CHAPTER III

RESEARCH METHOD

3.1 Scope of the study

The systematic principle of rice milling operation can be pictured as the focus of the technical efficiency study (Figure 3.1). There are many factors that influence production management process. Specifically, these are found to be associated with the internal management factors of the rice mills themselves ranging from paddy rice, land, labor, capacity, capital, processing technology, and types of business. On the other hand, the external linkages among key players involved in the rice mill industry. There are farmers and assemblers, who sell paddy to rice mills and distributors, and consumers, and the government, through its policy. All may have the potential to exert an influence on the system and indirectly on milling performance.

3.2 Data collection

3.2.1 Secondary data

To gain better understanding of the rice mill operation system, relevant publications were reviewed from the Engineering Division of the Ministry of Agriculture and Cooperatives, the Ministry of Industry in Thailand, and the Taiwan Statistical Yearbook in Taiwan, rice milling studies, and useful internet sites. This sources provide general information on rice production and rice mill, for example, planted area, total production, consumption, export, number of rice mills and types of rice mill.

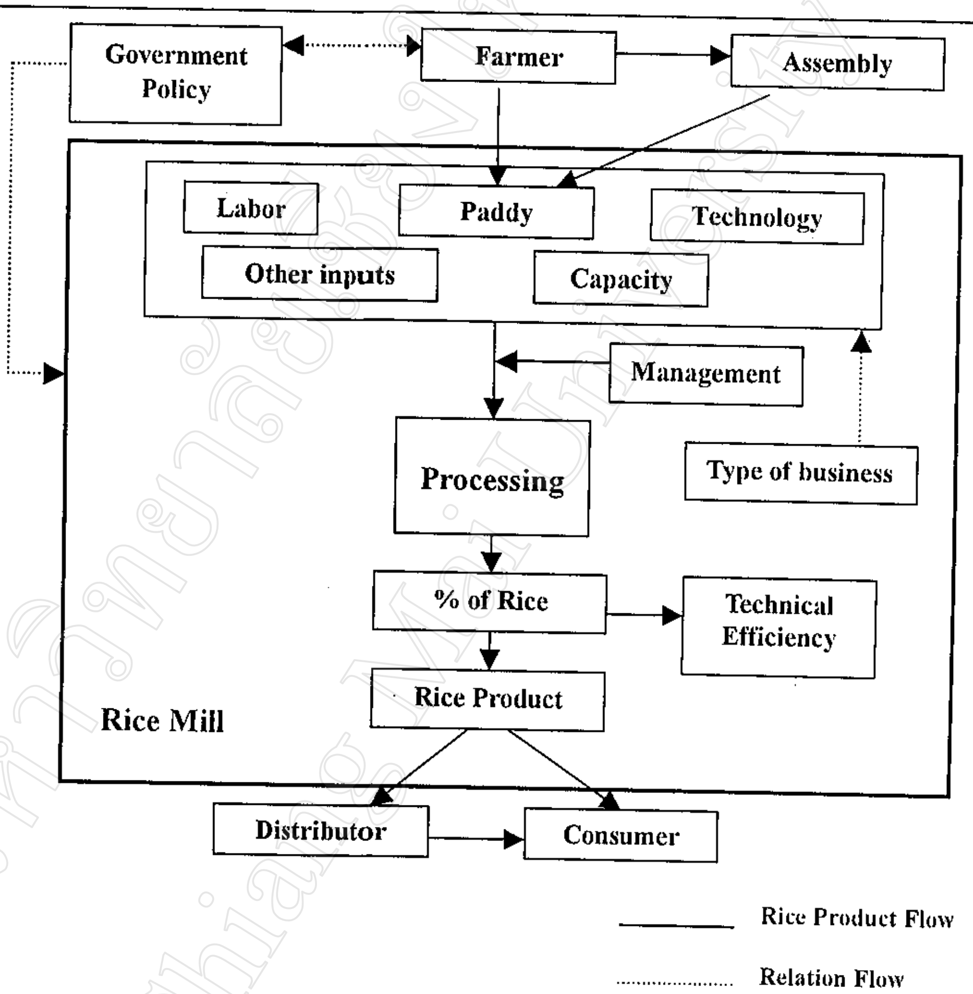

Figure 3.1 Rice Mill System

3.2.2 Primary data

This study is based on cross sectional data obtained from field survey. The data that are required for measuring the technical efficiency index for the rice milling industry in both Thailand and Taiwan, and for each particular firm are; output, paddy, land, labor and other intermediate inputs. Other data are general information such as type of business, milling technology, and problems in rice mill business, etc. Stratified and purposive sampling techniques were used to select the rice mills.

In Thailand, rice cultivation areas in the South and West regions are relatively less significant and have small numbers of rice mills. The rice mills to be chosen as representatives of the rice mill industry of the country are in the Northeastern, Central and Northern regions. Surin, Phitsanulok and Chiang Mai provinces were selected to represent these areas respectively. Surin is an important rice planting area in the Northeast, which is called "Tung Gularonghai". In the 1998/99 crop, it had harvested area of 2,689,984 rais and production of 607,735 tons. Phitsanulok, is the second planted area in the Central region, which had harvested area of 1,355,861 rais, and production of 567,927 tons. In Chiang Mai, the planted area is not abundant, the harvested area is 472,782 rais and production is 224,064 tons (Office of Agricultural Economics, Ministry of Agricultural and Cooperatives, 1999). However, paddy rice in other provinces is imported to process in rice mills in Chiang Mai. There are 901 rice mills in Chiang Mai, 743 mills in Surin, and 956 mills in Phitsanulok (Department of Factory, Ministry of Industry, 1999). The list includes commercial mills and service mills. The study is focusing only on commercial mills since the number of service mills are quite large but the quantity of paddy, which passes through them, is small in proportion. The 11 samples were chosen from the name list of the Provincial Commercial Office, which classified commercial mills in medium and large-scale businesses. In addition, one cooperative with a rice mill firm in each province was chosen for comparison with private rice mills.

There are more than 1,300 rice mills in Taiwan. However, most of them are located in Central and Southwestern regions, as they constitute the largest proportion of rice growing areas in the country. Therefore, rice mills in the two regions were selected for the study. However, the samples to be covered by the study were drawn only from the 135 rice mills that have been registered as members of Taiwan Rice and Cereals Industry Association. The members include 6 large mills, 34 medium mills, and 95 small mills. Then the 30 samples are selected as representative of each category. Moreover, five farmer associations were chosen to compare with private rice mill operation.

3.3 Data analysis

3.3.1 The descriptive analysis

The study generally focuses on the current situation of rice mill systems in Thailand and Taiwan. It describes characteristics of rice mill, technology, rice milling operational process, productive capacity, and channels of product distribution. In addition, the study analyzed the concerns of rice millers in Thailand and Taiwan. The technical and physical factors of rice millers were explored and the existing political factors and legal sides in both countries is also discussed.

3.3.2 The quantitative analysis

The procedures are two-dimensional in order to carry the purpose of this study. For the second objective, Data Envelopment Analysis (DEA), the analytical method, was employed to analyze and compare the level of technical efficiency for rice millers by combining all rice mills in both Thailand and Taiwan.

Rice processing features multiple outputs and inputs. Accordingly, Cooper, Seiford and Tone (2000) suggested that a number of observations should be used based on the number of inputs and outputs in the analysis. The choice of variables was constrained by the available data and the need to avoid the 'curse of dimensionality' that can affect the DEA method. This occurs if there are too many variables in the model and, as a result, a large proportion of the firms will be efficient. This suggested minimum, provided only as a rule of thumb with no inherent statistical implication, is given by $n \geq \max \{m \times s, 3(m+s)\}$, where is the n is number of observations, m is the number of inputs and s is the number of outputs. For the purpose of efficiency analysis, therefore, an input oriented measure, output is aggregated into one category and inputs are aggregated into four categories, namely, paddy, land, labor, and value of machine, as variables to be included in the model specification. The variables are adjusted to account for such exchange rate differences between Thailand and Taiwan. These output and input variables are described below.

Output (Y) represents the total quantity of rice after processing (ton).

Paddy (X_1) represents the total quantity of annual paddy (ton).

Land (X_2) represents the total quantity of land (rai).

Labor (X_3) represents the total amount of family labor and hired labor (person).

Machine (X_4) represents the initial value of machine in mill operation (baht).

The survey data was given that rice processing was the dominant activity of the sample firms. Therefore, the output is total quantity of head rice produced by individual rice mills. The various inputs used in the analysis were adjusted. Paddy is only one raw material of processing. It was measured by ton per year of total quantity paddy used in 2000. Next, land was the total number of rai that the rice mill possessed as their processing area, warehouse and rice mill yard. Labor input was measured in number of persons. Each person was defined as the one man working 8 hours a day in the rice processing activity. Labor was measured by skilled and unskilled labors. Most rice mills are the family businesses, family labor ranging at 2-5 people per mill, was assumed to be skilled labor. Except for hired managers, hired labor was unskilled labor to perform bagging, pilling, carrying, and loading for example. Hence, disparity of labor was the quantity of hired labor. Finally, capital investment use for rice mill includes fixed cost and variable cost. Paddy is one variable that can be indicated in the variable cost. This study used value of machine to represent capital.

Consider the situation with n firms or decision-making units (DMUs), each producing a single output by using m different inputs. Here, Y_i is the output produced and X_i is the $(m\times 1)$ vector of inputs used by the ith DMU. Y is the $(1\times n)$ vector of outputs and X is the $(m\times n)$ matrix of inputs of all n DMUs in the sample.

The technical efficiency (TE) measure under constant returns to scale (CRS) is obtained by solving the following DEA model:

$$\min_{\theta_i^{CRS},\lambda} \theta_i^{CRS} \tag{20}$$

Subject to

$$Y_i \leq Y\lambda$$

$$\theta_i^{CRS} X_i \geq X\lambda$$

$$\lambda \geq 0$$

where θ^{CRS} is a TE measure of the *i*th DMU under CRS and λ is an $n\times 1$ vector of weights attached to each of the efficient DMUs. A separate linear programming (LP) problem is solved to obtain the TE score for each of the n DMUs in the sample.

If $\theta^{CRS} = 1$, the DMU is on the frontier and is technically efficient under CRS. If $\theta^{CRS} < 1$, then the DMU lies below the frontier and is technically inefficient.

The CRS or 'overall' (TE $_{CRS}$) measure can be decomposed into its 'pure' TE and scale efficiency components by solving a variable returns to scale (VRS) DEA model, which is obtain by imposing additional constrain on equation (20) (Banker et al., 1984) as specified below.

$$\begin{aligned} & \min_{\theta_i^{CRS},\lambda} \theta_i^{CRS} \\ \text{Subject to} \quad & Y_i \leq Y\lambda \\ & \theta_i^{CRS} X_i \geq X\lambda \\ & \textstyle\sum_{j=1}^{n} \lambda_j = 1 \\ & \lambda \geq 0 \end{aligned} \qquad (21)$$

Let θ_i^{VRS} denote the TE index of the *i*th DMU under variable returns to scale (TE_{VRS}).

Because the VRS analysis is more flexible and envelops the data in a tighter way than the CRS analysis, the VRS TE measure (θ^{VRS}) is equal or greater than the CRS measure (θ^{CRS}). This relationship is used to obtain a measure of scale efficiency (SE) of the *i*th DMU as

$$SE_i = \frac{\theta_i^{CRS}}{\theta_i^{VRS}} \qquad (22)$$

where SE = 1 indicate scale efficiency or CRS and SE < 1 indicates scale inefficiency. Scale inefficiency is due to the presence of either increasing or decreasing returns to scale, which can be determined by solving a nonincreasing returns to scale (NIRS) DEA model which is obtained by substituting the VRS constraint $\sum_{j=1}^{n} \lambda_{j=1}$ with $\sum_{j=1}^{n} \lambda_{j\leq 1}$. Let θ^{NIRS} represent the TE measure under nonincreasing returns to scale. If $\theta^{NIRS} = \theta^{CRS}$, there are increasing returns to scale and if $\theta^{CRS} < \theta^{NIRS}$ there are decreasing returns to scale (Färe et al., 1994).

The analytical method for the third objective was to identify the factor affecting technical inefficiency from the DEA results. In the first stage to solving a DEA problem analysis involves the traditional inputs and outputs. Second-stage regression can be used to explain the efficiency scores for the various firm-specific factors. This analysis can be helpful in targeting extension activities to deal with technical inefficiencies in production. Tobit regression in Eq. (28) was used to identify possible factors associated with inefficiency.

Tobit model was employed to estimate the equation because when the dependent variable is discrete, the OLS is not an appropriate method since the expected value of the error term is not equal to zero, which is the major assumption in classical OLS methods of estimation. To see this consider the following example.

$$I = b_0 + b_1 K + b_2 L + U \quad (23)$$

Where, b_i = Parameter

K, L = explanatory variable

U = error term

Applying OLS, we get

$$\hat{I} = \hat{b}_0 + \hat{b}_1 K + \hat{b}_2 L \quad (24)$$

$$\hat{I} = \hat{b}_0 + \hat{b}_1 K + \hat{b}_2 L + \hat{U} \quad (25)$$

Suppose $K^{\bullet}$ and $L^{\bullet}$ satisfies the following equation

$$\hat{I} = \hat{b}_0 + \hat{b}_1 K^{\bullet} + \hat{b}_2 L^{\bullet} = 0 \qquad (26)$$

then $I = \hat{I} + \hat{U}$

$= 0 + U$

I is dependent on the value of $\hat{U}$. Since I is restricted to be nonnegative, then $\hat{U}$ must always be nonnegative. Hence $E(U) \neq 0$. This violates the OLS assumption, and hence the estimates are not BLUE.

Therefore, when dependent variables are discrete, there are other estimation techniques, which provide maximum likelihood estimates such as Logit, Probit and Tobit. In case of Logit and Probit, the dependent variable can take any value between 0 or 1 but in the case of Tobit the dependent variable can take any value between 0 and any arbitrary number. So, for this study the most suitable method is Tobit because in efficiency in percentage which is a dependent variable that lies between 0 and 100 (Paudyal, 1996; Llewelyn and William, 1996; Burki and Terrell, 1998; Thiam et. al., 2001). Tobit's analysis can be described as follows:

In the above example an index is constructed as

$$P = c_0 + c_1 K + c_2 L \qquad (27)$$

The P is a linear index of the explanatory variables influencing the inefficiency of farmers. Since the inefficiencies of farmers are not fully explained by the index P, there must be a disturbance term, U.

Then the rice mills are assumed to behave according to

$$I = 0 \text{ if } P + U < 0$$

$$I = P \text{ if } 0 < P + U < 100$$

$$I = 100 \text{ if } P + U > 100$$

Figure 3.2 illustrates the main idea of Tobit analysis. The vertical axis measures the dependent variable (inefficiency in percentage). The horizontal axis is the explanatory variables. The S curve is an inefficiency curve. Under Tobit estimation the index line P is estimated, and this is the line P=βX in the figure. If X is at X_0, then P is negative. But a positive inefficiency, I_0, is observed. This is possible under Tobit because the deviation from the index, U_0 is large such that $P+U_0 > 0$.

The line AA is an OLS approximation of the inefficiency curve. It is less steep than index line P. In fact over the mid range of the explanatory variables, the responses from the OLS estimation are smaller than the true responses. Predictions from Tobit analysis method are more accurate than the OLS over this range.

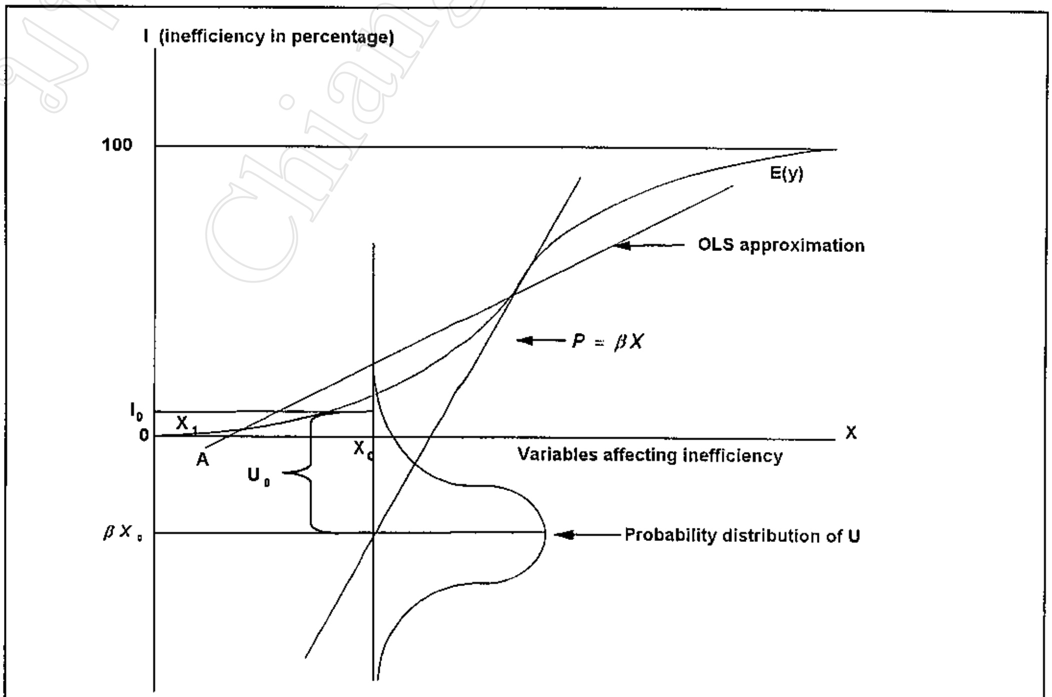

Figure 3.2 Tobit's estimation method

The variation of technical efficiencies in the rice mill industry is caused by two major reasons. One is the variation in technical aspect with respect to the quality of milling machine. The other is the variation in other factors such as managerial capacity, labor skill etc.

The variable specialization gives the share of production in total output. An independent variable, maximum machine capacity which can be operated in one day, and source of power used, is the main difference in technique of production. These sources can be classified into four types as electric motor, diesel engine, steam engine and computer machine, and are included to account for additional technological difference.

It is not only the improvement in machinery quality or production technique but also the improvement in managerial skill that can increase the technical efficiency level. However, management is a wide concept that comprises many activities within a firm, including; interdependent decision making unit and interdependent implementation by organization members. Therefore this section has taken the potential influencing factor which is predominantly the skills and ability of entrepreneurs to increase rice mill efficiency utilizing the existing resources in their firms. This starts with the importance of education, and working experience in milling or related field has contributed to management skill. Also, age of the enterprise reflects the impact of plant vintage on productivity and type of business, which provides the different outputs while managing their rice mill.

Firm specific estimates of pure technical efficiency are used as a dependent variable. Technical efficiency scores are regressed on the explanatory variables which include years of establishment, degree to full capacity of operation, experience, Dummy variables are used for education of entrepreneurs, energy source in operation and dummy variable of business type (i.e. private rice mill and cooperatives rice mill) of each rice mill.

The Tobit regression to estimate an equation of the general form is

$$\text{PTE}_i = \alpha + \beta_1 Year_i + \beta_2 Capa_i + \beta_3 Exp_i + \beta_4 Edu_i + \beta_5 Energy_i + \beta_6 Type_i + \varepsilon_i \qquad (28)$$

Where:

PTE_i = Pure Technical Efficiency score for rice mill i

Year_i = Number of years established of rice mill

Capa_i = Maximum degree to full capacity of machine operating (ton per day)

Exp_i = Manager's experience (Number of year to engage in rice mill business)

Edu_i = Education of entrepreneurs (1=Primary schoodl, 2=Secondary school, 3=High school, 4= University)

Energy_i = Energy source in rice mill operation (1=diesel engine, 2= electronic motor, 3=Stream engine, 4=Automatic machine)

Type_i = Dummy variable, equals to 1 if rice mill is private, 0 is association or cooperatives

α, β = Prameters.

ε_i = Error term.

It is hypothesized that older established, more experienced and better educated rice millers are more technically efficient, due to better skills and access to information. Capacity of operation may positively affect efficiency, if rice mills are able to achieve some economies of scale. In addition, the energy source in rice mill operation and type of business could have some affect to technical efficiency.