CHAPTER 3

MATERIALS AND METHODS

This study comprised of two different sets of work: one,system understanding and analysis of agricultural practices in Chitawon, Nepal and the other, field experiment in Chiang Mai, Thailand.

3.1 Field study : determination of farming systems

Terai region of Nepal is one of the most populated and productive to perform agricultural activities. The inner *terai* range, which covers a narrow valley of productive and fertile area consists of millions of people involved in farming. Chitawon, an inner *terai* district, is one of the such districts which has a good interactions between crop and livestock component as a practice of farming system to sustain the agricultural activities.

In the given circumstances, the objectives of this study were two folds.

a. To learn about farming systems with respect to various relationship among different households, off-farm activities and their interactions with livestock, and

b. To evaluate the feasibility of introduction of lablab bean (*lablab purpureus* (L.) Sweet) in terms of adoption, labor requirements and other economic aspects, as an intercrop component with maize.

Lanku and Tandi, two distinct sites of Chitawon district of Nepal were taken for this case study. Lanku site represents the rainfed upland condition, while major portion of Tandi site covers irrigated low land farming system with a strong support of livestock components in the both areas.

Several visits were made in villages in order to built rapport with the farmers. To understand the agricultural systems, various interactions were made by discussing with farmers, extension workers and officials. This type of work enabled to be familiar with the situations and define working boundary.

To know the exact situation of farmers and to enumerate various problems related to farming, intensive field visit were made. It helped to draw relationship of activities among households, and functional component in the area. Besides this, six key informants from each site were selected representing low, medium and big size land holding having upland and wet land cultivation practices with livestock as an integral parts of the agricultural systems in the both sites. They were informally interviewed to know about problems/ constraints general practices, and to overview the farming access and tendencies.

Apart from this, in order to represent the situation of whole site, three groups of people i.e., rich, medium and poor (each group having at least 2 people) were categorized on the basis of land holdings through participatory approach. With the involvement of those people in groups, Participatory Rural Appraisals (PRA) was conducted in three different area in each site to understand their labor profile, trends of rainfall, cropping patterns etc. People were encouraged to discuss themselves and come to the agreement about average monthly working days, crops grown in patterns for the whole year etc. in the area. Results were confirmed later on again by discussing in group. Fodder trees and grasses were ranked to know the fodder status and interactive reactions of crop and livestock.

Feasibility for the production of lablab bean as an intercrop component of maize was discussed in same group with references to labor needs, appropriateness, possible benefits and constraints into the system. PRA was conducted with the help of agronomist, economist, social scientist and livestock specialists representing different disciplines from IAAS, Rampur campus Chitawon Nepal.

3.2 Intercropping maize and lablab

3.2.1 Field experiment

The experiment was located at the University of Chiang Mai field station, approximately 10 Km from Chiang Mai (18.48°N, 98.59°E), on a sandy loam

(San Sai series) of pH 6.35. Total N in top 20 cm was 0.17 ppm. Similarly, soil was characterized by 0.5 % OM, 83 ppm available P, and 53 ppm exchangeable K at the time of sowing. The climate of Chiang Mai is characterized by definite wet and dry season. The wet season lasts from May to October; daily mean temperatures are 24 - 29°C and precipitation averages 1,004.5 mm (Table 1).

Table 1. Meteorological data of the study period on the experimental station, Chiang Mai, Thailand

Month	Tmax (°C)	Tmin (°C)	Tmean (°C)	Rainfall (mm)	Sunshine (h/day)
May	37.6	23.9	29.8	23.6	8.0
June	34.7	24.3	28.8	146.6	4.0
July	31.8	23.2	26.9	343.6	2.1
August	32.2	23.3	27.1	139.0	4.3
September	32.4	22.7	26.8	243.7	4.8
October	29.7	20.9	24.6	107.0	4.6
November	29.2	17.3	22.4	11.5	6.8

Source: Resources and Environmental management, Soil Science Department, Faculty of Agriculture, Chiang Mai University, Thailand.

The additive series design (Singh and Gilliver, 1988) was used to quantify the effects of lablab competition on maize. A total of eleven treatments {under two cropping systems i.e, mono lablab (L) and intercropped of maize and lablab (ML) ; each having two cutting days 40 (C40) and 60 (C60) days after sowing (DAS); two level of cutting height 30 cm (S30) and 20 cm (S20) from the base, along with mono (LC0) and intercropped lablab without cutting (MLC0) and monoculture maize (M)} were arranged in RCBD factorial combinations, with four replicates. The eleven treatments are listed in Table (2).

Seeds of maize (cv. Suwan 1) were sown at 3-5 seeds per hill and the seedling were thinned to one plant/hill one week after emergence. The hill was spaced at 75 X 25 cm (53,333 hills/ha).

Table 2. Combinations of the treatments used in the experiment

Designation	Cropping systems
M	Mono Maize
LC0	Mono Lablab without cutting
MLC0	Intercropped lablab without cutting
LC40, S30	Cutting 40 days of maize sowing at 30 cm height, mono lablab
LC40, S20	Cutting 40 days of maize sowing at 20 cm height, mono Lablab
LC60, S30	Cutting 60 days of maize sowing at 30 cm height, mono Lablab
LC60, S20	Cutting 60 days of maize sowing at 20 cm height, mono Lablab
MLC40, S30	Cutting 40 days of maize sowing at 30 cm height, I. lablab
MLC40, S20	Cutting 40 days of maize sowing at 20 cm height, I. lablab
MLC60, S30	Cutting 60 days of maize sowing at 30 cm height, I. lablab
MLC60, S20	Cutting 60 days of maize sowing at 20 cm height, I. lablab

The lablab (local unnamed cv.) in monocrop was sown at the same spacing and seed rate as the maize. In the intercrop plots, one row of (25 cm. between hill) lablab was sown in between every other row of maize bringing the total intercrop plant density to 80,000 hills/ ha. Each plot was measured 9.0 X 3.5 m^2. Thinning single plant to per hill was done two weeks after sowing.

Seeds were treated with appropriate fungicides for both species and soil from the rhizobium inoculum were mixed before sowing with lablab. A minimum level of fertilization was done. 25:0:30 Kg.NPK/ha as a basal dose was followed by 25:30:0 Kg NPK/ha as side dressing one month after sowing. Irrigation was given at a minimum level. Hand weeding was done once after one month of sowing and insect/ disease control were done whenever necessary. In order to evaluate the shading effect of lablab as well as productivity of the intercropping system, cutting treatments were set to be done once earlier (40 DAS) and the other at latter stage (60 DAS) visualizing the probable competitive effect of lablab with maize in uptaking soil nutrients.

3.2.2 Sampling procedure and data collection

Sampling was done from early vegetative growth (V7) in lablab corresponding to knee height stage in maize (30 DAS). Subsequent sampling were done in V12, V26 and V36 stages of lablab corresponding to 40, 60 and 100 DAS in maize respectively. Final sampling of lablab was done at V48 stage (130 DAS).

Plant height, Leaf Area Index (LAI), green and dry matter accumulation of maize and lablab in both mono and intercrop were determined on the basis of randomly selected 8 plants on each plot each sample date. LAI was measured on the basis of leaf area of the plants over an unit area. However, plants might have utilized the more space due to profound spreading in nature. Therefore, LAI could be somehow over estimated in lablab. At maturity of maize (100 days after sowing) 16 randomly selected plants were harvested to estimate grain yield of maize in both mono and intercrops. Harvested grains were sun dried. Moisture content of the seeds was determined with a Infra Red Lamp moisture meter, i.e., YEASTEN moisture meter model YL-1. Grain yields were adjusted to 14% moisture. Yield components of maize, calculated at harvest were prolificacy (ear per plant, number of kernels per cob and thousand grains weight).

Both grains, dry and green matter yields were expressed in Mg ha^{-1}. The yields were calculated per hectare and relative to respective monoculture yield. Plants used for dry and green matter estimation of lablab at each sampling were also used to measure total plant nitrogen by Kjeldal method. Dry samples were chopped and ground using the willey Mill No. 3 passing through 1 mm screen, then thoroughly mixed for sub-sampling analysis of nitrogen. Nitrogen content of the plant were later converted into per cent cruide protein (CP) by multiplying with a conversion factor of 6.25.

Root-bleeding sap of lablab was collected from the root stumps of same plants (8) using a pasteur pipette (Peoples *et al.*, 1989) from each replicated plots at each sampling. Which was immediately placed on ice for later analysis. At each sampling time, the root system of plants used in sap bleeding collection were dug from within each sampling area and washed. The number of nodules per plant was noted. Sampling was done at 10 am to 4 pm.

3.2.3 Chemical analysis and determination of N fixation

Sap nitrogen compound concentrations were determined: Ureides were estimated colorimetrically as the phenylhydrazine derivative of glyoxalate; amino-N by ninhydrin method and nitrates by salicylic acid method (Peoples *et al.*, 1989).

The relative abundance of ureide-N sap (RU %) was calculated as:

Relative ureide-N = 4a / (4a+b+c) * 100

Where, a, b, and c are the molar concentrations of ureide (one ureide molecule contains 4 nitrogen atoms), amino-N and nitrate-N respectively (Peoples *et al.*, 1989). P fix calculation was based from screen house calibration conducted by Rerkasem and Rerkasem (1989). Where,

P fix (%) = 1.68 (RU - 10)

for plants in vegetative stage. Where, RU denotes per cent relative abundance of ureide nitrogen in root bleeding sap (Peoples and Herridge, 1990). The same P fix computation was used for all stage of sampling considering the indeterminate characteristics of lablab. The process of estimating nitrogen fixation is shown in figure 1.

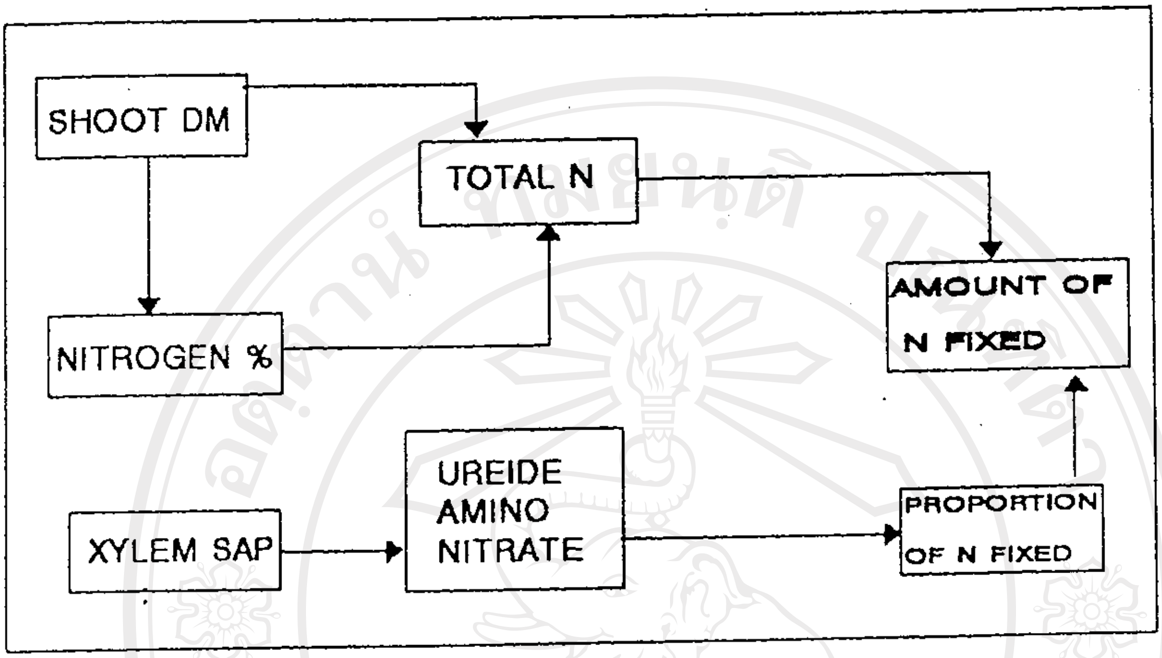

Figure 1. Flow chart on the process of estimating nitrogen fixation (Wang, 1990)

3.3 Statistical analysis

All data collected were analyzed statistically. The analysis of variance (ANOVA) was done in order to compare the various treatments. Yield of maize was compared among various treatments. Besides, dry matter yield advantage was calculated using the Land equivalent ratio (LER). LER was used to compare DM yield among the treatments harvested at the same time.

$$LER = \frac{Yi1}{Ym1} + \frac{Yi2}{Ym2}$$

Where, m1 and m2 are sole crops and

i1 and i2 are intercropped, Y is the yield per unit area.

LER value greater than 1 are considered advantageous (Heibsch and McCollum, 1987).

Similarly, ATER was also used to compare DM as well as protein yield advantage among the treatments having final harvest at different time.

$$ATER = (Liti + Ljtj)/T$$

Where, Li and Lj are relative yields or partial LERs of component crops i and j, ti and tj are the durations (days) for crops i and j and T is the duration (days) of the whole intercrop system. ATER value greater than 1 are considered advantageous (Ofori and Stern, 1987).

3.4 Economic analysis

In addition to statistical analysis, economic considerations was given in order to understand the profitability of maize and lablab intercropping system. Gross return analysis was carried out for this purpose.