CHAPTER 3

MATERIALS AND METHODS

This study consisted of two parts: (i) a field survey in the Namkha area of Houn district, Oudomxay province, in the Lao PDR; (ii) a field experiment conducted at the Irrigated Agricultural Research Station of the Multiple Cropping Center, Faculty of Agriculture, Chiang Mai University, Chiang Mai, Thailand.

3.1 Field survey

The field survey was undertaken to document existing farmer practices for weed control in maize and soybean production, and to identify the limiting production in the current systems. The survey was undertaken during March to May 2002 in the Namkha area, Houn district, Oudomxay province in the Lao PDR. The field survey studied the cropping systems, crops and weeds, management, and socio-economic constraints to production.

Three villages were selected for the field survey, namely: Ban Donkeaw, (Lao loum, Lao theung and Hmong), Ban Heuayhia, (Hmong) and Ban Donthat, (Hmong). The villages selected reflected differences in land use categories in the sloping lands, differences in cropping management and ethnic groups.

The data on farmers' weed management practices was collected through the combination of the use of an unstructured interview, and structured personal interviews by questionnaire specially designed for the purpose. The questionnaire was tested in households of the three villages in the target area. A total of 45 households involved in maize and soybean production were surveyed. Reliable secondary data on cropping systems was

obtained from various agencies such as Agriculture and Forestry office, Planning and Cooperation office and any reports.

Data collected during the survey was analyzed to establish the most important constraints to production, particularly with regard to weeds management. Particular attention was given to the management of labor resources for weed control.

Other supporting data collected to assist in the analyses and interpretation of the survey data included information on climatic conditions, soil properties, cropping patterns and household agro-economic data. This information was collected during the farmer interviews and from various government agencies. Data from field survey have been to analyze using statistic description methods.

The results of the survey were then used to formulate the details of the weed and labor management in field study undertaken under more controlled conditions at Chiang Mai University.

3.2 Field experiment

The field experiment was conducted in the Irrigated Agricultural Research Station of Multiple Cropping Center, Faculty of Agriculture, Chiang Mai University, Chiang Mai, Thailand. The site is located at 18° 46' N latitude, 98° 57' E, and altitude is 1035 feet above sea level. The experiment was conducted in the period August to December 2002.

3.2.1 Treatments and experimental design

The objectives of the experiment were to identify the critical timing for weed control in maize and soybean intercropping systems. A split-plot experimental design with three replications was used in the study. Time-of-weed-control was used as the main-plot treatment, with the sub-plot treatments

being cropping combinations and row spacing. Experimental plot layout is illustrated in appendix Figure A 1.

Six main-plot (time-of-weeding treatments) were assigned as follows:

1. Weed-free.
2. No weeding.
3. Weeding at V4 stage of maize growth (weeding-V4).
4. Weeding at V8 stage of maize growth (weeding-V8).
5. Weeding at V4 and V8 stages of maize growth (weeding-V4+V8).
6. Weeding at V4, V8 and V12 stages of maize growth (weeding-V4+V8+V12).

Four sub-plot (treatments combining different combinations of row spacing and maize-soybean intercropping sequences) were designed as follows:

1. Sole maize alone using a 75 cm row spacing and 25 cm hill spacing.

2. Sole soybean alone using a 50 cm row spacing and 25 cm hill spacing.

3. Maize and soybean intercrop with maize planted using a 75 cm row spacing and 25 cm hill spacing; in alternate rows soybean was planted using a 75 cm row spacing and 25 cm hill spacing (M: SB 1: 1).

4. Maize and soybean intercrop with maize planted using a 75 cm row spacing and a 25 cm hill spacing; in alternate rows of maize, two rows of soybean were planted using a row spacing of 37.5 cm and hill spacing of 25 cm (M: SB 1: 2).

Individual plots were 2 m x 3m. The total area of the experiment was 800 m^2.

Plot layout was illustrated in appendix Figure A 2.

3.2.2 Management practices

Seeds of maize and soybean were hand-sown in rows using the specified row spacing. For maize, 2-3 seeds were sown per hill, while for soybean the seeding rate was 4-5 seeds per hill. Two weeks after emergence the number of plants per hill was thinned to one per hill for maize, and three per hill for soybean.

The variety of maize used in the experiment was Nakonsawan 1 (NS 1), while the variety of soybean used was Chiang Mai 60 (CM 60). Both maize and soybean varieties are improved Thai varieties.

Insect pests, diseases control, and others management measures are undertaken as appropriate and when necessary.

Fertilizer was applied the rate at 90N-60P_2O_5-60K_2O kg ha^{-1} in form of 16-16-16, and 46-00-00 (urea). The fertilizer was applied as a split application, 50 % as a basal application just before planting, and 50 % at 35 days after sowing.

Weed control was done by hand-weeding according to the treatments allocated to specific treatment plots. Hand weeding of the maize was done at growth stages V4, V8, and V12 of maize leaves.

3.2.3 Sampling procedures and data collection

3.2.3.1 Soil sampling

Before planting, soil samples were taken to a depth of 0-20 cm depth in each replication for analysis of pH, organic matter (OM), and N, P, and K contents.

3.2.3.2 Crop sampling and data collection

Crops, sampling and data collections were taken at different stages of growth for each crop. For maize consists of plant height, lea area index, light intensity and light interception, total dry matter of crops. Biomass was measured at V12, VT, and at harvest. Yield components, grain yield of maize and harvest index were recorded after harvest.

Similarly, for soybean sampling and data collections such as plant height, leaf area index, light intensity and light interception, total dry matter of soybean crop was measured at R2, R5, and at harvest. Yield components, grain yield of soybean and harvest index were also recorded after harvest. The area harvested for the estimate of crops yield was 1.125 m^2 for each subplot.

3.2.3.3 Weed sampling and data collection

Weed samples were done by list quadrate method (Wirjahardja and Pancho, 1975 and Radanachaless., *et al* 1990) using a 50 cm x 50 cm quadrate. With two points in each treatment plot were randomly selected for measurements of weed population density, weed species composition, and weed dry matter yield. Weed related measurements were made one day before the scheduled weeding treatments.

Weeds, data collections for weed consists of weed population density, weed species, weed dry matter weight from each weeding i.e. weeding at V4, V8, V12 of maize growth stages and before crops harvest, included labor use for weeding at the same-time of weeding.

3.2.3.4 Labor use

The labor involved in the various weeding treatments was recorded and expressed in terms of labor-day-per-ha (Ld ha^{-1}).

3.2.4 Data analysis

The field survey data collected in Oudomxay province of the Lao PDR was analyzed by using descriptive statistics in which percentages, means and standard errors were computed.

Data from the field experiment undertaken in Chiang Mai were analyzed using analysis of variance (ANOVA), descriptive statistics, and LSD comparisons. Weed management was treated in the same way as for crop growth, crop yield and harvest index (HI).

Land Equivalent Ratio (LER) analysis to compare the crop yield of maize alone and soybean alone, and for the different combinations of maize and soybean intercrops. Leaf area index and light intensity and light interception were analyzed for each of the single crop and intercropping treatments.

An analysis of weed species was done to determine the dominant weeds and their Summed Dominance Ratio (SDR) on the basis of relative density and relative frequency using the following equations:

$$\% \text{ Relative density} = \frac{\text{Density for a species x 100 \%}}{\text{Total density for all species}}$$

$$\% \text{ Relative frequency} = \frac{\text{Frequency value for a species x 100 \%}}{\text{Total of frequency values for all species}}$$

$$\% \text{ SDR} = \frac{\text{Relative density + Relative frequency}}{2}$$

3.2.5 Economic analysis

Economic analysis was used to examine the efficiency of labor use in the different weeding and intercrop treatments. Input costs and net income

were used to examine the profitability of the different cropping systems in the Namkha area, Houn district, Oudomxay province in the Lao PDR. The variable costs used in the estimates were those, which existed at the time the survey was undertaken in the Lao PDR

For the experiment undertaken at Chiang Mai University, economic returns for labor use in all aspects of the production cycle when cropping maize and soybean alone and in the different intercrop treatments, were estimated. Estimates of cost and returns were also made and compared for the different weeding treatments in the different cropping combinations. The economic analysis was done with steps basic on gross margin equation as following:

1. Total Revenue (TR) = Total yield * farmgate price

2. Total Variable Cost (TVC) = (Cost of material and services (seeds cost + fertilizer

pesticides cost + power and labor cost)

3. Gross Margin (GM) = Total Revenue (TR) - Total Variable Costs (TVC)