Chapter III

Materials and methods

The study consisted of two parts: field survey and field experiment. The purpose of the field survey is to understand the current farmer practices in rice production and other cropping systems with fertilizer management in order to understand crop production systems and to identify the major problem in farmer's fertilizer practices.

3.1 Field survey

Field survey was conducted in March 2005, in rainfed lowland areas of Takeo province about 70 km south of capital Phnom Penh. Boeng Tranh Khang Tboung, commune, Samraong district was selected for the case study because it is located in an area where most villages are considered to be quite similar to field experiment in terms of land condition (soil type), and cropping pattern.

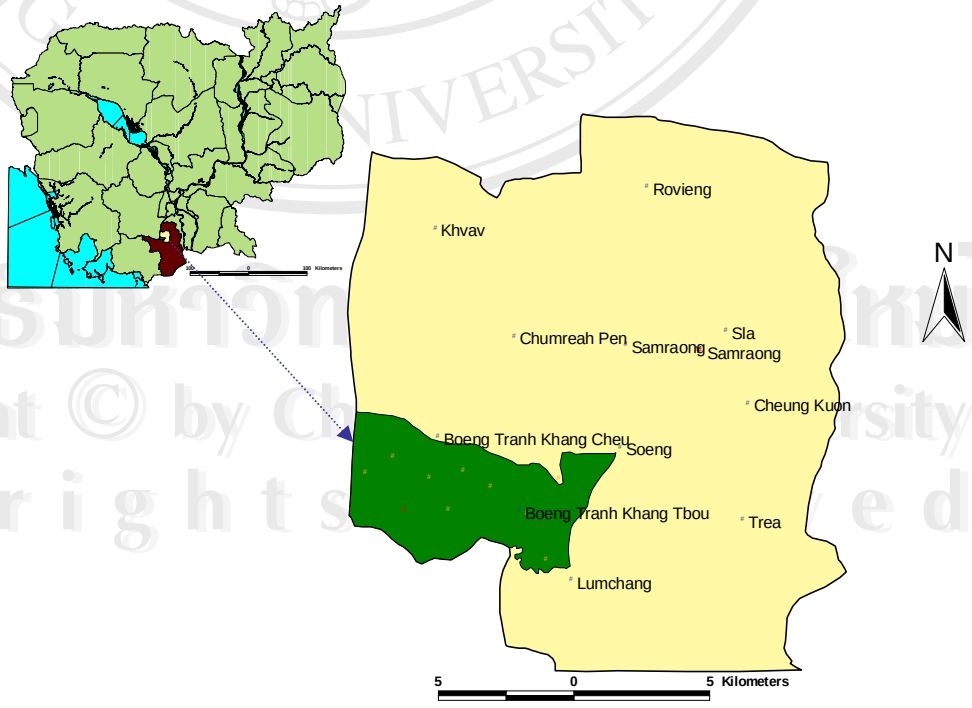

Figure.3.1. Map of study areas Beong Tranh Khang Tboung, Samrong district

In the first step, we went to see the head of the village and asked permission to interview villagers. The purposes of the study were clearly explained and general information was requested on the number of families, landholdings, farming activities and other off-farm activities in the village. With cooperation and support from the village head fifteen farmers were randomly selected from the list for formal structured interview with questionnaire.

In subsequent several days before the interview, the selected farmers were visited to solicit their assistance, and to make an appointment for the interview. A map of the village noting the location of the selected farmers' residences and their field layouts was drawn with the assistance of the village head. The map of the field layout was used to find the selected farmers and monitor their fields without repeatedly disturbing the village head.

A questionnaire was developed with 15, mostly open-ended, questions about the household's farming practices, farming inputs and outputs, and farmers' decision-making processes. The same questions were asked for the early wet season (EWS) crop and for the wet season (WS) crop. The interviews provided information about the dates of land preparation, planting, weeding, fertilizer application, crop harvest, crop yield, the rates of fertilizer used, and constrains in farming. Reliable secondary data were obtained from various agencies.

3.2 Field experiment

The Cambodian Agricultural and Development Institute (CARDI) will be chosen as study site, about 20 kilometers north of the capital Phnom Penh of Cambodia. The institute posses' 70 hectares area on Prateah Lang group, which is the sandy-textured top soil overlying a loamy or clayey textured subsoil (White *et al*., 1997a,b). The group of soil represents a major rice production soil type, and its surface layer, structure less, is hard dry with vary color from pale brown, gray or while to lighter shades brown gray. As almost absent clay in the top soil is very easy disperse and it very infertile soil.

The climate, which is not different from other lowland areas, is hot and humid. In generally, the temperature varies from 25^{o}C to 35^{o}C, which reach the peak in April and May, and between December and January is cold period of the year.

3.2.1 Experimental design

There were five consecutive cropping cycles spanning 2 early wet and 3 wet seasons were conducted at the Cambodian Agricultural Research and Development Institute (CARDI) from 2003 to 2005(Table 3.1).

The experiment was carried out in Split-split Plot Design with 4 replications consisting of total 48 plots. The main plot was crop/season and sub plot was fertiliser and sub-sub plot was residue. Individual plot size was 5 m X 5 m.

Table 3.1 Residue and Fertilizer in treatment over 5 successive cropping cycles (2 early wet seasons and 3 wet seasons) 2003-05

Crop1 wet season 2003			Crop2 early wet season 2004			Crop 3 wet season 2004		
Trt.	Fertilizer	Crop	Residue	Fertilizer	Crop	Residue	Fertilizer	Crop
1	0	Rice	0	0	Rice	0	0	Rice
2	0	Rice	0	0	MB	0	0	Rice
3	0	Rice	0	0	MZ	0	0	Rice
4	F	Rice	0	F	Rice	0	F	Rice
5	F	Rice	0	F	MB	0	F	Rice
6	F	Rice	0	F	MZ	0	F	Rice
7	0	Rice	ST	0	Rice	R/R	0	Rice
8	0	Rice	ST	0	MB	R/MB	0	Rice
9	0	Rice	ST	0	MZ	R/MZ	0	Rice
10	F	Rice	ST	F	Rice	R/R	F	Rice
11	F	Rice	ST	F	MB	R/MB	F	Rice
12	F	Rice	ST	F	MZ	R/MZ	F	Rice

Note: Trt: treatment; F: with fertilizer; ST: with straw, R/R: residue rice, R/MB: residue mung bean, R/MZ: residue maize, MB: mung bean, MZ: maize

Table 3.1 Residue and Fertilizer in treatment over 5 successive cropping cycles (2 early wet seasons and 3 wet seasons) 2003-05(continue)

Crop 4 early wet season 2005				Crop5 wet season 2005		
Trt.	Residue	Fertilizer	Crop	Residue	Fertilizer	Crop
1	0	0	Rice	0	0	Rice
2	0	0	MB	0	0	Rice
3	0	0	MZ	0	0	Rice
4	0	F	Rice	0	F	Rice
5	0	F	MB	0	F	Rice
6	0	F	MZ	0	F	Rice
7	ST	0	Rice	R/R	0	Rice
8	ST	0	MB	R/MB	0	Rice
9	ST	0	MZ	R/MZ	0	Rice
10	ST	F	Rice	R/R	F	Rice
11	ST	F	MB	R/MB	F	Rice
12	ST	F	MZ	R/MZ	F	Rice

Note: Trt: treatment; F: with fertilizer; ST: with straw, R/R: residue rice, R/MB: residue mung bean, R/MZ: residue maize, MB: mung bean, MZ: maize

3.2.1.1 Wet season crop (Crop1)

The experiment was established in wet season 2003 with the treatment outline in the Table3.1, with four-replicate consisting of total 48 plots. The objective of this experiment is to determine a response of new release rice Senpidour to sole organic fertilizer application ((N: 50, P: 13, K: 25 kg/ha) compared to recommended rates fertilizer.

Plots were ploughed to 15-20 cm depth and harrowed immediately prior to transplanting rice.

Phosphate fertilizer (P) as di-ammonium phosphate (DAP) and potassium (K) as muriate of potash (KCl) at rate 28.26 kg P/ha, 41.66 kg K/ha were applied. Other nutrients were applied (24 plots) to all plots in each cropping cycle nitrogen (N) as urea (CH4N2O) at rates of 97.63 kg N/ha. The DAP and KCl were broadcast and incorporated into the soil to 15-20 cm depth just before transplanting. Urea was applied in two equal splits: 50 % basally incorporated, and 50 % broadcast at panicle initiation (PI).

Rice (*Oryza sativa* L.), cv. Sanpidor was used. This variety is photoperiod, insensitive with 115-120 days duration, high-yielding potential. It is suitable for both rainfed and irrigated dry season cultivation in Cambodia. Rice seeds were pre-germinated by soaking in a wet sack for 24 to 48 hours prior to broadcasting on the nursery at a rate of 40 kg dry seed/ha. To stimulate the initial growth of seedlings, 50 kg of cow manure, and N, P and K fertilisers at the rates of 1, 0.25 and 0.20 kg/100 m^2 area, were applied to the nursery (White *et al*., 1997b). When the rice seedlings were 25 days old, healthy seedlings with similar physical appearance were selected for transplanting with 2 to 3 plants per hill at spacing between hills of 20 cm x 20 cm. Missing rice plants were replaced at 5 to 7 days after transplanting (DAT). Grain and straw were harvested and determined for dry weight.

3.2.1.2 Early wet season crop (Crop2)

The experiment was established in early wet season 2004 .On the same plots as used for the first experiment (Crop1). In this experiment, rice straw (the whole amount of rice straw was re-applied into the same plots from which as it was harvested) was returned to half of the total plots (24plots) 2-3 weeks before planting. Three diverse crops (rice, maize, and mungbean) were cultivated in both plots of straw-treated and non-treated (treatment outline 1.5). Mungbean and Miaze used as directed seeding with 5 seeds per hill at spacing between hills of 20 cm x 30 cm for mungbean and 30 cm X 40 cm for maize. After 2 weeks, when the crop grown thinning the plant were taken to keep only 2 crops per hill. Rice was transplanting with 2 to 3 plants per hill with 25 days old of seedling at spacing between hills of 20 cm x 20. The chemical fertilisers at the rate of (N: 50, P: 13, K: 25 kg/ha) was applied to all treatments (24 plots) and every cropping cycle.

Yield and above ground biomass of each crop were collected to quantify total dry weight.

3.2.1.3 Wet season crop (Crop3):

The experiment was established in wet season 2004. Again, this is a continuation from early wet season experiment (crop2). Whole plant biomass of all

three crops (rice, maize, and mung bean) was incorporated into the same plots from which they were harvested (treatment outline Table 3.1). The only 24 plots which rice straw is incorporated in the second cropping season. The chemical fertilisers at the rate of (N: 50, P: 13, K: 25 kg/ha) was applied to all treatments and every cropping cycle (only 24 plot). In this experiment only rice crop was cultivate in all plot.

3.2.1.4 Early wet season crop (Crop4):

This experiment was repeated from the crop 2

3.2.1.5 Wet season crop (Crop5):

This experiment was repeated from the crop 3

3.2.1.6 Plant growth and yield measurements

Rice

Measurements in the rice crop included the date of transplanting, flowering and harvest, total tiller number at maximum tillering, plant height at ripening stage, number of panicles per m^2 at ripening stage, total rice grain yield, weight of straw.

At the booting and ripening stages, the number of tillers was determined from three sampling units (one sampling unit equalled four adjacent hills) in separate locations just outside the central 3 m x 3 m (9 m^2) harvested area in each plot. All tillers and panicles were counted for each sampling unit and recorded separately. The date of 50 % flowering for each plot was recorded. Plant height was measured from the ground to the tip of the tallest panicle at the ripening stage at three separate locations outside the final harvested area in each plot.

Before the second application of urea at panicle initiation (PI), plant samples were randomly taken of shoots by cutting 12 hills (i.e. three sampling units; one sampling unit equalled four adjacent hills) outside the final harvested area. Plants were cut at ground level and a total fresh aboveground biomass was determined. All

shoot samples were washed in tap water before they were oven-dried at 70^{o}C for 48 hours to determine dry weight.

At maturity, the central 9m^2 portion of each plot was harvested to measure total grain and straw fresh weights.

Mung bean

Measurements in mung bean crops included date of planting, flowering, total grain yield (pods were harvested three times as they matured) and total biomass.

At the reproductive stage and ripening stages, the number of tillers was determined from three sampling units (one sampling unit equalled four adjacent hills) in separate locations just outside the central 3 m x 3 m (9 m^2) harvested area in each plot.

Before the second application of urea at reproductive stage, plant samples were randomly taken from the field by cutting 5 hills (i.e. three sampling units; one sampling unit equalled four adjacent hills) outside the final harvested area. Plants were cut at ground level and a total fresh aboveground biomass was determined. All fresh biomass samples were washed in tap water before they were oven-dried at 70^{o}C for 48 hours to determine dry weight.

Other observations were also recorded including pod per plant and seed per pod. The date of 50 % flowering for each plot was recorded. Plant height was measured from the ground to the tip of the tallest leaf at the ripening stage at three separate locations outside the final harvested area in each plot.

Maize

Measurements in maize crops included plant density and date of flowering, total grain yield and total biomass.

At the reproductive stage and ripening stages, the number of tillers was determined from three sampling units (one sampling unit equalled four adjacent hills)

in separate locations just outside the central 3 m x 3 m ($9m^2$) harvested area in each plot.

Before the second application of urea at reproductive stage, plant samples were randomly taken the field by cutting 5 hills (i.e. three sampling units; one sampling unit equalled four adjacent hills) outside the final harvested area. Plants were cut at ground level and a total fresh aboveground biomass was determined. All shoot samples were washed in tap water before they were oven-dried at 70^oC for 48 hours to determine dry weight.

Other observations were also recorded including tillers and ear were counted for each sampling unit and recorded separately. The date of 50 % flowering for each plot was recorded. Plant height was measured from the ground to the tip of the tallest leaf at the ripening stage at three separate locations outside the final harvested area in each plot.

3.2.1.7 General maintenance

Weeds were controlled manually to prevent excessive levels, which could impair crops growth. Weeding was done three times for all crops. Supplementary irrigations were applied to avoid significant water stress in crops.

3.2.2 Field experiment data analysis

For every crop cycle of field experiment, an analysis of variance (ANOVA) for each of growth parameters was undertake to determine treatment effects using statistical package. When the treatment effects are significant, the least significant difference (LSD) are using for mean comparison.

3.2.3 Gross margin analysis

The crop options were analyzed by technical feasibility i.e. which crop sequence is best for nutrient recharge in the soil and crop yield improvement. Secondly the gross margin for each crop was calculated based on market price of

input and output. The variable cost for the calculation of gross margin were obtained from summing up the all the required input costs and labour cost for land preparation. Gross margin computations were base on following equations:

Total revenue = Total production in Kg multiplied by per unit price
Total variable cost = Labour (land preparation) + seed + fertiliser
Gross margin = Total revenue – Total variable cost