Chapter 5

DISCUSSION

5.1 Hypothesis I

"The high income farmers have good soil and the low income farmers have poor soil"

5.1.1 Characterize individual fields

The six selected farmers in three villages have totally 20 upland fields, which were divided into land form units and slope units, we decided to do 80 augers and took soil samples at the topsoil for each drill. In Fig 4.40 (chapter 4, page 93) showed the comparison of the stock of Corg and N in 20 fields of the six selected farmers. In two villages (Kho Vang and Ta Lang Thap), the stock of Corg in the fields of the rich farmers is lower than the poor farmers. And in another case (Na Ten), the stock of Corg in fields of the rich farmer is higher than the poor farmer. In Ta Lang Thap village, the Corg stock of the fields is difference between the rich and poor farmers. In two case (Na Ten and Ta Lang Thap), the fields of the rich farmers have less N stocks than the fields of the poor farmers. However, one case (Kho Vang) the fields of rich farmer has higher N stock than the poor farmer.

In generally, the 80 top soil samples were used to assessment soil quality of 20 upland fields of the six selected farmers by comparing individual parameter of the Corg stock and N stock (kg/m2) of each farmer. The result (Fig 4.40) is not clear enough to indicate the relation between the economic status and the soil quality of the six farmers.

5.1.2 Comparison of soil fertility of the six soil profiles by the LSC/ITC-Ghent method, Landon (1984) and Jahn (2006).

According to the LSC/ITC-Ghent method (Sys et la, 1993), parameters of soil physical and chemical properties for the six fields (six profiles) were considered indirectly in land evaluation. To have more details to compare single soil parameter of soil properties of the rich and poor farmers, it is chosen to use the evaluation of soil quality according to Landon (1984) and Jahn (2006) instead of the LSC/ITC-Ghent.

The evaluation of soil fertility of six selected farmers' upland fields was based on physical and chemical properties of the soil profiles by the LSC/ITC-Ghent method (Sys et al.1993). The most important crop in the study area is maize and it is a major cash crop for the farmers in Yen Chau district (Keil et al. 2008). Thus, maize crop was selected to evaluate the cropping systems.

Among six fields, two fields (Profile Y-nt and T) are marginally suitable (S3) and four other fields (profile Y, H, B and BA) are not suitable (N) for maize cultivation (Table 4.46, chapter 4, page 88). The main reason for this low suitability is that maize crop is cultivated on steep slope which ranges between 15^0 and 38^0. According to land evaluation by Sys (1993), Table 4.42 (page 86) shows that the topographical ratings for the six fields are low: two fields (profile Y-nt and T) have the topographical rating 98 and 65 (very suitable and moderately suitable respectively), and the ratings of four other fields are lower than 50 (just marginally and unsuitable). More than 75% of the study area (three villages) has inclination between 15^0 and 38^0. Soil fertility is influenced by the topographical condition; that is, the soils which are on the steep slope have lower organic matter (Troeh & Thompson, 2005). Soil erosion on steep slope is caused by increasingly erosive slope length. As a consequence, soil cover and soil organic matters are decreasing (Clemens, et al. 2010).

According to land evaluation method of LSC/ITC-Ghent, the topographical condition is an important factor which limits the suitability of maize cultivation in Yen Chau district. As can be seen from Table 4.47 (chapter 4, page 88), where the soil and land index classes are calculated regardless of the topographical factor. The soil and land index increase moderately for all soil profiles. As a consequence, two out of six fields (profile B and BA) are moderately suitable (S2) and four other fields (profile Y, H, Y-nt and T) are marginally suitable (S3).

The physical properties of soil are very important condition for the maize crop to produce high yield. Soil depths of the profiles are an important criterion for the evaluation of soil quality according to Landon (1984) and Sys (1976). The soil depths can be divided in to five classes:

- > 150 cm very deep
- 100-150 cm deep
- 50-100 cm moderately deep
- 20-50 cm shallow to medium
- < 20 cm very shallow

In the study area, five soil profiles (profile Y, H, B, BA and Y-nt) have soil depths ranging from deep to very deep. Another soil profile (profile T) is moderately deep (80 cm deep). Soil profile T is 80 cm deep and the second horizon has about 60% coarse fragment. According to Sys (1991), these figures are rated 85 and it is a limitation for root growth (Table 4.44, chapter 4, page 87). The soil profile Y-nt is 150 cm deep but actually the rootable depth of this profile for maize and other plants is limited to 45 cm because of stagnic conditions in the subsoil (Btg. Table 4.35, chapter 4, page 81). Therefore, drainage rating for this profile is 68 (Table 4.45, chapter 4, page 87).

Soil textures play an important role in determining soil physical qualities because they influence soil properties such as soil water capacity, drainage, infiltration rate, tillage conditions and the capacity to retain nutrients (Attanda., 2000). Evaluating soil texture according to ITC-Ghent method results very suitability for maize cultivation: the soil texture is rated from 91 to 99 (table 4.43). The bulk density of soil presents the pore space and soil solid. The high bulk density indicates a low porous soil and a poor environment for root growth (Jahn, 2006). In general, among six profiles, five profiles have the bulk density ranging at the top horizons, from 1.2 kg/dm^3 to 1.4 kg/dm^3, which is very suitable and moderately suitable for root ability. However, the profile Y-nt has high bulk density (1.54 kg/dm^3). The soil structure is granular for top soil and subangular-blocky for sub-soil for six soil profiles, except for the profile Y-nt is clody and very compact at top soil.

In general, Table 4.43 shows that in Kho Vang and Ta Lang Thap, the rich farmers have a slightly higher soil physical rating than the poor farmers. In Kho Vang, the rich farmer: rating 86, the poor farmer: rating 79; in Ta Lang Thap, the rich farmer: rating 79, the poor farmer: rating 70. In Na Ten village, the physical rating for the soil profile of the poor farmer and the rich farmer is almost the same: the poor farmer: rating 99, the rich farmer: rating 95.

Soil chemical properties of the six profiles including pH value, Nt, Corg, CEC (Cations Exchange Capacity), exchange cations, BS (base saturation), P-Bray1 (available phosphate) and K-Bray 1 (available potassium) were considered.

pH value indicates the activity of the hydrogen ions in the soil solution. It affects weathering processes of soil and the availability of mineral nutrients to plants (Jahn, 2006). The chemical and biological soil and crop parameters are influenced directly by soil acidity (Graef, 1999). According to Sys (1993), pH values in H_2O upper 25 cm soil profile depth are assessed. The pH values of the six studied profiles are between 5.5 and 7. Table 4.48 indicates that the pH (H_2O) ratings for the six profiles (between 76 and 100) are very suitable for maize crop. However, according to Foth (1990), the soil of four profiles (Y, H, B and Y-nt) has moderate acidity (pH value 5-6) and the soil of two others (BA and T) has slight acidity (pH value, 6-7).

The CEC (cation exchange capacity) is an important parameter to evaluate soil fertility. CEC is the capacity of the soil to bind exchangeable cations and it depends on organic matter content and clay in soil. In the tropical areas, the transported clays from topsoil to subsoil are common; therefore, CEC is often low in such areas (Brady, 2002). CECpot (potential) of the six soil profiles was assessed by LSC/ITC-Ghent and this figure reaches the optimal rating (100) for all soil profiles of the rich and poor farmers. Nevertheless, according to Landon (1984), the CECpot of the three soil profiles (Y, H and B) is medium (20-25 cmol/kg), CEC of the soil profile Y-nt and T is a low value (9-15 cmol/kg), the CEC of the soil profile BA is a high value 30 cmol/kg. In general, as can be clearly seen from Table 4.29-4.40, the CECpot of all six profiles increases due to high clay contents with depth. It indicates that clay and organic matter transport from topsoil to subsoil.

Sys el al (1993) used the sum of exchangeable basic cations (Ca^{2+}, Mg^{2+}, K^{+} and Na^{+}) as a parameter for land evaluation. In Na Ten and Ta Lang Thap, the sum of basic cations rating for the rich farmers is higher than that of the poor farmers (two rich farmers with rating 100 and two poor farmers with rating 88 and 94) (Table 4.44). In Kho Vang village, the sum of exchangeable basic rating of both rich and poor farmers is equal to 100. This optimal rating indicates high suitability for maize crop. Erikson et al. (2005) assert that Ca^{2+} is important to chemical and physical properties of soil. According to Landon (1984), the exchangeable Ca of three profiles (Y, H and T) is medium rate, between 6.6 and 8.6 cmol/kg. The exchangeable Ca of the profile Y-nt is very low, about 3 cmol/kg. In contrast, the exchangeable Ca of the profile BA is very high, about 16 cmol/kg. The exchangeable Mg of all six profiles is medium. The exchangeable K of the profile BA is very high: about 0.9 cmol/kg but the exchangeable K of five other profiles is medium. The exchangeable Na of the six soil profiles is very low: from -0.001 to 0.004 cmol/kg.

The percentage of the base saturation (BS) was assessed according to Landon (1984). Landon (1991) categorize soils with high BS to be fertile soil (eutric); soils with low BS are less fertile soils. The percentage of base saturations was low in soil that indicated an acid soil (Erikson et al, 2005). The percentage of base saturations of the soil profile BA (rich farmer in Ta Lang Thap) was the highest of six profiles about 64%. That means the soil of profile BA is the most fertile of six profiles. The percentage of base saturations of profile Y-nt (poor farmer) Na Ten village is the lowest of six profiles, 40%. That mean the soil of profile Y-nt is the least fertile. The percentage of base saturations of other four soil profiles is medium, ranging from 50% to 56%.

The Corg, Nt and Pa (available Phosphate) of the six soil profiles were assessed by LSC/ITC-Ghent method and after that they were evaluated according to Landon (1984). The Corg is a parameter that indicates the P and N-status in soils also. Therefore, LSC/ITC-Ghent method uses only Corg parameter to evaluate and Corg is assessed the upper 25 cm. Table 4.44 (chapter 4 page 87) shows that Corg ratings of the two soil profile (Y and T) are moderately suitable for maize crop (rating 67 and 74 respectively) and the other four soil profiles (H, B, Y-nt and BA) are very suitable for the maize cultivation (ratings 86, 87, 78 and 88 respectively). More specifically, in two villages (profile B,Y-nt, BA and T) the Corg ratings in the profiles of the rich farmers are higher than those of the poor farmers: profile B (rich) with rating 87 and profile Y-nt (poor) with rating 78, profile BA (rich) with rating 88 and profile T (poor) with rating 74

According to Landon (1984), in general the Corg values of the six soil profiles are very low, ranging between 0.8% and 1.06%. The Nt values of the six soil profiles are very low also: ranging between 0.04% and 0.06% (Fig 5.1). But this may be also a sign, that the turnover of C and N is high for all profiles.

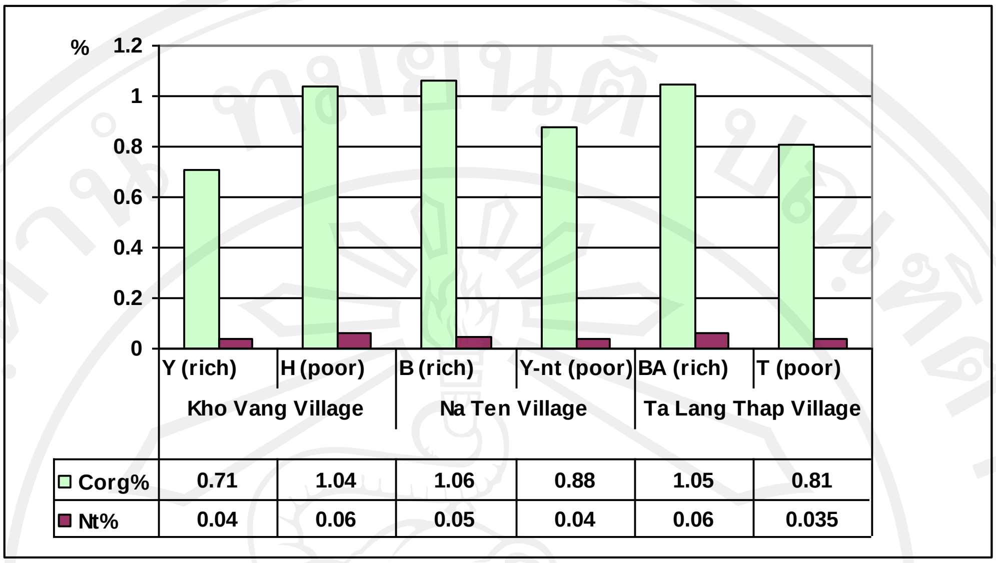
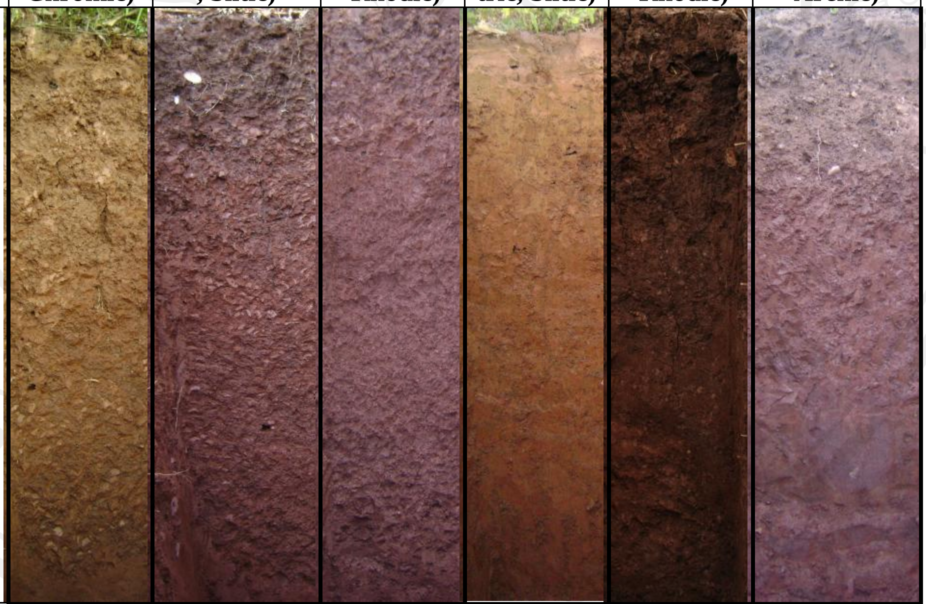


Fig 5.1: Comparing Corg and Nt of the six soil profiles at upper horizons (topsoil and second horizon)

In two cases (Na Ten and Ta Lang Thap villages) the Corg and N content is higher in soil of the rich farmers than the poor farmers (Fig 5.1). In contrast, in Kho Vang village the soil in the profile of the rich farmer has less Corg and N content than the poor farmer. The parameter Corg and N in percentage of the six soil profiles were used to compare soil quality of six farmers in three villages. It is indicated that two villages of three villages (Na Ten and Ta Lang Thap), the soils of the rich farmers have better quality than that of the poor farmers (Fig 5.1), (coincident with the first hypothesis). In Kho Vang village, the soil of the rich farmer has worse quality than that of the poor farmer (contradict with the first hypothesis).

The summary of the land evaluation of the six fields (6 soil profiles, Table 5.1) by LSC/ITC-Ghent method. In two out of three villages (Na Ten and Ta Lang Thap), the soil quality of the rich farmers is better than the soil quality of the poor farmers (coincident with the first hypothesis). In these two villages the soil quality of the rich farmers' fields are suitable (S2) in classification for the maize crop and the soil quality of the poor farmers' fields are marginally suitable (S3) in the classification. In Kho Vang village, the fields of both the rich and poor farmers have the same soil quality: marginally suitable (S3) in classification for the maize cultivation.

Table 5.1: Summarize land evaluation for the six soil profiles- LSC/ITC-Ghent

Village	Kho Vang		Na Ten		Ta Lang Thap	
Status Property	Rich	Poor	Rich	Poor	Rich	Poor
Profile	**Y**	**H**	**B**	**Y-nt**	**BA**	**T**
Soil Type	**Haplic Alisol (Siltic, Chromic)**	**Haplic Alisol (Endoskeletic, Siltic)**	**Haplic Alisol (Siltic, Rhodic)**	**Stagnic Acrisol (Hyperdys. tric, Siltic)**	**Haplic Luvisol (Clayic, Rhodic)**	**Haplic Acrisol (Epieutric, Arenic)**
						
Climate rating	81					
Soil Index*	45	52	68	36	63	49
Land Index*	36	42	55	29	51	40
Suitability Class	**S3**	**S3**	**S2**	**S3**	**S2**	**S3**

S1: very suitable, S2: moderately suitable, S3: marginally suitable, N: unsuitable

**did not consider topographical factor.*

The fact, that the topographical factor is not considered mean, that the actual fertility of the field is rather good. The erodibility of the fields is of course high and will reduce fertility. Therefore, continuous cropping with maize should be not recommended.

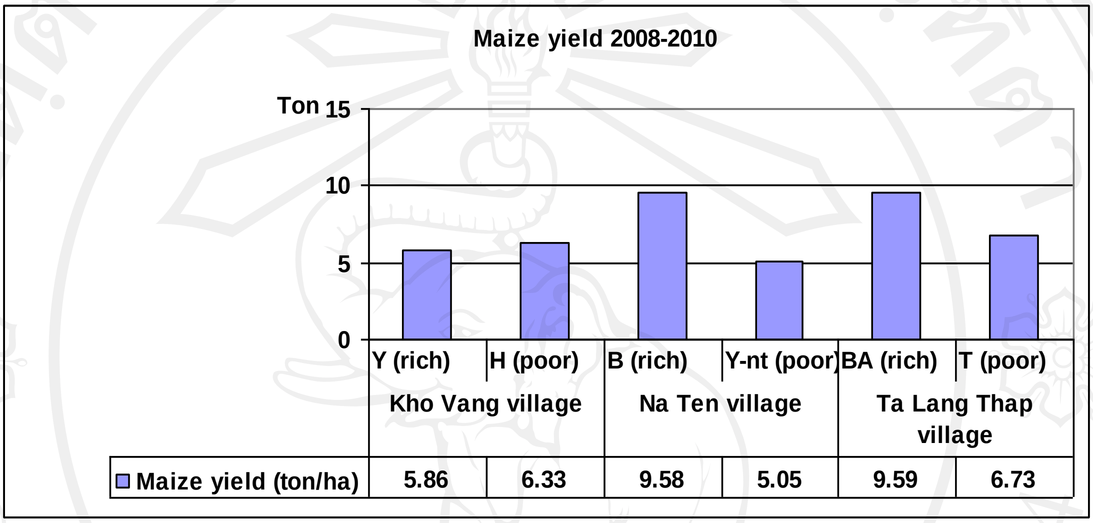
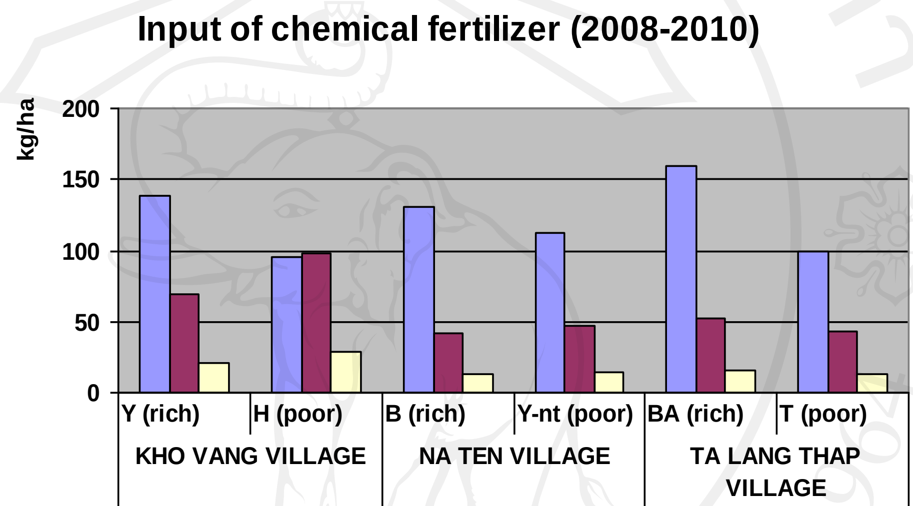


Fig 5.2: Average maize yield in three years (2008-2010)

The soil quality determines the productive maize yield. As can be seen from Fig 5.2, in two out of three villages (Na Ten and Ta Lang Thap) the rich farmers have a higher maize yield per hectare than the poor farmers. In these villages the rich farmers have better soil quality than poor farmers also (Table 5.1). In the Kho Vang village the rich and poor farmers have similar maize yield. And according to Table 5.1, in this village, the rich and poor farmers have similar soil quality. Table 5.1 and Fig 5.2 show clearly the correlation between the soil quality and maize yield of the six farmers. In general, the maize yields of the six selected households are high, especially two farmers (B and BA) with nearly 10 ton/ha, which is very high as compared the average maize yield in Yen Chau district: from 6 to 7 ton/ha (Keil, 2008 and Ha, 2004).

The chemical fertilizer is a factor which influences directly the yield of maize and the supply nutrient for plant and corn. Fig 5.3 shows that all three cases input of amount of N (kg/ha) into the rich farmers' fields is higher than the poor farmers. It indicates the positive correlation with the amount of chemical fertilizer input and economics status of households.



	Y (rich)	H (poor)	B (rich)	Y-nt (poor)	BA (rich)	T (poor)
	KHO VANG VILLAGE		NA TEN VILLAGE		TA LANG THAP VILLAGE	
Nitrogen (kg/ha)	138	95.16	131.1	112.74	158.83	99.55
P (kg/ha)	69	97.4	41.4	47	52.7	42.7
K (kg/ha)	20.7	29.22	12.42	14.1	15.81	12.81

NPK (5:10:3) and Urea (N=46%)

Fig 5.3: Input of chemical fertilizer into maize's fields,

In one case (Kho Vang villages) the rich farmer has poor soil (lower Nt and Corg) than the poor farmer (Fig 5.1), invests more N than the poor farmer (Fig 5.3) but the maize yield is not higher than the poor farmer (Fig 5.2). In two cases (Na Ten and Ta Lang Thap) have a positive correlation with maize yield (Fig 5.2), input of chemical fertilizer (Fig 5.3), Corg and Nt (Fig 5.1), and economics status of households. .

5.2 Hypothesis II

"The rich farmers have bigger farm, have more labor work, and invest more in seed and more in fertilizer than the poor farmers"

Major income of the farmer comes from the crop production. Land is the most important resource in rural farm production. The farmers with larger fields operate with better economics of scale due to supervision management and capital investments. These in turn lead to higher returns (Ibekwe, 2010). Size of land resource of the farmers is a factor contributes to the poverty status of the local area. Comparison of the rich and poor farmers' total land areas (Fig 5.4) shows that the farm size is positively correlated with the economic status of the households in three study villages. The rich farmers have a bigger total area than the poor farmers.

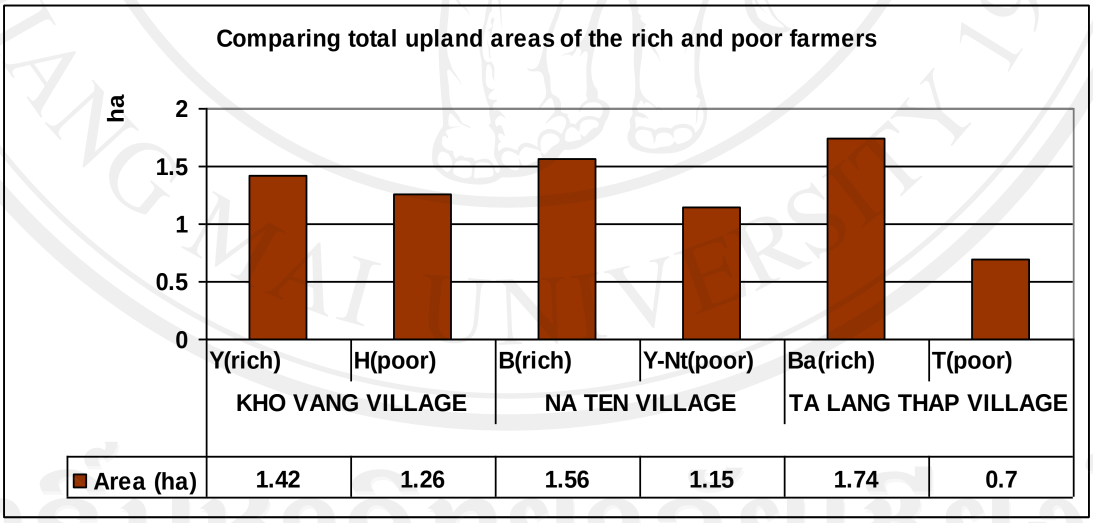
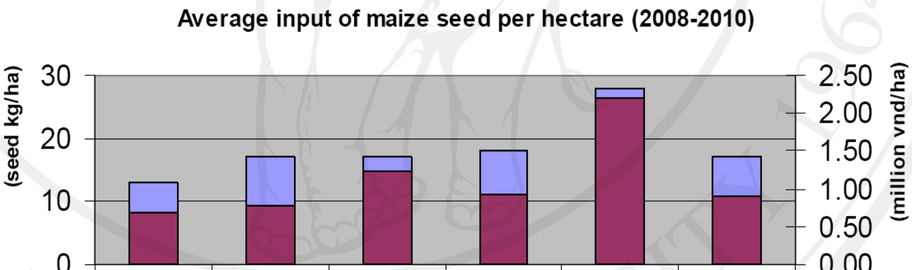


Fig 5.4: Comparison of the rich and poor farmers' total upland field areas (ha)

Fig 5.5 shows the comparison of the maize seed input of six selected farmers' upland field in three study areas from 2008 to 2010. The rich and poor farmers in three villages invested different amount of maize seed per hectare. The relation between the amount of seed input and the economics status of the households cannot be indicated. In Yen Chau district there are many companies selling maize seed, each company has different type of maize seed and the price of maize seed is depending on the types of maize seed. The comparison of input maize seed (kg/ha) could not assess exactly the relation between seed investment and economics status. Therefore, the total expenditure (VND/ha) is used to compare the seed investment of the farmers. In two cases (Na Ten and Ta Lang Thap villages) the rich farmers spend more money per hectare for maize seed than the poor farmers. And in one case (Kho Vang), the rich farmer invests less money than the poor farmer. The correlation between expenditure for maize seed and the economics status of the households can be indicated only in two cases.



	Y (rich)	H (poor)	B (rich)	Y-nt (poor)	BA (rich)	T (poor)
	KHO VANG VILLAGE		NA TEN VILLAGE		TA LANG THAP VILLAGE	
Seed (kg/ha)	13	17	17	18	28	17
Expenditure (million VND/ha)	0.69	0.78	1.23	0.92	2.19	0.91

Fig 5.5: Input of maize seed of the six selected farmers

In general, the farmers in three villages have a small amount of maize input per hectare. According to Keil, et al., (2008), the farmers in Yen Chau district apply about 22.5 kg of maize seed per hectare. But the yield per hectare is higher as compared with the yield given by Keil (2008). High maize yield of these farmers may be due to higher investment into fertilizers for maize fields.

In three cases the expenditure input of chemical fertilizer for maize of the rich farmers is higher amount of money per hectare than the poor farmers (Fig 5.6). It can be indicated that a positive relation between expenditure for chemical fertilizer and the well-being status of households in three villages. In one case (Kho Vang) the rich farmer invested more money for chemical fertilizer (Fig 5.6) but the maize yield (Fig 5.2) was not higher than the maize yield of the poor farmer.

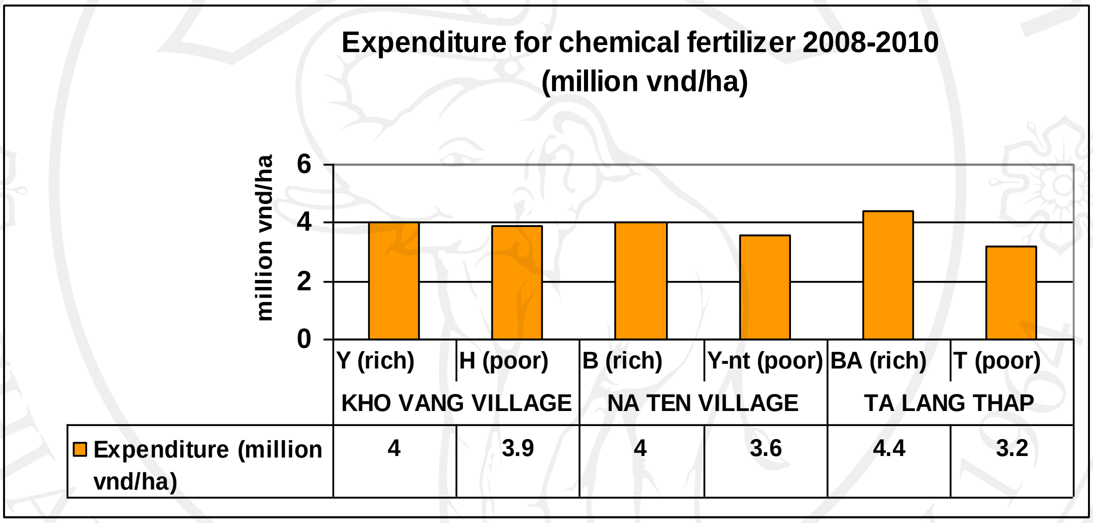


Fig 5.6: Expenditure of chemical fertilizer 2008-2010

The labor works, which are very important for the productive farm, effect on the farm management on the upland fields. More land area needs more labor work and high steep slope fields need more labor forces.

Table 5.2: Comparing labor ratio between rich and poor farmers

Village	Household	Year of birth	Status poverty	People in Household	Labor work	Ratio
Kho Vang	Y	1965	Rich	3	3	1
	H	1965	Poor	4	4	1
Na Ten	B	1945	Rich	5	4	0.8
	Y-nt	1979	Poor	4	2.5	0.6
Ta Lang Thap	BA	1963	Rich	5	3.5	0.7
	T	1981	Poor	4	2	0.5

The relation between labor work and household well-being is shown in Table 5.2 (the labour work count half labour for children with age from 7 to 12). In two villages (Na Ten and Ta Lang Thap) the rich households have a higher labor work ratio than the poor. In Kho Vang the rich and poor households have the same labor force ratio.

The hypothesis II can be concluded that in all three cases the rich farmers have larger area than the poor farmers. The expenditure of chemical fertilizer is coincident with the hypothesis for all three cases. In one case (Kho Vang village) the rich farmer has the less fertile soil, invest more money for fertilizer and larger area than the poor farmer but the maize yield is not higher than the maize yield of the poor farmer. So if he would invest less in fertilizer, his harvest would also be less. If the harvest is multiplied with total land area, then all rich farmers have a higher harvest than the poor farmers. In additionally, in Na Ten and Ta Lang Thap the rich farmers have very larger paddy field area than poor farmer (Table 4.1, chapter 4, page 25); in Na Ten 3000 m^2 for rich farmer and only 500 m^2 for the poor farmer, in Ta Lang Thap 1250

m^2 fro the rich farmers and 0 m^2 for the poor farmer. It indicates that the rich farmers in two these villages are really richer than the poor farmers. However, for Kho Vang village the poor farmer has the paddy field area that is higher twice than the rich farmer. And two other cases are coincident with the hypothesis. In two cases the total expenditure for maize seed is coincident with the hypothesis and another is not.