Assessment of the Condition of Rubber Nurseries and Factors Associated with the Quality of Plants and the Productivity of Rubber Nurseries

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ABSTRACT

Rubber plays a major role in the economy of Sri Lanka. However the national productivity of rubber in Sri Lanka is far below the potential yield of improved clones. One of the main reasons for this is the use of poor quality planting materials. This study was therefore conducted to assess the performance of rubber nurseries and to identify constraints in nurseries, which leads to production of substandard plants. Data were collected from 38 nurseries, owned by government, Regional Plantation Companies and private owners. Results revealed that the productivity of most of the nurseries is below the required level and the nurseries are not properly managed. Lack of labor, lack of knowledge and delaying input supply were identified as major constraints. Basal dressing, culling of weak plants, proper fertilizer application and management of budwood nurseries were found to be associated with the quality of planting materials.

KEYWORDS: Budgrafting, Planting Materials, Rootstock Plants, RRI Recommendations, Rubber Nursery

INTRODUCTION

Rubber (*Hevea brasiliensis*), being one of the major plantation crops, plays a major role in the economy of SriLanka. It contributes 0.7 percent to the Gross Domestic Production (GDP) of SriLanka (Anon, 2005). During the last few years, the demand for natural rubber increased significantly. The total production of rubber in Sri Lanka is about 104 kg million while the average productivity being 1170 kg/ha/year (Anon, 2005). However the productivity of rubber in SriLanka is far below the potential yield level, *i.e.* 2500-3000kg/ha/year (Nugawela 2002). One of the major reasons for the low productivity of rubber in SriLanka is the use of poor quality planting materials in planting programmes. Annual planting material requirement in Sri Lanka for both replanting and new planting programmes is about 3.375 million (Seneviratne, 2005).

Earliest method of establishing rubber lands was by seeds. However with the realization of the large variation in growth and yield of seedling trees, bud-grafting technique was introduced. In order to produce planting materials, vigorous rootstock plants are bud grafted with buds (scion) from good quality budwood nurseries of recommended clones. Therefore production of planting materials requires maintenance of bud wood or source bush nurseries and seedling or rootstock nurseries. Rootstock nurseries are established every year using unselected seeds collected during seed falls while the budded plants of recommended clones are maintained as bud wood nurseries.

As in any other crop, quality of planting materials affects, significantly, the growth performance and the yield potential of rubber. The use of advanced planting materials ensures not only the uniform growth, but also the reduction in immature period of rubber plants in the field (Samaranayake, 1983). In order to produce high quality planting materials, rubber nurseries have to be maintained at the optimum level. In SriLanka, rubber nurseries are owned by three types of owners *i.e.* Government, under Rubber Development Department (RDD), Regional Plantation Companies (RPCs) and private owners. Nurseries play a major role in rubber industry as the quality of planting materials totally depends on their performances. Therefore the guidelines have been laid out by Rubber Research Institute of SriLanka (RRISL) for the proper maintenance of rubber nurseries, in order to secure the required quality of planting materials. However those recommended practices are not properly adopted in some nurseries and as a result, the quality of plants is substandard. This has become a serious issue, since it affects the production and the productivity throughout the recommended tapping period of 24 years.

This study was intended to find out the factors associated with the quality of rubber planting materials produced in rubber nurseries. Since the agronomic practices directly influence the quality of planting materials, major consideration was given to identify them. In addition to that, several other factors, which possibly could affect the quality of rubber planting materials, were also considered in this study.

METHODOLOGY

A survey was conducted from April 2006 to July 2006 to gather data from the rubber nurseries

located in four rubber growing districts *i.e.* Kegalle, Ratnapura, Kalutara and Moneragala.

Sampling

Data collection was done in 38 rubber nurseries, including the government nurseries, RPC nurseries and private nurseries from each of above mentioned regions. All government nurseries were selected and the others were randomly selected using Stratified Random Sampling Method. Details of three categories of nurseries selected from each district are shown in Table 1.

Table 1 - Distribution of nurseries:

Region	No. of nurseries selected		
	Govt	RPC	PR
Kegalle	2	6	7
Ratnapura	1	4	4
Kalutara	2	4	2
Moneragala	1	2	3
Total	6	16	16

Govt. = government owned nurseries
RPC = nurseries owned by Regional Plantation companies
PR = private nurseries

Data Collection

Primary data were collected through a pre-tested structured questionnaire distributed among each nursery owner selected in the sample. In addition to that, visual observations were also made in each nursery site in search of primary data. Secondary data were gathered from the Central Bank Report, Advisory Circulars issued by RRISL, Handbook on Rubber, Statistical Bulletins and other relevant documents.

Data Analysis

1. *Identification of deficiencies in rubber nurseries*

RRISL has introduced a set of guidelines to be followed by nursery owners (Annex 2). However, despite of those guidelines, most of the nursery owners were reported making deficiencies which affect the quality of planting materials. This study was aimed at identification of those deficiencies. Data were analyzed through descriptive analysis techniques.

2. *Assessment of factors associated with the productivity of quality planting materials*

Spearman's' Rank Correlation method was identified as the best statistical method for this, as the population distribution is not easily specified (Robert et al., 1997). Data were analysed using Genstat (Genstat 7th Edition). Under this the factors associated with the production of quality rootstock plants and the successes of bud grafting were assessed separately. All the variables considered in the study are given in Annex 1.

RESULTS AND DISCUSSION

1. General Information

Rubber nurseries in Sri Lanka are categorized in to three types based on their ownership. The total number of nurseries under each ownership *i.e.* Government, RPC and Private are 6, 76 and 41 respectively (Anon, 2005). Based on the nursery reports prepared by RRISL for all the nurseries established in August 2005, the contribution to the total production of planting materials in SriLanka by each nursery type is presented in Figure 1.

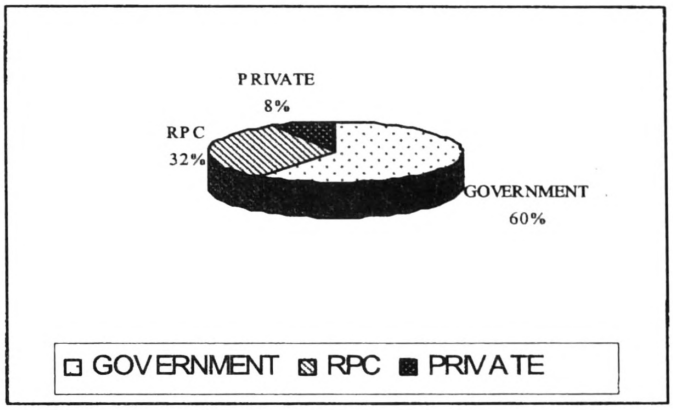

Figure 1 - Percentage of good quality planting materials produced in August 2005 by three categories of nurseries

2.Current situation of rubber nurseries in Sri Lanka

RRISL has introduced a set of recommendations to be followed by nursery owners. Through the implementation of those recommendations, at least 90 percent of plants produced in rootstock nurseries are expected to be high quality buddable plants. However this study revealed that the production of high quality buddable plants is far below the expected level in most of the rubber nurseries as a result of neglecting nursery recommendations (Table 3).

Table 3 - Average percentage of buddable plants at bud grafting:

Type of Nursery	Average percentage of buddable plants
Government	61.8
RPC	75.9
Private	69.8

2.1. Seed selection

The study revealed that 28.6 percent of nursery owners do not receive fresh seeds to be used in their germination beds. They often receive old seeds which grow in to weak plants. This happens due to the lack of knowledge of nursery owners to select fresh vigorous seeds.

2.2. Germination beds

Despite the recommendations laid by RRISL, 57 percent of nursery owners prepare their germination beds incorrectly. They use soil to prepare germination

beds instead of pure sand. Therefore the number of plants attacked by soil born pathogen is higher in those nurseries resulting low germination.

2.3. Harvesting germinated seeds

It was revealed that 30 percent of nursery owners tend to harvest all germinated seeds including late germinated seeds (Table 4). This was observed mostly in small holders nurseries followed by RPC nurseries.

2.4. Poly bag filling and basal dressing

It was revealed that 71 percent of nurseries including all the government nurseries use infertile sub soil to fill poly bags. Also 51 percent nursery owners do not apply basal dressing (Table 4). It was critical in government nurseries due to the delay in receiving fertilizer.

Table 4 - Percentage of nurseries that do not adopt RRISL recommendations:

Factor	% of nurseries
Incorrect Seed Selection	28.6
Improper Germination Beds	57.0
Improper Harvesting of Seeds	30.0
Without Basal Dressing	51.5
Improper Poly bag Filling	71.4

2.5. Fertilizer application

Fertilizer application is one of the most important agronomic practices in rubber nurseries. Selection of correct fertilizer type, preparation of correct fertilizer mixture, use of correct method of fertilizer application and maintaining the correct time gap between two fertilizer applications as recommended by RRISL (Annex 2) are equally important in order to raise the productivity of both rootstock and budwood nurseries. However it was observed that fertilizer application in most of the nurseries is extremely unsatisfactory. This was most significant in government nurseries followed by RPC and private nurseries. Fertilizer application is delayed in 77 percent of nurseries. This was most significant in government nurseries followed by RPC nurseries. Both the government and RPC nursery owners claim that there is a delay in receiving fertilizer from RDD and RPCs. Method and frequency of fertilizer application were also observed unsatisfactory (Table 5). This occurs mainly due to the lack of labors and awareness of nursery managers.

2.6. Fungicide application

Proper fungicide application is not practiced by 70% of nurseries. It was crucial in private nurseries possibly due to the high cost.

2.7. Culling of weak plants

Almost all nurseries do not practice this. Both the government and RPC nursery managers say that they don't have an adequate labor supply.

Table 5 - Percentage of nurseries that do not adopt recommendation on fertilizer application:

Fertilizer Application	% of nurseries
Incorrect Dosage	29
Incorrect Method	40
Incorrect Commencement	77
Incorrect Frequency	62.8

2.8. Bud wood nursery

Only 14 percent of nurseries have over aged bud wood nurseries, which is a satisfactory level. However the management of bud wood nurseries especially the manuring and regular pruning is not practiced properly in most of the nurseries (Table 6). This was crucial in government nurseries due to the labor shortage and the delay in receiving inputs such as fertilizer. Most of the small holders prune their bud wood nurseries incorrectly due to the lack of knowledge.

Table 6 - Percentage of nurseries that do not adopt the recommendations on management of bud wood nurseries:

Management Practice	% of nurseries
Over aged	14.0
Improper Pruning	48.5
Improper Manuring	63.0
Without Clone Demarcation	77.0

3. Other constraints faced by nursery owners

In this study, several constrains faced by nursery owners were identified. It was further revealed that those constraints differ from one type of nursery to the other type. Those constraints are summarized in Table 7.

4. Factors associated with the productivity of rootstock plants.

The results of this study revealed that the basal dressing, culling of weak plants, fertilizer application (commencement, dosage and method of application) and the harvesting of germinated seeds were significantly affecting the production of quality root stock plants (Table 8). As shown in Table 8, commencement of fertilizer application (FC) has the highest influence on the production of quality root stock plants (0.6044) followed by the basal dressing, (0.5183), harvesting of germinated seeds (0.4488), culling of weak plants (0.4105) and other factors. This clearly indicates the importance of proper fertilizer application, proper harvesting of germinated seeds and removing of weak plants in order to get a high quality root stock plants.

Table 7 - Various constraints faced by nursery owners:

Type of Owners	Constraints
Government	Lack of labors Delay in receiving inputs Soil degradation Soil loss due to poly bag filling in larger amounts Unavailability of good quality soil
RPC	Labor shortage Delay in receiving inputs Lack of knowledge
Small holders	High cost of inputs Lack of knowledge Lack of capital

Table 8 - Factors affecting the production of quality rootstock plants:

Variable	Spearman's Correlation Coefficient	p- value
BD	0.5183	0.001**
CWP	0.4105	0.014*
FC	0.6044	<0.001***
FD	0.3404	0.045*
FM	0.3732	0.026*
HGS	0.4488	0.007**

*= Significant at 0.05, ** = significant at 0.01, *** = significant at 0.001, BD= bud grafting, CWP=culling of weak plants, FC=commencement of fertilizer application, FD=fertilizer dosage, FM = method of fertilizer application, HGS = harvesting of germinated seeds.

Some significant interrelationships between certain factors were also found in this study. Those interrelationships are given in Table 9.

As shown in Table 9, there is a positive interrelationship between the Size of Nursery and fertilizer application (commencement, dosage and method). It indicates that when the size of nursery (total number of plants handling) become smaller, performance of fertilizer application tends to become satisfactory. Therefore it was revealed that the size of nursery indirectly affects the production of quality root stock plants. It was further revealed that the type of soil used for poly bag filling (SBF) was positively combined with basal dressing (BD). Therefore the production is indirectly affected by SBF.

Table 9 - Significant combinations between the factors associated with the production of quality root stock plants:

Combination	Spearman's Correlation Coefficient	p- value
FC Vs SN	0.604	<0.001***
FM Vs SN	0.376	0.026*
FD Vs SN	0.401	0.045*
BD Vs SBF	0.400	0.017*

*** =Significant at 0.001, *=Significant at 0.05, FC=commencement of fertilizer application, SN=size of nursery, BD=basal dressing, FD=fertilizer dosage, FM=method of fertilizer application, SBF=soil for bag filling,

5. Factors associated with the success of bud grafting

Table 10 shows the association of factors with the budding success. It was revealed that the age of bud wood nurseries and manuring the bud wood nursery significantly affected the success of bud grafting (Table 10). In addition to that, pruning method of bud wood nursery (PBN) indirectly affected the budding success, as it is interrelated with the age of bud wood nursery (ABN) as shown in Table 10.

Table 10 - Association of factors on budding success:

Factor	Pearson's Correlation Coefficient	p value
ABN	0.573	0.001**
MBN	0.352	0.048*
ABN, PBN	0.355	0.046*

** = Significant at 0.01, *= significant at 0.05,
ABN =Age of bud wood nursery, MBN= Manuring the bud wood nursery, PBN=Pruning of bud wood nursery.

CONCLUSIONS

This study revealed that the productivity of most of the rubber nurseries in Sri Lanka is far below the expected level. It was also revealed that the fertilizer application, preparation of germination beds, basal dressing, seed selection, bud wood nursery management and poly bag filling are extremely unsatisfactory in rubber nurseries. The study confirmed that the productivity of planting materials is severely affected by above-mentioned deficiencies.

Loss of soil due to the poly bag filling was identified as a major problem in government rubber nurseries followed by labor shortage, lack of skilled labors and delay in receiving inputs such as fertilizer. Most of the RPC nurseries had labor shortage and lack of knowledge was also seen. High cost of inputs and lack of knowledge were identified as the major constraints faced by private nurseries. The study further revealed that the government and RPC

nursery managers pay a relatively less attention on nursery management than private nurseries.

The study also revealed that the basal dressing, fertilizer applications, harvesting of germinated seeds and culling of weak plants were significantly affecting the productivity of quality rootstock plants. Also the age of bud wood nursery and manuring the budwood nursery were identified as factors that significantly affect the budding success.

This study suggests that there is a possibility to increase the productivity of rubber nurseries in Sri Lanka by paying special attention on fertilizer application, basal dressing, preparation of germination beds etc. Steps should be taken to improve the level of knowledge of nursery managers, specially the private nursery owners on nursery management. Further, attention should be given to solve the constraints faced by nursery managers. It is also necessary to take steps to find out a remedy to minimize soil loss in government nurseries due to the removal of soil in larger quantities with the poly bag plants.

ACKNOWLEDGEMENTS

Authors would like to offer their sincere thanks to prof. SJBA Jayasekara, Dean, Faculty of Agriculture and Plantation Management and prof. NEM Jayasekara, Former head, Plantation Management Department for their great encouragement and valuable suggestions and staff members of computer unit for their great assistance. Authors gratefully acknowledge the valuable assistance given by Dr. Wasana Wijesuriya, Head, Biometry Department, RRISL, in the process of data analysis of this study. Special thanks are also due to Mr. M.N de Alwis, Experimental Officer, RRISL, for the support given and guidance in conducting the study. The assistance of all the staff members of Plant Science Department and library of RRISL is also highly appreciated.

REFERENCES

Anon (2005). Central Bank Report 2005, Central Bank of Sri Lanka, Colombo.

Anon (2005). Nursery Report for the Nurseries Established in August 2005, Rubber Research Institute of SriLanka, Dartonfield, Agalawatta.

Nugawela, A. (2002).Rubber-Potential Yields and Strategies to Achieve it in Traditional and Marginal Areas, Bulleting of RRISL, (2002).44, 60-68.

Robert, G.D.S., J.H.Torrie, D.A. Dickey (1997). Nonparametric Statistics. In: Principals and Procedures of Statistics, Schaum Division, McGrew-Hill, inc., 1221, Avenue of the Americas, New York, NY10020, pp.584.

Samaranayake, C. (1983). Propagation of Rubber. In: Hand Book of Rubber Culture and Processing, O.S.Peries, D.M.Fernando, Caxon Printing Workers Limited, 280, Dam Street, Colombo 12, Sri Lanka. Pp. 1-21.

Seneviratne, P., A. Nugawela, U.S. Weerakoon, and M.N. de Alwis (2000). Effect of the Conditions of Bud wood Nurseries on the Productivity: Mixed Clones, Bulleting of RRISL, 41, 44-48.

Seneviratne, P. (2001). Management of Rootstock and Bud wood Nurseries. In: Hand Book of Rubber, L.M.K.Tillekeratne, A. Nugawela, Vishva Lekha Printers, 41, Lumbini Avenue, Ratmalana, Sri Lanka, pp. 54-65.

Annex 1. Variables considered in the analysis.

Variable	Unit
Variables considered in the analysis of production of buddable plants.	
DEPENDENT VARIABLE	
Percentage of buddable plants	Percentage of buddable plants
INDEPENDENT VARIABLES	
Time for seed germination	Number of days
Harvesting of germinated seeds	Percentage of harvested germinated seeds
Type of soil for bag filling	Type of soil used in poly bags
Basal dressing	Type of fertilizer used as basal dressing
Fertilizer dosage	Grams per liter
Method of fertilizer application	Type of method of application
Commencement of fertilizer application	Days after planting
Frequency of fertilizer application	Time gap between two applications
Type of fungicides used	Type of fungicide applied
Commencement of fungicide application	Days after planting
Frequency of fungicide application	Time gap between two applications
Size of nursery	Total number of plants in the nursery
Culling of weak plants	Number of weak plants culled
Variables considered in the analysis of budding success.	
DEPENDENT VARIABLE	
Percentage of budding success	Percentage of successfully budded plants
INDEPENDENT VARIABLE	
Bud wood supply	Place of budwood supply
Age of bud wood nursery	Years
Pruning the bud wood nursery	Method and frequency of pruning
Manuring the bud wood nursery	Method and frequency of manuring
Commencement of bud grafting	Months

Annex 2. RRISL recommendations on poly bag nursery management

Factor	Recommendation
Seed selection	Fresh deeds from an early seed fall
Germination bed	Lay pure sands to a depth of 4.5cm with a shade
Harvesting of germination seeds	Harvested as soon as the tip of the radical is seen, Harvest every other day with maximum of 4 rounds Only the early germinated 50% of seeds
Poly bag filling	Top soil sieved with a 1cm mesh
Basal dressing	50g of IRP per one poly bag
Fertilizer Application (until cut back)	
Dosage	112g of fertilizer dissolved in 4.5L of water
Commencement	two weeks after planting
Method	Apply 50ml for each plant with a yogurt cup
Frequency	Once in 14 days
Fungicide Application	
Type	Group 1 and group 2 fungicide types should be used alternatively
Commencement	One week after planting
Frequency	Once in 14 days
Culling of weak plants	Weak plants should be discarded once a month
Bud wood supply	Own supply
Management of the bud wood Nursery	
Age of nursery	Below ten years of age
Pruning of nursery	Once in every year
Manuring of nursery	1st year – 275g/tree/year (Type of fertilizer - based on soil type), 2nd year – 550g/tree/year (Type of fertilizer – based on soil type)
Commencement of bud grafting	Four months after planting

Source: Hand Book on Rubber