CHAPTER II RESEARCH METHODOLOGY

II.1 Model Formulation

II.1.1 General model

The model used in this study is multi-objective and multi-period in nature. Optimal farm plans are to maximize net income and minimize soil erosion while it must meet consumption needs in different periods during the planning horizon.

The approach suggested by Mendoza et al. (1986), El-Shishny (1988), Wojtkowski et al. (1988), and also an example given by Shakya and Leuschner (1990) was that multiple objective model could be handled through Multiple Objective Programming (MOP). This approach allows one to include maximization and minimization of competitive and complementary goals. It requires an assigned weight for each goal which is subjected to the preference of decision makers. An alternative approach to handle multiple goals model is to select one objective and treat the remaining goals as constraints. A limitation of this approach is that the goals in the constraint set must be rigidly enforced, if they can not be met then the problem is not feasible (Hazel and Norton, 1986). To achieve optimal plans including these remaining goals, one can evaluate their impacts via sensitivity analysis which also resolves the problem of rigidity due to enforcement of the goals as constraints.

Since the farmers in this village grow perennial crops and to make plans more realistic, a Multi-period Linear Programming (MLP) was used for solving optimum plans for series of time (years). According to Rajino (1987), the economic life of coffee tree is 35-40 years and the one of tea can be more than 50 years under management of big commercial estate. In this study, the length of the planning horizon is 20 years although the model can be expanded to include as many as necessary. This length of period is enough since it is larger than the longest gestation periods of perennial crops. Further time would have furnished only redundant information which can be calculated from the solutions, and once perennial crops are planted, the plan is self perpetuating. The total period will be divided into a yearly interval. This allows net income and saving generated in one year to be invested in the following year. On the other hand, consumption can be modelled to differ from one to the other period depending on levels of income and family size.

II.1.2 The objective function

To keep the model at manageable size for a given time limit and assuming that the farmers are risk neutral, this study employed a Multi-period Linear Programming for a single objective, that is to maximize the net present value of income, with discounted factor at 8 percent, subject to resource constraints and consumption demand. This level of discounted factor is based on the average long term deposit rate.

II.1.3 Activities

Activities which are included in the model can be divided into six categories and these contributed positive, negative and zero gross income to the objective function. It is assumed that product prices, rice and corn yield, and wage rate are constant over the planning horizon.

II.1.3.1 Crop activities

There are five crop activities (coffee, tea, lychee, rice and corn). The average gross income per rai as well as labor use per rai for each crop are used as coefficients in the model.

As mentioned earlier that soil conservation is an important implicit goal embodied in for permanent farming systems in the highlands, two methods of soil conservation as practiced by farmers were included in each crop activity in the model. These practices utilize mainly labor resource. The average labor used to build terrace and contour grass strip are 19.62 per rai for perennial crops and 1.96 mandays per rai for field crops (rice and corn).

II.1.3.2 Wage labor activity

Cha Siam Tea Estate (CSTE) and Raming Tea Plantation (RTP) provide labor opportunities to the villagers with wage rate at 60 baht/manday (1 womanday labor is equivalent to 0.8 manday). This model allows farmer to be employed by these two companies.

II.1.3.3 Labor hiring activity

In reality, some farmers hired laborers during the peak season (April- May) when family labor is not enough to carry on farm activities.

II.1.3.4 Capital borrowing activity (credit)

In this model farmer is allowed to borrow capital to meet farm operating costs. According to an officer from the Bank of Agriculture and Cooperatives (BAAC), farmers in this area can borrow collectively money from BAAC through cooperative or social-economic organization at the village since farmers in this area are small farmers who borrow money in small quantity.

Capital borrowed has to be paid back within five years. The farmers have to pay interest during the first three years period. After that, they have to repay credit and interest during the second period (the last two years) when they can earn income from their coffee and tea. The interest rate is 14.5 percent per annum (medium term loan).

II.1.3.5 Capital transfer activity

The cash surplus which is the difference between (a) total net cash income of previous year and (b) fixed cost and household withdrawals on expenditure of the previous year, is automatically transferred to the following year in the programming operation by including household expenditure and transfer of capital between the year.

II.1.3.6 Household expenditure activity

It is assumed that the farmers seek to maximize the profit from their farming systems. Although they may not explicitly state such objective, observation suggested that they wanted to have high income from selling their produce. They usually pursue profit maximization after they can meet their consumption needs which depend on income and family size.

II.1.4 Constraints

The objective function defined in the preceding subsection is to be maximized subject to some constraints. The constraints (resource limitations) used in the model are specified as follows :

II.1.4.1 Land constraint

Land is the major production constraint considering that it is an important resource for the farmers in the northern highlands and most of the farmers have limited land.

In the study area, farmers do not rent (in or out) their land, they cultivate their own land, so additional land rental is not included in this model. Land is treated as homogeneous resource in terms of fertility, water supply, and suitability for perennial or field crops. The amount of land owned by each group of farmers is to be the land constraint for the respective group.

II.1.4.2 Labor constraint

Family labor is subdivided into male, female and children. The estimation of average family labor availability every year is based on the following assumptions:

1. That most of the children up to 14 years old do not work in family farm because they attain school, so they are not included as source of family labor until 14 years old.
2. That the children will be married and separated from their parents after 20 years old for the daughters and 25 years old for the sons.
3. That the total working days is 250 days in a year after deducting by the amount of time used for religion, social and communal activities.
4. Total labor availability is calculated base on the growth age of family members every year.

In this model, labor constraint is divided in two categories according to the actual labor utilization.

Firstly, labor constraint for farm activities during peak season April-May period. Secondly, labor constraint for wage labor and farm activities which is the off season labor availability.

The estimation of family labor availability results which were used as the labor constraints for each group in the model are presented in Appendices 1 and 2 for labor availability during peak season and off season, respectively.

II.1.4.3 Family expenditure

The Model developed by Sriboonchitta (1988) was employed to estimate family's expenditure. The expenditure includes food basic needs, cloth, medical treatment and ceremony expenses. The basic needs can be written explicitly as follows :

$$BNS = a + b\ FS + c\ ADEQ \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where :

BNS = basic needs (baht)/family
FS = family size (person)/family
ADEQ = total adult equivalent/family
a = the average of ceremony expense/family
b = the average of medical treatment/person
c = Food basic need and cloth expenses/adult

The food basic needs per family expense depends on the number of adults equivalent per family which is calculated by weighing family members according to age and sex (Table 2).

Table 2. Adult equivalent index for weighing family members related to food consumption

Age	Male	Female
> 6	0.17	0.18
6 - 10	0.35	0.40
11 - 15	0.68	0.60
16 - 20	0.98	0.70
21 - 60	1.00	0.90
< 60	0.43	0.25

Source : Wiroonsri (1988).

Food basic needs for adult can be based on human body needs as follows :

1. 330 g/day or 120.45 kg/year of carbohydrate (rice)
2. 73.3 g/day or 26.755 kg/year of fat (vegetable)
3. 55 g/day or 20.075 kg/year of protein (pork meat, chicken, salted and canned fish).

Actually, the expenditure of villagers also depends on family income, but if the family does not have any income, the expenditure is just the expense on the basic needs. The expenditure can be written as:

$$EXP = a + b\,FS + c\,ADEQ + d\,INC \qquad \text{........} \qquad (2)$$

EXP = total family expenditure (baht)
INC = family gross income (baht)
d = marginal propensity to consume (parameter)

By restricting parameters a, b and c, parameter d can be obtained by running the regression using least squares method.

II.2 Data Collection And Processing

Based on the objectives and model of this research, it requires the data for a series of years during planning horizon (20 years). Since these data were not available, cross-sectional data were used in this research. There were two activities in the process of data collection :

1. The Rapid Rural Appraisal (RRA) which was conducted in March and July 1990. The main purpose of this survey was to collect data about the general information and identify problems of Huai Tadd village by interviewing those concerned to this scheme such as officers from TA-HASDP, RTP, CSTE and Mae Teang District.
2. The field survey with structured questionnaire was conducted in February-March 1991. All the farmers in the village (66) were divided according to their types of permanent farming systems and interviewed. This survey covered 12 months of the following data during 1990-1991:

1. General information
   - household details (composition, age, occupation)
   - land holding and utilization
   - water resource utilization

2. Crop production activities (coffee, tea, lychee, rice and corn)
3. Other source of income
4. Credit and saving
5. Household expenditure (basic needs and other expenditure)
6. Problems and potential expansion
7. Social and economic activities

All production, input costs and labor utilization (the peak and off- season) data for each crop per rai were classified according to ages of each crop. Gross income for each crop per rai was calculated by multiplying production per rai with it's price and subtracting it from the input costs. These values were used as gross income coefficient of each crop activity. Labor wage rate at 60.00 baht/manday was used as coefficients of wage labor and labor hiring activities which contributing positive and negative to the total gross income, respectively.

To derive values of labor (during and off- season) and basic need constraints, farmers were grouped based on land size and then, the calculation of these constraints could be done according to each group.

After all coefficients were calculated, Lotus 123 Package is used to build the matrix of Multi-period Linear Programming. When the matrix had been constructed, the Equation Program of SARA (Spreadsheet Assisted Resource

Analysis) Package is utilized to transform and translate the detached coefficients in the worksheet into linear equations (Scott, 1991). To complete the model, additional constraint equations and objective function were added to the equation file through DOS Copy Command. Then, the model is ready for solution by LINDO (Linear INteractive and Discrete Optimizer) Package (Schrage, 1991). The results were summarized by Report and Table Programs of SARA Package.