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An Analysis of the impacts of Labour Scarcity on Land Productivity in Sri Lankan Tea Plantations

H.W. Shyamalie*, B.M.N.C. Karunarathne, H.M.C.G. Pilapitiya, P.T.P. Lakshani, T.H.I. Chathuranga and K.W.N. Nadeeshani

Agricultural Economics Division, Tea Research Institute, Talawakele, Sri Lanka

ABSTRACT

Tea is a labour - intensive industry and labour scarcity is being felt as a major impediment in the sector. The objectives of this study were to determine annual labour declining rates in different tea growing regions, to determine severity of labour scarcity in the selected estates, and to assess the effect of severity of labour scarcity on land productivity. Stratified Random Sampling Technique was used to select the sample containing 66 large estates in Sri Lanka. Data were collected from the estate records for a ten-year period (2006-2015). Estates were categorized into four groups, based on its severity of labour scarcity. Chi-Square tests were performed to compare the productivity of the estates affected by labour scarcity with the estates that were not affected by labour scarcity.

Annual labour declining rates in Up country, Mid country, Uva and Low country were 2.94%, 4.87%, 4.22% and 5.06%, respectively. Results also showed that mean land productivity declined with the increase in labour scarcity. The productivity gap between the estates which were not affected and affected by severity of labour scarcity were correlated. Regression analysis revealed that VP tea, extent in bearing and region of tea cultivation had positive significant effects on land productivity. Further, plucker scarcity showed a negative significant impact on land productivity. Since these findings highlighted the importance of identifying solutions to labour scarcity, action has to be taken to attract and retain labour in tea plantations and to promote mitigation measures such as adopting labour saving techniques to overcome this problem for a sustainable tea industry in Sri Lanka.

*Corresponding author : rchamath@yahoo.com

INTRODUCTION

Plantation sector plays an important role in the Sri Lankan economy in terms of revenue generation and employment opportunities. This sector directly employs about 161,557 workers, which accounts for 2% of total workforce in Sri Lanka (Ministry of Plantation Industries, 2016). Within the plantation sector, a majority of workers are found in the tea sector (88%) with a highest value of labour per hectare of 2.87 relative to rubber and coconut (Ekanayake, 1995). Each agronomic and processing step from nursery to the end product requires more labour than it does with other crops (Sivaram and Herath, 1996). The most labour - intensive activity is harvesting and it accounts for about 65% of the workforce in an estate (Wijeratne, 2008) and about 57% of the total labour required for all field practices. Cost of harvesting too accounts for 45 % of the total Cost of Production (COP). Weeding is the second-most labour intense field activity (Prematilake, 2003) accounting for 9% of the total labour requirement. Particularly, on account of Maximum Residue Level (MRL) issues, chemical weed control has been limited thus promoting the use of manual weeding, which is laborious and time consuming. Fertilizer application remains to be a manual operation too (third most labour intensive activity, accounting for about 5% of the total labour requirement) (Prematilake, 2003). The labour days involved for this activity is about the same across different fields, with the exception of fields with very high productivity levels, which require additional rounds of fertilizer application. Pruning is important for maintaining the tea bush in the right form and at the right height both for its growth and the ease of plucking. Pruning is also a labour-intensive activity. For maintaining one hectare of tea land yielding 1000 kg of made tea, 533 labour days are required and the labour requirement for high yielding fields can be higher (Sivaram and Herath, 1996).

The extent of tea lands in Sri Lanka remained to be 203,000 ha in 2018 (Central Bank, 2018). However, number of registered workers in the plantation sector has declined by 42% from 405,304 in 1990 to 161,557 in 2016 (Ministry of Plantation Industries, 1990; Ministry of Plantation Industries, 2016). This implies that workers have moved away from the estates. This decrease in labour is likely to have affected the planned estate activities. Meanwhile, only a few estates (27% of the total) adopt mechanical devices for agricultural practices such as plucking and pruning (Wijeratne, 2012; Shyamalie *et al.,* 2016). Unlike with other tea producing countries, there are limitations for the adoption of mechanical devices in tea plantations in Sri Lanka, such as undulating terrains, topography, low bush density etc. (Wijeratne, 2003).

The labour scarcity exists when there is a mismatch between labour demand and supply. Considerable changes have taken place both in the estate sector and the macro environment of the country that have influenced the supply and demand of workers in tea plantations. Labour supply in tea estates mainly depends on two factors; the availability of workers who are willing to work in the estates and the frequency with which they report to estate work when work is offered (Dunham *et al.,* 1997). However, the problem of labour scarcity is aggravated further by their irregular attendance or absenteeism. Given the stigma attached to working in estates, traditional management practices and the harsh working conditions due to the very nature of work, the estate inhabitants, more educated and politicized youth in particular, do not give preference to estate employment (Dunham *et al.,* 1997; National Institute of Plantation Management, 1998). To aggravate the problem, even the workers who remain on the estates do not report to work regularly when the work is offered.

Tea land productivity is influenced by many factors. Age of tea bushes and adoption of agricultural practices (soil management, infilling and management, shade and drainage) affected tea production (Basu, 1969; Chakravarti *et al.,* 1992). Materials used, technology, weather conditions, variety of tea, soil condition and rainfall also influenced the tea production (Laskar and Thappa, 2018). The effects of a number of genotypic, environmental and management

factors on tea yield are quantified by Dutta *et al.* (2012). Rate of fertilizer use and number of tea varieties propagated were significant in influencing tea productivity (Mwaura *et al.*, 2008). Prevalence of acute labour scarcity has affected the productivity levels of almost all crops and even lead towards the permanent changes in the cropping pattern (Prabakar *et al.*, 2011). Labour scarcity of the tea sector affects all agricultural practices, especially the harvesting and leads to reduced land productivity and total tea production. Due to plucker unavailability, the plucking round may be extended, resulting in lower leaf standard and reduced tea production (with high percentage of coarse leaves) (Wijeratne, 2003). Labour scarcity in the tea sector affects not only the agricultural practices, but also land development programs such as new planting, replanting and infilling of vacancies.

In this background the present study focused on the study of labour scarcity in large tea plantations (Tea lands having extent of greater than 50 acres were considered as large tea plantations in Sri Lanka). The objectives of this study were to calculate annual labour declining rates in different tea growing regions, to calculate severity of labour scarcity in each selected estate and to assess the effect of severity of labour scarcity on the land productivity in tea plantations.

MATERIALS AND METHODS

Sampling procedure

The study was undertaken in corporate sector tea estates representing all Up, Mid, Uva and Low country regions in Sri Lanka. Stratified Random Sampling Technique (SRST) was used to select the 66 sample estates (Table 1).

Table 1: Sampling details.

Region	Total number of estates	Number of sampled estates
Up country	128	30
Mid country	51	12
Uva	55	12
Low country	49	12
Total	283	66

Collection of data

Secondary data were obtained from the estate records for a ten-year period, from the year 2006 to 2015. The monthly progress reports and financial accounts of each tea estate were used as data sources. Data were collected on changes of annual workforce, land productivity in terms of made tea (kg/ha/year), tea extent (ha), types of tea, monthly labour availability (labour/ha), monthly labour requirement (labour/ha), and labour saving techniques in each selected estate.

Analytical procedure

Calculation of annual labour declining rate

Annual labour declining rate for the ten-year period was calculated using the following equation:

Annual Declining Rate

$$= \left\{ \left(\frac{\text{Starting Value}}{\text{End Value}} \right)^{1/t} - 1 \right\} * 100$$

Where,

t = number of years

Calculation of severity of labour scarcity

Severity of labour scarcity (%) was calculated using the following formulas:

$$\text{Demand and Supply Gap} = \text{labour requirement} - \text{labour availability}$$

$$\text{Severity \%} = \frac{\text{Demand supply gap}}{\text{Total labour requirement}} * 100$$

Labour demand and supply gap were assessed by considering the annual/monthly labour requirement (demand of labour) and the annual/monthly man days available in each estate (supply of labour).

For the ease of analysis, results of labour scarcity were categorized into four groups namely, severe (labour availability, less than 50% of the requirement), high (labour availability, 50 – 75% of the requirement), moderate (labour availability, 75-100 % of the requirement) and adequate/ excess (labour availability adequate/ exceeds requirement).

Assessing effect of severity of labour scarcity on land productivity

Chi - Square test

Chi - Square tests were performed to compare the land productivity of estates as affected by the degree of labour scarcity (moderate, high and severe) in comparison to the estates that were not affected by labour scarcity.

Regression analysis

A multiple regression analysis was employed to determine the relationship between estate land productivity and field characteristics, labour scarcity and use of labour saving techniques such as mechanization of suitable agricultural practices and alternative worker deployment models using the data in year 2015. In addition to traditional labour deployment system, estates practice different worker deployment arrangements such as contract farming, block plucking, contract work, cash work etc. in order to increase labour and land productivity (Shyamalie *et al.*, 2013). Dummy variables for Mid country, Up country and Uva tea growing regions were included to represent environmental factors (climate, soil etc.) and it was assumed that there is no variation in environmental factors in the estates located in the same region. The variables were, types of tea, age and the management factor, since seedling tea gardens were very old and less attention has been given in the management. The log-log function used in this study is given in the following equation:

$$lnY = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + e$$

Where,

Y = estate average land productivity (kg/ha/yr.)

X_j = field characteristics, use of inputs and labour saving techniques of ith estate

j = 1, 2, 3, 4, 5, 6

X_1 – Extent in bearing (ha)

X_2 – Plucker scarcity (PLUCKERSC) (As %)

X_3 - Sundry worker scarcity (SUNLABSC)(As %)

X_4 – Type of tea (Dummy variable, if VP=1, otherwise =0)

X_5 – Use of mechanical devices (MECH) (Dummy variable, if use=1, otherwise=0)

X_6 – Practice alternative worker deployment models (AWDM) (Dummy variable, if practice=1, otherwise=0)

X_7 - Mid country (Dummy variable, If the tea land located in Mid country =1, otherwise=0)

X_8 - Up country (Dummy variable, If the tea land located in Up country =1, otherwise=0)

X_9- Uva region (Dummy variable, If the tea land located in Uva region =1, otherwise=0)

$\beta_i's$- Unknown parameters to be estimated

e- Error term

Descriptive analysis

Descriptive analysis was used to study characteristics of sample estates and to calculate mean land productivity level in each severity group.

RESULTS AND DISCUSSION

Characteristics of sample estates

Average land productivity, extent in bearing and use of mechanical devices and alternative worker deployment models were analysed. The average productivity of 28 estates (42% of the sampled estates) was below 1000 kg/ha/year. However, 18% of the sampled estates had a productivity level exceeding 1600 kg/ha/yr. Extent in bearing of sampled estates were grouped into three categories (>150 ha, 150-250 ha and <250 ha) and approximately one third of the estates were categorized into each group. Of the total sampled estates, 20 estates used mechanical devices, while 17 estates adopted different alternative worker deployment models.

Changes in annual workforce in different tea growing regions

The data presented in Figure 1 shows four clusters representing Up country, Mid country, Uva and Low country, and a gradual decline of total workforce can be observed in the sampled estates in all regions during the period 2006-2015.
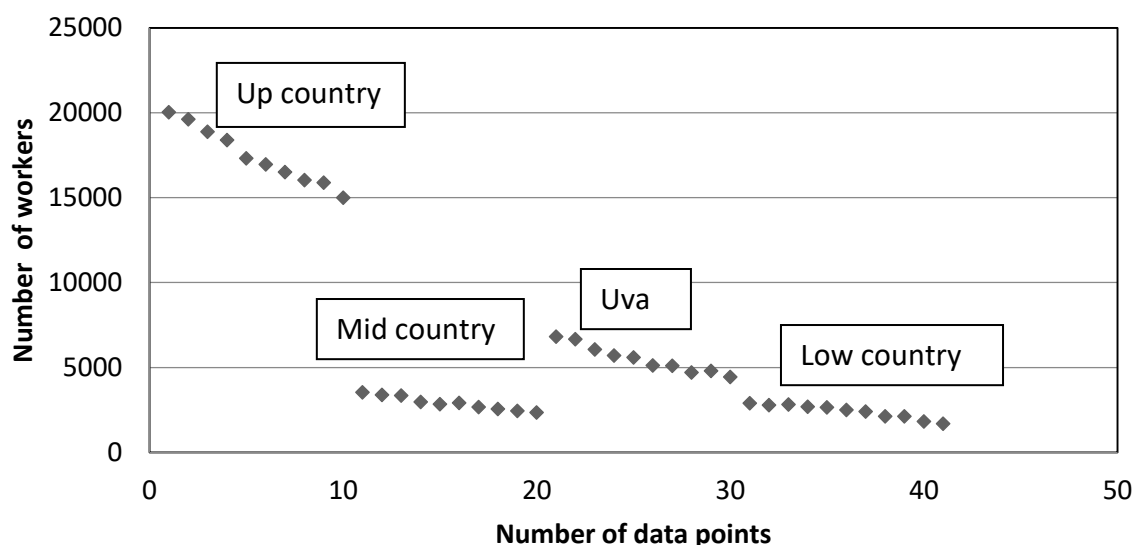

Figure 1: Annual variation of total workforce in different tea growing regions, during the period 2006-2015. Each point represents the number of workers in a given consecutive year.

Table 2 represents the annual rates of workforce decline in all tea growing regions over the given 10-year period. It is revealed that the highest annual decline was observed in the Low country at 5.06%. The reason for this may be migration of labour from the estate sector to small holder tea lands where 77% of smallholdings are located. The lowest rate was recorded in the Up country at 2.94%. The rates of decline in the Mid country and Uva region were 4.87% and 4.22%, respectively.

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Table 2: Annual workforce decline during 2006-2015.

Region	Workforce in sampled estates		Annual rate of workforce decline (%)
	2006	**2015**	
Up country	20029	14994	2.94
Mid country	3523	2334	4.87
Uva	6812	4430	4.22
Low country	2891	1824	5.06

Severity of labour scarcity in tea plantations

Many reasons affected the labour availability, such as migration to urban areas, self-employment and diversification of farming towards other crops (Rymbai *et al.*, 2012). Monthly labour requirement of the estate has been calculated based on land productivity, plucking rounds and the extent to be allocated for other agricultural practices, according to the Tea Research Institute's recommendations. Estates were categorized into four groups based on severity of labour scarcity; adequate or labour in excess, moderate labour scarcity (labour availability in between 75 – 100 % of the requirement), high labour scarcity (labour availability in between 50-75 % of the requirement) and severe labour scarcity (labour availability less than 50% of the requirement).

As presented in Table 3, majority of the sample estates (56%) belonged to high or moderate labour scarce category, irrespective of the elevation. In Up country and Uva regions, percentage of sampled estates under "severe" category was higher than in the other elevations. The results also revealed that, only three sampled estates (5% of total respondents) had excess labour.

Table 3: Number and percentages of estates with different severities of labour scarcity.

Category of labour shortage	Up country		Mid country		Uva		Low country		Total	
	No. of estates	%	No. of estates	%	No. of estates	%	No. of estates	%	No. of estates	%
Severe	4	13	0	0	2	17	1	8	7	11
High	14	47	4	33	3	25	4	33	25	38
Moderate	11	37	7	58	7	58	6	50	31	47
Adequate/ excess	1	3	1	8	0	0	1	8	3	5
Total	30	100	12	100	12	100	12	100	66	100

Effect of severity of labour scarcity on land productivity

There was a monthly variation in the demand and supply gap in the estates and therefore, monthly severity of labour scarcity was also studied. Mean monthly land productivity for each level of severity which was calculated considering monthly labour demand and supply gaps is presented in Table 4. Data clearly showed that mean monthly land productivity declined with the increase of labour scarcity. A similar study conducted in the Cuddalore district of Tamil Nadu, India, also revealed that there was a yield reduction, invariably in all crops in labour-scarcity-affected farms (Prabakar *et al.*, 2011).

The land productivity levels were categorized into four groups, i.e., below 60 kg/ha/month (group 1), 61-120 kg/ha/month (group 2), 121-180 kg/ha/month (group 3) and above 180 kg/ha/yr. (group 4). As presented in Table 5, results of the Chi-Square test revealed that there was a very strong relationship between severity of labour scarcity and differences in productivity levels of the estate (Chi-Square =30.740, df =9, p<0.001). The productivity level moved towards the low productivity levels with labour scarcity.

The mean differences of land productivity between different geographical locations (Up country, Mid country, Uva and Low country) for each category of labour scarcity (group 1-4 as above) were also studied. The Chi-Square test results revealed that there was a strong relationship between severity of labour scarcity and differences in productivity levels for Up country (Chi-Square =22.607, df =9, p<0.001) and Mid country (Chi-Square =23.057, df =9, p<0.001). There was no association between the severity of labour scarcity and differences in productivity levels for low country and Uva.

Table 4: Mean monthly land productivity of estates with different labour severities.

Category of labour shortage	Mean land productivity (kg made tea/ha/month)
Adequate/ excess	118.27
Moderate	115.56
High	101.06
Severe	92.65

Table 5: Results of Chi-Square test showing relationship between severity of labour scarcity and differences in land productivity.

	Value	df	Significant level (2-sided)
Pearson Chi-Square	30.740	9	0.000
Likelihood Ratio	30.599	9	0.000
Linear-by-Linear Association	7.170	1	0.007
N of Valid Cases	600		

Table 6: Mean differences of land productivity (kg made tea/ha/month) between estates affected and not affected by labour scarcity.

Severity level category (a)	Severity level category (b)	Mean Difference of land productivity (a-b)	Change as a %
Adequate/ excess	Moderate	2.71	2.29
	High	17.21	14.55
	Severe	25.61	21.66

The changes in land productivity of estates that were affected by labour scarcity to different extents were compared with the estates that had adequate labour, and Table 6 shows these results. The results confirmed that the gap in mean land productivity without labour scarcity and Table 7 reports the results of Chi-Square test that was employed to examine whether there was a significant difference in land productivity between estates affected by all levels of labour scarcity and those that were not affected by labour scarcity. The results revealed that there was no significant difference in productivity between estates that were affected and not affected by labour scarcity.

Tables 8 and 9 present the results of Chi-Square tests conducted for the association

with labour scarcity increases with the rise in severity of labour scarcity. The productivity of estates that were severely affected by labour shortage dropped by more than 25% compared to that of the estates with adequate amounts of labour.

in productivity between different labour scarcities. The results confirmed that there was a significant difference in land productivity between estates that were not affected by labour scarcity compared to estates affected by high (Table 8) and severe labour scarcities (Table 9). The plucking interval of tea leaf increases due to labour scarcity and hence the tea production as well as quality of tea decreases.

Table 7: Chi-Square test results of land productivity levels of estates that were affected and not affected by labour scarcity.

	Value	Df	Significant level (2-sided)
Pearson Chi-Square	162.90	149	0.206
Likelihood Ratio	201.31	149	0.003
Linear-by-Linear Association	0.176	1	0.675

Table 8: Chi-Square test results showing relationship of land productivity between estates highly affected and not affected by labour scarcities.

	Value	Df	Significant level (2-sided)
Pearson Chi-Square	166.000	143	0.091
Likelihood Ratio	207.692	143	0.000
Linear-by-Linear Association	9.259	1	0.002

Table 9: Chi-Square test results showing relationship between land productivity of estates severely affected and not affected by labour scarcities.

	Value	Df	Significant level (2-sided)
Pearson Chi-Square	224.600	192	0.054
Likelihood Ratio	228.676	192	0.036
Linear-by-Linear Association	5.593	1	0.018

Table 10: ANOVA table with land productivity as the dependent variable.

Model	Sum of Squares	Df	Mean Square	F	Significant level
Regression	1.083	10	0.120	5.815	0.000
Residual	0.683	48	0.021		
Total	1.766	58			

Predictors: (Constant), Extent, Type, MECH, AWDM, PLUCKSC, SUNLABSC, D1, D2, D3
Dependent Variable: land productivity

Table 11: Results of multiple regression analysis.

	Standardized coefficient	Standard error	T value	Significant level
(Constant)	2.320**	0.264	8.785	0.000
Extent in bearing	0.487**	0.109	3.220	0.003
Type of tea	0.558**	0.056	4.052	0.000
Use of mechanical devices	0.134	0.059	1.048	0.302
Practice alternative worker deployment models	0.043	0.067	0.337	0.738
Plucker scarcity	-0.464*	0.089	-2.500	0.010
Sundry worker scarcity	-0.028	0.049	-0.169	0.867
Mid country	0.764**	0.087	3.572	0.001
Up country	0.216	0.073	1.621	0.114
Uva	0.360*	0.086	2.093	0.044

Dependent Variable: Yield
**, and * denote, coefficients are significant at 1%, and 10% probability level, respectively

The results of the ANOVA test are presented in Table 10. The *F*-ratio in the ANOVA table tests whether the overall regression model is a good fit of the data. Results show that the independent variables were significantly predictive of the dependent variable, $F_{(48, 58)} = 5.815$, $p<0.000$.

Multiple regression analysis that was performed to determine the relationship between estate land productivity and labour scarcity, field characteristics and use of labour saving techniques showed that the adjusted coefficient of determination (R^2) was 0.508. This indicated that the independent variables explained 50.8% of the variability of dependent variable, the estate land productivity.

Results obtained from multiple regression analysis indicated that plucker scarcity and sundry worker scarcity had a negative impact on estate land productivity. However, there was a negative significant impact between plucker scarcity and estate land productivity. In addition, bearing tea extent, having VP tea, location of the estate were significant positive factors of estate land productivity (Table 11). It was also found that for a 1-unit increase in labour scarcity, a 0.464 point decrease in the productivity was evident. Similarly, for a 1-

unit increase in land extent, land productivity increased by 0.487 units. Having VP tea, tea estates located in the Mid country and Uva regions increases productivity by 0.558, 0.764 and 0.360 units, respectively. Use of mechanical devices and practicing alternative worker deployment models had positive impacts on estate productivity, which were statistically not significant.

These findings highlighted the importance of finding solutions to overcome labour scarcity in large tea plantations. Estate has to maintain its tea lands with limited workforce. Since this situation could be aggravated in the future, improving efficiency of available workforce is very important. Therefore, estates should adopt techniques for labour saving and improving labour efficiency. The responsible authorities must promote mitigation measures such as adopting labour saving cultural practices, proper deployment of existing workforce, promoting mechanization of field practices and employing different farming models to overcome the problem. In addition, action has to be taken to retain and attract workers into tea plantations for the sustainability of tea industry in Sri Lanka.

CONCLUSIONS

According to the results, the highest annual labour declining rate was observed in the Low country and the lowest rate was in the Up country. The severity of labour scarcity varied with the tea growing regions and the majority of the sampled estates (56%) belonged to high or moderate labour scarcity categories. The study provided strong evidence of a relationship between severity of labour scarcity and differences in productivity levels in a given estate: when the labour scarcity increases, the productivity decreases, and plucker scarcity had a negative, significant impact on land productivity. Although widely practiced, use of mechanical devices and practicing alternative worker deployment models did not show significant positive impacts on estate productivity in this study.

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