a

Volume: 1, Issue: 1, (August, 2019), pp 41-51
www.rjt.ac.lk/agri/sljae

SRI LANKAN JOURNAL OF AGRICULTURE AND ECOSYSTEMS ISSN: 2673-1401

SLJAE

ORIGINAL ARTICLE

The Most Effective Holding Size for Small Scale Rubber Sector in *Kegalle* District, Sri Lanka

I.R.T.D. Senanayake and G.A.S. Ginigaddara*

Department of Agricultural Systems, Faculty of Agriculture, Rajarata University of Sri Lanka, Puliyankulama, Anuradhapura

Correspondence:
*sanjeewanieg@gmail.com
ORCID: 0000-0001-5561-1544

Abstract

The contribution of the rubber smallholding sector of Sri Lanka to the national rubber production is about 77% and *Kegalle* is a district where a higher number of small-scale rubber production land units are located. Therefore, a study was conducted in major rubber growing divisions of this district with the aim of identifying the most effective rubber smallholding size for the higher productivity. As the study was highly based on primary data, a field survey with 100 small scale farmers was conducted using the multistage random sampling technique. Results of the descriptive analysis revealed that male farmers are dominant (84%) in managing small rubber plantations and only 32% of farmers had 10-20 years of rubber farming experience. The mean productivity and the mean holding size respectively were 180.37 kg /ha/month and 1.27ha. Multiple linear regression using general linear model was used to explain the relationship between productivity with the explanatory variables such as the size of the land, availability of extension services and application of fertilizer and their impact on rubber productivity. The regression results revealed that there exists a significant inverse relationship between land size and the rubber productivity of rubber smallholdings. Regression analysis revealed that extension services for growers, income, and occupation of the household have significantly positive relationships ($p<0.05$) and age of the plantation and rubber variety have a significant inverse relationship with productivity ($p<0.05$). Response surface with a simple optimum result confirmed that the effective land size which yields higher productivity is 0.79 ha for small rubber holdings in *Kegalle* district. Hereafter the results imply that it is vibrant to take initiatives to promote small scale rubber plantations for more productivity than bigger estates.

Keywords: *Effective land size, Kegalle district, Productivity, Rubber, Smallholders*

Date of Submission: 09-05-2019 Date of Acceptance: 17-07-2019

1. Introduction

Rubber is a commercially important plantation crop in the world as well as in Sri Lanka. It is a prime export agricultural crop that brings foreign exchange to the country. In 2014, Sri Lanka produced 98,570 metric tons of natural rubber and nearly 17% of that was exported (SLDB 2017). Contribution of the Rubber sector to the worlds' total and natural rubber production is 0.7% and 1.9% respectively (Samarappuli et al. 2014). In 2013, the contribution of these sectors to the GDP of Sri Lanka is 0.9%. Furthermore, it is the second most important commodity in terms of foreign exchange earnings and employment generation (CBSL 2014).

Rubber plantation sector in Sri Lanka consists of two sub-sectors namely the smallholding sector and the estate sector. In 2013, rubber extent of Sri Lanka is 133,668 ha of which 85,083 ha (63.4%) are rubber smallholdings (plantations of < 20 ac) which are scattered in 19 districts in the country. The total land extent under rubber in the country has reduced from 171,126 ha to 114,681 ha from 1982 to 2002 whereas the reduction of land extent is 56,445 ha during this period. At the same time, a 24% decline in rubber production from 130,420 to 98,573 metric tons was reported from 2013 to 2014 (CBSL 2014).

A gradual decline in contribution to the national production of prevailing rubber plantations has been observed during the last 34 years from 1980 to 2014. On one hand, domestic rubber consumption has been increased over time creating a gap between rubber production and the actual demand, mainly due to the change occurred in alternative land uses in traditional rubber growing areas in the wet zone of Sri Lanka (Samarappuli et al. 2014). On the other hand, scarcity of cultivable lands limits the expansion of plantations. Therefore, it is vital to raise the productivity of existing rubber lands to sustain the system and to minimize the prevailing gap between the production and the actual demand.

Land size of the plantation is one of the major factors affecting rubber productivity (Thapa, 2007). There exists an inverse relationship between the productivity and the size of any agricultural farm according to Mazumdar (1965), Srinivasan (1972) and Jayalath et al. (2007). Srinivasan (1972) argued that the use of lands more intensively by utilizing own resources and exchanged labor are higher in larger farms though the success of the harvest is uncertain and which will ultimately lead lower productivity in their farms.

It transpired that there prevails a significant negative relationship between land size and productivity for home gardens and small scale coconut plantations in Sri Lanka. However, there is a lack of empirical evidence for the relationship of land size and productivity of smallholder rubber plantations of Sri Lanka. Thus, it's timely and nationally important to investigate the relationship between land size and productivity of rubber, and it was the focal point of this study. This study was conducted

with small scale rubber plantations in *Kegalle* district of Sri Lanka.

2. Material and Methods

Three Rubber Development Officers' (RDO) divisions[1] in *Kegalle* district which recorded the highest number of rubber smallholder namely Dedigama, Ruwanwella and Galigamuwa were purposely selected which include more than 50% of total rubber extent in *Kegalle* District adopting stratified random sampling method. A sample of ten Grama Niladhari (GN) divisions namely Warakapola, Malmaduwa, Algama, Mahapallegama, Amithigala, Ruwanwella, Galapitamada, Pindeniya, Damunupola, and Weragoda were selected from the above-stated divisions in order to include more than 50% of total rubber plantation extent. A random sample of 100 farmers who owned matured plantations (6-35 years of age) was drawn from the lists maintained by the rubber development officers in respective areas.

Using a pre-tested structured questionnaire, data were collected during the period from April to June 2017 via face to face interviews. Details of respondents' profile, production and socio-economic characteristics, rubber cultivation details and farmer perceptions on small scale rubber cultivation were recorded. Key personal interviews with directors and rubber development officers of the regional office of the department of Rubber Development, *Kegalle* and the committee members of farmer organizations were also conducted. Both qualitative and quantitative techniques were employed to analyze data. Descriptive statistics, multiple linear regression using General Linear Model (GLM) and response surface with a simple optimum was used to analyze the data to find the most effective holding size for the higher productivity in *Kegalle* district. Delivery of extension services, fertilizer application (kg/ha), farming experience of the Landholder (years), income/month (Rs.), number of tapping plants/ac, land size (ha), age of the plantation (years), labor used (man-days/ha), occupation of the landholder, rubber variety and land suitability were used as independent variables while productivity was used as the dependent variable. The r-square value was premeditated to validate the regression model.

3. Results and Discussion

3.1 Descriptive Statistics

Results revealed that the majority of the respondents are married males (84%) with the age between 40 and 70 years while the mean was recorded as 58 years. This reveals the fact that rubber cultivation has become less popular among youths. All respondents had received some form of formal education and were literate. Their farming experience ranged from 2 to 60 years with a mean of 27 years and nearly one-third of the respondents were with 10 to 20 years of farming experience. It was also revealed that the majority of the planters are newly emerged ones while more-aged people in the study area have been engaged in rubber cultivation throughout their life.

The mean actual productivity of the area was 29.15 kg ha^{-1} $month^{-1}$ while the targeted productivity was recorded as 56 kg ha^{-1} $month^{-1}$.

Thus, there prevailed a wide gap between realized and targeted levels of productivity of the rubber smallholdings in *Kegalle* district.

The mean land size of a holding was 1.27 ha, with a range of 0.1 – 8.1 ha. The majority (89%) of the holdings were between 0.1 and 2.02 ha of holding size which was relatively a smallholding size. The age of rubber plantations was ranged from 6 to 35 years with a mean age of 13.7 years. More than 50% of the rubber plantations were within the age range of 5 to 15 years denoting that most of the plantations are young plantations. The number of tapping plants per ha was high as 103 in some plantations while it was as low as 28 plants per ha in some other plantations with a mean number of 66. Moreover, the correct stand per hectare recommended by the Rubber Research Institute (RRI) is 200 trees. Hence, the plantations in the study area were not maintained as per the RRI recommendations.

a. Factors Affecting Productivity

Factors affecting the productivity of small-scale rubber plantations in *Kegalle* district were examined using a multiple linear regression function. Majority of the explanatory variables included in the model were categorical variables (i.e., extension services, fertilizer application, occupation of the farmer, rubber variety and land suitability) while some variables were continuous (i.e., farming experience, income, land size, number of tapping plants, labor usage and age of the plantation).

Table 1: Determinants of Productivity (kg/ha) of Small-Scale Rubber Plantations

Variable	Pr>t
Extension Services	<.0001*
Fertilizer Application (kg/ha)	0.6482
Farming Experience of the Landholder (Years)	0.6910
Income (Rs /month)	0.0408*
Land Size (ha)	0.0257*
Number of Tapping Plants (plants/ha)	1.8849
Age of the Plantation (years)	0.0478*
Labour Used (number of man days /ha)	2.4752
Occupation of the Landholder	0.0422*
Rubber Variety	0.0065*
Land Suitability	0.7954

*** Significant at 5% level**

Source: Field Survey (2017)

Results revealed that extension services, income, land size, age of the plantation, occupation of the farmer and rubber variety have significant relationships with productivity. Other variables such as fertilizer application, the farming experience of the landholder, number of tapping plants/ha, labor usage/ha and land suitability were not significantly contributing in explaining the rubber productivity of smallholdings in *Kegalle* District.

3.2 Parameter Estimates of the Factors Affecting Productivity of Small-Scale Rubber Plantations

Table 2 reports the results from regression analysis between the productivity, land size and other parameters which were considered in the study. Out of 11 explanatory variables comprised in the model, the results indicate that the extension services, income, and occupation

had a significantly positive relationship while the land size of the plantation, age of the plants and variety showed a significantly negative relationship with the productivity of small-scale rubber plantations (*p=0.05*).

Table 2: Impact of the Levels of the Variables on Productivity

Variable		Estimates	Pr Value
Extension Services	1	40.588	0.0007*
Extension Services	2	15.030	0.1815
Extension Services	3	5.935	0.6356
Extension Services	4	-7.999	0.6339
Extension Services	5	0	-
Fertilizer Application	1	9.229	0.2619
Fertilizer Application	2	0	-
Farming Experience of the Landholder		-0.084	0.6910
Income		0.000	0.0408*
Land Size		-4.012	0.0104*
Number of Tapping Plants/ha		0.0074	0.7615
Age of the Plantation		-1.179	0.0478*
Labor Used/ha		28.846	0.1091
Occupation of the Landholder	1	26.904	0.0108*
Occupation of the Landholder	2	27.716	0.0179*
Occupation of the Landholder	3	31.299	0.0076*
Occupation of the Landholder	4	9.582	0.4752
Occupation of the Landholder	5	36.799	0.0739
Occupation of the Landholder	6	0	-
Rubber Variety (RRIC 121)	1	-99.270	0.0202*
Rubber Variety (RRIC 100)	2	-85.374	0.0602
Rubber Variety (PB 86)	3	-116.339	0.018*
Rubber Variety (RRISL 102)	4	-126.065	0.0286*
Rubber Variety (RRIC 103)	5	-125.186	0.048*
Rubber Variety (RRISL 203)	6	0	-
Land Suitability	1	20.657	0.5018
Land Suitability	2	17.603	0.5367
Land Suitability	3	0	-

*** Significant at 5%**

Source: Field Survey (2017)

Land size of the plantation showed a significantly negative relationship with productivity explaining the fact that when increasing the land size of smallholding rubber plantations, the productivity of the plantation declines. Parameter estimates -4.0125 indicates if land size increase from one ha, the productivity of the land will be decreased by

4.01kg per ha. It explains that small plantations are more productive than larger estates (Fig 1.). Furthermore, land productivity decreases rapidly when the land size increases up to 8.09 ha within the smallholder category. Hence the larger plantations are difficult to manage by the landholders individually. Smaller plantations have a more relative advantage of using family labour as it reduces the cost of monitoring and supervision of hired labour. It reveals that small farms perform better than large farms within the smallholder category. Jayalath et al. (2010) also reported similar results indicating that there exists a significant inverse relationship between land size and productivity of coconut lands in Sri Lanka for home gardens and smallholders. Moreover, Thapa (2007) has suggested that small farms, in general, are more productive compared to larger ones.

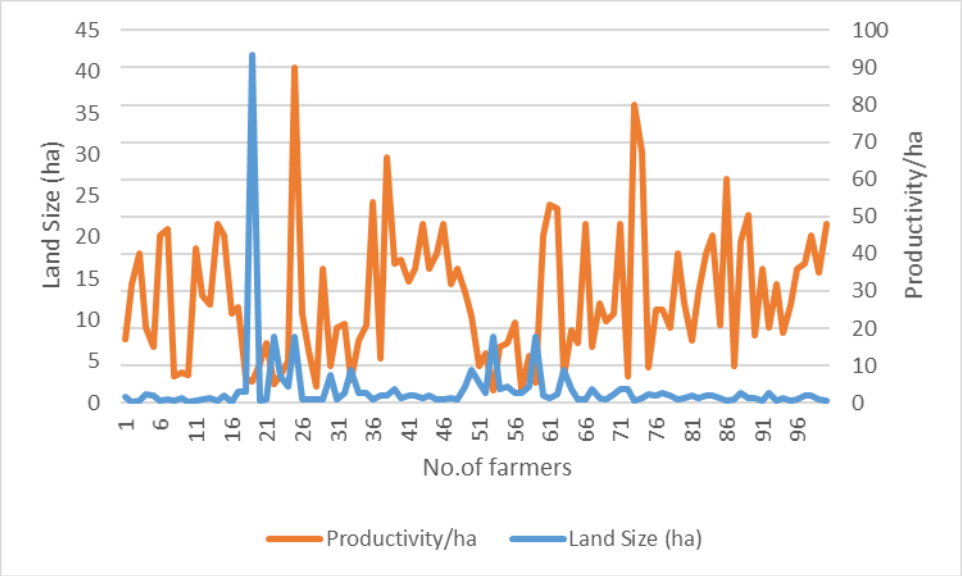

Figure 1: Variation of Rubber Productivity with respect to Land Size

Source: Field Survey (2017)

The productivity level of each plantation was plotted against the size of the land (Fig. 1). The graph illustrates that the productivity tends to increase of majority of plantations when there is lower land size explaining higher productivity in the lesser land extents within 0-5 acreage category.

The results indicated that the extension services have a significantly positive relationship with productivity. Parameter estimates of 40.588 indicate that if extension services are excellent, the productivity of rubber plantations will be increased by 40.588 kg per ha. It implies that farmers become more aware of new technologies, new varieties, agronomic practices, and market channels when extension services are better provided. Hence better extension services could enhance the productivity of rubber plantations. It transfers skills to farmers to apply them in the real world. Therefore, an effective agricultural extension service can contribute to improving rubber

productivity with increased output, and household income for the economy by bridging the gap between educational discoveries in extension providers and status in individual farmers. Further Evenson and Mwabu (2001) reported that the productivity effect of agricultural extension is highest for farmers at the extreme ends of the distribution of yield residuals.

As illustrated in table 2, the income of the rubber landholders showed a significantly positive relationship with rubber productivity. Parameter estimate value implies that when monthly income increases by Rs.1000, productivity per ha will be increased by 0.2360kg/ha. Received income of landholders from any other sources is more stable than from sole rubber cultivations. The return for their investment was comparatively low. Hence, they refused to invest more on rubber plantations to increase productivity. One of the major reasons behind this phenomenon is the low income on investment with lower market prices and high rubber price fluctuation. Landholders are unable to hire the required number of labourers due to the higher labour cost than income from the land in return. Especially, as new management practices tend to increase the production cost, re-planters tend to replace their rubber plantation with some other crops.

Majority of the farmers were not pleased with the income gained from rubber and according to their perception, it was not sufficient to cover their cost of production. Most farmers revealed that a larger portion of their income goes to the tappers leaving a smaller portion for them. A high cost of production due to the high cost of labour compared to the crop management practices such as weeding and fertilizer application was observed and hence farmers were reluctant to perform crop management practices properly. It agrees with the findings of Edward (2011). Furthermore, the results revealed that there exists a positive and significant relationship between the farmers' income and the farm yield. Hence farmers could be spending more money on their farms to buy vital farm inputs for increasing productivity. The income may also be used to hire farm labour. According to Oluwasola et al. (2008), a household that is pressurized by other family needs such as school fees and clothing, spends less on farming and hence is more likely to get lower farm yields. Increased income also increases the chances of adoption of new technology that improves farm yield. For better yields, farmers need to use improved seeds and adequate fertilizers.

A significantly negative relationship was observed with age of plants and productivity among matured small-scale rubber plantations in *Kegalle* district. Parameter estimate values imply that when the age of the plantation increases by one year, productivity will be reduced by 2.92 kg per ha. When the age of the plants is increased beyond a critical stage of 20 years, the productivity of plantations would be reduced due to the reduction of the economic

value of rubber trees with the reduced latex yield and quality.

The results indicated that the occupation of rubber landholders has a significantly positive relationship with rubber productivity. With reference to the landholders who are engaged in other occupations, government sector occupants proved a more significant effect on rubber productivity. This is due to their stable and secured income than in other sectors. A study conducted by Edvard (2013) in Kenya reported that 50% of respondents receive their income from non-farm work or businesses. The income gained from any other occupation could be used to supplement other income for family use and farm expenses. This could be attributed to the fact that the farmers could be spending more money on their farms to buy vital farm inputs for increased productivity. Hereafter, the farmers are reluctant to engage rubber cultivation as a full-time occupation due to the instability of the income.

Rubber varieties can be categorized as newly introduced and traditional varieties (RRISL102, RRIC103, RRISL203 as newly introduced and PB86 as traditional). The rubber variety grown has a significantly negative relationship with productivity. Variety RRIC100 has no significant difference with reference to the variety RRISL203. When considering six varieties, variety 1 (RRIC100) and variety 6 (RRISL203) had more effect on productivity than other varieties titled RRIC121, PB86, RRISL102, and RRIC103.

Greater portion of land extents (93%) were cultivated with older varieties (RRIC100, RRIC12, PB86) and very few extents (7%) which were planted with new varieties could be observed. It reveals, that the majority of the farmers who planted their holdings lately (immature holdings) had newly improved clones (RRISL102, RRIC103, RRISL203) and some farmers still grow traditional varieties as PB 86, which is low yielding and succumbs to most of the rubber diseases. Tilekeratne (1996) further stated that newly introduced RRIC clones such as RRIC 100, 102 and 121 are yielding nearly double compared to the traditional PB 86 clone.

3.4. Results of the Analysis for Optimum Land Size and Higher Productivity

Only the significantly affected variables on the productivity of the rubber plantations were used in the Canonical Analysis (Table 03). Size and age of the plantation as continuous variables and occupation and income as categorical variables were used keeping the varieties 01 (RRIC121) and 02 (RRIC100) as references in the analysis.

Table 3: Critical Values of Canonical Analysis of Response Surface Based on Coded and Uncoded Data

Variable	Coded values		Uncoded values	
	Variety 1	Variety 2	Variety 1	Variety 2
Land Size	-0.810213	-0.683355	0.8595	0.7428
Income	-0.926201	-1.063647	24228	- 1041.55
Age of the plantation	0.214001	-0.437321	14.89	14.15
Occupation of the landholder	-0.801771	-1.352587	1.49	0.11

Source: Field Survey, 2017

According to table 03, variety showed a significant relationship with the productivity of rubber plantation. Survey identified six varieties of rubber which are cultivated in *Kegalle* district. When considering the percentage values of varietal distribution data, it shows that majority of the plantations has cultivated variety 1 (RRIC121) and variety 2 (RRIC100) representing more than 75% from the sample while variety 3 (PB86) represents, 18% and variety. The varieties 4 (RRIC102), 5 (RRISL103) and 6 (RRISL203), represent only 7% of the sample. However, in this study, varieties one and two have only been considered to determine the optimum productivity and other varieties have been fixed in the model.

The uncoded critical value of land size for variety one was 0.85. It revealed that the optimum land size for rubber plantations which cultivated variety one was 0.85 ha. The uncoded critical value of land size for variety two was 0.74. Further, it revealed that optimum land size for variety two as 0.74 ha, which yields higher productivity. Then the average optimum land size can be identified as 0.79 ha in extent for higher productivity probably due to the easily manageable nature of small lands by the landholders. Consequently, the productivity of the small scale rubber plantations tends to decline when increasing the size of the land.

Table 4: Model Summary

Model	R-Square	Pr value	Yield Mean
1	70.71	<.0001	70.71

Source: Field Survey data 2017

The R-Square value indicates how much of the total variation in the dependent variable can be explained by the independent variable. The R-Square gives 70.70 which indicates that 70.7% of the variance in the model is explained by the extension services, income, land size, age of the plantation, occupation, and variety (Table 4). The rest of 30% of land productivity is explained by other factors. Therefore, it can be concluded that this regression model is reasonably fit for the data.

4. Conclusion

The study concludes that there is an inverse relationship between the land size and

productivity in small scale rubber plantations in *Kegalle* district. Rubber productivity significantly depends on the size of the holding and is set up to be optimum of 0.79 ha average-sized lands which gives higher productivity. Results emphasize that the promotion of rubber cultivation in the smallholding sector with lesser land extents is more effective in the *Kegalle* district in Sri Lanka since they were verified to be highest productive from this perspective.

5. References

Benjamin D and Brand L (2002) Property Rights, Labor Markets, and efficiency in a Transition Economy: The Case of Rural China. *The Canadian Journal of Economics*, Vol. 35(4): 689-716.

Central Bank of Sri Lanka (CBSL) (2014). Annual Report of 2013. Colombo. Sri Lanka.

Edward O B (2013) Social-economic factors affecting farm yield in Siaya district, Siaya country, Kenya, Unpublished M.Sc. thesis submitted to the Project Planning and Management Department, University of Nairobi.

Evenson R E and Mwabu G (2001) The effect of agricultural extension on farm yields in Kenya. *African Development Review*, 13(1): 1-23.

Griffin K, Khan A R, Ickowitz A (2002) Poverty and Distribution of land. *Journal of Agrarian Change*, Vol 2 (3): Pp 279 .330 DOI: 10.1111/1471-0366.00036.

Jayalath K, Pathiraja P, Jayasinghe-Mudalige, U, Fernando M (2012) An Empirical Investigation on the Effect of Land Size on its Productivity of Coconut Plantations in Sri Lanka. *COCOS*, 19(2). 67-75.

Mazumdar (1965) A Problem of Indian Peasant Agriculture. *Economica,* New Series, Vol. 32, No. 126, pp. 161-173 Doi:10.2307/2552546.

Oluwasola O, Idowu E O and Osuntogun D A (2008) Increasing agricultural household incomes through rural-urban linkages in Nigeria. *African Journal of Agricultural Research*,3 (8):566-573. Retrieved from: http://www.academicjournals.org/AJAR.

Samarappuli L, Wijesuriya W, Dissanayake D M A P, Karunarathne S B, Herath H M J K (2014) Land Suitability for Sustainable Rubber Cultivation in Moneragala District. *Journal of Environmental Professionals Sri Lanka*: 3(1), 10.4038/jepsl. 3(1):7313

Sri Lanka Export Development Board (SEDB) (2017) Improving Sri Lanka's Rubber Sector with New Breeds and Varieties. Available online at http://www.srilankabusiness.com/blog/new-rubber-clones-to-develop-rubber-industry-sri-lanka.html. Retrieved on 20.05.2017.

Srinivasan T N (1972) Farm size and productivity implications of choice under uncertainty. Sankhyā: The Indian Journal of Statistics, Series B: 409-420.

Thapa S (2007) The relationship between farm size and productivity: empirical evidence from the Nepalese mid-hills. Paper presented at the 106th seminar of the EAAE Pro-poor development in low-income countries: Food, agriculture, trade, and environment 25-27 October 2007 – Montpellier, France.

Tillakeratna L M K (1996) How to increase the productivity of rubber in the national year of productivity? Bulletin of the Rubber Research Institute of Sri Lanka. 34:22-25.