A LOW FREQUENCY HARVESTING SYSTEM EXCLUSIVELY FOR SMALLHOLDER RUBBER GROWERS BEING EMPLOYED OFF-FARM

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Abstract

A system in which rubber trees could be harvested on weekly basis was developed enabling smallholders in Sri Lanka (having less than 1 ha of rubber) to use own labour for rubber tapping during weekend holidays. Latex harvesting is undertaken here on two consecutive days per week with the application of 2% ethephon biweekly (S/2 d1 2d7 2% ET every two weeks). This system provides a comparable yield to what given by the traditional S/2 d2 system. As per the biochemical and physiological parameters of latex, no indication on stress factors was evident. When compared to traditional S/2 d2 harvesting, the new system was able to reduce the cost of production by LKR 135/= per kg of rubber and thereby increasing the profit margin by LKR 274,448/= per hectare per year due to the use of own labour in latex harvesting. Just one day tapping per week is also possible with the application ethephon 5% monthly, should 5% yield decline be acceptable in lieu of saving the tapping cost incurred in hired labour.

Keywords : ethephon, Hevea, *leisure, socioeconomics, weekend harvesting*

INTRODUCTION

Financial worthiness of rubber cultivation depends mainly on latex harvesting not only because it brings the income but also does it contribute to highest portion of the cost of production (COP). Latex harvesting is rather labour intensive resulting in such contribution to COP. Further, working on rubber estates is not attractive enough; hence, availability of latex harvesters for new recruitments and retaining them continuously on-farm have also been problematic. Typical smallholder farmers may cope with these issues with own labour whilst well-established management systems facilitate large scale plantation companies to deal with such problems. Nevertheless, smallholder rubber growers who are being employed off-farm and manage the rubber lands with hired labour, have been the worst affected category from the above mentioned issues. They are the majority growing rubber in the traditional rubber growing areas. Lands have either been inherited to them from ancestors or bought with the earnings from other economic ventures.

Therefore in such instances, growers tend to hire workers for on-farm activities instead of own labour.

Low intensity harvesting (LIH) systems ease the tapping related issues to some extent by reducing the number of latex harvesters required per unit land area, reducing the cost of tapping and motivating latex harvesters to be in this profession with increased wages. Therefore as practiced elsewhere, tapping rubber trees once in three days (Nugawela *et al.* 2000; Rodrigo, 2007) and once in four days (Rodrigo *et al.*, 2011) is recommended in Sri Lanka. Although such LIH systems are adopted by large scale estates, its use in smallholder sector is very limited since need of hired workers for latex harvesting is still in demand even in these systems. Despite the intention of reducing the cost with the adoption of LIH and having limited extent of lands, some smallholder rubber growers tend to adopt high intensity harvesting systems to retain latex harvesters within their rubber lands by providing continuous daily wages. High intensity harvesting systems affect tree health reducing the yielding capacity (Jacob *et al.*, 1989). Therefore, this has formed an interconnected double sided vicious cycle. On one hand, high intensity harvesting leads to low productivity in long run and it tempts rubber growers to increase the harvesting intensity further with an ultimate result of continuous decline in yields. On other hand, lack of harvesters results in high intensity harvesting in smallholdings leading to low productivity which in turn provides poor wages resulting in less people joining to this profession. Land size distribution in the smallholder sector shows that 44.7% of lands are below 02 acres (Anon, 2015). If owners of such lands are employed off-farm, it is mandatory for them to hire latex harvesters in above manner. In particular, latex harvesting is to be done early morning for high yields and therefore, such farmers could utilize their leisure time for other farm activities but not for latex harvesting.

Having understood the needs of the above said farmer category, i.e. farmers who are employed off-farm and have a rubber land less than one hectare with hired labour for latex harvesting, the present study was aimed to develop a harvesting system in which farmers could use their own labour for latex harvesting. In off-farm employments, weekends are generally free and therefore, a harvesting system which enables to utilize the leisure time in weekends in latex harvesting was attempted.

MATERIAL AND METHOD

In general, farmers prefer not to reduce the yields in adopting new harvesting systems. Therefore in developing a weekend harvesting system, no decline in overall yield was expected; hence, yield per tree per tapping (GTT) had to be increased to compensate the reduction in harvesting frequency. In doing so, latex physiological parameters were monitored to assure the maintenance of tree health.

A field experiment was set up in Kuruwita Substation (KSS) of the Rubber Research Institute of Sri Lanka (RRISL) situated in the low country wet zone of Sri Lanka. Latitudes and longitudes are $6^{o}30'$-$7^{o}00'$N and $80^{o}00'$-$80^{o}30'$E, respectively. The soil was acidic (pH 4.8) and belonged to the order Ultisol. Rubber trees, genotype RRIC 121, planted in 2001 and tapped on BO-I panel in second year was used for the study. Experiment was conducted in several steps and at the beginning, trees were tapped once a week with monthly application of ethephon of which a concentration of 2.5% was applied initially and then increased up to 3.3% and subsequently to 5%. Once a week tapping was tested in 3 plots each having about 100 trees. In parallel, traditional system of half spiral once in two day tapping (S2 d2) was practiced without any ethephon stimulation in the same field in three plots for comparison. Since monthly application of ethephon was not sufficient in the weekly harvesting system to provide a comparable yield to that given by S/2 d2, stimulation frequency was increased to once a week with 2.5% ethephon. As failing to achieve the expect yield level, tapping frequency was changed to two consecutive tapping per week with 5% ethephon applied in two weeks interval. Productivity level under this system was significantly higher with comparatively lower dry rubber content in latex, hence strength of stimulant was reduced to 2.5% with same application frequency. Even with this stimulation level yield level achieved was significantly higher than the expected yield level, therefore stimulation level was further reduced to 2.0% in every two weeks interval without affecting the latex physiological parameters. This system has been further tested on commercial basis since 2015.

Standard methods were used in assessing the physiological parameters of latex namely, pH (Jenway 3051, Jenway Co., UK), sucrose (Scott & Melvin, 1953), thiol (Boyne & Ellman, 1972) and inorganic phosphorous (Taussky & Shorr, 1953). Incidence of tapping panel dryness (TPD) was also monitored visually along with the development of weekend harvesting system.

The amount of latex harvested was assessed in terms of percentage of dry rubber content (% DRC) and yield per tree per tapping (GTT). The intake per harvester (IPH) and the yield per tree per annum (YPT) were derived by multiplying the GTT with the standard number of trees per tapping block (i.e. 300) and the actual number of tapping days in a year for the particular harvesting frequency, respectively. Total number of tapping days per tree for a year was in the range of 156 - 165 for the traditional S/2 d2, 50 – 52 for once a week tapping and 92 – 94 for two consecutive tapping per week. Yield per hectare per annum (YPH) was estimated with the knowledge of YPT and tree density per hectare (400 trees/hectare).

Data analyses were rather descriptive and mean values were derived with Standard Error. Considering the local applicability and importance, the financial analysis was performed in Sri Lankan rupees (conversion rate: US$ 1 = LKR 155). The tapping cost in S/2 d2 was based on the standard daily wage of a general workers in Sri Lanka (Rs. 800/=); however with the possibility of using own labour in weekly tapping system, an option of no labour cost for tapping was also considered. Nevertheless, ethephon application cost (chemical cost) was included in the weekend harvesting system. In addition to the tapping related costs, cost components on mature area upkeep and manufacturing which remain unchanged across the harvesting systems, were included in the estimation of overall cost of production (COP).

RESULT AND DISCUSSION

As shown in the figure 1, monthly application of ethephon up to 5% in once a week harvesting system was not sufficient to provide a comparable yield level to that given by the traditional every other day tapping (S/2 d2). At 2.5% ethephon, over 10% yield drop was recorded and the yield drop narrowed down to ca. 5 % with 3.3% and 5% ethephon. Even with weekly application of 2.5% ethephon, the yield level given by S/2 d2 system could not be achieved again with ca. 5% yield difference (Fig. 1) and also dry rubber content of latex was reduced to 31% (Fig 2).

However, tapping a tree for two consecutive days per week (S/2 d1 2d7) with biweekly application of 5% ethephon has given ca. 19% higher yield than the traditional S/2 d2 system (Fig. 1). Therefore, ethephon concentration applied was reduced to 2.5% with ca. 12% yield increase and ultimately to 2.0% which was able to provide a slightly higher (ca.

5%) yield over the S/2 d2 system. In India, monthly application of 2.5% ethephon was sufficient in once a week tapping system to deliver the required level of latex yield (Rajagopal, 2002). This system was not applicable in Sri Lanka demanding two tappings per week with higher dose of ethephon. The clone tested in India has been RRII 105 of which the recommended harvesting frequency without stimulation is once in three day tapping whilst the recommended harvesting frequency without stimulation of the clones used in the present study is once in two days. This indicates the comparatively low level of latex metabolism in the clones tested with less response to ethephon (Thanh and Thuy, 2003).

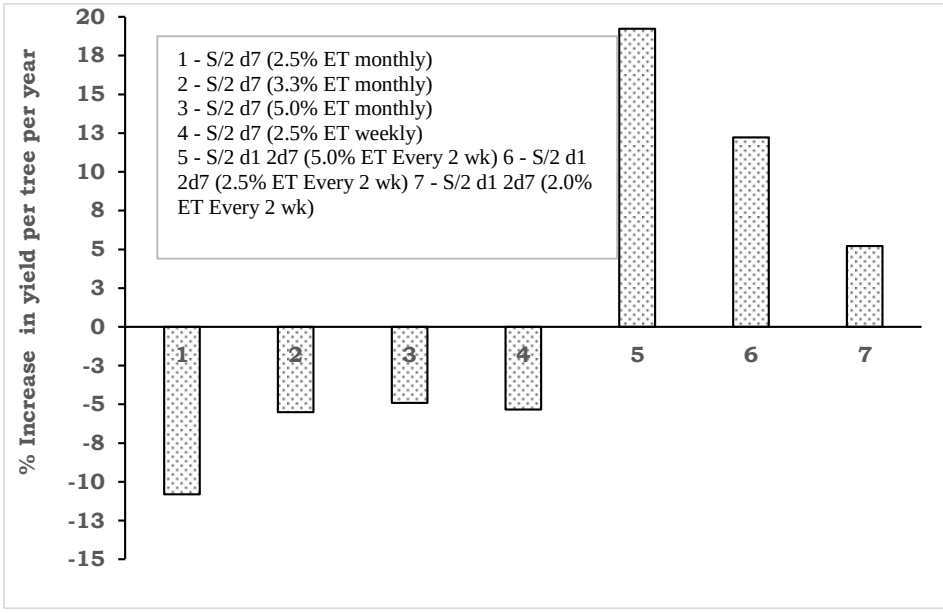

Figure 1. Deviations observed in the development process of the yield per tree per year (YPT) of weekend harvesting from the traditional S/2 d2 harvesting

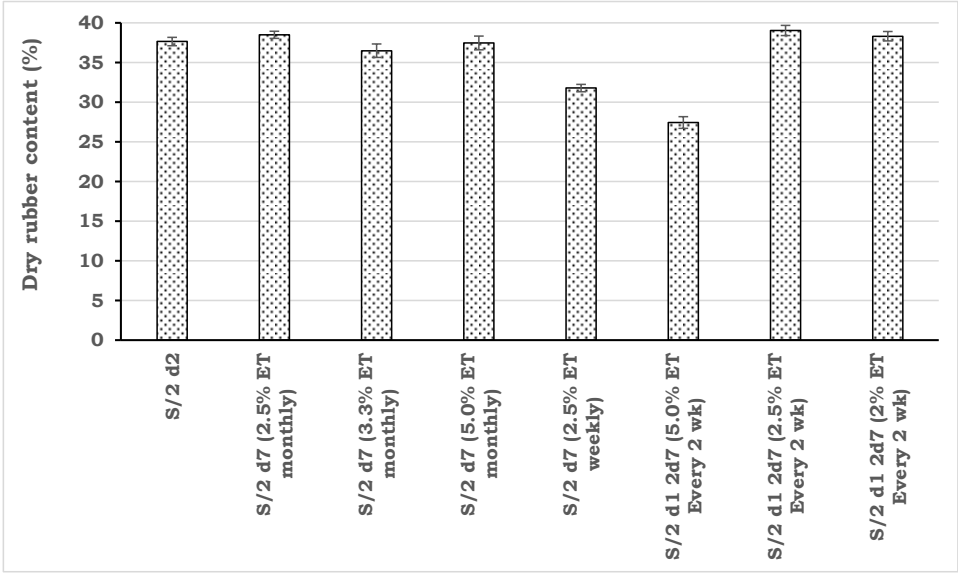

Figure 2. Average dry rubber content in latex (%) under the different weekend harvesting systems tested

Dry rubber content (%DRC) in latex has been above 35% throughout the testing of different tapping systems except for S/2 d7 and S/2 d1 2d7, respectively with weekly and biweekly application of 2.5% and 5.0% ethephon (Fig. 2). However, with reduction of ethephon level 2.5% biweekly, dry rubber content of latex (%DRC) had increased to 39% and with further reduction to 2.0% ethephon, %DRC remained more or less same (Fig. 2). This indicates the level of safety in the stimulation protocol adopted in the finally developed weekend harvesting system. In general, if the tree is under stress due to over exploitation of latex, then %DRC and sucrose levels should tend to decline due to the difficulty in sustaining the increase in demand for latex synthesis (Jacob *et al.*, 1988). No such effect was observed in the present study with comparable levels of both sucrose and thiol in latex between those of the traditional S/2 d2 and finally developed weekend harvesting systems (Table 1). Similar findings have been recorded in Côte d'Ivoire with different genotypes of rubber (Obouayeba *et al*., 2011). Total solid content in latex was also comparable (Table 1) further confirming the safety level of ethephon stimulation in the newly developed weekend harvesting system.

Inorganic phosphorous in latex tended to be higher in the finally developed weekend harvesting system (Table 1). This indicates the increased level of energy (ATP/NADP) for latex synthesis in the new

system (Jacob *et al*., 1989) since more latex is to be extracted on each tapping day.

Higher Initial flow rate and less plugging index were recorded in the newly developed weekend harvesting system than in the traditional S/2 d2 system (Table 1). This could be attributed to longer lapse between two harvestings and the use of ethephon (Jacob *et al.*, 1989) resulting in higher yield per each tapping.

Table 1. Physiological parameters of latex in the finally developed weekend harvesting system; a comparison with traditional S/2 d2 system

Harvesting systems	Sucrose (mM)	Thiols (mM)	Pi (mM)	Initial flow rate (ml/minute)	PI	%TSC
S/2 d2	12.82	0.46	13.70	3.29	4.86	39.67
S/2 d1 2d7	15.77	0.60	26.22	5.15	3.25	41.33

Yield parameters in the commercial scale testing of the newly developed weekend harvesting system show the potential of introducing this system to smallholder farmers. Ultimate yield in terms of yield per tree per year and yield per hectare and dry rubber content in latex were comparable with those of the traditional S/2 d2 system with over 75% higher values for yield per tree per tapping and intake per harvester (Table 2). Out of 52 weeks in the year, it has been able to undertake harvesting in 47 weeks in the newly developed weekend harvesting system, i.e. ca. 90% from the potential. In the case of the traditional S/2 d2 system, 87% of potential tapping days has been achieved, i.e. 3% less compared to the newly developed weekend harvesting system. This shows practicality in adhering to the new harvesting system.

Table 2. Yield performance of S/2 d1 2d/7 low intensity system with ethephon stimulation at commercial scale; a comparison with traditional S/2 d2 system.

Tapping system	Actual tapping days	DRC (%)	GTT (g)	IPH (kg)	YPT (kg)	YPH (kg)
S/2 d2	159	37.67	29.56	8.86	4.70	1880
S/2 d1 2d/7	93	38.33	52.23	15.65	4.84	1943

Cost benefit analyses shows that the worthiness of the newly developed weekend harvesting system for the smallholder sector (Table 3, Fig. 3). As stated in the objectives, this study aimed to develop a harvesting system where smallholders themselves could attend to tapping instead of using hired labour as in the present S/2 d2 system. In such

situation, over LKR 105/= per kilogram of rubber can be saved from harvesting cost with total reduction of LKR 135/= in cost of production (COP). On hectare basis, LKR 253,658/= per year could be saved. Therefore, both overall profit per kilogram of rubber and per hectare per year increases by 74% and 80%, respectively. Even with hired labour, the weekend harvesting system was able to increase the profit by 22% per kilogram and 26% per hectare (Table 3, Fig. 3).

Table 3. Cost benefit analyses of S/2 d2 and S/2 d1 2d7 harvesting systems at current market prices for materials and worker wage in Sri Lanka

Harvesting system			With own labour		With hired labour	
			S/2 d2	S/2 d1 d7	S/2 d2	S/2 d1 2d7
Stimulation cost	Chemical cost	LKR/kg	0.00	2.90	0.00	2.90
		LKR/tree/yr	0.00	14.08	0.00	14.08
	Labour cost	LKR/kg	0.00	0.00	0.00	4.53
		LKR/tree/yr	0.00	0.00	0.00	22.00
Total harvesting cost (Including total cost of stimulation)		LKR/kg	0.00	2.90	108.26	68.69
		LKR/tree/yr	0.00	14.08	508.80	333.68
Overall cost of production		LKR/kg	10.00	12.90	148.26	108.69
		LKR/tree/yr	47.00	62.66	696.80	527.98
Net income		LKR/kg	320.00	317.00	181.74	221.31
		LKR/tree/yr	1504.00	1540.30	854.20	1075.00

Although the present study was able to meet its objectives by developing a suitable weekend harvesting system (S/2 d1 2d7 2% ET every two weeks) for smallholders, the development and testing process was undertaken under the conditions of commercial estate management. Therefore, no confirmation was received by the relevant party, i.e. smallholders, in achieving the perceived benefits. To resolve this issue, it is intended to apply the newly developed weekend harvesting system in smallholdings of needy growers as the next step.

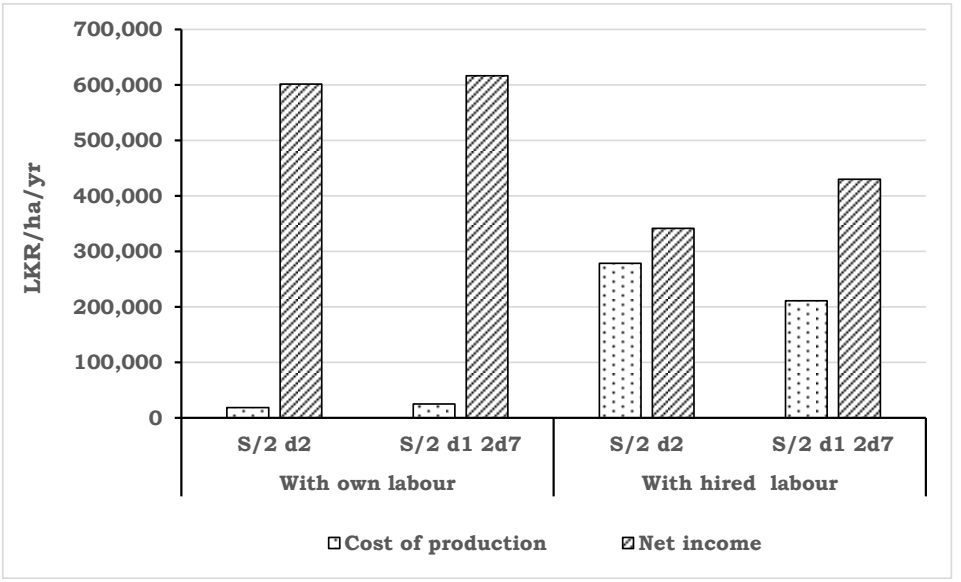

Figure 4. Changes in cost of production and net income associated with the adoption of weekend harvesting system

CONCLUSION

The present study was able to develop a system in which rubber trees could be harvested on weekly basis enabling smallholders to use own labour for rubber tapping during weekend holidays. In this system, two consecutive days per week are used for latex harvesting with the application of 2% ethephon (S/2 d1 2d7 2% ET every two weeks) instead of the every other day harvesting (S/2 d2).

Although once a week harvesting was tested with different protocols for ethephon stimulation in developing the above system, no such system was able to provide comparable yields to what given by the traditional S/2 d2 system. However, such system could be adopted in smallholdings with monthly application of 5% ethephon, should 5% yield decline be acceptable in lieu of saving the tapping cost incurred in hired labour.

Biochemical and physiological parameters of latex in the newly developed weekend harvesting system (S/2 d1 2d7 2% ET every two weeks) were in acceptable levels with no indication on stress factors.

It was evident that the newly developed weekend harvesting system (S/2 d1 2d7 2% ET every two weeks) is capable of reducing the cost of production by LKR 135/= per kg of rubber and thereby increasing the

profit margin by 74% per kg due to the use of own labour in latex harvesting.

Application of the newly developed weekend harvesting system is to be tested in needy smallholders to validate the perceived benefits.

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REFERENCE

Anon, (2015). Statistical Information of Plantation crops, Ministry of Plantation Industries, Sri Lanka.

Boyne, A. F. and Ellman, G. L. (1972). A Methodology for analysis of tissue sulphydryl components. *Analytical Biochemistry,* 46, 639-653

Jacob, J. L., Prevot, J. C. Eschbach, J. M. Lacrotte, R., Serres, E. and Vidal, A. (1988). Latex flow, cellular regeneration and yield of *Hevea brasilliensis* influence of hormonal stimulation. *Proceedings of the International Congress of Plant Physiology*, (pp. 15-20). New Delhi, India.

Jacob, J. L., Prevot, J. C., Roussel, D., Lacrotte, R., Serres. E., d'Auzac, J., Eschbach, J. M., and Omont, H. (1989). Yield limiting factors, latex physiological parameters, latex diagnosis and clonal typology. In J. d' Auzac, J. L. Jacob, H.Chrestin (Ed). *Physiology of rubber tree latex* (pp. 345-382). CRC Press, Florida, USA.

Nugawela A., Peries M.R.C., Wijesekara S. & Samarasekara 8. R. (2000). Evaluation of d/3 tapping with stimulation to alleviate problems related to d/2 tapping of Hevea. *Journal of the Rubber Research Institute of Sri Lanka.* 83, 49 − 61.

Obouayeba, S., Soumahin, E. F., Okoma, K. M., N'guessan, A. E. B., Lacote, R., Coulibaly, L. F. and Ake, S. (2011). Relationship between the tapping cut length and the parameters of vegetative growth and rubber yield of *Hevea brasiliensis*, Clone GT 1 and PB

235 in South Eastern Cote D' Ivoire. *Journal of Crop Science* 2(2), 27-44.

Rajagopal, R., Vijayakumar, K. R. and Thomas K. U. (2002). Comparative effectiveness of different stimulation methods on yield performance of *Hevea brasiliensis*. *Proceedings of PLACROSYM XIV*, (pp. 420-423). Hyderabad, India.

Rodrigo, V.H.L. (2007). Adoption of different tapping systems in the rubber industry of Sri Lanka with special reference to low frequency tapping. *Journal of the Rubber Research Institute of Sri Lanka*, 88, 1-21.

Rodrigo, V.H.L., Kudaligama, K.V.V.S., Fernando, K.M.E.P. and Yapa, P.A.J. (2011). Harvesting the rubber tree once in four days; a solution to the current issues in the rubber industry in Sri Lanka. *Journal of the Rubber Research Institute of Sri Lanka*. 91, 15-35.

Scott T. A. and Melvin, E. H. (1953). Determination of dextran with anthrone. *Analytical Chemistry,* 25(11), 1656-1661.

Taussky, H. H. and Shorr, E. (1953). A micro-colourimetric method for the determination of inorganic phosphorous. *Journal of Biological Chemistry,* 202, 675-685.

Thanh, D. K. and Thuy, K. T. (2003). *Hevea* clonal Typology; Latex physiological parameters and clonal grouping by principal component analysis. *Proceedings of the International Rubber research and Development Board Workshop on exploitation technology*, (pp. 179-190). Kottayam, India: IRRDB.