75 percent of 1/2 S d/2. Girth increment was not retarded whilst DRC and latex sucrose content was slightly decreased. There were linear correlation, $y=100.29 + 0.43x$ ($r=0.98^*$), between proportion of cut tapping in combination tapping system with plant response.

Key words: Clonal response; Yield; Indonesia

147 The response of clone PB 86 to low frequency tapping under smallholder management conditions

Nugawela, A; Amaratunga, K A G B; Wilbert, S and Karunasena, R P

Proceedings of the IRRDB Symposium on Agronomy Aspects of the Cultivation of Natural Rubber (Hevea brasiliensis), 5-6 November 1996, Beruwela, Sri Lanka. pp.69-73.

In Sri Lanka about 60 of the mature rubber consists of clone PB 86. The Rubber Research Institute of Sri Lanka recommends 1/2 S d/2 tapping for this clone from the inception of tapping until intensification. However, this commonly adopted tapping system has the disad-

vantages of being a). tapper demanding and having high b). annual bark consumption rates c). tapping costs. With the objective of finding an alternative tapping system, 1/2 S d/3 system to gather with stimulation was tested on clone PB 86. Different stimulant concentration and frequencies of stimulation applications were also tested to select the most economical method. Data gathered reveals that 4 rounds of stimulation per year with 2.5 Ethrel to give the most economical yields from 1/2 S d/3 tapping system during the first year. 1/2 S d/3 with stimulation {2.5 ET, Ba 1.6 (2.5) 4/y} gave yields comparable to conventional 1/2 S d/2 system. As comparable yields are obtained with a lesser number of tappings, the tapping costs and bark consumption rates are reduced. The incidence of TPD is comparable in both 1/2 S d/2 and 1/2 S d/3 with stimulation systems. Therefore, it could be concluded that 1/2 S d/3 with stimulation tapping system may be adopted to over come the deficiencies of conventional 1/2 S d/2 system.

Key words: Clonal response; Ethrel; Low frequency tapping; Profitability; Stimulation; Yield;

148 Response of recommended *Hevea* clones to low intensity exploitation system

Junaidi, Untung; Tjasadiharja, A; Kuswanhadi and Thomas

Jurnal Penelitian karet 14 (2): 1996 . 137-152

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.167)

The aim of this experiment was to study the response of several recommended *hevea* clones to low intensity exploitation systems in the long term. The trial was arranged in a randomized block design with three treatments and four replications. Each plot consisted of 50 trees with relatively uniform girth. This trial was conducted on six clones *viz.* PR 255, PR 261, PR 300, GT 1, RRIM 600 and AVROS 2037. The results showed that all clones had similar responses to low intensity exploitation system (LIES), namely higher yield in the first two years and lower in the third year when tapping frequency of the conventional exploitation system (CES) was changed from d/3 to d/2. Clones GT 1 and RRIM 600 were very suitable to be tapped with CES because it gave highest cumulative yield and income. Clones PR 255, PR 300 and AVROS 2037 could be tapped with both either CES or LIES 2. Yield and income of these system were comparable. LIES 2 could lengthen the exploitation period (1.6 times than CES) so that it would give higher yield (about 79-141% of CES) in the end of plant life cycle. Clone PR 261 was most suitable to be tapped with LIES 2 and the yield increased about 15% of CES in ten years and would lengthen the exploitation period. On the contrary, LIES 2 increased intensity of tapping panel dryness (TPD). LIES 1 could be used for rubber area with labour shortage. Despite TPD decrease, LIES 1 decreased cumulative yield about 20-23% in ten years of tapping, but it lengthened the exploitation period about 1.6 time compared with CES, so the cumulative yield increased about 23-80%.

Key words: Clonal response; Low intensity tapping; Yield; Indonesia

149 Response of recommended clones to upward and HLE tapping systems

Kuswanhadi; Junaidi,Untung and Lukman

Makalah disampaikan pada Pra-Rakker Badan Litbang Pertanian di Padang Marpoyan, Riau, 17-18 Februari 1997: 14 hal.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.189.)

Research in upward and HLE tapping systems have been conducted at Sembawa Research Station, Palembang (South Sumatra) on various recommended *hevea* clones and on GT 1 at

North Sumatra. These trials were aimed to study response of various hevea clones to those tapping systems. The result showed that on GT 1 and BPM 1, upward tapping systems of 1/4 S↑ d/2 ET and 1/3 S↑ d/3 ET could be recommended as alternatives to 1/2 S d/2 ET and 1/2 S d/3 ET control respectively. While on PR 255 and PR 261, upward tapping systems of 1/4 S↑ d/2 ET and 1/3S↑d/3 Et could be recommended as alternatives to the control respectively. For North Sumatra, only 1/4 S d/3 ET could be the alternatives to both control. Yield on HLE system still lower than control, so that it need to look for a new application method of stimulation. Decreasing of latex DRC, increasing of TPD intensity and decreasing of plant growth rate on those upward systems were still relatively low and could be said normal.

Key words: Clonal response; Upward tapping; Indonesia

150 Response of rubber trees (*Hevea brasiliensis* Muell. Arg., clone RRII 105) to Low Frequency Tapping (LFT) systems

Karunaichamy, K; Vijayakumar, K R; Thomas, K U; Rajagopal, R and Anilkumar, D

Indian Journal of Natural Rubber Research 14(2): 2001. 79-87.

Yield of *Hevea brasiliensis* Muell. Arg. (clone RRII 105) over a period of three years under third daily (d/3), fourth daily (d/4) and weekly (d/7) frequencies of tapping of half spiral cuts with different frequencies of ethephon application (stimulation) were compared with that of unstimulated trees under alternate daily tapping (d/2). Tapping under d/2 frequency was injurious and resulted in yield depression in the third year. Tapping under d/3 frequency with stimulation resulted in high yield of 7382 kg/ha for three years. Comparable yield could be achieved under d/4 frequency of tapping with appropriate stimulation. There was yield depression under weekly tapping in the first two years. In the third year, yield responses under weekly tapping were comparable to those of d/3 and d/4 frequencies of tapping. The low yield under d/7 frequency of tapping in the newly opened trees can be overcome by increased frequency of stimulation. Under d/7 frequency of tapping, maximum response to stimulation was observed when it was done between 48-72 h before tapping. Thus the Low Frequency Tapping systems including weekly tapping can be successfully adopted in India without compromising production.

Key words: Ethephon; Low frequency tapping; Stimulation; Yield; India

151 Response of several recommended rubber clones to high intensity of tapping systems

Junaidi, Untung and Kuswanhadi

Prosidings of the Lokakarya Nasional Pemuliaan Tanaman Karet, 7-9 December 1992, Medan 1992, pp.149-156.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002 No.162.)

The trial was aimed to study the response of some recommended rubber clone to high intensity of tapping system. The trial was arranged in a randomized block design with 11 treatments and three replications. Three kinds of rubber clones (PR 255, PR261 and PR 300) were treated paralelly. Each plot comprised 30 trees. Plant yield and growth were observed in terms of dry rubber yield, dry rubber content, girth increment, renewed bark thickness, bark consumption and bark dryness. PR 300 and PR 255 had better response to high intensity of tapping system compared with PR 261. Tapping system of 1/2 /S d/1 2d/3 with or without rest (6d/7) could be

recommended for those clones. For PR 300, tapping as high as d/1 5d/7 still could be done. Further study to obtain more data will be conducted.

Key words: Clonal response; High intensity tapping; Indonesia

152 Response of some *Hevea* clones to periodic tapping systems

Kuswanhadi ; Junaidi, Untung; Tjasadihardja, A and Thomas

Indian Journal of Natural Rubber Research , 05(1&2): 1992. 172-178

The objective of this experiment was to study the response of recommended *Hevea* clones in Indonesia to periodic tapping systems. Cumulative yield for 5 years of tapping of periodic tapping systems (1/2 S d/1 5d/7 2m/3 and 1/2 S d/1 6d/7 m/2) were comparable with the conventional system of GT 1; but lower for PR 300 and AVROS 2037, and higher for RRIM 600. For PR 261, only 1/2 S d/1 5d/7 2m/3 resulted in a higher yield. Girth increment was slightly retarded in periodic systems, especially for PR 300. Growth of renewed bark was not affected, but dry rubber content of latex was slightly lowered. Intensity of dry bark incidence depended on clonal susceptibility. PR 261 seemed to be prone to bark dryness. Periodic tapping systems could be recommended as alternatives to the conventional system for the clones GT 1 and RRIM 600. RRIM 600 showed the best response to periodic systems.

Key words: Clonal response;Periodic tapping system; Indonesia

153 The response of various recommended rubber clones to tapping systems

Junaidi, Untung; Tjasadihardja, A and Kuswanhadi

Prosiding Lokakarya nasional Pemuliaan Tanaman Karet, 1995, 201-214.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.166.)

In selection of rubber clones, the tapping system used was 1/2 S d/3 for the first two year and then changed to 1/2 S d/3 in the subsequent years. This system has been no more used by estates and smallholders rubber. Another tapping system should be used as alternative to meet the estate and smallholder need. Tapping system should be based on the characters of clone. Tapping system with stimulant has been used by estate. Therefore a research to study the response of recommended rubber clones should be conducted. The results of ten years observation showed that clones gave various response to low intensity systems. Clones with good response to stimulation also had good response to low intensity systems. Tapping with 1/4 S d/2 (t,t) with stimulation showed higher production (95 115%) compared with the conventional tapping. The highest response (15%) was found on PR 261. The tapping panel dryness (TPD) was also increased in the tapping system with low intensity. Periodic tapping systems is often practiced by smallholder in various regions because they grow food crop beside rubber. The results of ten years observation showed that periodic system of 1/2 S d/1 5d/7 2m/3 gave higher production than 1/2 S d/1 6d/7 m/2. The response of clones was about 90-110% of the conventional tapping system. Clones RRIM 600 and PR 261 showed good response without regarding plant growth and without increasing TPD. The limited latex drainage area on downward tapping system, mainly when the tapping cut approaches the stock/scion union, often causes yield decline and TPD increase. Upward tapping system was proposed to attain good response to long-term stimulation. The result of 2-3 years of study showed that upward tapping system pf 1/2 S /d/2 without stimulation on various clones gave higher yield than the down-

ward tapping system, ranging from 10-26%, whereas upward tapping system with low intensity 1/2S/d/2 with stimulation, increase yield around 8-20% more than 1/2 S d/2. The research on upward tapping system will be continued to study the response of clones in the long term.

Key words: Clonal response; Low intensity tapping; Stimulation; Upward tapping; Indonesia

154 Review of dryness incidence in exploitation trials

Thanh, Do Kim

IRRDB Workshop on Tapping Panel Dryness in Hevea brasiliensis, 29-30 April, 1997, Hainan, China, pp. 78-81.

Data on dryness incidence in Class I clones in various exploitation trials are presented. The effects on the incidence of dryness of tapping frequency, stimulation, soil type and the altitude of the various rubber planting areas also discussed.

Key words: Stimulation; Tapping frequency; Tree dryness; Vietnam

155 Role of female farmers in activities and decision making of rubber farming and their contribution to family income

Nancy, C; Gunawan, A; Oakeley, H B and Conroy, C

Jurnal Penelitian Karet, 14 (2): 1996. 153-172.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No.235)

The objective of this research was to study the characteristics of farmers' wives, to analyze women participation in decision making process in the management of rubber farm and home garden, to evaluate the main role of the women in their daily activities and their contribution in supporting the family income. The field survey was conducted in four location, i.e., new-comers villages (Batumarta and Mulia Agung) and local indigenous villages (Kertajaya and Air Gilas), namely 46, 10, 15 and 8 women. The results showed that the main occupation of the majority of women is housewife. The percentage of women who tapped rubber was about 20-80% of the total respondents. However, in general (50-80% of respondents), the women participated in field activities, particularly in planting and cultivating intercrops. Women had a significant contribution, particularly in decision making relating to planting and cultivating of intercrops. While men were more dominant in decision making concerning funds for the purchase of agricultural inputs and the marketing of product. Efforts were made to grow intercrops as long as possible, because during the intercropping period the women would intensively maintain their plantations. The management of home garden was entirely done by wives. The highest time allocated for productive activities was found in Mulia Agund, where the wives were active in tapping and field activities. The contribution towards income was around 15.3-36% of the total income. The highest percentage of the contribution by women was found in Mulia Agung, where almost all farmers' wives participated in tapping and working in the fields. The available time for the women per day was ranged from 15.3-16.3% hours. After deducting the women's time for tapping, field works and activities outside farming, apparently the time remaining for domestic activities was around 61-84%. The contribution of the women in supporting the family income was 15.3-36% if the total income.

Key words: Family income; Female workers; Rubber farming; Indonesia

156 RRIM's achievements in production research and development from 1925 to 1995

Pushparajah, E

The Planter 71(837): 1995. 571-587.

The review evaluates achievements in four categories namely increased yield, reduced unproductive phase, increased productivity of labour, and contributions to a sustainable environment. The assessment clearly reveals that R & D has led to large yield increases. These increases have been achieved through breeding and selection, improved propagation and planting practices, enhanced soil management practices including cover management and efficient fertiliser use, improved exploitation systems, and appropriate developments in crop protection. Increase in profitability was made possible through development of practices to reduce the unproductive immature phase. The contributions include introduction of more vigorous and precocious clones, field practices and inputs and exploitation systems (in particular early exploitation of trees with smaller girths). Mechanisation of some of the field operations(e.g. felling, holing, terracing, application of crop protection chemicals, etc), and development of low intensity tapping systems, as led to increased labour productivity; but much more R and D in this area is needed. Research has to the same time addressed the issue of a safer environment, and sustainability. The contributions include conservation of germplasm, practices which ensures soil conservation, introduction of use of chemicals with low toxicity and reduced dependence on inorganic nitrogen fertilisers. At the same time practices to minimise pollution from processing waste have been successfully introduced. More recent development of importance is the findings on the value of rubberwood, which has led to the realisation of rubber plantations as a sustainable source of medium hardwood timber. The review calls on the need for more concerted work to make rubber production in Malaysia more attractive. Some areas for research have been suggested.

Key words: Ethephon; Labour productivity; Yield; Malaysia

157 RRIMFLOW: A novel technique of exploitation of *Hevea* trees

Sivakumaran, S

In: *Towards Greater viability of the Natural Rubber Industry: Proceedings of the RRIM Rubber Growers Conference*, Kuala Lumpur, 1991 (Ed. Abdul Aziz Bin S.A Kadir), RRIM, Malaysia. pp.123-46.

A novel technique of exploitation of *Hevea* trees and referred to as RRIMFLOW has been developed incorporating promising elements from past work at the Rubber Research Institute of Malaysia (RRIM). This novel technique involves single punctures once a week (IPI d/6) coupled with application of stimulant into applicators fixed over a scraped area of bark at the desired position on the tapping panel. Single punctures (2mm diameter) are made outside the stimulated area with a 2 mm blunt needle mounted on a wooden handle. Latex is collected with the aid of 60 mm length and 2 mm diameter plastic straws fitted at one end into the punctures and the other end leading into a closed receptacle containing 20-30 milliliters o 10 ammonia solution. The crop is collected as latex 72 h after tapping. This novel technique has been extensively investigated in comparison with conventional systems in several trials. Tapping with single puncture once a week plus weekly stimulation 48 h prior to tapping gave the best yields

when compared with other frequencies of tapping and stimulation. Data available shows that punctures can be made on the panel upto a distance of 100 cm to 120 cm above or below the applicator. The yield responses of virgin and renewed panels over nine months was several-fold higher than that of corresponding trees tapped on conventional systems. The mean flow time ranged from 40 h to 44 h, with d.r.c. values being 6 to 7 units lower than that of conventionally tapped trees. Good yield responses were obtained from most clones tapped on the novel exploitation system with yields being twice or thrice that of control trees tapped on conventional system. The mean flow times for all clones ranged from 38 h to 44 h. A decline in d.r.c. values was noted for all clones relative to 1/2 S d/2 or d/3 tapped control trees. The flow rates decline progressively with sharp drop being recorded after 24 h. The final yield obtained and duration of flow appear not to be related to the initial flow rates. Factors influencing performance of this technique are identified. Dry trees and trees of low girth (25 cm to 35 cm) have given promising yields with corresponding increases in flow time when tapped with the novel technique. The yields form large scale evaluation of this technique on half-task of clone PR 255 (*panel BO-2*) shows that yields for four months were 143% more than that of 1/2S d/2 tapped control trees. The fundamental reasons for the prolonged flow and higher yields associated with this novel technique are explained. Although the long term effects are not known, nevertheless, plausible reasons are advanced to support the suggestion that the trees may be more tolerant to this mode of tapping. The advantages include use of unskilled labour for tapping of trees with this technique, reduction in costs of production a rising from once a week tapping, no loss in crop due to rain interference, flexibility in time of tapping and harvesting of entire crop as latex with consequently better returns. Some adverse effects noted are bleeding form previous puncture points on the panel and isolated occurrence of bark bursts in trees of certain clones. The practical problems include damage to applicators by pests and the prospect of loss of crop in the field. These problems however, can be resolved with adoption of appropriate measures.

Key words: Tapping system; RRIMFLOW; Yield; Malaysia

158 RRIMFLOW: A promising radical method of crop production in *Hevea*

Sivakumaran, S; Kewi, Choong and Ahmad Zarin Mat Tasi

Planters' Bulletin, 208-209: 1991. 81-91.

The tapping method described differs in important ways from previous standard practices, and offers higher productivity per unit of labour, crop and land. Other advantages include tapping by unskilled labour at any time of day, no losses to raine, exploitation of normally unproductive trees and a high-value all-latex crop. Stimulant applicators made of plastic or rubber are glued to a scraped area of bark and a "poltent" (unidentified) stimulant added weekly. At tapping (2 days later), a single 2 mm diameter hole is pierced in the bark, up to 1 m away from the applicator. and a 60 mm length of plastic tube inserted, leading to a closed receptacle containing 20-30 ml of 8-10% ammonia. Latex is thus collected protected from rain and other contaminants, and can be gathered 2-3 days after tapping. Tapping is done only once a week, and the same site of stimulant application can be used for 6-8 months. Field trials (on RRIM 600, RRIM 703, PB 217, PB 235, PB 260 and PR 255) showed yield increases of 20-111% (kg/ha over 18 months). Dry rubber content, reported for 4 clones, was always (up to c.25%) lower under the new system. Commercial trials over 6 months on RRIM 600, PB 217, PB260, PR

261 and GT1 showed meant yields (kg/tapping per task) up by 147-287% and total yields (kg/ha) up by 19-139%. Practical problems include bleeding, cracking and deformation of the bark, damage by monkeys, theft, and the need for maintenance of applicators and a higher level of management input. The effects of long-term stimulation have yet to be assessed.

Key words: RRIMFLOW; Tapping system; Yield; Malaysia

159 RRIMFLOW: Short-cut system of exploitation

The Rubber International Magazine, 4(38): 2002. 35-42

Key words: RRIMFLOW; Tapping system; Malaysia

160 RRIMFLOW short-cut systems: Techniques to increase tapper and land productivity

Sivakumaran,S; Kewi, Chong; Nayagam, James and Wan, Yong Hing

In: *Ensuring sustainability and competitiveness of the NR industry: Proceedings of the Rubber Growers' Conference*, 1995, Kuala Lumpur, (Ed Abdul Aziz S. A Kadir). RRIM, Malaysia. pp.73-112.

The RRIMFLOW short-cut systems involving tapping of either one-eight or one-quarter cuts on d/3 or d/4 frequencies in combination with enlarged task sizes (650-750 trees) have been developed as effective techniques to enhance tapper productivity with consequently better incomes, and adequately increase land productivity to ensure higher ex-estate profitability. These novel systems have been extensively evaluated and the data obtained have been assessed in relation to yield performance and related parameters besides comparative assessment of economic viability. The mean yields per tree per tapping obtained from panel *HO*-1 of clones PB 235, RRIM 717, PR 107, PB 5/51 and PB 252 tapped on 1/8S↑ or 1/4 S↑d/2 d/3 plus RRIMFLOW stimulation weekly over periods of thirty to thirty-four months were in the range of 19% to 78% higher than that obtained from the corresponding control trees tapped on 1/4S ↑ d/2 d/3 plus ethephon (5.0%) monthly. The mean yields per tapper per tapping in six commercial task size trials on clone RRIM 600 (*HO-1*) tapped on 1/8S↑d/3 d/4 plus RRIMFLOW stimulation weekly ranged from a low of 42 kg for a task size of 405 trees to a high of 73 kg for a task size of 632 trees over periods of eighteen to twenty months. The mean yields for the corresponding control trees, irrespective of the tapping system used, ranged from 17 kg to 35 kg. In similar trials on other clones, namely PB 260, PR 261, GT1, PR 107 and PR 255, over periods of twelve to nineteen months with task sizes ranging from 486 to 750 trees, the mean yields, in ascending order, were 48 kg, 77 kg, 78 kg and 87 kg, respectively, from the RRIMFLOW tapped trees. In two older commercial task size trials on clones RRIM 600 and GT 1 in combination with task sizes of 350 trees to 470 trees tapped on 1/8S↑d/3 plus RRIMFLOW stimulation weekly, the yields per tapper per task were 40 kg and 46 kg, respectively, over a period of twenty-nine months. The increase in yields per hectare of the RRIMFLOW tapped tasks in six trials on clone RRIM 600 ranged from a low of 12% to a high of 136% over that of respective control trees over periods of twelve to twenty months. The increase in kg/ha for clones PB 260, PR 107, GT 1, PR 255 and PR 261 over that of respective control trees were 49%, 99%, 27% and 62%, respectively, for periods of twelve to nineteen months. The increase in kg/ha relative to respective controls over a period of twenty-nine months for the two older

commercial task size trials on clones RRIM 600 and GT1 were 27% and 49% respectively. The DRC values of RRIMFLOW tapped trees of most clones recorded an initial depression but subsequently recovered to a level generally comparable to that of corresponding control trees. The decline in DRC values of RRRIMFLOW tapped trees varied between clones. The dryness incidence recorded in most trials for trees tapped on RRIMFLOW short-cuts were generally low (less than 5%) irrespective of the duration of tapping on this system. The incidence in previously RRIMFLOW puncture tapped trees (12-18 months) which were converted to CUT tapping (10-12 months) in four trials was 6.4% and 5% on clones PB 260 *(BO-2)* and RRIM 600 *(H0-1)*, respectively, while no incidence was recorded in clones PR 261 and PB 260 (*HO-*1). The detailed economic analysis of selected RRIMFLOW commercial task size trials shows that the increase in ex-estate profitability per ha annum over that of respective control tapped tasks ranged from a low of 19.7% for clone GT 1 (29 months) to a high of 190% for clone RRIM 600 (21 months). The tappers' incomes in RRIMFLOW tasks, though it was governed by task sizes, nevertheless, were all higher than that earned by tappers in control tasks. The average monthly incomes of RRIMFLOW tappers ranged form RM750.00 (21months) to a high of RM 1554.00 (8 months). The tappers' incomes was also influenced by the payment modes used in RRIMFLOW tasks. Thus, tappers paid either on piece or contract rates earned generally higher incomes than tappers paid according to MAPA/NUPW rates. The percentage increase in yields per ha required for the RRIMFLOW systems (d/3, d/4) to break-even in ex-estate profitability relative to control trees tapped on d/2 frequency is 20% for selling price zones of RM2.50 to RM3.50/kg, while at higher price zones of RM4.00 to RM4.50/kg, it is only 10%, assuming control yields range from 1400-2000 kg/ha. The margin of ex-estate profitability for RRIMFLOW tasks is also influenced by the percentage of low grades with consequently higher profit margins for tasks with evening latex collection. The stable DRC value and generally low level of dryness recorded in most trials would suggest that trees would be able to tolerate the RRIMFLOW system of exploitation with attendant level of crop extraction. The higher yields per tapping per tapper and per hectare with consequently better ex-estate profitability than hitherto obtained with existing systems would indicate that the RRIMFLOW short-cut systems are very attractive for use on mature rubber under prevailing conditions of tapper shortage, poor incomes for tappers and low margins of profitability. The RRIMFLOW short-cut systems are therefore in the interim recommended for commercial adoption on old rubber due for replanting in five years.

Key words: Dry rubber content; Economic analysis; Land productivity; RRIMFLOW; Tapper productivity; Malaysia

161 RRIMFLOW system of exploitation: Recent improvements and update on yield performance

Yew, F K; Sivakumaran, S and Chong, D T

Proceedings of seminar on Low Intensity Tapping Systems (LITS), 10th August 1998, Sungai Buloh, Selangor, Malaysia. pp.42-65.

Recent technical improvements have made exploitation with the novel RRIMFLOW system more attractive. These improvements are: the uses of water reactive gum to fix applicators. The introduction of the diaphragm gassing valve, and the use of hot sauce and rat glue to deter monkey and squirrel damage. Although clonal variation in yield response due to RRIMFLOW

technology was noted, commonly cultivated clones were found to be responsive to the system. In fact, long term (34 months on the average) yield records of 26 Joint Commercial Trial sites showed that high tree, tapper and land productivity could be achieved by using the system. The 17 sites tapped on panel HO had a mean tree productivity of 112 g/t/t (g/tree/tapping). The mean tapper's productivity was 72 kg/tapping while the land productivity averaged 2,298 kg/ha/year. On this panel, the RRIMFLOW technology was found to be superior in tree productivity to the 1/2 S d/2 ET system by 158% and the increase over tapping on the HO panel of 1/4S↑d/3Sd/3 ET system was 57 %. The RRIMFLOW system also yielded 300% more per tapping (tapper's productivity) than 1/2 S d/3 ET system and 104% more than the 1/4 S↑d/3 ET system. The land productivity (kg/ha/year) was 46% higher in the RRIMFLOW than the 1/2 S d/3 ET system and was 32% more than that for the 1/4 S↑ d/3 ET system. Higher tree productivity (113% more), tapper productivity (221% more) and land productivity (49% more) were obtained with the use of the RRIMFLOW system as compared to the double cuts of 1/8S↑1/2S d/3 ET on a site tapped on panel B1-1. For the seven sites tapped on panel BO-2, very high yields were also obtained with RRIMFLOW. The mean tree productivity was 109g/t/t, tapper productivity was 92 kg/tapping and land productivity was 1,776 kg/ha/year. In another 15 sites where RRIMFLOW was practiced on a large commercial basis, high yields were still achieved. An average tree productivity of 114 g/t/t was obtained while the average tapper's productivity was 59.3 kg/tapping and the average land productivity was 1,917 kg/ha/year. The first improvement has enabled fixing of applicators to be done easily and rapidly. The applicators will not leak easily. Hence a lower frequency of only one to two maintenance rounds a year to reseal applicators is needed. Similarly, the second improvement has reduced gas usage as well as made the 'gassing process' faster. All these improvements have led to a simpler system involving less work, and less maintenance, thus saving labour and money. It was also found that periodic change of panel in tapping could sustain the high RRIMFLOW yield over time. As such, dry rubber content values were stable and increase in tree dryness, ranging from nil to 5% over 42 months was negligible. These clearly showed that the trees could tolerate the RRIMFLOW system without long term adverse results. Currently, the RRIMFLOW system is a workable and viable method of exploitation, which is recommended for adoption on a large scale in the country. Future research work will be directed towards studies to make the RRIMFLOW system more practical and user-friendly. The sustainable response of young rubber trees tapped on Panels BO-1 and BO-2 to the RRIMFLOW system will also be investigated.

Key words: Panel change; RRIMFLOW; Tree productivity; Yield performance; Malaysia

162 Save rain-guard polythene on controlled upward tapping (Malayalam)

Vijayakumar, K R

Rubber, **306**:1991. 10.

Key words: Controlled upward tapping; Rain-guard; India

163 Seasonal variation in yield of rubber

Wijesuriya, W; Munasinghe, C; Wanigatunga, N

Bulletin of the Rubber Research Institute of Sri-Lanka **36**: 1997. 34-37.

Key words: Seasonal variation; Yield; Sri Lanka

164 Seasonal yield variation of rubber tree *Hevea brasiliensis* in climatic conditions of major rubber growing areas in Vietnam

Thanh, Do Kim; Nang, Nguyen; Truong, Dinh Xuan; Nghia, Nguyen Anh; Minh, Tran and Thao, Phan Dinh

Proceedings of IRRDB symposium on Natural Rubber (Hevea brasiliensis) V2. *Physiology and Exploitation and Crop Protection & Planting Methods Sessions*, 14-15 October 1997, Ho Chi Minh City, Vietnam. pp. 26-37.

Data on the dry rubber yield of the tapping system 1/2 S d/3 used with clones GT 1, PB 235, PB 255 and VM 515, in a tapping experiment web laid out in Vietnam's major rubber growing areas, were used to investigate seasonal yield variations in relation to the climatic condition of each area(rainfall, number of rainy days/month, average temperature in every month). The results showed that the long dry season in those areas affected the yield and the period of tapping in the first half-year. Yield increased in the rainy season although high and concentrated rainfall influenced tapping. The highest yield was obtained during the last quarter of the year. Yield percentages in almost all clones were similar in every month, except PB 235 which had a low yield ratio in the dry season and a high yield ratio in the last quarter of the year.

Key words: Climatic conditions; Tapping system; Yield; Vietnam

165 Share tapping system on rubber smallholding: A case study at Telangkah rubber demonstration plot, Riau

Haris, U and Dereinda, R

Bulletin Perkaretan 8 (3): 1990. 84-87.

(WAERA. 2526, 1993)

Key words: Smallholding; Share tapping

166 Short cut alternate tapping and Guthrie paste stimulation system

Leong T T and Yuen, Chooi Siew

In: *Management for Enhanced Profitability in Plantations: Proceedings of the 1994 International Planters Conference*, Kuala Lumpur, (Ed. Chee Keng Hoy). The Incorporated Society of Planters, Malaysia,1994. pp.351-367.

The rubber industry is facing shortage of skilled tappers. This paper is investigated the low frequency 1/4 S alternate tapping (t,t) system that requires less of these skilled tappers. With the same tapping frequency, it was observed that the 1/4S (t,t) with stimulation produced crop higher than the control, 1/2S system. In addition, the yield per task per tapping was enhanced by the tapping of more trees per day. By tapping a large task size of 700-800 trees instead of the normal task size of 600 trees, a tapper brought in more crop, and therefore, earned a higher daily wage. By reducing tapping frequency but with increased stimulation intensity using the Guthrie paste technique of stimulation applied to the 1/4 S d/4 (t,t) system, very encouraging yield compared with the 1/2 S d/2 control was obtained. This has resulted in substantial saving in labour as well as higher revenue and wages for the tappers.

Key words: Guthrie paste stimulation; Low frequency tapping; Tapping cost; Yield; Malaysia

167 **Smallholders' experiences in implementing REACTORRIM stimulation system: A case study of Felda Jengka 22**

Mohd.Raffali Mohd. Nor and Ahmad Zarin Mat Tasi

In: *Ensuring Sustainability and Competitiveness of the NR industry: Proceedings of the Rubber Growers' Conference*, 1995, Kuala Lumpur, (Ed. Abdul Aziz S.A. Kadir). RRIM, Malaysia. pp.113-134.

Scarcity of labour, especially that of skilled tappers, is the main problem in the Malaysian NR industry today. One of the methods that does not require skill is puncture tapping. In the earlier method of puncture tapping, where the tree was stimulated by brushing stimulant to a strip of scraped bark, the yield obtained was not attractive enough for adoption on large scale. In 1990, a new method of stimulation was developed and found to be promising for puncture tapping. This method, called REACTORRIM stimulation system, involves the continuous slow-release of a gaseous stimulant to *Hevea* trees. From a probing trial initiated in Felda Jengka 22 in 1991 in a participant's holding, it developed into REACTORRIM Monitored Development Project (RMDP) involving 100 participants by 1993. Feedbacks obtained direct from the participants of the project helped to modify and improve the system further. The most suitable system of puncturing developed from this study was 2PI d/3, *i.e.* two punctures on vertical strip done on third daily frequency. However, the stimulation system which started from gas released from chemical reaction in a reactor bottle was further improved involving gas released from a canister via microvalve. Participating smallholders benefited from the system through increased yield per tapping (puncture), savings in labour and increased economic life of the trees as there was no bark shaving involved. In a study over two years, the average yield per tapping for all participants was around 80 g per tree per tapping for mixed clone, RRIM 600 and GT 1. The average income was around RM2052 per month, with a maximum of upto RM3937. In addition, unlike conventional tapping, majority of the participants attended to their lot alone. Over a period of seven months, a single lady participant who managed her lot alone, had a steady income of RM2000 per month from 1133 trees fixed with REACTORRIM stimulation system. Some smallholders, however, withdrew from the project because of constraints and disadvantages within the system. With continuous improvements, the REACTORRIM stimulation system has the potential to be widely adopted by the NR industry in the near future.

Key words: FELDA; REACTORRIM; Smallholding; Tapping system; Malaysia

168 **The situation, effect and conceivability of Chinese tapping system reform.**

Qing, Zeng and Wencheng, Huang

Meeting of Exploitation and Physiology Special Committee of Chinese Learned Society of Tropical Crops, 1998.

(Cited by Xiaodi, Wei et al. IRRDB Symposium, China,1999)

Key words: Tapping system; China

169 **Socio-economic status and availability of tappers in rubber estates.**

Nancy, C; Supriadi, M and Anwar, C

In: *Proceedings of Indonesian Rubber Conference and IRRDB Symposium* 2000. Bogor-Indonesia, 12-14 September 2000. V.1. pp.182-193.

Since the beginning of estate development in Indonesia, living standard of estate labour has been low. This has caused the difficulty of recruiting estate labour, including tappers in rubber

estates especially in Java and some places in Sumatera where industrial sector has developed. This paper presents the results of a study investigating socio-economic status and availability of tappers in some rubber estates in Southern Sumatera and West Java. The study involved the government and private-owned estates which were selected based on the location and the performance of the estates. The study showed that the welfare level of tappers was different among estates. The tappers in established estates have relatively a better welfare life than the tappers in new estates which are indicated by assets ownership, income level and the percentage of saving. The availability of tappers for the established estates has not been a crucial problem, however, there was a lack of tappers in the isolated new rubber estates and in some estates in West Java in terms of quantity and quality of tappers. Increasing basic wage, improving work condition and implementing alternative tapping systems are some efforts that can be made to solve the problems of tappers shortage in the selected rubber estates.

Key words: Rubber estate; Tapper welfare; Indonesia

170 Some instructions for improving efficiency in tapping (Malayalam)

Sulochanamma, S

Rubber, 318: 1992. 13.

Key words: Tapping efficiency; India

171 A special and localized senescence disease-bark dryness due to over-exploitation and over-drainage

Siwei, Fan; Shaoqiong, Yang

Proceedings of the IRRDB TPD workshop, 26-28 July 1994, South China Academy of Tropical Crops, Hainan, China.

The present paper compares in a static way the contents of antioxidants and total phenols, activity of peroxidase, cathepsin and acid phosphatase as well as lutoid bursting index of latex or bark tissues from *Hevea* rubber trees with dryness of different severity. Based on the findings on these physiological and biochemical changes, the authors suggest that the physiological dryness of *Hevea* due to over-exploitation of latex, is a special and localized senescence malady in nature.

Key words: Over exploitation; Over drainage; Bark dryness

172 Status of exploitation research in India

Vijayakumar, K R; Thomas, K U; Rajagopal, R and Karunaichamy, K

Paper presented at IRRDB Joint Work Shop on Plant Breeding, Agronomy and Socio-Economics, 29 August 2002, Kuala Lumpur, Malaysia.

Country report of India on exploitation research. Extensive experiments were conducted in research farms and estates of planters on low frequency tapping comprising d/3, d/4 and d/7 frequencies tapping with stimulation,. In estates plot size of experiments are one tapping block of 300-400 trees, with 3-4 replications. The experiments conducted for more than 5 years in clones RRII 105, PB 217, GT1 and RRIM 600 showed that 15-30% sustainable yield increase could be achieved under 1/2 S d/3 system of tapping by imposing 3-4 stimulations per year. It was shown that the same yield could be achieved under 1/2 S d/4 6d/7 or 1/2 Sd/6 6d/7 systems of tapping with increased frequencies of stimulation. Complete success of weekly tapping with reduction in land productivity is novel. Weekly tapping was successful in clones RRII 105, PB

26 and PB 235. Under weekly tapping maximum response to stimulation using ethephon was observed between 48 to 72 hours after stimulation. Experiment conducted on panel change showed 20% increase in yield and reduced in incidence of TPD (50% less). Experiment on reduced spiral cut showed that 80% of normal yield could be achieved from 10cm cut with stimulation. There was very little reduction in girthing of trees tapped on reduced spiral cuts. Long term experiment on raingurading showed that stimulation did not have any effect in 1/2 Sd/2 system of tapping and that recovery of crop loss due to rain was not possible. Under 1/2 Sd/3 system of tapping without rainguarding , crop loss was more compared to crop loss under 1/2 S d/2 frequency of tapping. Increased loss could be overcome by stimulation. Recommendations issued by RRII for d/3, d/4 and d/7 frequencies of tapping in different clones are also presented.

Key words: Clonal response; Rainguarding; India

173 **Stimulated tapping system for clone RRIM600 and its physiological status**

Xianzhou, Xiao and Wenxian, Xu

Chinese Journal of Tropical crops, 12(02):1991, 8-16.

Stimulated tapping experiments showed that (s/4, s/4↑) d/2 (m,m) + ET 5% Ga2(-)(m) system on mature RRIM600 buddings gave higher yield and sucrose content in latex with less consumption in both bark and sugar reserve and weaker peroxidase activity. Upward tapping favoured the physiological status of the trees even better. But upward tapping gave lower dry rubber content than downward tapping although not significant. The clonal characteristics of RRIM600 could offer the possibility of sustained higher yield with better safety on periodic short cut upward and downward tapping system with low concentration Ethrel at low application frequency.

Key words: Clonal response; Ethrel; Physiological parameter; Stimulation; Tapping frequency; Yield; China

174 **Stress on scientific tapping (Malayalam)**

Sulochanamma, S

Rubber, 306: 1991. 17.

Key words: Scientific tapping

175 **Studies and application of stimulated exploitation systems for *Hevea brasiliensis* in China**

Xiaodi, Wei; Wenxian, Xu; Xianzhou, Xiao; Shiqiao, Luo and Wencheng, Huang

Paper presented at IRRDB Symposium, Hainan, China, 1999

The research and application of tapping systems with ethephon stimulation for *Hevea brasiliensis* in China were introduced, including the technical conceivability of stimulated tapping systems in China; the characteristic of stimulated tapping systems in China; the physiological effects of trees with stimulation tapping systems; several stimulated tapping systems in research and application, and the effects and experience of application of stimulated tapping systems.

Key words: Ethephon; Stimulation; Tapping system; China

176 Studies on the protective coating for tapping panel against winter cold

Xiaoping, Wu; Xiangdong, He; Juqun, Wu and Zhiyu, Niu

Paper presented at IRRDB Symposium, Hainan, China, 1999.

Many years of large-scale trials of a newly made protective coating for rubber panel against winter cold reveal that it is more effective than the conventionally used protective coatings such as the vegetable oils (rubber seed oil, palm oil, castor oil), waxes (paraffin wax, beeswax) and rosin mixture coating, the petrolatum coating and the wet clay and cattle dung mixture coating. It can not only protect the rubber panel against cold in winter, but also increase rubber yield in the early period of the next year, promote the growth of the regenerated panel bark and the recovery of the dry panel. Application of the new protective coating is convenient , and has not caused any disease in the panel up to now.

Key words: Bark regeneration; Protective coating; Tapping panel; Tapping panel dryness; China

177 A study on physiological adaptability of clone RRIM600 under stimulation with ethephon concentration

Shiqiao, Luo; Wenxian, Xu and Wuming

Yunnan Science and technology of tropical crops, (2):1992, 15-23.

(Cited by Xiaodi, Wei et al. IRRDB Symposium, China,1999)

Key words: Ethephon; Stimulation; China

178 A summary of exploitation trials on stimulated tapping systems for middle-aged trees of clones PR107, GT1 and PB86.

Wenxian, Xu; Leping, Li and Zibin, Lin, *et al.*

Science and Technology of tropical crops, 4:1990. 1-10.

(Cited by Xiaodi, Wei *et al.* IRRDB Symposium, Hainan, China, 1999)

Key words: Clonal response; Stimulation; Tapping system; China

179 A summary on exploitation trials on stimulated tapping systems for middle-aged trees of clone RRIM 600

Wenxian, Xu; Shiqiao, Luo; Boye, Luo *et al.*

Science and Technology of Tropical Crops, 4(3):1994. 7-14.

(Cited by Xiaodi, Wei *et al.* IRRDB Symposium, Hainan, China, 1999)

Key words: Clonal response; Stimulation; Tapping system; China

180 A summary report of study on stimulated tapping for young mature trees of slow starter PR 107 (1985-1994)

Wenxian, Xu; Yanqiu, Fu; Shiqiao, Luo, *et al.*

Research of tropical crops, 4(4):1995. 1-7.

(Cited by Xiaodi, Wei *et al.* IRRDB Symposium, Hainan, China, 1999)

Key words: Clonal response; Stimulation; Tapping system; China

181 Survey of tree dryness on panels BO-1 and BO-2 of clone PB260

Hoong, Chan Weng

The Planter, 72(839):1996, 55-65.

In the study, the incidence of dryness was higher in PB 260 compared to PB217 and GT1. On panel BO-1, mean dryness ranged from 2.1 per cent in the first year to 8.5 per cent in the sixth year of tapping compared with 0.2 to 2.7 per cent in the first and fourth year respectively for PB217. On panel BO-2, the range was 16.0 to 18.6 per cent from the third to sixth year compared with only 8.1 per cent in the third year for GT1. The maximum dryness in individual fields of PB260 however reached 23.5 per cent on panel BO-1 and 44.6 per cent on panel BO-2 which is considered very high. Rainfall pattern and depth of soil strongly influenced the extent of dryness in clone PB260. Tree dryness was highest on shallow soils located in Kedah, Kelantan and Negeri Sembilan where a regular dry season lasting three to four months exists and where moisture deficits are most likely to occur. On the other hand, low incidence of dryness was observed on deep soils located in Perak, Selangor, Pahang and Johor where climatic conditions are more favourable and moisture deficits are more likely to be less severe or even absent. Tree dryness more than 10 per cent on panel BO-1 and 15 per cent on panel BO-2 is considered high. All areas except deep soils in the states of Perak, Selangor, Pahang and Johor have exceeded the above figures. The remedial measures proposed to minimize tree dryness include reduction in tapping intensity and increasing the stand per hectare for locations with high propensity to tree dryness.

Key words: Decreased tapping intensity; Soil type; Tree dryness; Malaysia

182 Systems of low-frequency tapping with the use of a stimulant in rubber plantations in Mato Grosso State

Rondon, E V; Santos, A M DOS; Silva, D DA; De Souza, C A F; Vital, A R and Abreu, J G DE

Pesquisa Agropecuaria Brasileira, 32(1):1997. 51-56.

(Horticultural Abstracts 11000: 1997)

In trials from September 1989 to December 1993, trees in 8-year-old stands of rubber clones IAN 873 and IAN 717 at 2 sites in Mato Grosso, Brazil were tapped on virgin bark 1.5 m above ground level at intervals of 2, 3, 4 or 7 days and were treated with the stimulant Ethrel [ethephon] at 2.5% at a rate of 1 ml solution/tree, 4, 6, 8 or 10 times annually, 3 days before tapping. Tapping at intervals of 4 or 7 days and stimulation 10 times/year gave the highest latex yields. Although IAN 717 was more prone to drying-out of the panel of bark, this clone produced significantly more dry rubber (1.29 t/ha per year) than clone IAB 873 (0.58 t) under the same conditions of production.

Key words: Ethephon; Low frequency tapping; Stimulation; Yield; Brazil

183 Tapping

Vijayakumar, K R; Thomas, K U and Rajagopal, R

In: *Natural Rubber: Agromanagement and Crop Processing* (Eds. P.J.George and C. Kuruvilla Jacob). Rubber Research Institute of India, Kottayam, 2000. pp.215-238.

Key words: Controlled upward tapping; Puncture tapping; Rainguarding; Stimulation; Tapping efficiency; India

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Key words: Clonal response; Stimulation; Tapping system; China

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Key words: Controlled upward tapping; Puncture tapping; Rainguarding; Stimulation; Tapping efficiency; India

184 Tapping aids to enhance productivity and reduce labour cost.

Said, Mohd Akbar and Hashim, Ismail

Proceedings of the Workshop on Exploitation Technologies to Address Current Labour Problems in the Rubber Industry, 5-6 December 1994, Kuala Lumpur, pp.131-139.

The Malaysian natural rubber industry is experiencing a shortage of labour in the plantation sector. This, coupled with the cumbersome traditional methods of crop collection and the effect of weather, primarily rain interference on tapping operations, has caused to intensify research and development activities by the Rubber Research Institute of Malaysia (RRIM) on tapping and its related gadgets. These gadgets serve as preventive measures to avoid loss of crops due to rain and to minimise labour requirement in crop production. Other aspects on development of suitable tapping knives for controlled upward tapping (CUT) have also resulted in the acceptance of CUT by the industry. The search for an effective device to alleviate the problem of crop loss due to rain was initiated in the sixties, and until the early eighties, several types of rainguard were developed using gutter and eaves concepts. Earlier studies in different regions of Peninsular Malaysia using both these methods shoed that additional yields were recovered. However, the extent of rainguard usage by the industry much depends upon the prevailing rubber price and profit margin obtained from the tapping days which would otherwise have been lost due to rain interference. The concept of less labour-intensive collection system (LELICS) was introduced by RRIM in the eighties. Polybag collection was used mainly in labour-shortage areas and also in areas where production of latex was not profitable due to poor transportation system. However, disposing off the plastic bags became a problem in these areas. In the early nineties, RRIM introduced RRIMCUP as an alternative to polybag collection. It comprises a 2.5 liter latex collection cup, RRIMCAP, a modified spring and stabiliser. Both the estates and the smallholdings used to-date more than 50,000 sets of RRIMCUP. Although both the systems are similar in terms of merits, in the long run, RRIMCUP is more economical as it is reusable and hence eliminates pollution problem. RRIMCAP is a device designed for protecting latex against contamination by direct rainfall. Used for 1.2 and 2.5 liter latex collection cups, it was first designed with a permanent minicup attached to the cap with a 4 mm diameter aperture. As modern methods of exploiting *Hevea* trees with high yielding clones resulted in a longer latex flow time than the conventional tapping systems, its aperture had to be widened to avoid latex spillage from the minicup. With the problem of rain interference and the current layout shortage, planters and smallholders are advised to adopt appropriate tapping aids that enhance productivity with less labour requirement for practical and economic reasons. Rainguard and RRIMCAP are devices designed to avoid crop washout due to rain. LELICS with polybag collection and RRIMCUP are useful to reduce the frequency of crop collection and labour requirement. Use of these devices would be more economical when combined with labour-saving technologies such as enlarged task, division of labour as well as low-frequency tapping systems.

Key words: LELICS; Labour cost reduction; RRIMCAP; RRIMCUP; Tapping aids; Malaysia

185 Tapping of *Hevea brasiliensis*

Abraham, P D

In: *Natural Rubber: Biology, Cultivation and Technology* (Eds. M.R. Sethuraj and N.M. Mathew). Elsevier publishers, Amsterdam, 1992. pp.263-281.

Key words: Tapping system; Stimulation

186 Tapping panel dryness in *Hevea brasiliensis*

Jacob, J L; Prevot, J C and Lacrotte, R

Plantations, Recherche, Developpement, 01(3): 1994. 22-24.

The total or partial absence of latex flow, or tapping panel dryness, in *Hevea brasiliensis*, may or may not be combined with necrosis. If there is none, it is usually a case of laticifer fatigue and tapping can be resumed after a rest period. Necrotic tapping panel dryness is a serious histological, cytological and metabolic disruption, which causes considerable disorganization of the entire secondary phloem and spreads in all directions. This is caused by disease types of stresses and is usually irreversible.

Key words: Tapping panel dryness; France

187 Tapping panel dryness on upward tapping

Lukman

Proceedings of the IRRDB joint meeting Breeders, Pathology and Physiology and Exploitation Groups, 27-28 October 1992, Jakarta, pp.68-71.

Rubber planters tend to apply high intensity exploitation systems to achieve high production targets and, as a result, occurrences of bark dryness increase. Observations on nine estates which used upward tapping combined with change -over panel indicated a high percentage of Tapping Panel Dryness (TPD). In this paper, the reasons for incidences of TPD are discussed in the light of these observations.

Key words: Tapping panel dryness; Tee fatigue; Upward tapping; Indonesia

188 Tapping, Processing, Marketing

In: *Rubber: A Pictorial technical guide for smallholders* (By, Michel A Delabarre and Dante A. Benigno). CIRAD-CP; France, 1994. pp. 117-139.

Key words: Tapping groove; Upward tapping; France

189 Tapping stimulation on the BO-1 panel of several recommended rubber clones

Junaidi, Untung; Tjasadihardja, A; Kuswanhadi and Thomas

Proceedings of IRRDB symposium: Physiology and Exploitation of Hevea brasiliensis, 6-7 October, 1990, Kunming, China. pp.69-82.

The aims of using stimulants in rubber tapping are to reduce the cost of exploitation, to reduce bark consumption and to increase profit. This trial investigated the response of a number of recommended clones to a stimulant and studied the effects, in the long term, on yield and growth. The trial was arranged in a randomized block design with three treatments and four replications. The clones used were GT1, PR 255, PR 261, and PR 300 and the stimulant was Ethrel 2.5 LS. The experimental results show that stimulation increased the yield of all of the clones especially in the first and second year of tapping but not beyond the third. Growth, drc and bark dryness were not significantly different between treatments whilst bark consumption of stimulated trees was lower than bark consumption of non-stimulated trees.

Key words: Bark consumption; Clonal response; Exploitation cost; Stimulation; Yield; Indonesia

190 Tapping systems recommended in West Africa

Gohet, E; Lacrotte, R; Obouayeba, S and Commere, J

In: *Towards Greater Viability of the Natural Rubber Industry: Proceedings of the Rubber Research Institute of Malaysia Rubber Growers' Conference,* (Ed. Abdul Aziz S.A. Kadir). RRIM, Malaysia, 1991. pp.235-254.

The tapping system recommended by IRCA for estates in West Africa is a downward half-spiral tapped three times every two weeks (1/2 S d/4 6d/7) with the possibility of changing to an upward quarter-spiral (1/4S 1 d/4 6d/7) after a minimum of ten years of tapping the lower panel. Physiological studies on the metabolism of laticiferous production have been in progress in Cote d'Ivoire and Cameroon in different tapping trials and also in commercial estates. Based on the physiological interpretation of the results of the 'latex diagnosis' (LD), an analytical tool designed and developed by IRCA to draw up a physiological balance for a producing tree whenever required, the studies have led to drawing up a clonal typology of metabolic functioning. Distinction is made between three categories of trees:1.Clones with slow metabolisms (AVROS 2037, R 261, etc); 2. Clones with intermediate metabolisms (GT 1, PR 107, RRIM 600, etc.); 3. Clones with active metabolisms (PB 235, PB 260, PB 5/1, etc.). IRCA uses the results of the latex diagnosis, whose principle is described in this article, to propose different stimulation mode (frequency of application, concentration of active ingredient in the paste) for each clone category according to the number of years of tapping. Likewise, preliminary observations indicate that it may be possible to define panel management suited to each class.

Key words: Clonal typology; Latex diagnosis; Stimulation; Tapping frequency; Tapping system; West Africa

191 Technical and economic evaluation of early use of CUT on commercial scale: A case study

AuYong, S F; Nayagam, James and Arshad, Najib Lotfy

In: *Towards Greater Viability of the Natural Rubber Industry: Proceedings of the Rubber Research Institute of Malaysia Rubber Growers' Conference,* (Ed. Abdul Aziz S.A. Kadir). RRIM, Malaysia, 1991. pp.213-225.

This paper discusses the technical and economic aspects of early utilisation of CUT (after completion of Panel BO-2 tapping) on large scale in fields of RRIM 600, RRIM 623 and RRIM628 clones which have been subjected to continuous stimulation of 10% concentration at height to nine rounds per year after the fourth year of tapping, and on d/3 frequency since opening for tapping. The field data showed that, with early CUT on 1/4S d/3 system, management was able to tap about eleven years on the high panels (Panels HO-1 to HO-4). CUT commenced on each of the high panels at an average angle of 32 to 33 degr ee and progressively increased to 42 and 48 on completion of tapping of the panels. The amount of bark consumed ranged from 3 cm to 4 cm per month. With the introduction of early stimulated CUT, there was a marked increase in yields (g/tree/Tapping) of about 54% during the first year. However, as CUT proceeded, the rate of yield increase continuously dropped to 13% in the fifth year, and then to negative yield response during the next five years; 1% to 17% lower than the average yields of Panel BO-2. Computation of the return to investment based on the production of the fields with RRIM 600 clones over the first twenty years of tapping indicated a comparatively high internal rate of return (IRR) of about 18.9% at average RSS 1 f.o.b. price of 230 sen/kg.

Since this estate had all its fields on early CUT, it was not possible to compare its economic performance with that of late CUT (after Panel BI-1 tapping) and conventional tapping (continuous basal tapping) under similar high stimulation. However, in two neighbouring estates where late CUT on 1/4 S d/3 and conventional basal tapping on 1/2 S d/2 were used with fairly conservative stimulation of 5% at five to nine rounds per year depending on the age of the trees, the IRR obtained for RRIM 600 clones for the same period and price was comparatively lower-approximately 15.6% and 16.0%respectively. Since the fields concerned were on d/3 frequency from the time of opening the trees for tapping, there was a reduction in tapper requirement by about 30 compared to conventional d/2 practices. Besides this benefit, the early use of CUT also allowed more time for comparatively better renewal of basal panels. It also enabled the basal panel brown bast trees to be brought into production on the high panel for some time.

Key words: Economic performance; Controlled upward tapping; Labour cost reduction; Panel change; Yield; Malaysia

192 To increase yield of smallholder rubber by application of appropriate exploitation system

Lukman

Indonesian Journal of Natural Rubber Research 13(3): 1995. 208-211.

A small part of smallholder rubber area has already used recommended planting materials and applied right planting method especially those involved in the development of smallholder rubber project. However, the tapping application is often too intensive with too bad tapping quality. Consequently, the yield declines and the economic life of the trees becomes shorter. To improve the above condition, an experiment on exploitation was carried out to find out an appropriate exploitation system to increase yield and lengthen the economic life of smallholder rubber. The results of a three-year experiment in smallholder rubber area using GT1 seedling as planting materials which was planted, managed and regularly manured showed that exploitation systems : 1/3S d/2.ET2.5%GaO.5.20/y(2w) and 1/4 S d/2(t, t).ET5.0%.Ga0.5.20/y(2w) could increase the yield significantly ($P \leq 0.01$) i.e. 25-29% and the economic life of the trees could be lengthened around 50-100% above the 1/2 S d/2 control. Exploitation treatments did not influence the dry rubber content of latex and did not depress the growth of the rubber trees. To increase yield and lengthen the economic life of smallholder rubber using GT 1 seedling, planted in regular distance, well managed and manure, it is suggested to apply the exploitation system: 1/4S d/2(t,t).ET5.0.Ga0.5.20/y(w) or 1/3 S d/2.ET2.5.Ga0.5.20/y(2w).

Key words: Smallholding; Yield; Indonesia

193 'Topping' of rubber trees for study of the mechanism involved in latex production

Serres, E; Clement-Vidal, A; Prevot, J C; Lacrotte, R and Jacob, J L

Proceedings of IRRDB symposium: Physiology and Exploitation of Hevea brasiliensis, 6-7 October 1990, Kunming, China. pp.59-68.

A comparison of different latex parameters - pH, mineral ion content, sucrose, R-SH, cytosolic organic acids and yield has been carried out on a group of control trees and a group of 'topped' (i.e. headless) trees, in two clones (PR 107 and GT1) over several months. Topping has the effect of drastically reducing latex production in topped - TSC is greatly diminished, a sign of

dysfunctioning of the latex regeneration process. Sucrose content is not a limiting factor, implying its production from a hydrocarbon storage pool in the exploited panel in the bark of the wood. It is also possible to observe as in the control trees, an increasing glucidic content at the 'leaf fall - refoliation period. This change may be linked with the annual endogenous rhythm of the rubber tree. -pH, bursting index and Pi content are not or are only slightly affected, R-SH and Fe contents decrease significantly whilst K, Ca and S contents show positive increase. Osmolarity values are reduced. Analysis of cytosolic organic acids shows that the glucidic catabolism is diverted to citrate and malate synthesis at the expense of the pyruvic pathway leading to rubber synthesis. It seems also that the biochemical energy producing pathways (*i.e.* Krebs cycle) are depressed. These results are dicussed in the context of a general scheme of biochemical processes in laticiferous vessels.

Key words: Cytosolic latex production; Osmolarity; Sucrose; Thiols; Cote d' Ivoire

194 TPD control on several recommended *Hevea* clones

Budiman, Arief and Kuswanhadi

Risalah seminar hasil penelitian Balai Penelitian Sembawa tahun 1992/1993: 81-89.

(Abstrak Hasil penelitian- Balai Penelitian Sembawa 1982-2002. No. 82)

This trial was aimed to study in tapping panel dryness control for recommended *hevea* clones by bark removing and painting of CPO and fungicide mixtures. The trial was arranged according to randomized block design with 2 factors and 3 replications. The first factor were 6 kinds of *Hevea* clones (PR 303, PR 300, BPM 1, AVROS 2037, RRIM 600 and GT 1), whilst the second factor were 3 kinds of fungicide (benomyl, mancozeb and captafol). Each plot consist of 30 trees. The result showed that mixture of CPO with fungicide could decrease TPD intensity showed by percentage of relative recovery index, which was differ among *Hevea* clones. The another significant difference were the effect to renewed bark thickness and latex volume. Further observation was needed to know some condition which caused the increasing of TPD symptoms.

Key words: Clonal response; Tapping Panel Dryness; TPD control: Indonesia

195 Upward tapping system as an alternative to downward tapping system on recommended *Hevea* clones

Junaidi, Untung and Kuswanhadi

Jurnal Penelitian Karet. Indonesia, 15(1): 1997. 1-12.

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Upward tapping system (UT) is assumed to have some advantages when compared with downward tapping system (DT). By UT, the relation between crown and tapping panel could be maintained so that the process of latex regeneration would be better. Thus the possibility of tapping panel dryness (TPD) incidence could be minimized and latex flow area would widen, so that the yield would be higher and the response to stimulation would increase. A research on upward tapping system was conducted on various *Hevea* clones at Sembawa Research Station, South Sumatra. This experiment was aimed to study the response of recommended clones to upward tapping system and to get advantageous exploitation system. The experiments consisted of six upward tapping systems and two downward tapping system as control. The result showed that the upward tapping system on BPM 1 with 1/3S d/3, ET2.5% gave effects to yield, TPD and girth increment comparable with the downward tapping system of 1/2 S d/3.ET2.5%. While on PR 255 comparable with the downward tapping system of 1/2 S d/3.Ft2.5% was comparable to

the control. But bark consumption of upward tapping with 1/2 S was higher and the intensity of TPD incidence increased. The upward tapping systems of 1/3S d/3.ET2.5% could be applied as an alternative to downward tapping systems of 1/2 S d/3.ET.5% on BPM 1. While on PR 255 and PR 261, the upward tapping systems of 1/4 S d/3.ET2.5% was the alternative.

Key words: Clonal response; Tapping system; Upward tapping; Indonesia

196 **Use stimulants in September (Malayalam)**

Thomas, K U

Rubber, 317: 1992. 23-24

Key words: Stimulant; India

197 **Yield decline in plantations - Can excessive double tapping be a cause?**

Nugawela, A

Bulletin of the Rubber Research Institute of Sri Lanka 38:1998. 43-49.

Key words: Yield decline; Sri Lanka

198 **Yield performance and Tapping Panel Dryness (TPD) in RRII 105 under different intensities of exploitation**

Sulochanamma, S; Vijayakumar, K R; Rajasekharan, P; Thomas, K U and Sethuraj, M R

Journal of Plantation Crops, 21 (*Supplement): Proceedings of the Placrosym X*, 1992, Kasaragod, (Eds. M.K. Nair et al). Indian Society of Plantation Crops, Kasaragod, India. pp.342-345.

The yield of rubber (*Hevea brasiliensis*) depends on the duration of flow at tapping and on the regeneration of latex between two tappings. Tapping panel dryness (TPD), a physiological disorder increases with tapping intensity and frequency. However, this incidence might be reduced by changing tapping system without much reduction in net profit. The common tapping system used for budded rubber tree is half spiral alternate daily tapping (1/2 S d/2 6d/7). In this study half spiral third daily tapping and quarter spiral change over system was evaluated in comparison to conventional 1/2 S d/2 system for a period of six years. The yield was maximum under 1/2 S d/2 followed by 1/2s d/3 and 2x1/4d/2 change over system. The yield difference between 1/2 S d/2 and 1/2 S d/3 systems narrowed down in fifth year and by sixth year 1/2 S d/3 out yielded 1/2 S d/2. Incidence of TPD was much low under d/3 tapping system. The discounted farm business income is more for 1/2 S d/2 6d/7 over a period of six years, even though the return is more for d/3 in the fifth and sixth year. Thus, half spiral third daily tapping system with weekly one day rest can be employed for RRII 105 with a view to reduce tapping panel dryness.

Key words: Profitability; Tapping system; Yield; India

199 **Yield potential for the clones PB 235 and PB 217 tapped with 1/2 S d/4 6d/7 for the first three years after opening in the South East of Cote d'Ivoire**

Commere, J; Serres, E and Lacrotte, R

Physiology and Exploitation of Hevea brasiliensis: Proceedings of IRRDB Symposium, 6-7 October 1990, Kunming, China. pp.93-102.

The clones PB 235 and PB 217 have different metabolic activities for the same tapping system. The paper reports on studies in the South East of Cote d'Ivoire of these two clones over the

three years following opening and on the effect of increased stimulation using the tapping system 1/2S, d/4 6d/7. Study of the parameters of girth changes, physiology of latex and of degree of bark dryness make it possible to determine the optimal production rate of those two clones without compromising the evolution of the trees.

Key words: Clonal response; Physiological parameter; Stimulation; Tapping stimulation; Cote d'Ivoire

200 Yield Stimulation in rubber: Current status and improvements for enhanced productivity

Sivakumaran, S and Kewi, Chong

In : Management for enhanced profitability in plantations : Proceedings of the 1994 *International Planters Conference*, Kuala Lumpur, (Ed. Chee Kheng Hoy). The Incorporated Society of Planters, Malaysia, 1994. pp.369-408.

This paper addresses issues raised and puts in perspective various aspects related to yield stimulation of *Hevea*. The limitations associated with the lacelgroove and scraped bark methods are assessed in relation to their effectiveness and in particular aspects associated with ethephon uptake and hydrolysis in the bark tissues. Data are presented to support possible improvements that can be adopted to enhance effectiveness and consequently yield responses. These include increased frequency with split-panel fortnightly application or combination of groove and scrapped bark methods at monthly intervals. It is shown that gaseous ethylene application either directly (*e.g.* RRIMFLOW system) or indirectly from hydrolysis of ethephon carried out externally to the trees (*e.g.* jacket system) are superior to that of ethephon application. However, there is an inverse relationship between amount of ethylene required for effective response and number of latex vessels cut at each tapping. Data available shows that novel tapping systems such as single puncture, mini-cuts or one-eight cuts require direct ethylene application for effective yield response irrespective of clones and age of materials. The indirect methods of gaseous ethylene application from chemical hydrolysis of ethephon (jacket system) are only adequate for quarter or half- spiral cuts tapped on normal frequencies. Time-course studies on ethylene release from stimulant mixtures used in the jacket system, both in the field and laboratory indicate that effectiveness of this system is affected by the reduced frequency of chemical application. The IOI patch method in the absence of a base (*e.g.* diammonium phosphate) in the formulation has not been very effective when compared to other techniques irrespective of tapping systems. The above findings are rationalized in relation to fundamentals governing yield stimulation in *Hevea*. The RRIMFLOW mini-cut and short-cut system (2.5 cmS d/3 d/4 or 1/8DS d/3 d/4) with ethylene application weekly in combination with enlarged task sizes are shown to be promising for tackling shortage of tappers (2.5 cmS d/3 d/4) and maximisation of crop extraction (1/8S d/3 d/4). It has been shown that yield responses of several clones of varying ages to these systems are promising though in certain clones the yield advantage when compared to CUT system (1/4 ST d/2 plus ethephon) has been marginal. Economic analysis of two trials shows higher ex-estate profitability despite current initial high cost for RRIMFLOW materials. The prevailing weaknesses of the system are identified with requirement for further improvements and the need to reduce material costs for greater viability. The potentials of these systems in meeting the rapidly changing demands of the rubber industry are indicated.

Key words: RRIMFLOW; Stimulation; Yield; Malaysia

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