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ORIGINAL ARTICLE

Socio-economic Context of Rubber Growing in Non-traditional Rubber Cultivating Areas

R.S.S. Chandrasiri* and N.P.A.S. Gunarathna

Department of Export Agriculture, Faculty of Animal Science and Export Agriculture, Uva Wellassa University of Sri Lanka.

Correspondence:
*sachini.chandrasiri7@gmail.com
https://orcid.org/0000-0003-4713-9088

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Abstract

Monaragala is one of the main non-traditional rubber cultivating areas in Sri Lanka, where majority of rubber is cultivated by smallholders. This is an attempt to identify the socio demographic characteristics, rubber cultivation characteristics, and rubber processing characteristic of smallholders in Monaragala district. The data used in this study were gathered through a field survey using a sample of 150 smallholders and the data were analyzed using descriptive statistics. The results of the survey showed that the knowledge of smallholders regarding rubber processing was around 70% and the processing standards was at a lower level. Majority of the smallholders are producing Ribbed Smoked Sheet (RSS) or sell raw field latex, which resembles that there is a potential to diversify the processing sector by introducing other processing techniques such as crepe rubber and technically specified rubber. Majority of the sample population which was around 63% were attracted towards high cost group processing centers than processing RSS at household level by using low-cost simple techniques such as using carpets for milling and chimney for smoke drying.

Keywords: *Field latex, Ribbed Smoked Sheet, Rubber processing, Socio demographic characteristics*

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1. Introduction

Rubber is one of the main plantation crops which provides around 0.6 % contribution to the gross domestic production (GDP) (Gonsalkorale 2020) and has a strong impact on socio- economic conditions of the people who are involved in rubber industry.

The rubber industry was established in Sri Lanka in 1876 by planting a few hundreds of Brazilian rubber seeds received from Kew Gardens in London. Rubber was then popularized in the wet zones making them as traditional rubber growing areas in Sri Lanka including Kegalle, Kalutara, Rathnapura, Colombo and Galle. By the 1970s, over 200,000 hectares were under rubber which also included small holdings. However, due to various reasons such as lack of labors, pest and disease attacks and urbanization, by 2010 the extent has decreased to 132,000 hectares (Dunuwila et al. 2018). Rubber was introduced to non-traditional areas in order to expand the rubber industry and cater to the rubber requirement in Sri Lanka.

Monaragala district is the largest administrative district in the country and also it records the second lowest GDP growth and highest level of poverty in Sri Lanka (Sri Lanka: small and medium-sized enterprises line of credit project 2017). Smallholder Plantations Entrepreneurship Development Programme (SPEnDP) is a project which was implemented to introduce and popularize rubber in non-traditional areas of rubber growing including Monaragala, Ampara and Badulla districts. This project was conducted by the International Fund for Agriculture Development (IFAD), which is a specialized United Nations (UN) agency and was an activity of the Asian Development Bank (ADB) financed by the government of United State through USAID (Sri Lanka Rubber Industry Master 2017).

As the initial phase of the project, 5000 hectares of rubber were cultivated in Monaragala district in 2006 including Buththala, Monaragala, Badalkumbura, Bibila, Madulla, Madagama, Siyabalanduwa and Wellawaya. Most of the rubber trees which were established under the project are now at tappable stage. Hence, there is an opportunity to produce different types of processed rubber. However, the smallholders in Monaragala district process only RSS (Ribbed Smoked Sheet) or sell raw field latex without any processing.

Rubber processing is the conversion of field latex into raw rubber products by performing series of chemical and mechanical operations (Lau and Loudjeva 2005). Sri Lanka produces most types of processed rubber including RSS, Crepe rubber, and concentrated latex (Paranawithana 2006). Ribbed Smoke Sheet (RSS) is a major type of processed raw rubber which is mainly produced at cottage level (Herath et al. 2010). The wrong operational practices at cottage level lead to a large number of defects in the prepared RSS sheets which include raw spots, reaper marks, tar spots and case hardening (Silva et al. 1998). Sri Lanka is the world's largest producer of high quality

latex crepe rubber due to its purity, light colour and low protein (Dunuwila et al. 2018). In order to market high quality crepe rubber, all necessary precautions have to be taken and rubber should be manufactured under carefully controlled hygienic conditions (Hartley et al. 1987). Therefore, it is clear that the smallholders should have a good knowledge on rubber processing to produce high quality end products. Concentrated latex is prepared by increasing the Dry Rubber Content (DRC) up to 60% of the field latex collected from rubber trees through the centrifugation process (Iqbal and Rodrigo 2006). This is the most popular type of processed rubber and has an increasing demand in the market.

The typical processed raw rubber chain consists of many people. Rubber chain starts with producers of both smallholders and estates with or without processing facilities, central processors or mobile collectors, village dealers, whole sale dealers and traders (Kirwan 2007). There are three processing types as individual processing, group processing and central processing (Lau and Loudjeva 2005). Individual processing is done by individual farmers especially with RSS making facilities. Group processing adds value to latex by processing at a certainly located processing unit and its average latex intake may vary between 100 to 500 kg per day. If this is specified for a RSS processing, it can include a small building with coagulating tanks, sheeting rollers, a smoke house and a storage room (Dayaratne and Gunawardana 2015). This may also include a mini laboratory to measure the DRC content and a trained person to measure the required properties (Dissanayake and Fernando 2005). The third method is the central processing when there are sufficient volumes of latex and other field grades are available for processing into higher types such as Technically Specified Rubber (TSR) and Latex Concentrates. These factories can be established in central locations with high technical and managerial competencies (Manig 1996).

The main objective of the research is to study the current market trends and processing techniques in Monaragala district using the smallholders established by the SPEnDP. Further, this also studies the farmer's perception towards alternative markets and diversified markets.

2. Materials and Methods

This study focuses on the small holders guided under the SPEnDP project in the Monaragala district. The data was gathered on the basis of rubber processing in Monaragala district. The targeted population was rubber small holders established by the SPEnDP project in the Monaragala district which is around 7000 scattered over eight divisional secretariats. The sample size of the survey was 150 small holders from eight divisional secretariat (DS) divisions in Monaragala district where the rubber is grown by the SPEnDP project. This included Bibila, Monaragala, Madulla, Madagama, Wellawaya, Badalkumbura, Siyabalanduwa and Buththala. Stratified sampling technique was

used to select the sample considering DS divisions as strata. The Table 1 below shows the sample collected DS divisions.

As per the below Table 1, a random sample of smallholders was selected from each DS division and each individual rubber smallholder was interviewed using a structured questionnaire. The questionnaire covered different topics in order to capture relevant information related to the study objectives.

Table 1: Number of samples collected from each DS division

DS Division	Number of Samples
Badalkumbura	65
Madagama	20
Monaragala	19
Bibila	12
Madulla	10
Buththala	09
Wellawaya	08
Siyabalanduwa	07
Total number of samples	150

Yield data and data related to rubber processing were collected through the questionnaire. To accomplish the above mentioned research objectives, both primary and secondary data sources were utilized throughout this study. The collected data were disused with the SPEnDP project office in Monaragala to authenticate the collected data that resembles the actual scenario.

As a part of primary data collection, face to face interviews were done with the rubber smallholders. A pre-test was conducted to investigate whether the respondents have difficulties with the questionnaire. Secondary data were collected from Ministry of Plantation Industries, SPEnDP project office in Monaragala, Project Coordinating office in Colombo and Rubber Development Department in Monaragala.

Once the primary and secondary data were gathered, statistical analysis and descriptive analysis were done to identify the current situation and potentials for rubber products. To get detailed information, maps were created by using Arc GIS (10.1) software and associations were made with one-way ANOVA by taking daily production and type of rubber produce as key determinants. The null hypothesis was that there is no difference between the means of the two parameters and the alternative hypothesis was that there is a difference between the means of the two parameters considered at a 0.05 significance level. A regression analysis was done in order to identify the association between daily output against the predictors; rubber planted land area and labour availability as key parameters.

Descriptive method consists of the collection, organization, summarization and presentation of data into a form that makes the data easy to understand and interpret. It further involves the presentation of data in meaningful form using charts, graphs and/or tables. The obtained results from descriptive method were used to identify the future potentials diversification of rubber processing in Monaragala district.

3. Results and Discussion

Rubber Cultivation Characteristics

Daily Production

The amount of dry rubber kilograms collected from latex on each day is considered as the daily production. The latex is collected by a process known as tapping which is a systematic wounding of the bark of the rubber tree. According to Fig. 1, nearly 70% of the small holders collect 10-15 kg daily which is sufficient to make 20 sheets of RSS. According to the RRI recommendations, from a properly maintained rubber land, one acre should provide a yield of 20-25 kg.

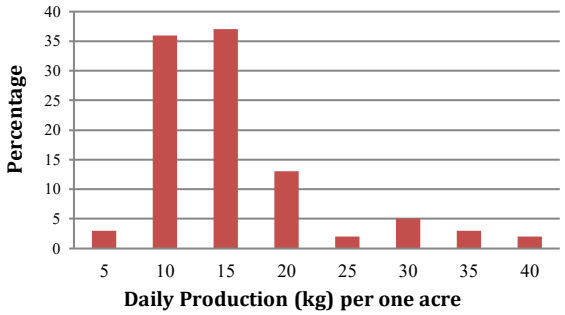

Figure 1: Amount of dry rubber produced daily from one acre of rubber land

Rubber Planted Land Extent

The land area used for the rubber cultivation by a single small holder is depicted in Fig. 2. According to that, around 28% of the small holders use two acres of land for rubber cultivation. Further, out of the total population used for the survey, around 80% own land areas between 1 to 3 acres.

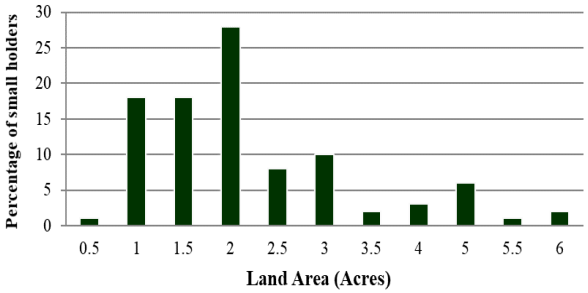

Figure 2: Rubber planted land extent

The one-way ANOVA for the association between daily production and rubber planted land area resulted a *P* value of 0.01 which resembles that there is a statistically significant association between the land area and the daily production output.

Rubber Clones

The planted clone is important to produce high quality latex as the amount of the latex, colour of the latex and non-rubber content is directly dependent on the planted clone. The clone is also important to identify the correct type of processed rubber, for an example, clones like PB 86 contain high amount of magnesium which makes a large sludge in centrifuging (Silva et al. 1998). It also contains high amount of yellow fragment which changes the colour of the crape sheet which ultimately results a quality defect named yellow discoloration.

The SPEnDP project has mainly promoted RRI 121 as it is a drought tolerance variety which is well suitable for a dry zone like Monaragala district. Fig. 3 below depicts the planted clones and according to that, majority of around 78% have used the RRI 121 verity while the rest have planted other clones which include RRIC 100 and RRIC 102.

The one-way ANOVA for the association between daily production and rubber clone resulted a *P* value of 0.003 which resembles that the null hypothesis; there is no effect of type of clones on the daily output that will be rejected. Therefore, it can be concluded that the type of rubber clone has an effect on the daily production output under 0.05 level of significance.

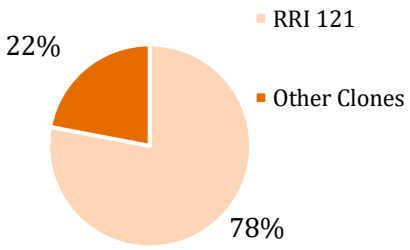

Figure 3: Planted rubber clones

Rubber Processing Characteristics

Type of Rubber Produced

In Monaragala district, the diversification of rubber products is very poor compared to traditional rubber growing areas. The only processed type of rubber is Ribbed Smoked Sheet (RSS). According to Fig. 4, out of the sample, 68% produce RSS, 29% sell raw field latex and nearly 3% produce both. This represents that RSS is the most popular type of processed rubber in this area.

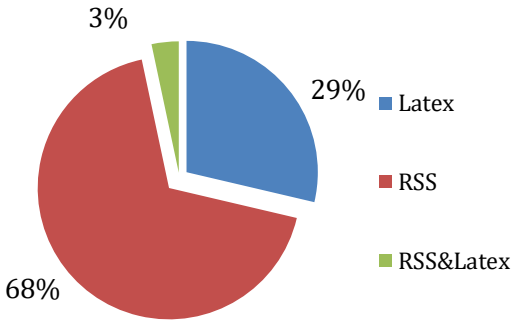

Figure 4: Type of rubber produced

The one-way ANOVA between daily production and type of rubber resulted a *P* value of 0.1 which resembles that the null hypothesis; there is no mean difference in daily output for RSS and Latex will not be rejected. Therefore, it can be concluded that the type of rubber produced will not depend on the daily production output under 0.05 level of significance.

Grades of Ribbed Smoked Sheets

According to the standards, there are five grades of RSS as grade 1, grade 2, grade 3, grade 4 and grade 5. Grade 1 and 2 are considered as high quality sheets while grade 3, 4, 5 are low in quality. The price given for high quality is grater compared with low quality. Therefore, by processing high quality smallholders can gain higher profits.

According to Fig. 5, around 70 % produce lower grades which include grade 3, 4 and 5 and only 30 % produce high quality sheet rubber. Therefore, it is clear that most of the people

produce low grades which will ultimately lead to low profit levels.

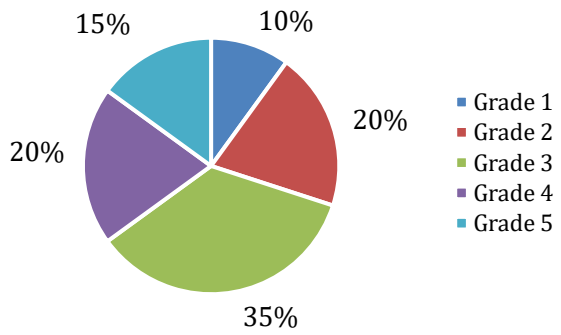

Figure 5: Grades of Ribbed smoked sheet (RSS)

The RSS are categorized into each grade by visual observation according to the presence of dirt particles, fungus growth, amount of moisture and colour of the sheet. Defects due to microbial origin and wrong processing practices are the two major reasons to reduce the grade of the RSS. Fungal attack can mainly occur if the sheets are not properly dried. However, this is not applicable to a dry zone like Monaragala.

The major cause for the production of lower RSS grades is due to the wrong processing practices followed by the smallholders. Blisters, reaper marks, case hardening, specky sheets and tackiness are the main wrong processing practices observed during the data collection.

Place of Processing

Place of processing is the place where the processing is done. Processing can be done by the Smallholder himself of herself if he or she has sufficient facilities like rollers and smoke house to prepare the sheets or use a group processing center. The latex manufacturing smallholders cannot usually centrifuge the latex at household level. Therefore, they must give the latex to group processing centers.

According to Fig. 6, around 37% produce rubber sheets in smallholder level. There are group processing centers established with the involvement of a few people together to prepare RSS which is around 63 %. The one-way ANOVA for the type of rubber and place of processing resulted a *P* value of 0.391 which resembles the null hypothesis; there is no effect of type of rubber produced on the place of processing that will not be rejected. Therefore, it can be concluded that the type of rubber produced will not depend on the place of processing under 0.05 level of significance.

The main purposes to use group processing centers is to either roll the sheets or to smoke dry. The majority of the people use group processing centers for smoke drying which costs five rupees per sheet and for both smoke drying and milling it costs 10 rupees per sheet. But most of the people do not prefer group processing centers for various reasons like high cost and improper smoke drying.

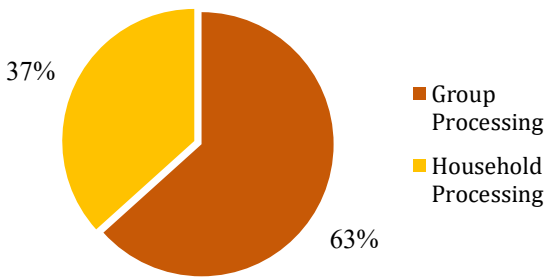

Figure 6: Place of processing

Processing Techniques

Instead of using the machines or smoke houses, milling and drying of sheets can be done by the smallholder himself or herself with the available resources. The main purpose of milling is to remove the excess water and the serum of the sheet. Insufficient milling may lead to fungal attack which reduces the quality of the sheet. Hence, it is essential to remove the water completely.

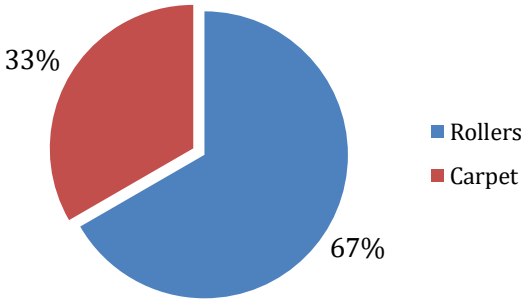

Figure 7: Usage of Carpets and Rollers

Milling of the sheets can be done with a well cleaned bottle filled with sand as the smooth roller and a carpet can be used as the diamond roller to make patterns on the sheet. Fig. 7 represents that 67% of the smallholders use in-house method of carpets for milling while 33% use commercially available rollers.

Further, Chimney can be used as alternative techniques to smoke dry the rubber sheets. In Monaragala district, many people use firewood for cooking purposes. Hence, the smoke generated in there can be used to smoke dry the well rolled rubber sheets.

As per the results obtained in Fig. 8, only 18% of the sample use chimney for smoke drying and the rest 82% use smoke houses available in the group processing centers for drying by paying five rupees per sheet. The small holders need to be encouraged to gain the maximum usage of their available resources because the same task can be done at home without any cost as the results obtained from chimney and smoke house are same.

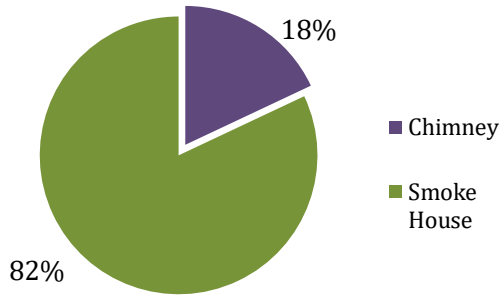

Figure 8: Usage of smoke house and chimney

Most of the people using higher cost processing centers than lower cost processing techniques like using carpets for milling and chimney for smoke drying. These low cost techniques can be easily adopted and the ultimate quality of the RSS made by using carpet and chimney is similar to the quality of the RSS made in the processing centers.

Awareness about Processing Standards

Awareness on processing standards is essential to produce high quality RSS. The awareness of the smallholders was categorized into four categories as poor, fair, good and excellent according to the answers given by the smallholders regarding processing standards.

The questions were based on important factors for processing RSS like correct ratios of water

and latex to be used, using correct dilution of acids, removal of froth, covering of the tray with polythene, thickness after rolling, washing after rolling, air drying of rubber sheet and smoke drying. According to the obtained results in Fig. 9, only 4% have an excellent knowledge on correct processing standards whilst 14 % have a good knowledge. Nearly 70% of the smallholders have a fair knowledge on the basics of the rubber processing and the rest 12% have a poor knowledge on rubber processing. According to the data obtained, the majority of the smallholders do not have a good awareness on processing standards.

The one-way ANOVA for the daily production and awareness on processing standards resulted a *P* value of 0.019 which resembles that the null hypothesis; there is no mean difference in daily output for different levels of awareness on processing standards that will be rejected. Therefore, it can be concluded that daily production output will depend on the level of awareness on processing standards under 0.05 level of significance.

However, the one-way ANOVA for type of rubber and awareness on processing standards resulted a *P* value of 0.21 which resembles that the null hypothesis; there is no effect of awareness on processing standards on the type of rubber produced that will not be rejected. Therefore, it can be concluded that type of rubber produced will not depend on the level of awareness on processing standards under 0.05 level of significance.

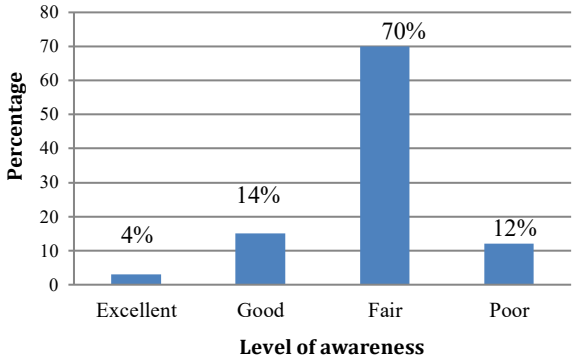

Figure 9: Awareness of processing standards

Socio Demographic Characteristics

Gender wise involvement for rubber processing

According to the results, male involvement in the rubber processing is higher which accounts for 77% while female participation is lower and around 23%. This is depicted in Fig. 10. The main reason for lack of female participation is that rubber processing involves handling of acidic chemicals and associated heavy work such as rolling of sheets. Further, ANOVA for gender against daily production resulted *P* value of 0.001 Therefore, the daily production will depend on the gender under 0.05 level of significance. However, the one-way ANOVA for the type of rubber produced against the gender resulted a *P* value of 0.549. This resembles that the type of rubber will not depend on the gender involvement.

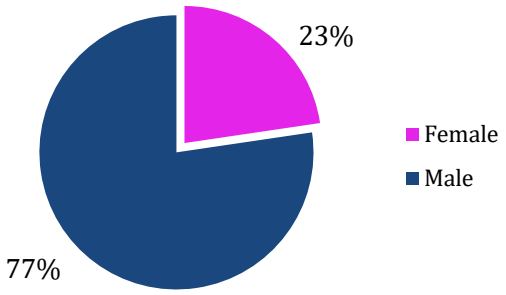

Figure 10: Gender wise involvement to the rubber processing

Table 2 indicates the total number of small holders who are involved in the rubber processing in the Monaragala district and the gender participation in each DS division.

As per below Table 2, the number of male and female rubber smallholders is high in Badalkumbura, Monaragala and Madagama areas. As the male smallholder population is higher than the female population, there is a clear potential to involve more females in rubber processing. Further, according to the data of the total Monaragala district, the female population is higher than male population and the majority of the females are engaged in chena cultivation.

Rubber cultivation related activities are comparatively easier than chena cultivation. Further, unlike chena cultivation which seasonal, profits can be generated throughout the year with the cultivation of rubber.

Labour Availability

There are two types of labours used for rubber cultivations in Monaragala district as own labour and paid labour. Own labour is where the small holders or their family members themselves work in the rubber filed and do not require any payment.

Paid labour uses third party involvement, which includes labour cost of around 1000 rupees per day. Fig. 11 which depicts the activity wise labour distribution shows that over 88% of the rubber small holders using own labour. Usage of own labour helps to reduce the cost of production by reducing the labour cost.

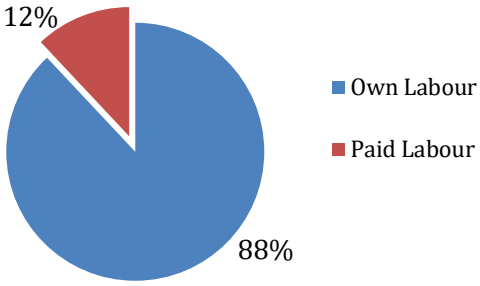

Figure 11: Labour availability

Labour strength is usually used to tap rubber trees, collection of latex, milling of sheets and smoke drying of sheets. Engagement in these activities improves the processing skills of the smallholders. Engaging in an activity is associated with accumulation of skills, more experience and accumulation of assets and thereby allowing the smallholders to diversify into more remunerative activities (Lau and Loudjeva 2005). Nearly 12% of the sample use paid labour and that also only for the tapping purposes. They do not make any processed rubber like RSS because of less availability of labours and also due to high labour cost.

Table 2: Total number of smallholders involved in rubber processing (Sri Lanka Rubber Industry Master Plan, 2017).

DS Division	Rubber small holder population	Male rubber small holder population	Female rubber small holder population
Badalkumbura	6250	4350	1900
Madagama	2900	1850	1050
Monaragala	4500	3100	1400
Bibila	900	500	400
Madulla	1200	700	500
Buththala	850	500	350
Wellawaya	1000	850	150
Siyabalanduwa	900	650	250

The one-way ANOVA for the daily production against labour availability resulted a *P* value of 0.1 which resembles that the labour availability will not depend on the daily production. Further, the one-way ANOVA for the association between type of rubber produced and gender resulted a *P* value of 0.412, this resembles that type of rubber produced will not depend on whether own labour or paid labour was used.

Regression Analysis

In the regression analysis, the rubber planted land area and labour availability were identified as the significant parameters which show an association with the daily output.

The regression model for the daily output vs rubber planted land area and type of labour is depicted in the equations below. The regression models for own labour and paid labour are expressed in equation (1).

Daily Output (kg) = 4.440 labour availability Own Labour + 8.82 labour availability Paid Labour + 4.292 Rubber Planted Area (Ac) ——(1)

The adjusted R^2 value for the model is 80.20% and as per the *P* values for both predictors are significant in the model. The obtained *P* values for the two predictor variables, namely; rubber planted land area and labour availability were 0.000 and 0.002 respectively. Therefore, rubber planted land area and labour availability has a significant relationship for determining daily output.

Fig. 12 below depicts the scatterplot of daily output and rubber planted land area. This clearly shows that with the increase of land area, the daily output increases.

Fig. 13 below depicts the boxplot of daily output and labour availability and according to that it is clear that paid labour provides increased output compared to own labour.

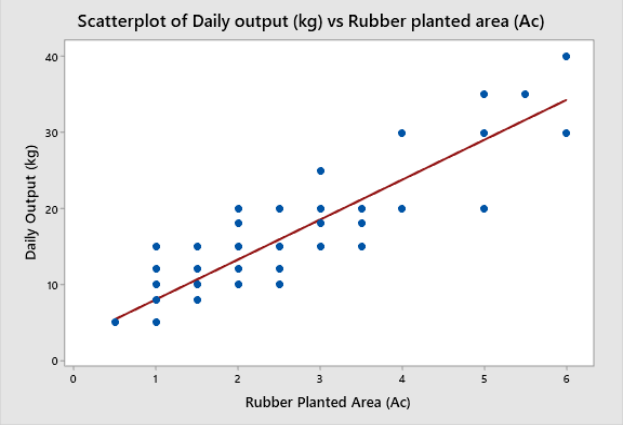

Figure 12: Scatterplot of daily output (kg) vs Rubber planted land area (acres)

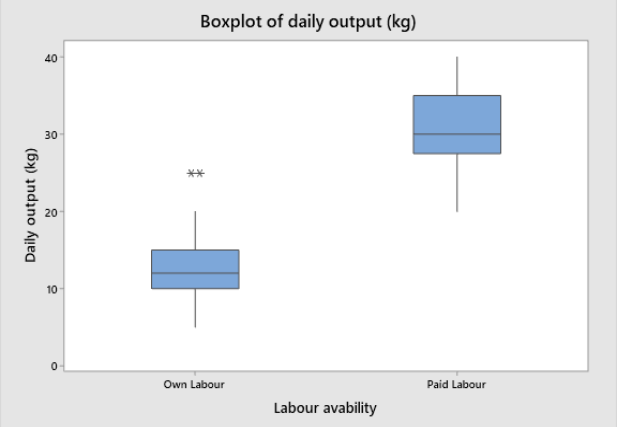

Figure 13: Boxplot of daily output (kg) vs labour availability

Binary logistic regression

In the binary logistic regression analysis, the gender, rubber planted land area and labour availability were identified as the significant

parameters which show an association with the type of rubber produced (RSS or Latex).

The logistic regression model for the type of rubber produced vs rubber planted land area, type of labour and gender is depicted in below equation (2).

$$\log\left(\frac{y}{1-y}\right) = B0 + B1 \times X1 + B2 \times X2 + B3 \times X3 \quad \text{(2)}$$

$$Probability\ of\ producing\ RSS; P(RSS) = \exp\frac{(Y')}{(1+\exp Y')}$$

Where,

$$Y' = e^{(B0+B1\times X1+B2\times X2+B3\times X3)}$$

$$Y' = 3.833 + 3.22\ Labour\ availability \times Own\ labour - 5.502\ Labour\ availability \times Paid\ Labour - 1.344\ Rubber\ planted\ land\ area$$

The adjusted R^2 value for the model is 84.92% and as per the *P* values for all the predictors are significant in the model. The obtained *P* values for each predictor variables, namely; gender, rubber planted land area, labour availability was 0.045, 0.000 and 0.028 respectively. Therefore, gender, rubber planted land area and labour availability has a significant relationship for determining type of rubber produced.

Fig. 14 below depicts the binary fitted line plot of probability of producing RSS and latex and daily output. The probability of producing RSS is taken as 1 while producing latex is taken as 0. This clearly shows that with the increase of daily output, smallholders mostly tend towards selling latex.

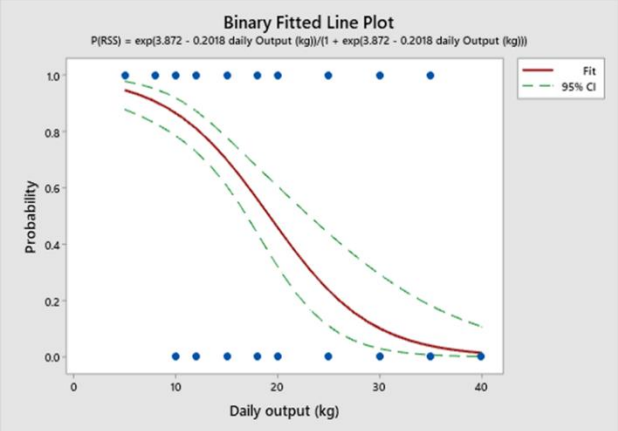

Figure 14: Binary fitted line plot of daily output (kg) vs probability of producing RSS and latex

Fig. 15 below depicts the main effects plot of type of rubber produced and labour availability. The probability of producing latex was considered as 1 while the probability of producing RSS was taken as 0. According to the results, smallholders tend to produce RSS when own labour is used and tend to sell latex as it is without processing when paid labour is used.

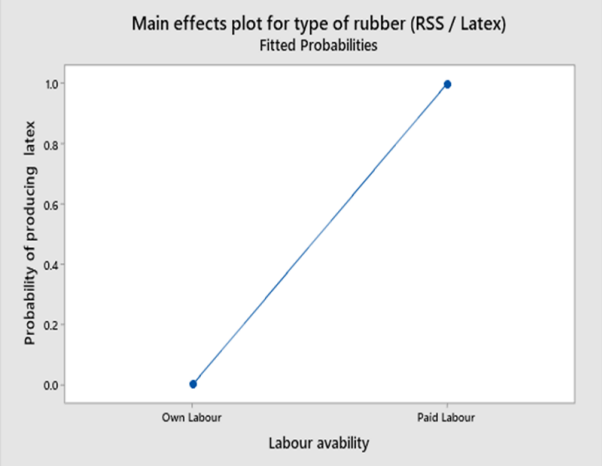

Figure 15: Main effects plot of probability of producing latex (kg) vs Labour availability

Based on the findings of the study, the following suggestions were made.

Among the determinants on rubber products diversification, changing of the produced type of rubber plays a major role which also has a huge impact on the profit. The only processed rubber in Monaragala district is RSS. Hence, other types of rubber which can be processed like Technically Specified Rubber (TSR), Air Dried Rubber (ADR) and Crepe rubber can be introduced.

Rather than delivering field latex to Colombo for producing centrifuged latex, a centrifuging latex factory can be established in Monaragala district because it has sufficient land and labour to establish a centrifuge latex factory.

More group processing centers have to be introduced for processing of RSS to reduce the high demand for group processing centers because now the SPEnDP project has allocated money for the establishment of group processing centers. But the most suggested method is to encourage the smallholders to produce RSS at smallholder level by using alternative techniques which will also reduce the cost of production.

Lack of rubber processing machineries is another major problem among smallholders which attracts them towards high cost group processing centers. Therefore, to overcome these smallholders have to be advised to use alternative techniques like using chimney for smoke drying and using carpets for rolling of the wet sheets because the ultimate results of RSS obtained from alternative techniques and smoke house are same.

Females should be motivated to involve in rubber production. Also, the responsible institutions like RRI and RRD need to pay more attention to rubber processing to meet the needs of the smallholders.

This study only focuses on Monaragala district, the same research can be conducted in Ampara and Badulla districts which are also considered to be non-traditional areas of rubber growing. Similar to Monaragala district, both Ampara and Badulla districts produce either RSS or sell field latex. Hence, identification of future potentials on diversification of rubber products processing is important to Ampara and Badulla districts to continue rubber processing in a sustainable manner.

4. Conclusions

The study intended to investigate the future potentials on diversification of rubber processing by smallholders in Monaragala district. According to the collected data, the female participation for rubber cultivation is very low compared to male population.

There is a statistically significant association of daily production with type of rubber produced, rubber planted land area and labour availability whilst the type of rubber produced has statistically significant associations with place of processing, awareness on processing standards, gender and labour availability.

Out of the total land extent, the rubber planted land extent is very low which is nearly 0.01%. According to the sample data, the majority of

the people have grown rubber in 1-2 acres, but their total land extent is higher than that which has not been used for any cultivation. So, there is a potential to encourage the smallholders to increase the land area of rubber grown and use the land in an optimum manner.

The average daily output of the field latex is 10-15 kg per day which is lower than that of the RRI recommended value of 20-25kg. The only processed type of rubber in Monaragala district is RSS and out of that, the majority produce low grade RSS.

When considering the knowledge on rubber processing, the majority have a fair awareness on rubber processing activities but when it comes to the implementation of correct processing standards and correct storage conditions, the majority are in poor stage. This enhances that even though smallholders are aware of the recommendations, they do not follow them properly. So, by motivating them to follow the recommendations good quality RSS can be produced which can be considered as a potential to diversify the produced grade.

Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this paper.

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