CHAPTER 4

RESULTS OF FIELD SURVEY

4.1. Topography and soil characteristics of the study site

Secondary data obtained from survey indicated that the soil topography in Central Vietnam has three characteristics and is divided into three different ecological zones. The first ecological zone consists of plains of poor alluvial soil supplied by rivers. This zone is mainly for planting rice. The second ecological zone consists of coastal sandy soils which are poor and dry. Some vegetables, sweet potato, chili, peanut and cassava are planted here. Moreover, willows (*Salix spp.*) are common planted in the zone in order to prevent from wind movement of sands. The third ecological zone consists of hilly and mountainous areas that occupy three quarters of the whole area of the region. The hilly and mountainous zone in Thua Thien Hue is divided into three types i.e. high hill (100 – 250m altitude), average hill (50-100m) and low hill (10-50m) (Nam, 1996).

The soils in the hilly zone are classified as Oxisols or Ferrasols and Acrisols (Chieu, 1996). The predominant soil type in the research area is Yellow - Red Ferralitic soil occupying 56.4% of the hilly and mountainous zone area (Nam, 1996). In addition, there are other types of soil in this zone such as Fluvisol and Humic Ferrasols. Most hilly soils are highly weathered, red to reddish, high in oxides of iron and aluminum and presumably low in base saturation. The Yellow – Red Ferralitic soils accumulates absolute Fe^{3+} and Al^{3+} to form laterite. Mineralization is rapid, and organic substances quickly break down making the content of humus low. Intensive surface and deep leaching process make the soil very acidic (pH 4 – 4.5) and poor in

nutrients. Nitrogen, phosphorous and anion phosphates (HPO_4^{2-}, PO_4^{3-}) are easily dissolved and carried away to such an extent that these soils can not be cultivated for very long time before they suffer serious degradation. In extreme cases of erosion, a hard pan of laterite nodules is exposed. In general, the hilly soil zone is less homogeneous, soil texture is silt to sandy loam and well aggregated with very strong structure (Cuc *et al.*,1990).

Peanut growing areas often locate in the foothill of hilly zone where its elevation ranged from 10 – 150 meters from sea level and where Yellow – Red Ferralitic soil on clay shale (Acrisols) is mainly. Properties of this type of soil from secondary data survey are presented in Table 1.

Table 1: Some characteristics of a typical soil in hilly zone of Thua Thien Hue province

Indicators	Depth (cm) 0 – 25	25 – 65	65 - 110
pH KCl	4.20	4.30	4.65
OM (%)	1.51	0.95	0.50
CEC (me/100g soil)	5.8	5.0	11.8
Ca^{2+}	0.89	0.74	0.72
Mg^{2+}	0.70	0.62	0.50
Al^{3+}	3.35	3.25	2.85
Total (%)			
N	0.12	0.09	0.07
P_2O_5	0.05	0.05	0.04
K_2O	0.06	0.05	0.04
Available phosphorous (mg/100g soil)	3.75	3.25	2.75
Texture soil (%)			
< 0.002mm	39.17	45.62	42.07
0.002 –0.02mm	7.90	6.07	11.97
0.02 – 0.2mm	39.25	35.43	33.86
0.2 – 1.0 mm	13.68	12.88	12.10

Source: Cong et al., 1997.

Result from Table 1 shown that each type of soil is characterized by some of particular properties depending on parent materials and formation process. Texture of this soil type is homogeneous and is classified from silty loam to sandy loam.

Soil pH greatly effects the solubility of mineral. It can also influence plant growth by the pH effect on activity of beneficial microorganisms. Data in Table 1 pointed out that soil pH gradually increases following the increase of depth of soil profile because of leaching process of Ca^{2+}, Mg^{2+} from the top horizon. For instance, pH at 0 –25 cm depth is 4.20 while this number is 4.65 at 65-110 cm in depth. In general, pH of hilly soil zone is acidic (pH_{KCl} from 4 – 4.6).

Organic matter is a very active and important portion of the soil. It is a nitrogen reservoir. It plays significant roles in furnishing large portion of the soil phosphorous and sulfur, protecting soil against erosion and loosening up the soil to provide better aeration and water movement. There is strong fluctuated of organic matter along with horizons of soil profile (Table 1). Top horizon (0-25 cm) has higher organic matter than below horizons which is 0.95, 0.50, respectively due to supplying of high organic matter in top horizon from plant residues.

Cation exchange is an important reaction in soil fertility. The plant nutrients i.e. calcium, magnesium and potassium are supplied to the plans in large measure from exchangeable forms. The capacity is low and highly dependent on the organic matter fraction. The high content of oxides indicates probable variable change (pH dependence) and a high capacity for fixation (adsorption) of applied phosphorous fertilizer. The amount of lime which requires to raise the pH of an acidic soil is greater as the CEC is greater. CEC of this soil is low and is often high at 0-25 cm in

depth (5.8 meq/100g soil), after that it will decreases at the 25 – 65 cm in depth (5.0 meq/100g soil) and finally, increases at deeper horizon (11.8 meq/100g soil).

Total nitrogen, phosphorous, potassium and available phosphorous are the essential nutrients for plant. General speaking, this soil is low in nitrogen, calcium, magnesium and potassium contents, especially very low in available phosphorous. Available phosphorous is fluctuating from (3.75 – 2.75 mg/100 g soil) at 0 –110 cm in depth while exchangeable Al^{3+} is quite high of 3.15 me/100g.

4.2. Climatic conditions

Hilly zone in Thua Thien Hue province is monsoon with hot dry summers (April – September) and cool, cloudy, moist winters (December – February). Climate condition in Thua Thien Hue province is presented in Figure 4.

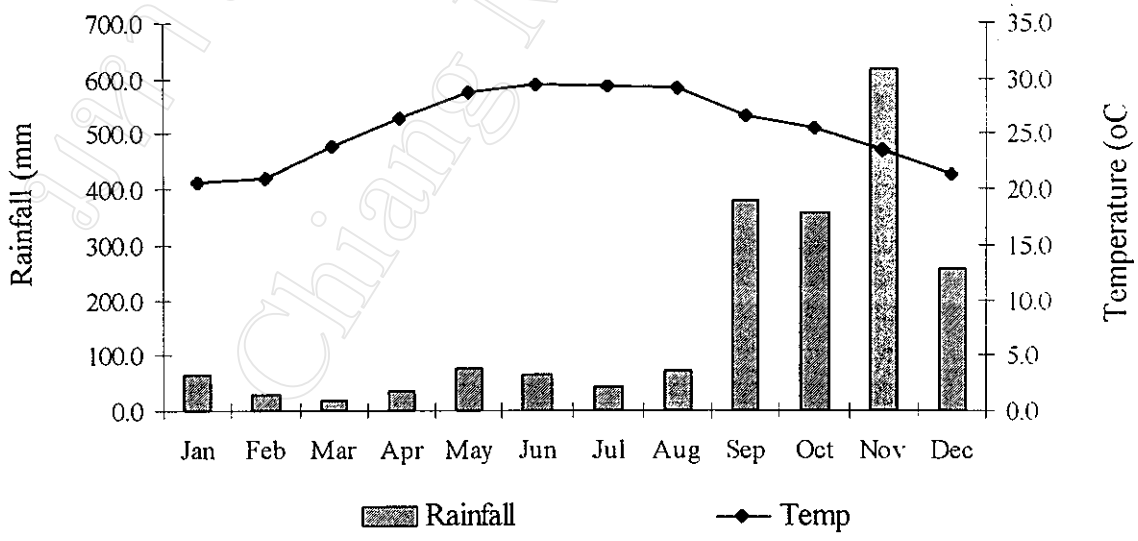

Figure 4: Ten - year average of rainfall (mm) and temperature (°C) in Thua Thien Hue province (1989 –1998)

Source: Hue Meteorological Station, 1999.

The annual average temperature is fluctuating from 21.6°C (Aluoi district) to 25.2°C (Hue city). The dry season in summer has the lowest rainfall and the highest temperature usually occurs in July. The highest temperature in the summer can reach up to 34°C. High temperature and low rainfall are often causes of drought which seriously affect crop production in the region. The total average rainfall ranges between 2800 –3300 mm per year and is not equally distributed. About 80% to 90% of the rainfall take place in the rainy season and are concentrated mainly in October and November. Therefore, some storms and floods occur at that time which can significantly affect crop production.

The fields experiment was conducted at Thuychau village of Thua Thien Hue province from March to June (1999) (climate as shown in Figures 5 and 6).

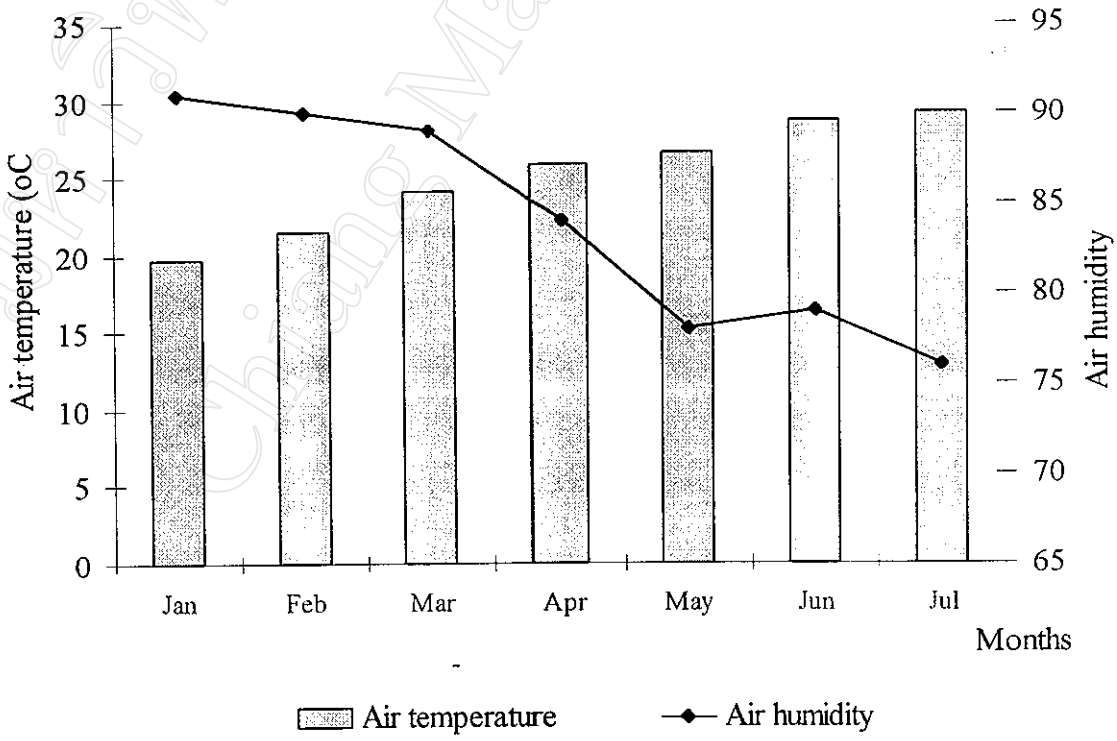

Figure 5: Air temperature and humidity of Thua Thien Hue province in 1999

Source: Hue Meteorological Station, 1999.

The total amount of rainfall in three months (March to May) is 432 mm and it's distribution was increasing from January to May. Air temperature ranged from 19.7 – 26.6°C. According to Pandey *et al.*, (1987) the optimum temperature and rainfall for peanut growth are about 22 – 33°C and 400 – 1700 mm respectively. While carrying out the experiment, the sunshine and evaporation were also increasing from January to May. Thus the climatic condition in the region are considered to be suitable for peanut growth and development. Moreover, air humidity ranged between 75 – 90% in which the highest air humidity was obtained in November when there was low temperature and high rainfall. The lowest air humidity often occurs in July and August (<70%). Data related to evaporation and rainfall (Figure 6) also indicated that water supply in this season is enough for peanut production and other crops in the areas. However, water shortage often occurs in the dry season from May to August which also affects growth and development of crops in the region.

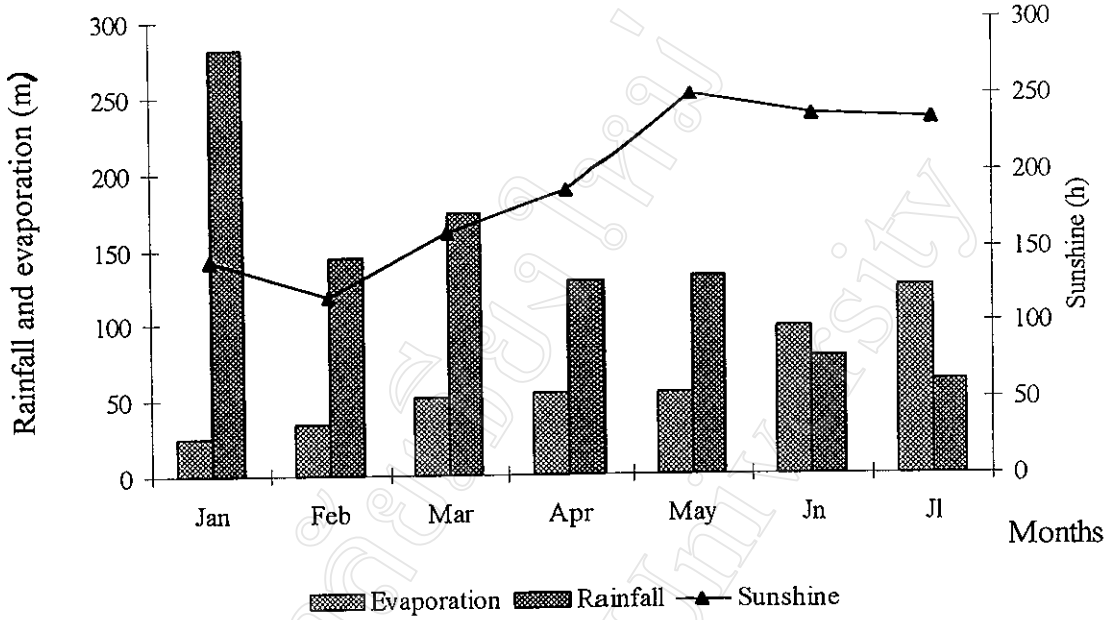

Figure 6: Evaporation, rainfall and sunshine in Thua Thien Hue province in 1999

Source: Hue Meteorological Station, 1999.

4.3. Land use

The character of rural landscape in the hilly zone is largely determined by topography and is fairly complex and the pattern of land use reflects this. Generally, there are two basic land forms for people to work which is lowlands and uplands (Cuc *et al.*, 1990). Total land area in the hilly and mountainous zone of Thua Thien Hue province is 329,609 ha in which cultivated land area occupies about 5% of the total land area. Food crop production area covers 80% of the cultivated land area in the region. Crop production is the major source of food, employment and incomes for most of hilly people. Wetland rice, cassava, sweet potato, peanut, mungbean and sugarcane are the six major crops in the regions (Table 2). Rice has been the sole dominant crop in terms of land utilization and food supply for hilly people. The

second important crop is peanut followed by cassava, sweet potato, sugarcane and mungbean.

Table 2: Land use of three surveyed villages

Villages	**Phongson** (m^2/household)		**Thuychau** (m^2/household)		**Binhdien** (m^2/household)		**Average**
Indicators	Mean	SE	Mean	SE	Mean	SE	
Spring rice	3,830	356.36	1,875	222.5	175	63.09	1,960
Summer rice	3,543	327.01	1,613	154.4	88	186.29	1,748
Peanut	1,498	194.37	460	41.29	331	34.69	763
Mungbean	400	106.38	200	46.59	221	63.09	274
Cassava	463	115.10	563	102.40	1265	129.22	764
Sweet potato	113	52.8	135	48.68	303	97.37	184
Sugarcane	425	81.31	750	123.01	575	114.85	583
Total areas	**10,272**		**5,596**		**2,958**		**6,275**

Note: SE = Standard error of mean; Number of surveyed households = 60

Source: Survey, 1999.

The survey data from Table 2 shows that average total cultivated area per household of three villages in hilly zone was 6,275 m^2. This area is higher than total cultivated area per household of delta plain zone (6,183 m^2) (Thanh's surveyed results, 1998) and lower than the coastal sandy zone (12,817 m^2) (Tinh's surveyed results, 1997).

Most of the cultivated land areas in three surveyed villages were planted with rice (3,708 m^2) occupying 60% of total cultivated area. The paddy fields are often on moderately flat lowlands. Wetland rice is grown in lowland areas near rivers or springs with irrigation. Irrigation systems seem to adequately provide supplemental

water to most farms visited; however, this probably differs from year to year according to rainfall condition. Most of the cultivated areas are planted to two rice crops per year which was spring rice (1,960 m^2/household) and summer rice (1,748 m^2/household). However, secondary data from survey on rice cultivated area in the hilly zone has been slightly declining (23,583 ha in 1991 down to 23,088 ha in 1998) (Hue Statistical Book, 1999). But, it accounts for rather a constant proportion of the provincial figures throughout the period in which this indicated that the new suitable area for rice become scarce. Farmers would like to change to grow peanut and other cash crops with higher income and soil fertility improvement.

The five remaining crops are considered as rotation crops, intercrops with perennial crops or other annual crops in both lowland and upland with non- irrigation (rainfed area). Peanut area in the hilly zone has been steadily increasing from 1,617 ha in 1994 up to 2,660 ha in 1998 (Hue Statistical Book, 1999) while areas of other crops such as sweet potato and cassava have been remarkably declining due to low yield, poor market and poor processing from post harvesting. Survey results also indicated that the average cultivated area for peanut is low at 763 m^2/household in comparison with rice and cassava cultivated areas. Although this crop provided higher economic values as compared to rice, but it requires higher cost for inputs.

Sugarcane is a new crop in the region. Farmers have been grown it since 1994 when Vietnamese Government freezes fresh issue of licenses for sugar industry and in order to achieve a target of one million tonnes sugar production by the turn of century, Vietnam has allowed 100% foreign direct investments in the sector. Therefore, a few India units have set up mills in Vietnam in which KCP Ltd was

setting up a mill in Thua Thien Hue province. KCP Ltd is responsible for paying the cost of land preparation (1 million VND per ha) for sugarcane growers. Farmers can borrow money for buying variety and fertilizer at the beginning of sugarcane season. At final harvest stage, this mill will be bought all sugarcane products from farmers' field. The sugarcane area of each household in the hilly zone is rather high (583 m^2). This is because sugarcane is needed as raw material for a sugar mill in the region. Hence, the cultivated areas of sugarcane in this region have increased rapidly from 128 ha (1995) up to 401 ha (1998).

Mostly, land use for agricultural production in hilly and mountainous zone is limited because it is very difficult to develop irrigation due to the complexity of the terrain. In addition, increase in the rural population and the new market economy in Vietnam are increasing the pressure on agriculture in the hilly zone to produce more. In other words, there is need to change into some new crops with higher income in order to replace for traditional crops i.e. sweet potato and cassava aiming at improving land productivity in this region.

4.4. Peanut in cropping systems

4.4.1. Cropping patterns in hilly zone

Due to topographic, climate conditions, irrigation facilities and small farm size, cropping patterns in the hilly zone are more diversified. Rice, cassava, sweet potato and peanuts are the most important crops in the production system of the hilly soil zone. There are some existing cropping patterns in this region both in lowland and upland areas (Figure 7). The lowland with irrigated areas is used to grow rice

and peanut. Crops such as cassava, peanut, mungbean and sugarcane are found on the foothill or gentle upland slope areas (less than 15%).

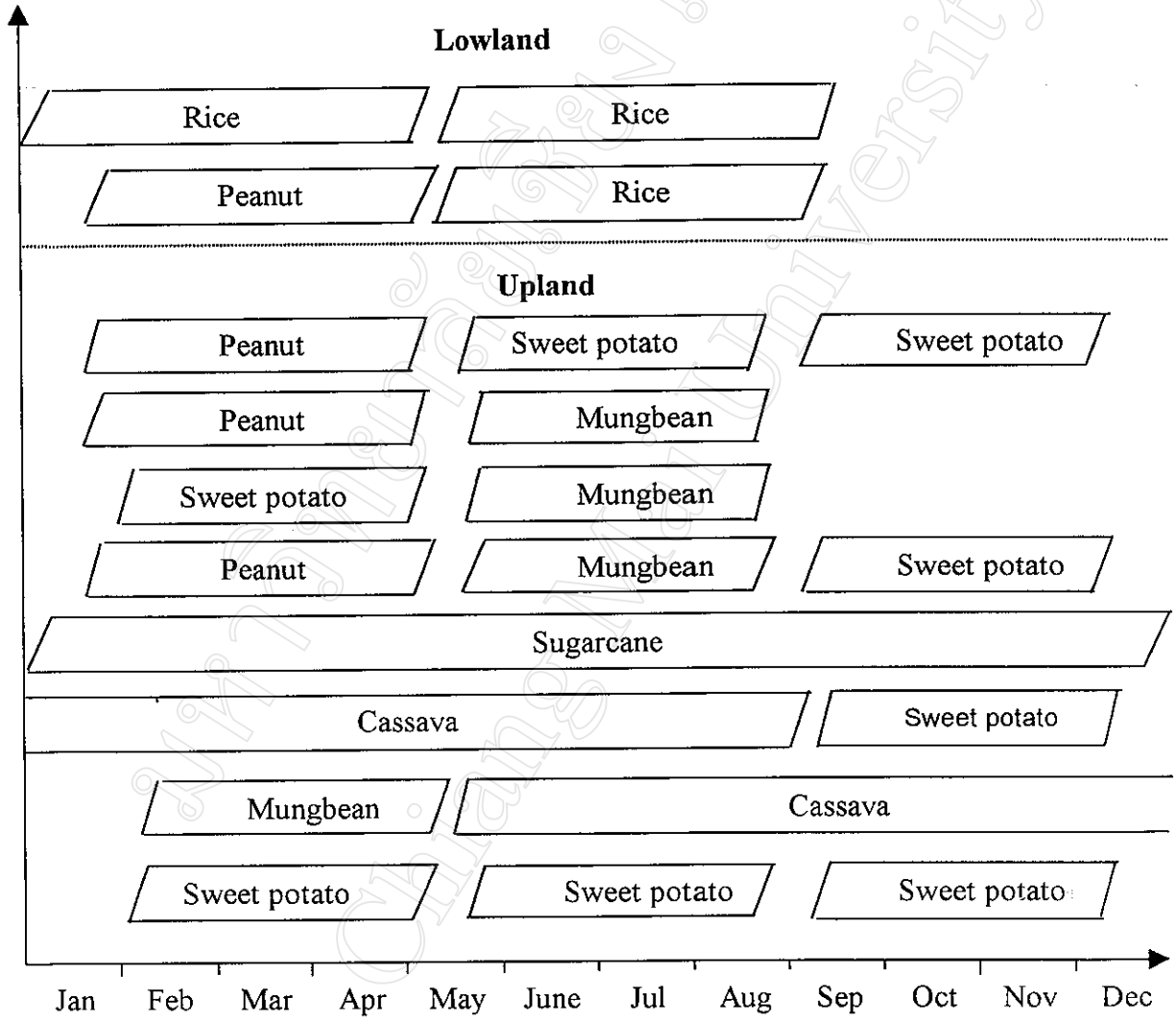

Figure 7: Some main cropping patterns in the three surveyed villages

Figure 7 shown that in lowland with irrigated area, non-glutinous rice is the dominant variety in the spring season and summer season since farmers normally reserve rice for home consumption. Besides rice - rice pattern, peanut - rice pattern is rather popular in this area. Outside the irrigated area of the hilly zone there is another different system which is upland. In this system, double cropping is possible like peanut - mungbean and peanut - other crops. Sweet potato - sweet potato - sweet potato and mungbean - cassava patterns are two traditional cropping patterns which mainly grown in the past. However, they become less feasible in economic efficiency than the remaining patterns. Therefore, farmers have recently changed to new cropping patterns namely peanut - sweet potato - sweet potato, peanut - mungbean and peanut - mungbean - sweet potato with higher income and probably soil fertility improvement. Nevetheless, these two traditional cropping patterns as mentioned above still exist in a fairly large area in the region occupying 60% growing area of the surveyed households. Because cassava and sweet potato can substitute for rice as a stable food when rice production is low and they do not require high soil fertility and their products are used not only for animal raising but also for food supply especially in poor households. Survey results also found that peanut - sweet potato - sweet potato and peanut - mungbean are applied much more in three villages. So peanut appears in most cropping patterns. It means that peanut plays an important role in the existing farming systems of the hilly zone.

4.4.2. The role of peanut in cropping systems

Peanut can considered as the most efficient crop in terms of economic as well as soil improvement for hilly zone. Results of interviews with farmers about the role of peanut in cropping systems of the hilly zone are shown in Table 3.

Table 3: Percentage of farmer's opinion on the role of peanut in farming systems

Indicators	Phongson	Thuychau	Binhdien
1. Cropping systems	n =20	n =20	n =20
1.1. Green manure, mulching			
- Very important	40	30	35
- Important	60	70	65
- Not important	0	0	0
1.2. Soil fertility			
- Increased	85	80	75
- Decreased	0	0	0
- No change	15	20	25
1.3. Pest situation for rotation			
- Increased	5	0	0
- Decreased	60	70	75
- Not change	35	30	25
2. Net return as compared with rice			
- Better	95	85	90
- Worse	0	0	0
- Similar	5	15	10
3. Family labor's use			
- Efficient	90	80	85
- Inefficient	0	0	0
- Not different	10	20	15

Source: Survey, 1999.

As green manure and mulching: One hundred percent of interviewed farmers in three surveyed villages said that peanut provides green leafs which are good source of animal feed and a nitrogen rich green manure. On the other hands, peanut residues is considered as green manure and they often applied to the rice crop as incorporation and cassava, sweet potato as mulching.

Peanut in improving the soil fertility: When asked about the role of peanut in improving the soil fertility, more than 75% of total interviewed farmers responded that soil fertility improvement based on planting peanut is important. Farmers said that rice and sweet potato developed better when they grown after harvesting peanut.

However, there was 15 – 25% of them assumed that nothing changed after growing peanut.

Peanut and pest status in subsequent crops: Almost all farmers answered that the peanut – rice and peanut – other crops rotation are the best way to limit the development of diseases and insect pests in the field. Because this maintains biodiversity and breaks the cycle of cereal cropping as well as reducing the incidence of weeds, insect pests and soil born diseases. Above 65% farmers said that pests and diseases in the field with growing peanut occurred less than in the field without growing peanut. Only 5% of total farmers in Phongson village disagreeded that idea. Besides, 25 – 35% interviewed farmers thought that nothing changed in their field where peanut grown (c.f. other fields).

Net return as compared with rice: 85 – 95% of farmers who expressed their opinion that growing peanut is better in net return as compared with rice growing (Table 3&9). Nobody assumed that growing peanut was decreased net return (c.f. other crops).

Peanut in family's labor use: The survey results in Table 3 also indicated that more than 80% of farmers answered when peanut appeared in cropping patterns, labor use became more efficient in terms of the working time and labor forces. Because, most peanut fields are located on dry land, therefore crop management practices in peanut production such as sowing, weeding, harvesting and processing can be done by all sources of labor in the household.

4.5. Farmers' practices in peanut production

Peanut is a long traditional crop in the region. Therefore, farmers have had many experiences in peanut production. Some farmers' practices in peanut production are presented in Table 4.

In the hilly zone of Thua Thien Hue province, soils are commonly tilled for growing peanut. One hundred percents of total farmers in three villages used tillage to prepare the seedbed for peanut. The main purpose for tillage is to prepare an adequate seedbed and to control weeds. In addition, tillage also improves aeration, increases water infiltration as well as bury crop residues. In the tilled fields. peanut seeds are sown in the row after plowing with one seed per hill, creating more or less equally spaced rows of about 25 – 35 cm apart and distances among plants are about 8 – 10 cm. Therefore, the plant density varies about 266 to 375 thousand plants per hectare. More than 75% of interviewed farmers grew peanut with plant density of about 333 thousand plants/ha (30 cm x 10 cm x 1 seed). Most farmers used local varieties such as "Giay BTT", "Moket", "Du Nghe An". Some farmers used new high yielding varieties such as "Sen Nghe An". But it is not popular because of the quality of product and the low price in the market as compared with other local varieties. Farmers prefer the local varieties especially Giay BTT due to higher commercial value of this variety (over 75% of total farmers). Regarding pests and diseases, 65% – 80% of farmers used pesticides for controlling pests and diseases in the field which is grown peanut. The remaining farmers ignored controlling pests.

Table 4: Farmers' practices in peanut production

Issue	Value	% in PS	% in TC	% in BD
1. Tillage	With	100	100	100
	Without	0	0	0
2. Manure application (kg/ha)	3000	5	0	5
	4000	30	20	35
	5000	30	70	60
	6000	25	10	0
	7000	10	0	0
3. Urea (kg/ha)	20-30	15	40	30
	31-40	45	40	55
	41-50	30	15	10
	51-60	10	5	5
4. Phosphorous (kg/ha)	20-40	40	65	60
	41-60	55	35	40
	61-80	5	0	0
5. Potassium (kg/ha)	10-30	70	85	80
	31-40	20	5	15
	41-50	10	10	5
6. Lime (kg/ha)	300	10	30	30
	400	65	45	65
	500	25	20	5
	600	0	5	0
7. Pest control	With	80	70	65
	Without	20	30	35
8. Plant density	30cm x 10cm	85	70	95
	35cm x 8cm	10	20	5
	25cm x 15cm	5	10	0
9. Fertilizer application number	3 times	100	100	100
10. Variety	Giay BTT	80	75	80
	Moket	15	15	15
	Du Ngean	5	10	5

Note: % in PS = content of farmers in Phongson village, % in TC = content of farmers in Thuychau village and % in BD = content of farmers in Binhdien village.

The survey results indicated that all farmers applied fertilizer to peanut (Table 4). Farmers applied fertilizer at different rates at each surveyed village. 30% - 70% of farmers applied 5,000 kg manure/ha. 10 – 30% of them applied 40 – 50 kg of urea ha^{-1}, especially in Phongson village there was 10% of farmers used 50 – 60 kg of urea ha^{-1} while there was only 5% of farmers (also in Phongson village) applied phosphorous fertilizer at 60 – 80 kg ha^{-1}. Although the soil pH is very low, the lime levels applied for peanut is still low (400 – 500 kg lime/ha).

Table 5: Average fertilizers applied for peanut field in three villages

Villages	Indicator (kg/ha)	Mean	Min.	Max.	CV (%)	SE	n
Phongson	Manure	5050	3000	7000	21.76	245.75	20
	Urea	45	20	60	40.42	2.36	20
	Phosphorous	50	30	80	27.39	3.03	20
	Potassium	33	20	50	24.28	1.79	20
	Lime	415	300	500	14.15	13.13	20
Thuychau	Manure	4900	4000	6000	11.28	123.54	20
	Urea	40	20	60	26.49	2.03	20
	Phosphorous	43	30	60	27.28	2.19	20
	Potassium	26	10	50	42.13	2.45	20
	Lime	400	300	600	21.46	19.19	20
Binhdien	Manure	4550	3000	5000	13.29	134.24	20
	Urea	37	20	60	19.14	1.38	20
	Phosphorous	40	20	50	26.45	2.46	20
	Potassium	25	10	50	46.77	2.56	20
	Lime	375	300	500	14.67	12.3	20

Note: n = number of households interviewed

In general, chemical fertilizers were used regularly but in relatively small amounts. Most of the farmers applied high levels of nitrogen fertilizer while phosphorous and potassium fertilizer were applied at low levels or not applied to some crops. Average fertilizers amount applied for peanut in Phongson village was

higher than the rest villages. The coefficient variation of applied fertilizer was fluctuating depend on each kind of fertilizer and each surveyed village (Table 5). Phosphorous, nitrogen and potassium fertilizers application had the high variation especially potassium application in which coefficient of variation was 46.77% in Binhdien while there was less fluctuated in manure and lime application between households in three villages. As implied above, most of the peanut growing areas in the region is low in phosphorous and high acid. However, the current rates of phosphorous and lime used by farmers in this zone are quite low in comparison with recommendations for high yield of crops (Kha, 1995). Thus, low peanut yield in this region might be caused by these limiting factors. Common methods for fertilizer and lime application for peanut were broadcasting and banding. Lime was often placed as broadcasting before sowing from two weeks to one month and incorporated to the soil in 20 cm depth. Phosphorous fertilizer and manure were applied at sowing as basal fertilizers. Both nitrogen and potassium fertilizer were applied as row applications at two stages of plant growth (1) one third of the amount at the stage of full expansion of the third leaf and (2) just prior to flowering the remaining two thirds of the amount.

According to field survey results, yield of crops in each surveyed village were different due to intensification levels of farmers and use of natural resources. Data regarding peanut yield variation was collected in three years (1997 – 1999) at 20 households in a village (Figure 8) and the yield variation of peanut in the research area is different (Table 6 & 7).

Table 6: Yield ranges of peanut in Phongson, Thuychau and Binhdien

Phongson			Thuychau			Binhdien		
Yield (kg/ha)	Farmer (%)	Cum. (%)	Yield (kg/ha)	Farmer (%)	Cum. (%)	Yield (kg/ha)	Farmer (%)	Cum. (%)
1060	5	5	1000	5	5	900	5	5
1200	5	10	1100	10	15	1000	5	10
1220	5	15	1200	15	30	1100	5	15
1300	30	45	1220	10	40	1140	5	20
1340	5	50	1240	5	45	1180	5	25
1360	5	55	1260	5	50	1200	15	40
1400	10	65	1300	15	65	1240	5	45
1420	5	70	1320	5	70	1260	5	50
1500	15	85	1340	10	80	1280	10	60
1520	5	90	1380	5	85	1300	10	70
1600	5	95	1440	5	90	1340	5	75
1660	5	100	1540	5	95	1360	5	80
			1600	5	100	1380	10	90
						1400	5	95
						1500	5	100

Note: Cum. = cumulative percentage

Table 7: Average yield of peanut in three surveyed villages

Villages	Mean (kg/ha)	Min. (kg/ha)	Max. (kg/ha)	CV (%)	SE	n
Phongson	1374	1060	1660	10.46	31.03	20
Thuychau	1280	1000	1600	11.15	34.49	20
Binhdien	1247	900	1500	11.31	30.45	20

Note: n = number of households interviewed

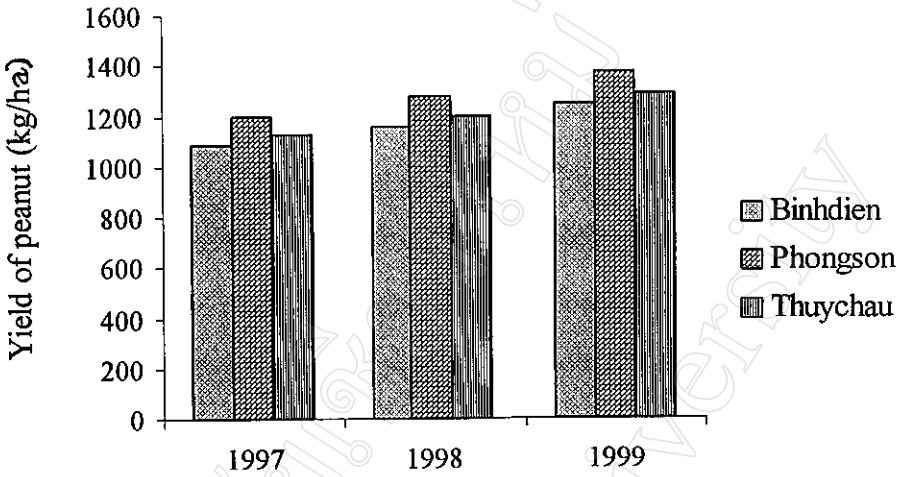

Figure 8: Yield variation of peanut crop in three surveyed villages

Source: Survey, 1999.

In Phongson village which had the highest levels of intensive use of fertilizer compared to the other surveyed villages, peanut yield among households is higher than other villages. About 55% of households in Phongson had peanut yield lower than 1.3 ton whereas these numbers were 80% and 90% in Thuychau and Binhdien, respectively. The highest yield of peanut obtained was 1,660 kg ha^{-1} (in Phongson) and often occurred in the household which had high intensification. The lowest yield was 900kg ha^{-1} (in Binhdien). It means that there was big gap of peanut yield in three villages. Average peanut yields in three villages in 1999 were 1,247; 1,280 and 1,373 kg ha^{-1}. These numbers are still low as compared with the potential yield of peanut. Most of the farmers had yields fluctuating from 1,300 to 1,500 kg ha^{-1}. This means that if farmers used proper fertilizer rates, they might obtain higher yields from the crop and there is high potential for improving peanut yield in the region. In addition, coefficient of variation of peanut yield in three villages from 10.46 to 11.31 prove

that peanut yield in the area is rather homogeneous. Nevertheless, peanut yield in three villages has also increased year by year. Surveyed data shown that the average peanut yields of households in Thuychau village were 1,127; 1,193 and 1,280kg ha^{-1} from 1997 to 1999. The purpose of the application of lime and phosphorous to peanut production was not something new to the farmers, but the problems may relate to the rates of uses. In fact, the fertilizers were applied differently from village to village depending on the economic conditions and condition of the land. This leads to different crop yields in these villages. Apart from fertilizer rates application, mismanagement practices of farmers for peanut is a limiting factor that affected to peanut yield in the region. Because the survey results indicated that all farmers applied fertilizer for peanut in 3 times, however they did not often apply on time i.e. late or early than the requirement time of application. Furthermore, the survey results also suggested that low available phosphorous and soil acidity could limit peanut yield in the farmers' field in the research areas.

4.6. Gross margin of some crops

Table 8 presents gross margin of some crops. It is shown that some crops give a higher gross margin (these include sugar cane, peanut and rice) than other crops such as mungbean, sweet potato and cassava. Average gross margin of peanut, sugarcane and rice are approximately 3.78, 2.27 and 1.31 million VND per ha, respectively. While gross margin of the other crops are 0.44, 1.12, 1.01 million VND per ha for mungbean, cassava and sweet potato, respectively.

Table 8: Gross margin (Thousand VND ha^{-1}) of some crops in hilly zone

Villages / Indicators	Phongson		Thuychau		Binhdien		Average
	Mean	SE	Mean	SE	Mean	SE	
Rice							
Variable costs	4,032	58.79	3,834	71.19	3,245	420.35	3,704
Revenue	5,400	112.90	5,130	190.81	4,500	227.75	5,010
Gross margin	2,268	81.9	1,296	124.24	1,255	580.91	1,306
Peanut							
Variable costs	3,504	81.98	3,346	66.42	3,260	49.76	3,370
Revenue	7,552	182.36	7,040	180.28	6,857	168.61	7,150
Gross margin	4,048	118.83	3,694	142.79	3,597	132.34	3,780
Mungbean							
Variable costs	2,437	39.91	2,061	50.14	2,076	38.24	2,191
Revenue	3,129	125.24	2,475	134.24	2,301	89.43	2,635
Gross margin	692	98.46	414	105.05	225	63.44	444
Cassava							
Variable costs	2,108	33.2	2,189	32.78	2,115	30.48	2,137
Revenue	3,059	154.45	3,493	249.72	3,212	116.06	3,255
Gross margin	1,201	131.18	1,304	184.88	1,097	96.51	1,118
Sweet potato							
Variable costs	1,809	26.33	1,803	65.26	1,712	59.44	1,775
Revenue	2,875	314.58	2,867	240.37	2,601	273.96	2,781
Gross margin	1,066	291.12	1,064	192.02	889	275.39	1,006
Sugarcane							
Variable costs	5,703	133.97	5,847	107.53	5,476	83.03	5,675
Revenue	7,908	401.67	8,463	335.02	7,471	284.09	7,947
Gross margin	2,205	291.33	2,616	256.17	1,995	214.4	2,272

Source: Survey, 1999.

Peanut also is the crop that can give a high gross margin for farmers, therefore, the peanut growing area in the hilly zone is increasing year by year, from 1,760 ha (1995) to 2,660 ha (1999) (Hue Statistical Book, 1999).

4.7. Gross margin of some cropping patterns

Gross margin of some cropping patterns in this soil zone are shown in Table 9. Analysis of economic efficiency is the final necessary stage for assessment of production output and efficient investment in farming systems.

Table 9: Gross margin (Thousand VND ha^{-1})of some cropping patterns

Cropping pattern	Total revenue	Variable cash costs	Gross margin
Rice-rice	10,020	7,408	2,612
Peanut- rice	12,160	7,074	5,086
Peanut- sweet potato- sweet potato	12,712	6,920	5,792
Sweet potato- mungbean	5,416	3,966	1,450
Peanut - Mungbean - Sweet potato	12,566	7,336	5,230
Peanut- mungbean	9,785	5,561	4,224
Mungbean - cassava	5,890	4,328	1,562
Cassava - sweet potato	6,036	3,912	2,124
Sugarcane	7,947	5,675	2,272

Source: Survey, 1999.

Results in Table 9 show that cropping patterns with peanut – sweet potato – sweet potato have the highest gross margin which was 5.79 million VND ha^{-1}, followed by peanut – rice and peanut – mungbean – sweet potato which were 5.09 and 5.23 million VND ha^{-1}, respectively. The lowest gross margin occurs in cropping patterns of mungbean – cassava and sweet potato – mungbean which were 1.56 and

1.45 million VND ha^{-1}, respectively. Almost all the cropping patterns with peanut can result in high gross margin. Mostly the gross margin of cropping patterns including peanut in the hilly zone is higher than in those of coastal sandy soil. According to the survey results of Tinh (1997) in the coastal sandy zone, gross margin of some cropping patterns including peanut like cassava – peanut and peanut – rice was only 2.27 and 2.23 million VND ha^{-1}, respectively.

4.8. The constraints on peanut production

The farmers reported that low productivity of crops as compared with the potential yield is one of the biggest factors limiting their production in the study zone. According to Anh (1992) the potential yield of peanut is 2.0 - 2.5 ton ha^{-1}. But the average yield of peanut, in fact, in many places in the country is still as low as 1.23 ton ha^{-1}, 1.56 ton ha^{-1} and 1.8 ton ha^{-1} in the Central, the Red river delta and the Mekong river delta, respectively.

In general, soil in the hilly soil zone has very poor fertility and high acidity as shown in Table 1. Among the physical factors that limit peanut productivity application of nitrogen, phosphorous and potassium fertilizer to overcome low soil fertility are the most important ones. Also the low rate of phosphorous application as compared to nitrogen application is another limiting condition for improving peanut productivity besides lack of manure. The results of interviewing farmers in the three surveyed villages reinforced of the above-mentioned conclusions (Table 10).

More than 70 % of farmers pointed out that physical factors i.e. low soil fertility, acid soil, lack of manure and imbalanced fertilizers were limiting to peanut

production in this region. Peanut cropping has not received attention for intensification by use of appropriate levels of fertilizer. Some households depend on the natural soil fertility and the nitrogen-fixing capacity of the peanut itself. Besides the physical factors, biological factors are also important factors affecting peanut productivity. About 50% of interviewed farmers answered that lack of varieties with resistance to drought, pests and which produce high yields is a limiting factor in peanut production. In addition, irrigation and rainfall are also limiting factors which constrain peanut yield. Because, all of the peanut growing areas in this zone are located in rainfed area as mentioned above.

Table 10: Percentage of farmers' opinion about limiting factors on peanut production in hilly zone

Indicators	**Phongson** n = 20	**Thuychau** n =20	**Binhdien** n =20
1. Physical factors			
- Poor soil fertility	70	80	85
- Imbalance fertilizer	80	80	75
- Lack of manure	65	70	80
- Low application of P or no	85	70	70
2. Biological factors			
- Pests	40	40	30
- Lack of high yielding variety	60	50	50
3. Socio –economic factors			
- Low price	80	50	50
- Lack of capital	60	80	85
- Small markets	100	90	85

Source: Survey, 1999.

On the socio- economic aspects of peanut production i.e. low price in this area as compared to other markets (above 50% of farmers responded), lack of capital for farmers, and 90 – 100% farmers answered that small markets are also important

constraints to peanut production in the hilly zone. With the self-sufficient economy, the market for consumption is narrow in certain localities which cope along with lower price and lack capital for production (Hoang, 1994). So the farmers only grow peanut just to fulfill their domestic demands. As a result, farmers have to concentrate the capital for food crop production before growing, which considerably restrains the spread of the sown area of peanut in most of hilly soil.

One of the problems regarding to peanut production in the region which was considered is imbalance proportion application of chemical fertilizers in terms of less application of phosphorous and lime rates. On the other hand, determining the effect of phosphorous fertilizer and lime rates on yield improvement of peanut in hilly zone was conducted in the field of experiment.