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Technical Efficiency for Tea Smallholder Farmers under UTZ Certification System in Sri Lanka: A Stochastic Frontier Approach

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Abstract

The study aimed to identify the determinants of the technical efficiency of Smallholder Tea Farmers (STFs) under UTZ certification system in Sri Lanka by employing stochastic production frontier using a sample survey of 75 STFs supported by the UTZ programme conducted between January and March in 2016. The results showed that a small number of STFs (11.8 percent) were over 90 percent efficient and the level of efficiency was found to be negatively related to coefficients of UTZ certified STFs and positively related to number of years with the same plants. The results further showed the labor and fertilizer were the significant factors that determine the tea production of STFs.

Keywords

Smallholder Tea Farmers, Stochastic Production Frontier, Technical Efficiency, UTZ Certification.

Introduction

One of main commercial crops in Sri Lanka is tea which was introduced by the British during the colonial period in 1867 and since then tea was popularised in the world as Ceylon Tea (Mohamed and Zoysa, 2006). Tea industry has been recognized as a dynamic sector in economic development in Sri Lanka. The sector provides employment for about 1.5 million people and contributes 1.2% to the Gross Domestic Product (GDP) and 15% of the total export income in 2015 (Central Bank of Sri Lanka, 2016). Tea export earnings (LKR. 212,588 Million) have contributed 58% of the total agriculture export earnings in 2014 (Central Bank of Sri Lanka, 2015). Tea industry supports livelihood of approximately 400,000 families of a total population of 2.2 million, nearly 10 per cent of the total population in Sri Lanka (Dissanayake, Udugama and Mudalige, 2013, Fernando, 2016).

Tea smallholding sector in Sri Lanka play a significance role in the industry contributing more than 70% of the total tea production and about 60% of the total tea land extent (Fernando, 2016). Tea industry is classified into two major sectors, the estate sector and the smallholding sector. The total extent of land under tea cultivation has been assessed at approximately 221,969 hectares in 2015 (Perera, 2016). Tea smallholding sector and estate sector account 121,429 hectares (56.7 per cent) and 100,540 hectares (43.3 per cent) respectively (Fernando, 2016). Though estate sector was previously dominated in the tea industry in terms of extent, the significant growth in extent in the smallholding sector captures that position (Dissanayake et al, 2013). The contribution of tea smallholding sector is largely based in low country in Sri Lanka. In 2015, total number of Smallholder Tea Farmers (STFs) in Sri Lanka was 397,223 and low country (Fernando 2016). At present, average land size of smallholding sector is 0.33 hectares. It has continuously decreased from 0.47 hectares in 1983 and 0.40 hectares in 1994. More than 74% of smallholding farms are less than 1 acre (0.4 hectares) and more than 93% of smallholding farms are less than 2 acres (0.8 hectares) (Fernando 2016).

The share of smallholding sector in total tea production in Sri Lanka has increased during recent past. It was above 70% during the period 2010-2012 and has increased up to 73% in 2014. Tea production reached in Sri Lanka amounting to 338 million kg in 2014. Out of it 73% (247 million kg) are contributed by smallholding sector (Fernando, 2016). Therefore, tea smallholding sector plays a leading role in country's tea production. In 2014, the average productivity of tea smallholding sector was about 2,123 kg per hectare which was very high as compared to the public estate sector productivity which was 1,275 kg per hectare.

Previous studies related to the tea smallholding sector in Sri Lanka have identified several constraints which are mostly reflected from productivity and technology. Samaraweera et al. (2013) studied the issues related to smallholder tea farmers in Sri Lanka and find that level of technical understanding was very poor among tea smallholders. Fernando (2016) identified that the major hindrance that avert the growth of tea smallholding including unsecured price, narrowing of profit margin, low rate of re-investment, labour shortage, poor access roads, facing adverse weather conditions, and land degradation. Basnayake and Gunaratne (2002) have estimated the technical efficiency and it's determinants in the tea smallholding sector in Sri Lanka and the result

for the efficiency indicates that age of farmer, education, occupation, type of crop and type of clone have significant effects on technical efficiency.

Considering the high competition in the world, production efficiency will become an important determinant of the future of Sri Lanka's tea industry (Basnayake and Gunaratne, 2002). Expecting to improve productivity of the tea smallholding sector ensuring sustainable development, UTZ programs has been introduced in 2011 (Haagsma, Vredeveld, Yoosuf and Maurice, 2016). The UTZ programme supports STFs to implement better farming methods, improve working conditions and take better care of the environment in order to generate positive outcomes on farm efficiency, higher yields and revenues, safer and healthier working conditions, better working relations, and safeguarding the environment (Haagsma et al., 2016).

UTZ Certified is a label for sustainable farming of tea, coffee, cocoa and hazelnuts in many countries. By year 2015, UTZ certified tea is produced in 10 countries by more than 8.500 farmers and 45.000 workers, and is marketed in 41 countries. UTZ means for sustainable farming and better opportunities for farmers, hired workers and their families. The volume of certified tea produced in Sri Lanka grew from 889 MT in 2011 to 5.447 MT in 2014, making Sri Lanka the fourth largest producer of UTZ Certified tea after Malawi, Kenya and Indonesia. In Sri Lanka, 85% of the UTZ certified tea is orthodox black tea, and 15% is green tea.

When the UTZ programme was started in 2011 in Sri Lanka, there were only 3 certificate holders, but it has gradually expanded to 7 certificate holders in 2015. Most UTZ certificate holders are tea estates managed by plantation companies which manage several estates. Tea plantations in Sri Lanka acquired majority shares in formerly state-owned plantations in the 1990's. The land still belongs to the Sri Lanka government, but the plantation companies manage the production, processing and marketing of tea. These companies have typically certified one or more estates to one or more voluntary standards, and may also hold other types of certificate such as ISO 22000. Two UTZ certificate holders are groups of smallholders, with a total of 325 members. The certified estates and factories employ 4.504 permanent and 220 seasonal workers. The UTZ certified tea estates are situated in the higher producing regions (Nuwara Eliya, Ragala) with a total production area of nearly 3.500 ha. One of the intended outcomes of the programme was to improve productivity and efficiency of STFs. However, there is no recent empirical evidence whether the UTZ programme has influence on the improvement of productivity and technical efficiency of STFs in Sri Lanka. Therefore, it is timely necessary to study the present level of efficiency of STFs and to find out factors influencing their level of efficiency.

The objective of the paper is to estimate the technical efficiency of STFs supported by the UTZ programme in Sri Lanka employing stochastic production frontier and to determine the contributory factors that influence technical efficiency. Through this exercise, the study addresses a specific case of tea smallholding sector in Sri Lanka i.e. how UTZ programme effects on technical efficiency of STFs in Sri Lanka? In literature, many recent studies (Baruwa and Oke, 2012; Dube and Guveya, 2014; Esham, 2014; Hong and Yabe, 2015; Kalimang, Kihombo and Kalimang, 2014; Kipesha, 2016; Kiprop, Hillary, Mshenga, Nyairo, 2015; Malinga, Masuku and Raufu, 2015; Simwaka, Ferrer and Harris, 2013) address only the technical efficiency without any specific circumstance. Dearth of studies related to the effect of UTZ programme on technical efficiency particularly STFs

represents a significant gap in the literature. The current study bridges this gap providing empirical evidence which improve the knowledge of policy makers to develop productivity of STFs in Sri Lanka and smallholder farmers in other sectors in Sri Lanka as well as other countries.

Methodology

The data was gathered from a sample survey of STFs in Central Province which is the largest tea producing province in Sri Lanka in 2016. A two-stage cluster sampling method was employed and within clusters individual STFs were randomly selected. As the clusters, two regions Liyangahawella and Alakolawewa were randomly selected form UTZ STFs. The sample comprised of 75 smallholder tea farmers supported by the UTZ programme. They had been certified during 2011 and 2015, under the project supported by Swiss Labor Assistance. A control group of 18 smallholder tea farmers, from Weralpatana and Walapane who were not involved in the UTZ certification process, were also included in the survey.

The variables included in the stochastic production frontier model and the technical inefficiency model are defined and summarized in table 01.

Table 1- Variable definition and units of measurements for the models

Variable	Definitions	Units	Mean	SD.	Min.	Max
Y	Tea output	Kg.	1306.43	837.84	42	3000
X_1	Farm size	Ha.	0.94	0.97	0.25	8
X_2	Labor	No. Person	3.81	2.55	1	14
X_3	Fertilizers	Kg.	199.12	65.41	50	400
Z_1	UTZ certification	1=yes, 0 = No	0.81	0.40	0	1
Z_2	Producer group	1=yes, 0 = No	0.72	0.45	0	1
Z_3	Off farm income	1=yes, 0 = No	0.73	0.44	0	1
Z_4	Age of HH* head	Years	53.06	12.57	30	83
Z_5	Experience of HH head	Years	22.03	15.29	1	70
Z_6	Same Plants	Years	15.90	9.67	1	42

*Household.

Source: Survey data, 2016.

Semi structured questionnaire was used to collect data. It was designed to collect variables on the socio-economic condition of the STFs, group-specific characteristics, farmers' output of tea, income from tea as well as other sources, inputs used in the tea farming including lands, capital, labor, fertilizer and seeds, capacity building under UTZ certification programme. The socio-economic characteristics include farmers' age, level of education, household size, farm size, membership in producer groups and some other relevant variables.

Following Battese and Coelli (1995), the model specification can be expressed as:

$Yi = \exp(Xi\ \beta + \varepsilon i) = \exp(Xi\ \beta + Vi - Ui)$; since $\varepsilon = Vi - Ui$, $i = 1, 2, 3, \ldots, N$ (3)

$Ui = Zi\ \delta + \omega i$, (4)

Where Z_i is a vector of variables which may determine the technical efficiency of the i th firm, δ is a vector of efficiency parameters to be estimated, and ω_i is the random error term which is the half truncation of the normal distribution with mean 0 and variance σ_U^2. Therefore, TE, which is the ratio of the scalar or observed output (Y_i) to the frontier output (Y_i^* or exp ($X_i \beta + V_i$)) relevant to the amount of inputs used by the firm. This can be expressed as follows:

$$TE = (Yi/Yi^*) = \exp(Xi\,\beta + Vi - Ui)/ \exp(Xi\,\beta + Vi) = \exp(-Ui) \quad (5)$$

So that $0 \leq TE \leq 1$, where 1 represents the best practice frontier firm (means no inefficiency) and zero represents the least technically-efficient firm in relation to the frontier firm. Following Battese and Coelli (1983) the parameters of the stochastic frontier production function is estimated using a one-step maximum likelihood estimates (MLE) procedure, and employs translog model specification. The translog model is specified as follows:

$$LnYi = \beta 0 + \beta 1 LnXi1 + \beta 2 LnXi2 + \beta 3 LnXi3 + \beta 11 LnXi12 + \beta 22 LnXi22 + \beta 33 LnXi32 + \beta 12 LnXi1 LnXi2 + \beta 13 LnXi1\ LnXi3 + \beta 23 LnXi2\ LnXi3 + \varepsilon i \quad (6)$$

Where Ln is the natural logarithm, Y_i is output of ith firm, X_i`s are inputs variable presented in table …. $\beta$`s are unknown parameters to be estimated, and $\varepsilon_i = V_i - U_i$.
This study uses a log likelihood ratio test to check viability of the translog model. The technical inefficiency model is estimated from the following equation.

$$Ui = \delta 0 + \delta 1 Zi1 + \delta 2 Zi2 + \delta 3 Zi3 + \delta 4 Zi4 + \delta 5 Zi5 + \delta 6 Zi6 + \omega i \quad (7)$$

Where Zi are various firm specific and operational variables defined in table 2 and δs are parameters to be estimated. Using parameters of the stochastic production frontier (equation 6), output elasticity of each input can be computed from the following equation:

$$\varepsilon_{x_i} = \frac{\partial lny}{\partial lnx_i} = \beta_i + 2\beta_{ii} ln\bar{X}_i + \sum_{i \neq j} \beta_{ij} ln\bar{X}_j \quad (8)$$

Thus the returns to scale is estimated as the sum of output elasticity for all inputs in which it can be decided that the production is exhibited increasing, constant, or decreasing returns to scale.

Results and Discussions

The average age of the STFs supported under the UTZ program was 54 while the average age of the STFs in the control groups was 49. The average years of experience in the sector was 20 for STFs supported by the UTZ program and 22 for the control group. For both UTZ supported and non-supported groups the average number of family members was 4 and the number of older persons (above 60 years) in the households was 1. The level of education among the UTZ supported STFs were: 21.3 percent with no education, 56% below Ordinary Level (O/L), 20% passed O/L and 2.7% passed Advance Level

examination. In the control group 27.8% did not have any education, while 66.7% had below O/L (A/L), only 5.6% had passed O/L and none of them had Advanced Level (A/L) examination qualifications.

For UTZ certified STFs the average land size was 1.04 acres (see table 02). Of this the tea cultivated land was 0.75 acres. 80% of them owned their land. 78.7% had one variety of tea while 21.3 percent had two varieties.

Table 2- Land and land size

Characteristics	**UTZ**	**Control**
Land size (total) acres	1.04	1.15
Land size (tea cultivated) acres	0.75	1.07
Land (tea) ownership (own-%)	80 (60)	94.4 (17)
Number of varieties planted (%) 1	78.7 (59)	83.3 (15)
2	21.3 (16)	16.7 (3)

Source: Survey data, 2016.

Table 3 shows that the average income of the UTZ certified STFs (LKR 6221.31) is higher than that of non-UTZ farmers (LKR 2664.71). The study found that income of UTZ farmers had increased by 34.7% after joining with UTZ programme while for the control group STFs' income had increased only by 11.6% during the similar time period. Before certification tea was the main source of income for 66.7% of the UTZ certified STFs, this has decreased slightly to 65.3% by 2015 (table 03). The figure remained unchanged among the control groups.

Table 3- Total income, sources and income from tea

		UTZ	**Control**
		2015	2015
Total Income	Average (LKR)	6221.31	2664.71
Main source of income	Tea	65.3 (49)	94.4 (17)
% (number)	Others	34.6 (26)	5.6 (1)
	NR*	13.3 (10)	-
	Total	100 (75)	100 (18)
Income share from tea	Less than 25%	24.0 (18)	11.1 (2)
	26 – 50%	37.3 (28)	33.3 (6)
	51- 75%	17.3 (13)	50.0 (9)
	More than 75%	8.0 (6)	-
	NR*	13.3 (10)	5.6 (1)
	Total	100 (75)	100 (18)

*Not Responded

Source: Survey data, 2016.

The slight decrease among the certified STFs could be due to the crisis affecting the tea sector in general where Sri Lanka tea markets have gone down drastically due to the uncertain political climate in the Middle East and reduction from the Russian markets. By 2015 for a majority of the certified STFs (37.3%) the income share from tea had risen to between 26 to 50%. By 2015 a few of the certified STFs (8%) were even attributing over 75% of their income to the tea sector.

Among the UTZ certified STFs in 2011, table 4 shows that 49.3% of the certified STFs' main cost of production was spent on fertilizer while 28 % of producers' main cost was labor. By 2015 the percentage that said that their main cost of production was fertilizer has decreased to 37.3 % while those that said labor had increased slightly to 29.3%. Among the control group those that said their main component of the production cost was fertilizer had decreased from 83.3% in 2011 to 66.7% in 2015 while those that said their main component of production cost was labor had remained unchanged at 16.7%.

Table 4- Cost of production

		UTZ		**Control**	
		2011	2015	2011	2015
Main Portion of the Production Cost	Fertilizer	49.3 (37)	37.3 (28)	83.3 (15)	66.7 (12)
	Labor	28.0 (21)	29.3 (22)	16.7 (3)	16.7 (3)
	Others	8.0 (6)	8.0 (6)	-	-
	NR	14.7 (11)	25.3 (19)	-	16.7 (3)
	Total	100 (75)	100 (75)	100 (18)	100 (18)

Source: Survey data, 2016.

Results of Stochastic Production Frontier and Efficiency Models

Table 5- Parameter estimates of stochastic production frontier and technical efficiency.

Variables	**Parameter**	**Coefficient**	**Standard error**
Stochastic production frontier			
Constant	β_0	-29.226	15.692
LnX_1	β_1	0.269	2.418
LnX_2	β_2	1.392*	0.435
LnX_3	β_3	13.317*	0.344
LnX_1^2	β_{11}	0.094	0.179
LnX_2^2	β_{22}	-0.219*	0.079
LnX_3^2	β_{33}	-1.191*	0.068
LnX_1 LnX_2	β_{12}	-0.034	0.690
LnX_1 LnX_3	β_{13}	-0.048	0.476
LnX_2 LnX_3	β_{23}	-0.191*	0.064
Technical inefficiency models			
Constant	δ_0	0.597	0.926
Z_1	δ_1	-1.137***	0.685
Z_2	δ_2	0.903	0.605
Z_3	δ_3	-0.185	0.423
Z_4	δ_4	0.0002	0.019
Z_5	δ_5	-0.017	0.018
Z_6	δ_6	0.036**	0.015
Ln (likelihood) = -87.4088, N = 93 Mean technical efficiency = 0.5325			
*** p < 0.01, ** p < 0.05, * p < 0.10			

Source: Survey data, 2016.

The parameters of stochastic production frontier and the efficiency model were simultaneously estimated using MLE method in STATA. Table 5 presents the MLE of parameters of the stochastic production frontier and the parameters of the technical efficiency model. Table 5 illustrates factors affecting technical efficiency. Only UTZ certification and number of years harvesting with same plants are statistically significant factors. While UTZ is significantly negative (δ_1 = -1.13) number of years with same plants is positive (δ_6 = 0.036). This indicates that when tea plants are getting older and older, it creates technical inefficiency. The negative UTZ indicates that farmers who are enrolled in UTZ certification are lesser technical efficiency than the other farmers. The reasons may be that UTZ certified farmers are given a good training to utilize scientifically as well as environmentally acceptable amount of fertilizers, while other farmers overdose fertilizers. This study did not look at positive externalities generated by UTZ programme. Furthermore, UTZ certified farmers are financially better off.

Table 6 displays the average technical efficiency scores of UTZ and other STFs. The results indicate that, on average, other farmers are more TE than the UTZ certified farmers.

Table 6- Technical efficiency scores of UTZ and other STFs

Groups	**Mean**	**Stand. Dev**	**Mini**	**Maxi**
UTZ	0.517	0.265	0.0127	0.999
Control	0.596	0.271	0.0154	0.999
Total	0.533	0.028	0.0127	0.999

Source: Survey data, 2016.

The estimates of farmers' specific technical efficiencies are presented in Table 7. The distribution of the technical efficiencies across the farmers is normal if one ignored the most efficient smallholders. Table 7 shows that 11.8% of the STFs have recorded technical efficiency scores above 90%. 47.3% of the farmers have technical efficiency scores above 50%. The estimated technical efficiency ranged between 0.013 and 0.999 with a mean of 0.533. However, previous studies showed fairly mixed results. According to Basnayake and Gunaratne, (2002), technical efficiency of the tea small holdings sector in the Mid Country Wet Zone in Sri Lanka was found to be 64.6%. Bogahawatte (1984) explained that technical efficiency of the tea smallholdings sector in Nuwara Eliya District in Sri Lanka was 57.5%. Dharmadasa and Wijethilaka (2014) showed that the increase of land extent by 1 % will increase output by 0.40%. Dube and Guveya (2014) found that technical efficiency of smallholder tea farmers in Zimbabwe was 79%. Hong and Yabe (2015) found that technical efficiency of smallholder tea farmers in Vietnam was 82.21%.

The estimates of output elasticity is displayed in table 8. The estimated values of output elasticity for labor and fertilizer are positive. Fertilizer is found to have the highest vale (0.454). The elasticity for farm size is negative (-0.042). The estimated value of returns of scale is 0.615, indicating that the STFs' tea production has decreasing returns to scale. This indicates that if the farmers increased all inputs by 1 percent tea production would increase by 0.62 percent only. About 74 percent of the returns to scale is attributed to use of fertilizers. This is why STFs over-use fertilizers.

Table 7- Distribution of Farmers' specific technical efficiencies

Efficiency	Number of farmers	Percentage	Cumulative percentage
< 10	7	7.5	7.5
10.1 – 20	5	5.4	12.9
20.1 – 30	3	3.2	16.1
30.1 – 40	15	16.1	32.3
40.1 -50	9	9.7	41.9
50.1 - 60	10	10.8	52.7
60.1 -70	23	24.7	77.4
70.1 -80	8	8.6	86.0
80.1 -90	2	2.2	88.2
90.1 -100	11	11.8	100.0
93	93	100.0	

Source: Survey data, 2016.

Dharmadasa and Wijethilaka (2014) indicated that the inputs of family labor and hired labor are increased by 1%, output will increase by 0.20% and 0.38 % respectively. He further found that STFs increase the fertilizer applied from 1 %, it will increase the output by 0.41 %. Basnayake and Gunaratne, (2002) further find a positive relationship between inputs and tea output and they explain that this result is contrary to the general expectation. Similar results were recorded by Dube and Guveya (2014); and Hong and Yabe (2015).

Table 8- Output elasticity

Input	Elasticity
Farm size	-0.042
Labor	0.203
Fertilizers	0.454
RTS	0.615

Source: Survey data, 2016.

The most salient feature is that UTZ farmers use socially acceptable amount of fertilizers, as a result, their productivity is low. However, the study found that though the UTZ producers are less efficient, they earn higher income because UTZ producers produce high quality tea. The UTZ certification programme has used several methods to improve the productivity of STFs in Sri Lanka.

Management practices

The certified STFs had been maintaining records on all aspects of management while the control group STFs maintained records only on pricing, use of supplies and plucking information. Furthermore among the certified STFs the maintenance of such records had significantly improved by 2015. This can be directly attributed to the certification process that requires the maintenance of records also supported by the provision of a farm diary among the UTZ certified STFs. The farm diary has become a useful tool for the STFs to keep track of their activities and cost, and plan for the future. When reviewing the STFs for certification the farm diaries are checked and verified. Further details are in table 09.

Table 9- Impacts on management practices (as a percentage)

Indicators	UTZ		Control	
	2011	2015	2011	2015
Accounting	25.3 (19)	60.0 (45)	0 (0)	0
Management	21.3 (16)	64.0 (58)	0 (0)	0
Pricing	30.7 (23)	66.7 (50)	88.9 (16)	61. 1 (11)
Workers records	21.3 (16)	53.3 (40)	0	0
Soils analysis	24.0 (18)	74.7 (56)	0	0
Training records	14.7 (11)	73.2 (55)	0	0
Use of supplies	36.0 (27)	62.7 (47)	5.6 (1)	0
Plucking info	38.7 (29)	65.3 (49)	5.6 (1)	5.6 (1)

Source: Survey data, 2016.

Quality Maintenance

The UTZ certified STFs have improved the maintenance of quality. It is significant that among the UTZ certified STFs the improvements in leaf collection, improved time of transportation to reach factory, improved time of production and delivery to collection centers and improved productivity have been over 20% (see table 10). Among the control group there are improvements in the transport time of green leaves to reach the factory, and a slight improvement in storage of green leaves. The control group STFs have recorded decreasing percentages in improved time of production and delivery to collection centers, productivity and maintenance of hygiene.

Table 10- Implementing measures to maintain quality

	UTZ		**Control**	
	2011	2015	2011	2015
Maintain hygiene and quality of green leaves	58.7 (44)	86.7 (65)	88.9 (16)	72.2 (15)
Improve productivity	54.7 (41)	86.7 (65)	77.8 (14)	61.1 (11)
Improve time of production and delivery to collection center	38.7 (29)	64.0 (48)	33.3 (6)	22.2 (4)
Improve transport time of green leaves to reach factory	29.3 (22)	50.7 (38)	16.7 (3)	27.8 (5)
Improve interval between leaf collection during season and off season	42.7 (32)	77.3 (58)	22.2 (4)	22.4 (4)
Store green leaves before collection by agent	30.7 (23)	41.3 (31)	0	5.6 (1)

Source: Survey data, 2016.

Many of STFs are planting tea along with other crops (i.e. pepper, vegetables and avocado). They also mentioned that due to the low price of tea (as a result of the current market conditions) their income from tea is also comparatively low. Before getting into UTZ programs, the STFs had plucked tea leaves once in two weeks, while now they are plucking once a week. They also practice alternatives to using pesticide and learnt about other crops that can be combined with tea (ex: avocado, which brings an additional

income, is planted as a shade tree). The records they have maintained for the last 6 months indicate that the tea they are currently producing brings higher weight and better prices.

Workers and Working Conditions

UTZ certified programme has done several activities to improve workers' safety and working condition. These activities have generated very positive impacts on workers and their life style. Maintenance of records of workers' health, safety and working conditions improved by 36% among certified and 11.1 percent among control group STFs. Provision of training to workers to improve quality of leaves improved by 39.7% among certified and 22% among control group STFs. Provision of training on handling hazardous substances improved by 29.3% among certified and 5.8% among control group STFs. Provision of protective clothing /equipment to workers when necessary improved by 3.7% among certified and 5.8% among control group STFs. Access to clean hand washing facilities have improved by 13.4% among certified and 11.1% among none certified smallholders (see table 11).

Table 11- Impact on workers and working conditions

	UTZ		**Control**	
	2011	2015	2011	2015
Maintain records of workers health, safety and working conditions	26.7 (20)	62.7 (47)	5.6 (1)	16.7 (3)
Provide training for workers to improve quality of leaves	40.0 (30)	79.7 (53)	22.2 (4)	22.2 (4)
Provide training on handling hazardous substances	40.0 (30)	69.3 (52)	61.7 (17)	66.7 (12)
Provide protective clothing/ equipment to workers when necessary	36.0 (27)	66.7 (50)	50.0 (9)	55.8 (10)
Provide workers access to clean hand washing facilities	61.3 (46)	74.7 (56)	72.2 (13)	83.3 (15)
Provide clean living and eating sites for workers	73.3 (55)	74.7 (56)	(13)	3 (15)

Source: Survey data, 2016.

Soil Management

Among UTZ certified STFs (table 12), the use of fertilizer has decreased from 74.7% in 2011 to 68% in 2015. Measures to prevent water contamination when using fertilizer has remained unchanged. In many other areas of soil management, the contribution of the certification process has been positive with an increase, including conducting analysis to determine nutrient levels, obtaining technical advice on the quantity of fertilizer to be applied, maintaining a list of fertilizers used, Receiving training on the application of fertilizer, Use of regular irrigation, Implementing measures to improve soil structure, Maintaining records of soil tests, Conducting soil tests and Keeping a map of cultivable tea lands.

Among the control group, the use of fertilizer has decreased by 5.6% from 66.7% to 61.1%. The following have also decreased; Conducting soil tests, Implementing measures to maintain soil structure, Use of regular irrigation, Receipt of training on the use of

fertilizer, Measures to prevent water contamination, Use of human sewage, sludge and sewage water on tea for any purpose and Conducting analysis to determine the content of nutrient. The following have remained unchanged; Keeping a map of the tea land, Maintaining records of soil tests, Maintaining a list of fertilizer and Obtaining technical advice on the quantity of fertilizer to be used.

Table 12- Impact on soil management and use of fertilizer

	UTZ		**Control**	
	2011	2015	2011	2015
Keep an area map of tea cultivable land	57.3 (43)	76.0 (57)	16.7 (3)	16.7 (3)
Conduct soil test	46.7 (35)	84.0 (63)	83.3 (15)	72.2 (13)
Maintain records of soil tests	33.3 (25)	78.7 (59)	16.7 (3)	16.7 (3)
Implement methods to maintain and improve soil structure	60.0 (45)	66.7 (50)	50.0 (9)	44.4 (8)
Use regular irrigation?	18.7 (14)	36.0 (27)	94.4 (17)	88.9 (16)
Use fertilizer	74.7 (58)	68.0 (57)	66.7 (15)	61.1 (11)
Received any training on the use and application of fertilizer	50.7 (38)	60.0 (45)	16.7 (3)	11.1 (2)
Maintain a list of fertilizer you use	29.3 (22)	52.0 (39)	11.1 (2)	11.1 (2)
Follow measures to prevent water contamination when using fertilizer	68.0 (51)	68.0 (51)	88.9 (16)	72.3 (13)
Obtained technical advice on the quantity of fertilizer to be used for your land	48.0 (36)	58.7 (44)	11.1 (2)	11.1 (2)
Used human sewage, sludge and sewage water on tea for any purpose	8.0 (6)	18.7 (14)	11.1 (2)	0
Before organic fertilizer is applied, conduct analysis to determine the content of nutrients (N P K)?	29.3 (22)	62.7 (47)	16.7 (30	11.1 (2)

Source: Survey data, 2016.

The higher levels of awareness among the control group in areas such as use of irrigation, soil testing and prevention of water contamination could be the result of programs conducted by other service providers including the TSHDA. For example any STFs can get their tea soils tested for acidity and obtain necessary recommendations for soil correction by paying a nominal fee to the TSHDA. They also provide funding for replanting with soil rehabilitation. For the land is situated in any tea growing districts LKR 350,000/- per hectare can be received. Approval will be granted up to one hectare for a STFs per annum.

Crop Protection

As indicated in the table 13, all aspects of pesticides management practices have improved among the UTZ certified STFs.

Table 13- Comparison of pesticide management practices

	UTZ		Control	
	2011	2015	2011	2015
Aware of crop protection products classified by any authorities (i.e. WHO)	25.3 (19)	54.7 (41)	11.1 (2)	11.1 (2)
Apply any crop protection products	44.0 (33)	69.3 (52)	11.1 (2)	11.1 (2)
keep away use of the protection products from the nearest stream /water source	53.3 (40)	81.3 (61)	100 (18)	100 (18)
Use visual signs to inform people of re-entry time after use of pesticides	44.0 (33)	60.0 (45)	94.4 (17)	94.4 (17)
Keep invoices/ documentary evidence of crop protection products	32.0 (24)	50.7 (38)	11.1 (2)	22.2 (4)
Follow methods of prevention, reduction, monitoring, intervention to reduce pest attacks	46.7 (35)	77.3 (58)	88.9 (16)	11.1 (2)
Use proper/safe storage for these crop protection products	33.3 (25)	64.0 (48)	55.6 (10)	55.6 (10)
Pesticides kept separately to other items	62.7 (47)	76.0 (57)	61.1 (11)	61.1 (11)
Have proper signs warning people of the dangers	48.0 (36)	49.3 (37)	61.1 (11)	61.1 (11)
Use proper ways of getting rid of empty bottles and other waste	50.7 (38)	57.3 (43)	100 (18)	100 (18)
Systems in place to address an emergency situation that may arise related to contamination	60.0 (45)	61.3 (46)	94.4 (17)	94.4 (17)

Source: Survey data, 2016.

Among the control group while many of the aspects have remained unchanged, some of these numbers being already at high levels. There has been a significant reduction in the methods of prevention, reduction, monitoring, and intervention to reduce pest attacks, which is an anomaly.

Environmental Sustainability

The implementation of a conservation plan to enhance bio diversity around the plantation has increased significantly by 34.7% among the UTZ certified STFs. In all other aspects too there is an improvement in conservation practices. Negative implications on environmental sustainability can be observed as well since the conversion of forest land into tea cultivation has also gone up. This, however may be mitigated by the overall increase in the implementation of conservation practices that has increased by 26.7% from 2011 to 2015 (table 14).

The respondents were asked to rate on a scale of 1 to 10 ways in which their estates had changed in the last five years in relation to the different aspects – environmental, social, economic etc. UTZ certified STFs have rated themselves higher than the control group

STFs in most categories except in disposal of waste water without treatment and waste water management.

Table 14- Environmental sustainability

	UTZ		**Control**	
	2011	2015	2011	2015
Implement a conservation plan to protect and enhance bio diversity in and around your plantation	41.3 (31)	76.0 (57)	100 (18)	88.9 (16)
Any water streams and other water sources running through your tea land	16.0 (12)	20.0 (15)	50.0 (9)	44.4 (8)
Implement actions to protect these water streams and other water sources from contamination and pollution	26.7 (20)	50.7 (38)	50.0 (9)	33.3 (6)
Attempts to convert forestland to tea cultivation	34.7 (26)	52.0 (39)	22.22 (4)	16.7 (3)
Converted forestland to tea cultivation	38.7 (29)	46.7 (35)	11.1 (2)	11.1 (2)
Implement any conservation practices	40.0 (30)	66.7 (50)	38.9 (7)	16.7 (3)

Source: Survey data, 2016.

Even the previous analysis indicated that the control group had better levels of irrigation and water management practices. The UTZ certified STFs rated themselves higher than the control group in indicators related to health, quality of life and income diversity. Many of the STFs mentioned that they were growing other crops in addition to tea (pepper, paddy, vegetables), this could be contribute to the diversity in income. They mentioned that the first aid training programs conducted as part of the certification process also improved their knowledge on health care practices. According to the group in Liyangahawela first aid taught them to deal with emergencies until they get to a hospital. They also probably have access to health extension services such as the mid wife – a primary health care provider that provides maternal and child heath related services even in the remotest regions. The control group had rated themselves higher in education, access to basic facilities (water and electricity), social relationships and caring for the environment. Since Weralapathana is located closer to the Nildandahinna town, they have better access to schools as well as having a better road network. They also have better access to infrastructure facilities including water and electricity. In all economic aspects the UTZ certified STFs rated themselves much higher than the control group STFs. The Good Agriculture Practices and other capacity development programs conducted by the certification process appears to have contributed to the higher rating provided by the UTZ certified STFs. They mentioned that they had learnt many new things such as the prices and the conditions in the world tea market, this increased awareness could have also contributed to the higher rating by the UTZ certified group. The UTZ certified group had rated themselves higher in all aspects except; workers safety and access to clean water for workers. The UTZ certified were made aware about workers safety and health through the programs conducted leading up to the certification process, therefore they may have rated themselves lower since they were more aware about the standards that should be maintained.

Table 15 indicates the cost items and the numbers are averages based on responses provided by all respondents. The highest cost item for both groups is fertilizer, even though the cost was much higher among the control group at 33.8%, indicating that STFs still spend a significant proportion of their costs on fertilizer. The second highest cost item for UTZ certified smallholders was management followed by weeding and disease control.

For the control group the second highest cost item was weeding, followed by milling and transportation. The high cost of transport among the control group maybe because they individually transport the leaves whereas the UTZ certified STFs mentioned in the FGD that they follow a method of collective transportation where one person transports the leaves of the entire group which may result in lowers costs.

Table 15- Percentage of cost per item

Item	UTZ	Control
Fertilization	16.69	33.82
Management	13.38	7.71
Weeding	12.22	19.00
For control of diseases	8.85	3.80
Tea planting	7.25	3.80
Milling	6.69	11.83
Controls of pests	5.64	3.83
Transportation	5.56	10.60
Certification	4.21	3.00
Others (specify)	19.51	2.60
Total	100	100

Source: Survey data, 2016.

The STFs were asked to rate on a scale of 1 to 10, 1 being lowest and 10 being highest, the level of improvements in the social, economic and environmental aspects (table 16). In terms of the environmental, economic, workers conditions and group performance the UTZ certified smallholders had given higher rates than the control group. For the social and women empowerment indices the control group smallholders gave higher rates than the UTZ certified group.

Table 16- Summery of impacts - social, economic, environmental

Index (Impact)	UTZ	Control
Environment index	5.295	2.820
Social Index	5.926	6.405
Economic Index	5.604	2.009
Index for workers condition	4.587	2.228
Group Performance index	5.659	1.318
Women Empowerment	6.309	8.825

Source: Survey data, 2016.

This could be because the sample of the control group had a higher proportion of women – 44.4% – as opposed to the UTZ certified smallholders, that had a lesser proportion –

33.3% – of women. The women in the control group may have been more aware and rated their social and gender empowerment indices on a higher level. They may also have participated in programs conducted by other service providers and developed a higher sense of awareness on these aspects making them rate themselves higher.

Conclusion

This study aimed at determining the technical efficiency of STFs under UTZ Certification System in Sri Lanka employing stochastic production frontier. The study identified the contributory factors that influence technical efficiency in the STFs production and the maximum likelihood estimate of the frontier production showed clearly that labor and fertilizer are the significant inputs in smallholder tea production. The stochastic frontier function estimated for the 93 respondents showed that the mean efficiency value was 0.533. A small number of STFs (11.8 percent) are over 90 percent efficient. The level of efficiency was found to be positively related to number of years with the same plants. The UTZ certified STFs have a good management practices, maintenance of quality of the products, workers and working conditions, soil management, crop protection and environmental sustainability compared to the control group of STFs.

UTZ programme has initiated several activities to enhance STFs' productivity and income, but one has to wait few years to see the ultimate results. It would be useful if one waits few years and conducts another study to examine the efficiency level of the UTZ STFs.

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