CHAPTER II

METHODOLOGY

2.1 Scope of the study

This study has mainly focussed on long term planning of hill farming systems taking into considerations of household resources and constraints. Since planning of perennial tree crop is complicated and dynamic because of time dimension involved in production, heterogeneity in resource use and intertemporal profit maximization, it includes the study of only one type of citrus fruits that is mandarin orange.

Considering the size, complexity and planning horizon of the multiperiod model, the study includes risk neutrality condition. However, the risk averse behaviors of the farmers will be accounted through sensitivity analysis by taking higher discount and interest rate, lower output and price rate. In addition to this, by maximizing net cash income under the conditions of satisfying household subsistence requirements from crops grown a major aspect of risk reduction will be accounted for (Emana and Storck, 1992). In order to capture the economic life of citrus fruit and to make multiperiod plan more realistic the planning horizon has been assumed to be twenty years in which, total period is divided into period of yearly intervals.

2.2. Data collection

2.2.1 Informal Survey

Reconnaissance field visit was conducted to appraise different sites and select the appropriate study sites for this study. Rapid Rural and Participatory Rural Appraisal was the main tool for the informal survey followed in understanding farming systems, indigenous practices, biophysical and socioeconomic circumstances, available resources, problems and general situation of the study areas. Matrix ranking (PRA) was done in the study site to know the preference of farm households for different enterprises and their potentiality in the existing systems.

2.2.2 Formal Survey

The information from informal survey was employed to proceed for formal survey. The field survey methodology consisted of a household survey and pretested questionnaire interview of the head of the households. The study was conducted in the relatively accessible but suitable areas for growing citrus fruits in two study sites of Kavre district, central mid hill region, Nepal. The two study sites were, Patlekhet and Sankhu village development councils (VDC's) of Kavre district. These area were selected because of the following reasons. 1) The study site I (Patlekhet), represents the true mid hill region of Nepal in respect of altitude, topography and climatic setting where soil fertility deterioration and erosion problems are most common. The study site II (Sankhu), also is true to many mid- hill region but is different in terms of farming systems where citrus fruit particularly mandarin orange has been successfully integrated by the farmers into their existing crop based systems. 2) These areas are relatively accessible by roads and markets, therefore, they have potentiality for expanding citrus production in the future. 3) The limited time of the study period and budget constraints did not allow researcher to take up field survey in the more potential yet successfully areas of other mid hill region.

Survey of the randomly sampled (n= 125) households from two village development councils: Sankhu and Patlekhet was conducted with the assistance from local resource persons in each study site. The field survey was combined and verified with participant observation and group discussion with local key informants and sampled households.

Finally, the size of sample remained 123 after omitting two incomplete samples from patlekhet site. The secondary source of bio-physical and socioeconomic data were combined with participatory field observation and field questionnaire survey in analyzing and describing different components of farming systems.

2.3 Method of Data Analysis

2.3.1. Descriptive Statistics

Descriptive statistics have been used to analyze resource base and describing farming systems of the study areas and also to assess the major constraints to integrating citrus into the existing hill farming systems.

2.3.2. Classification of Sampled farm households

In this study farm planning over time, policy and resource supply analysis have been done by classifying sampled farmers into four different homogenous groups based on the farm size: group I (marginal), group II (small), group III (medium) and group IV (large). There fore, input-output coefficients and resource endowments of each group were estimated differently for each group.

Table 3 Classification of sampled farms into different farm sizes

Groups	Farm Size Range (hectare)	No of farms		Average farm size(ha.)	
		Patlekhet	Sankhu	Patlekhet	Sankhu
I	0.05-<0.5	13	11	0.308	0.331
II	0.50-<1.0	23	21	0.860	0.778
III	1.00-<2.0	17	18	1.330	1.336
IV	> 2.00	10	10	2.054	2.304
		(N = 63)	(N = 60)		

2.4 Model Formulation

The basic analytical technique used in the planning process of this study is a farm level multiperiod linear programming model (MLP), which is expressed mathematically in the following form (Rae, 1987).

$$\text{Max. } P = \sum_{i=1}^{m} GM_{j1}\, Y_{j1} + \sum_{i=1}^{m} GM_{j2}\, Y_{j2} + \ldots + \ldots \sum_{i=1}^{m} GM_{jT}\, Y_{jT} \quad \ldots\ldots(1)$$

Subject to,

$$\sum_{i=1}^{m} A_{ij1}\, Y_{j1} \leq X_{i1}, \quad i = K+1, k+2, \ldots n$$

$$\sum_{i=1}^{m} A_{ij2}\, Y_{j1} + \sum_{i=1}^{m} A_{ij2}\, Y_{j2} \; . \quad \leq X_{i2}$$

$$\vdots$$

$$\sum_{i=1}^{m} A_{ijT}\, Y_{j1} + \sum_{i=1}^{m} A_{ijT}\, Y_{j2} + \ldots + \sum_{i=1}^{m} A_{ijT}\, Y_{jT} \leq X_{iT}$$

$$Y_{jT} \geq 0, \; j = 1, 2, ..'m;$$

$$t = 1, 2, .., T.$$

Where,

P = present net value (PNV) of total gross margin,

Y_{jT} = level at which activity Y_j is initiated in year t;

GM_{jT} = the gross margin (present net value) per unit of activity Y_j initiated in period t:

X_{iT} = supply of the resources i, in period t; and

A_{ijT} = per unit requirement of activity Y_j for resource X_i in period t.

During the initial time period (t=1) resources will be required by activities initiated at that time; during the second time period (t=2), resources might be allocated amongst the activities in the second period time plus those already initiated during the first time period, and so until the real time period (t=T) is reached , when period T resources might be required by activities initiated at that time plus all previously initiated activities.

The main objective of the model is to maximize present value of future income (gross margin) subject to resource constraints and consumption requirements. Any LP model is basically composed of three components: an objective function, activities and constraint sets. The model has been formulated for a planning horizon of twenty years with yearly interval as periods to incorporate dynamic, complex and semi-subsistence nature of hill farming systems by taking into consideration of economic life span of orange trees. Therefore, in this case, while formulating models, resource supplies, activities and input-output coefficients are dated and built based on the growth and productivity of orange in different years.

Activities and constraints are included in each period for all the relevant decisions and many of these, particularly the activities of annual crops have been duplicated from one period to the next. On the other hand consumption is modelled to differ from one to other period depending on the levels of income and family size. Models have been applied for four representative farms constructed by farm size.

Appraisal of the existing systems were done based on how resources are being utilized and what are the incomes obtained from various enterprises adopted by different size of the farms. With in the frame work of the resource restrictions and keeping in view of the weaknesses of the existing systems and possibilities of incorporating new technologies, alternative farm plans have been developed based on long term farm income and consumption demand of the households.

Sensitivity analysis has been done to examine the suitability of the optimal farm plan with citrus integration when economic and other conditions changed. This post-optimality analysis has covered the effect of various changes in output prices, wage rate, credit interest rate and discount factor of net present value of income to the optimum plan and production level.

There are four major factors considered in the formulation of MLP model for the economic evaluation of hill farm systems (Figure 1).

1. Human factors: Farmers' goals of maximizing of farm income after satisfying their minimum consumption requirements.
2. Resource factors: The availability of labor (peak and off-season), land and capital constraints are considered in this factors.
3. Technological factors: The yields of crop output and activities, labor

and non labor inputs (seeds and fertilizers etc.) are included in this factors.

3. Market factors: Input and output prices, and hired human labor and bullock labor wages are included in this category.

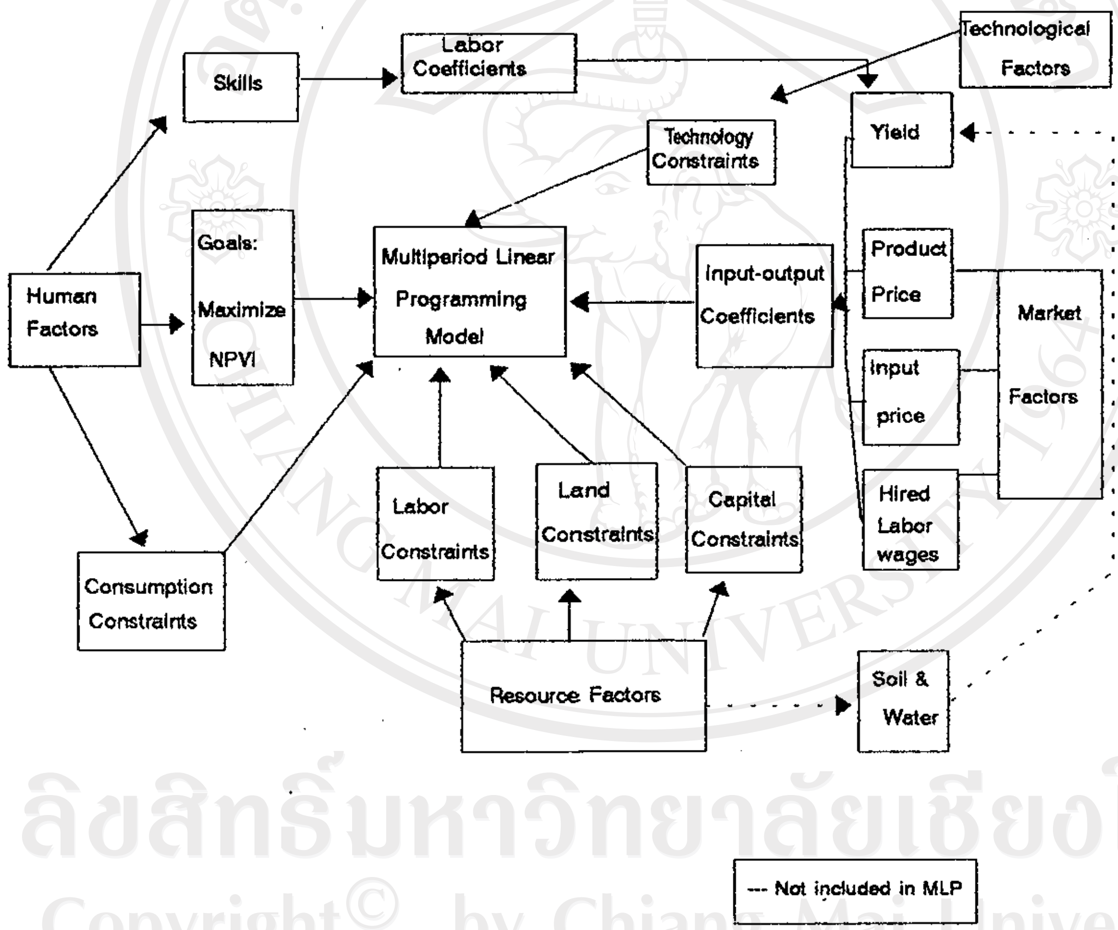

Figure 1. Framework for Multiperiod Linear Programming (MLP) Model for Nepalese Hill Farms

2.4.1 Objective Function

The main objective of the model is to maximize net present value of gross margin or income (NPVI) subject to land, labor, credit constraints through improved resource use planning after fulfilling their basic consumption requirements. This is a reasonable assumption since in a semi-subsistence economy such as the case of middle hills of Nepal, the primary objective of the small farm households is often to allocate resources to provide basic consumption requirements. The cash surplus or resources which is left over after meeting household consumption and expenditure requirements, are only then invested or used to generate cash income as higher net income provides them the means of satisfying many of their wants. In the other words, basically this model is a multiobjective and multiperiod programming model in the sense that one goal that is present value of future income is maximized and the remaining goal (basic consumption requirement) is specified as inequality constraint (Hazel and Norton, 1986).

2.4.2 Decision Variables

There are ten basic decision variables each representing different alternative annual crops and perennial fruit tree (citrus) production, and other farm and off-farm related activities.

2.4.2.1 Production Activities

The production activities include alternative annual and perennial crops activities such as rice, wheat, maize, mustard and orange which are mainly grown in the study sites. The average gross margins, cash used and labor use per each activity for a given land unit are used as the coefficients in the model. The following crop production activities are included in the MLP algorithm.

a. Rice production activity b. Wheat production activity c. Maize production activity d. Mustard production activity e. Mandarin orange production activity.

2.4.2.2 Off-farm Activities

All activities performed by farm households outside the traditional agricultural activities are included in the off-farm (labor wage) activities. The off-farm activities which are mentioned in this study include both farm wage labor and non farm activities. Since, farmers in the study areas work in different sorts of wage labor, and off-farm activities, the provision has been made in the model for the farmers to go for off-farm activities. The average labor wage coefficients of off-farm activities like farm labor, portering (milk and other goods), skilled labor (carpentry, construction worker) and other side line activities were included in the construction of MLP algorithm .

2.4.2.3 Labor Hiring Activities

Farmers, in the study areas hire labor during peak season of farming (June, July, and middle of November to middle of December). Hired labor for both male and female are available during peak seasons when family labor is not enough to carry out field operations. The coefficient for labor hiring activity is used in the matrix from prevailing market wage rate of the study areas.

2.4.2.4 Capital Transfer Activities

The cash surplus which is difference between (a)total net cash income of the previous year and (b)fixed costs and household withdrawals on consumption 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. The activity produced in the k<u>th</u> year has a positive coefficients in the capital equation for year k, but has a negative coefficients in the capital equations for the k+1. However, in the first year of the investment, cash transfer row is negative assuming farmers have zero saving as the return from the existing crop based systems in the study areas do not provide enough income to save for future investment.

2.4.2.5 Capital Borrowing Activity (credit)

Since farmers own fund is not sufficient for investing and meeting farm operating costs in citrus fruits, credit borrowing provision is made in the model. According to discussion with the personnel from agricultural development bank (ADB/Nepal) and fruit growing farmers in the area, farmers can borrow money for their fruit cultivation and meeting other farm expenditure. Capital borrowed has to be paid within 10 years with the interest rate of 16% for fruit trees. The farmers have to pay only interest during the first five years period and repay principles and interest during the second five year period when they can get return from citrus fruits.

2.4.2.6 Household Consumption and Expenditure Activity

Survey of farm households reveals that majority of the farmers grow crops to satisfy their household consumption and expenditure requirements. After meeting the subsistence consumption requirements only farmer go for such activities which maximizes their net income. Therefore, provision has been made in the MLP algorithm to include the basic consumption (food, cloth, medicine and ceremony) requirement and expenditure which depends on household income and growth of family size. The details of this activity is elaborated in 2.4.3.3 .

2.4.3 Resource Constraints

2.4.3.1 Land Constraints

Land in this study is treated as homogenous resources in terms of fertility, water supply, and suitability for fruit trees and field crops. Additional land rental (in or out) is not allowed as it is not a common practice in the study area. Maximum availability of land in each period is limited to average amount of land owned by the different groups of farmers respectively.

2.4.3.2 Family Labor

Numbers of family agricultural laborers available per man-day per year for both peak and off-season have been used to represent labor availability coefficients. Children above 15 years old and 1.25 women days are considered equivalent to one male adult. Labor taken on exchange basis has been considered as family labor since farm family do not spend cash or kind for this labor. While calculating the supply of family labor 8 hours of day is considered as one man day.

The estimation of family labor availability over planning period is based on the average growth age of family members and the growth rate of population per year over the past years. Labor restriction was imposed both for the peak and off-season of the farming.

2.4.3.3 Capital Constraints

Farm operating costs are specifically used as capital in this model. Cash saving transferred from the previous year has been considered as the sources of capital. But the once cash saving was zero or insufficient then the model was designed to borrow capital to cover the farm operating costs. The capital coefficients in mandarin orange become negative until 5th year as it does not furnish capital surplus until this time.

2.4.3.4 Consumption Constraints

Average farmers in the study areas have some monetary objective and some subsistence objectives and therefore production and consumption decisions are interrelated. Consumption expenditure is modelled differently for different group of farmers based on the income and growth of household size over the planning horizon. The household consumption and expenditure includes expenditure on food basic needs, cloth, education, medical treatment and ceremony expenses.

$C = \alpha + \beta Y$

C = total consumption expenditure/family

Y = family gross income

α = the average of basic needs consumption expense /family

β = marginal propensity to consume

Econometric methods namely ordinary least square (OLS) is used to solve the above model and linear restriction is imposed to the constant term α, in the above equation by using average of basic need consumption which is estimated through survey and minimum calorie requirements for an adult per annum. Therefore, the basic need consumption is a predetermined variable in the model. The standard percapita minimum requirement of calorie for an adult in the hills of Nepal has been estimated to be 2250 k cal per day (EAD, 1984).

2.4.4 Programming Softwares for Data Analysis

Since the model size of multiperiod programming was very large, it was impossible to write and run directly in LP softwares. Therefore, firstly, Quattro Pro3 was utilized to build the matrix and then the Equation program of SARA (Spread sheet Assisted Resource Analysis) was utilized to transform and translate the detached input-output coefficients matrix in the worksheet into linear equation (Scott, 1991). Similarly, the constraints and objective function equations are constructed in Dos Editor program and combined to the equation file through DOS Copy command. Finally, this full combined model file is run in HYPER LINDO (Linear Interactive and Discrete Optimizer) package (Scharge, 1991). The final output solutions are summarized by Report and Table sub program of SARA program.