MATERIALS AND METHODS

Informal and formal surveys

Informal and formal surveys were conducted in order to identify the sources and amount of organic matter and to understand farmers' management system during April to June 1990 in four villages: Tung Or, Mae Kung Bok, Patan and Ban Ta located at San Klang subdistrict under the Mae Taeng Irrigation Project of Sanpatong district in Chiang Mai Province. Informal survey including farm visits and interviews with farmers was used in order to develop the specific topics for questionnaires in the formal survey with emphasis on the sources, the amount and farmers' management system on organic matter in rice-soybean cropping system. Forty two farmer respondents who practiced rice-soybean cropping system in the unfertile soil of San Sai series were interviewed in the formal survey. At the same time, the samples of organic materials used by farmers in this system were collected from 10 selected farmers and consequently analyzed for the nutrient content. The analysis used two of 2 m^2 quadrant for crop residues and one kg samples for animal manures.

Field experiment

The field experiment was carried out during June to December 1990 at the experimental station of Multiple Cropping Center, Chiang Mai University (19°N, 99°E). The soil is sandy loam with pH 5.8, organic matter of 0.79 %, total nitrogen of 0.04%, available phosphorus of 70 ppm (Bray II), and exchangeable potassium of 35 ppm (NH_4OAC 1 N pH 7).

The factorial experiment was laid out in a randomized complete block design with three replications and the plot size of 7 x 8 m. The experiment involved two factors: two varieties of rice and five nitrogen sources. The treatment combinations are shown in Table 1. The layout of the experiment is described in Appendix Figure 1.

Table 1.   Treatment combinations

N-sources	Treatment combinations	
	RD7(V1)	KDML105(V2)
1. No fertilizer (F_0)	V_1F_0	V_2F_0
2. Nitrogen fertilizer at 50 kgN/ha (F_1)	V_1F_1	V_2F_1
3. Soybean residue at 1.25 t/ha (F_2)	V_1F_2	V_2F_2
4. Soybean residue at 1.25 t/ha + Nitrogen fertilizer at 35 kgN/ha (F_3)	V_1F_3	V_2F_3
5. *Sesbania rostrata* (F_4)	V_1F_4	V_2F_4

Two rice varieties, RD7 and KDML105, were transplanted on 21 August 1990. In the nitrogen fertilizer treatments, 50 kgN/ha of urea was applied 70% of which was applied one week after transplanting and 30% at panicle initiation stage. Based on the amount of soybean residues incorporated in the farmers' field, soybean residues at 1.25 t/ha of dry matter was incorporated in the treatment with soybean residue during land preparation. In the treatment with soybean residue mixed with nitrogen fertilizer, soybean residue was incorporated at 1.25 t/ha of dry matter with 15 kgN/ha plus urea at 35 kgN/ha. The estimated amount of total nitrogen fertilizer in this treatment was 50 kgN/ha. The nitrogen fertilizer in the form of urea was applied during land preparation and one week after transplanting. For the *Sesbania rostrata*, about 12-19 t/ha of fresh *Sesbania rostrata* (68-125 kgN/ha) was incorporated into the soil. Prior to applying this treatment, *Sesbania rostrata* seeds were broadcasted at the rate of 31.25 kg/ha on 13 June 1990. *Sesbania rostrata* was incorporated in the soil at fifteen days before rice transplanting when it was fifty days old. A basal fertilizer containing 35 kgK_2O/ha in the form of potassium chloride was applied to each plot.

The density, biomass (fresh and dry weight basis), nitrogen accumulation, phosphorus, potassium and organic carbon of leaves and stems of *Sesbania rostrata* grown in the experimental plots were determined.

Soil samples were taken at 0-15 and 15-30 cm. depth before planting and after harvesting rice for the analyses of pH, organic matter, total nitrogen, phosphorus, and potassium. Soil pH was determined by using 1:1 soil:water. The organic matter and total nitrogen content of soil samples were determined by Walkley Black and Kjeldahl methods, respectively. The available phosphorus in soil was extracted with Bray II and the concentration was determined colorimetrically. The exchangeable potassium was analyzed by extracting soil samples with NH_4OAC 1 N and determined the concentration of the extract by flamephotometer.

Plant samples were made in 1 m^2 quadrant of each plot for dry matter, total nitrogen, phosphorus, and potassium in the plant tissues at panicle initiation, flowering and harvesting stages. The Kjeldahl method was used for the analysis of total nitrogen (Dalrymple et al., 1945). Dry ashing plant samples for plant ash solution were prepared for analyses on phosphorus and potassium. Then the spectrophotometric and the flame emission procedures were used for determination of phosphorus and potassium. Rice yield was measured from plant samples taken from 10 m^2 of each plot.

The analyses of variance of the yield, soil nutrients, and nutrient uptake by crops at panicle initiation, flowering and harvesting stages were done in order to compare the results of various treatments. The ANOVA tables are reported in Appendix Table 1 to Appendix Table 6.

Economic analysis was analyzed by considering the return over total variable cost, the marginal rate of return and the sensitivity analysis.