CHAPTER 4
RESEARCH METHODS

4.1 Gross margin analysis

As economic comparison, the alternative was chosen that comparison of both enterprises in both tea production systems. Gross margin analysis (GMA) is widely used by researchers to analyze the performance of a particular farm enterprise (Castle *et al.*, 1987). Gross margin of an enterprise is defined as the enterprise gross return minus the variable expenses attributable to that enterprise. Gross margin analysis facilitates the evaluation of the economic efficiency of the farms existing way of producing crops or livestock. It is used to compare the profitability of the enterprise within the farm, or the profitability of a similar farm (Anderson *et al.*, 1977)

The variables included in the gross margin analysis are as follows

Yield per area = total production/total area

Gross revenue = total production in kg x price per kg

Direct cost = cost of seed (own supply or purchase), fertilizer, pesticide, water fees + material inputs + hired labor + machine cost

Fixed cost = depreciation + taxation

Total cost = Fixed cost + direct cost

Gross margin = total revenue – direct cost

Net margin = total revenue – total cost

Revenue to total cost = revenue/total cost

Net margin to total cost = net margin/total cost

Revenue to labor ratio = revenue/labor cost

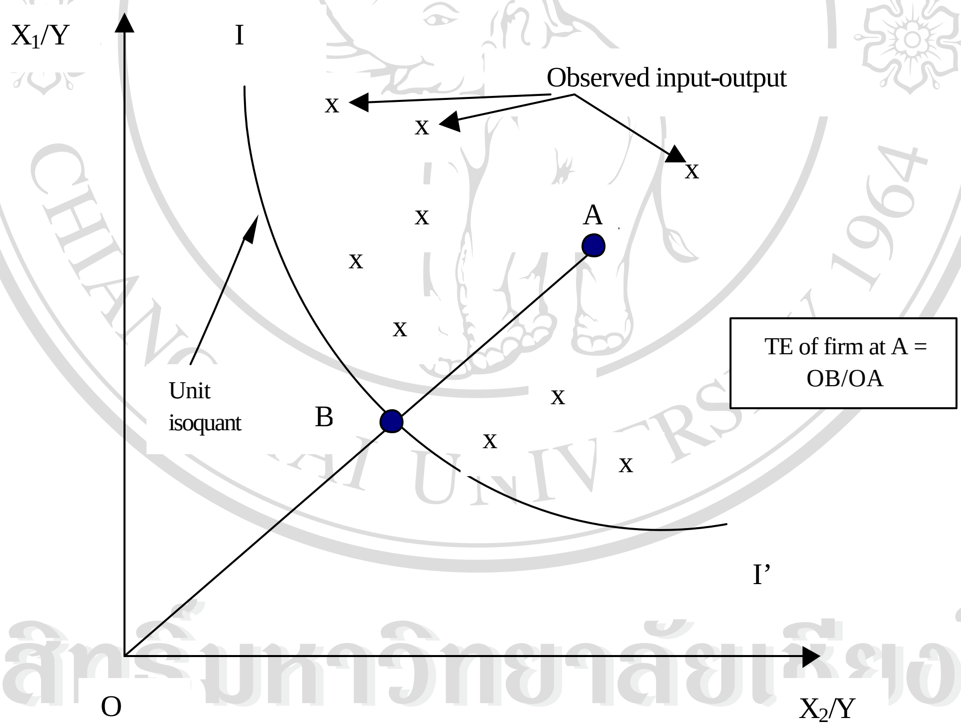
Net margin to labor ratio = net margin/labor cost

Currency used in calculating cost, revenue and others is Vietnamese monetary unit (VND). One US$ was equal to 15,500 VND during the survey in March 2002. Costs and revenue of production were evaluated at farm gate prices.

4.2 Stochastic frontier approach

4.2.1 Technical efficiency

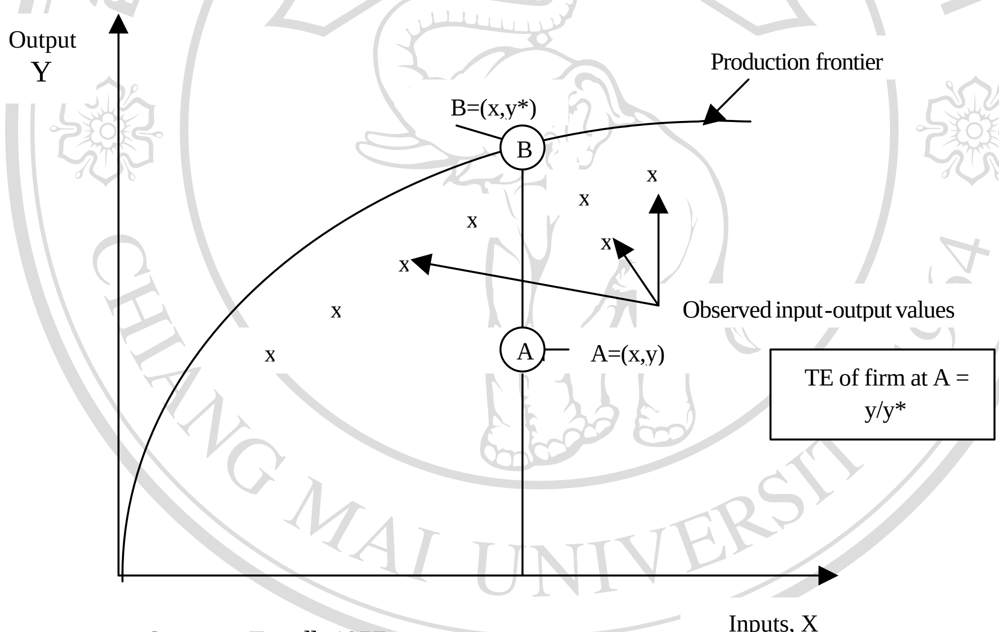
Technical efficiency is just one component of overall economic efficiency. However, in order to be economically efficient, a firm must first be technically efficient. Profit maximization requires a firm to produce the maximum output given the level of inputs employed (i.e. be technically efficient), use the right mix of inputs in light of the relative price of each input (i.e. be input allocative efficient) and produce the right mix of outputs given the set of prices (i.e. be output allocative efficient) (Kumbhakar and Lovell, 2000).



Source: Farrell, 1957.

Figure 1 Technical efficiency of firms in relative input space.

Econometric modeling of production functions, as traditional defined, was stimulated by seminal paper of Farrell (1957). Given that the production function to be estimated had constant return to scale, Farrell (1957) assumed that observed input-per-unit of output values for firms would be above the so-called unit isoquant. Figure 1 depicted the situation in which firms use two inputs of production, X_1 and X_2, to produce their output, Y, such that the points, defined by the input-per-unit of output ratio, (X_1/Y, X_2/Y), are above the curve, II'. The unit isoquant defines the input-per-unit of output ratios associated with the most efficient use of the inputs to produce the output involved. The deviation of observed input-per-unit of output ratios from the unit isoquant was considered to be associated with technical efficiency of the firms involved. Farrell (1957) defined the ratio, OB/OA, to be the technical efficiency of the firm with input-per-unit of output values at point A.



Source: Farrell, 1957.

Figure 2 Technical efficiency of firms in input-output space.

A more general presentation of Farrell concept of the production function (or frontier) is depicted in Figure 2 involving the original input and output values. The horizontal axis represents the (vector of) inputs, X, associated with producing the output, Y. The observed input-output values are below the production frontier, given that firms do not attain the maximum output possible for the inputs involved, given the technology available. A measure of technical efficiency of the firm which produces output, y, with inputs, x, denoted by point A, is given by y/y*, where y* is the 'frontier output' associated with the level of inputs, x (point B). This is a measure of technical efficiency, which is conditional on the levels of the inputs involved.

4.2.2. Theoretical stochastic frontier model

The stochastic frontier model was proposed in 1977 by Aigner, Lovell and Schmidt (1977), Meeusen and van den Broeck (1977). The original form of the model,

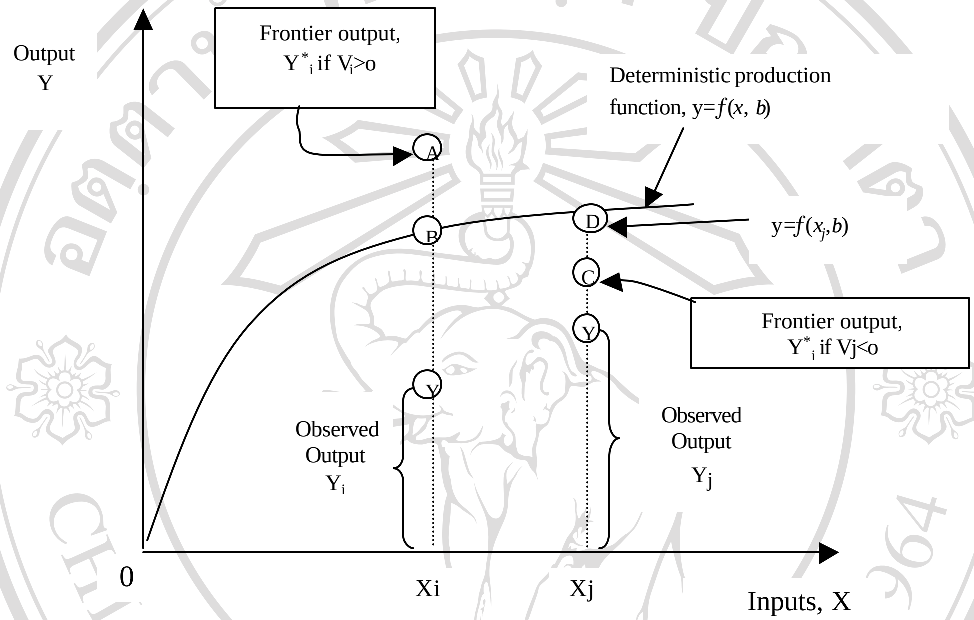
$$\text{Ln}\ (Y_i) = f\ (b;\ X_i) + (v_i - u_i) \qquad \ldots\ldots(2)$$

v_i - the error component represents the symmetrical disturbance that captures random errors, erroneous data, etc., and is assumed to be identically and independent distributed as a N $(0, \sigma_v^2)$.

u_i – the error component is the asymmetrical term that captures the technical inefficiency of the observations and is assumed to be distributed independently of vi, and to satisfy that $u_i \leq 0$

The non- positive disturbance ui reflects that the output of each firm must be located on or below its frontier, $\alpha + \Sigma_{j=i} b\ X_{ij} + v_i$. Any deviation is the result of factors within the firm's control, such as technical and allocative efficiency.

The basic structure of the stochastic frontier model is depicted in Figure 3 in which the productive activities of two firms, represented by i and j, are considered. Firm i used inputs with values given by (the vector) x_i and obtains the output, Y_i, but the frontier output, Y^*_i, exceeds the value on the deterministic production function, $f(x_i;\ b)$, because its productive activity is associated with 'favorable' conditions for which the random error, V_j is positive. However, firm j uses input with value given by (the vector) x_j and obtains the output, Y_j, which has corresponding frontier output, Y_j*, which is less than the value on the deterministic production function $f(x_j;\ b)$ because its productive activity is associated with 'unfavorable' conditions for which the random error, v_j, is negative. In both cases, the observed production values are less than the corresponding frontier values, but the (unobservable) frontier production values would lie around the deterministic production function associated with the firms involved.



Source: Battese, 1992.

Figure 3 Stochastic frontier production function.

The frontier can vary randomly from firm to firm, for this reason it is stochastic, with disturbance vi $\lesseqgtr$ 0, which is result of factors outside the decision making process, whether favorable and unfavorable for the firm, such as climate, luck and machine performance, as well as errors in observing and measuring data.

The density function of $\varepsilon = u_i - v_i$ is

$$f(\varepsilon) = \frac{2}{s_e} f^*\left[\frac{e}{s_e}\right] [1 - F^*(-\varepsilon\lambda\sigma_\varepsilon^{-1})], \quad -\infty \le \varepsilon \le +\infty, \qquad \text{....(3)}$$

$$\text{where } \sigma_\varepsilon^2 = \sigma^2_u + \sigma^2_v, \lambda = \sigma_u / \sigma_v \qquad \text{... (4)}$$

and f^* (.) and F^* (.) are the density and distribution function of a standard normal. The log likelihood function, if there are N observations, can be written as:

$$LnL(y \mid \beta, \lambda, \sigma^2) = N \ln \frac{\sqrt{2}}{\sqrt{p}} + N\ln \sigma_\varepsilon^{-1} + \Sigma \ln [1 - F^*(\varepsilon_i \lambda \sigma_\varepsilon^{-1})]$$

$$- \frac{1}{2s_e^2} \int_{i=1}^{N} e_i^2 \qquad \ldots(5)$$

Once λ, σ_ε are obtained, σ_u and σ_v can be calculated.

Technical efficiency of an individual firm is estimated as

$$TE = Y/Y^* = f(X_i; b) \exp(v_i - u_i) / f(X_i; b) \exp(v_i) = \exp(-u_i) \qquad \ldots.(6)$$

Mean of technical efficiency of each farm given ε_i (Jondrow *et al.*, 1982) is

$$E(u_j/v_j) = \sigma^* \left[\frac{f(.)}{1 - F(.)} - \varepsilon_j \frac{l}{s^*} \right] \qquad .... (7)$$

$$\text{Where } \sigma^* = \sigma_u \sigma_v / \sigma_\varepsilon \qquad \ldots (8)$$

The Battese and Coelli (1995) technical inefficiency effect model is an extension of the more usual stochastic error component frontier function which allows for identification of factors which may explain differences in efficiency levels between observed decision making units. The conventional stochastic frontier approach involves estimation of a function with a composite error term, including a symmetric and one-sided component (following Aigner *et al.* (1977), Meeusen and van den Broeck (1977)). In the case of the frontier production function, the symmetric components represent random variations in production due to factor outside the control of the farmer such as climate, measurement errors, etc.) and is assumed to be independently and identically distributed as $N(0, \sigma^2)$. The one sided component is associated with technical inefficiency of production and measures the area to which observed output deviates from potential output given a certain level of inputs and technology. Commonly, it has been assumed that this component has an identical and independent half normal distribution, although a variety of other distributional specifications are possible (Green, 1997).

The model proposed by Batesse and Coelli (1995) builds upon Kumbhakhar *et al*. (1991) and Reifsneider and Stevention (1991) and areas to panel data the work of Huang and Liu (1994) who formulated a non - neutral stochastic frontier production function model, for cross sectional data, in which the one sided inefficiencies effects are specified as a function of firm -specific factors and input variables, believe to influence technical inefficiency. The technical inefficiency effect, for the *i*-th firm in the *t*-time period, u_{it}, is defined by the truncation (at zero) of the N (μ_{it}, σ_{it}^2) distribution where the firm specific mean, μ_{it}, is specified as follows:

$$\mu_{it}, = d_0 + d'Z_{it} \qquad \text{.....(9)}$$

Where, Z_{it} is a column vector of technical inefficiency explanatory variables and the δs are unknown parameters, whic h are to be estimated.

4.3 System properties quantification

Any system can be analyzed in terms of their properties namely stability, productivity, sustainability and equitability. The features of the system can be analyzed for each term or complete terms. Productivity measured by yield, output of the system over the time, employed index coefficient of variation, the index ranged largely mean that productivity of the system is unstable and hardly controlled (FAO, 1997). System properties which can be compared in qualitative and quantitative indicators in order to explore the advantages and disadvantages of each tea production system. Marten (as *cited* in Jintrawet, 1991) stated that the purpose of evaluating agro-ecosystems performance is to attain better agro-ecosystems. According to suggest of FAO (1997), indicators have been appropriately applied in the study. For assessing productivity, we based on yield of fresh tea per farm, yield of tea per ha, gross margin, net margin. For evaluating stability of syste m, we based on calculating the coefficients of variation (CV) for gross margin, price, yield for 5-year period in both systems. For assessing sustainability, we based on aggregating all sub indices, economic indices namely gross margin, net margin, and productivity; environment indices namely protect air, water from contamination of production, good for health, and maintain soil fertility; social indices namely generate employment, and raising income.

Table 4 System properties and indicators for measurement of performance

Property	Indicator
I. PRODUCTIVITY	Yield per land, animal unit or other unit of resource or the value of output per unit of cost
II. PROFITABILITY	In financial terms or measured subjectively as net benefits
1. of activities	1. Gross margin
2. of whole farms	2. Various whole-farm profitability measures
3. over time	3. Discount measures
III. STABILITY	Coefficient of variation
VII. SUSTAINABILITY	No single general quantitative measure (measuring specifically depend on the study).

Source: FAO, 1997

4.4 Types of comparisons

The study was based on sampled groups comparison; including two samples were selected, conventional and organic. Reason for doing this is to identify the difference and similarity in terms of input use, output, gross margin, production and processing cost, through which the advantages and disadvantages of each system are shown and support to decision making at farm level. The survey data were processed statistically and use to compare the performances of two systems.

- Comparison of yield and input used means between two sample groups, conventional and organic, t – test for significant difference between two sample groups, n_1 = 56, n_2 = 54. The results were obtained from STATISTX 2.0. Compare t* with critical *t* at (n_1+n_2 – 2) degree freedoms at certain level of significance. We reject the null hypothesis if t* > t-critical, and accept the null hypothesis, otherwise. Where n_1 and n_2 are number of observations of conventional sample and organic sample, respectively.

- Budget farm comparisons, gross margin analysis was applied for each tea farm sample, and done average, then using it to compare.

- Description comparisons were applied to explore processing and marketing practices in the study.

4.5 Data selection

4.5.1 Secondary data collection

Secondary data were reviewed from research documents of institutions, annual reports of VINATEA, researches on tea varieties of Tea Researching Institution (TRI), international projects for tea development, review of agriculture and rural development; journals and other documents from organizations related to organic farming. Secondary sources were synthesized and summarized on policies, production, varieties, and economic performance of tea at national and farm levels.

4.5.2 Sampling technique

The sample was selected by simple random procedure. Field survey last from March to May 2002 in two sites, Dong Hy district, Thai Nguyen province, and Thanh Ba district, Phu Tho province. We consider that total respondents of 110, in which, number of conventional tea farms are 56 and number of organic tea farms is around 54, distributed into two selected agro-ecological zones, 55 for North mountainous zone and 55 for Mid hill zone. The sample selection procedure was shown in Figure 4.

Questionnaire form included:

- General information as name of household head, age, gender
- Production situation such as area, output, number of tea plots, age of tea gardens,
- Processing tea in household, tea processing equipment and machines
- Marketing practices, i.e., tea price, marke ting channels.

Two locations considered as study sites, in which, Thai Nguyen as represented for NMR, and Phu Tho as represented for MHR. There were some reasons for selecting study sites. Firstly, conventional and organic tea systems are being existed in parallel in the areas. Secondly, number of tea farmers in above regions covered high percent of total tea growers in the whole country.

Eligible tea farms were selected randomly, but in principles, tea farms have area under tea harvest, pure organic tea, not mixing conventional and organic enterprises in the same tea farm, and get over twenty % of income from tea production.

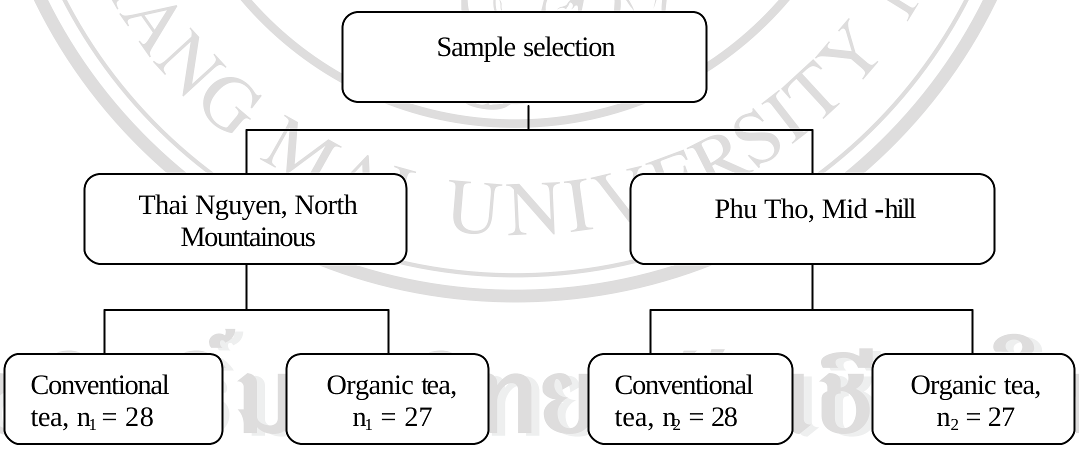


Figure 4 Sample selection for the study