Chapter 3

MATERIALS AND METHODS

This study consisted of a field survey and a field experiment.

1. Field survey:

The informal and formal survey was conducted in four villages in the Mekong Delta of Vietnam. Three villages (namely Nhi Qui, Nhi My, Long Khanh) are in Cai Lay district (Tien giang province) where cultivating 2-3 crops per year is common practice. The other is Phong Hoa village in Lai Vung district (Dong Thap province) where farmers have practiced *Sesbania sp.*-Rice intercrop for a long time (Figure 1). The purposes of the field survey are to understand the environmental conditions, farmers' practices, and farmers' perceptions with respect to soil conservation, and fertilizer and green manure management. The results and observations were then analyzed statistically. These results were incorporated into the design of field experiment. The survey was conducted in April 1991.

In Cai lay district (Tien giang), 29 farmers who have been practicing different land use methods were interviewed by using semi-structured questionnaires. In addidtion, 5 soil samples from different land use patterns were taken for nutrient content analysis. Informal information about land management, soil map, etc... was also collected. Field observation was carried out after interviewing. In Phong Hoa village, Lai vung district (Dong Thap province), 11 farmers were interviewed, and 2 soil samples were taken from rice fields with and without *S. rostrata* intercrop. Several fields with *S. rostrata* growing after rice harvest during the dry season were also observed.

Soil type and land use maps of the study areas were collected from The Soil Science Department of The University of Cantho, Provincial Department of Agriculture of Tien giang and Dong Thap provinces.

MAP OF THE MEKONG DELTA OF VIETNAM

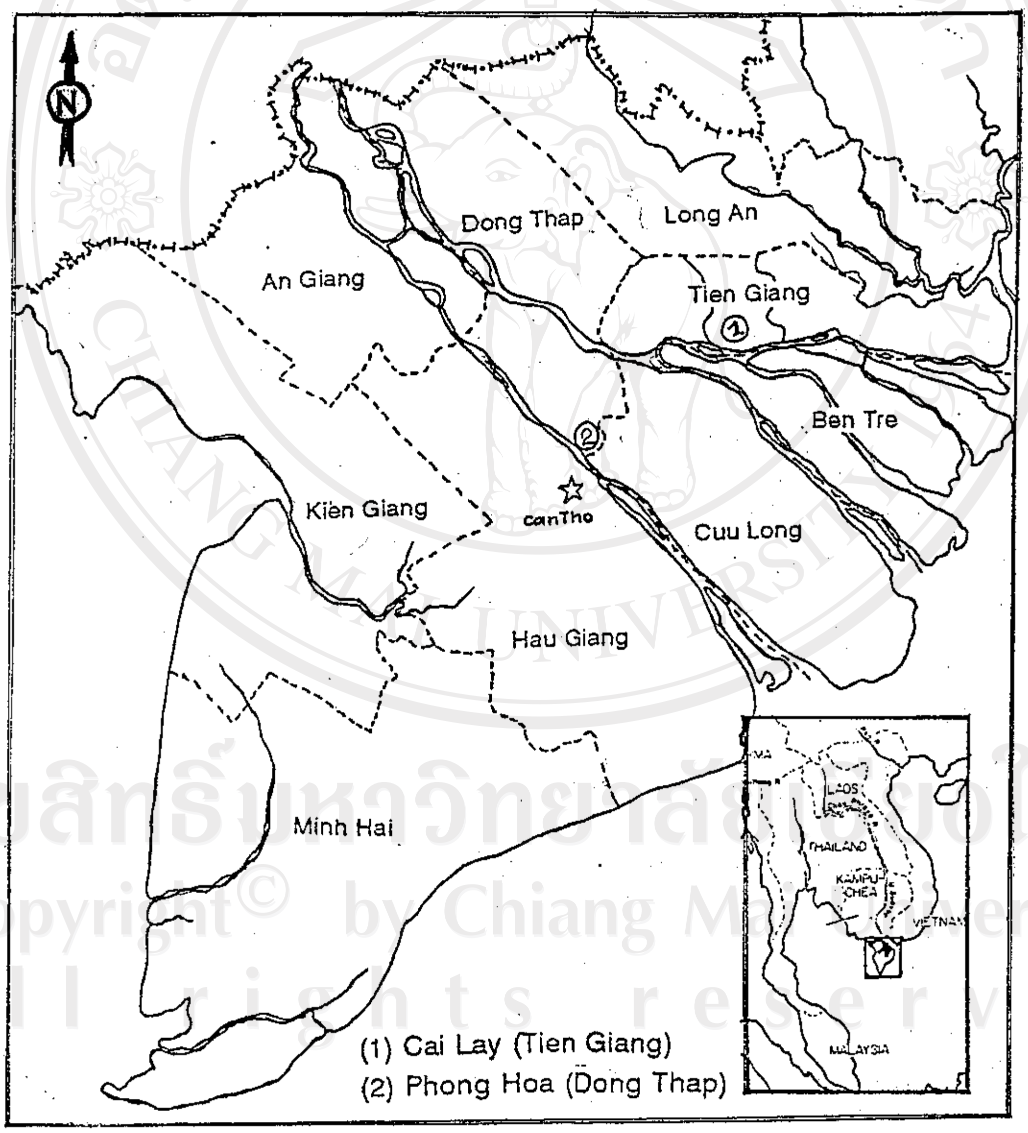

Figure 1. Locations for the field survey in the Mekong Delta of Vietnam conducted in April 1991.

2. Field experiment:

The field experiment was conducted on sandy loam soil (San Sai series) at the experimental station of Multiple Cropping Center, Chiang Mai University (19^{o}N, 99^{o}E) from May to December 1991. Results of the soil analysis indicated that soil pH was 5.9, organic matter 1.08 %, total N 0.06 %, available P 70. Temperature during this period of time varied from 21.1 to 29.4^{o}C and the total rainfall was 958.4 mm with the peak in August (336.1 mm).

2.1. Treatments:

The replacement series, on a "plant unit" basis of 1 plant of *Sesbania rostrata* equivalent to 1 hill of rice, was used to evaluate the productivity and the interactions of *S. rostrata* and rice in intercropping. Two factors involved in the experiment were the date of *S. rostrata* introduction and the proportion of *S. rostrata* to rice in intercrops. The treatment combinations are shown in table 1.

2.2. Design:

The experimental design was randomized complete block design (RCB) with 10 treatments in 3 replications. Plot size was 4 m x 10m.

2.3. Cultural practice:

The 30-day-old seedlings of rice (RD7) were transplanted in rows 12.5 cm apart with 25 cm between hills, at a density of 32 hills per m^2, with 3 seedlings per hill (see Appendix Figure 3). The rows were staggered so that hills in one row were placed at equal distance from the two hills in each neighboring row. The 30-day-old seedlings of *S.*

rostrata were transplanted into simultaneous sowing plots (D0) on the day of rice transplanting, with 1 seedling per hill. Germinated seeds of *S. rostrata* were sown, at 3-5 seeds per hole, into intermediate sowing plots (D1) on the same day. Thinning was done 2 weeks after sowing to keep only one seedling per hill. The same method of sowing *S. rostrata* seed was done for late sowing plots (D2) at 30 days after transplanting rice.

Table 1. The treatment combinations used in the experiment.

Cropping systems	Time of *Sesbania* introduction	Treatment
Sole rice	-	P0
Intercrop 25% *Sesbania*	Simultaneous sowing	P1D0
	Intermediate sowing	P1D1
	Late sowing	P1D2
Intercrop 50% *Sesbania*	Simultaneous sowing	P2D0
	Intermediate sowing	P2D1
	Late sowing	P2D2
Sole *Sesbania*	Simultaneous sowing	P3D0
	Intermediate sowing	P3D1
	Late sowing	P3D2

* Date of *Sesbania* introduction :
- D0: Simultaneous: Sowing and transplanting *Sesbania* at the same time as rice. (Sowing *Sesbania* at 30 days before transplanting rice).
- D1: Intermediate: Sowing *Sesbania* at the time of transplanting rice.
- D2: Late : Sowing *Sesbania* at 30 days after transplanting rice.

* Proportion of *Sesbania* and Rice in intercrops :
- P0: Sole rice : 100% Rice (32 hills/m^2) + 0% *Sesbania* (0 plant /m^2)
- P1: Intercrop 25% Ses.: 75% Rice (24 hills/m^2) + 25% *Sesbania* (8 plants/m^2)
- P2: Intercrop 50% Ses.: 50% Rice (16 hills/m^2) + 50% *Sesbania* (16 plants/m^2)
- P3: Sole *Sesbania* : 0% Rice (0 hills/m^2) + 100% *Sesbania* (32 plants/m^2)

Hand weeding was done at 25 days after transplanting. Insecticide was applied to control insect damage to the flowers of *S. rostrata* at 45 and 50 days after transplanting rice.

Fertilizer of 50-40-30 kg/ha of N-P_2O_5-K_2O was applied. All P in form of Triple phosphate was applied once as basal. K in form of Potassium chloride was applied twice as basal, and 45 days after transplanting (DAT). N in form of Urea was applied at 8, 20 and 45 DAT.

2.4. Data collection

2.4.1. Soil:

Soil samples at 0-20 cm deep of the experiment area were taken twice for analysis of pH, N, P, K and organic matter. The first time, before setting the experiment, one soil sample representing the soil feature of the whole experiment, at the beginning, was taken. The second time, after finishing the experiment, one soil sample for each plot was taken and analyzed to compare the differences in soil fertility among treatments.

2.4.2. Rice:

Plant height and tiller number of rice were recorded at 20, 30, 45, 60, and 75 days after transplanting (DAT), and at harvest. Plant height of rice was measured on the main culms from ground level to the tip of the highest leaf during the vegetative stage, and to the tip of the highest panicle after anthesis. Three hills were randomly measured and twelve hills were counted for number of tillers in each plot.

Light interception was measured around noon at 30, 45, 60, and 75 DAT by using the Integrating Quantum/Radio meter/Photo meter (Model LI-188 B) with $uEs^{-1}m^{-2}$ as the unit of measurement. Percentage of light penetration reaching to the top of rice canopy was calculated from the maximum light interception for each plot.

The 10-hill samples of rice per plot were taken at 20, 30, 45, 60, and 75 DAT, and at harvest, to measure shoot dry matter after oven drying until constant weight was reached. N content in rice plants was measured at flowering and harvesting stages. Total nitrogen content was analyzed using the Kjeldahl method. One m^2 area of rice per plot was harvested for measuring yield components. Five m^2 area of rice per plot was used for grain yield measurement. N content in grain was also analyzed at harvest.

2.4.3. Sesbania:

Plant height of 3 *S. rostrata* plants per plot was measured, from ground level to the tip of the main stems, at 20, 30, 45, 60, and 90 days after transplanting rice. Stem nodule, leaf and shoot dry matter of 8 *S. rostrata* plants from each plot were measured separately at 20, 30, 45, 60, 90, 105 and 120 days after transplanting rice. N content in leaf and stem of *S. rostrata* was measured at the flowering and harvesting stages of rice. 2-m^2 area of *S. rostrata* from each plot was chosen for seed harvest to measure yield components and seed yield. N content in seed was also analyzed.

2.5. Data analysis

RYT and ATER (Relative yield total and Area time equivalency ratio) were computed to evaluate the advantage of intercrops in terms of seed, biomass, and N yield. The use of these terms was discussed in chapter 2, section 5.3. Mathematically, RYT and ATER can be expressed as follows:

$$RYT = \frac{Yij}{Yii} + \frac{Yji}{Yjj} \qquad (1)$$

where *Yij* is the yield of rice in intercrops, *Yii* : the yield of rice in sole crop, *Yji* :the yield of *Sesbania* in intercrops, *Yjj* : the yield of *Sesbania* in sole crops; and

$$ATER = \frac{Yij.ti}{Yii.T} + \frac{Yji.tj}{Yjj.T} \qquad (2)$$

where *ti, tj, T* are durations of rice, *Sesbania* in intercrops and total durations of intercrops, respectively.

The amount of nitrogen fixation was computed by using N-difference method in which rice was used as a non N-fixing reference plant.

$$N_2\text{-fixed by legume} = \text{Total } N_{legume} - \text{Total } N_{non\text{-}fixing\ plant}{}^{(*)} \qquad (3)$$

(*) adapted from F. Ofori and W.R. Stern (1987).

In this case, the amount of fixed nitrogen was calculated for the whole system using the amount of N-uptake by sole rice crop as soil N budget and as a basis for calculation. Thus, the equation (3) became:

N-fixed = Total N from the whole system - Total N from sole rice crop(4)

Simple N-balance was estimated for two cases. If all crop residues are supposed to be returned to the soil, then N-balance would be equal to the difference between N-fixed by the system and N-removed by seeds. If Sesbania stems are removed and used as firewood, as commonly practiced by farmers, and only rice straw and Sesbania leaves are returned to the soil, then N-balance would be the difference between N-shoot yield of rice plus N-leaf yield of Sesbania and N-uptake by sole rice crop.