CHAPTER 7

THE FACTORS AFFECTING YIELD OF TEA OF CONVENTIONAL AND ORGANIC TEA SYSTEMS

The chapter focuses on exploring the factors affecting yield of fresh tea, based on employing stochastic frontier model. Yield of tea originally is the most concerned subject to tea farmers. Farmers hope to have the highest productivity and to use the least inputs; it means that they like to maximize the profit from their tea plantations. The question is how to operate tea farm efficiently in economic aspect that consists of allocative and technical efficiency. Likewise, recognition of difference and similarity of factors affecting yield of fresh tea has significance in having right interventions in conventional tea production as well as organic tea production. This would suggest tea farmers according to each input used in conventional and organic tea production processes in order to obtain the best production performance.

7.1 Empirical models

7.1.1 Description of variables in the models

Conventional and organic tea production systems have existed in selected study sites, Thai Nguyen and Phu Tho. Production data were obtained from surveys by simple random selection of sample as presented in details in the Chapter 4. Reasons for selection of tea farmer sample in two provinces were that each province was a representative for distinct agroecological region, Thai Nguyen as a representative for the North Mountainous Region and Phu Tho as representative for the North Mid- hill Region.

The sample consisted of data on yield of conventional fresh tea, tea land size, inputs used (urea, potassium, phosphate, manure), chemical cost, labor, for conventional tea farms, and on yield of organic fresh tea, tea land size, inputs used (organic fertilizer, manure, compost), and labor employed in organic tea farms. In addition, the sample also included data on social indicators such as age, education level, gender of tea farm head, the training courses received by farmers in a year.

Variables concerned to possibility of improving technical efficiency, i.e., clone, types of propagating materials, were employed in inefficiency model in order to explore the possibility of improving technical efficiency for the surveyed tea farms. Descriptive statistics of these variables was illustrated in Tables 43, 44, 45 and 46.

Table 43 Descriptive statistics of the variables used in stochastic frontier model for conventional tea farms

	Unit	Mean	Standard deviation	Minimum value	Maximum value	CV%
Yield	*kg*	603.3	433.2	80.0	1,669.0	71.8
Tea land size	m^2	1,324.0	679.8	79.8	2,565.7	51.3
Urea	*kg*	40.2	48.7	2.0	179.5	121.0
Potassium	*kg*	26.7	28.7	1.0	90.0	107.6
Phosphate	*kg*	7.8	11.6	1.0	40.0	149.3
Manure	*kg*	1,291.3	1,056.3	114.4	6,002.9	81.8
Chemical cost	*'000VND*	38.9	39.1	0.0	156.4	100.5
Labor	*man-day*	74.2	41.5	5.0	160.8	56.0
Location	*dummy*	0.5	0.5	0.0	1.0	100.9

Source: calculation, 2002

Table 44 Descriptive statistics of the variables used in stochastic frontier model for organic tea farms

	Unit	Mean	Standard deviation	Minimum value	Maximum value	CV%
Yield	*kg*	519.1	377.6	84.8	1,022.5	72.7
Tea land size	m^2	1,042.3	429.7	497.7	1,495.2	41.2
Org. fertilizer	*kg*	1,001.8	824.0	67.4	3,010.9	82.3
Manure	*kg*	944.9	1,173.4	49.9	3,983.8	24.2
Compost	*kg*	935.3	438.8	450.3	1,603.6	46.9
Labor	*man-days*	120.1	70.6	40.0	376.2	58.8
Location	*dummy*	0.5	0.5	0.0	1.0	100.9

Source: calculation, 2002

It was rather difficult to compare the production systems that differ from each other by forms of input used; however, there were some factors assessed solely for suggesting farmers in each production system.

Table 45 Descriptive statistics of variables in technical inefficiency model for conventional tea farm

	Unit	Mean	SD	Min	Max	CV%
Age of family head	*Year*	44.1	6.3	30	54	14.29
Family size	*member*	5.3	1	3	7	18.87
No of labors	*Person*	2.3	0.7	1	4	30.43
Education	*schooling year*	5.9	1.8	2	11	30.51
Training	*Times*	3.9	1.7	1	7	43.59
Type of clone	*dummy*	0.36	0.48	0	1	135.40
Type of propagating materials	*dummy*	0.45	0.5	0	1	112.40

Source: calculation, 2002

Table 46 Descriptive statistics of variables in technical inefficiency model for organic tea farm

	Unit	Mean	SD	Min	Max	CV%
Age of family head	*year*	42.3	6.9	30	55	16.31
Family size	*member*	4.9	1.1	3	7	22.45
No of labors	*person*	2.5	0.8	1	4	32.00
Education	*schooling year*	7.4	2.4	2	12	32.43
Training	*times*	7.9	2.7	4	14	34.18
Type of clone	*dummy*	0.39	0.49	0	1	125.00
Type of propagating materials	*dummy*	0.5	0.5	0	1	100.03

Source: calculation, 2002

7.1.2 Multicolinearity test

To avoid the multicolinearity among independent variables, examine of relationships among the input variables were found to be necessary. Using the STATISTIX program, the results of these relationships for conventional farms were summarized in Tables 47, 48.

Table 47 Correlation matrix of variables in stochastic frontier model for conventional tea farms

	$TSIZE_1$	$UREA_1$	$POTA_1$	$PHOS_1$	$MANU_1$	$CHEM_1$	$LABD_1$
$TSIZE_1$	1						
$UREA_1$	0.1176	1					
$POTA_1$	0.2354	0.2261	1				
$PHOS_1$	0.4781	0.5626	0.4458	1			
$MANU_1$	0.1421	0.3127	0.3022	0.7360	1		
$CHEM_1$	0.0346	0.1039	-0.1078	0.1445	0.3245	1	
$LABD_1$	0.1752	0.2493	0.3158	0.4996	0.2488	0.4607	1

Source: calculation, 2002.
Note: TSIZE tea size, $UREA_1$ urea, $POTA_1$ potassium, $PHOS_1$ phosphate, $MANU_1$ manure applied, $CHEM_1$ chemical cost, $LABD_1$ labor in mandays.

Table 48 Correlation matrix of variables in technical inefficiency model for conventional tea farms

	AGE_1	$PERS_1$	$LABS_1$	EDU_1	$TRAIN_1$
AGE_1	1				
$PERS_1$	0.1864	1			
$LABS_1$	0.2002	0.5423	1		
EDU_1	0.0817	-0.4263	-0.3071	1	
$TRAIN_1$	0.0620	-0.2277	-0.1670	0.2142	1

Source: calculation, 2002.
Note: AGE_1 age of household head, $PERS_1$ persons in family, $LABS_1$ labors in family, EDU_1 education level, $TRAIN_1$ training courses received a year.

Similarly, the consideration of multicollinearity was applied for variables in stochastic frontier production function and technical inefficiency models of organic tea farms. The results were summarized in Tables 49 and 50.

Table 49 Correlation matrix of variables in stochastic frontier model for organic tea farm

	$TSIZE_2$	$ORGF_2$	$MANU_2$	$COMP_2$	$LABD_2$
$TSIZE_2$	1.0000				
$ORGF_2$	0.1866	1.0000			
$MANU_2$	0.1200	0.0986	1.0000		
$COMP_2$	0.3618	-0.1720	0.2047	1.0000	
$LABD_2$	0.1865	0.2412	0.4823	0.3075	1.0000

Source: calculation, 2002.
Note: $TSIZE_2$ tea area, $ORGF_2$ bio urea, $MANU_2$ manure, $COMP_2$ compost, $LABD_2$ labor in man- days.

Table 50 Correlation matrix of variables in technical inefficiency model for organic tea farms

	AGE_2	$PERS_2$	$LABO_2$	EDU_2	$TRAIN_2$
AGE_2	1.0000				
$PERS_2$	0.2314	1.0000			
$LABO_2$	0.2148	0.4321	1.0000		
EDU_2	-0.2626	0.0422	0.1723	1.0000	
$TRAIN_2$	-0.1445	0.0199	0.0466	0.0025	1.0000

Source: calculation, 2002.
Note: AGE_2 age of household head, $PERS_2$ persons in family, $LABO_2$ Labors in family, EDU_2 education level, $TRAIN_2$ training course times.

Most of correlation coefficients among independent variables in both models of stochastic frontier and inefficiency model were acceptable due to their small values (less than 0.3), except for the variables, namely family size and labor in family. They were omitted due to relatively high multicolinearity (correlation coefficient of 0.43). All earlier mentions prove that multicolinearity did not occurred among independent variables in the proposed models.

7.1.3 Model specification

A stochastic frontier model was used for the study in order to examine a technical efficiency and its determinants. The model of both conventional tea and organic tea systems were estimated.

The tea industry in study areas is presently structured according to two tea production types, conventional and organic tea production. Selected study areas consist of both production types. Based on farm level data, the estimation of frontier production functions was considered for each tea production type regarding agroecological regions, and the answer was being seek that whether the factors affecting yield of fresh tea, the mean technical efficiency in both production systems were equal. To predict individual technical efficiencies of tea farms was also examined in this study.

Stochastic frontier function model

The stochastic frontier model was expressed as follows. The Cobb-Douglas production function of conventional tea farm was specified as,

$$LnY_{1i} = \beta o + \beta_1 ln\ TSIZE_{1i} + \beta_2 ln\ URE_{1i} + \beta_3 ln\ POTA_{1i} + \beta_4 ln\ PHOS_{1i} + \beta_5 ln\ MANU_{1i} + \beta_6 ln\ CHEM_{1i} + \beta_7 ln\ LABD_{1i} + \gamma\ DLOC_{1i} + u_i - v_i \quad \ldots..(10)$$

Where, $i = i^{th}$ of tea farm, $i = 1, 2, \ldots 56$.

Y_{1i} = Yield of conventional tea per farm (kg of fresh tea)

$TSIZE_{1i}$ = Tea land size (m^2)

URE_{1i} = Urea application dose (kg)

$POTA_{1i}$ = Potassium application dose (kg)

$PHOS_{1i}$ = Phosphate application dose (kg)

$MANU_{1i}$ = Manure application dose (kg)

$CHEM_{1i}$ = Chemical cost (1000VND)

$LABD_{1i}$ = Labor employed (man days)

$DLOC_{1i}$ = Location dummy, Thai Nguyen (NMR) denoted 1, Phu Tho denoted 0

The Cobb-Douglas production function of organic tea farms,

$$LnY_{2i} = \beta o + \beta_1 \ln AREA_{2i} + \beta_2 \ln ORGF_{2i} + \beta_3 \ln MANU_{2i} + \beta_4 \ln COMP_{2i} + \beta_5 \ln LABD_{2i} + \gamma DLOC_{2i} + u_i - v_i \quad \ldots\ldots(11)$$

Where, i= i^{-th} organic farm and i = 1,2,…,54.

Y_{2i}	= Yield of organic tea per farm (kg of fresh tea)
$TSIZE_{2i}$	= Tea land size (m^2)
$ORGF_{2i}$	= Organic fertilizer application dose (kg)
$MANU_{2i}$	= Manure application dose (kg)
$COMP_{2i}$	= Compost application dose (kg)
$LABD_{2i}$	= Labor employed (man days)
$DLOC_{2i}$	= Location dummy, Thai Nguyen (NMR) denoted 1, Phu Tho denoted 0

u_i	= one sided non – negative error term, independently and identically distributed as $N(0, \sigma^2_u)$
v_i	= random error independently and identically distributed $N(0, \sigma^2_v)$
b, g	= parameters to be estimated.
ln	= natural logarithm

Technical inefficiency model

It was hypothesized the technical inefficiency had relationship with age, education level of family head, training courses concerning tea farm practices he/she received a year, tea clone, and type of crop. The technical inefficiency model was used the same for two systems, and expressed as follows:

$$TI_i = \delta_0 + \delta_1 AGE_i + \delta_2 EDU_i + \delta_3 TRAIN_i + \delta_4 GEN_i + \delta_5 CLON_i + \delta_6 PROP_i + \varepsilon_i \quad \ldots.(12)$$

Where, i= 1,2,…,56 for conventional, 1,2,…,54 for organic.

TI_i = Technical inefficiency index (.00 to 1.00)

AGE_i = Age of family head (years old).

EDU_i = Education (schooling years).

$TRAIN_i$ = Training (times).

GEN_i = dummy variable, gender of family head (female = 1, male = 0).

$CLON_i$ = Dummy variable, type of clone (hybrid = 1, local varieties = 0).

$PROP_i$ = Dummy variable, type of propagating materials (Vegetative propagation VP = 1, seedling =0).

e_i = Error term.

d' = Parameter vector to be estimated.

7.1.4 Variable descriptions

Y (Tea yield)

Yield of fresh tea is measured by kg of fresh tea per farm. The explanatory variable is called output or productive achievement of farm. Data of this variable were obtained from the field survey, in practice, calculated and reported by tea farmers = number of harvesting rounds a year x amount of fresh tea per one round.

TSIZE (Tea land size)

Each farm has owned some field plots, in which, tea farmers cultivate food crops, fruit trees, and tea. Number of tea plots was averagely 3 plots and average tea area per farm was 1, 324 m^2 for conventional farm and 1,042 m^2 for organic farm. Tea farmers in Thai Nguyen and Phu Tho own larger tea land size than ones in others provinces.

UREA (Urea), POTA (Potassium), PHOS (Phosphate)

Fertilizers are required to add specific substances to the soil. The variables such as urea, potassium, and phosphate were included in conventional tea model. Urea as nitrogen can help tea grow effectively and rapidly after harvesting. Tea leaf is greener when tea farmers apply more urea or nitrogen on tea fields. Nitrogen is an important element in plant nutrition. Between 40 and 50% of the protoplasm is made up of nitrogenous compounds and 18 to 20% of dry protein is in the form of nitrogen. Because of this, nitrogen is of considerable importance in the vegetative growth of plant. The sign of the estimated coefficient would be expected to be positive (+).

Potassium plays an important role in the synthesis of protein by the plant and in the stability of such protein. In the absence of potash, one notes an accumulation of non-protein nitrogen in the plant tissue and a corresponding drop in protein nitrogen. It has also been associated with the ease of movement of water and salt solution through the plant system. The sign of the estimated coefficient would be expected to be positive (+).

Phosphorus is an important constituent of nucleic acid and its is necessary for cell division which is the main feature of vegetative growth. It plays an important role in the plants complex enzyme system. The signs of the estimated coefficients would be expected to be positive (+).

MANU (Manure), COMP (Compost)

Livestock was existed in both organic and conventional tea farms, so source of manure or dung from the activity was used to apply tea fields. Although its nutrient content was not high but it was so cheap, this is reason tea farmers take an advantage of it to supplement the nutrient to soil. The signs of the estimated coefficients would be expected to be positive (+).

Compost was new perception for tea farmers in terms of keeping it 2 – 3 months and mixing it with green leaf, straw. Due to last time, they only kept warm for 30 – 40 days, and then transported them to apply. Some tea farmers purchased manure from other farms having livestock activity, then composted and finally, carried them to apply. Price of manure at surveyed time was around 500 VND per kg. The variable was measured by kg. The signs of the estimated coefficients would be expected to be positive (+).

CHEM (Chemical cost)

It shows all expenses of tea farmers on crop protection, measured in Vietnamese currency (1000VND). The cost was included the pesticide, insecticide, growth regulator, chemical element used for curing tea diseases. The cost was only occurred in conventional tea farms. Moreover, the expense on crop protection is different among tea farms due to different tea land size, pest occurrences and tea branch diseases. The sign of the estimated coefficient would be expected to be positive or negative (+/-).

LABD (Labor employed)

Labor is considered as major input in tea production, including family labor, hired labor, and exchanged labor. Measured unit of the variable is man-day that is calculated 8 hours per day, and paid for VND 20,000 in case of tea farm hired labor for tea production. In tea production, the harvesting consumed most man-days, and is period in which hired and exchanged labor is occurred in conventional and organic tea farms. For organic farms, rate of man-day can be increased more due to increase of it for pest control. The signs of the estimated coefficients would be expected to be positive (+).

DLOC (Location dummy)

The dummy variable is given into the model with purpose of considering whether change of geographical location, in other words, environmental conditions, affects the yield of fresh tea or not. One is denoted for Thai Nguyen in NMR that is located at higher elevation than Phu Tho in MHR. So zero is denoted for Phu Tho. The sign of the estimated coefficient would be expected to be positive (+).

AGE (Age)

Age variable shows about age of family head or tea farm head, relating to farming skill and experience. This variable hoped to increase technical efficiency of tea farm; therefore it is used to be in hypothesis relating to technical efficiency and employed in technical inefficiency model. The variable was measured by age of family head in years old. The sign of the estimated coefficient is expected to be negative (-).

EDU (Education)

The variable illustrates the relationship between education level of family head or tea farm head and technical efficiency. Hopefully, increase of number of years attain in school can improve technical efficiency in conventional and organic tea farms. Education is issue that has been considered by government of Vietnam, however, in some areas, the opportunities of accessing to school are limited. Education is proxy that is controlling the capability of tea farmer adopt technologies and information to bring tea production to the best performance. The sign of the estimated coefficient is expected to be negative (-).

TRAIN (Training times)

The variable was hypothesized to have the association with the technical efficiency, this may be due to tea farmers having more training courses than other, having more knowledge not only in tea production but also in social and marketing activities when they communicate with other accompanied mates in their courses. Therefore, hopefully, these things can help them improve technical efficiency for their tea farms in conventional as well as organic type. The variable was measured by number of times, which was received by family head in a year. The sign of the estimated coefficient from the technical inefficiency model was expected to be negative (-).

GEN (Gender dummy)

This dummy variable is employed in the model to identify whether female is family head or tea farm operator who can improve technical efficiency. As the same level of fertilizer applied by tea farmers but higher technical efficiency means that tea farmer operated tea farm more efficiently than another. The sign of the estimated coefficient from the technical inefficiency model was expected to be negative (-).

CLON (Type of clone) , PROP (Type of propagating materials)

The dummy variable of type of clone was used in the technical inefficiency model to identify capability in improving technical efficiency. It denoted as 1 if tea farm owned tea gardens with hybrid tea variety, otherwise denotes as zero. Hybrid is known to be drought tolerant and pest resistant, and create good quality tea. The sign of the estimated coefficient from the technical inefficiency model was expected to be negative (-).

The dummy variable of type of propagating materials was put in the technical inefficiency model in order to explore whether new method of vegetative propagation applied by tea farmers is better than old method of planting by seed or not. The sign of the estimated coefficient from the technical inefficiency model was expected to be negative (-).

7.2 Empirical results

7.2.1 Estimation results of stochastic frontier model for conventional tea farms

Test of variance parameters

The estimate of γ was 0.86, which indicated that the vast majority of error variation was due to the inefficiency error u_i (and not due to the random error v_i). This indicated that the component of the inefficiency effects made a significance contribution in the analysis. The one sided LR test of $g = 0$ provided a statistic of 52.8 which exceeded the χ -square five percent critical value of 16.9. Hence the stochastic frontier model appeared to be significant improvement over an average (OLS) production function (Appendix 4). In other words, there was existence of a frontier production function for conventional tea production. Estimated results of stochastic frontier model (using Maximum Likelihood Estimation: MLE) were summarized in Table 51.

Table 51 Estimated parameters in the Cobb – Douglas stochastic frontier model for conventional tea farms by MLE

Variable	Parameter	Coefficient	*t*- statistics
Stochastic frontier model			
Constant	b_0	1.5397***	4.1280
Ln (TSIZE)	b_1	0.1101***	2.9250
Ln (UREA)	b_2	0.2582***	7.9709
Ln (POTA)	b_3	0.0859***	4.5743
Ln (PHOS)	b_4	-0.0937***	-3.4156
Ln (MANU)	b_5	0.1116*	1.9123
Ln (CHEM)	b_6	0.0090ns	1.4268
Ln (LABD)	b_7	0.5903***	13.5482
DLOC	b_8	-0.0137ns	-0.3043
	s_e^2	0.0227***	3.2326
	g	0.8571***	5.0516

Source: calculation from FRONTIER 4.1c.

Note: $s_e^2 = s^2_{u} + s^2_{v}$ $\quad g = \frac{s_u^2}{s_u^2 + s_v^2}$

*** : statistical significance at 0.01 level

** : statistical significance at 0.05 level

* : statistical significance at 0.10 level

ns : non significance

Discussion on estimated coefficients in stochastic frontier models

Most coefficients had positive signs, except variable of location, phosphate in the frontier production model, shown inversed association among input variables and yield in the sample of the selected study areas. Estimated coefficients had statistical significance at 0.01, 0.05 levels, such as urea, potassium, and labor used. The results indicated that if increment of these factors were by one percent, i.e., urea, potassium applied, and labor employed, there would be increasing by 0.26 percent, 0.09 percent, 0.59 percent in yield of fresh tea, respectively. Since this is the model of whole farm production yield, the land size variable is necessary to capture the difference of total production due to production size. The coefficient of tea land size had positive sign and was statistically significant, indicating that an increase of one percent of land raised yield by 0.11 percent. On the average, an increase of 1 m^2 raised yield of 0.05 kg. The estimated coefficient of phosphate had negative sign and was statistically significant, implying that conventional tea farmers have overused amount of phosphate, average 6.8 kg per farm, which was equivalent to 130 kg per ha. This was explained that tea farms have ignored suggest of applying 50 – 60 kg per ha of this fertilizer from the extension agents. The coefficient of chemical was statistically insignificant, indicating that chemical cost in both content for curing tea diseases and pesticides seemed not to affect the yield of fresh tea, even though tea farmers had expensed more or less for their tea farms. The estimated coefficient of location was statistically insignificant, revealed that geographical and environmental conditions such as rainfall, elevation of two study sites had approximately the same effect on yield of fresh tea.

7.2.2 Determinants of technical efficiency in conventional farms

The predicted technical efficiencies of the conventional tea farmers in the sample, obtained by using Cobb-Douglas model, were given in Appendix 3. The average technical efficiency was 0.786, indicating that most surveyed conventional tea farms were operated relatively closely their best productive performance (frontier). This also implied that, on average, the conventional tea farmers in the study sites were producing conventional tea to about 78.6 percent of the potential (stochastic) frontier production levels, given the levels of their inputs and the technology currently being used. Technical efficiencies of individual conventional tea farms were clustered in groups of 0.71 - 0.8 (27% of sampled farms), 0.91 –1.0 (30% sampled farms), revealed that haft of conventional tea farms operated fairly efficiently but some conventional tea farms had poor technical efficiency, it was found that 5% sampled farms were operated at technical efficiency of 0.41 - 0.5. The distribution of the predicted technical efficiencies of conventional tea farms shown in Figure 9.

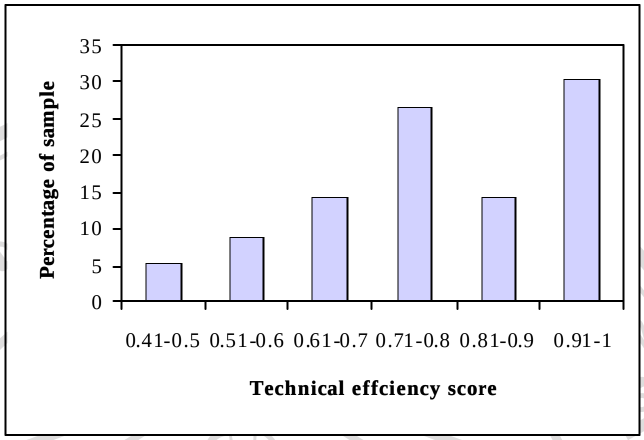

Figure 9 Distribution of technical efficiency of conventional tea farmers

Given the certain state of technology, farmers varied in their level of achievement of maximum possible output. The difference depended upon farm characteristics such as age, number of years attaining school, gender, training times received by tea farm head, and socio economic and natural conditions. In this study, farm-specific technical efficiency was hypothesized to influence by age, education, training, gender, clone, and type of propagating materials.

The estimated coefficients in the inefficiency model were of particular interested to this study and were depicted in Table 52. The age coefficients appeared to be negative and significant which indicated that older tea farmers were more than efficient than younger ones. This also proved that old tea farmers often have more experience in tea production than young tea farmers. This may be due to their good managerial skills, which they have learnt over time. Therefore the younger organic tea farmers should be encouraged to work with elder tea farmers.

Coefficient of education was negative and significant, revealing that education had impact on increasing technical efficiency of tea farm. This may be due to his managerial skill and easy access to information and advanced techniques.

Estimated coefficients of type of propagating materials and training were statistically insignificant, implying that types of crop such as vegetative propagation or seedling did not affect technical efficiency of the sampled tea farms. Similarly, training courses concerned tea farm practices also had not impact on reducing technical inefficiency of conventional tea farms.

Table 52 Estimated parameters in technical inefficiency effect model for conventional tea farms

Variables	Parameter	Coefficient	*t*- statistics
Constant	d_0	1.5330***	6.0918
AGE_1	d_1	-0.0182***	-3.4941
EDU_1	d_2	-0.0431**	-2.1127
$TRAIN_1$	d_3	-0.0222ns	-1.0874
GEN_1	d_4	-0.1676***	-2.5326
$CLON_1$	d_5	-0.2063**	-2.0749
$PROP_1$	d_6	-0.0925*	-1.6240

Source: calculation from FRONTIER 4.1c.
Note: SE standard error, ***, **, *, ns: statistical significance at the 0.01, 0.05, 0.10, non significance levels, respectively.

The estimated coefficient for gender, tea clones coefficient showed negative values and have statistical significance. The negative and significant coefficients for gender suggested that female as family head or key tea farm operator to be more efficient than male as household head.

Likewise, tea hybrid applied had significant effects on increase in technical efficiency. It was proved that the coefficient sign was negative and had statistically significance at the 0.05 level. It indicated that tea farmers applied hybrid tea was more efficiently than tea farmers did not applied type of hybrid tea.

Negative value and significant of the estimated coefficient for type of propagating materials indicated conventional tea farmers used vegetative propagation (cuttings) more efficient than applying seedling in newplanting tea.

7.2.3 Estimated results in stochastic frontier model for organic tea farms

In regard with organic tea farms, the factors affecting yield of fresh tea were considered, the technical efficiency for individual farms were predicted, and factors affecting technical efficiency were examined. The results were obtained by available software FRONTIER 4.1c, summarized in Table 53.

Table 53 Estimated coefficients in the Cobb-Douglas stochastic frontier production function by MLE for organic tea farms

Variable	Parameter	Coefficient	t-ratio
Stochastic frontier production			
Constant	b_0	-7.7723***	-22.8370
Ln ($TSIZE_2$)	b_1	1.6597***	36.9814
Ln ($ORGF_2$)	b_2	0.0672***	2.7782
Ln ($MANU_2$)	b_3	0.0029ns	0.4216
Ln ($COMP_2$)	b_4	0.2295***	4.6662
Ln ($LABD_2$)	b_5	0.0960*	1.8425
$DLOC_2$	b_6	0.0239ns	1.0536
	s_e^2	0.0202***	3.0608
	g	0.9527***	125.925
Log (likelihood)		57.6818	
LR one-sided		82.3560	

Source: calculation, 2002.

Note: $s_e^2 = s_u^2 + s_v^2$

$$g = \frac{s_u^2}{s_u^2 + s_v^2}$$

*** : statistical significance at 0.01 level
** : statistical significance at 0.05 level
* : statistical significance at 0.10 level
ns : non significance

Test of variance parameters

The estimate of g was 0.95, which indicated that the vast majority of error variation was due to the inefficiency error u_i (and not due to the random error v_i). This indicated that the component of the inefficiency effects made a significance contribution in the analysis. The one sided LR test of g = 0 provided a statistic of 82.35 which exceeded the χ -square five percent critical value of 14.1. Hence the stochastic frontier model appeared to be significant improvement over an average (OLS) production function (Appendix 5). In other words, there was existence of frontier production function for organic tea production.

Discuss on factors affecting yield of organic fresh tea and technical efficiency

Most estimated coefficients showed positive value as expected and had significant at various levels. Estimated coefficient of tea land size showed positive value of 1.66, and significant, revealing that tea land size had significant effects in increasing yield of fresh tea. Therefore, increment of tea land size by one percent would increase output by a larger proportion (1.66 percent). That is at the mean, the increment was 0.80 kg per m^2. The estimated coefficients of organic fertilizer, compost, and labor showed positive values of 0.07, 0.23, 0.096, respectively and were significant, revealed that they were effects on increasing yield of fresh tea. This also indicated that if increment of organic fertilizer, compost, and labor by one percent would increase the yield by 0.07 percent, 0.23 percent, and 0.096 percent, respectively.

Estimated coefficients of manure and location were positive but statistically insignificant, explained that manure had less impact on raising yield of fresh tea in surveyed organic tea farms. Another interpretation for this was quality of manure made by tea farmers themselves was not insured in terms of quality. Location dummy coefficient was estimated to be in positive sign but insignificance, presenting that geographical and environmental conditions of selected study sites had no effects on increasing yield of fresh organic tea. It was clear that two selected sites might be less different from each other in terms of elevation as well as environmental conditions such as temperature and rainfall.

7.2.4 Determinants affecting technical efficiency

The technical efficiencies of the organic tea farmers in the sample, obtained by using Cobb-Douglas model, were given in Appendix 3. These values ranged from 0.469 to 0.992, with the mean technical efficiency estimated to be 0.846. This implied that, on average, the organic tea farmers in the study sites were producing organic tea to about 84.6 percent of the potential (stochastic) frontier production levels, given the levels of their inputs and the technology currently being used. There were sixty four percent of the sample organic tea farmers who had technical efficiencies greater than 0.81. There were about thirty five percent of the organic tea farmers with technical efficiencies less than 0.8. A simple frequency distribution of the predicted technical efficiencies of the 54 organic tea farmers was presented in Figure 10.

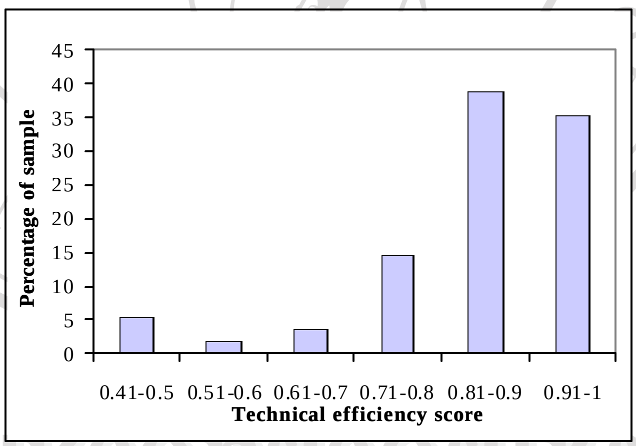

Figure 10 Distribution of technical efficiency of organic tea farmers

Technical efficiencies of individual organic tea farms clustered in ranges 0.81 - 0.9 (38% of the sample), 0.91-1.0 (35% of the sample), implied that most conventional tea farms were operating so efficiently because they have been guided and under the supervision of the project officers of CIDSE organization. However, the figure indicated that, although there were very high relative frequencies of the technical efficiencies above 0.81, there were also some organic tea farmers who were quite poor in their technical efficiency performance (5 percent of the sample); it was explained more that almost all the organic tea farms were outside of the project.

The estimated coefficients in the inefficiency model for organic tea farms were of particular interested to this study and were depicted in Table 54. The age coefficients appeared to be negative and significant which indicated that older tea farmers were more than efficient than younger ones. However, the coefficient values was less so the deviation of age of organic tea farm head between old and young would be less significant in increasing technical efficiency.

Education coefficient was negative and significant, revealing that educated organic farmers were more efficient than others. This may be because the educated farmers accessed to information and adopted sensitively new techniques more easily than lower educated farmers.

Negative and significant estimated coefficient of training suggested that whoever organic tea farmer taken part in more training courses were more efficient than other organic farmers having less than training courses concerned to organic farm practices, i.e., making compost, controlling pest, and applying organic fertilizer and compost in right way.

The estimated coefficient for gender, tea clones coefficient showed negative values and had statistical significance. The positive and insignificant coefficient for gender supposed that in organic tea farms, male or female was tea farm head or key operator had not effect on increasing technical efficiency. Like other factors affecting actively technical efficiency, tea hybrid had significant effects on increasing technical efficiency. It was proved that coefficient had negative sign and was statistically significant at the 0.10 level. So, the suggestion of using hybrid tea varieties for organic tea farmers in new-plantation was acceptable.

Table 54 Estimated coefficients in technical inefficiency model for organic tea farms

Variable	Parameter	Coefficient	*t*-ratio
Constant	d_0	1.5903***	10.2658
AGE_2	d_1	-0.0094**	-2.4895
EDU_2	d_2	-0.0873***	-3.4126
$TRAIN_2$	d_3	-0.0659**	-2.7147
GEN_2	d_4	0.0228ns	0.1757
$CLONE_2$	d_5	-0.2615*	-1.6817
$PROP_2$	d_6	-0.0229ns	-0.2331

Source: calculation from FRONTIER 4.1.c.
Note: SE standard error,
*** : statistical significance at 0.01 level
** : statistical significance at 0.05 level
* : statistical significance at 0.10 level
ns : non significance

Negative value and significant of coefficient for tea clone showed that organic tea farmer applying new improved and hybrid tea was more efficient than organic tea farmer applying local varieties as 'Trung Du'. It was also proved that most of organic tea fields were from converting process, not from new planting.

Positive value and insignificance of estimated coefficient for type of propagating materials explained that types of crop such as vegetative propagation and seedling had not influenced on reducing technical inefficiency in organic tea farms.

7.2.5 Comparison of the factors affecting yield, technical efficiency and determinants in inefficiency effect models between two systems

Comparisons of factors affecting yield of fresh tea

Coefficients estimated from Cobb-Douglas production function were output elasticity of input use. In the Cobb-Douglas functional form, the estimated coefficients showed the partial elasticity of each input (Ei), it can be expressed as,

$$E_i = \frac{\%\ \text{change in ouput}}{\%\ \text{change in input i}} = \frac{\delta Y/Y}{\delta X_i/X_i} \quad \text{....(13)}$$

$$= MP_{Xi}/AP_{Xi}$$

$$MP_{Xi} = E_i * AP = E_i * Y/X_i \quad \text{....(14)}$$

Marginal products of various inputs were calculated from Eq. (14) and summarized in Table 55.

Table 55 Marginal products and average products of conventional and organic tea production

	Unit of input	MP --*kg/ unit of input use*--	AP --*kg/unit of input use*--	Elasticity
Conventional tea				
$TSIZE_1$	m^2	0.05	0.46	0.1100
$UREA_1$	kg	15.27	3.14	0.2582
$POTA_1$	kg	1.94	22.60	0.0859
$MANU_1$	kg	0.05	0.47	0.1116
$LABD_1$	$man-day$	4.80	8.13	0.5903
Organic tea				
$TSIZE_2$	m^2	0.80	0.50	1.6397
$ORGFER_2$	kg	0.04	0.52	0.0672
$COMP_2$	kg	0.13	0.56	0.2295
$LABD_2$	$man-day$	0.42	4.33	0.0960

Source: calculation, 2002.

It is clear that factors affected differently the yield of fresh tea between two systems, and the estimated coefficients were different in values and items. For instance, factor of tea land size had significant effect in increasing yield of fresh tea in both systems, but for conventional tea less significant effect (estimated coefficient for it was 0.11) but for organic tea farm, was so significant effect (estimated coefficient for it was 1.66). If increase by one percent in land size would increase 0.11 percent in mean yield of conventional tea farm and 1.66 percent in yield of organic tea farm. This also revealed that if when measure at the mean (1,324m^2), an increment of one square meter in tea land size would increase the yield by 0.05 kg of fresh tea conventional farm (Table 55), whereas it would increase the yield by 0.80 kg of fresh tea for organic tea farm (at the mean size = 1042 m^2).

However, because the yield elasticity of tea land in conventional tea production was not unique, marginal product value was approaching to zero (MP = 0.05), indicating that if increasing tea land in the selected tea farms (size of 1,324 m^2) the incremental yield approached zero. Thus, it was suggested that in conventional tea system, there was no economies of land size. The existing average per square mater also declined as land size increased. Therefore, farmers may need to replace the old tea gardens by new-planting tea on the existed tea land size or convert into organic system.

Estimated coefficients for manure were different between both systems, in conventional tea farm, manure had significant effect in increasing yield of fresh tea but had not in organic tea farms. This was illustrated that the estimated coefficient of manure was in positive sign and statistically significant in frontier model for conventional tea farmers while also in positive sign but had insignificance (0.1116^{*} and 0.0029^{ns}) in the model for organic tea farms.

Both estimated coefficients for labor used were in positive signs and significance for both systems, however they were different from values and significant effects in increasing yield of fresh tea. It was illustrated that the coefficients were 0.59 and 0.096 in conventional and organic frontier models, respectively. Increased by one percent in labor used would increase 0.59 percent in average yield of conventional tea farm and 0.096 percent in organic tea farm, or increase one man-day contributed to the increase in yield of conventional tea farm by 4.8 kg of fresh tea and 0.42 kg of fresh tea in organic tea farm.

Yield of tea continued to increase when tea farmers spent more and more man days (mainly increasing number of harvesting rounds a year). However in organic farms, the coefficient of labor or yield elasticity of labor use was 0.096, less than one, or MP was 0.42, closer zero than that of conventional. Therefore, to increase labor in organic tea production need to consider prices of tea and wage cost.

Regarding conventional tea production, an increase of 1 kg of urea, potassium, manure would increase 15.3, 2.0 and 0.05 kg of fresh tea per farm, respectively. For organic tea production, if sampled tea farmers applied one more kg of organic fertilizer and compost, yield of fresh tea would be increased 0.04 and 0.13 kg of fresh tea per farm, respectively.

Comparison of mean technical efficiency and its determinants

Estimates of the mean technical efficiencies, based on the frontier production function, indicated that conventional tea farms were 78.6% technically efficient, whereas organic tea farms had technical efficiency of 84.6%. These estimates were significantly different, shown that t-test value of 2.12 was greater than t-critical at 0.05 level.

Using the estimated parameter values for the frontier production function (Eq. 10, 11), predictions were obtained for the technical efficiencies (Eq. 12) of individual conventional and organic farms. The values obtained are summarized by reporting the frequencies (and percentage) of farms within the decile ranges indicated in Table 56.

For conventional farms, the technical efficiencies ranged from 0.483 to 0.976, whereas for organic farms, the range was 0.469 to 0.992. Thus, the technical efficiencies of organic tea farms were much more variable than those of conventional tea farms and were generally higher. This implied that organic farms operated closer to their frontiers than conventional farms did with respect to their frontiers production function. This did not necessarily imply that organic farms were more efficient in absolute terms or more economically viable than conventional farms.

There were differences from estimated coefficients in technical inefficiency models for both systems, age of tea farm head had significant effects on improving technical efficiency in tea conventional farms, but less significant impact on this in organic tea farms, the estimated coefficients were (-0.0182***) and (-0.0094**) for conventional and organic farms, respectively.

Table 56 Technical efficiency of both conventional and organic tea farms

Technical efficiency score	Conventional		Organic	
	Freq.	Percent	Freq.	Percent
0.41-0.5	3	5.36	3	5.56
0.51-0.6	5	8.93	1	1.85
0.61-0.7	8	14.29	2	3.70
0.71-0.8	15	26.79	8	14.81
0.81-0.9	8	14.29	21	38.89
0.91-1.0	17	30.36	19	35.19
	TE		TE	
Mean	0.786		0.846	
SD	0.132		0.130	
Min	0.483		0.469	
Max	0.976		0.992	
N	56		54	

Note: TE=technical efficiency, Freq. = number of tea farms

Training was significant in improving technical efficiency in organic farms, but insignificant in conventional farms. Within the range of 1 – 7 trainings for conventional practices made no significant difference to improve farmers' management. This may be due to conventional tea farmers already had much experience in tea production. Whereas organic tea farmers received more training courses related to organic tea farm practices, averagely 8 times a year. This is since organic farmers had less experience on organic techniques and were under the project of CIDSE.

Gender variable had significant effect on increasing technical efficiency in conventional farms but not significant effect on doing this in organic farms, illustrated that estimated coefficients were (-0.1676***) and (0.0028^{ns}) in conventional and organic farms, respectively. It indicated that role of woman in conventional tea farm was important while in organic farms, this was not apparent.

Regarding type of propagating materials, it had significant impact on reducing technical inefficiency in conventional farms but not doing in organic farms, the estimated coefficients were (-0.0925^{*}) and (0.0229^{ns}) in conventional and organic farms, respectively. It suggested that conventional farms should apply vegetative propagation (cuttings) in new planting tea to replace the old tea gardens, while not suggested more for organic tea farms in terms of this.

Estimated coefficients for education had significant and negative value in both systems, which indicated that it had the same effect on increasing technical efficiency in both tea systems.