Chapter 6

Technical Efficiency of Small Tea Growers in North Bengal−A Stochastic Frontier Analysis

6.1 Introduction:

There is little doubt now that the smallholder- bought leaf sector has become a tremendous force to reckon with within the contour of India's tea industry because of their commendable contribution to total production of tea. This sector is now referred to as the unorganized sector of the tea industry in India. With the increase in tea acreage within the domain of this sector, the share of production has been rising at an increasing rate over time. Notably, this sector has now been recognized by the government as well as the Tea Board as a major stakeholder of the tea industry whose contribution to total production of tea deserves mentioning in recent time. The major economic force behind the reckoning of this sector as a key stakeholder of the tea industry is perhaps the unsatisfactory production and productivity performance of the large estate sector in the wake of massive and unprecedented generation of demand for tea in India's domestic market. For a long period of time, the supply capacity of the estate sector could not keep pace with the growth of demand in the domestic market for tea. At present, the internal demand is growing at a rate about 2.29 percent while tea production is showing a growth rate of 2.99 percent. As tea production registering sluggish growth, nearly 80 percent of the tea produced is consumed within the country. The steady increase in internal demand and the slow rate of growth of production could definitely be made responsible for a decline in tea exports in recent time. It may be mentioned in this connection that no country can afford to export any commodity to the desired level if that creates demand and supply imbalance in the domestic market with the inconvenient effect of pushing up price upward and thereby affecting consumers' welfare adversely. It has been projected that if growth of domestic consumption continues at a CAGR of more than 2 percent, India will have to import tea by a large amount in order to meet its domestic demand and maintain export targets. Failing to do so might destabilize the internal market as well as the market abroad in terms of significant supply demand imbalance. It needs to be mentioned here that the supply gap problem created by the organized sector has substantially been eased out by an increasing flow of output from the unorganized smallholder sector.

Like rest of the country, the smallholder tea sector is an important and promising sector of the tea economy of North Bengal. In the last few decades, the sector has shown tremendous progress in terms of growth of area and number of gardens as well as its growing contribution to total production of tea in the State. It is now widely contended that this sector is going to overtake the estate sector in terms of both area and production in the foreseeable future. This apart, following this transformation of the tea industry, the traditional agrarian economy of North Bengal has been seen to experience some significant changes in terms of land-use change, crop transfer, alternative employment generation, changing options of occupational choices, impact on living standard etc.. These developments obviously necessitate a thorough study of economics of small tea growing to identify the factors that have contributed to the proliferation process of this emerging sector. In this respect, the performance measurement becomes essential to understand the extent of achievement by this sector. Any operation at sub-optimal level gives rise to inefficiency that implies wastages of resources and makes organization economically vulnerable. In the long-run, this inefficiency makes its existence at stake thereby reducing the social well-being of all concerned stakeholders involving this organization. For this reason, the 'efficient performance' of an organization is considered to be a key factor for business sustainability. An efficiency measure is defined so as to reflect the difference between actual performance and potential performance. The smaller the gap between these two levels of performance, the better the utilization of input resources in the production process and the better is the efficiency. Efficiency can be considered in terms of optimal combination of inputs to achieve a given level of output (an input orientation) or the optimal output that could be produced given a set of inputs (an output orientation).

The assessment of performance of a production organization or individual farms comprising it in using real resources to produce output can be made using a host of optimizing tools and techniques. These techniques can be broadly organized into two approaches− the parametric stochastic frontier production function approach (SFP) and the non-parametric mathematical programming approach commonly referred to as data envelopment analysis (DEA). It is important to mention here that the choice among these two alternative approaches is a contentious issue. This is because both of the SFP regression method and the DEA method have their own comparative advantages and disadvantages for measuring efficiency. While the main disadvantage of the parametric method is the difficulty involved in selecting a specific functional form and making the distributional assumption about the data, it has the advantage that statistical inference can be made from the obtained results. The advantage of DEA is its flexibility in terms of imposing less restrictive assumption for the representation of the production technology. For this reason, DEA method is less prone to miss-specification error (Wu, 1996). However, a major drawback of DEA method is that it does not make any distinction between technical efficiency and statistical noise-effects, with the result that any deviation from the frontier is attributed to inefficiency.

The present study attempts to estimate technical efficiency (TE) of tea small growing operation at the plantation level. The method employed in the study is the stochastic production frontier approach. The results obtained from the study would help making a comprehensive assessment of the productivity performance of the sector. The study is based on the same set of cross-sectional data collected from 124 small tea growers that we have used previously in chapter 3 for estimating TE in the small tea plantations sector using DEA technique. The present study can considerably supplement the DEA study we made earlier by helping us to identify, through the application of standard hypothesis test, the resource inputs to which efficiency gain can be attributed.

6.2Methodology

6.2.1Theoretical Framework

The frontier concept of efficiency measurement was initially introduced by Farrell (1957). The basic idea underlying Farrell's approach is to define efficiency relative to some benchmark level. The benchmark is consisted with the most efficient firms and is referred to as the "best practice frontier". Hence, under Farrell's approach, efficiency is a relative measure and indicates how close the actual or observed production is to the production corresponding to the "best practice frontier" level of operation. Alternatively stated, the cornerstone of Farrell's approach to efficiency measurement is to map a frontier, that is to say, to find the locus of maximum (or minimum) points in the feasible production set, and estimate firm-specific efficiency as a deviation from the fitted frontier. This approach to efficiency measurement is quite well-known as the "frontier approach".

For a graphical illustration of this approach, Farrell used a simple example of firms producing a single output y with the aid of two inputs x_1 and x_2 under the assumption of constant returns to scale (CRS). Therefore, the production function is $y = f(x_1, x_2)$ and the unit isoquant is $1 = f\left(\frac{x_1}{y}, \frac{x_2}{y}\right)$ which Farrell calls "efficient unit isoquant" that captures the minimum combination of inputs per unit of output required to produce a unit of output. This is represented by the curve QQ' in figure 6.1

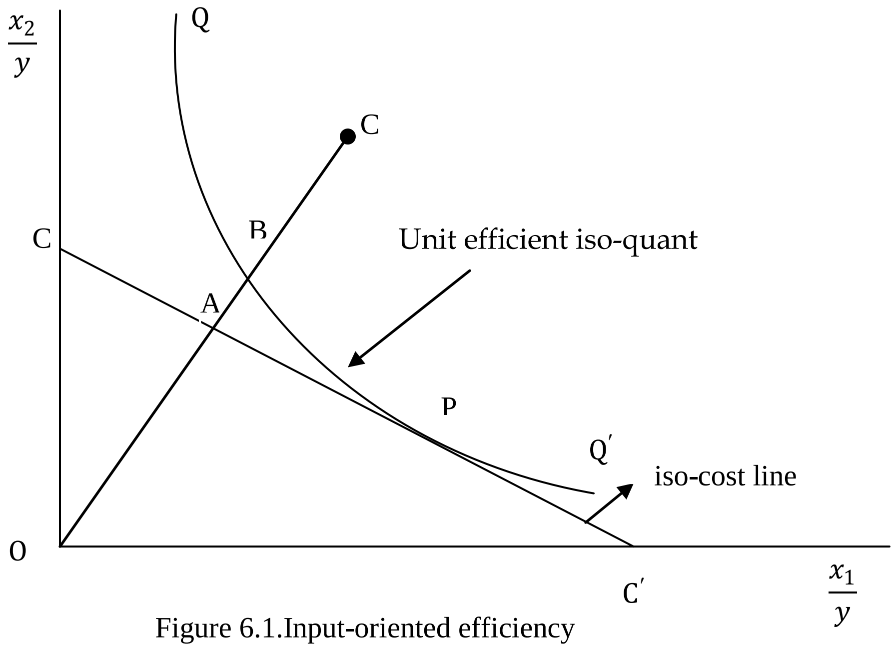

Figure 6.1.Input-oriented efficiency

The production possibility set in the above diagram is the input requirement set and it is constructed by points on the unit isoquant QQ' or above and to the right of it. As we have assumed CRS, every producer with an input combination along the unit quant QQ' is considered as technically efficient while any producer with an input bundle above and to the right of it, such as one represented by point C, is termed as a technically inefficient producer since input bundle that is being used by it is more than enough to produce a unit of output. The technical inefficiency of the firm located at C is measured by the distance BC along the ray OC. This distance represents the amount by which all inputs can be reduced equi-proportionately without decreasing the amount of output. In relative terms technical inefficiency of C can be expressed as the ratio $\frac{BC}{OC}$, and therefore, the measure of TE of the point C would be given by the ratio

$$TE = 1 - \frac{BC}{OC} = \frac{OB}{OC}$$

which is the ratio of the distance between the origin and point B to the distance between the origin and the point C. Thus, according to Farrell, TE is one minus maximum feasible equi-proportionate reduction in all inputs that allows the continued production of output.

Farrell's TE measure analyzed so far follow an input-oriented scheme as efficiency is considered in terms of the optimal combination of inputs to achieve a given level of output. An output-based measure that considers efficiency in terms of optimal output that could be produced from a given set of inputs is also possible to derive using Farrell's framework. For an illustration, we use the simplified one-input-two-output example in figure 6.2.

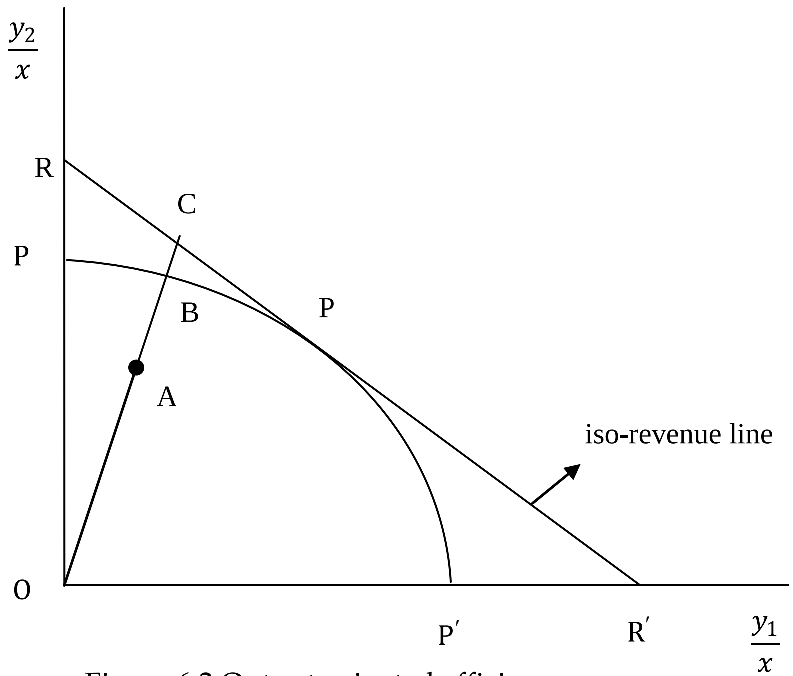

Figure 6.2.Output-oriented efficiency

In the figure, the distance AB indicates technical inefficiency. That is, the amount by which outputs could be increased without requiring extra inputs. Hence a measure of output-oriented TE is the ratio

$$TE_O = \frac{OA}{OB}$$

6.2.2 Econometric Model based on the Frontier Approach

The introduction of Farrell's frontier approach has subsequently led to the development of SFP regression approach for the estimation of TE. The wide application of stochastic frontiers began in 1970s. Major contributions have been due to Aigner, Schmidt, Lovell, Battese and Coelli and Kumbhakar.

The SFP analysis can be viewed as a mix of ordinary least squares (OLS) and deterministic production frontiers. The method of OLS fits a function through the "average" points of the data set. Thus, under OLS, all deviations from the estimated line are due to noise caused by measurement errors, missing variables, etc. The deterministic frontiers, on the other hand, assume all deviations are attributable to inefficiency. Hence, under this approach, data noise could lead to bias estimation of regression line and also we cannot conduct standard hypothesis test. The SFP approach tries to reconcile the OLS and the deterministic frontiers methods by introducing two error terms− one for data noise and another for inefficiency. This has the implication that any deviation from the frontier is attributable to both noises in the data set as well as technical inefficiency. Thus, the model has the advantage of making a distinction between technical inefficiency and statistical noise effects. It also allows conduction of standard hypothesis test. In a DEA model, unlike that in a SFP model, any deviation from the frontier is solely attributed to inefficiency. The idea of a stochastic frontier can be understood from figure 6.3

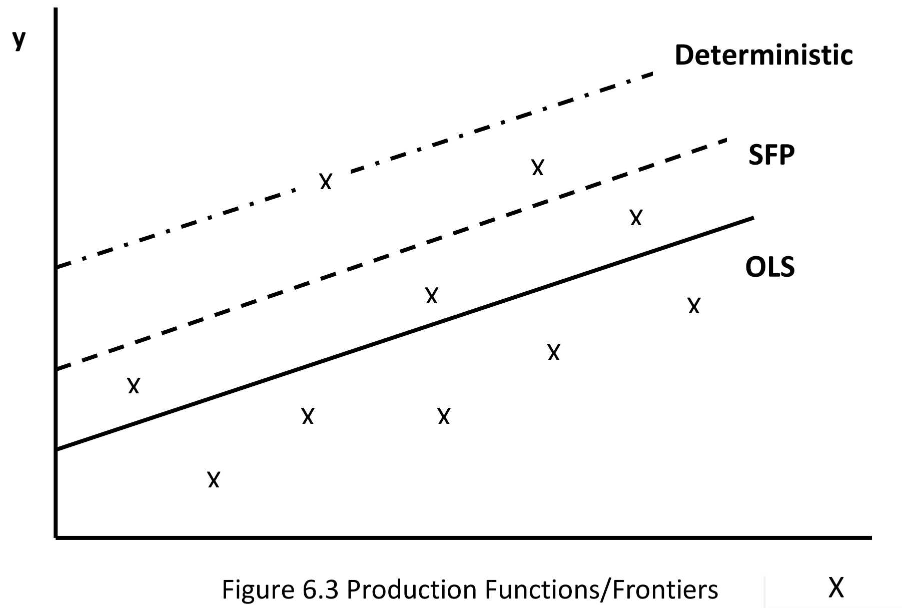

Figure 6.3 Production Functions/Frontiers

The general model of the stochastic frontier is

$$\ln y_i = x_i^{/}\boldsymbol{\beta} + v_i - u_i \text{ , i=1, 2, ⋯⋯, N} \quad \text{.......... (1)}$$

where

y_i = the production of the i^{th} firm;

$x_i^{/}$ = the vector of inputs for the i-th firm;

$\boldsymbol{\beta}$ = the vector of unknown parameters to be estimated;

v_i = a two-sided (or symmetric) stochastic (white noise) error term representing "noise";

u_i = a one-sided error reflecting "technical inefficiency" of farms i;

N = the number of farms included in the sample

In the above model, v_i are assumed to be independently and identically distributed random variables having normal distribution, iid $N(0, \sigma_V^2)$, and u_i are assumed to be independently and identically distributed non-negative random variables having, say for example, a half-normal distribution, iid $N^+(0, \sigma_u^2)$. The variables v_i are assumed to be independent of the variables u_i.

For the above function, the farm-specific (or the observation-level) estimates of inefficiency can be obtained as

$$TE_i = \exp(-u_i)$$

$$= y_i / \exp(x_i^{/}\boldsymbol{\beta} + v_i)$$

$$= \exp(x_i^{/}\boldsymbol{\beta} + v_i - u_i)/\exp(x_i^{/}\boldsymbol{\beta} + v_i) \ , 0 \leq TE_i \leq 1 \qquad \text{…………………. (2)}$$

Thus, the measure of technical efficiency is equivalent to the ratio of "observed" or "realized" output of the i^{th} firm to the stochastic frontier output, that is to say, the output value when the inefficiency effect u_i were zero.

6.2.3 Specification of Stochastic Frontier

The estimation of stochastic frontier has preliminary been made using both the Cobb-Douglas and Translog functional forms. The preliminary analysis reveals that the sample data set is best fitted to Cobb-Douglas production frontier in terms of results of likelihood ratio (LR) test. Thus, the model is specified as

$$\ln y_i = \beta_0 + \sum_j \beta_j \ln x_{ij} + v_i - u_i \quad \text{…………………. (2)}$$

where i refers to the observation of the i^{th} small tea plantation and j refers to inputs used.

Here we have

y = quantity of green leaf (in kg.)

x_1 = tea area (in acre)

x_2 = irrigation (in hours)

x_3 = nitrogen fertilizer (in kg)

x_4 = potash fertilizer (in kg)

x_5 = phosphate fertilizer (in kg)

x_6 = family labour

x_7 = hired labour

x_8 = nutrients and pesticides (in kg)

x_9 = cow dung manure (in kg)

v_i = random errors as previously defined

u_i = technical inefficiency effects as previously defined

6.2.4 Estimation and Testing of Hypothesis

The parameters to be estimated in model (3) are $\boldsymbol{\beta} = (\beta_0\ \beta_1, \dots\dots\dots, \beta_9)$, σ_V^2 and σ_U^2. Maximum Likelihood Estimates of the parameters are obtained using the computer programme FRONTIER 4.1 (Coelli, 1996). The variance parameters are estimated by FRONTIER in terms of

$$\gamma = \sigma_U^2/\sigma^2$$

where $$\sigma^2 = \sigma_U^2 + \sigma_V^2\ ;$$

so that $$0 \leq \gamma \leq 1$$

If the value of γ equals zero the difference between growers' 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 growers' less than efficient use of technology, i.e., technical inefficiency (Coelli, 1995).

For estimating plantation level efficiencies, we first compute the following terms

$$u_i^* = -(\ln y_i - x_i^{/}\boldsymbol{\beta})\sigma_U^2/\sigma^2 \quad \text{and} \qquad \sigma_*^2 = {\sigma_v^2\sigma_u^2}/{\sigma^2}$$

Next we obtain the best predictor of TE for each firm i using the expression

$$\widehat{TE}_i = E(\exp(-u_i)|y_i) = [\Phi\,(\frac{u_i^*}{\sigma_*} - \sigma_*]\,/(\Phi(\frac{u_i^*}{\sigma_*})]\ \exp\left\{\frac{\sigma_*^2}{2} - u_i^*\right\}$$

where Φ is the cumulative standard normal distribution function.

For estimating efficiency of the sector, which is the average of technical efficiencies of the production units in the sample, we use the expression

$$\widehat{TE} = E\{\exp(-u_i)\} = 2\Phi(-\sigma_u)\ \exp\left\{\frac{\sigma_u^2}{2}\right\}$$

For the tests of hypotheses of the parameters $\beta_0\ \beta_1, \dots\dots\dots, \beta_9$ in the frontier function, we are having

$$\mathbf{H_0:}\ \beta_1=\beta_2=\cdots\cdots\beta_9=0, \quad \mathbf{H_1:}\ \mathbf{H_0}\ \text{false}$$

The absence or presence of TE can be tested using the variance ratio γ as follows

$$\mathbf{H_0:}\ \gamma=0\ \text{versus}\ \mathbf{H_1:}\ \gamma>0$$

where the null hypothesis is that there is no inefficiency effect in the model.

There are two test options: i) the t test; ii) the likelihood ratio (LR) test. For the LR test, the test statistic is defined by

$$LR = -2(LLF_0 - LLF_1)$$

where LLF_0 = estimate of log likelihood function under the restricted model (setting γ=0)

LLF_1 = estimate of log likelihood function under the unrestricted model

This test statistic has approximately a chisquare or a mixed chi-square distribution with degrees of freedom equal to the number of restrictions. For the LR test, the critical values of the LR statistic are obtained from table 1 in Kodde and Palm (1986).

6.3 Results and Discussion

6.3.1Estimates and Tests

The OLS as well as ML estimates of the Cobb-Douglas model presented in table 6.1

Table6.1. OLS estimates and ML estimates for parameters of the Cobb-Douglas Production Frontier for small tea growers

Variables	Parameters	Coefficient		t ratio	
		OLS	MLE	OLS	MLE
Constant	β_0	4.13*	5.84*	6.28	9.53
Land	β_1	0.50*	0.60*	4.86	8.20
Irrigation	β_2	0.0003	0.001	0.01	0.05
Nitrogen	β_3	0.14*	0.15*	1.86	2.36
Potash	β_4	-0.04	-0.02	-0.69	-0.44
Phosphate	β_5	0.05*	0.04*	2.41	2.54
Family labour	β_6	0.01	-0.01	0.61	-0.88
Hired labour	β_7	0.13*	0.05**	2.63	1.64
Nutrients & pesticide	β_8	0.34*	0.25*	4.70	3.99
Animal fertilizer	β_9	-0.003	-0.001	-0.07	-0.04
σ^2			0.57		5.43
γ			0.95		22.99
log likelihood		-86.51	-73.78		
LR test			25.46		

N =124,* Significant at 5 per cent probability level or less than 5%; ** Significant at 10 per cent probability level

Source: *Field Survey, 2007-08*

In order to checking for multicollinearity among the independent variables, a VIF diagnostic test was conducted. The test criterion demonstrates that there is a potential multicollinearity problem if VIF is greater than 10. No serious multicollinearity problem among explanatory variables included in the model was detected by the VIF test.

For examining the existence of technical inefficiency, we need to conduct one-tailed test pertaining to γ as mentioned earlier. For doing this, we have two options− either to use t test or the LR test. As N is large, the t and $Z \sim N(0, 1)$ statistics are approximately identical. The computed Z statistic has a value of 22.99. At the significance of 5% level, $Z_{\text{critical value}} = 1.645$. Since the calculated value is greater than the critical value, the null hypothesis of $\gamma = 0$ is strongly rejected at 5 percent level. The alternative test that might be employed is the LR test which provides LR statistics = 25.46. At the significance of 5% level, Kodde and Palm critical value can be obtained as 2.71, a value being smaller than the computed value. Therefore, the null hypothesis of no inefficiency effects is also rejected by the LR test at $\alpha = 0.05$ level. The estimate of γ in this model is 0.95, which means that 95 percent of the total variation of output level is due to technical inefficiency. This also implies that the contribution of random error to output variation is only to the tune of about 5 percent. Hence, the Cobb-Douglas form seems to be a good approximation of the production frontier as the vast majority of errors are attributable to inefficiency errors.

Using the above table, we now proceed to analyse the relative contributions of different inputs to production of green leaf. As this study used Cobb-Douglas production frontier function, the coefficient value of the variables represents elasticity coefficients measuring the change in output resulting from one percent increase in inputs. The MLE shows that the coefficient of land area is positive and significant, suggesting land area as a determinant of tea leaf production in STGs' gardens. Among the different components of inorganic fertilizers used in small tea gardens, nitrogen fertilizer and phosphate fertilizer can be seen to have significant positive impact on tea yield. This indicates that increment of these inputs by one percent will increase output by 0.15 percent and 0.04 percent, respectively. The estimated model also shows a positive and significant relation between tea yield and foliar nutrients and pesticides with a production elasticity coefficient of 0.25. Notably, this coefficient has the highest value among all the coefficients which appear to be significant. This result is found as expected. It was observed during the field survey that tea growers are heavily dependent on this input for increasing their yield. The estimated ML coefficient of hired labour shows a positive value which is significant. One interpretation of this result is that the necessity of hiring skilled labour is crucial for running tea plantations efficiently. A plantation enterprise cannot be operated properly only using family labourers who often do not have requisite skills for activities like pruning, drainage, applying manure etc. Furthermore, for the timely completion of plucking round, especially during time of peak flush, the hiring of labour is of utmost importance. If the use of hired workers is less than the minimal requirement, the plucking round is likely to be delayed and as a consequence, the fine leaf percentage in total plucking would fall short of required standard. This substantially reduces their bargaining capacity of the tea growers in the price fixing process. Finally, it may be noticed that the same set of inputs have statistically significant coefficients under both the MLE and OLS methods.

6.3.2Technical Efficiency Analysis

The summary statistics related to plantation level technical efficiencies are depicted in the following table

Table6.2. Descriptive Statistics for TE Scores

Statistics	Value (%)
Minimum TE	13%
Maximum TE	94%
Mean TE	62%
Std. Deviation	19%
Mean TE for cultivators category	62%
Mean TE for others category	62%

Source: *Field Survey, 2007-08*

As the table shows, the predicted plantation specific TE ranges from as low as 13 percent to as high as 94 percent. The mean TE score has been found to be 62 percent, which indicates that, on an average, there is a possibility of 38 percent potential yield improvement in this sector. In the present study, none of the STGs has achieved 100 percent level efficiency for yield. The possible explanation for this variation could be the weakness of STGs in the input application methods and adoption and implementation of plantation management practices to the required level. It is to be mentioned here that our sample is consisted of two categories of tea growers-i) peasant tea growers and ii) non-peasant tea growers including former pine apple growers, petty traders, service men etc. The mean TE score for both segments of growers has been found to be of identical magnitude. This result is found as expected. In a rural setting, people do have the opportunity of interacting with each other repeatedly. A person is often seen to gather knowledge about any new method of cultivation from his neighbors. This means that the knowledge of tea growing is not exclusive to a particular segment of village people. On the contrary, knowledge is transferable from one segment to the other through repeated interactions between them. Given this scenario, it is quite expected that the activity of tea growing provides equal opportunity of efficiency gains across different segments of growers. This seems to constitute a major pulling factor for unprecedented proliferation of this sector.

The percentage distribution of STGs based on their estimated TE are shown below

Table6.3. The distribution of technical efficiencies of small tea plantations

Range of TE	% of plantations
10-19	1.61
20-29	4.03
30-39	6.45
40-49	13.71
50-59	19.35
60-69	15.32
70-79	15.32
80-89	19.35
90-100	4.84

Source: *Field Survey, 2007-08*

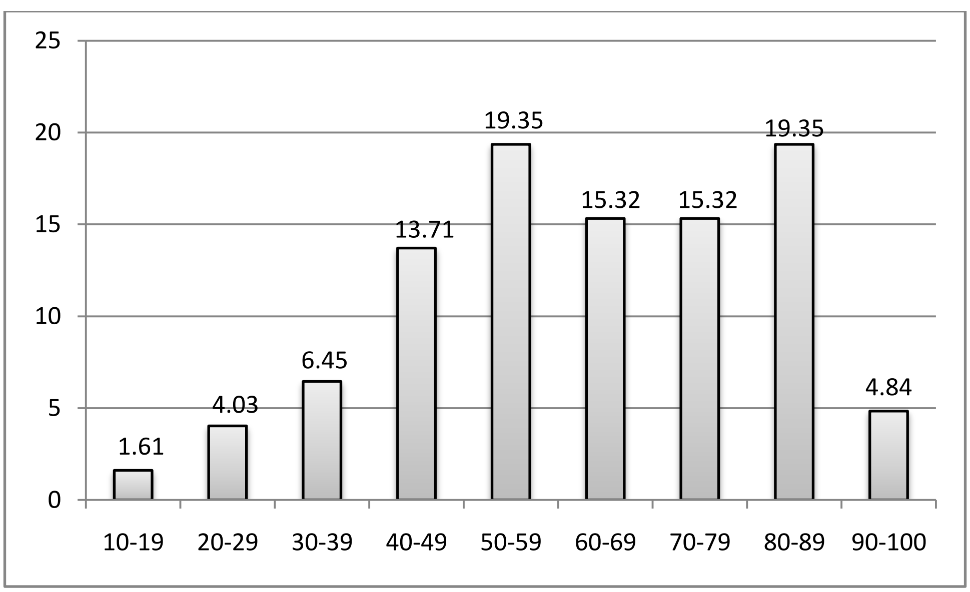

Figure6.4.The percentage distribution of technical efficiencies within the sample

An inspection of Table 6.3 reveals that the highest frequency range of TE more than 90 percent comprises about 5 percent of the total gardens which is significantly low. The percentage of gardens operating at efficiency level of 70 percent or above can be estimated to be 40 percent of the total. The table also shows that a relatively smaller percentage of gardens (about 12 percent) are operating below 40 percent efficiency level. The percentage of gardens having efficiency scores between 40 percent and 70 percent can be estimated to be 48 percent. This suggests that there is significant variation in TE among the small tea growers.

The region-wise mean TE of yield for the study regions is shown in the following table and figure

Table6.4.Region wise Mean Efficiency of Yield for the study regions

Regions	Mean TE Score
Chopra	0.74
Islampur	0.71
Chat Hut	0.54
Kharibari	0.60
Fatapukur	0.52
Helapakri	0.58
Jahuri Talma	0.62
Panbari	0.56
Mekhliganj	0.60

Source: *Field Survey, 2007-08*

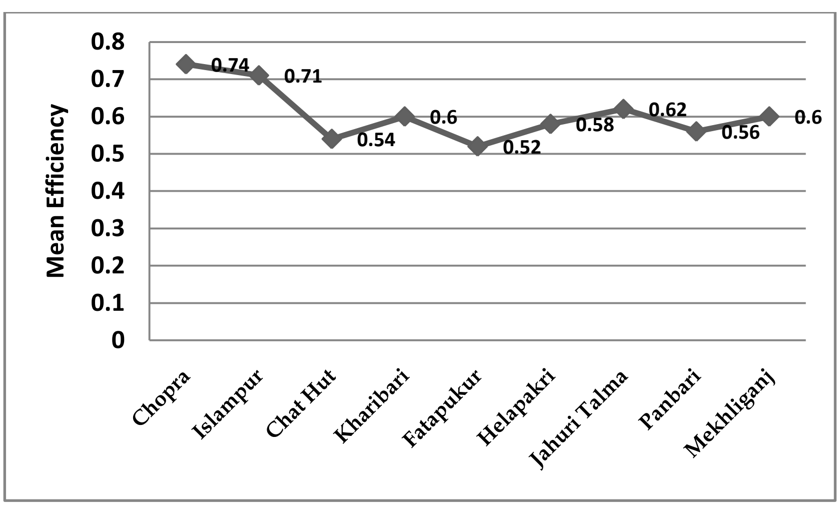

Figure6.5. .Region wise Mean Efficiency of Yield for the study regions

From the table, it can be noticed that the highest mean TE scores of 74 percent and 71 percent have been recorded in the regions of Chopra and Islampur. These regions are followed by Jahuri Talma, Kharibari and Islampur with mean TE score of 60 percent or above. The study regions like Chat Hut, Fatapukur, Helapakri and Panbari have relatively lower TE score compared to other regions. There are some possible explanations for high TE of the STGs located in the regions of Chopra and Islampur. These regions, in fact, marked the inception of the adoption of the model of tea small growing in North Bengal. Subsequently, it had extended its outreach in other regions included in the study. Evidently, these regions are highly specialized for growing of tea in small scale plantations. The growers are technically skilled and highly experienced. Moreover, the availability of adequate skilled labour and earlier advent of bought-leaf factories for selling green tea leaf have provided them with enormous scope in raising yield efficiency.

6.3.3 Plantation by Holding Sizes and Efficiency Scores

The study shows that land is a significant determinant of production of green leaf in STGs' gardens. The coefficient of land input is estimated to be positive which indicates that yield is positively correlated with land area. An important question we need to address now is whether the plantation is to be of specific optimum size for extracting maximum efficiency gain. To investigate this issue in details, we consider the following table showing the relationship between efficiency and the plantation size.

Table6.5. Efficiency according to size of tea gardens

Size of gardens (in acres)	Mean TE
0-3	61.34
3-6	61.48
6-9	63.55
9-12	52.99
12-15	68.57
15-25	69.21

Source: *Field Survey, 2007-08*

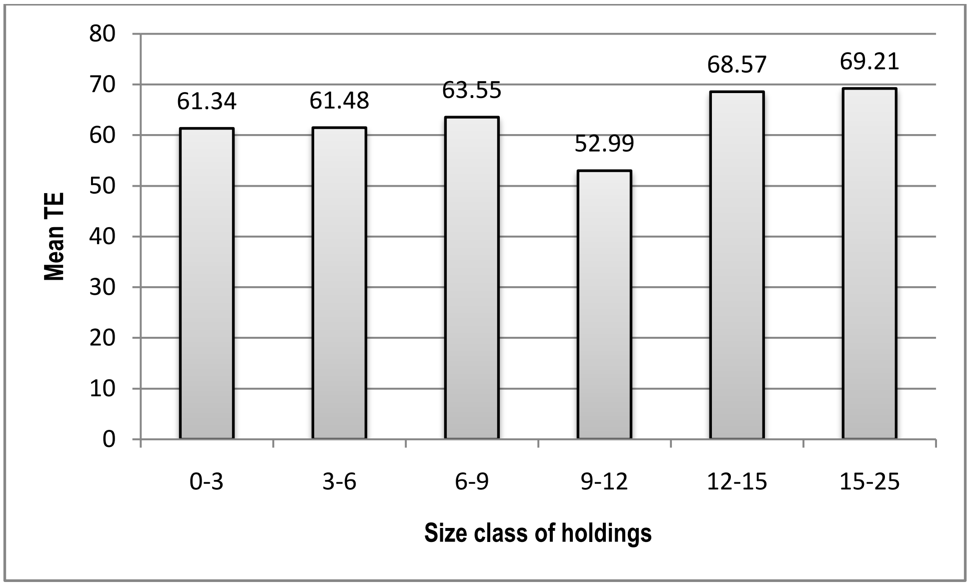

Figure6.6. Efficiency according to size of tea gardens

The above table indicates that the average TE score increases with the increase in size class of land holdings excepting the holding size of 9-12 acres. This might be due to fewer number of sample observations falling within this size class. The highest mean TE score has been found for the top size class of 15-25 acres. This establishes the fact larger plantations are more efficient than smaller plantations. In addition, it can be inferred that the optimum size of plantation should be of 12 acres or more to achieve maximum gain of efficiency. The possible reasons of lower level of efficiency for the gardens below the optimum size may not be the same. For the gardens with smaller size, the advantage of cost saving from purchasing optimum level of inputs may not be feasible and that may be a possible source of inefficiency. Another source of inefficiency for a number of smaller sized plantations is likely to be the use of family labour by more than the optimal amount of necessity vis-à-vis the use of hired labour less than the minimal requirement. As tea plantations are deemed to be skilled labour demanding production activity, the employment of hired labour to the adequate level is of prime necessity.

Reasons for difference between DEA and Stochastic Frontier Output

We know that DEA is a non-parametric method and SFA or OLS regression is a parametric method. There are basic differences in approaches of these two categories of methodology. Being a non-parametric method which does not require to specify a function, DEA measures the comparative efficiency of a particular DMU with respect to virtual inputs created as benchmarks. On the other hand, SFA or OLS regression computes estimates of the efficiencies of individual DMU using a hypothesized function. While SFA can separate random noise from efficiency, the DEA methodology is such that it does not separate random noises, rather it incorporates random noises as a part of the efficiency score. Thus, the results obtained from these two methods may sometimes differ.

6.4 Conclusion

The primary objective of the study is the estimation of technical efficiency using Stochastic Frontier Approach. We observed that the average technical efficiency of tea smallholding sector given by the Cobb-Douglas model is 62 percent. This suggests that there is scope of further increasing output by 38 per cent without increasing the levels of inputs. The study also shows that there is a large difference in technical efficiency scores among small tea growers in the sample. One of the observations during field survey may be helpful to understand this technical efficiency gap problem. It was observed that two categories of land had come under small tea plantations−i) high lands being unsuitable for agriculture and ii) low lands which were used for traditional crop cultivation. The tea plantations standing on high lands could have achieved high efficiency score due to the reason of land suitability. However, plantations that cropped up on agricultural low lands could not have shown satisfactory productivity performance in terms of efficiency score due to land adversity problem. Our survey observation reveals that the main reason for bringing agricultural low lands under tea plantations is the digging up of high drainage trenches in newly established tea plantations adjacent to these land plots. This had caused lowering of water table of these farmlands through huge draining of water. The resulting degradation of the suitability of land for paddy cultivation had eventually forced a large number of cultivators to shift from cultivation of paddy to production of green leaf. Thus, it is primarily the land adversity problem that could be made accountable for having huge gap in technical efficiency. Despite their effort to run the production operation in an efficient manner, they could not be able to do so due to land suitability problem over which they have no control.

As far as the relative contribution of different inputs to production of green leaf is concerned, the study reveals that tea yield has a positive relationship with size of land, quantity of chemical fertilizers including nitrogen and phosphate fertilizers, quantity of nutrients and pesticides and employment of hired labour. It follows that there is scope of further increasing yield through increased use of these inputs including land. The positive and significant coefficient of hired labour input is supposed to have a further implication. This result indicates that the tea smallholding sector has a considerable potential for generating rural employment, thereby benefitting a large chunk of captive agricultural labour force in a labour surplus rural economy of North Bengal. Tea yield being a perennial crop which is harvested for a period of nearly ten months during a year, the total man-days worked on plantations are quite larger than man-days worked on traditional crop farming. There are two descriptions of hired labour−i) permanent labour and ii) casual labour. The former category is consisted of monthly rated workers like managerial or supervisory staffs employed in such plantations. The latter category is mainly comprised of daily rated workers who find work in field activities like plucking of tea leaves, pruning, digging drainage trenches etc. Finally, the creation of employment opportunity in small tea plantations has brought significant changes in women work profile in the rural areas. Since women are generally found to be more competent in plucking work than the men, a lot of employment opportunity tends to be opened up for them. Earlier, they earned the status of subsidiary income earners as traditional agricultural operation activities were largely found to be unsuitable for them. Thus, the springing up of tea plantations has led to employment diversification in the form of opening up of gainful employment opportunities for women, which were previously confined to men only.