IMPACT OF LABOR OUT-MIGRATION ON TECHNICAL EFFICIENCY OF TEA SMALLHOLDERS IN LOW COUNTRY WET ZONE

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ABSTRACT

This paper investigates the effect of labor out-migration and receipt of remittances on the technical efficiency of tea production using a sample of 200 tea smallholders in Ratnapura and Kalawana divisional secretariat divisions of Sri Lanka. A stochastic production function is estimated to evaluate the effects of migration, remittances and prominent characteristics of migrants on the mean green tea output and levels of technical efficiency. Results reveal that remittances have positive and significant effect on tea production. The inefficiency model indicates that amount of remittances sent and the education level of migrants have significant effects on deceasing inefficiency. However, duration of migration and age of migrants are shown to increase the inefficiency. This could be due to the fact that they are permanent migrants. The average technical efficiency of green leaf production of migrant smallholders is 77%, which is 15% higher than that of non-migrant smallholders. Overall, the findings suggest that the efficiency of allocation of inputs in green leaf production can be improved by using remittances to make more timely purchases of inputs and hired labor.

Keywords: Out-migration, tea smallholders, stochastic production function, technical efficiency

INTRODUCTION

Farmer productivity in agrarian economies is frequently and considerably altered by the out-migration of households. It may reduce the certainty of production and continuity of repeated cooperative relations and therefore the entire stability. Loss of labor to migration can reduce the agricultural production in migrant-sending areas. Outmigration reduces labor productivity along with its demand and increases unemployment in rural communities (Lewis, 1954). However, labor departure may diminish agricultural productivity in the short-run while enhancing local productivity in the long-run (Lucas, 1987). Although agricultural production in migrant households may fall due to a decrease in family labor, the remittances send home can have positive effects on house production and income. Migrants could help relax the households' credit or liquidity constraint by sending back remittances (Taylor et al., 2003). All these findings suggest that there are two important effects of migration – earnings in the form of remittances and loss of labor – are likely to lead to changes in household agricultural activities and affect the technical efficiency (Wouterse, 2010). The unresolved question regarding labor migration and agricultural production is whether remittance incomes enhance production enough to compensate for the reduced availability of labor in any specific setting (Mochebelele and Winter - Nelson, 2000). Therefore, Understanding the relationship between migrations and effects of remittances on technical efficiency in production will guide agricultural scientists in the development and dissemination of the best combination of efficient crop and resource management technologies suited to farmers' needs and the environment. The theoretical prediction of the impacts of migration on agricultural production, however, is indistinct.

Scholars advocating New Economics of Labor Migration argue that migration and remittances might increase agricultural productivity through providing better access to information and more flexible liquidity as well as enabling rural households to overcome credit and risk constraints (Wouterse, 2010). More on the optimistic view is strengthened by the arguments that migration outflows come along with certain monetary inflows; remittances from migration increase the household welfare (Massey et al., 1993). Remittances both from internal and international migration are predominantly used to meet daily expenses including food, farm and children’s education. In the short term household may use migrant remittances primarily to supplement income. In the long term migration and the remittances of migrants may play a large role in the household’s development strategy (Tayloret al., 2003). The more outmigration, the greater will be the capitalization agriculture and the greater displacement of labor leading to generate migration (Massey et al., 1993). Outmigration increases moral hazards in agricultural labor contracts and decreases the absolute and relative quality and size of the households’ labor force. Furthermore, migration can decrease farmer attention to the appropriate use of technology and change labor quality (from adult male members to female, child, and elderly members) and other inputs, which would ultimately cause a decline in productivity (Yue and Sonoda, 2012).

In light of the increasing interest of the labor outmigration from Sri Lankan tea industry, especially in a situation where shortage of skilled labor has become a major threat to the future of the tea industry (Illukpitiyaet al., 2004), shortage of laborers in tea smallholders sector has been given much attention as workers’ interest in working in the sector has been declining and mainly young people prefer employment in towns and cities. Most tea smallholders employ family labor in the green tea production process, but problems of labor supply are emerging because the young generation is resistant to this work as it has low dignity in Sri Lankan society (Wickramasinghe and Cameron, 2003). In this context, parents also encourage children to be educated and find a socially accepted job. This issue is common for tea plantations as well (Wickramasinghe and Cameron, 2003).As it could clearly be seen that there exists a strong relationship between migration and agricultural productivity, there is an unsolved question as to which extent the migration and sending remittances affect the agricultural productivity in tea smallholders in Sri Lanka and whether the remittances enhance the production enough to compensate for the reduced availability of labor. In order to understand the impact of migration on tea production, this paper is an attempt to measure the technical efficiency smallholder tea production as it is rarely studied in Sri Lanka especially in the tea smallholders sector. Therefore, this study examines the effects of remittances and other socioeconomic factors on technical efficiency among tea small holders and attempts to contribute towards a better understanding of the impact of migration on the labor and non-labor inputs used and production outputs in tea smallholder families in Ratnapura Divisional Secretariat (DS) division and Kalawana divisional secretariat division.

MIGRATION AND TECHNICAL EFFICIENCY

The literature on the impact of migration on agricultural productivity is lacking in Sri Lanka. However, technical efficiency of tea smallholders of mid country wet zone of Sri Lanka has been estimated by Basnayake and Gunaratne (2002). They have not considered the effect of migration. They show that average technical efficiency of tea smallholding sector is 63.1%. In a study carried out in Thailand, Nonthakot and Villano, (2008) remittances have positive and significant effect on maize production. In contrast to this finding, Sauer et al. (2013) indicate that migration has an efficiency decreasing effect which is amplified for better educated and older workers suggesting the presence of labour market imperfections with a lack of suitable alternative workers to replace such migrants. They further notice that, for Kosovo total household income is not a significant determinant of technical efficiency although remittances may partially compensate for the lost labour effect in some cases (Taylor et al., 2003). Wouterse (2010) reveals that continental migration has a positive relation and intercontinental migration has no relation with technical efficiency in cereal production in Burkina Faso. The author further finds that both continental and intercontinental migrations represent a loss of labor to the household. However, two types of migration also both represent a gain in the form of remittances, which is much more substantial for households with intercontinental migration. One important finding that could be highlighted through this study is that the destination of migrants is an important explanatory factor in inefficiency. In a study carried out in Southern Africa, Low (1986) argues that inefficiency in production increases with migration, because the departure of young, educated adult male members would lead to changes in the quality and quantity of the household labor force. Yang et al. (2014) finds that neither migration nor local off-farm employment has a negative effect on the technical efficiency of grain production in China. They argue in this study that the shift from male labor to female labor or from more young labor to older labor does not affect productivity and the loss of labor to migration is largely offset by the more intensive use of agricultural machinery. Migration among highly skilled workers can reduce productivity and management skills in the source regions (World Bank, 2007). Adaku (2013) showed that households whose members engaged in temporary migration had significantly reduced farm production while households whose members engaged in permanent migration had no significant effect on production in agricultural production in northern region of Ghana. Maharjanet al. (2013) comes up with an interesting finding that, whenever remittances are high enough to substitute income from subsistence farming, the farm households are more likely to neglect farming than be engaged in commercial farming. Gubert (2002) find a negative effect of migration and remittances on technical efficiency of cereal production of agricultural households in Kayes Area (Western Mali). However, the author stresses that remittances constitute the only reliable mechanism to protect agricultural households from food-insecurity in Mali. Gubert further argues that without the financial support of the migrants, the two droughts of 1973 and 1984 would have had much worse consequences in Mali. All these reviewed literature suggest that migration and remittances on technical efficiency of agricultural production is mixed and context specific. Therefore, estimation of technical efficiency including migration and remittance effect in a situation where crop cultivation totally depends on labor would provide better insights into the future of an agricultural industry like tea industry in Sri Lanka. It is a fact that tea industry is operated by two major production sectors, the estate sector and the small holding sector. Although the largest extent belongs to the estate sector, tea small holders sector in which 390,346 tea small holders cultivate tea (Tea Smallholders Development Authority, 2012) contributes about 73% to the national tea production in Sri Lanka (Central Bank, 2013). Therefore, this study attempts to answer the following questions

- How do remittances affect efficiency of the green leaf production of tea smallholders?
- How does the loss of labor affect the technical efficiency?

DATA

The Ratnapura Divisional Secretariat (DS) and the Kalawana Divisional Secretariat were selected for this study due to several reasons. These two areas have recorded large number of tea smallholders in Ratnapura district. Numerically it is 13,342 and 11,876 respectively. And also Ratnapura is the district that has recorded largest number of tea smallholders in the low country wet zone. Numerically it is 97,984. Simple random sampling technique was used to get the sample. The tea smallholders register that has been prepared according to the information of censes in 2005 is available at the Tea Smallholder Development Authority (TSHDA) Ratnapura regional office. The addresses of the tea smallholders of each DS divisions were taken from the registry. This list of addresses was used as the sample frame to select the sample. Finally, 106 and 94 smallholders were selected to gather data. Data were gathered through a pre tested questionnaire which was supplemented with formal discussions with randomly selected small holder from two DS Divisions. Data were collected during the months of June and July in the year of 2013.

Data shows that 57% of households are the migrant households and 43% of households are non-migrant households. Most of the migrants (67.82%) are male. Many of them (83%) send the remittances to their family. Majority of migrant (56.52%) households has only one migrant. Average amount of remittances received to these households is 3597.79 Rupees per month. Only 29.56 % of migrant households have 2 migrants while 11.3% of migrant households have 3 migrants. Only about 2.6% migrant households have 4 migrants. Average amount of the remittances received by households that has 2, 3 and 4 migrants are 4420.73, 4265.38 and 6500 rupees per month respectively. About 87.49% of migrants belong to 20-40 age category, out of which 66.07 % of the migrants are aged between 20-30 years. Most of the migrants have a better education background. About 37 % of migrants have Ordinary Level qualification whereas about 42% of migrants have Advanced Level qualifications. Only 12 % of migrant are graduates.

Table 1: Descriptive statistics of the migrants

Variable name	Number	%
1. Gender		
Male	78	67.82
Female	37	32.17
2. Place of migration		
In province	30	26.08
Other province	84	73.04
Other country	1	0.008
3. Nature of job as migrant		
Agricultural job	1	0.008
Job at Factory	61	53.04
Service job	37	32.17
Job in construction or engineering field	5	4.2
Job in medical field	2	1.7
General job	9	7.82
4. Reasons for migration		
Free from agricultural work	28	24.34
To increase the family income	41	35.65
To care for somebody	2	1.7
Gain experience	18	15.65

Went with spouse	23	20
Other	3	2.6
5. Sending remittances		
Yes	96	83.47
No	19	16.52

Most of the migrant (73.04%) have migrated to urban areas in another province. But some migrants have migrated to their own province. The migrants who have migrated to their own province have gone with their spouse after the marriage. Migrants are engaging with many types of jobs. Majority working in the migrants (53.04%) are working at manufacturing factory and garment factory. And they are working in industrial zone mainly in Export Processing Zone (EPZ). Most of the migrants have migrated to increase the family income.

Summary Statistics of Input and Output Variables

Summary statistics about input and output variable are shown in Table 4. The average production of green leaf is approximately 4216 kg per household annually, which translates to a mean yield of 4081kg per acre annually. Total green leaf production is highly variable, ranging from 300 kg to 13.2 tons per household annually. About 650.2 kg per acre of fertilizer is applied and Rs.1709 per hectare is spent on herbicides. The average family and hired labour use is about 151.29 man-days and 80.83 man-days, respectively. The age of household head varies from 25 to 76 years old and 40.72% of the household members are dependents. The average age of migrants is 28.079 years old, with an average level educational attainment of 12.495 years. Most of them have migrated to other places recently and the average of the duration of migration is of almost 5.331years. There are about 115 households with migrants in the sampled data. The average remittance is Rs.46739 per household per year.

Table 2 Descriptive statistics of input and output variables

Variable name	Mean	SD	Minimum	Maximum
Output/Input variables				
Total green leaf production (kg/acre)	4216	2753	300	13200
Land Extent (Acre)	1.061	0.6548	0.25	4
Family labour used (man days)	151.3	97.72	0	410
Hired labour used (man days)	80.83	128.76	0	617
Quantity of fertilizer (Kg/yr)	672.5	425.7	100	3200
Cost for chemicals (Rs/yr)	1709	2384	0	11400
Cost for dolomite (Rs/yr)	1519	1370.6	0	8000
Remittances used as the input (Rs/yr)	18345	13169	0	48000
Household characteristics and economic variables				
Age of household head (years)	53.64	11.906	25	76
Education of household head (years)	6.995	2.847	3	15
Dependency ratio	0.407	0.1585	0	0.66
Remittances(Rs)	3057	2195	1000	8000

Age of migrants (years)	28.08	5.767	17	42
Education of migrants (years)	12.5	1.75	10	20
Duration of migration(years)	5.331	2.048	1	9
Number of migrant in the family	1.655	0.7813	1	4

ANALYTICAL MODEL

The problem of measuring the production efficiency of an industry is important to both the economic theorists and the economic policy makers (Farrel, 1957). If economic plan is to concern itself with particular industries, it is important to know how far a given industry can be expected to increase its output by simply increasing its efficiency without absorbing further resources (Farrel, 1957). Two main methods are generally used to analyze the efficiency of production. They are parametric method where the stochastic production frontier, which was independently proposed by Aigner, Covell, and Schemidt (1977) and Meeusen and Van den Broek (1977) is used, and non-parametric method where Data Envelopment Analysis (DEA) is used to compute technical efficiency scores. This study employs stochastic production frontier as it makes allowance for stochastic errors due to statistical noise or measurement errors while it accounts for firm specific inefficiency (Forsund et al., 1980; Battese, 1992; Coelli et al., 1998).
Although there are its well-known limitations, the stochastic production frontier is specified using the Cobb-Douglas functional form in this study as it provides an adequate representation of the production technology as long as interest rests on efficiency measurement and not on the analysis of the general structure of the production technology.

The specification of the production function form is given by

$$lnY = \beta_0 + \sum_{j=1}^{7} \beta_j \, lnX_{ij} + \sum_{k=1}^{2} \emptyset_k \, D_k + V_i - U_i \qquad (1)$$

Where:
ln denotes Natural logarithms; Y is the average green tea leaf production per year, v is a pure noise component with mean 0 and constant variance σ_v^2 and that $u_i \geq 0$ follows a half normal distribution with variance σ_u^2. βs and $\emptyset$s are unknown parameters to be estimated. The subscripts, j, i and refer to the j-th input (j = 1,2,…,7), i-th tea smallholder (i=1,2,…, 200)respectively; and the βs and $\emptyset$s are unknown parameters to be estimated.

We specify its Cobb-Douglas stochastic production frontier in the following way:

$$lnY = \beta_0 + \beta_1 ln\mathrm{X}_1 + \beta_2 ln\mathrm{X}_2 + \beta_3 ln\mathrm{X}_3 + \beta_4 ln\mathrm{X}_4 + \beta_5 ln\mathrm{X}_5 + \beta_6 ln\mathrm{X}_6 + \beta_7 ln\mathrm{X}_7 + \emptyset_1 \mathrm{D}_1 + \emptyset_2 \mathrm{D}_2 + \mathrm{v_i} - \mathrm{u_i} \qquad (2)$$

Table 3: Variable description in the production function

Variable	Variable notification	Variable name
Y	Output	Total green Leave production (Kg/yr)
X_1	Land_ex	Land extend (Acre)
X_2	F _labour	Family labour used (man days/yr)
X_3	H_labour	Hired Labour used (man days/yr)
X_4	Ferty	Amount of fertilizer (Kg/yr)
X_5	Chem_cost	Cost for weed control (Rs/yr)
X_6	Dolo_cost	Cost for dolomite (Rs/yr)
X_7	Remit	Amount of remittances used as the input for tea land
D_1	D_migrt	dummy variable for migration, with a value of 1 if the household does not experience migration and 0 if the household does experience migration
D_2	D_remit	dummy variable for the amount of remittances used as the input of tea land, with a value of 1 if X_7= 0 and 0 if X_7> 0

The inefficiency model specified for Battese and Coelli (1995) specification is,

$$u_{ij} = \delta_0 + \sum_{j=1}^{9} \delta_j Z_{ij} + \mathrm{W_i} \quad (3)$$

Where;

δ_j (j=0, 1,…., 9) are unknown parameters; $\mathrm{W_i}$ is unobservable random variables.

We specify the inefficiency model in the following way;

$$U_i = \delta_0 + \delta_1 \mathrm{Z}_1 + \delta_2 \mathrm{Z}_2 + \delta_3 \mathrm{Z}_3 + \delta_4 \mathrm{Z}_4 + \delta_5 \mathrm{Z}_5 + \delta_6 \mathrm{Z}_6 + \delta_7 \mathrm{Z}_7 + \delta_8 \mathrm{Z}_8 + \delta_9 \mathrm{Z}_9 + \mathrm{W_i} \quad (4)$$

The expression of Technical Efficiency relies on the value of the unobservable$\boldsymbol{U_i}$, which must be predicted. These predictions are obtained by deriving the expectation of the appropriate function of $\boldsymbol{U_i}$conditional on the observed value of $\mathbf{v_i} - \mathbf{u_i}$

Table 4: Variable used in the inefficiency model

Variable	Variable notification	Variable name
Z_1	Age_hh	Age of the household head (years)
Z_2	Edu_hh	Education of the household head (years)
Z_3	Amnt_remit	Amount of remittances (Rs)
Z_4	Dep_ratio	Dependency ratio in family
Z_5	Migrt_period	period of migration (years)

Z_6	Age_migrant	age of first migrant (years)
Z_7	Num_migrant	Number of migrants in the family
Z_8	Edu_migrant	Education of the migrants (years)
Z_9	Gen_migrant	Dummy variable for gender of migrant. If male 1, if female 0

The maximum likelihood method is used to estimate the parameters of both the stochastic frontier model and inefficiency effects model. According to Battese and Corra (1977), the variance parameter of the likelihood function is estimated in terms of $\sigma^2 = \sigma^2_u + \sigma^2_v$ and $\gamma = \sigma^2_u / \sigma^2$. So that $0 \leq \gamma \leq 1$

Much of stochastic frontier analysis is directed towards the prediction of inefficiency effects. The most common output-oriented measure of technical efficiency is the ratio of observed output (q_i) to the corresponding stochastic frontier output.

$$TE = \frac{Y_i}{\exp(x_i\beta + v_i)} = \frac{\exp(x_i\beta + v_i - u_i)}{\exp(x_i\beta + v_i)} = \exp(-u_i) \qquad (5)$$

Finally, the technical efficiency of production for the *i*-th tea smallholder could be defined by$\boldsymbol{TE = exp(-U_i)}$

The technical efficiency index (*TEi*) is equal to 1 if the farm is perfectly efficient and equal to zero if perfectly inefficient. If the value of γ equals zero the difference between farmers yield and the efficient yield is entirely due to statistical noise. On the other hand, a value of one would indicate the difference attributed to the farmers' less than efficient use of technology i.e. technical inefficiency (Coelli, 1995).

Finally a stochastic trans log production function was estimated to test the robustness of the functional form. The following is the trans log specification of the function;

$$\begin{aligned} lnY = {} & \beta_0 + \beta_1 ln\mathrm{X}_1 + \beta_2 ln\mathrm{X}_2 + \beta_3 ln\mathrm{X}_3 + \beta_4 ln\mathrm{X}_4 + \beta_5 ln\mathrm{X}_5 + \beta_6 ln\mathrm{X}_6 + \beta_7 ln\mathrm{X}_7 + \beta_8 \mathrm{D}_1 \\ & + \beta_9 \mathrm{D}_2 + \beta_{10}(ln\mathrm{X}_1)^2 + \beta_{11}(ln\mathrm{X}_2)^2 + \beta_{12}(ln\mathrm{X}_3)^2 + \beta_{13}(ln\mathrm{X}_4)^2 \\ & + \beta_{14}(ln\mathrm{X}_5)^2 + \beta_{15}(ln\mathrm{X}_6)^2 + \beta_{16}(ln\mathrm{X}_7)^2 + \beta_{17}(ln\mathrm{X}_1 * ln\mathrm{X}_2) \\ & + \beta_{18}(ln\mathrm{X}_1 * ln\mathrm{X}_3) + \beta_{19}(ln\mathrm{X}_1 * ln\mathrm{X}_4) + \beta_{20}(ln\mathrm{X}_1 * ln\mathrm{X}_5) \\ & + \beta_{21}(ln\mathrm{X}_1 * ln\mathrm{X}_6) + \beta_{22}(ln\mathrm{X}_1 * ln\mathrm{X}_7) + \beta_{23}(ln\mathrm{X}_2 * ln\mathrm{X}_3) \\ & + \beta_{24}(ln\mathrm{X}_2 * ln\mathrm{X}_4) + \beta_{25}(ln\mathrm{X}_2 * ln\mathrm{X}_5) + \beta_{26}(ln\mathrm{X}_2 * ln\mathrm{X}_6) \\ & + \beta_{27}(ln\mathrm{X}_2 * ln\mathrm{X}_7) + \beta_{28}(ln\mathrm{X}_3 * ln\mathrm{X}_4) \\ & + \beta_{29}(ln\mathrm{X}_3 * ln\mathrm{X}_5) + \beta_{30}(ln\mathrm{X}_3 * ln\mathrm{X}_6) + \beta_{31}(ln\mathrm{X}_3 * ln\mathrm{X}_7) \\ & + \beta_{32}(ln\mathrm{X}_4 * ln\mathrm{X}_5) + \beta_{33}(ln\mathrm{X}_4 * ln\mathrm{X}_6) + \beta_{34}(ln\mathrm{X}_4 * ln\mathrm{X}_7) \\ & + \beta_{35}(ln\mathrm{X}_5 * ln\mathrm{X}_6) + \beta_{36}(ln\mathrm{X}_5 * ln\mathrm{X}_7) + \beta_{37}(ln\mathrm{X}_6 * ln\mathrm{X}_7) + \mathrm{v_i} \\ & - \mathrm{u_i} \qquad (6) \end{aligned}$$

RESULT AND DISCUSSION

The OLS as well as maximum likelihood (ML) estimates of the Cobb-Douglas model are presented in table 5. The estimate of γ, the variance ratio parameter which relates variability of u_i to the total variability, is 0.728.It indicates that the majority of error variation is due to the inefficiency error u_i (and not due to the random error v_i). This finding implies that the random component of the inefficiency effects does make a significant contribution in the analysis. The one sided LR test of γ=0 provides a statistic of 60.1438 which exceeds the chi-square five % critical value of 25.188. Hence the stochastic frontier model does appear to be a significant improvement over an average (OLS) production function. Except dummy variable for migration, other variables in production function are significant. The dummy variable for remittances used by household as an input for tea land shows a negative relationship with output. It implies that when no remittance receives, tea output decreases. When large members of households migrate to get the jobs in the urban areas, the shortage of labor will affect the several activity of tea land. If remittances have been received from the migrant people, tea smallholders can allocate this money to recover the labor shortage by hiring laborers.

Table 5: OLS Estimates and MLE estimates of the Stochastic Frontier (Cobb-Douglas model) for Tea Small Holders

Variables	parameters	Coefficient		Standard error	
		OLS	MLE	OLS	MLE
Constant	β0	0.3472***	3.9526***	0.5378	0.5651
Land extend	β1	0.3887***	0 .4024 ***	0.0931	0 .0907
Family labour	β2	0.2197***	0 .2013 ***	0.0658	0 .0618
Hired labour	β3	0.0371**	0 .0376 **	0.016	0 .0149
Fertilizer	β4	0.4363***	0.4144***	0.0779	0 .0786
Chemicals cost	β5	0.0363*	0.0368 **	0.0192	0.0183
Dolomite cost	β6	0.0608***	0.0576 ***	0.0152	0 .0145
Remittances	B7	0.0182**	0 .0169 **	0.0065	0 .0062
(D_1)migration	$\emptyset_1$	0.1251*	0.1284	0.0752	0 .0725
(D_2)remittances used	$\emptyset_2$	-0.0816	-0.0927 ***	0.0544	0 .0521
σ^2			0.2307		
γ			0.728		
Log-likelihood			-72.6897		
LR-Test			60.1438		

*, **, *** *Significant at 10, 5 and 1 % probability level*

The estimated ML coefficient of extent of land shows a positive value of 0.4024, which is at 1% significant level. Therefore, increase of land extent by 1 % will increase output by 0.4024%. Similar results were recorded by Basnayake and Gunaratne, (2002); Msuya and Ashimogo (2005); Nonthakot and Villano, (2008); and Rawlins, (1989).The estimated ML coefficientsfor family labour and hired labour show positive values of0.2013 and 0 .0376 at 1% and 5% significant levelrespectively. This indicates if the inputs of family labour and hired labour are increased by 1%, output will increase by 0.2013% and 0 .0376 % respectively. Coefficient of family labour is greater than the coefficient of hired labour. Therefore, it could be realized that the use of family labour is more prominent for tea small holders. Quantity of fertilizer has shown positive relationship. The coefficient is 0.4144 at 1% significant level. When smallholder increases the quantity of fertilizer applied from 1 %, it will increase the output by 0.4144 %. ML coefficients for chemical cost and dolomite cost also have shown the positive value of 0.0368 and 0.0576which are significant at 5% and 1%significant level respectively. This indicates that increase of the inputs of chemical cost and dolomite cost by 1%output will increase by 0.0368 % and 0.0576% respectively. In a study carried out in up country wet zone, Basnayake and Gunaratne, (2002) found the same relationship for the variables of fertilizer, chemicals, and types of labor. Basnayake and Gunaratne, (2002) further find a negative relationship between dolomite cost and the green tea output in mid country wet zone of Sri Lanka and they explain that this result is contrary to the general expectation. It should also be noted that the prices of chemicals used in tea production and dolomite have not significantly changed during the period of the study. Therefore, we used cost of them for study. However, Msuya and Ashimogo (2005) found a negative relationship between output, hired labor and family labor in Tanzanian sugar cane production. They argue that it has occurred due to the over usage of those two types of labor. ML coefficients for remittances show the positive value of 0.0169which is at 5% significant level. Therefore 1% increase in remittances used for tea land will increase the output by 0.0169 %. Remittance is one outcome of labour migration. Results indicate the positive relationship between remittances used as the input for tea land and the green leaf production. Similar results were obtained by Nonthakot and Villano (2008).

The table 6 shows the maximum likelihood estimates of the parameters of the inefficiency model. The coefficients of the variables of age of household head, education of household head and age of migrant in the inefficiency model are significant at 10% significant level. The coefficients of the variables of dependency ratio, period of migration and education of migrants are significant at 5%. The variable, age of household head has a negative association, indicating younger farmers tend to be more inefficient.

Table 6: Inefficiency Effects Model

Variables	Parameters	Coefficient	Standard error	P value
Constant	δ_0	2.1970	2.3838	0.357
Age of household head (yr)	δ_1	-0.0249*	0.0148	0.091
Education of household head(yr)	δ_2	-0.1374*	0.0772	0.075
Dependences ratio	δ_3	3.5107**	1.2739	0.006
Remittances(Rs)	δ_4	-0.00007**	0.00011	0.025
Period of migration	δ_5	0.1484**	0 .0631	0.019
Age of migrants(yrs)	δ_6	0.0273*	0.0154	0.077
Number of migrants	δ_7	0.0835	0.1919	0.664
Education of migrants (yrs)	δ_8	-0.4222**	0.1659	0.011
Gender of migrants	δ_9	0.4202	0.3379	0.214

**, **, Significant at10 and 5 % probability level*

It can be explained that the older farmers have more experience and knowledge of the management practices and are more reliable in performing production tasks (Nonthakot andVillano, 2008; Tauer, 1995). According to Tauer (1995), the productivity of farmers peaked between ages 35 and 45 and it was 30% greater than for farmers under age 25. The author further explains that beyond 45 years of age, the productivity of farmers decreases with additional age. Moreover, the findings of Wouterse (2010) clearly indicate that there is a negative role of the age of the household head in technical efficiency, with older heads being less efficient. Weir (1999) finds that at least 4years of schooling is needed to lead to significant effects of farm level technical efficiency. Lockheedet al. (1980) and Phillips (1994) show that on average 4years of schooling can improve output by about 7.4%. In this study, education level of migrants has a negative association, which indicates that a higher level of education of migrants can help increase migrants' income so that they can send remittances to help their families. The major reason for this is that they can find better job with higher salary. The remittance variable has a negative association, indicating that higher remittances are associated with more efficient tea production. The dependency ratio has a positive association with technical inefficiency, which indicates that the higher the proportion of dependents to total members of the household the more inefficient tea production will be. If there are more dependents in the family, household head has to expend more money on the dependents. The sign for the period of migration is positive indicating that it has positive association with technical inefficiency. It indicates that technical efficiency will reduce, when duration of migration increases. It could be seen that some temporary migrants become permanent migrant after passing five or six year, because they have got married and built residency in urban areas sparely. After becoming permanent migrant, they may not send remittances like before, because their expenses can go up. However, Nonthakot and Villano (2008) find a negative association between duration of migration and technical inefficiency. They argue that this relationship exists as permanent migrants have higher remittances than temporary migrants

Descriptive statistics for technical efficiency model are presented in Table 6. The mean technical efficiency of the tea small holding sector was found to be 71%, which indicates that the output could be increased by 29 % if all farmers achieved the technical efficiency level of the best farmer. The overall mean technical efficiency for all the migrant households is 0.77, implying that their production could be increased by 23% using the same amounts of inputs if they were able to reach maximum efficiency. On the other hand, the non-migrant households have a mean technical efficiency of 15% less than the migration farms. It is evident from this finding that the migrant smallholder households produce tea more efficiently than the non-migrants small holders. The maximum technical efficiency is 0.99 which could be achieved by both a migrant household and a non-migrant household.

Table 6: Mean technical efficiency

	Migrant family	Non-migrant family
Mean	0.7767	0.6269
Standard deviation	0.1887	0.1993
Minimum	0.2253	0.1312
Maximum	0.9960	0.9958

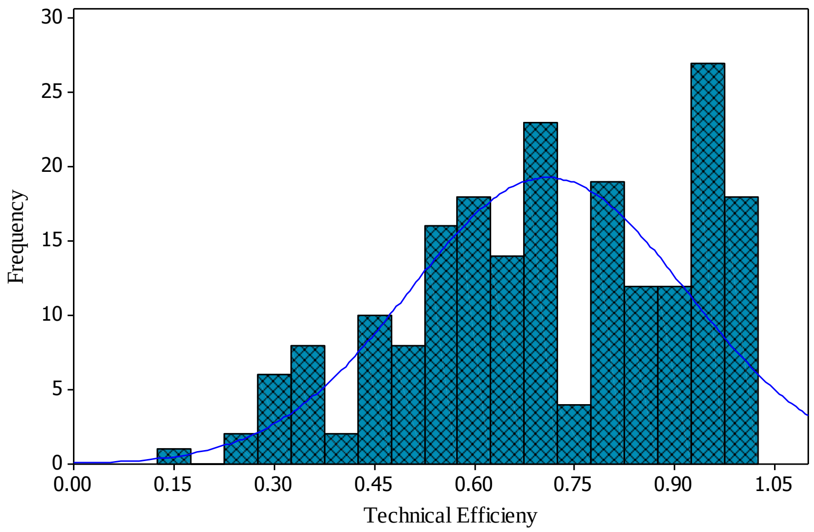
Table 7 shows distribution of technical efficiencies of tea smallholdings in Ratnapura and Kalawana DS divisions. Technical efficiency of migrant household ranges from as low as 22.53 % to as high as99.60%. Majority of migrant household (82.6%) shows technical efficiency more than 50 %. And also the technical efficiency of non-migrant households rages from as low as 13.12 % to as higher as 99.25 %. Then the technical efficiency of none migrate household ranges wider than that of migrant household. It implies that more technical inefficient household can be seen in the non-migrant category.

Table 7: Distribution of Technical Efficiencies (based on Cobb-Douglas specification)

Technical efficiency %	Number of smallholders	
	Migrant households	Non migrant households
10-20	0	1
20-30	2	2
30-40	8	5
40-50	10	4
50-60	19	15
60-70	17	10
70-80	17	12
80-90	14	14
90-100	28	22
Total	115	85

The distribution of technical efficiency estimates is presented in Figure 1. A majority of migrant tea small holders have technical efficiency estimates between 0.77 and 1.00; whereas the technical efficiency for the non-migrant farms varied from 0.13to 0.99 and 49% have technical efficiencies above the group's average whereas more than 58% of the migrant tea small holders have efficiencies above the group's average. It implies that efficiency of migrant tea small holders is higher than that of non-migrant tea small holders. About 36% of the migrant tea small holders and 70.7% of the non-migrant tea small holders have technical efficiencies less than mean technical efficiency of 0.71.

Figure 1: The distribution of technical efficiency



The comparison of technical efficiency in the non-migrant and migrant households implies that migrant households have higher technical efficiency on average than that of the non-migrant households. The migrant households appear to have greater ability to allocate their inputs effectively. It can be said that the remittances from migrants can increase the efficiency of tea land because they can use remittances to buy fertilizer and hire labour for their management practices in tea land in a timely manner. The findings also suggest that the knowledge of tea land management practices of the head of household can help increase efficiency in tea production. Scope exists for tea small holders in both migrant and non-migrant farms to increase output of tea land. About 36% of the migrant farms and 70.7% of the non-migrant farms have technical efficiencies less than mean technical efficiency of 0.71. Thus, migration and associated remittances combined with greater knowledge of tea land management. Then it can be helped to smallholders to increase technical efficiency.

A stochastic trans log production frontier was estimated to test the interaction effect among the variable in the Cobb-Douglas production function. The ML estimates are given in Table 8.The interaction of hired labour and chemical cost and dummy variable for remittances used are significant at 1 % significant level. And also interaction of hired labour and chemical cost show the negative relationship with output. And dummy variable for remittances used showa positive relationship with output. Coefficient of chemical cost, hired labour square, dolomite cost square, remittances square, interaction of land extend and chemical cost, interaction of family labour and chemical cost and the interaction of hired labour and quantity of fertilizer are significant at 5 % significant level. But family labour and chemical cost show the negative relationship with output. Coefficient of Fertilizer square, interaction of family labour and hired labour, interaction of fertilizer quantity and dolomite cost and interaction of chemical cost and dolomite cost are at 10 % significant level. But interaction of chemical cost and dolomite cost showed the positive relationship with output and all other 10 % significant variables showed negative relationship with output.

Table 8: Maximum likelihood estimates for parameters of the stochastic frontier (trans log)

Variables	Parameters	Coefficient	Standard Error	P-Value
Constant	β_0	-1.4051	7.0598	0.842
Land ex	β_1	2.0678	1.2478	0.338
F_labour	β_2	-1.5016	1.2478	0.229
H_labour	β_3	-0.4507	0.2861	0.115
Ferty	β_4	2.6840	2.0161	0.183
Chem_ cost	β_5	0.9729**	0.4002	0.015
Dolo _cost	β_6	-0.0895	0.3713	0.809
Remit	β_7	0.1688	0.1294	0.192
D_migrt	β_8	-0.0044	0.0873	0.959
D_remit	β_9	0.1899***	0.0572	0.001
$(Land\_ex)^2$	β_{10}	-0.1714	0.1818	0.346
$(F\_labour)^2$	β_{11}	0.0524	0.1095	0.632
$(H\_labour)^2$	β_{12}	0.0434**	0.0143	0.002
$(Ferty)^2$	β_{13}	-0.2691*	0.1613	0.095
$(Chem\_Cost)^2$	β_{14}	-0.0247	0.0262	0.345
$(Dolo\_Cost)^2$	β_{15}	0.1321**	0.0449	0.003
$(Remit)^2$	β_{16}	-0.0007**	0.0003	0.012
Land ex *F_labour	B_{17}	0.0931	0.2114	0.659
Land ex *H_labour	B_{18}	0.0356	0.0741	0.630
Land ex *Ferty	B_{19}	0.1505	0.3173	0.635
Land ex *Chem_ cost	B_{20}	0.1615**	0.0639	0.011
Land ex *Dolo _cost	B_{21}	0.0518	0.0524	0.323
Land ex *Remit	B_{22}	0.0333	0.0239	0.164
F_labour* H_labour	B_{23}	-0.0573*	0.0325	0.078
F_labour*Ferty	B_{24}	0.2757	0.1689	0.103

F_labour*Chem_ cost	B_{25}	-0.1303**	0.0493	0.008
F_labour*Dolo _cost	B_{26}	-0.0201	0.0465	0.667
F_labour*Remit	B_{27}	0.0016	0.0136	0.933
H_labour*Ferty	B_{28}	0.1078**	0.0423	0.011
H_labour*Chem_ cost	B_{29}	-0.0443***	0.0096	0.000
H_labour*Dolo _cost	B_{30}	0.0005	0.0092	0.952
H_labour*Remit	B_{31}	-0.0064	0.0058	0.270
Ferty*Chem_ cost	B_{32}	-0.0589	0.0531	0.267
Ferty*Dolo _cost	B_{33}	-0.0728*	0.0378	0.054
Ferty*Remit	B_{34}	-0.0107	0.0201	0.591
Chem_ cost *Dolo _cost	B_{35}	0.0389*	0.0232	0.094
Chem_ cost *Remit	B_{36}	-0.0004	0.0041	0.921
Dolo_ cost *Remit	B_{37}	-0.0124	0.0118	0.295
σ^2		0.1131		
γ		0.47		
Log-likelihood		-29.4141		
LR-Test		29.488		

*, **, *** *Significant at 10, 5 and 1 % probability level*

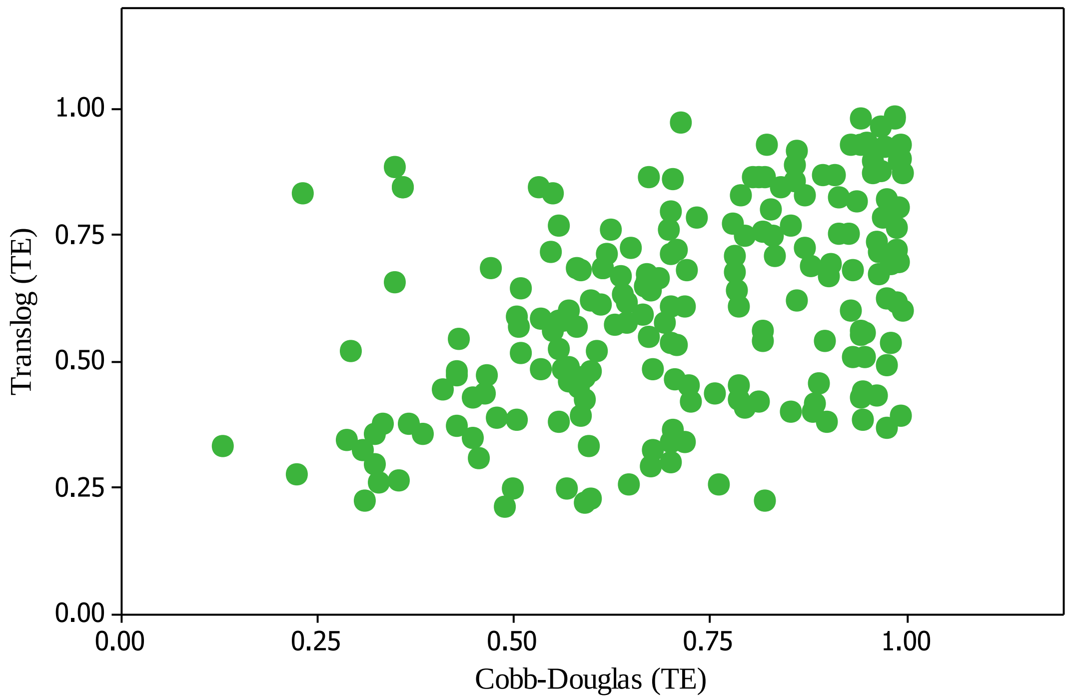
Table 9: Results of the Inefficiency model for trans log function

Variables	Parameters	Coefficient	Standard error	P value
Constant	δ_0	-1.9533	2.0473	0.357
Age of household head (yr)	δ_1	-0.0181	0.0121	0.138
Education of household head(yr)	δ_2	-0.0363	0.0658	0.581
Dependences ratio	δ_3	5.9539***	1.4501	0.000
Remittances(Rs)	δ_4	-0.0002	0 .0002	0.135
Period of migration	δ_5	0.0851	0.05746	0.139
Age of migrants(yrs)	δ_6	0.0348**	0.0150	0.020
Number of migrants	δ_7	0.1501	0.1817	0.409
Education of migrants (yrs)	δ_8	-0.1951*	0.1127	0.083
Gender of migrants	δ_9	0.2931	0.2981	0.326

*, **,*** *Significant at 10,5 and 1 % probability level*

Figure 1 shows the robustness of technical efficiency estimates obtained by Cobb-Douglas and trans log models. It clearly shows that the difference of the technical efficiency value from Cobb-Douglas function and the trans log function differ very much. If there is no much difference, the values should be near 45-degree line. The mean technical efficiency obtained from the Cobb-Douglas model is 0.71% while the trans log model showed a mean technical efficiency of 0.60 %. If these two technical efficiency values are close, it should be in 45 degree line but figure 1 shows large variability. Then it implies that considerable interaction effect can have in the chosen stochastic frontier model.

Figure 2: Robustness of technical efficiency estimates



CONCLUSIONS

Stochastic frontier production model has been used with inefficiency effects to analyze the relationships between labour migration, remittances and total green leaf production using data that have been collected from Ratnapura and Kalawana DS divisions. Most of the migrant are temporary migrants. But most of the migrants who have migrated more than five year are permanent migrants. Results indicate that remittances have positive and significant effect on tea production. Characteristics of migrants show significant effect on the level of technical efficiencies of small holders in studied area. The average technical efficiency on migrant farms was 77%, which was more than 15% higher than on non-migrant farms. The age and educational attainment of the household head, and age and education of migrants in the household are found to have significant effects in decreasing technical inefficiency. But period of migration is found to have significant effect in increasing technical efficiency. The efficiency of allocation of inputs in tea land can be improved by using remittances to make more timely purchases of inputs and hired labour, and by improving the tea land management knowledge of the household head. Findings of this study imply that a higher level of education can help the migrants to get more income, then the remittance that they send back to their families will increase. However, migration can also have a negative effect on tea production by causing shortages of labour in the land sector. But labour shortage is not only due to labour migration. It may have other reasons. One is cultivating the own tea land. The people who work in others' tea land as hired laborers try to cultivate their own tea land. After they cultivate their own tea land they never go to work in others tea land as the laborers. It may be one of the reasons to create labour shortage. In other word, when increase the number of tea smallholders in the area, labour shortage will increase. Finally, the duration of migration implies that permanent migrants send low remittances due to high expenses in the urban area.

RECOMMENDATIONS

Based on the above conclusions following recommendations were made. Mainly household should motivate the younger generation to get better education, because better education can increase the amount of remittances as they can find better paying jobs. In order to solve this labour shortage problem, an effective rural development program can reduce the number of people in farm households who migrate to get income in the other places. And also, small holder should develop strategies to motivate the exiting labour to get the maximum productivity from them. Smallholder can develop some intensive system for tea pluckers to increase their plucking efficiency. And also tea small holders should try to get new technologies to increase the efficiency. As an example they can use plucking machine to reduce tea puckers' requirement. In addition, tea smallholders can increase the wage of the labour. Then the satisfaction of the laborers may increase and they are motivated.

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