CHAPTER 3

MATERIALS AND METHODS

The study consisted of two parts: field survey and field experiment. The field survey was carried out in order to meet with the first objective of the research which aims to acquire overall knowledge and understanding of the context of the farming systems with emphasis placed on farmers' current pest management and rice production practices in the rainfed lowland area. Important findings regarding pest management practices arose from this study were analyzed and then superimposed in the field experiment. The field experiment designed basing on these information was conducted with an aim to primarily meet with the second objective by trying to investigate their effects on the population dynamic of the most damaging green rice leafhopper, *Nephotettix viresecens* (Distant), and the diversity of its important natural enemies. Input and output involved in this experiment were used for the analysis of the third objective, which is the analysis of economic return. Details of these research activities are described as follows:

3.1. Field survey

The formal survey was conducted from March to April 2001 in rainfed lowland area of Kandal province, Cambodia. Four out of the 23 villages of rice-based development community of Roleang Ken commune, Kandal Stueng district were chosen as study sites. Twenty rice farmer respondents, half assigned to non-IPM and another half assigned to IPM farmers, were randomly chosen from the lists obtained from the village headmen for formal structured interviewed with questionnaires. The non-IPM and IPM farmers are respectively known as those who have and have not been trained about the integrated pest management approach (IPM). As a whole, respondents were interviewed about their rice production practices. However, more emphasis was placed on pest management practices adopted to cope with mounting pest problems in which important related aspects such as the use of agrochemicals and farmers' attitudes, knowledge of pest management and natural enemies were thoroughly investigated. Additionally, important information pertaining to input and output of their rice production were collected as well. Other reliable secondary data on climatic condition and related information were obtained from various agencies and local authorities.

A multi-method approach used for the conduct of the field survey encompassed rapid rural appraisal (RRA), unstructured interview, and structured personal interview. Rapid Rural Appraisal (RRA) method was adopted for use in a series of contact and inquiries with all target groups of farmers and key informants. An unstructured interview approach was employed to gain new insights, raise questions, and examine phenomena from different perspectives from key informant (Heong and Escalada, 1997).

The data on farmers' pest management and rice production practices were collected through structured personal interviews, using a questionnaire specially designed for the purpose. It was actually developed basing on a version of questionnaire employed by the Cambodia-IRRI-Australia Project (CIAP) in 1996 to survey farmers' pest management and rice production practices in Cambodian lowland rice. The questionnaire was pretested once with 5 farmers from each category of the target groups of farmers and subsequently modified to avoid ambiguities. In its final form the survey consisted of 76 questions. The survey was conducted with the participation of 1 provincial IPM trainer and 3 village-based IPM farmer trainers. Survey data was analyzed by using descriptive statistical methods in which percentage, mean, and standard error were computed. Analyzed data were used to plan and execute the field experiment.

3.2. Filed experiment

3.2.1. Experimental site

The field experiment was conducted from June to December 2001 at the Irrigated Research Station of the Multiple Cropping Center, Faculty of Agriculture, Chiang Mai University located at longitude 98°57' and latitude 18°46', 1035 m above sea level. Considerations over the selection of this experimental site based primarily on time constraint that made it impossible for the study to be conducted in the survey area, and on reports over the increasing trends of green leafhopper populations in Chiang Mai valley.

3.2.2. Systems management and design

Systems design

The field experiment was made of 3 system plots. They were assigned in a randomized complete block design (RCBD) consisting of 4 replications (Appendix A). Each system plot was laid out at the size of 5m x 9m. The overall layout and design of the experiment are as follow:

System:
1. Cambodian pest management system (CPMS)
2. IPM-based pest management system (IPMS)
3. Low input rice cultivation system (LIRCS)

Systems management

The term "system" used in this research is referred to the manipulated rice pest management systems in which different levels of inputs and management strategies are practiced. Important variables used for the design of the three systems included age of seedling, numbers of seedling per hill, fertilizer application, and pest management practices.

System I (CPMS) was designed basing on the common pest management and rice cultivation practices by farmers in the surveyed areas. Specifically, the system was planted to a 45-day-old seedling of KDML-105, which was transplanted at 5 to 6 seedlings per hill with a distance of 25 cm apart. A split-fertilization of a total amount of 230kg ha^{-1} was done at 3 phases. First fertilization was done basally at the rate of 60kg of DAP (18-46-0) which is equivalent to 11kg of nitrogen (N) and 28kg of Phosphate (P). The second and third fertilization were done as a top dressing at tillering and panicle initiation stage at the rate of 85 kg of Urea (46-0-0), which is equivalent to 40kg of nitrogen (N), respectively. As for insect pest management, a conventional insecticide control measure was taken to control green leafhopper *Nephotettix virescens* (Distant) at two important growth stages of rice crop, namely, the tillering and milky stage. The system was treated with the spray of Folidol insecticide at a dosage of 0.5l ha^{-1}.

System II (IPMS) was designed basing on the basic concepts and principles of the IPM practices in which proper rice husbandry techniques and management are rationally practiced to enable better crop growth and yield. Mostly, all cultivation and crop establishment practices were based on that being practiced by the Irrigated Research Station of the Multiple Cropping Center (MCC), Faculty of Agriculture, Chiang Mai University. Specifically, the system was planted to a 25-day-old seedling of KDML-105, which was transplanted at 2 to 3 seedlings per hill with a distance of 25 cm apart. A split-fertilization of a total amount of 195kg ha^{-1} was done at 2 phases. The first fertilization was carried out at tillering at the rate of 162.5kg ha^{-1} of 16-20-0, which is equivalent to 26kg and 32.5kg of nitrogen (N) and phosphate (P) respectively. The second fertilization was carried out at the panicle initiation stage of rice at the rate of 32.5kg ha^{-1} of urea (46-0-0), which is equivalent to 15kg of N. For insect pest management, the concept of economic threshold was applied. The plot would receive chemical treatment only when the numbers of GLH have reached the threshold of 5GLH/hill and 10GLH/hill at the vegetative and post flowering stage, respectively (Adopted from Dale, 1994). However, no insecticide spray was implemented because the observed pest population never reached the threshold.

System III (LIRCS) was a low-input one, a common rice farming system practiced by most of the northern Thai farmers, designed with important factors, such as, fertilizer treatment and pest control measure excluded. Other planting practices were identical to those in system II.

3.2.3. Sampling procedures and samples management

Two sampling methods were employed to estimate the population size and dynamics of the adults and nymphs of *Nephotettix virescens* (Distant) and population of the natural enemies in the experimental plots. These included direct visual count and sweep net in which a "lazy-8" parallel sweeps of 38 cm in diameter and about 75 cm deep method recommended by Kogan and Pitre (1980) was used. Direct visual count of the populations of *N. virescens* (Distant) and natural enemies were detected at 3 hills of rice randomly selected along field diagonals. Sweep net samplings were carried out on the basis of 3 sweep samples, consisted of 9 strokes, along field diagonals. A total number of 13-week-samplings was started from 11 August to 03 November 2001. However, the final sweep catch was not done as the field was covered with the net to protect the crop from birds. So, the total number of sweep catch observation was only 12. Sweep catch samples were brought to the laboratory for identifications. While known insect pests and natural enemies were recorded, the unidentifiable specimen were sent to laboratories of the Department of Entomology of the Faculty of Agriculture, Chiang Mai University, and the Biological Control Research Center, Mejo University for identification.

An additional estimate of population size and dynamics of the *N. virescens* (Distant) was done using a 220-watt-light trap placed in the vicinity of the station, which is about 200m away from the experimental rice fields. Adult green leafhoppers caught by the light trap were collected and counted in every three days starting from 07 August to 29 November 2001.

Identification of natural enemies causing damages to *N. virescens* (Distant) eggs was done through whole plant examination of 3 potted rice hills (trap plants).

The plants, which were of the same age as the plants transplanted to each system and kept in an insect-free screened-house, were placed at the rate of 3pots/system plot per observation. The total of 36 potted plant samples were then replaced and retrieved weekly. The retrieved plants were taken to the Multiple Cropping Center Laboratory for a whole plant examination to descry eggs laid in by leafhoppers and eggs damaged by parasitoids and predators. The potted plants placement began from 11 August to 13 October 2001.

3.2.4. Data analysis

Analysis of variance (ANOVA), least significant difference (LSD) of the randomized complete block design (RCBD) were the main statistical tools employed for the analysis of the abundance of leafhoppers and natural enemies in systems. Remedial measures such as *logarithmic*, log (X+1), and *arcsin* transformation were then also taken, when necessary, to reduce the heterogeneity of the variance of data derived from numbers of leafhoppers and natural enemies and proportions of relative contribution of parasitoids and predators to leafhopper egg mortality. Further observation of population dynamics of the green leafhoppers and the natural enemiės were made by plotting the numbers arthropods of against time.

Simpson index as determined by Gliessman (1998) was adopted for the study of spececies diveristy of important natural enemies as affected by each pest management system. It is given by the following forlmular:

$$\text{Simpson Index} = \frac{N(N-1)}{\sum n_i(n_i - 1)}$$

Where, N is the number of individuals, and

n_i is the number of individuals in the systems belonging to *ith* species.

To grasp the economic picture of the pest management systems practiced, all variable costs, including labor cost, seed cost, fertilizer cost, and insecticide, invested were summed for the estimation of gross margins. Gross margin computations were based on the following equations:

1. Total revenue = Total production in Kg multiplied by per unit price
2. Total variable cost = Labor + Seed + Fertilizer + Insecticide
3. Gross margin = Total revenue – Total variable cost