CHAPTER 3

MATERIAL AND METHOD

The ultimate objective of this study is to improve the production of food legumes in mountainous region of Northern Vietnam. In order to achieve this, the study was conducted in two parts.

3.1 Field survey

Formal and informal survey were conducted from March to May 1995 in the North-east mountainous region of Vietnam to evaluate the role of food legumes in farming systems and identifying factors limiting their production in the region.

Three representative provinces of the region (Cao bang, Lang son and Bac thai) were chosen for collecting general informations. In each province, one representative village (Lung rieng in Cao bang, Parang in Lang son and Um in Bac thai), in which 30 households were selected for more detail survey.

Informations about the status of food legume production, factors limiting their production, the role of food legumes in human diets and animal feeds as well as in cropping systems have been collected from local statistical stations of provinces and districts and by interviewing farmers (questionnair in appedix H). In each village, 10 soil samples were taken representatively for analyzing soil chemical properties. Survey data have been analyzed by descriptive statistical method. Results from the survey were used to adjust plan execution of the field experiment (3.2).

3.2 Field experiment

The experiment was conducted in the field of the experimental station of Agricultural University No.3, Bac thai located in 21°35' N latitude, 105°50' E longtitude. This experiment aims at examining responses to possible soil improving measures of soybean and peanut (the major food legumes in the region), and, on this basis, find out possibilities for improving their productivity.

3.2.1 Conditions of the experiment

The experiment was laid out on the hilly soil with a slope is 10.5%. The soil chemical properties were:

pH_{KCl}	4.80
OM (%)	2.60
Exc. Al (meq./ 100 g soil)	0.85
N (%)	0.12
Available P (ppm)	3.60
Available K(ppm)	60.00

The experiment was conducted in the spring crop from March to June, 1995.

The variety of soybean in the experiment was *Cuc* (a local variety) with a growth duration in the spring crop was about 85-90 days. It is determinate variety.

The variety of peanut in the experiment was *Do Bac Giang*, with a growth duration in the spring crop was about 90-95 days.

3.2.2 Treatments and design

The experiment consists 8 soil treatments with two species of food legumes: soybean and peanut. The design of the experiment was split plot with three replications. The 8 soil tretments were in main plots, soybean and peanuts were in subplots. Plot size was 3 x4 m.Thus, the soil treatments of the experiment are a factorial combination of 3 factors, each at two levels. The factors were:

- Lime (0 and 1400 kg $CaCO_3$ ha^{-1}). Burnt limestone (CaO) with 178 % $CaCO_3$ was applied.

- Phosphorus (0 and 150 kg P_2O_5 ha^{-1}). Superphosphate with 16.5 % P_2O_5 was applied

-Nitrogen (0 and 150 kg N ha^{-1}). Urea with 46 % N was applied

The determination of lime rate was based on the amount of exchangeable aluminum in the topsoil, and the lime rate (ton $CaCO_3$ ha^{-1}) was calculated by multiplying the miliequivalents of aluminum by 1.65 (Sanchez, 1976, from Kamprath, 1970).

The determination of phosphorus rate was based on concentration of phosphate in the soil solution associated with 95 percent of maximum yield to be 0.2 ppm (Wild, 1988, from Fox, 1981). This was done by adding varying values of superphosphate fertilizer to soil samples and shaking gently in 100 ml 0.01 M $CaCl_2$ for 30 minutes twice each day for six days (Wild, 1988). A relationship between rates of superphosphate added and concentrations of phosphate in the soil solution was established. The rate of superphosphate to be added to the soil layer of 20 cm depth to raise the phosphate

concentration of its solution to 0.2 ppm was derived from this relationship. The result was presented in appendix E.

The nitrogen rate was calculated on basis of the amount of nitrogen required by soybean for maximum dry matter yield of 6 ton ha^{-1} (N concentration is about 3% of dry matter yield, Wild and Jones, 1988), N fixed by plant (about 57% of total N in the plant, Cattelan and Hungria, 1994), and the efficiency of N fertilizer utilization (about 30% in the tropical regions, Myers and Wood, 1987). It is supposed that N absorbed by plant from the soil is negligible, because the soil is very poor in nitrogen content.

Soil treatment combinations are designated as follows:

P ($kg\ P_2O_5\ ha^{-1}$)	L ($kg\ CaCO_3\ ha^{-1}$)	N ($kg\ ha^{-1}$) 0	150
0	0	0	N
150	0	P	PN
0	1400	L	LN
150	1400	PL	PLN

3.2.3 Cultural management practices

Soybean and peanut in the experiment were sown in March, 28, 1995. Row spacing is 40 cm for both, with 10 cm between hills. Two plants for each hill was remained after

plants have 2 fully developed leaves for soybean, and one plant for peanuts. The plant density was 50 plants m^{-2} for soybean and 25 plants m^{-2} for peanuts.

Potassium fertilizer (KCl, 60% K_2O) with a rate of 40 kg K_2O ha^{-1}, was applied as a basal fertilizer for both soybean and peanut. Phosphorus fertilizer (superphosphate, 16.5% P_2O_5), and lime (burned limestone) were applied before sowing by broadcasting. Nitrogen fertilizer (urea, 46% N) was applied in two times: (1) before sowing with one third of amount and (2) just prior to flowering stage of soybean with two third by row application. Before sowing, the seeds were inoculated with two various inoculates: (*sp.* DT_5 + G_3 + D 344) for soybean, and (*sp.* LB_1+ TAL 236+ D 384) for peanuts. These inoculates were from the Microbiological Department of Soil Science Faculty of Hanoi Agricultural University.

3.2.4 Sampling for observation indicators

3.2.4.1 Soil

A soil sample with 20 cm depth for each block were taken before doing experiment to analyze for soil chemical properties: pH, OM, total and available N, P, K concentration, and exchangeable Al. Before experiment, soil samples were also used with treatments of adding various amounts of superphotphate to determine phosphorus fertilizer rate applied in the experiment as above mentioned. After experiment, soil samples were also taken for each plot to analyze for these properties. Total nitrogen was determined by Kjeldahl, available phosphorus was determined by Bray II; Exchangeable K was extracted with 0.05 N HCl (Jackson, 1960); pH was determined in 1N KCl ; Organic C was determined

by oxidation to CO_2 in 2N H_2SO_4-5% $FeSO_4$, and organic matter (%) was calculated by multiplying organic carbon by 1.724 (Nelson and Sommers, 1982); Exchangeable Al was determined by extraction in 1N KCl , after that it was determined by titrimetric methods (Barnhisel and Bertsch, 1982).

3.2.4.2 Plant

At 3 stages during growth duration (V4.5; R4.5; and R6.5), an area of 1 m^2 was sampled from each plot for the following measurements:

Nodulation

Number of nodules and nodule dry weight per plant were determined on 10 plants selected randomizedly of each plot. These plants were dug carefully and then cleaned in the water tank. Number of nodule was counted and dry weight was determined after drying at 85-105^oC until stable weight.

Leaf area index (LAI)

In each plot, 10 plants were chosen randomizedly. After that, all leaves were cut and weighed with the weight A. An area of 1 dm^2 of leaf was cut by puting fully the leaves in a cardboard with area of 1 dm^2 and cut. Then, 1 dm^2 of leaf was weighed with the weight B. Proportion of A:B is number of dm^2 of leaf in 10 plants.

Biomass

Leaves and stems of each plot were separated and dried at 85-105^{o}C until stable weight. The dried plant samples including stems and leaves together were also taken for each plot to analyze for nitrogen content in the plant.

Plant height

10 fixed plants for each plot were measured at the three stages of growth.

Nitrogen content in the plant and nitrogen yield

Kjeldahl method was used for analyzing nitrogen content in the plant (leaves and stems together) at the three stages. Nitrogen yield was calculated by multiplying nitrogen content by dry matter yield at various stages.

Economic yield and its components

An area of 2 m^2 in each plot was harvested to determine the yield, and 10 plants for each plot were subsampled for yield components. For soybean, plants were cut near the soil surface, and dried. Seeds were separated out of pods, and seed yield with 14% of moisture was determined. For peanut, filled pods were separated and dried. Filled pod yield with 12% of moisture was determined.