CHAPTER 3

RESEARCH METHODOLOGIES

The Social Accounting Matrix (SAM) theoretical framework was applied for analyzing the economic and environmental impacts from the operation of golden brown dried longan processing community enterprises. This is because SAM enables the investigation of both direct and indirect impacts through the backward linkage upon the raw material supplying sector, and through the forward linkage upon the product users, with income and employment effects on both backward and forward sectors or industries. By using the coefficients and SAM based multipliers from Matrix A and Matrix B, it is possible to trace the effects of one sector's activities on another or all other sectors in an economy. Furthermore, the entries or transactions in a SAM can be used as inputs for data processing by Matlab software program to estimate the changes in outcomes in the affected sectors or groups of economic agents under different scenarios. For the analysis of environmental impacts, a meta-frontier was constructed using Data Envelopment Analysis (DEA) technique to compare the technical efficiencies between groups employing different production technologies namely the conventional drying oven and the improved version and then the implications in terms of fuel wood consumption and environmental consequences can be assessed.

The community enterprises use farm outputs as raw material and thus their expansion can generate value addition to the local agricultural sector and create more employment of local as well as extra-village labors due to the labor-intensive nature of dried longan processing; but they face the problems of labor shortage, inadequate working capital as the running of their business involves substantial capital fund, causing air pollution from fuel wood burning for heating energy, and heavy market dependence on middle agents and overseas demand. The research contents, procedures, and models for the present investigation can be summarized as in the following presentations and figure 3.1:

3.1 Research steps and activities

1) Review and compilation of data. Identification of key questions and production situations of golden brown dried longan processing community enterprises. Analysis of internal and external factors determining the weakness, strength, and limitations of these community enterprises through focus group discussion procedure and the involvement of one representative each from the 33 relevant enterprises operating in Tambon Makhuea Chae in the focus group sessions.

2) Explanation, summarization, and detailed presentation by the research investigator on the production situations of golden brown dried longan processing to cover a comprehensive range of issues such that primary analysis can be undertaken on the production situations and the socio-economic as well as the environmental impacts.

3) Tambon Makhuea Chae local context study from data and information available and provided by Tambon Makhuea Chae Municipality Office, the Provincial Development Office, the Provincial Industry Office, and the Provincial Agriculture Office. Determination of sample size. Development of data and information collection tools. Construction of Social Accounting Matrix portraying the interconnection between various economic agencies and all the economic activities

involved in the operations of the community enterprises under study in terms of use of inputs including raw material (fresh longan fruits), labor, investment capital, and energy (fuel wood) and distribution of outputs to other local and external production sectors**.** Use of transactions records in SAM for analyzing the spill-over effects of the community enterprises' operations on other sub-economic sectors through forward, backward, income, and employment linkages.

4) Estimation of meta-frontier function through Data Envelopment Analysis procedure for technical efficiency comparison between two different longan drying technologies and for assessing the environmental impacts from the use of improved technology or the modified longan drying ovens in the present case.

5) Use of information or records in SAM model developed in 3) above for processing by Matlab software program a Computable General Equilibrium model within Walras' general equilibrium framework to estimate the possible outcomes under different scenarios.

6) Proposing policy guidelines or a master plan for the development of golden brown dried longan processing community enterprises to deal with the existing problems.

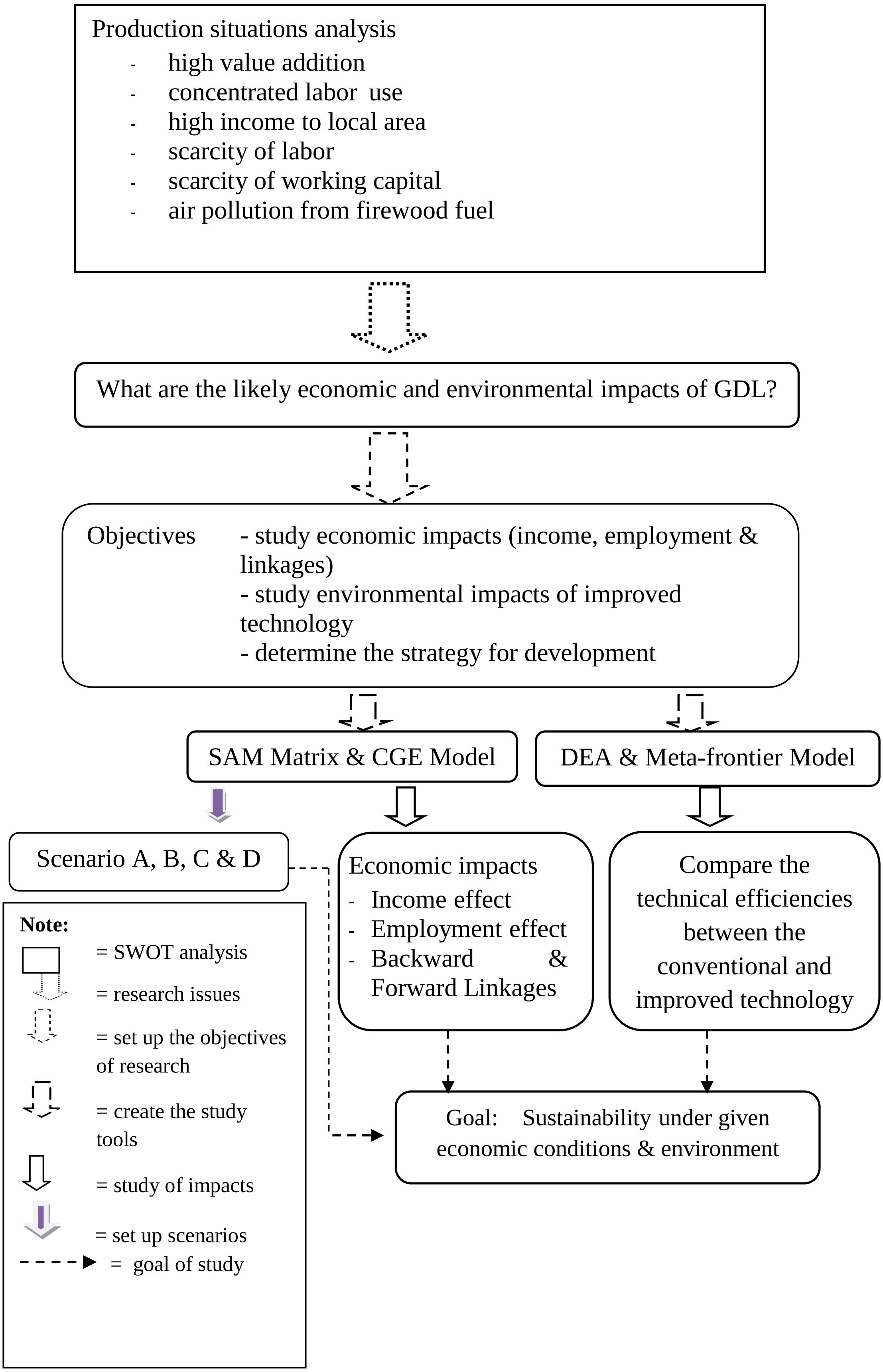

Figure 3.1 conceptual framework

3.2 Study on economic impacts by SAM model and CGE model

3.2.1 The study on economic impacts following the SAM model addresses the effects through three economic interconnections namely: backward and forward linkages with raw material sources and product users or consumers, respectively; effect on income level of the local community; and effect on employment level of the local community. It covers 6 steps or components of investigation to be elaborated later including:

1) construction of a Social Accounting Matrix;

2) calculation for direct and indirect production coefficients;

3) calculation for backward linkage effect in terms of input;

4) calculation for forward linkage effect in terms of output;

5) calculation for income impact on the community;

6) calculation for employment impact.

<u>Step 1</u> construction of a 35*35 SAM of economic activities and entities as listed below based on information from field and documentary surveys as presented in Table 3.1

Table 3.1 The structure of the SAM

Sector	Production 1 2......n	Factor of production	Final Demand (Y)	Row Total (X)
1	Z_{11} Z_{12} …. Z_{1n}	Land, Labor	C_1 I_1 G_1 E_1	X_1
2	Z_{21} Z_{22} …. Z_{2n}		C_2 I_2 G_2 E_2	X_2
.	.			.
.	.			.
.	.			.
n	Z_{n1} Z_{n2} …. Z_{nn}		C_n I_n G_n E_n	X_n
Value Added(V)	W_1 W_2 …. W_n		W_C W_I W_G W_E	W
	L_1 L_2 …. L_n		L_C L_I L_G L_E	L
	N_1 N_2 …. N_n		N_C N_I N_G N_E	N
	M_1 M_2 …. M_n		M_C M_I M_G M_E	M
Total outlay(X)	X_1 X_2 …. X_n		C I G E	

Reading along the columns in Table 3.1, one will know the transactions in monetary term of a production sector with others in the economy and understand the former's production behavior. Production sector 1, for example, will be seen to have used inputs Z_{11}, Z_{21},…, Z_{n1} from production sectors 1,..., 21 (X_i) and made payments for factors of production in terms of wage (W), rent (L) and profit (N) or savings. These payments from production activities represented by value added and plus imports (M). The last entry in a column is the record of total outlay (X). Reading the activity accounts by row, one can understand the consumption behavior for example from the flow of outputs Z_{11}, Z_{12},…,Z_{1n} of production sector 1 which are distributed to production sectors 1,…,21. Some part of the outputs from production sector 1 will be distributed to satisfy the final demand represented by the $Y_1 = C_1 + I_1 + G_1 + X_1$ equation or the aggregation of household consumption, investment, government spending, and net export. The distribution of the outputs produced by all production sectors can be written in mathematical relationship as follows:

$$X_i = \sum_{j=1}^{21} Z_{ij} + Y_j \qquad (j=1,2,3,\ldots,21) \qquad (3.1)$$

where $\sum Z_{ij}$ is the value- added of production sector j from its outputs which are distributed for use as factor inputs in other production sectors throughout the economic system (reading along row).

$$X_j = \sum_{j=1}^{21} Z_{ij} + V_i \qquad (j=1,2,3,\ldots,21) \qquad (3.2)$$

Where $\sum Z_{ij}$ is the total payment of economic sector i for factor inputs supplied by other economic sectors (reading along column).

Step 2 calculation for direct and indirect coefficients based on the accounts in SAM constructed in step 1. The direct coefficient or technical coefficient of demand-side model can be obtained from dividing the total output accounts by total outlay accounts along columns as in (3.3)

$$a_{ij} = z_{ij} / x_j \tag{3.3}$$

From (3.3), one can see the relationship in the demand-side model in which the direct coefficient is the value of fixed proportions between outputs and inputs meaning that an increase in output level will correspond with a proportional increase in input use thus exhibiting the constant returns to scale production.

Substituting the term $Z_{ij} = a_{ij} * X_j$ from (3.3) into the output distribution equation (3.1), we obtain the following:

$X_i = a_{ij} \times X_j + Y_i$

$$X_i = a_{ij} * X_j + Y_i \quad (j = 1, \dots, 21) \tag{3.4}$$

The input use equations can be expressed in matrix form as follows:

$$X = AX + Y \tag{3.5}$$

where X is the column vector of aggregate output in each economic sector;

Y is the column vector of final demand in each economic sector;

A is the direct coefficient matrix.

The values of direct and indirect coefficients indicate that an increase in input used in any economic sector will lead to an increase in demand for factor inputs from other sectors to enable the overall production expansion. An example is the growth in construction sector, which is possible with more uses of such construction materials as steel and cement, will give rise to the production increase in steel and cement industries to satisfy the growing demand.

From equation (3.5) $X = AX + Y$

$$(I - A)X = Y$$

$$X = (I - A)^{-1} * Y$$

The term $(I - A)^{-1}$ is called Leontief Inverse Matrix giving the direct and indirect coefficients.

Given $X = \alpha Y$

$$\text{Then} \begin{bmatrix} X_1 \\ . \\ . \\ . \\ X_{21} \end{bmatrix} = \begin{bmatrix} \alpha_{11} & \dots & \alpha_{1n} \\ . & \alpha_{ij} & \\ . & & . \\ . & & . \\ \alpha_{211} & \dots & \alpha_{2121} \end{bmatrix} \begin{bmatrix} Y_1 \\ . \\ . \\ . \\ Y_{21} \end{bmatrix}$$

which gives the direct and indirect input coefficients for explanation that an increase in a unit of final demand in production sector *i* with directly and indirectly cause the expansion in production sector *j* by α_{ij} monetary unit.

Similarly, the production of production sector *j* for distribution of outputs to other sectors involves the employment of factor inputs as well as raw materials from other sectors; thus, this generates a relationship in the form of supply-side model from which a direct output coefficient can be determined by the following:

$$b_{ij} = Z_{ij} / X_i \tag{3.6}$$

The direct output coefficient also has the value of fixed proportion between inputs and outputs, meaning that outputs will increase proportionally with increase in the use of inputs.

From (3.6), we obtain $Z_{ij} = b_{ij} * X_i$

Substituting the term Z_{ij} into output distribution equation (3.2), we obtain the following output matrix:

$$X_j = b_{ij} * X_i + V_j \qquad (i = 1, \ldots, 21) \qquad (3.7)$$

or

$$\begin{bmatrix} X_1 \\ X_2 \\ \cdot \\ \cdot \\ \cdot \\ X_{21} \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & \ldots & b_{121} \\ b_{21} & b_{22} & \ldots & b_{221} \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ \cdot & \cdot & \cdots & \cdot \\ b_{211} & b_{212} & \ldots & b_{2121} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \cdot \\ \cdot \\ \cdot \\ X_{21} \end{bmatrix} + \begin{bmatrix} V_1 \\ V_2 \\ \cdot \\ \cdot \\ \cdot \\ V_{21} \end{bmatrix}$$

Then $X' = i'X^{\wedge}B + V'$ (3.8)

where (‘) = row vector

i = identity matrix

(^) = diagonal matrix

B = output coefficient matrix

If $i'X^{\wedge} = X'$ then

$$X' = X'B + V' \qquad (3.9)$$

$$X' = V'(I - B)^{-1} \qquad (3.10)$$

where X = output vector

V = value added

$(I - B)^{-1}$ = output inverse matrix

Given $(I - B)^{-1} = \bar{\alpha}$

Then $X' = V'\bar{\alpha}$

$$[X_1, \ldots, X_{21}] = [V_1, \ldots, V_{21}] \begin{bmatrix} \bar{\alpha}_{11} & . & . & . & \bar{\alpha}_{121} \\ & & \bar{\alpha}_{ij} & & \\ \bar{\alpha}_{211} & . & . & . & \bar{\alpha}_{2121} \end{bmatrix}$$

which gives the direct and indirect output coefficients for explanation that a unitary increase in value-added of production sector *j* will directly and indirectly cause the expansion in production sector *i* by $\bar{\alpha}_{ij}$ unit of monetary value

Step 3 calculation for impacts on backward linkages from the demand-side model in the following formula:

$$(I - A)^{-1} = \begin{bmatrix} \alpha_{11}\cdots & \alpha_{121} \\ \alpha_{211}\cdots & \alpha_{2121} \end{bmatrix}$$

and the total (direct + indirect) impact is represented by

$$B(d+i)_j = \sum_{i=1}^{21} \alpha_{ij} \tag{3.11}$$

The term $B(d+i)_j = \sum_{i=1}^{21} \alpha_{ij}$ is the total increase in outputs of all production sectors in the economy in response to a unitary increase in the final demand for outputs from production sector *j*, or the impact of production sector *j* on backward linkages. An illustration is the impacts of increased production of golden brown dried longan (GDL) on two backward linkages; directly on longan growers as the raw material supplier to produce more fresh longan fruits and indirectly on agro-chemical manufacturers and farm laborers whose outputs and labor are demanded more for increasing longan outputs.

Step 4 calculation for impacts on forward linkages from the supply-side model in the following formula:

$$(\bar{I} - B)^{-1} = \begin{bmatrix} \bar{a}_{11}\cdots & \bar{a}_{121} \\ \bar{a}_{211}\cdots & \bar{a}_{2121} \end{bmatrix}$$

The total (direct + indirect) effect is determined by

$$F(d+i)_i = \sum_{j=1}^{21} \bar{a}_{ij} \tag{3.12}$$

The term $F(d+i)_i$ represents the increase in outputs produced by production sector *i* to satisfy a unitary increase in the final demand for outputs of other production sectors. An example of golden brown dried longan production impacts on forward linkages can be drawn from the increase in demand for raw material of the longan cake production sector (brown dried longan) which is the direct forward linkage and the increase in demand for flour and labor, which are the indirect forward linkages because of greater longan cake production. The present investigation adopted the backward linkages concept of Rasmussen (1968) and the forward linkages concept of Bulmer – Thomas (1982). Furthermore, it will consider the impacts on labor employment and income to be discussed later.

Step 5 calculation for the impacts on community's income distinguishable into impacts on backward linkages and those on forward linkages. The impacts on income are in terms of payments to owners of factor inputs or wage, entrepreneur's profit, depreciation, and indirect tax and are measured by the income coefficient value in the form of value-added of each category of factor inputs.

The income coefficient is defined by

$$H_j^P = V^P / X_j \qquad (3.13)$$

where V^P = the value-added of the owner of factor input *p*.

X_j = total value of outputs of production sector *j*

H_j^P = income coefficient of sector *j*

Empirical model of GDL showed that the value of owner of factor input in GDL sector are 56.07 million baht and total value of outputs of GDL sector are

160.54 million baht so the income coefficient of GDL are 0.35 (H^{p}_{GDL}= 56.07/160.54 =0.35)

Consequently, H^{p}_{j} is the ratio between value-added of the owner of factor input *p* and 1 baht output of production sector *j* which is called the income coefficient.

The impacts on income of other sectors can be found from the following relationships.

Impacts on income of backward linkages

$$C_j^P = \sum_{i=1}^{21} \left[\alpha_{ij} \times H_i^p \right] \qquad ;(i = 1, 2, 3, \ldots,21) \qquad (3.14)$$

C^{p}_{j} is the overall income generation for the owner of factor input *p* in the economic system when there is a unitary increase in the final demand for outputs from production sector *j*. The impacts on income of backward linkages can be understood by the illustration that the increase in dried longan production will involve greater use of raw material and other inputs and thus will generate more income directly and indirectly for the owners of various factor inputs.

Impacts on income of forward linkages

$$C_i^P = \sum_{j=1}^{21} \left[\overline{\alpha}_{ij} \times H_j^p \right] \qquad ;(i = 1, 2, 3, \ldots,21) \qquad (3.15)$$

C_i^{p} is the overall increase in income of the owner of factor input *p* in various production sectors associated with one unitary increase in value-added of sector *i*. An example of impacts on income of forward linkages is the situation where the increase in dried longan production enables the other production sectors that use dried longan as a raw material to expand their production and earn more income.

<u>Step 6</u> calculation for the impacts on employment distinguishable into the impacts in backward linkages and those in forward linkages. The concepts on

forward and backward linkage effects of outputs in an economic sector of Rasmussen and Bulmer - Thomas respectively will be applied for measuring the impacts on employment which takes into account the employment coefficients of various production sectors. The employment coefficient is defined by

$$W_i = e_i / X_i \qquad (3.16)$$

where W_i = employment coefficient value of production sector *i*

e_i = value of labor employed in production sector *i*

X_i = total value of outputs of production sector *i*

Empirical model of GDL showed that the value of labor employed in GDL sector is 23.25 million baht and total value of outputs of GDL sector is 160.54 million baht so the employment coefficient value becomes 0.14 (W_{GDL}= 23.25/160.54 =0.14)

Employment impacts on backward linkages

Measuring the employment impacts on backward linkages takes the following procedure:

$$E_j = \sum_{i=1}^{21}\left[\alpha_{ij} \times W_i\right] \quad ;(i = 1, 2, 3, \ldots,21) \qquad (3.17)$$

Where α_{ij} = Leontief inverse matrix

W_i = employment coefficient of production sector *i*

E_j = employment impacts on backward linkages

The term E_j is the measured overall increase (directly and indirectly) in labor employment in all production sectors in an economy associated with a unitary increase in final demand for outputs of production sector *j*. For example, the increase in GDL production and outputs means a greater use of various factor inputs and thus generates directly and indirectly a greater employment in the sectors that supply inputs for GDL processing.

Employment impacts on forward linkages

$$E_i = \sum_{j=1}^{21} \left[\overline{\alpha}_{ij} \times W_j \right] \quad ; (i = 1, 2, 3, \ldots, 21) \qquad (3.18)$$

where $\overline{\alpha}_{ij}$ = output inverse matrix

W_j = employment coefficient of production sector *j*

E_i = employment impacts on forward linkages

The term E_i is the overall increase in labor employment in all production sectors in an economy where there is a unitary increase in value-added of production sector *i*. For example, the increase in GDL production will enable the expansion of production of products using GDL as an ingredient and hence the greater labor employment in the related production sectors.

3.2.2 Study of economic impacts by CGE model

The study on economic impacts by CGE model has 3 steps: 1) constructing the SAM of 35*35 sectors 2) setting up the equations system and 3) using the Matlab software program for calculation which the following details:

<u>Step 1</u> Construction of a 35 x 35 SAM covering 35 different production activities, factors of production, and institutions; or more specifically 21 production sectors, 5 factors of production, 4 institutions, 1 Municipality as local government, 1 investment account, and 3 household accounts.

<u>Step 2</u> Development of a CGE model in the form of zero-profit equation system as presented below:

F_1: $p_1q_1+p_1Z_1-p_2Z_2-p_3Z_3-p_4Z_4-\ldots-p_{21}Z_{21}-p_{22}V_{22}-\ldots -p_{26}V_{26}-p_{27}I_{27}\ldots-p_{30}I_{30}-p_{31}G_{31}-p_{32}S_{32}-wH_{33}-wH_{34}-wH_{35}=0$

F_2: $-p_1Z_1+p_2q_2+p_2Z_2-p_3Z_3-p_4Z_4-\ldots-p_{21}Z_{21}-p_{22}V_{22}-\ldots -p_{26}V_{26}-p_{27}I_{27}\ldots-p_{30}I_{30}-p_{31}G_{31}-p_{32}S_{32}-wH_{33}-wH_{34}-wH_{35}=0$

F_3: $-p_1Z_1-p_2Z_2+p_3q_3+p_3Z_3-p_4Z_4-\ldots-p_{21}Z_{21}-p_{22}V_{22}-\ldots -p_{26}V_{26}-p_{27}I_{27}\ldots-p_{30}I_{30}-p_{31}G_{31}-p_{32}S_{32}-wH_{33}-wH_{34}-wH_{35}=0$

F_4: $-p_1Z_1-p_2Z_2-p_3Z_3+p_4q_4+p_4Z_4-\ldots-p_{21}Z_{21}-p_{22}V_{22}-\ldots -p_{26}V_{26}-p_{27}I_{27}\ldots-p_{30}I_{30}-p_{31}G_{31}-p_{32}S_{32}-wH_{33}-wH_{34}-wH_{35}=0$

.
.
.

H_{35}: $w(H_{35})-p_1q_1-p_2q_2-\ldots-p_{21}q_{21}-p_{22}V_{22}-\ldots-p_{26}V_{26}-p_{27}I_{27}-\ldots-p_{30}I_{30}-p_{31}G_{31}-p_{32}S_{32}-wH_{33}-wH_{34} = 0$ (3.19)

where F = Firm (production sector) in cells 1 -21;
V = Factor of production in cells 22 – 26;
I = Institute in cells 27 -30;
G = Municipality or local government;
S = Investment/Saving;
H = Households in cells 33 – 35;
p_i = output prices of production sector *i*;
Z_i = output quantities of production sector *i* sold as factor input to other production sectors;
q_i = output quantities of production sector *i* sold as consumption goods to households;
w = prices of factor inputs supplied by households in this case is labor input.

Step 3 Application of Matlab software program (Suriya, 2013) made available by the Faculty of Economics and Business Forecasting Center at Chiang Mai University to the equation system in step 2; such that the data sets from SAM constructed in step 1 can be processed for simulated outcomes to determine the best scenario which is appropriate in the local community area given the emphasis on analyzing the impacts of golden brown dried longan processing community enterprises' operations. The five facts or assumptions are considered taken into account the following different situations: 1) The main problem of GDL is labor scarcity while the official wage rate was raised by government announcement. 2) The production cost is sensitive for producers thus it is assumed to be increased. 3) The capital fund for village funds can be varied 4) Government funding directly through golden brown dried longan enterprises and 5) The expenditure budget of Municipality Office can be increased. Consequently, five main scenarios are set for calculation.

Scenario A

The increase in minimum wage to 300 baht/day countrywide announced by the Thai Ministry of Labor and Social Welfare in 2013 which is above the minimum wage previously determined for Lamphun Province at 236 baht/day means a 27 % increase in labor cost. This may cause the economic impacts in the following directions:

A1**:** Increase in labor wage by 27 % in the case firms cut down labor employment due to the lack of investment capital or government subsidy (no increase in money availability).

A2: Increase in labor wage and money availability by 27 % in all production sectors.

Scenario B:

The likely impacts of the change in production cost of golden brown dried longan processing community enterprises while production cost of other production sectors remain unchanged, from the situations that:

B1: production cost increases by 20 %;

B2: production cost increases by 40 %;

B3: production cost increases by 60 %;

Scenario C:

Impacts on the local community's economy from the state policy to increase capital fund for village funds or community enterprises which is the main formal credit source for golden brown dried longan processing community enterprises' operations, and the policy may be implemented to the following extents:

C1: government injection of money to Tambon economic system through community production groups increases by 20 %.

C2: government injection of money to Tambon economic system through community production groups increases by 40 %.

C3: government injection of money to Tambon economic system through community production groups increases by 60 %.

C4: government injection of money to Tambon economic system through community production groups increases by 80 %.

C5: government injection of money to Tambon economic system through community production groups increases by 100 %.

Scenario D:

Impacts on the local community's economy from government injection of money to Tambon economic system directly through golden brown dried longan and this policy may be implemented to the following extents:

D1: government injection of money to Tambon economic system directly through golden brown dried longan increases by 20 %.

D2: government injection of money to Tambon economic system directly through golden brown dried longan increases by 40 %.

D3: government injection of money to Tambon economic system directly through golden brown dried longan increases by 60 %.

D4: government injection of money to Tambon economic system directly through golden brown dried longan increases by 80 %.

D5: government injection of money to Tambon economic system directly through golden brown dried longan increases by 100 %.

Scenario E:

Economic impacts on the local communities from increased budget spending by the local government through Municipality Office to the following extents:

E1: increase in local government spending by 20 %;

E2: increase in local government spending by 40 %;

E3: increase in local government spending by 60 %;

E4: increase in local government spending by 80 %;

E5: increase in local government spending by 100 %;

3.3 Environmental impacts study through efficiency analysis

The environmental impacts study was based on comparative efficiency analysis by a meta-frontier function constructed in DEA approach. The study procedures are presented below.

Step 1 finding technical efficiency of decision making unit: DMU.

A group production frontier was estimated by DEA method using the input and output data of all DMUs in the group. If there are k technologically heterogeneous groups of DMUs and each group has L_k DMUs, then the solutions may be obtained by solving an input – oriented linear programming problem under constant returns to scale assumption as defined below:

$$
\begin{aligned}
& Min_{\theta,\lambda}\theta \\
& \text{s.t.} \quad -y_i + y_k\lambda \geq 0, \\
& \qquad \theta x_i - x_k\lambda \geq 0, \\
& \qquad N1\lambda \leq 1 \text{ and} \\
& \qquad \lambda \geq 0 .
\end{aligned}
\tag{3.20}
$$

Where

y_i = 1×1 vector of output of producer *i*

x_i = 4 ×1 vector of input of producer *i*

y_k = 1×L_k matrix of output of L_k producers

x_k = 4×L_k matrix of input of L_k producers

$N1$ = L_k×1 vector of 1

λ = L_k×1 vector of weight given to producer *i* and

θ = scalar matrix

K = number of groups with specific technologies;

L_k = number of producers or DMUs in a technologically specific group.

The θ values are solved by linear programming procedure with respect to equation (3.20) and will be less than 1. Any θ value indicates the proportion of inputs the firm *i* can possibly reduce while keeping its fixed output level and thus θ is the input – oriented measurement of technical efficiency.

The input and output sets for analyzing technical efficiencies of golden brown dried longan processing community enterprises are presented in the Table below.

Table 3.2 Variables in the estimation of technical efficiencies of GDL community enterprises

Output variable (Y)	**Input variable (X)**
Y1 = value of dried longan output (baht/oven)	X1 = value of fresh longan fruits (baht/oven) X2 = labor cost for peeling and pitting (baht/oven) X3 = quantity of fuel wood for heating energy(kg/oven) X4 = electricity cost for the drying process (baht/oven)

The dependent variable is in the left hand side of Table 3.2 while the explanatory variables are in the right hand side. There are four producers that have adopted the improved version of longan drying oven to save input cost for the existing output levels and this gives rise to another specific longan drying technology. However, the limited size and quantity of conventional-styled at present prohibit the increase in GDL outputs in the short-run. Therefore, the producers should improve the features of existing ovens to reduce the input factors in right hand side of the Table. It thus becomes logical to use input – oriented DEA method for the present study.

<u>Step 2</u> constructing a meta-frontier based on the pooled data of all producers in both conventional and improved oven technology groups for validating whether there is a statistically significant difference in technical efficiency between

the two technologies. The meta-frontier was constructed by solving the following linear programming problem:

$$Min_{\theta^*,\lambda^*} \theta^*$$

$$\text{s.t.} \quad -y_i + y^* \lambda^* \geq 0,$$
$$\theta^* x_i - x^* \lambda^* \geq 0,$$
$$N1\lambda^* \leq 1 \text{ and}$$
$$\lambda^* \geq 0\,. \qquad (3.21)$$

where

y_i = 1×1 vector of output quantities for the producer *i*

x_i = 4 ×1 vector of input quantities for the producer *i*

y_k = 1 × 48 matrix of output quantities for all the 48 producers

x_k = 4 × 48 matrix of input quantities for all the 48 producers

N1= 48 × 1 vector of 1

λ^* = 48 × 1 vector of weight given to *i* producer and

$\theta *$= scalar matrix

k = number of groups with difference technologies

Step 3 finding the meta-technology ratio (O’Donnell. , 2008) or technology gap ratio (Battese et al., 2004) from the following formula:

$$MTR^2(X,y) = \frac{\mathrm{D(x, y)}}{\mathrm{D}^2\mathrm{(x, y)}} = \frac{T(x,y)}{T^2(x,y)} = \frac{\mathrm{T(x, y)}}{\mathrm{T}^2\mathrm{(x, y)}} \qquad (3.22)$$

given $MTR^2(X,y)$ = meta-technology ratio

$T(x,y)$ = technical efficiency of producers under meta-frontier;

$T^k(x,y)$ = technical efficiency of producers in case of having k technological specific groups.

The equation (3.22) can be rearranged to find technical efficiency of an input-output combination as follows:

$$T(x,y) = T^2(x,y) \times MTR^2(x,y) \tag{3.23}$$

3.4 Data for the study

Information was collected from samples of the population in the administrative area of Tambon Makhuea Chae in Mueang District of Lamphun Province. The sample size was determined by Yamane criteria at 95 % statistically significant level to include 364 households (Table 3.3) out of the total 4,075 households in 21 villages of Tambon Makhuea Chae. Village samples were proportional to the respective village population. Then the sampled households for interview were identified by simple random sampling technique.

3.4.1 Data for economic impacts study collected from samples in 21 production sectors operating in Tambon Makhuea Chae.

1) Rice. Totally 70 rice farming households were interviewed. Their aggregate rice area was 357 rai while the annual paddy area of the whole Tambon was 3,641 rai (Lamphun Provincial Agriculture Office, 2012). Average rice yield was 500 kg/rai and the total output was valued at approximately 15 million baht. The output was primarily consumed locally and was exported to outside markets at about 4 million baht value.

2) Longan. This study covered 115 samples of longan growing households that altogether had 540 rai of harvestable longan area. Tambon Makhuea Chae as a whole had 4,772 rai of harvestable longan area with an average yield of 700 kg/rai (Lamphun Provincial Agriculture Office, 2012) and approximately 50 million baht of

output value. The harvested outputs were largely used locally as raw material for golden brown dried longan production at about 34 million baht value and the remaining fresh fruits were exported to outside markets at about 16 million baht value.

Table 3.3 Number of population and samples

Village	Number of household	Number of sample
1 Ban Makhuea Chae	211	19
2 Ban Sa Laeng	210	19
3 Ban Chaem	291	26
4 Ban San Kayom	357	32
5 Ban Mueang Guak	271	24
6 Ban Hong Gaw Muang	429	38
7 Ban San Pa Hiang	380	34
8 Ban Kiew Muen	152	14
9 Ban Pa Pao	177	16
10 Ban Nong Hoi	128	11
11 Ban Si Don Ton	208	19
12 Ban Lao	151	13
13 Ban San Pu Lei	139	12
14 Ban Pa Tueng	129	12
15 Ban Nong Hiang	127	11
16 Ban Kok Wua	67	6
17 Ban San Ton Pheung	103	9
18 Ban Mai Fai Hin	131	12
19 Ban Mai Mueang Guak	156	14
20 Ban Yi Kaw	65	6
21 Ban Hong Gaw Muang Song	193	17
Total	4,075	364

Source: Community Development Department (Community Development Department, 2006)

3) Golden brown dried longan. Covered in this study were a total 68 samples of golden brown dried longan processors, out of the Tambon’s total 248 processors that collectively had 305 drying ovens. During the survey period, 220 ovens were working, producing about 660,000 kilograms of dried fruits at approximately 160 million baht value.

4) Rice mills. Six out of the seven local rice mill operators were interviewed. The local milled rice was valued at about 12 million baht and was exported to out of Tambon markets at approximately 1.8 million baht value.

5) Food shops. Out of the 18 local noodle shops and cooked-to-order food shops, five shop operators were interviewed. These shops made about 12 million baht yearly to serve mostly the local customers.

6) Construction material stores. All four construction material stores in the Tambon were studied. Their total sale volume was in the neighborhood of 16.6 million baht mainly from selling to local buyers.

7) Suppliers of LPG for cooking. Interviewed for this study were six out of the total 16 local stores that supplied LPG for cooking in tanks to home and food shops. All LPG for cooking came from imports from out-of-Tambon sources at the cost of 3.5 million baht to make a total local sale valued at 4.14 million baht.

8) Grocery stores. Out of the total 52 grocery stores scattered in different villages of the Tambon, 11 were examined as samples. Their total sale volume was 37.1 million baht, from selling consumer products which were mainly imported from outside at the buying cost of about 22.8 million baht and selling the major locally produced products namely ice and rice they purchased from local ice making factory and rice mills at the cost of 1.8 million baht and 4.6 million baht, respectively.

9) Agro-chemical supply stores. Four out of the total six stores in the Tambon were investigated. Sold in these agro-chemical supply stores were fertilizers, pesticides, weedicides, and various farm tools and hardware. Their total business volume was 5.3 million baht from investing 3.8 million baht for importing the products from outside for local selling.

10) Garages. There were three garages altogether providing auto repair services making totally 1.6 million baht money a year.

11) Drinking water and domestic water suppliers. Investigated in this study were 8 out of the total 21 plants scattered in various villages that produced water for drinking purpose and supplied piped water for domestic consumption. The total output value was 4.1 million baht.

12) Mobile shops. Three out of the 5 mobile shops were interviewed. All the inputs for providing recharging prepaid phone card services were imported from external sources. The overall business volume was 9.7 million baht.

13) Fresh food markets. All four fresh food markets with a total business volume of 43.0 million baht in the Tambon were studied. The input costs of these markets involved primarily the imports of produce and goods from outside suppliers at 29.2 million baht value; and the purchase of rice from local rice mill agents at 1.7 million baht, the purchase of meat from slaughterhouse agents at 5.8 million baht, the labor cost for 3.0 million baht, and 3.1 million baht savings.

14) Market fairs. Market fair once a week was arranged in two locations of the Tambon. Most of the products sold at the market fairs were offered by the out-of-village merchants who altogether paid 11.9 million baht for procurement of the products and made 16.0 million baht from selling.

15) Fuel station. There was only one standard Esso gas station serving in the Tambon with the business volume of 48.6 million baht, and the input cost for the petro products supplied by the Esso company at 47.3 million baht, and the remaining balance for labor cost and savings.

16) Small fuel stations. There were six small gasoline pump stations in operation with a total business volume of 0.36 million baht.

17) Slaughterhouse. There was one legal slaughterhouse in the Tambon with 10.8 million baht meat sale from slaughtering cattle and buffalos imported mainly from Mae Sod District of Tak Province at 8.3 million baht cost.

18) Teak furniture. There were 10 teakwood furniture manufacturers in the Tambon which worked with 33 small local furniture makers, making a total output value of 32.1 million baht. Most of the raw materials were the wood boards from old teak houses brought from other areas at 18.6 million baht cost. This economic activity generated as high as 6.0 million baht household labor employment and 0.9 million baht of off-farm income for farming households.

19) Teak lamps. The study covered 24 teak wood lamp manufactures within the Tambon which worked with 63 small scaled teak wood lamp makers, getting the total output value of 45.2 million baht. Similarly, the wood materials came from the old teak houses brought from other areas at 24.4 million baht cost. This production sector contributed to 11.4 million baht value of household labor employment.

20) Traditional medicines. There were three manufacturers and distributors of traditional herbal medicines with the total output value of 6.2 million baht. Most raw materials were purchased from Waroros Market in Chiang Mai City at 5.3 million baht cost. The export of the traditional medicines to out-of- village markets amounted to 3.4 million baht.

21) Ice making. There was one ice making plant making a 6.2 million baht business volume, out of which 2.2 million baht was from ice export to other places. Most laborers working in this plant were not local villagers.

Five factors of production accounts, recorded the inputs used in various production sectors from the surveys of 21 production sectors and 364 sampled households, are for:

22) rent and use of land, commercial buildings, etc.

23) household labor

24) farm labor (daily)

25) off-farm labor (daily)

26) off-farm labor (montly)

Four institutions include:

27) Savings group, cooperative, and community enterprise network. Ten out of the 20 organizations were studied.

28) Funeral welfare group. Twelve out of the 21 organizations were studied.

29) Temple. Eight out of the 17 temples in the Tambon were studied.

30) School. All but one of the 8 schools were examined.

Local government is represented by:

31) Municipality Office. Records and information concerning the operation of Tambon Makhuea Chae Municipality Office were examined.

Private investment sector is represented by:

32) Investment. The amount of investments by all production sectors.

Household sector covers 364 sampled households which are categorized into three sub groups:

33) eleven poor households (Community Development Department, 2006) with annual income less than 23,000 baht;

34) totally 254 medium income households with 23,000 – 100,000 baht annual income;

35) totally 99 high income households with annual income more than 100,000 baht.

3.4.2 Data for environmental impacts study

This study used input-oriented approach as some, or precisely four, GDL processors had attempted to reduce inputs while keeping the previous levels of output by switching to use improved version of drying oven which is regarded as a new technology. Thus a meta-frontier function was constructed by pooling the input and output sets of both groups of processors that used different drying technologies. Then the two groups were compared in terms of technical efficiency to prove whether there existed the statistically significant difference between technologies. The meta-frontier function based on DEA technique was estimated for performance comparison and environmental impacts study using the field surveyed data from both technologically specific groups. Specifically, field data were collected from 48 samples of GDL processors identified by simple random sampling technique in the purposively selected area which is Tambon Makhuea Chae in Mueang District of Lamphun Province where dried longan processing activities are the most prevalent of all areas. The total 48 samples of GDL processors can be further distinguished into those 44 in the conventional technology group and the remaining 4 in the new technology group.

The studied variables on the input side are:

1) Input 1 – value of fresh longan (baht/oven);

2) Input 2 – labor cost for peeling and pitting longan fruits (baht/oven);

3) Input 3 – fuel wood volume for longan drying (kg/oven)

4) Input 4 – electricity cost for longan drying (baht/oven).

The output variable for the analysis is:

1) output – value of dried longan (baht/oven).

Some fundamental production factors such as oven size, fuel wood moisture, and the labor for attending the stove and drying process were omitted from the present study as explanatory variables of technical efficiency for the reason of data homogeneity. It was found from the primary survey that all ovens have the same size and dimension namely 4.0 x 2.5 x 3.0 meter, one worker is required for attending the stove and drying process, completely dried fuel wood is used for heating energy as all processors will buy the fuel wood at least six months prior to the longan drying season.