Chapter 4

RESULTS

4.1 The situation of three villages

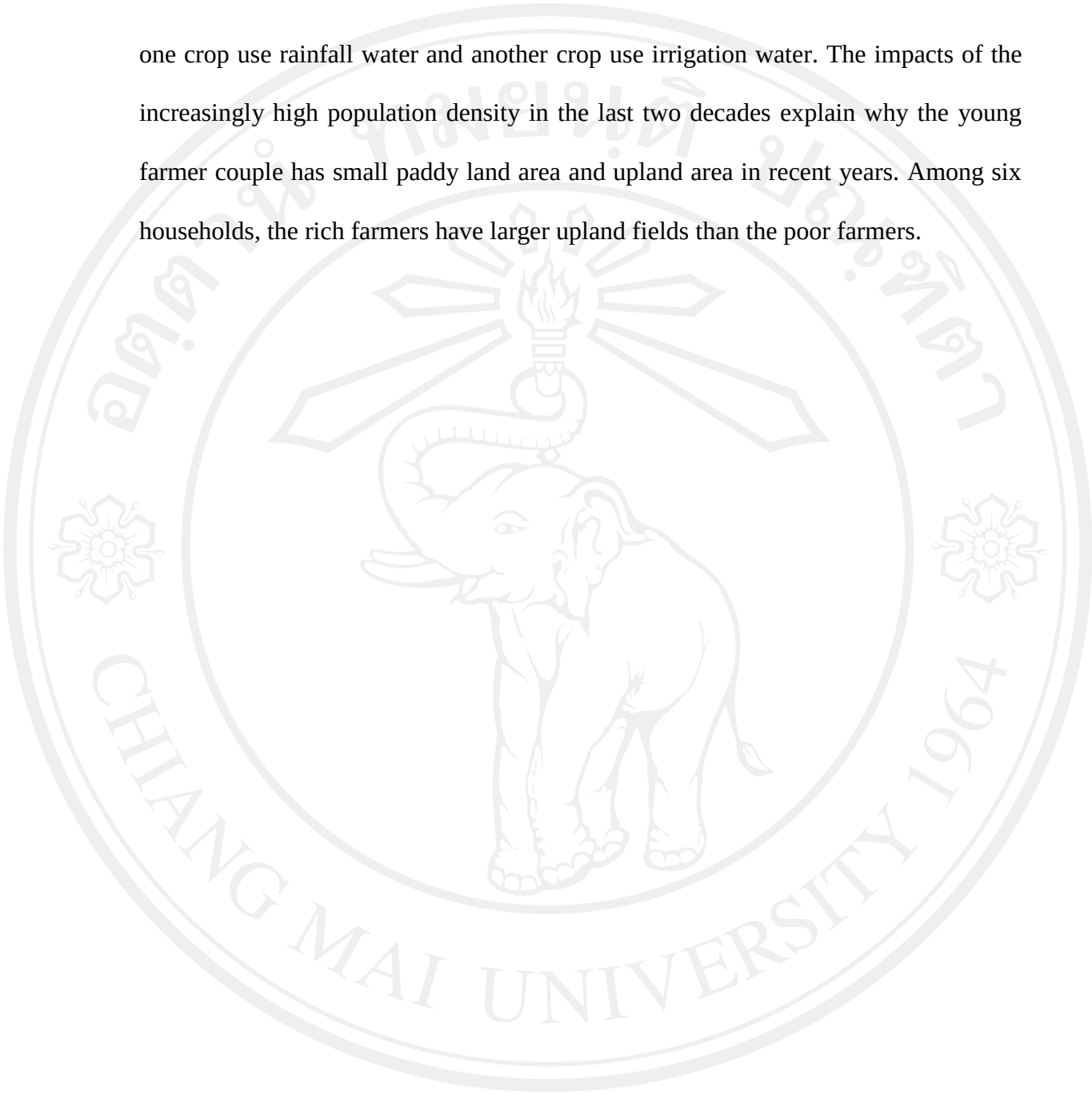
The general information of the six households in the three villages was collected from interviews, field surveys and GIS data analysis (Table 4.1)

Table 4.1: General information of the six households

Village	Name of HH head	Rich and poor	Year of birth	People in HHs	Year of HH found-ation	Labour (people)	Upland field		Paddy rice
							Number of plots	Area (m^2)	Area (m^2)
Kho Vang	Lo Van Hac (H)	*Poor*	1965	4	1983	4	4	12624	2000
	Lu Van Yen (Y)	*Rich*	1965	3	1988	3	3	14243	1160
Na Ten	Vi Van Yen (Y-nt)	*Poor*	1979	4	1998	2.5	3	11498	500
	Luong Van Bien (B)	*Rich*	1945	5	1975	4	4	15692	3000
Ta Lang Thap	Hoang Van Tuan (T)	*Poor*	1981	4	2005	2	2	7028	0
	Lo Thi Bau (BA)	*Rich*	1963	5	1984	3.5	4	17382	1250

As can be seen from Table 4.1, wealthy households have a larger land area than poor households. In Na Ten and Ta Lang Thap villages, the rich farmers are 20 - 30 years older than the poor farmers (in Na Ten: the poor farmer: 31 years old, the rich farmer: 66 years old; in Ta Lang, the poor farmer: 29 years old, the rich farmer: 47 years old). The poor farmers have smaller paddy land area than the rich farmers. In contrast, in Kho Vang village there is no difference in age between the rich and poor farmers, and the paddy land area of the poor farmer is bigger than the paddy land area of the rich farmer. On most paddy fields the farmers can cultivate two crops per year;

one crop use rainfall water and another crop use irrigation water. The impacts of the increasingly high population density in the last two decades explain why the young farmer couple has small paddy land area and upland area in recent years. Among six households, the rich farmers have larger upland fields than the poor farmers.



4.2 Properties of individual fields

4.2.1 Kho Vang Village

The map presents the field locations of the two selected farmers (Fig 4.1). The rich farmer is Mr. Yen, having three plots (Y1-kv –Y3-kv), and the poor farmer is Mr. Hac, having four plots (H1-H4).

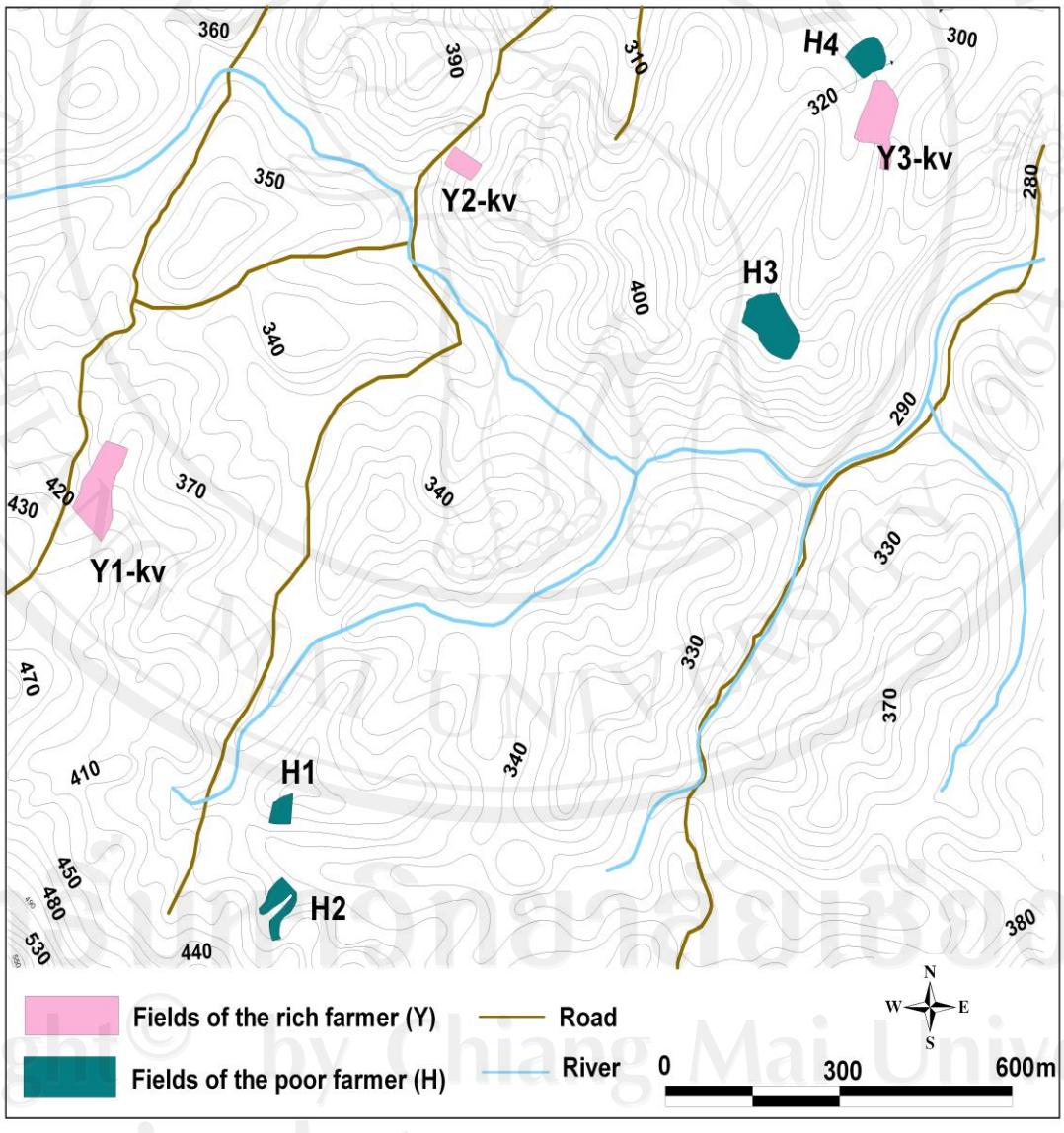


Fig 4.1: Plot locations of the rich (Y-kv) and poor (H) farmers in Kho Vang village

Field Y1-kv:

- **General information**

Size (m^2)	7050.21
Slope range	7^0 to 25^0
Altitude (a.s.l)	425 m
Ownership since	1992
Current cultivation	Maize
Using hybrid seed	2002
Main exposition	West
Soil erosion	moderate erosion with rills and gullies in the middle and at the foot of the slope
Landslide	$8m^2$ at foot slope

Fig 4.2: Y1-kv field information

The plot Y1-kv (Fig 4.2) has a slope range from 7^0 to 25^0, but mainly from 16 to 20^0, altitude: 425 a.s.l (at middle plot), size: about 7000 m^2, with Western exposition. There was an $8m^2$ landslide at the foot of the slope in 1995. The soil erosion is not observed at ridge form. However, it can be seen more often in the middle and at the foot of the slope. Near the foot of the slope, the soil erosion appears more seriously with rills and gullies. The sediment material, which can be found at the toe of the foot slope, comes from the upper slope (from observation of soil texture, structure and seal surface)

Before 1992 this plot belonged to Vieng Lan agricultural co-operative and it was managed by members of the agricultural co-operative, who cropped upland rice on this plot. The farmer has cultivated in this plot since 1992. From 1992 to 1995, upland rice, then mixing local maize and local cassava varieties were cultivated there until the end of 1997. However, from 1998 to early 2002 the plot was given a fallow

land because the farmer recognized the soil quality of this plot was getting worse, seeing low annual yield and thinner top soil layer. In 2002 the farmer cleared the field and has planted hybrid maize until now.

Table 4.2: Output and input of maize crop of Y1-kv from 2008 to 2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	6 (8.5 ton/ha)	2800	10 (14*)	LVN 10	150 (212*)	500 (709*)
2009	6.5 (9.2 ton/ha)	3200	12 (17*)	CP888	200 (283*)	600 (851*)
2010	4 (5.7 ton/ha)	4700	12 (17*)	CP888	200 (283*)	600 (851*)

** kg/ha*

Table 4.2 presents the input and output of Y1-kv plot for maize crop in three years, 2008 to 2010. The yield stood at 6 ton in 2008 and increased to 6.5 ton in 2009 but it fell to only 4 ton in 2010 due to dry weather during maize season. The maize price increased considerably from 2800 VND/kg in 2008 to 4700 VND/kg. The farmer applied a larger amount of chemical fertilizer; Urea 150 kg and NPK 500 kg in 2008, and Urea 200kg and NPK 600 kg in 2010 (Table 4.2).

- **<u>Division into landform unit, drill points and samples</u>**

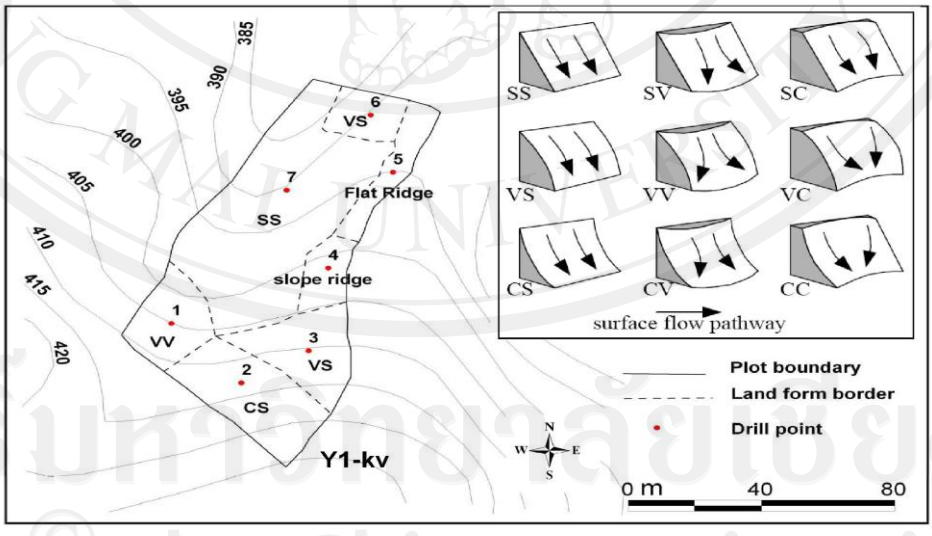


Fig 4.3: Division of Y1-kv plot into landform units

Table 4.3: Results of the field work and lab-analysis data of Y1-kv

N^0 drill	1	2	3	4	5	6	7
Landform unit	VV	CS	VS	Slope ridge	Flat ridge	VS	SS
Area (m^2)	671.9	1159.1	837.2	358.01	454.8	391.3	3177.8
Ap (cm)	18	15	12	12	20	15	12
Slope degree	25	16	20	13	4	14	20
Soil colour	2.5YR, 3/3	2.5YR, 4/2	5YR, 4/4	2.5YR, 3/2	5YR, 3/3	2.5YR ,4/3	5YR, 3/3
Soil texture (at field)	SiL Clay poor	SiL Clay poor	SiL Clay poor	Si	Si	SiL Clay rich	SiL Clay rich
Nt (%)	0.1228	0.1462	0.1171	0.1503	0.1364	0.1456	0.1196
Corg (%)	1.0991	1.6427	1.2836	1.5248	1.3495	1.2687	1.1077

The plot Y1-kv is divided into 7 sub-plots with different landform units and slope degrees (Fig 4.3). The dominant land form unit in this field is SS (drill number 7) with 3177.8 m^2, slope 20^0, and soil thickness around 12 cm (Table 4.3). The soil colour is not much different for all drills. The soil texture can be found in three kinds: SiL clay poor can be found at drill 1, 2 and 3; Si at drills 4 and 5 with ridge form characteristic; SiL clay rich at drills 6 and 7. The rill and gully soil erosion can be seen at drill 7 with land form SS. A landslide happened at drill 6 with land form VS. Ct ranges from 1.1% to 1.65% which are relatively low (according to Landon 1984).

Field Y2-kv:

- **General information**

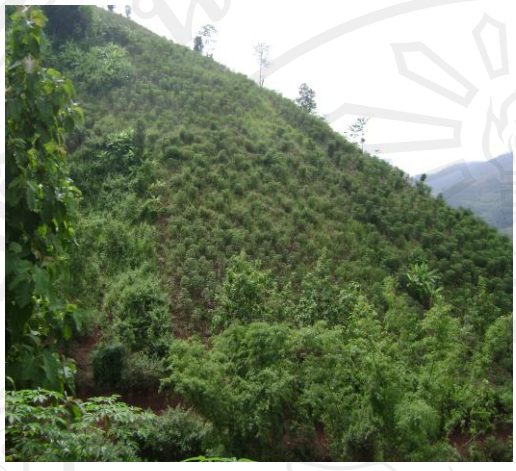


Fig 4.4: Y2-kv field information

Size (m^2)	1687.66
Slope range	33^0
Altitude (a.s.l)	350 m
Position	From the middle to the foot of the slope
Ownership since	1988
Current cultivation	Mixing maize and cassava
Using hybrid seed	2003
Main exposition	WWN
Soil erosion	Considerable with gullies in the middle and at the foot of the slope

The plot Y2-kv has a homogeneous slope with 33^0, size 1687.66 m^2, exposition WWN direction, and altitude 350 m (a.s.l) (Fig 4.4). The plot is located from the middle to the foot of the slope and soil erosion appears on all surface of the plot.

The farmer has cultivated on the Y2-kv plot since 1988. Upland rice was cropped in this field during the first two years; then cassava was cultivated until 1994. Local maize and Mexico maize varieties were planted from 1995 to 1998. However, from1999 to 2003 the farmer planted banana trees. The reason for changing to banana was that during this period green banana fruits were sold for higher prices, as compared with other crops, to local traders who then exported this fruit to China. In late 2003, the export of green banana fruits was stopped and the farmer had to plant hybrid maize till 2007. During this period the soil quality got worse very quickly and soil erosion was very serious. From 2008 until now the mixing hybrid maize and hybrid cassava have been planted because the farmer thought that this mixing system

could bring better income than mono-crop system (either maize or cassava) when the soil quality was quite poor

The maize yield reduced from 1.25 ton in 2008 to 1.2 ton in 2009 and 1 ton in 2010 (Table 4.4). In contrast, the application of the urea fertilizer increased from 50 kg in 2008 to 60kg in 2010, and the amount of NKP applied to field was stable with 200kg/year. The quantity of seed decreased from 3kg (VNL 10) in 2009 to 2.5 kg (CP888) in 2010. The reason for this change is that in 1kg CP888, there are more seeds than in 1kg VNL 10.

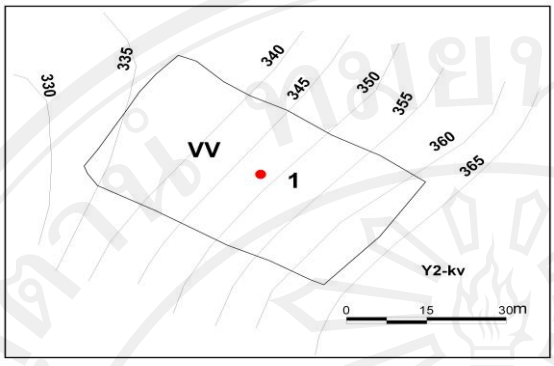
Table 4.4: Input and output of maize crop of Y2-kv 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	1.25 (7.7 ton/ha)	2800	3 (18*)	LVN 10	50 (296*)	200 (1184*)
2009	1.2 (7.1 ton/ha)	3200	3 (18*)	LVN 10	50 (296*)	200 (1184*)
2010	1 (5.9 ton/ha)	4700	2.5 (14*)	CP888	60 (355*)	200 (1184*)

** kg/ha*

- **Division into landform units, drill points and samples**

The plot Y2-kv has only one land form VV (Convex - Convex) with very steep slope, the top soil was 20 cm deep, texture with SiL clay poor and no reaction with HCl test (Fig 4.5). Ct is very low with 0.86%. This plot has very shallow soil. When drilling to the depth of 60 cm, we could see the silt stone with strong weathering. The sediment material can be found at the toe of the foot of the slope with thick layer (1.5 m depth).



N^0 drill	1
Landform unit	VV
Area (m^2)	1687.66
Ap (cm)	20
Slope degree	33
Soil colour	2.5YR, 4/3
Soil texture (at field)	SiL, Clay-poor
HCl reaction	no
Nt (%)	0.1010
Ct (%)	0.8688

Fig 4.5: Division Y2-kv plot into landform units

Field Y3-kv:

- **General information**

Size (m^2)	5505.225
Slope range	15^0 to 35^0
Altitude (a.s.l)	320 m
Ownership since	1992
Current cultivation	Maize + cassava + banana
Using hybrid seed	2004
Main exposition	WN
Soil erosion	Strong erosion with more serious gully at the foot of the slope
Landslide	15 m^2 at upper foot slope

Fig 4.6: Y3-kv field information

The plot Y3-kv has 5505.225 m^2, very steep slope with the slope range from 15 to 35 degree, exposition to West-North direction and altitude 320 a.s.l (Fig 4.6). The soil erosion is very strong and often occurs at the middle and around the upper foot slope. There was a 15 m^2 landslide near the upper foot slope in 1994.

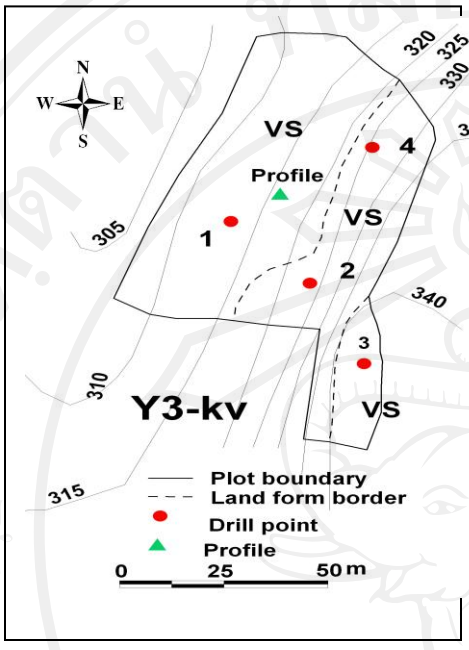
Mr. Yen took over this plot from his parents in1992, he planted local maize from 1992 to 1996. During this time, the soil quality was already poor and maize yield was very low. After that, he decided to change the maize crop to mixing banana and cassava for three years but with this change he still made very little benefit. At the end of 1999 the GZT project invited him to plant the teak trees on this plot to prevent soil erosion and improve soil quality. The farmer thought that it was a good chance for him and during some first years when the teaks were small, he could cultivate maize or other crops together with teak. However, this system did not bring good income to him, and he decided to cut down all teak trees and cleared his field to plant hybrid maize in 2004. The mono crop (hybrid maize) gave high yield during the first two years. Then the yield was lower. From 2008 to now the farmer has cultivated mixing three plants on this plot: banana, cassava and hybrid maize. The maize yield of this field is described in Table 4.5.

Table 4.5: Input and output of maize crop of Y3-kv 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	1.8 (3.2 ton/ha)	2800	5 (9*)	LVN 10	50 (90*)	50 (91*)
2009	1.8 (3.2 ton/ha)	3200	5 (9*)	LVN 10	100 (181*)	300 (544*)
2010	1.5 (2.7 ton/ha)	4700	5 (9*)	LVN 10	100 (181*)	300 (544*)

** kg/ha*

- **Division into landform units, drill points and samples**



N^0 drill	1	2	4	3
Landform unit	VS	VS		VS
Area (m^2)	3275.33	1776.85		453.03
Ap (cm)	20	20	20	20
Slope degree	25	35	35	15
Soil colour	2.5Y 4/6	2.5YR 4/4	5YR 4/3	2.5YR 4/3
Soil texture (at field)	SiC	SiC	SiL clay rich	SiL clay rich
HCl acted	No	No	No	No
Nt (%)	0.0898	0.0926	0.1268	0.1291
Ct (%)	0.569	0.7479	1.1779	1.1847

Fig 4.7: Division of Y3-kv plot into landform units

The field Y3-kv has only one type of land form but it is divided into three sub-land form plots with different slopes; four augerings were drilled. The land form VS (Convex-Straight) with slope 25^0 at the augering number 1 has the biggest area, about 3275.33 m^2 and was dug to take the soil profile (Fig 4.7). The top soil depths of four augerings are the same but the soil textures and soil colours are different; drills 1 and 2 have the texture SiC but drills 3 and 4 have SiL clay rich, the soil colours of drills 1, 2, 3 are reddish brown but that of drill 4 is dull reddish brown. The Ct levels are very low, from 0.56% to 1.18%

Field H1:

- **General information**

Fig 4.8: H1 field information

Size (m^2)	1426.28
Slope range	27^0 to 32^0
Altitude (a.s.l)	380 m
Ownership since	1992
Current cultivation	Maize
Using hybrid seed	2001
Main exposition	ES
Soil erosion	Considerable erosion with serious rills at the foot slope
Landslide	20 m^2 at the upper foot slope

The field H1 has an area of 1426.28 m^2, altitude 380 a.s.l, exposition at East-South direction and very steep slopes with slope range from 27^0 to 32^0 (Fig 4.8). The rill soil erosion is typical form on the surface and the landslide area, which happened in 2007, is about 20 m^2 from the middle to the foot slope.

The field H1 was opened in 1992 and issued red book certificate in 2002. Before 1992 this field was given a fallow land and managed by the Vieng Lan committee. From 1992 to 1999 the plot was cultivated upland rice then given fallow for two years. From 2001 to now, hybrid maize has been cultivated in this field and produced high yield.

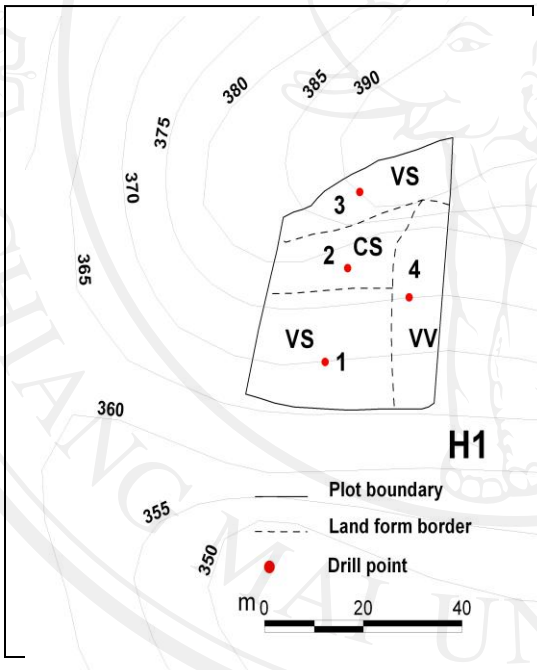
Table 4.6: Input and output of maize crop of H1, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	1.5 (10.5 ton/ha)	3200	3 (21*)	CP888	20 (140*)	150 (1051*)
2009	1.5 (10.5 ton/ha)	3400	3 (21*)	CP888	20 (140*)	150 (1051*)
2010	2 (14 ton/ha)	4700	3 (21*)	LVN10	25 (175*)	200 (1402*)

** kg/ha*

In 2008 maize yield was 1.5 ton and it increased to 2 ton in 2010 (Table 4.6). Fertilizer was applyed increasingly: 150 kg NPK and 20kg Urea in 2008, and 200kg NKP and 25kg Urea in 2010.

- **Division into landform units, drill points and samples**



N^0 drill	1	2	3	4
Landform unit	VS	CS	VS	VV
Area (m^2)	548.5	276.6	275.9	325.6
Ap (cm)	25	18	18	15
Slope degree	28	32	27	27
Soil colour	5YR, 4/4	5YR, 4/3	5YR, 4/4	10R, 3/3
Soil texture (at field)	SiL Clay rich	SiL Clay rich	SiL Clay rich	SiL Clay rich
Nt (%)	0.092	0.087	0.098	0.085
Ct (%)	0.654	1.055	2.273	0.587

Fig 4.9: Division of H1 plot into landform units

The field H1 was divided into 4 land form plots. There are two plots of land form VS (Convex-Straight) which are located at drills number 1 and 3 with slopes 27^0 and 28^0 respectively (Fig 4.9). Drill 1 and drill 3 have the same land form but had different top soil depths: 25 cm for drill 1 and 18 cm for drill 3. The soil colour at drills 1, 2, 3 is nearly the same: 5YR-4/4 and 5YR- 4/3, but at drill 4 is 10R-3/3. All

land form plots of this field have the same soil texture; SiL clay-rich. The Ct ranges are from medium to very low: from 2.27% to 0.58%.

Field H2:

- **General information**

Size (m^2)	2588.3
Slope range	14^0 to 22^0
Altitude (a.s.l)	375 m
Open land	1987
Current cultivation	Maize
Using hybrid seed	2001
Main exposition	ESS
Soil erosion	Serious rill and gully
Landslide	30 m^2 at the upper food slope

Fig 4.10: H2 field information

This field is located at 375 a.s.l, with a slope ranging from 14^0 to 22^0, 2588.3 m^2 and has big problems with landslide ($30m^2$) (Fig 4.10), rill and gully soil erosion. The landslide area is getting bigger year after year and the soil erosion has been more serious in recent years.

The field H2 was a natural forest before 1987 when Mr Hac cleared and burnt trees to cultivate upland rice crop during seven years. In 2002 he was issued a red book certificate for this field. From 1994 to 2001 the farmer planted mixing local maize and cassava. Since early 2002 the field has been cultivated hybrid maize and he is very satisfied with its high yield.

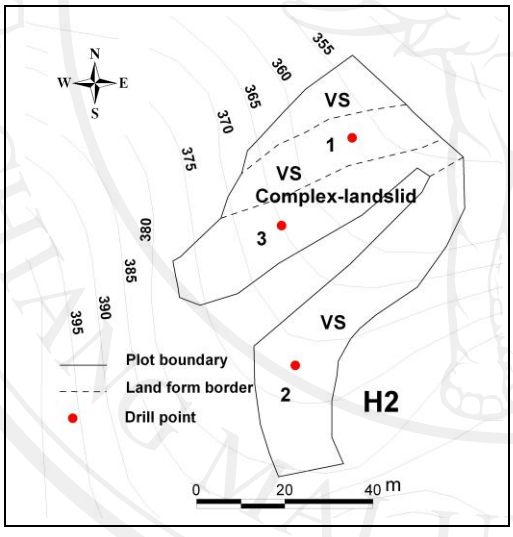
Table 4.7: Input and output of maize crop of H2, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	2 (7.7 ton/ha)	3200	8 (30*)	CP888	50 (193*)	500 (1931*)
2009	2 (7.7 ton/ha)	3400	8 (30*)	CP888	70 (270*)	600 (2318*)
2010	1.5 (5.7 ton/ha)	4700	9 (34*)	LVN10	50 (193*)	500 (1931*)

** kg/ha*

Table 4.7 presents the input and output of this plot in three years 2008 to 2010. The yield reduced from 2 ton in 2008 to 1.5 ton in 2010, the amount of fertilizer applied to the field also decreased. However, the amount of seed increased: 8kg in 2008 and 9kg in 2010 (Table 4.7).

- **Division into landform units, drill points and samples**



N^0 drill	1	2	3	no
Landform unit	VS	VS	Complex	VS
Area (m^2)	412.18	1144	755.4	277
Ap (cm)	12	18	20	
Slope degree	14	22	22	14
Soil color	2.5YR 3/3	2.5YR 3/4	10R 5/3	
Soil texture (at field)	SiL clay poor	SiL clay rich	SiL clay poor	
Nt (%)	0.1092	0.1028	0.1128	
Ct (%)	0.8699	0.8051	1.4735	

Fig 4.11: Division of H2 plot into landform units

There are four land form plots and three drills for this field. Most area in the field has VS land form (Convex-Straight), the slope was 14^0 at drill 1 and 22^0 at drill 2 and 3 (Fig 4.11). The top soil depth is shallow at drill 1 (12cm) and thick at drill 2 and 3: about 18 and 20 cm, respectively. The soil texture is nearly homogeneous for all drills. The soil colour at drills 1 and 2 is nearly the same (2.5YR, 3/3) but at drill 3 it is different from the others. The Ct levels are relatively low, from 0.8% to 1.47%.

Field H3:

- **General information**

Size (m^2)	6247.94
Slope range	16^0 to 26^0
Altitude (a.s.l)	370 m
Ownership since	1984
Current cultivation	Maize+ Cassava
Using hybrid seed	2005
Main exposition	E
Soil erosion	Serious erosion at the foot slope, slight erosion at the middle slope
Landslide	80 m^2 at the upper foot slope

Fig 4.12: H3 field information

The field H3 has a slope ranging from 16^0 to 26^0, 6247.94 m^2 and main exposition at East direction, and is located at 370 a.s.l (Fig 4.12). Since 1987, there was a big landslide occurring from the middle slope to the foot slope; about 80 m^2. The rill soil erosion appeared slightly at the middle slope and the gully erosion was strong at the foot slope.

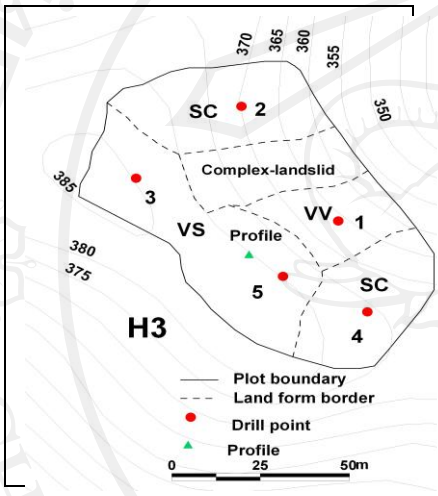
The farmer got this field from his parents since 1984 then it was cultivated upland rice in three years. After that his family was lack of labour and this field was given a fallow land in 15 years (1987-2002). From 2002 to now, the field has been planted mixing cassava and hybrid maize. The reason for planting mixing cassava with maize is that this plot is near the farmer's house and it is convenient to harvest cassava. The input and output of maize is presented at Table 4.8.

Table 4.8: Input and output of maize crop of H3, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	3.5 (5.6 ton/kg)	3200	6 (10*)	CP888	40 (64*)	300 (480*)
2009	2 (3.2 ton/kg)	3400	6 (10*)	CP888	40 (64*)	300 (480*)
2010	3.5 (5.6 ton/kg)	4700	8 (12*)	LVN10	40 (64*)	300 (480*)

**kg/h*

- **Division into landform units, drill points and samples**

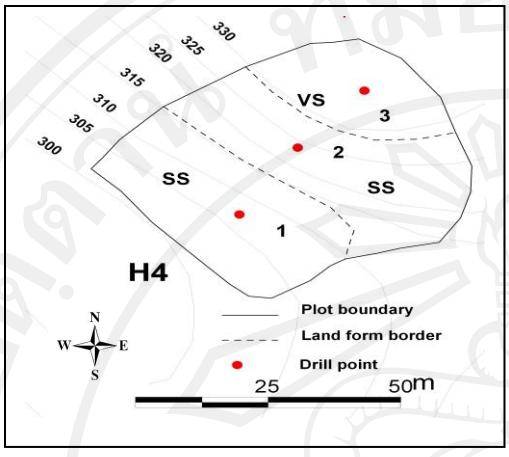


N^0 drill	1	2	3	5	4	no
Landform unit	VV	SC	VS		SC	Complex Land slide
Area (m^2)	937.9	1320	1971.3		1174	842.9
Ap (cm)	20	15	25	20	25	
Slope degree	26	26	18	18	16	26
Soil colour	2.5YR 3/4	5YR 4/4	5YR 4/3	5YR 3/3	2.5YR 3/3	
Soil texture (at field)	SiL Clay poor	SiL Clay poor	SiL Clay poor	SL clay poor	SL clay poor	
Nt (%)	0.095	0.100	0.118	0.102	0.102	
Ct (%)	0.822	0.959	1.236	1.015	0.936	

Fig 4.13: Division of H3 plot into landform units

The field is divided into five plots with five different land forms and five drill samples. The land form VS (Convex-Straight), which was drilled with two samples (number 3 and 5) and has slope 18^0, was dug to take soil profile (Fig 4.13). The top soil depths at drills 3 and 5 (25 cm and 20 cm respectively) are quite good for crops. The drills number 2 and 4 had the same landform SC (Straight –Concave) but different slope angles and the top soil depths: 26^0 and 16^0, 15 cm and 25 cm, respectively. The soil colour is nearly the same at all drills. The soil texture at drill 1, 2 and 3 is SiL clay poor and at drills 4 and 5 is SL clay poor. The landslide with complex landform impacted large area (842 m^2), of which 80 m^2 is directly affected by the landslide. The Ct ranges are very low, from 0.8% to 1.2%

Field H4:



N^0 drill	1	2	3
Landform unit	SS	SS	VS
Area (m^2)	1122.2	1140.9	599
Ap (cm)	5	12	15
Slope degree	30	36	9
Soil colour	10R, 4/4	2.5YR, 4/6	2.5RY, 3/4
Soil texture (at field)	SiL clay poor	SiL clay poor	SiL clay poor
Nt (%)	0.1018	0.1093	0.1201
Ct (%)	0.8765	0.8974	0.9921

Fig 4.14: Division of H4 plot into landform units

Table 4.9: Field H4 information

Size (m^2)	2362.3
Slope range	9^0 to 36^0
Altitude (a.s.l)	315 m
Open land	1990
Current cultivation	Fallow
Using hybrid seed	2003
Main exposition	SSW
Soil erosion	Very strong and serious

The field H4 has an area of 2362.3 m^2, slope range from 9^0 to 36^0, exposition at South-South-West direction and altitude 315 a.s.l (Table 4.9). This field is divided into three land form plots and was drilled one augering for each of these land forms (Fig 4.14). The top soil depth at drills 1 and 2 is very shallow, about 5 cm and 12cm, respectively. The land form SS is very steep slope and has very strong and serious soil erosion. The soil colour is reddish and the texture is the same (SiL clay poor). The soil depth at drill 3 is better; 15 cm and slope 9^0.

The field was used by the farmer's parents to plant upland rice and was given fallow from 1980 to 1990. He took over this field to plant local maize in 6 years then

it was given fallow until 2002. From 2003 to 2005 the field was cropped hybrid maize but it had very low yield the farmer decided to give it a fallow land again until now. The Ct levels are from 0.87% to 0.99%, which is relatively low.

4.2.2 Na Ten village

The map presents the field locations of the two selected farmers in Na Ten villages. The rich farmer is Mr. Bien who has four fields (B1-B4), and the poor farmer is Mr. Yen who has three fields (Y1-nt to Y3-nt) (Fig 4.15).

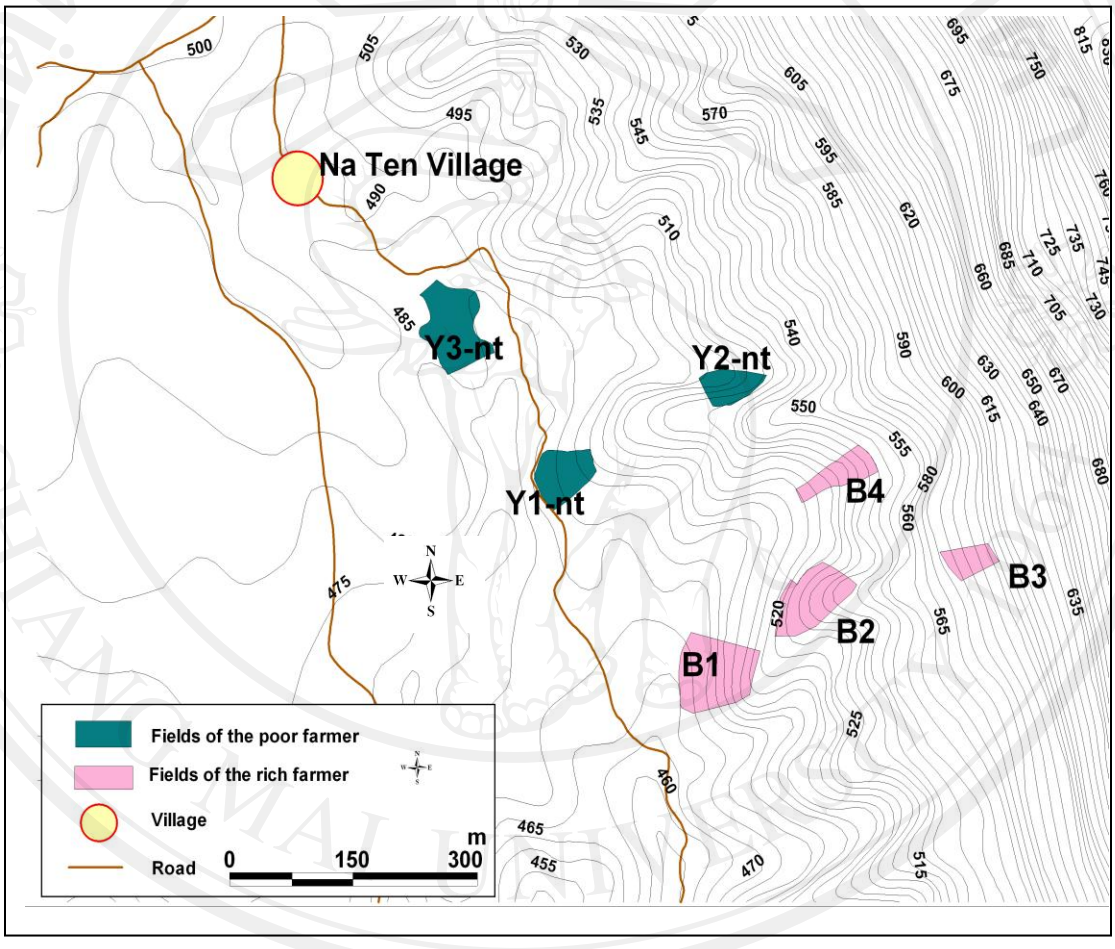


Fig 4.15: Plot locations of the rich (B) and poor (Y-nt) farmers in Na Ten village

Field B1:

- **General information**

Size (m^2)	6627.4
Slope range	12^0 to 26^0
Altitude (a.s.l)	490 m
Open land	1981
Current cultivation	Maize
Using hybrid seed	1999
Main exposition	W
Soil erosion	Strong erosion with gullies
Landslide	No

Fig 4.16: B1 field information

The field B1 with a slope range from 12^0 to 26^0 is located at 490 a.s.l (at the middle field), an exposition at West direction, and 6627.4 m^2 (Fig 4.16). The gully soil erosion is strong and run from the top to the foot in the centre of the field. The slight rill erosion appeared on all surface of the field.

Before 1981 the field B1 was a natural forest area. After that, Mr. Bien cleared all forest trees to cultivate upland rice in 5 years. From 1986 to 1998 the field was planted local maize and Mexico maize varieties. Then, from 1999 to now it has been cultivated hybrid maize. The farmer is satisfied with this field because it gives high maize yield, despite soil erosion. He thinks that this field is good soil quality and will be productive for long time. The input and output of this field is presented in Table 4.10.

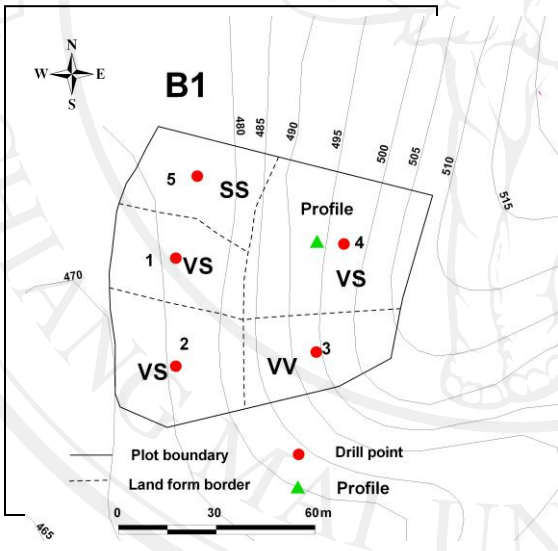
Table 4.10: Input and output of maize crop of B1, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	6 (9 ton/ha)	3500	10 (15*)	NK54	150 (226*)	200 (301*)
2009	6 (9 ton/ha)	3800	10 (15*)	NK54	150 (226*)	200 (301*)
2010	5.4 (8 ton/ha)	5300	10 (15*)	NK54	180 (271*)	200 (301*)

** kg/ha*

The maize price increased significantly from 3500VND/kg in 2008 to 5300VND/kg in 2010. However, the yield reduced from 6 ton in 2008 to 5.4 ton in 2010, even though more Urea fertilizer was applied: 150kg in 2008 and 180 kg in 2010.

- **Division into landform units, drill points and samples**



ill	1	2	3	4	5
orm t	VS	VS	VV	VS	SS
m^2)	1040	1368	1045	2141	1031
m)	16	20	12	18	20
egree	15	17	25	26	12
l ır	5YR, 3/3	5YR, 3/3	5YR, 3/3	7.5YR, 4/2	5YR, 3/2
ture ld)	SL clay poor	SL clay poor	SiL Clay poor	SL Clay poor	VFS
%)	0.1138	0.1274	0.1218	0.1168	0.0564
%)	1.1584	1.4605	1.1450	1.0453	0.9912

Fig 4.17: Division of B1 plot into landform units

The field H1 is divided into five land form plots and VS land form (Convex-Straight) dominates in this field. Drills number 1, 2 and 4 have slope angles about 15^0, 17^0 and 26^0 respectively (Fig 4.7). This land form was selected to dig a soil profile at drill number 4. The top soil depths of the drill 1, 2 and 4 was 16 cm, 20cm and 18 cm, and have the same soil texture (SL clay poor). The soil colour is dark reddish brown (5YR-3/3 and 7.7 YR-4/2). Drill 5 at land form SS has a slope of 12

degree, the top soil depth 20 cm, and soil texture VFS. The Ct levels from 0.99% to 1.46% are relatively low.

Field B2:

- **General information**

Size (m^2)	4742.4
Slope range	17^0 to 30^0
Altitude (a.s.l)	525 m
Open land	1985
Current cultivation	Maize
Using hybrid seed	1998
Main exposition	W
Soil erosion	Slight rill
Landslide	No
Position	Upper slope

Fig 4.18: B2 field information

The field B2 has an area of 4742.4 m^2, slope range from 17^0 to 30^0, exposition at West direction, and is located at the upper slope 525 a.s.l. Soil erosion occurred with slight rill on the land surface.

The field was opened in 1985. Before that year, it was a natural forest with very dense trees. This field was cultivated upland rice from 1985 to 1992, and then local maize until 1995 without applying any kinds of fertilizer. Then it was given a fallow period in three years and since 1998 to now it has been planted hybrid maize.

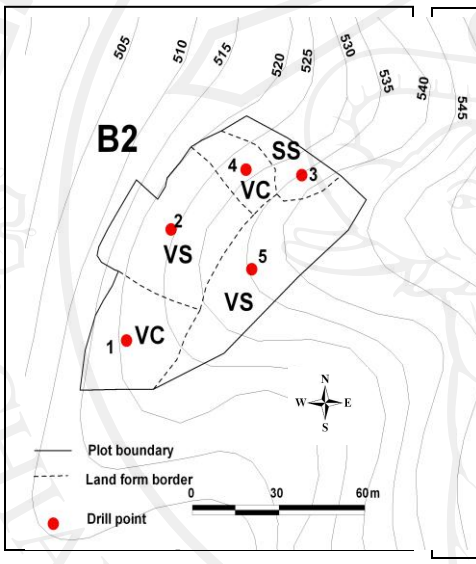
The yield in 2008 and 2009 was high but in 2010 it was low (Table 4.11). From 2008 to 2010 the amount of Urea, NPK and seed applied to the field was not changed: 150 kg Urea, 250kg NPK and 7kg seed.

Table 4.11: Input and output of maize crop of B2, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	5.7 (12 ton/ha)	3500	7 (15*)	NK54	150 (316*)	250 (527*)
2009	6 (12.6 ton/ha)	3800	7 (15*)	NK54	150 (316*)	250 (527*)
2010	3.5 (7 ton/ha)	5300	7 (15*)	NK54	150 (316*)	250 (527*)

** kg/ha*

- **Division into landform units, drill points and samples**

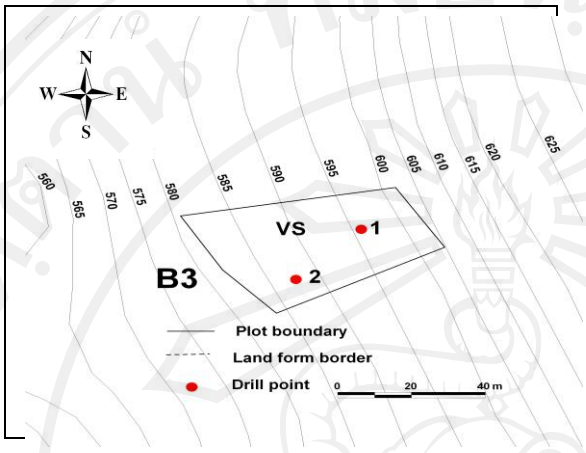


drill	1	2	3	4	5
and m unit	VC	VS	SS	VC	VS
a (m^2)	962.5	1461	404.7	395.9	1517
(cm)	15	12	15	25	17
lope egree	22	25	30	28	17
Soil lour	2.5YR 3/4	5YR 3/2	5YR 3/3	2.5YR 3/3	5YR 3/3
Soil xture field)	SiL Clay rich	SiL clay poor	SCL	SiL Clay poor	SiL clay poor
t (%)	0.0546	0.0731	0.0782	0.0793	0.0809
t (%)	0.9013	1.1601	1.2398	1.3114	1.2752

Fig 4.19: Division of B2 plot into landform units

There are five land form plots which are divided from the field B2, and one augering was drilled on each of these land form plots (Fig 4.19). The land form VS at drills number 2 and 5 dominates in this field with about 3000 m^2. The top soil is the thickest at drill 4 with 25 cm and the thinnest at drill 2 with 12 cm. In general this field is steep slope: 22^0 at drill 1, 25^0 at drill 2, 30^0 at drill 3 and 28^0 at drill 2. The soil colour is dark reddish brown and the soil texture is SiL clay poor at drills 2, 4 and 5, and SCL at drill 3. The Ct levels from 0.9% to 1.3% are low.

Field B3:



N^0 drill	1	2
Land form unit	VS	
Area (m^2)	1745.7	
Ap (cm)	10	15
Slope degree	20	20
Soil colour	5YR 4/3	5YR 4/4
Soil texture (at field)	SiL clay poor	SCL
Nt (%)	0.0590	0.0680
Ct (%)	1.0883	1.1270

Fig 4.20: Division of B3 plot into landform units

The plot B3 has only one land form VS and was drilled with two samples with slope 20^0 and the top soil depth 10cm and 15 cm (Fig 4.20). It is located at about 590 a.s.l, at exposition West direction and total area of 1745.7 m^2. At drills 1 and 2 the soil colour was the dull reddish brown but the soil textures are different: SiL clay poor at drill 1 and SCL at drill 2. The Ct is 1.1%, which is very low.

Before 1984, field B3 was a natural forest, but then it was cut to cultivate upland rice by Mr. Bien in 8 years. From 1992 to 2003 cassava crop was changed to hybrid maize till now.

The input and output of maize in three years is presented in Table 4.12. The yield reduced from 2.5 ton in 2008 to 1.5 ton in 2010 but the amount of fertilizer applied and seed were stable.

Table 4.12: Input and output of maize crop of B3, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	2.5 (14 ton/ha)	3500	4 (23*)	NK54	50 (286*)	100 (572*)
2009	2.5 (14 ton/ha)	3800	4 (23*)	NK54	50 (286*)	100 (572*)
2010	1.5 (8.5 ton/ha)	5300	4 (23*)	NK54	50 (286*)	100 (572*)

** kg/ha*

Field B4:

- **General information**

Size (m^2)	2576.6
Slope range	16^0 to 23^0
Altitude (a.s.l)	530 m
Open land	1981
Current cultivation	Maize
Using hybrid seed	1998
Main exposition	SSW
Soil erosion	moderate rill
Landslide	No

Fig 4.21: B4 field information

The field B4 is located at 530 m.s.l, slope range from 16^0 to 23^0, exposition at South-South- West direction and total area of 2576.6 m^2(Fig 4.21). Before 1981 it was a natural forest; then it was opened by Mr. Bien to plant upland rice in two years and then cassava crop in six years. From 1989 to 1993, local maize was cultivated in this field before it was given a fallow period in five years and since 1998 the hybrid maize has been cultivated here.

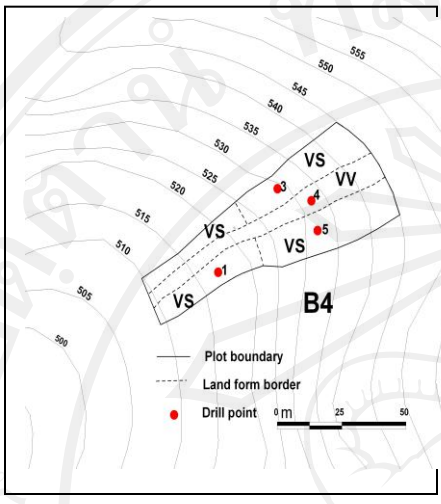
The input and output of this field for maize crop in three years are presented in Table 4.13. The maize price increased considerably in three years: 3500VND/kg in 2008 to 5300VND/kg in 2010. However, the yield reduced from 3 ton in 2008 and 2009 to 2.4 ton in 2010. The amount of Urea applied and seed increased: 5kg seed in 2008 and 7kg seed in 2010, and 50kg Urea in 2008 and 70 kg in 2010.

Table 4.13: Input and output of maize crop of B4, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	3 (11.6 ton/ha)	3500	5 (19*)	NK54	50 (194*)	100 (388*)
2009	3 (11.6 ton/ha)	3800	5 (19*)	NK54	50 (194*)	100 (388*)
2010	2.4 (9 ton/ha)	5300	6 (23*)	NK54	70 (271*)	100 (388*)

**kg/ha*

- **Division into landform units, drill points and samples**

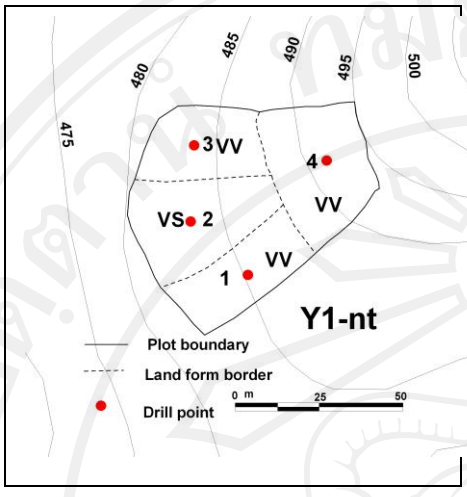


N^0 drill	1	3	4	5	no
Land form unit	VS	VS	VV	VS	VS
Area (m^2)	382.7	581	649.8	731	231
Ap (cm)	15	15	12	12	
Slope degree	18	22	18	23	16
Soil colour	2.5YR 3/3	5YR 3/4	5YR 3/3	5YR 3/2	
Soil Texture (at field)	SiL Clay poor	SCL	SiL clay poor	SiL clay poor	
Nt (%)	0.071	0.063	0.062	0.054	
Ct (%)	1.217	0.998	0.971	0.882	

Fig 4.22: Division of B4 plot into landform units

The field B4 has five land form plots and was drilled four augering samples. In this field the dominated land form VS is located at drill 1, 3 and 5, and has the top soil depth of 15 cm and 12 cm (Fig 4.22). The slope angles are 18^0 at drill 1, 22^0 at drill 3 and 23^0 at drill 5. The soil textures of drill 1, 4 and 5 are the same (SiL clay poor), the soil colours of this field is dark reddish brown. The Ct levels from 0.9% to 1.2% are low.

Field Y1-nt:



N^0 drill	1	2	3	4
Land form unit	VV	VS	VV	VV
Area (m^2)	726.6	1005	720.6	1071
Ap (cm)	18	15	20	15
Slope degree	8	10	12	15
Soil colour	7.5YR 4/6	7.5YR 4/6	10YR, 4/3	10YR 3/3
Soil texture (at field)	SL	VFS	FS	VFS
Nt (%)	0.091	0.089	0.109	0.115
Ct (%)	0.945	0.865	1.164	1.243

Fig 4.23: Division of Y1-nt plot into landform units

The field Y1-nt is divided into four land form plots, with the total area of 3524 m^2 and four augering samples are drilled. It was located at 485 a.s.l with exposition at WWS direction and has slope ranging from 8^0 to 15^0 (Fig 4.23). Dominant in this field is the landform VV (Convex-Convex), which is located at drills 1, 3 and 4 with the top soil depths about 18 cm, 12 cm and 15 cm respectively. The soil colour at the augering 1 and 2 is brown (7.5YR, 4/6) and at the augering 3 and 4, the soil colour is dark brown (10YR, 3/3). The Ct levels are from 0.86% to 1.24%

Before 1986 this field was a natural forest before forest trees were by his parents to plant local upland rice and maize. His parents transferred the ownership of this field to him in 1998 when he got married. From that time to now this field has been cultivated hybrid maize.

The maize yield increased in three years: 1.5 ton in 2008 and 1.8 ton in 2010. Besides that, the application of NPK fertilizer also increased from 100 kg in 2008 to 250 kg in 2010 (Table 4.14).

Table 4.14: Input and output of maize crop of Y1-nt, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	1.5 (4 ton/ha)	2800	5 (14*)	CP888	50 (141*)	100 (283*)
2009	2 (5.6 ton/ha)	3500	6 (17*)	PC06	50 (141*)	200 (567*)
2010	1.8 (5 ton/ha)	4500	6 (17*)	NK 54	50 (141*)	250 (709*)

** kg/ha*

Field Y2-nt:

- **General information**

Fig 4.24: Y2-nt field information

Size (m^2)	2287.97
Slope range	20^0 to 36^0
Altitude (a.s.l)	515 m
Open land	1987
Current cultivation	Maize
Using hybrid seed	1998
Main exposition	NNW
Soil erosion	Moderate erosion with rills at the upper and in the middle, strong erosion with gullies at the foot slope.
Landslide	No

The field Y2-nt has the total area of 2287 m^2, slope range from 20^0 to 36^0, altitude 515 a.s.l and exposition at NNW direction (Fig 4.24). The rill soil erosion is moderate at the middle and upper slope and the gully erosion appears strongly at the foot slope.

The field was a natural forest and it was opened in 1987 by the farmer's parents to plant upland rice. From 1987 to 1991 his parents cultivated upland rice. Then local maize was planted in 4 years and after that cassava was planted until 1997. This farmer got married in 1998 and his parents transferred this field to him and since 1998 it has been cultivated hybrid maize.

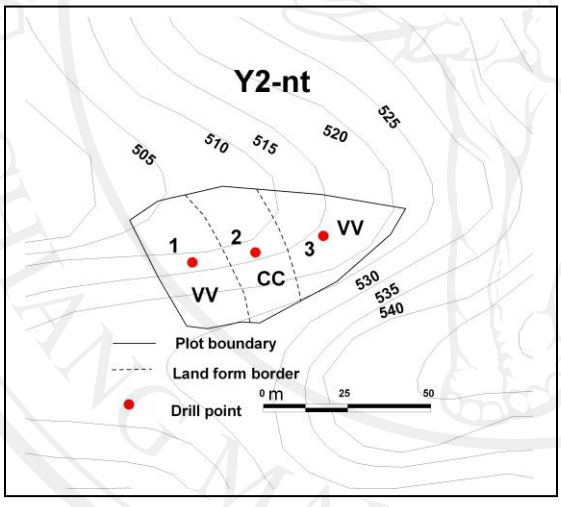
The yield reduced slightly from 2 ton in 2008 to 1.8 ton in 2010 but the application of NPK fertilizer increased from 120kg in 2008 to 150kg in 2010 (Table 4.15)

Table 4.15: Input and output of maize crop of Y2-nt, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	2 (9 ton/ha)	2800	5 (21*)	CP888	50 (218*)	120 (524*)
2009	1.8 (8 ton/ha)	3500	4 (17*)	PC06	50 (218*)	150 (655*)
2010	1.8 (8 ton/ha)	4500	4 (17*)	NK 54	50 (218*)	150 (655*)

** kg/ha*

- **Division into landform units, drill points and samples**



N^0 drill	1	2	3
Land form unit	VV	CC	VV
Area (m^2)	813.9	706.9	767
Ap (cm)	22	25	25
Slope degree	36	30	20
Soil colour	7.5YR, 4/1	2.5Y, 3/2	10YR, 5/2
Soil texture (at field)	VFS	SiL Clay rich	SiL clay poor
Nt (%)	0.110	0.152	0.115
Ct (%)	1.068	1.665	1.094

Fig 4.25: Division of Y2-nt plot into landform units

The field Y2-nt is divided into three land form plots and drilled three augering samples (Fig 4.25). The dominant land form VV is located at drill 1 with the steep slope angle 36^0 and at drill 3 with slope angle 20^0. The drill number 2 in the land form CC (Concave-Concave) has the slope 30^0 and the top soil depth 25 cm. The soil colousr at three drills are different: drill 1 is Brownish gray (7.5YR, 4/1), drill 2 is dark reddish brown (2.5YR, 3/2) and drill 3 is grayish yellow brown (10YR, 5/2). The

soil textures are VFS (very fine sand, clay <5%) at drill 1, SiL clay rich at drill 2 and SiL clay poor at drill 3. The Ct levels from 1% to 1.66% are relatively low.

Field Y3-nt:

- **General information**

Size (m^2)	5677.33
Slope range	0^0 to 15^0
Altitude (a.s.l)	480 m
Ownership since	1984
Current cultivation	Maize
Using hybrid seed	1998
Main exposition	Flat
Soil erosion	Very slight rill
Landslide	No

Fig 4.26: Y3-nt field information

The field Y3-nt is an isolated area like an island because the low foot slope is surrounded by small stream, fish ponds and paddy rice plots. It is a big field with the total area of 5677.33 m^2 and located at 480 a.s.l with the range slope angle from 0^0 to 15^0 (Fig 4.26).

Before 1984 this field was given a fallow land and was managed by Na Ten agricultural co-operative. In 1984 the farmer's parents cleared the field to cultivate upland rice in two years then planted local maize in seven years then cropped cassava until 1997. Since 1998 he took over this field from his parents and then it has been planted hybrid maize until now.

The yield was very low as compared with other fields: in 2008 the yield was 2.5 ton and in 2010 only 1.5 ton (Table 4.16). However, the fertilizer applied

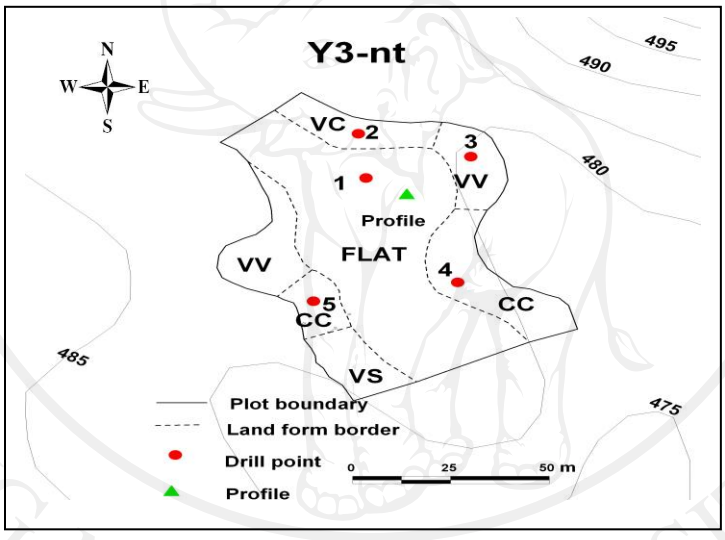
increased from 120 kg urea and 200kg NPK in 2008 to 150kg urea and 250kg NPK in 2010.

Table 4.16: Input and output of maize crop of Y3-nt, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	2.5 (4 ton/ha)	2800	12 (21*)	CP888	120 (211*)	200 (352*)
2009	2.5 (4 ton/ha)	3500	9 (15*)	PC06	100 (176*)	200 (352*)
2010	1.5 (2.6 ton/ha)	4500	10 (17*)	NK 54	150 (264*)	250 (440*)

** kg/ha*

- **<u>Division into landform units, drill points and samples</u>**



N^0 drill	1	2	3	4	5		
Land form unit	Flat	VC	VV	CC	CC	VS	VV
Area (m^2)	3059	410	384	725	247	355	495
Ap (cm)	10	10	12	20	18		
Slope degree	0	15	15	12	8	8	12
Soil colour	10YR 4/4	7.5YR 4/4	5YR 4/3	7.5YR 4/4	10YR 4/3		
Soil texture (at field)	MS	CS	VFS	SiL clay poor	VFS		
Nt (%)	0.0745	0.0914	0.1083	0.1073	0.1069		
Ct (%)	0.7832	0.9396	1.1426	1.1598	1.2114		

Fig 4.27: Division of Y3-nt plot into landform units

The field is divided into seven landform plots with five drill samples (Fig 4.27). The flat form dominates in the field with an area of 3059m^2, top soil depth

10cm, slope 0^0, brown soil colour and soil texture MS (medium sand). The flat form is selected to dig a soil profile. The second dominant landform is CC (Concave-Concave) with the total area of $972m^2$, top soil depth from 18 to 20 cm. In general the top soil has high sandy percentage; the textures at drills 1, 2, 3, 4, 5 are MS, CS, VFS, SiL and VFS. Ct ranges from 0.78% to 1.2%, which are low.

4.2.3 Ta Lang Thap village

The map presents the location of the fields of two selected farmers in Ta Lang Thap village. The rich farmer is Mrs. Bau who has four fields (BA1-BA4), and the poor farmer is Mr. Tuan who has two fields (T1-T2) (Fig 4.28).

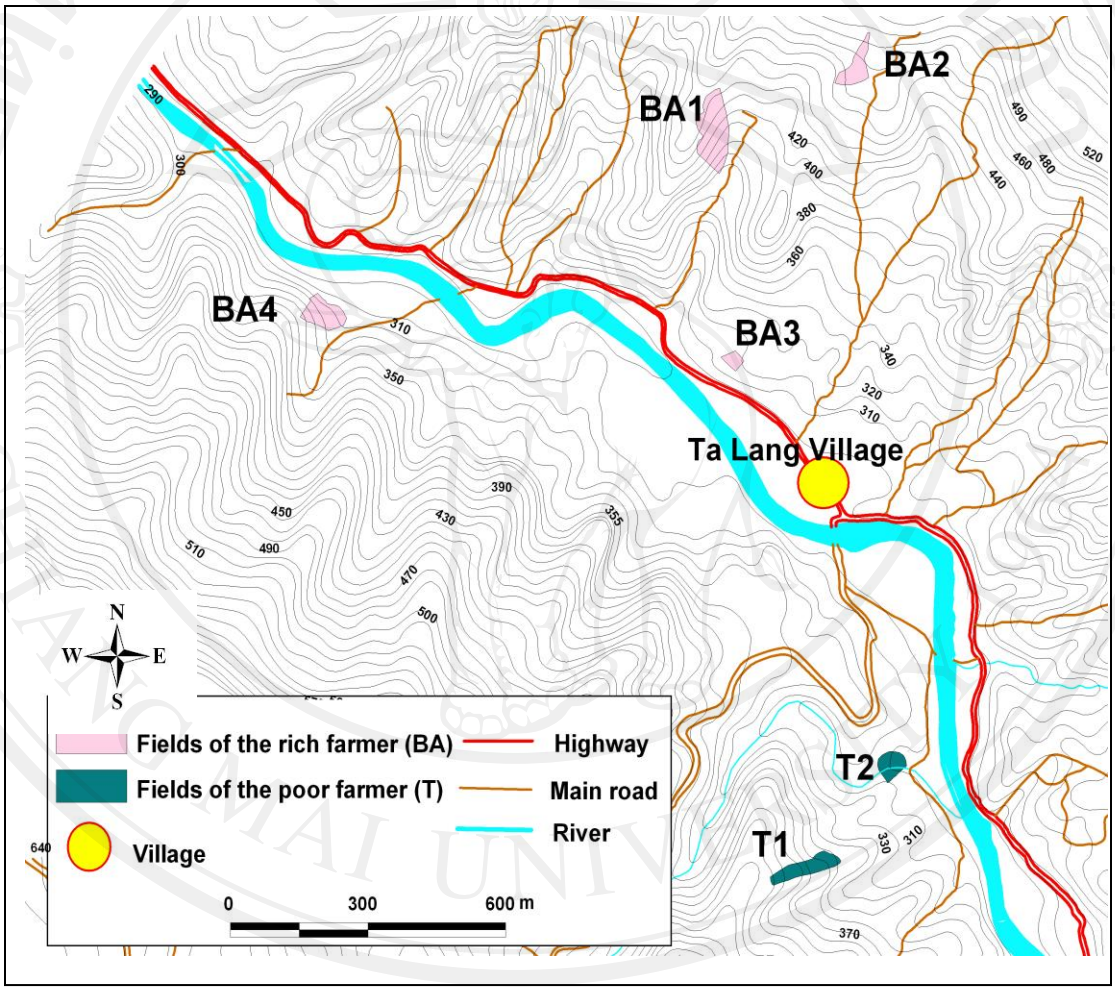


Fig 4.28: Plot locations of the rich and poor farmers in Ta Lang Thap village

Field BA1:

- **General information**

Size (m^2)	8560.2
Slope range	15^0 to 35^0
Altitude (a.s.l)	400 m
Ownership since	1985
Current cultivation	Maize
Using hybrid seed	1997
Main exposition	SSE
Soil erosion	Very slight rill
Landslide	100 m^2 at the middle slope

Fig 4.29: BA1 field information

The field BA1 has very steep slope with the slope range from 15^0 to 35^0, altitude about 400 a.s.l, exposition at South South- East, and total area 8560.2 m^2 (Fig 4.29). The soil erosion is very strong with rills and gullies from the middle slope to the foot slope and it has a piece landslide in an area of about 100m^2 at the middle slope.

The field was opened in 1984 to cultivate upland rice in five years but previously it was a fallow land and was managed by the farmer's parents. From 1990 to 1997 the field was cultivated local maize and cassava then since 1997 to now it has been cultivated hybrid maize crop.

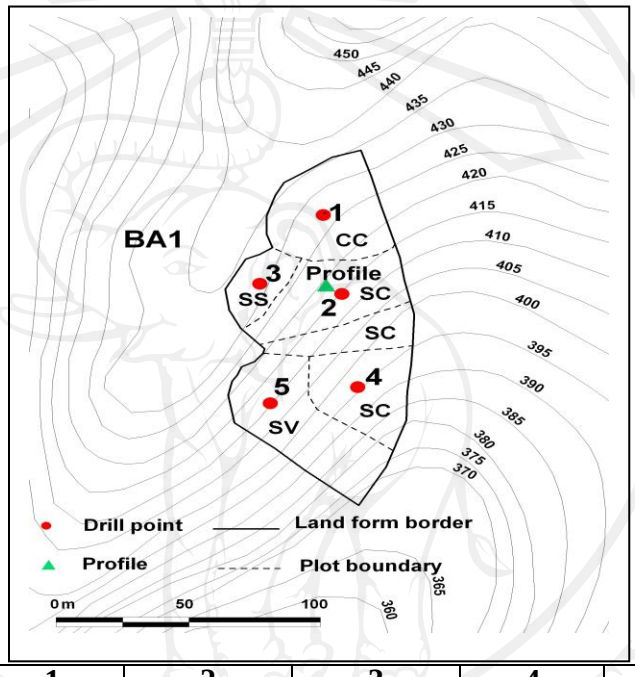
The input and output of maize for this field is presented in Table 4.17. The yield was 8.5 ton in 2008 but only 2.6 ton in 2010. The reason for low yield in 2010 was dry weather during cropping time. The application of urea fertilizer increased from 200kg in 2008 to 250kg in 2010.

Table 4.17: Input and output of maize crop of BA1, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	8.5 (10 ton/ha)	2600	30 (35*)	LVN10	200 (233*)	400 (467*)
2009	9.3 (11 ton/ha)	3200	30 (35*)	CP888	200 (223*)	400 (467*)
2010	2.6 (3 ton/ha)	4800	25 (29*)	NK4300	250 (292*)	400 (467*)

** kg/ha*

- **Division into landform units, drill points and samples**



N^0 drill	1	2	3	4	5	
Land form unit	CC	SC	SS	SC	SV	SC
Area (m^2)	1891	1634.7	637	1432	2179	784
Ap (cm)	14	12	16	10	10	
Slope degree	15	31	18	28	35	28
Soil colour	7.5Y,3/2	7.5YR,3/3	7.5YR,3/3	2.5Y,3/3	5YR,3/4	
Soil texture (at field)	Si	SiL clay rich	SiL clay rich	CL	SiL clay rich	
Nt (%)	0.1558	0.1463	0.1786	0.1300	0.1499	
Ct (%)	1.8710	1.5900	1.9505	1.0462	1.4637	

Fig 4.30: Division of BA1 plot into landform units

The field BA1 is divided into six land form plots and drilled five augering samples (Fig 4.30). The land form SC (Straight-Concave) dominates in this field with the total area of 3851.3m^2, the top soil depth around 10 cm and the average slope angle 30^0. This land form is selected to dig a profile. The soil texture and soil colour

of SC land form at the drill 2 are SiL clay rich and dark brown respectively. The soil texture and soi colour of SC land form at the drill 4 are CL and dark reddish brown. In general the soil colour of this field is dark. The Ct ranges are from low to medium: from 1.04% to 1.95%.

Field BA2:

- **General information**

Size (m^2)	3364.6
Slope range	8^0 to 23^0
Altitude (a.s.l)	475 m
Open land	2001
Current cultivation	Maize
Using hybrid seed	2001
Main exposition	W
Soil erosion	No
Landslide	No

Fig 4.31: BA2 field information

The field BA2 has the total area of 3364.6 m^2, slope range from 8^0 to 23^0, altitude at 475 a.s.l and an exposition at West direction (Fig 4.31). The soil has black colour, good structure and no soil erosion.

Before 2001, the field was secondary forest with low dense trees, and then it was cut and cleared by Mrs. Bau to cultivate hybrid maize. This field has not issued red book certificate.

The maize yield in three years 2008-2010 presented in Table 4.18. The yield did not change much: 3.8 ton in 2008 and 4 ton in 2010. The applied urea fertilizer

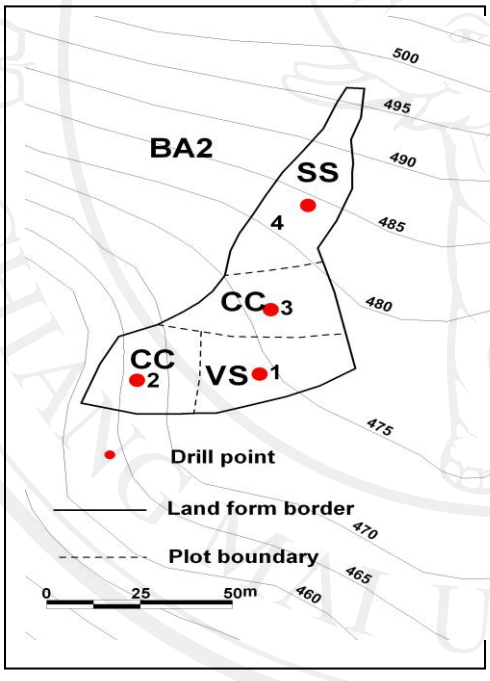
was stable at 100kg in three years but the amount of NPK increased from 200kg in 2008 to 250kg in 2010. The amount of seed increased between 8kg in 2008 and 10kg in 2010.

Table 4.18: Input and output of maize crop of BA2, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	3.8 (11 ton/ha)	2600	8 (23*)	LVN10	100 (297*)	200 (594*)
2009	3.5 (10 ton/ha)	3200	8 (23*)	CP888	100 (297*)	200 (594*)
2010	4 (11 ton/ha)	4800	10 (29*)	NK4300	100 (297*)	250 (743*)

** kg/ha*

- **Division into landform units, drill points and samples**



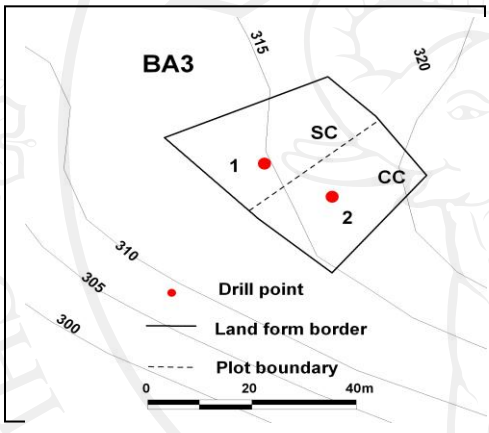
N^0 drill	1	2	3	4
Land form unit	VS	CC	CC	SS
Area (m^2)	820	722	806	1015
Ap (cm)	20	15	25	15
Slope degree	8	23	11	15
Soil colour	7.5YR, 3/4	5YR, 3/3	7.5YR, 3/2	7.5YR, 3/2
Soil texture (at field)	SCL	SCL	SiL clay rich	CL
Nt (%)	0.2126	0.2151	0.1974	0.2184
Ct (%)	3.3397	2.1041	2.3930	2.5362

Fig 4.32: Division of BA2 plot into landform units

The field BA2 is divided into four land form plots and drilled four augering soil samples (Fig 4.32). The dominating land form CC (Concave- Concave) in this field is located at drills 2 and 3 with slope 23^0 and 11^0, soil depths 15 cm and 25cm respectively. It has dark reddish brown soil colour (5YR, 3/3) and soil texture SCL (Sandy Clay Loam) at drill 1, and brownish black soil colour (7.5YR, 3/2) and soil

texture SiL clay rich at drill 3. The land form SS at the drill number 4 takes up the second largest area in this field with slope 15^0, the top soil depth 15cm, brownish black soil colour (7.5 YR, 3/2) and soil texture CL (Clay loam). In general, the soil colour of the field is black. The Ct ranges from 2.1% to 3.3% are medium.

Field BA3:



N^0 drill	1	2
Land form unit	SC	CC
Area (m^2)	559	517
Ap (cm)	20	12
Slope degree	10	13
Soil colour	7.5YR,3/2	5YR,3/2
Soil texture (at field)	SiL clay poor	SiL clay poor
Nt (%)	0.1789	0.1469
Ct (%)	2.0542	1.7806

Fig 4.33: Division of BA3 plot into landform units

The field BA3 was located at 315 a.s.l altitude, exposition at West direction and total area 1076 m^2. It was divided into land form units: SC (Straight-Concave) with the top soil depth 20 cm, slope 10^0 and brownish black soil colour, and CC (Concave-Concave) with the top soil depth 12cm, slope 13^0 and dark reddish brown soil colour. The soil texture was the same at two land forms (Fig 4.33). Ct levels from 1.78% to 2% are low.

The farmer has used this field since 1985. He cultivated cassava crop in two years. Then he planted local maize until 1996 and since he has planted hybrid maize. The yield decreased significantly in three year, from 1.2 ton in 2008 to 0.6 ton in

2010 (Table 4.19). The seed and fertilizer were applied with the same amount in three years: 3kg seed, 50kg urea and 100kg NPK.

Table 4.19: Input and output of maize crop of BA3, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	1.2 (11 ton/ha)	2600	3 (27*)	LVN10	50 (464*)	100 (929*)
2009	1.5 (13 ton/ha)	3200	3 (27*)	CP888	50 (464*)	100 (929*)
2010	0.6 (5.5 ton/ha)	4800	3 (27*)	NK4300	50 (464*)	100 (929*)

** kg/ha*

Field BA4:

- **General information**

Size (m^2)	4381.06
Slope range	5^0 to 30^0
Altitude (a.s.l)	325 m
Ownership since	1985
Current cultivation	Maize
Using hybrid seed	1997
Main exposition	E
Soil erosion	Strong rill erosion
Landslide	No

Fig 4.34: BA4 field information

The field BA4 has the total area of 4381.06 m^2, a slope range from 5^0 to 30^0, altitude at 325 a.s.l, and exposition at East direction (Fig 4.34). The field has two parts, one part is very steep hill with slope from 22^0 to 30^0 and the other part is nearly flat with slope lower than 5^0 (Fig 4.34). The soil erosion was strong with rills which happened at the slope more than 22^0.

The farmer took over this field from her parents in 1985 then local cassava crop was planted for 4 years. From 1989 to 1993, local maize was cultivated on the

slope more than 22^0 and cotton was cultivated on the slope less than 5^0. From 1994 to 1996 it was given a fallow land but since 1997, hybrid maize has been planted there.

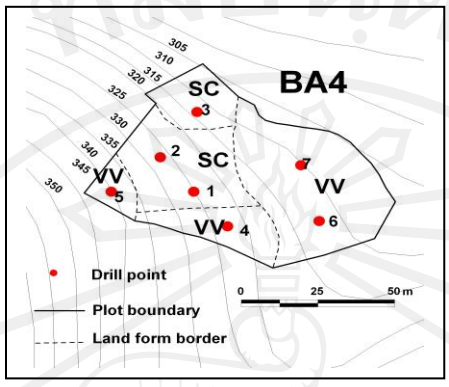
The maize yield during three years is presented in Table 4.20. The yield was stable at 5 ton in three years; whereas the applied fertilizer increased from 100kg urea in 2008 to 150 kg in 2010.

Table 4.20: Input and output of maize crop of BA4, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	5 (11 ton/ha)	2600	8 (18*)	LVN10	100 (228*)	200 (456*)
2009	5 (11 ton/ha)	3200	10 (22*)	CP888	150 (342*)	200 (456*)
2010	5 (11 ton/ha)	4800	10 (22*)	NK4300	150 (342*)	200 (456*)

** kg/ha*

- **Division into landform units, drill points and samples**



N^0 drill	1	2	3	4	5	6	7
Land form unit	SC		SC	VV	VV	VV	
Area (m^2)	1151		482	556	226	1965	
Ap (cm)	10	14	20	18	14	25	20
Slope degree	30	30	22	24	26	5	5
Soil colour	2.5YR, 4/3	2.5YR, 3/3	2.5YR, 3/3	2.5YR, 3/4	5YR, 3/3	5YR, 3/2	7.5YR, 3/3
Soil texture (at field)	SiL clay poor	SiL clay poor	SiL clay rich	SiL clay rich	SiL clay rich	VFS	SiL clay poor
Nt (%)	0.1625	0.1645	0.1488	0.1748	0.1657	0.1208	0.1232
Ct (%)	1.6441	2.1493	1.5282	2.6841	1.6465	1.6788	1.4657

Fig 4.35: Division of BA4 plot into landform units

The field BA4 is divided into five land form plots but seven augering samples were drilled, the land form VV (Convex-Convex) and SC (Straight-Concave) dominate in the field (Fig 4.35).Three drills 1, 2 and 3, have the topsoil depth 10cm, 14cm and 20cm and the slope angles is 30^0, 30^0 and 22^0 respectively. The drill number 4, 5, 6 and 7, with the land form VV, have the topsoil depth 18cm, 14cm, 25cm and 20cm, and the slope angle 24^0, 26^0 and 5^0 respectively. The soil colours are dark reddish brown (2.5YR and 5YR, 4/3 and 3/3) and dark brown (7.5YR, 3/3). Most drills have the soil textures SiL clay rich or poor but drill number 6 has VFS (Very Fine Sand). The Ct levels are from 1.4% to 2.68%.

Field T1:

- **General information**

Size (m^2)	4345.8
Slope range	16^0 to 34^0
Altitude (a.s.l)	370 m
Ownership since	2006
Current cultivation	Maize
Using hybrid seed	2006
Main exposition	N
Soil erosion	Slight rill
Landslide	No

Fig 4.36: T1 field information

The field T1 is located at 370 a.s.l, exposition at the Northern direction, and has the total area of 4345.8 m^2 with slope range between 16^0 and 34^0 (Fig 4.36). The field was transferred to the farmer's parents in 2006 to cultivate hybrid maize. Before that time banana and cassava was planted. Since it belonged to him, the field has been divided into parts; one part has cultivaterd hybrid maize and the other part has an agro-forestry system (hybrid maize + forest trees) that is located from upper slope to te htop of the hill. The soil erosion is slight on the second part with no landslide.

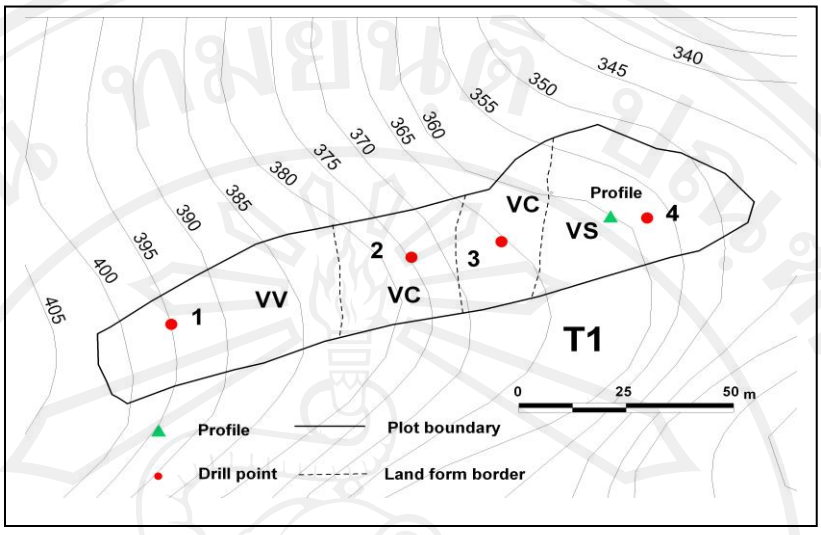
The maize yield from 2008 to 2010 is presented in Table 4.21. The maize yield remained stable at 3.5 ton; application of fertilizer and seed were stable in three years but the maize price and type of maize seed were changed.

Table 4.21: Input and output of maize crop of T1, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	3.5 (8 ton/ha)	2800	8 (18*)	LVN10	50 (115*)	150 (345*)
2009	3.5 (8 ton/ha)	3100	8 (18*)	LVN10	50 (115*)	150 (345*)
2010	3.3 (5.5 ton/ha)	4200	8 (18*)	Song Boi	50 (115*)	150 (345*)

** kg/ha*

- **<u>Division into landform units, drill points and samples</u>**



N^0 drill	1	2	3	4
Land form unit	VV	VC	VC	VS
Area (m^2)	1481	800	670	1394
Ap (cm)	20	18	18	20
Slope degree	20	34	20	16
Soil colour	2.5YR, 3/3	7.5YR, 3/2	7.5YR, 4/2	7.5YR, 3/2
Soil texture (at field)	SiL clay poor	SiL clay rich	SL clay poor	SL clay poor
Nt (%)	0.1616	0.1612	0.1418	0.1118
Ct (%)	1.7195	1.8512	1.6453	1.3812

Fig 4.37: Divided T1 plot into landform units

The field T1 is divided into four landform plots and drilled four augering samples (Fig 4.37). The drills number 2 and 3 have the same land form unit VC (Convex-Concave) with the top soil depth 18 cm. But the slope angles are different: 34^0 at the drill 2 and 20^0 at the drill 3. The land form at drill 4 is selected to dig a soil profile with the top soil depth about 20cm, slope 16^0. The soil colour of this field changed with different land forms and slopes and the soil textures also change. The agro-forestry system is applied from land form VC at drill 2 to land form VV at the drill 1. The Ct levels are from 1.64% to 1.85%.

Field T2:

- **General information**

Size (m^2)	2683.08
Slope range	2^0 to 6^0
Altitude (a.s.l)	300 m
Ownership since	1983
Current cultivation	Maize
Using hybrid seed	2001
Main exposition	N
Soil erosion	No
Landslide	No

Fig 4.38: T2 field information

The field T1 is located at the river side and at altitude 300 a.s.l. It has the total area of 2683.08 m^2, slope range between 2^0 to 6^0 and exposition at the Northern direction, without soil erosion (Fig 4.38).

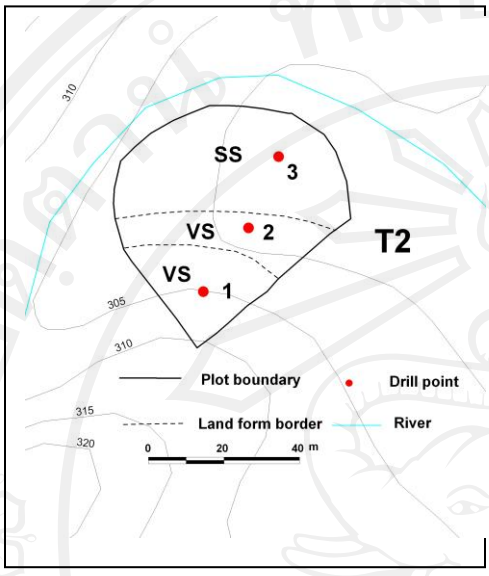
The field was opened in 1983 to cultivate paddy rice by the farmer' parents, and then from 1996 to 2001 local maize was planted. From 2001 to now hybrid maize has been planted. The maize yield increased slightly from 1.2 ton in 2008 to 1.5 ton in 2010 (Table 4.22). The applied was stable for both Urea and NPK in three years: 70kg urea and 150kg NPK.

Table 4.22: Input and output of maize crop of T2, 2008-2010

Year	Yield (ton)	Price (VND/kg)	Seed (kg)	Seed name	Urea(kg)	NPK(kg)
2008	1.2 (4.5 ton/ha)	2800	4 (15*)	LVN10	70 (260*)	150 (559*)
2009	1.2 (4.5 ton/ha)	3100	4 (15*)	LVN10	70 (260*)	150 (559*)
2010	1.5 (5.5 ton/ha)	4200	5 (18*)	SongBoi	70 (260*)	150 (559*)

** kg/ha*

- **Division into landform units, drill points and samples**



N^0 drill	1	2	3
Land form unit	VS	VS	SS
Area (m^2)			
Ap (cm)	20	15	25
Slope degree	4	6	2
Soil colour	7.5YR,4/2	10YR,3/3	5YR,3/2
Soil texture (at field)	S	S	CS
Nt (%)	0.1111	0.1151	0.1370
Ct (%)	1.2791	1.3063	2.9912

Fig 4.39: Division of T2 plot into landform units

The field T2 is divided into three land form plots with three drilling samples. The drill 1 and 2 are located in the land form VS (Convex Straight) with slope 4^0 and 6^0, respectively (Fig 4.39). They have the same soil texture S but they had different the topsoil depths and soil colours: 20cm depth and gray brown soil colour at the drill 1, and 15cm depth and dark brown soil colour at the drill 2. Drill 3 was located at the land form SS (Straight-Straight) with slope 2^0, the top soil depth 25cm, dark reddish brown soil colour and SC (Sandy Clay) soil texture. The Ct ranges from 1.27% to 3%, which are low.

4.3 Location profile selection:

The soil quality is influenced by the topographical factors. The method to select the plots and position to dig a profile was based on the combination of the biggest size unit, typical land form and typical slope angle in the fields of the selected farmers. The GIS Tools were used to analyse and combine three factors above and gave a result that shown some options for us to select a place for digging soil profile

Mr. Yen's fields

Table 4.23: Process and location of selected soil profile in Mr. Yen's fields

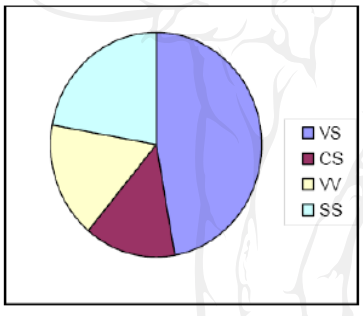
a) GIS data result

Id	Land_forms	Slope	Exposition	Altitude	Augering ID	Land form area (m^2)	Plot area(m^2)
Plot 1	VS	14	W	390	6	391.296	7050.21
	CS	7	N	395	5	454.809	
	CS	13	N	401	4	358.015	
	VS	20	W	413	3	837.26	
	CS	16	W	412	2	1159.067	
	VV	25	WN 33	401	1	671.911	
	SS	20	W	392	7	3177.852	
Plot 2	VV	33	WN 30	350	1	1687.655	1687.66
Plot 3	VS	15	WN 32	340	3	453.033	5505.23
	VS	35	WN 32	326	2--4	1776.858	
	VS	**25**	**WN 32**	**314**	**1**	**3275.334**	
Total							14243.09

Place to dig a profile

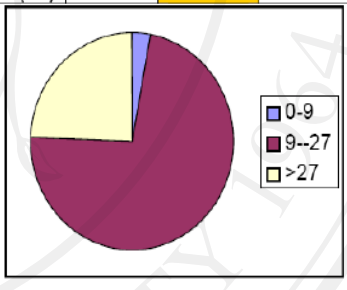
b) Landform analysis result

Land form	Area (m2)
VS	6733.8
CS	1971.9
VV	2359.6
SS	3177.8

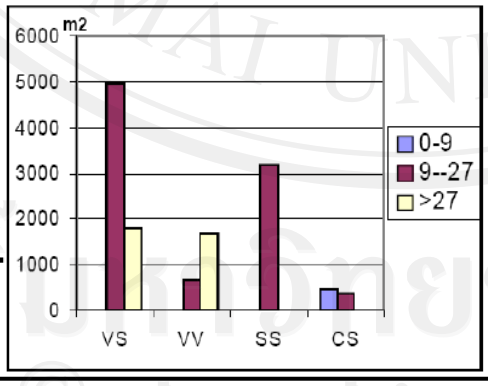


c) Slope analysis result

Slope (degree)	0-9	9--27	>27
Area(m^2)	454.80	10323.77	3464.51



d) Combination of landforms and slopes result



Combination of landforms with slopes			
	0-9	9--27	>27
VS	0	4956.92	1776.85
VV	0	671.91	1687.65
SS	0	3177.82	0
CS	454.809	358.01	

Mr. Hac's fields

Table 4.24: Process and location of selected soil profile in Mr. Hac's fields

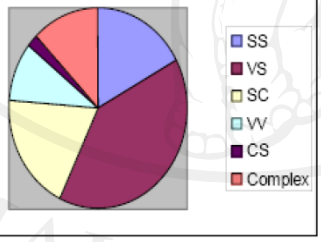
a) *GIS data result*

Id	Land forms	Slope	Exposition	Altitude	Augering ID	Land form area (m2)	Plot area (m2)
plot 4	SS	30	SW 21	307	1	1122.244	
	VS	9	SW 21	332	3	599.232	2362.38
	SS	36	SW 21	325	2	1140.909	
Plot 3	SC	26	E	368	2	1320.865	
	Complex-landslid	26	E	367	3	842.939	
	VV	26	E	366	1	937.978	**6247.94**
	SC	16	E	376	4	1174.851	
	VS	**18**	**E**	**384**	**3 - 5**	**1971.316**	
Plot 2	VS	14	W	356		276.649	
	VS	22	W	377	2	1144.015	2588.3
	Complex-landslid	0	ES 15	357	3	755.454	
	VS	14	ES 12	356	1	412.183	
Plot 1	VS	27	ES 13	389	3	275.972	
	VV	27	ES 13	375	4	325.605	1426.28
	CS	32	ES 13	337	2	276.232	
	VS	28	ES 13	372	1	548.474	
Total							12624.9

Place to dig a profile

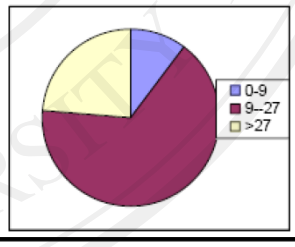
b) *Landform analysis result*

Land form	Area (m^2)
SS	2263.1
VS	**5227.8**
SC	2495.7
VV	1263.6
CS	276.2
Complex	1598.4

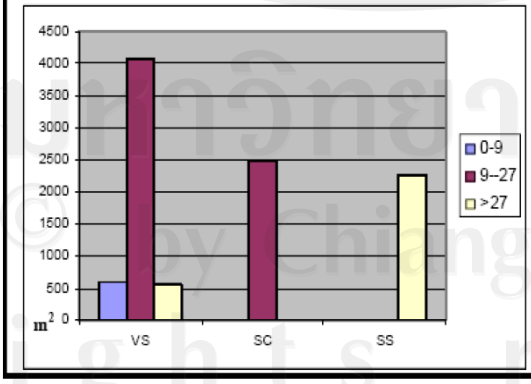


c) *Slope analysis result*

Slope (degree)	0-9	9--27	>27
Area (m^2)	1354.69	**8682.37**	3087.86



d) *Combination of landforms and slopes result*



Combination of landforms with slopes

Landform (m^2) \ Slope (degree)	0-9	9--27	>27
VS	599.23	**4080.13**	548.47
SC	0	2495.72	0
SS	0	0	2263.15

Mr. Bien's fields

Table 4.25: Process and location of selected soil profile in Mr. Bien's fields

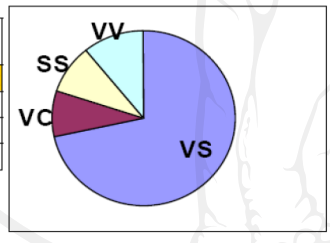
a) GIS data result

Id	Land_form	Slope	Exposition	Altitude	Augering_ID	Landform area (m^2)	Plot area (m^2)
Plot 1	SS	12	W	476	5	1031.169	6627.449
	VS	**26**	**W**	**500**	**4**	**2141.456**	
	VS	15	W	476	1	1040.448	
	VS	17	W	477	2	1368.461	
	VV	25	W	496	3	1045.915	
Plot 2	VS	25	WN 29	523	2	1461.951	4742.403
	VC	22	W	521	1	962.511	
	SS	30	WN 31	532	3	404.722	
	VC	28	WN 32	528	4	395.937	
	VS	17	SW 24	535	5	1517.282	
Plot 3	VS	20	SW 23	594	1--2	1745.709	1745.709
Plot 4	VS	16	W	518		231.749	2576.698
	VS	22	W	529	3	581.289	
	VV	18	SW 22	532	4	649.837	
	VS	23	S	527	5	731.047	
	VS	18	SW 21	518	1	382.776	
	Total						15692.259

Place to dig a profile

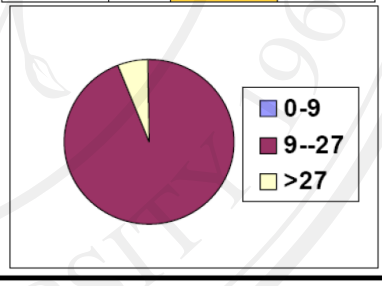
b) Landform analysis result

Land form	Area (m^2)
VS	**11202.2**
VC	1358.4
SS	1435.9
VV	1695.7

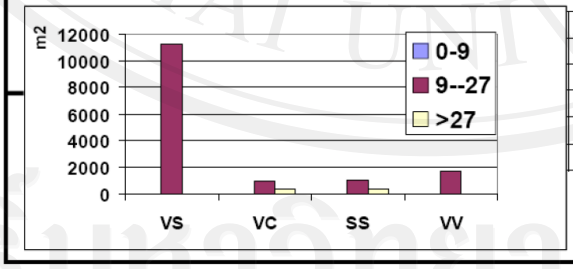


c) Slope analysis result

Slope (degree)	0-9	9--27	>27
Area(m^2)		12750.1	800.7



d) Combination of landforms and slopes result



Combination of landforms with slopes	0-9	9--27	>27
VS	0	11202.17	0
VC	0	962.511	395.937
SS	0	1031.169	404.722
VV	0	1695.752	0

Mr. Yen-nt's fields

Table 4.26: Process and location of selected soil profile in Mr. Yen-nt's fields

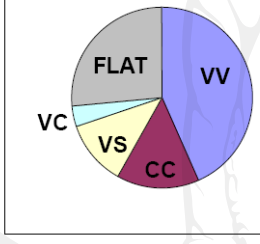
a) GIS data result

Id	Land_form	Slope	Exposition	Altitude	Augering_ID	Landform area (m2)	Plot area (m2)
Plot 1	VV	12	WN 32	484	3	720.63	3524.50
	VS	10	SW 24	484	2	1005.55	
	VV	15	SW 24	489	4	1071.62	
	VV	8	SW 24	483	1	726.68	
Plot 2	VV	20	WN 33	519	3	767.05	2287.97
	CC	30	WN 33	519	2	706.99	
	VV	36	WN 33	517	1	813.92	
Plot 3	VC	15	NE 4	480	2	410.45	5677.33
	VV	12	SW 22	480		495.69	
	CC	8	SW 22	480	5	247.96	
	VS	8	SW 22	480		355.03	
	FLAT	**0**	**0**	**481**	**1**	**3059.08**	
	VV	15	NE 6	480	3	384.15	
	CC	12	NE 8	480	4	724.948	
Total							11489.81

Place to dig a profile

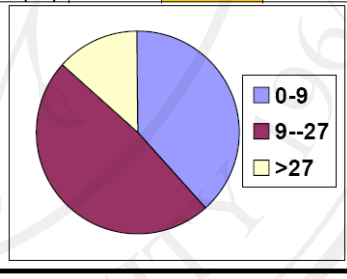
b) Landform analysis result

Land form	Area (m2)
VV	4979.77
CC	1679.9
VS	1360.59
VC	410.45
Flat	3059.08

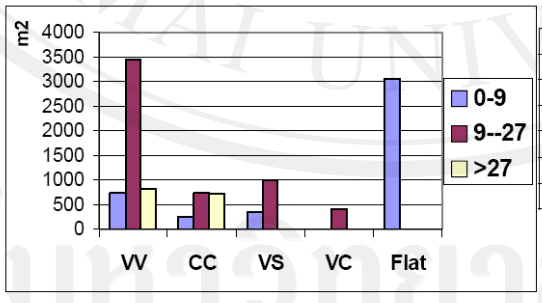


c) Slope analysis result

Slope (degree)	0-9	9--27	>27
Area(m^2)	4388.77	5580.12	1520.91



d) Combination of landforms and slopes result



Combination of landforms with slopes	0-9	9--27	>27
VV	726.68	3439.17	813.92
CC	247.96	724.94	706.99
VS	355.03	1005.55	0
VC	0	410.45	0
Flat	3059.08	0	0

In this case, the dominant landform is VV then is Flat and the typical slope is 9^0-27^0 then is 0-9^0. But we selected Flat form and slope 0^0-9^0 because the Flat form has the biggest size and belongs to the largest plot.

Mrs. Bau's fields

Table 4.27: Process and location of selected soil profile in Mr. Bau's fields

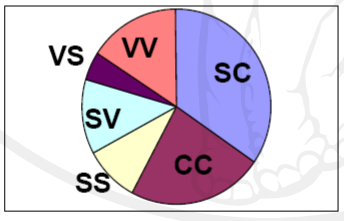
a) GIS data result

Id	Landform	Slope	Exposition	Altitude	Augering_ID	Landform area (m^2)	Plot area (m^2)
Plot 1	CC	15	ES 16	426	1	1891.561	8560.214
	SS	18	ES 16	431	3	637.425	
	SC	**31**	**ES 15**	**414**	**2**	**1634.679**	
	SC	28	ES 16	414	LANDSLIDE	784.431	
	SV	35	ES 16	409	5	2179.705	
	SC	28	ES 16	395	4	1432.413	
Plot 2	SS	15	SW 21	483	4	1015.258	3364.697
	CC	11	SW	476	3	806.535	
	CC	23	W	467	2	722.327	
	VS	8	S	474	1	820.577	
Plot 3	SC	10	W	314	1	559.129	1076.477
	CC	13	SW 23	316	2	517.348	
Plot 4	SC	22	E	313	3	482.041	4381.065
	SC	30	E	325	1--2	1150.962	
	VV	5	E	310	6--7	1965.285	
	VV	26	E	340	5	225.883	
	VV	24	E	322	4	556.894	
Total							17382.453

Place to dig a profile

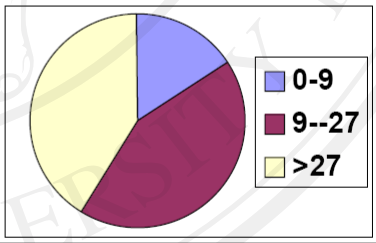
b) Landform analysis result

Land form	Area (m2)
SC	**6043.655**
CC	3937.771
SS	1652.683
SV	2179.705
VS	820.577
VV	2748.062

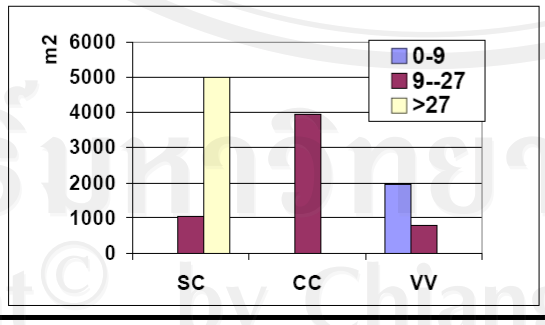


c) Slope analysis result

Slope (degree)	0-9	9--27	>27
Area(m^2)	2785.86	7414.40	7182.19



d) Combination of landforms and slopes result



Combination of landforms with slopes			
	0-9	9--27	>27
SC	0	1041.17	5002.485
CC	0	3937.771	0
VV	1965.285	782.777	0

Mr. Tuan's fields

Table 4.28: Process and location of selected soil profile in Mr. Tuan's fields

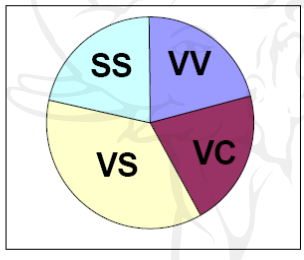
a) GIS data result

Id	Landform	Slope	Exposition	Altitude	Augering_ID	Landform area (m2)	Plot area (m2)
Plot 1	VV	20	NE 7	394	1	1481.157	
	VC	34	NE 3	373	2	800.387	
	VC	20	NE 3	364	3	670.021	
	VS	**16**	**NE 4**	**356**	**4**	**1394.236**	**4345.801**
Plot 2	VS	4	N	304	1	610.57	
	VS	6	N	300	2	558.476	
	SS	2	NE 3	299	3	1514.037	2683.083
Total							7028.884

Place to dig a profile

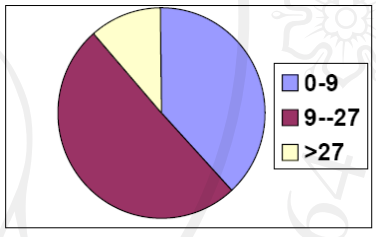
b) Landform analysis result

Land form	Area (m2)
VV	1481.157
VC	1470.408
VS	**2563.282**
SS	1514.037

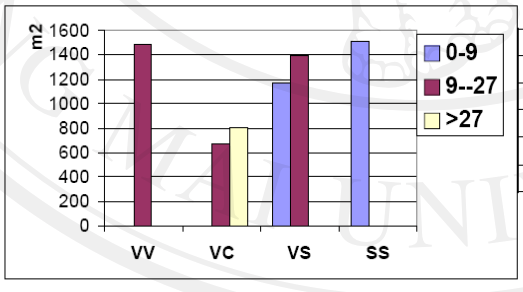


c) Slope analysis result

Slope (degree)	0-9	9--27	>27
Area(m^2)	2683.08	**3545.41**	800.38



d) Combination of landforms and slopes result

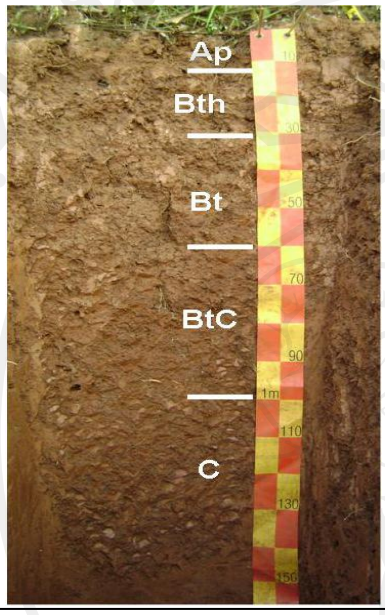


Combination of landforms with slopes	0-9	9--27	>27
VV	0	1481.15	0
VC	0	670.02	800.38
VS	1169.04	**1394.23**	0
SS	1514.03	0	0

In this case, GIS gave two options that is landform VV and VS with slope groups 9^0-27^0 (Plot 1). Two these landforms have the same condition that is fit with requirements to dig soil profile.

4.4 Soil profile descriptions and laboratory results

Profile Y: Mr. Yen, rich household in Kho Vang village



Haplic Luvisol (Siltic, Chromic)

Parent material: Silt + Sand stone
Location: Kho Vang
GPS coordination: X-Y: 426851-2326689
Altitude: 322 m (a.s.l)
Slope position: Middle slope
Slope angle: 25^0
Land form:VS. **Exposition:** WN
Open land: 1992
Present crop: Maize + cassava + banana
Using History:
1992-1999 mixing local maize+banana+cassava
1999-2004 mixing maize+teak
2004-2007 hybrid maize
2007-2010 mixing maize+ cassava+ banana

Table 4.29: Description of soil profile Y at field

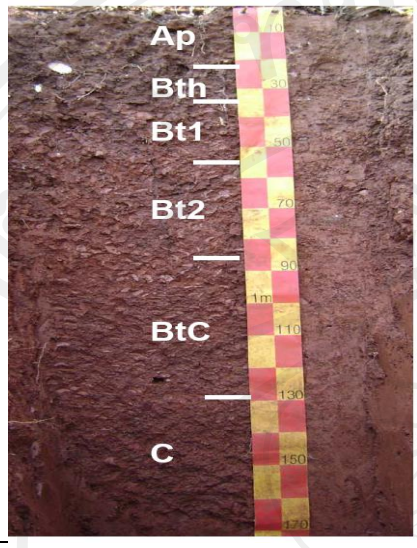
Hor	Dept (cm)	Texture	Color	Structure*	Coars fragment	Void (vol%)	Cutans		Concretion%	Root (dm^2)	Bio. feature**
							%	Nature			
Ap	12	SiL	2.5YR,4/6	G	0	40	2-5	Humus	Fe,1	40-60	C.ant -termite
Bth	30	CL	2.5YR,3/6	B-S	1	4	40-80	Clay-humus		15-30	
Bt	60	SC	2.5YR,3/6	B-S	5	15	20-40	clay		10-20	
BtC	100	CL	10YR,3/6	B-S	40	15	10-15	clay		15-25	
C	160				95						

Structure; G: Granular, B-S: Blocky –sub-angular. Biol-feature**; C: common, F: few*

Table 4.30: Lab-analysis result-Profile Y

Hor	Bulk	Texture			Ct	Nt	pH	pH	Bray1		Exchang.Basic Cations				CEC pot	BS
		Sand	Silt	Clay					Ka	Pa	Ca2+	Mg2+	K+	Na+		
	g/cm3	%			%		H2O	KCl	mg/kg		mmol(+)/kg					%
Ap	1.39	44.8	20.1	35.3	0.81	0.05	5.6	4.0	76.9	1.53	66.7	30.5	2.8	0.4	202.5	49.6
Bth	1.40	32.6	19.2	48.2	0.64	0.04	5.4	3.8	74.9	0.28	57.9	40.6	3.3	0.4	275.9	37
Bt	1.56	46.1	19.8	34.1			5.9	3.9	68.4	0.20	73.8	44.6	2.9	0.5	237.7	51.2
BtC	1.55	57.5	19.4	23.1			6.2	4.0	74.4	0.46	78.0	43.5	2.6	0.5	208.5	59.8

Profile H: Mr. Hac, poor household in Kho Vang village



Haplic Alisol (Endoskeletic, Siltic)

Parent material: Silt + Sand stone
Location: Kho Vang
GPS coordination: X-Y: 426665-2326359
Altitude: 380 m (a.s.l)
Slope position: Upper slope
Slope angle: 23 ^{0}
Land form: VS. **Exposition:** E
Open land: 1984
Present crop: Maize+cassava

Using History:
1984-1987 Upland rice, 1987-2002 Fallow land
2002-2010 mixing cassava + hybrid maize

Table 4.31: Description of soil profile H at field

Hor	Dept (cm)	Texture	Color	Structure*	Coars fragment	Void (vol%)	Cutans		Root (dm^2)	Bio. feature**
							%	Nature		
Ap	23	SiL	5YR,3/2	G	1	40			120-150	C.ant-termite
Bth	35	SL	5YR,3/3	B-S	2	15	30	Clay-humus	80-100	C.ant-termite
Bt1	55	SC	2.5YR,4/6	B-S	23	10	40	Clay	6-15	C.ant-termite
Bt2	85	CL	2.5YR,4/6	B-S	35	3	20	Clay	6-15	F
BtC	130	CL	2.5YR,4/8	B-S	45	2	18		2-5	Non
C	170									

Structure; G: Granular, B-S: Blocky –sub-angular. Biol-feature**; C: common, F: few*

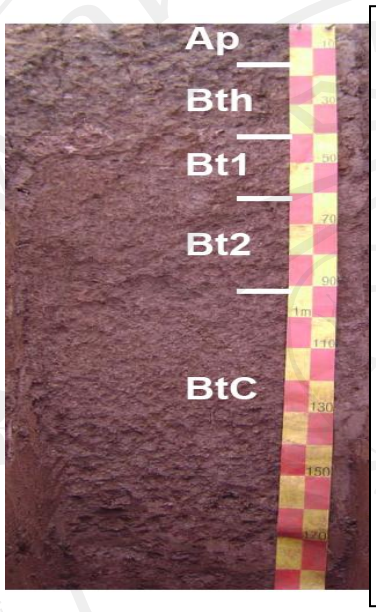
Table 4.32: Lab-analysis result-Profile H

Hor	Bulk	Texture			Ct	Nt	pH	pH	Bray1		Exchang.Basic Cations				CEC pot	BS
		Sand	Silt	Clay					Ka	Pa	Ca2+	Mg2+	K+	Na+		
	g/cm3	%			%		H2O	KCl	mg/kg		mmol(+)/kg					%
Ap	1.26	50.3	20.2	29.4	1.04	0.06	5.6	4.2	60	9.33	86.5	21.1	2.3	0.2	202.8	54.3
Bth	1.39	49	20.8	30.2	0.91	0.05	5.2	3.9	58	0.61	73.3	24.2	2.3	0.3	211.2	47.4
Bt1	1.49	36.6	17.7	45.7			5.5	3.9	71.9	0.26	91	35	3.2	0.5	284.4	45.6
Bt2	1.5	43.6	21.2	35.2			5.7	3.9	67.8	0.21	93.4	34.9	3.1	0.3	266.3	49.4
BtC	1.55	41.9	22.9	35.2			5.8	4	72.9	0.26	97	36.4	3.3	0.4	249.8	54.9

The profile H was dug 170cm deep. Silt and sand stone, which can be found at the top soil, concentrate at the depth of 35cm downward. Silt and sand stone account for 23% at >35cm depth and 45% at 85 cm depth, and are strongly weathered. Clay

and humus can be found from 23 cm to 35 cm depth (Bth horizon) were transported from the topsoil (Table 4.31).

Profile B: Mr. Bien, rich household in Na Ten village



Haplic Alisol (Siltic, Rhodic)

Parent material: Silt + Sand stone
Location: Na Ten
GPS coordination: X-Y: 442217-2318674
Altitude: 495 m (a.s.l)
Slope position: at middle slope
Slope angle: 26 ^{0}
Land form: VS. **Exposition:** W
Open land: 1981
Present crop: Maize

Using History:
Before 1981 natural forest
1981-1986 upland rice
1987-1998 local maize
1999-2010 hybrid maize

Table 4.33: Description of soil profile B at field

Hor	Dept (cm)	Texture	Color	Structure*	Coars fragment	Void (vol%)	Cutans		Root (dm^2)	Bio. feature**
							%	Nature		
Ap	15	SiL	5YR,3/4	G	1	15-25			30-50	C.ant-termite
Bth	40	CL	5YR,3/6	B-S	3	10-15	30	Clay-humus	20-30	C.ant-termite
Bt1	60	CL	2.5YR,4/6	B-S	1	1-8	30	Clay,pressur	5-10	F.termite
Bt2	90	C	2.5YR,4/6	B-S	8	1	15	Clay,pressu	0	Non
BtC	170	C	2.5YR,4/6	B-S	20	5-10	15	Clay,pressu	0	Non

Structure; G: Granular, B-S: Blocky –sub-angular. Biol-feature**; C: common, F: few*

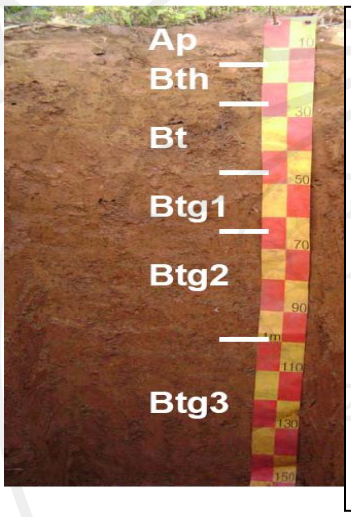
Table 4.34: Lab-analysis result-Profile B

Hor	Bulk	Texture			Ct	Nt	pH	pH	Bray1		Exchang.Basic Cations				CEC pot	BS
		Sand	Silt	Clay					Ka	Pa	Ca2+	Mg2+	K+	Na+		
	g/cm3	%			%		H2O	KCl	mg/kg		mmol(+)/kg					%
Ap	1.35	40.2	25	34.8	1.31	0.06	5.9	4.4	278	4.8	68.7	29.9	6	0.2	203.7	51.5
Bth	1.37	31.1	19.3	49.5	0.91	0.05	5.4	3.9	88.4	0.46	56.5	40.4	3.6	0.4	263.8	38.3
Bt1	1.38	27.9	23.2	48.9			5.5	3.8	73.9	0.33	46.8	36.4	3.1	0.4	288.3	30.1
Bt2	1.49	39.7	22.9	37.4			5.7	3.9	63.6	0.26	59.7	40.6	2.6	0.4	266.3	38.8
BtC	1.62	40.1	24.9	35			5.8	3.9	68.5	0.33	74.3	45.7	2.9	0.5	253.1	48.7

The profile B was dug 170cm deep, at which point C horizon with silt and sand stone could be seen. The soil is quite moist and has good structure from the top to the bottom of the profile; the biological feature is strongly active with ants and

termites at the first and second horizon. The clay and humus, which can be found at the second horizon, were transported from the first horizon.

Profile Y-NT: Mr. Yen-NT, poor household in Na Ten village



Stagnic Acrisol (Hyperdystric, Siltic)

Parent material: Silt + Sand stone
Location: Na Ten
GPS coordination: X-Y: 441887-2319076
Altitude: 480 m (a.s.l)
Slope position: at the flat ridge
Slope angle: 0^0
Land form: Flat
Open land: 1984
Present crop: Maize

Using History: Before 1984 fallow land
1984-1986 upland rice, 1987-1993 local maize
1993-1997 cassava, 1997-2010 hybrid maize

Table 4.35: Description of soil profile Y-nt at field

Hor	Dept (cm)	Texture	Color	Mott %	Structure*	Coars Fragment	Void vol%	Cutans		Concretion%	Root (dm^2)	Bio. feature**
								%	Nature			
Ap	14	SL	10YR,5/6		Clody	1	3			Fe. 0,5	5-12	C.ant-termite
Bth	26	SiL	7.5YR,6/6		B-S	1	5	12	Clay-humus	Fe. 0,5	2-8	C.ant-termite
Bt	45	CL	7.5YR,6/6		B-S	2	15	15	Clay-humus	Fe. 1	1-3	F.termite
Btg1	65	CL	7.5YR,5/8	5-15	B-S	1	8	15	Clay	Fe. 3		Non
Btg2	100	C	5YR,6/8	40	B-S	5	4	30	Clay			Non
Btg3	150	C	5YR,6/8	40			3	30	Clay			

Structure; G: Granular, B-S: Blocky –sub-angular. Biol-feature**; C: common, F: few*

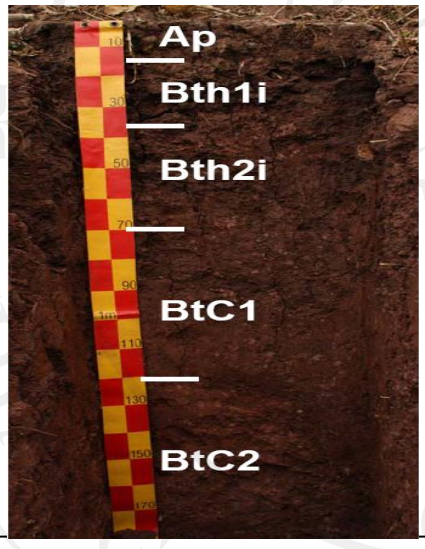
Table 4.36: Lab-analysis result-Profile Y-nt

Hor	Bulk	Texture			Ct	Nt	pH	pH	Bray1		Exchang.Basic Cations				CEC pot	BS
		Sand	Silt	Clay					Ka	Pa	Ca^{2+}	Mg^{2+}	K^+	Na^+		
	g/cm3	%			%		H2O	KCl	mg/kg		mmol(+)/kg					%
Ap	1.54	55.9	23	21.1	0.93	0.04	5.7	4.3	117	2.47	31	8.2	3.3	0.28	106.4	40.2
Bth	1.43	44.6	23.5	31.9	0.82	0.04	5.2	3.8	87.1	0.86	24.6	8.9	2.7	0.22	140.2	26
Bt	1.43	40.3	22.8	36.9			5.3	3.8	105	0.74	26	11	3.3	0.06	162.6	24.7
Btg1	1.44	30.5	22.8	46.8			5.3	3.8	142	0.54	29.6	13	5.3	-0.03	205.1	23.3
Btg2	1.46	27.4	20.6	52			5.3	3.8	150	0.33	33.8	14	5.8	-0.06	218.5	24.4
Btg3	1.45	22.1	24.4	53.4			5.4	3.8	121	0.18	46.8	18	5	0.01	260.2	26.8

The soil profile Y-nt was dug 150cm deep. About 1% to 5% roundish gravel can be found from topsoil to 100cm depth. The stagnic horizons (Btg) appear from

45cm depth to 150 cm depth (indicating temporary lack of oxygen). The mottling takes up 5% to 15% at the fourth horizon (Btg1) and 40% at Btg2 and Btg3. Fe oxide can be found from the topsoil to 65cm depth: about 0.5% at top soil and 3% at 65cm depth. Fe oxide, which appears at topsoil, was transported from subsoil by the farmer's plowing activity.

Profile BA: Mrs. Bau, rich household in Ta Lang Thap village



Haplic Luvisol (Clayic, Rhodic)

Parent material: Silt + Sand stone
Location: Ta Lang Thap
GPS coordination: X-Y: 444295-2315968
Altitude: 420 m (a.s.l)
Slope position: at middle slope, 31 ^{0}
Land form: SC. **Exposition:** SSE
Open land: 1984
Present crop: Maize

Using History:
Before 1984 fallow land, 1984-1990 upland rice
1990-1997 local maize and cassava
1997-2010 hybrid maize

Table 4.37: Description of soil profile BA at field

Hor	Dept (cm)	Texture	Color	Structure*	Coars Fragment	Void (vol%)	Cutans		Root (dm^2)	Bio. feature**
							%	Nature		
Ap	15	SiL	5YR,3/3	G		40			5-12	C.ant-termite
Bth1i	35	C	2.5YR,4/3	B-S	1	30	40	Clay-humus	2-8	C.ant-termite
Bth2i	70	C	2.5YR,4/3	B-S	3	25	35	Clay-humus	1-3	F.termite
BtC1	120	CL	2.5YR,3/6	B-S	40	10	20	Clay, pressure		Non
BtC2	170	SC	2.5YR,4/8	B-S	60	2	5	Clay, pressure		Non

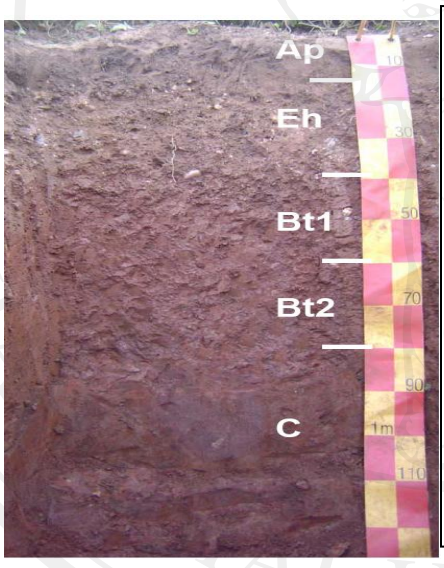
Structure; G: Granular, B-S: Blocky –sub-angular. Biol-feature**; C: common, F: few*

Table 4.38: Lab-analysis result-Profile BA

Hor	Bulk	Texture			Ct	Nt	pH	pH	Bray1		Exchang.Basic Cations				CEC pot	BS
		Sand	Silt	Clay					Ka	Pa	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}		
	g/cm3	%			%		H_2O	KCl	mg/kg		mmol(+)/kg					%
Ap	1.26	35.4	31.9	32.7	1.26	0.07	7.1	5.8	250	28.6	162	25.7	9.9	0.08	304.8	64.9
Bthi1	1.33	27.2	30	42.7	0.9	0.05	6.8	5.2	123	1.62	164	26	5.5	0.3	315.8	61.9
Bthi2	1.38	25.5	28.9	45.6			6.6	4.9	114	1.06	148	32.4	5.2	0.22	316.6	58.7
BtC1	1.55	33.9	22.4	43.7			6.6	4.8	106	2.45	153	34.3	4.7	0.2	307.6	62.4
BtC2	1.6	38.6	27.9	33.5			7.4	5.8	83.7	1.11	192	22.2	3.5	0.29	300.8	72.5

The profile BA was dug 170cm deep and divided into five horizons. The topsoil is Ap horizon with 15cm depth. The second and third horizons (Bthi1 and Bthi2) from 15cm to 70cm depth denote a slickenside condition with the appearance of oblique shearing faces of horizons because of shrink – swell action of clay. The seasonal surface cracks are often present. The transported clay-humus can be seen from 15cm to 70cm depth (Table 4.37).

Profile T: Mrs. Tuan, poor household in Ta Lang Thap village



Haplic Acrisol (Epieutric, Arenic)

Parent material: Silt + Sand stone
Location: Ta Lang Thap
GPS coordination: X-Y: 444538-2314445
Altitude: 360 m (a.s.l)
Slope position: at middle slope
Slope angle: 16 ^{0}
Land form: VS. **Exposition:** North
Open land: upper foot slope
Crop: Maize and forest
Using History:
Before 2006 banana and cassava
2006-2010 hybrid maize

Table 4.39: Description of soil profile T at field

Hor	Dept (cm)	Tex ture	Color	Struc ture*	Coars Frag ment	Void (vol%)	Cutans		Root (dm^2)	Bio. feature**
							%	Nature		
Ap	15	SiL	5YR,3/2	G	1	15			50-100	C.ant-termite
Eh	40	SL	5YR,4/6	B-S	60	45	8	Clay-humus	10-20	F.termite
Bt1	60	SC	2.5YR,4/6	B-S	10	2	10	Clay	10-15	F.termite
Bt2	80	SC	2.5YR,4/6	B-S	3	2	10	Clay	2-8	Non
C	120	sandstone								Non

Structure; G: Granular, B-S: Blocky –sub-angular. Biol-feature**; C: common, F: few*

Table 4.40: Lab-analysis result-Profile T

Hor	Bulk	Texture			Ct	Nt	pH	pH	Bray1		Exchang.Basic Cations				CEC pot	BS
		Sand	Silt	Clay					Ka	Pa	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}		
	g/cm3	%			%		H_2O	KCl	mg/kg		mmol(+)/kg					%
Ap	1.21	57.5	20.7	21.8	1.16	0.06	6.4	5.1	228	2.15	65.3	15	6.9	-0.1	155.4	56
Eh	1.54	62.8	20.3	16.9	0.6	0.02	5.9	4.4	88.5	0.65	31.5	12.1	2.1	-0.1	89.16	51.1
Bt1	1.35	29.1	10.6	60.4			5.2	3.7	172	0.23	50.4	36.3	7.2	0.17	273.8	34.4
Bt2	1.43	35.7	12.5	51.8			5.4	4	215	0.2	63.5	34.1	8.7	0.17	244.9	43.5

The soil profile T is divided into five horizons with the depth of 120 cm. The topsoil from land surface to 15cm depth is Ap horizon. The second horizon from 15cm to 40cm depth was Eh horizon with high roundish gravel (60%) and the second horizon has transported clay-humus from the topsoil. From 80cm downward is C horizon with 100% sandy stone and is strongly weathered (Table 4.39). The rood density is high, from 50 to 100 roots/dm^2.

4.5 Land evaluation by LSC/ITC-Ghent for fields

4.5.1 Assessment of the climate for the maize crop

The ten - year climate data of the Yen Chau station were used to evaluate the climate for all fields of the study area. The period of the maize crop is from April to September. Climate factors (the total precipitation, mean air humidity and mean temperature) were considered to calculate the climate index and climate rating, which are based on the climate requirement for maize crop by Sys et al (1193) (Appendix 1)

Table 4.41: Climate Index and Climate Rating for maize crop

Year	Crop	Month	Rainfall -Rating	Humidity -Rating	Temp-Rating	Climate-Index	Climate-Rating
1998-2007	**Maize**	**April-September**	**100**	**71**	**100**	**71**	**81**

The rainfall rating and temperature rating are optimal ratings with 100 but the humidity rating is low, 71, which indicates that the climate factor is limited by extremely high humidity (82%).

4.5.2 Soil evaluation

Table 4.42 presents the flooding, drainage, wetness and topographical ratings. The flooding, drainage and wetness factors of the six profiles have an optimal rating with 100, except drainage rating for the profile Y-nt is 68 it is low because deeper 45 cm it is stagnical condition with mottling colour (indicating lack of temporary oxygen).The topographical factor is low rating, ranging from 37 to 98 and it reflects that the field stands on the steep slope hills

Table 4.42: Wetness rating and topographical rating for maize crop

Profile	Flooding	Drainage	Wetness	Topography
Y (rich)	100	100	100	45
H (poor)	100	100	100	50
B (rich)	100	100	100	42
Y-nt (poor)	100	68	100	98
BA (rich)	100	100	100	37
T (poor)	100	100	100	65

The soil depth rating (Table 4.43) of five profiles is an optimal rating (100) but the soil depth rating of profile **T** is lower and the reason for this is that profile **T** is shallow (about 80 cm deep). The soil texture and coarse fragment factors are not optimal ratings. These factors range from 80.1 to 99.7 and from 90.7 to 98.7 respectively. Because of these limited factors, soil physical ratings do not reach the optimal point.

Table 4.43: Soil physical rating for maize crop

Profile	Soil depth	Coarse fragment	Texture	**Soil Physical rating**
Y (rich)	100	87.9	96.5	**86**
H (poor)	100	80.1	97.9	**79**
B (rich)	100	95.3	98.7	**95**
Y-nt (poor)	100	99.7	94.7	**99**
BA (rich)	100	79.4	90.7	**79**
T (poor)	85	87	91.9	**70**

The CEC of six profiles (Table 4.44) is optimal rating for maize cultivation but the sum of basic cations of two profiles (Y-nt and T) does not reach the optimal rating: 87.6 rating for the profile Y-nt and 94.1 rating for the profile T. The pH-H_2O and organic Carbon ratings are low and because of these two limited factors, soil chemical rating does not to reach the optimal point. The soil chemical ratings range between 52 and 78 and these figures are low ratings for suitable maize cultivation.

Table 4.44: Soil chemical rating for maize crop

Profile	CEC	Sum of basic cations	pH-H_2O	Corg	**Soil chemical rating**
Y (rich)	100	100	77.5	67.4	**52**
H (poor)	100	100	76.4	85.6	**65**
B (rich)	100	100	82.8	86.9	**72**
Y-nt (poor)	100	87.6	78.8	78.3	**54**
BA (rich)	100	100	89.3	87.8	**78**
T (poor)	100	94.1	100	74.25	**70**

The wetness, salinity and alkalinity (Table 4.45) reach the optimal ratings (100) but three limited factors (topography, physical and chemical properties) have low ratings: the topographical rating between 45 and 98, chemical rating between 52 and 78, and physical rating between 70 and 99. These limited factors reduce the value of the soil index which ranges from 20 to 36.

Table 4.45: Calculations of Soil Index from individual categories

Profile	Wet-Rating	Drainage Rating	Topogr-Rating	Phys-Rating	Chemic-Rating	Sal.Alk-Rating	**Soil Index**
Y (rich)	100	100	45	86	52	100	**20**
H (poor)	100	100	50	79	65	100	**26**
B (rich)	100	100	42	95	72	100	**29**
Y-nt (poor)	100	68	98	99	54	100	**36**
BA (rich)	100	100	37	79	78	100	**23**
T (poor)	100	100	65	70	70	100	**32**

Table 4.46 presents the land indexes which are calculated from the climate rating and soil index. As can be seen from this table, the land index is significantly low. Four out of six soil profiles have land index ranging from 16 to 23; therefore, they are unsuitable (N) in the suitability class. However, the other two soil profiles (Y-nt and T) have land index 29 and 26 and they are marginally suitable (S3) in the suitability class. It is the topographical factor which lowers the land index of five out

of six soil profiles with the slope parameter ranging from 16^{0} to 38^{0} for the five soil profiles.

Table 4.46: Calculations of Land Index from Climate Rating and Soil Index

Profile	Climate-Rating	Soil-Index	**Land-Index**	**Suitability-Class**
Y (rich)	81	20	**16**	**N**
H (poor)		26	**21**	**N**
B (rich)		29	**23**	**N**
Y-nt (poor)		36	**29**	**S3**
BA (rich)		23	**19**	**N**
T (poor)		32	**26**	**S3**

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

Table 4.47 shows the land index without considering the topographical factor. The land indexes are higher and there is no N (unsuitable) for suitability class. Profile B (Land Index 55) and BA (Land Index 51) are moderately suitable (S2), and other four profiles are marginally suitable (S3).

Table 4.47: Calculation the Land Index without the topographical factor

Profile	Cliamte-Rating	Soil-Index	**Land-Index**	**Suitability-Class**
Y (rich)	81	45	**36**	**S3**
H (poor)		52	**42**	**S3**
B (rich)		68	**55**	**S2**
Y-nt (poor)		36	**29**	**S3**
BA (rich)		63	**51**	**S2**
T (poor)		49	**40**	**S3**

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

4.6 Comparing stock of organic carbon and nitrogen for all fields of the selected farmers

The amount of Corg (organic carbon) and N (nitrogen) in the soil plays an important role in the soil quality and stocks of Corg and N (kg/m^2) are factors to assess the quality of soil. Each selected farmer had several fields; therefore, we could not dig a soil profile on each field. We decided to do augers with all fields and dig only one soil profile. We drilled totally 80 augers in all upland fields of the selected farmers and took topsoil at each auger to analyses Nt (Total nutrient and total Carbon). To identify the farmer whose field has higher Corg and N than others, we have a method.

In this method, the stocks of Corg and N (kg/m^2) are weighted for all fields of each selected farmer. Then the weighted Corg and N values were compared together to find out which farmers had the field with higher stock Corg and N than others (Fig 4.40, chapter 4.6.1).

4.6.1 Weighting Corg and Nitrogen of the topsoil for all fields of six selected farmers

We tried to obtain accurate soil quality assessment of the upland fields of the selected farmers; therefore we considered not only soil properties of six soil profiles but also the Ct and Nt at the topsoil of 80 augerings. Corg and Nt in percentage was converted into stock Corg and N in kg/m^2, and then it was weighted according to areas for each selected farmer. The bulk density parameter of the topsoil was used to convert the percentage of Corg and Nt into kg/m^2 but the bulk density was not

measured; therefore, the bulk density of the topsoil was a constant factor with 1.35 g/cm^3 for all fields of the selected farmers.

Table 4.48: Stock of Corg and N of the topsoil for all fields of Mr. Yen-kv (rich farmer)

Field	Auger	Topsoil Depth (cm)	Corg %	N %	Bulk (g/cm3)	Mass (kg/m^2)	Corg kg/m^2	N kg/m^2	Area (m2)	Weighted mean-Corg (kg/m^2)	Weighted mean-N (kg/m^2
Y1-kv	1	18	1.1	0.12	1.35	243	2.67	0.3	672	2.23	0.26
	2	15	1.6	0.15	1.35	202.5	3.33	0.3	1159		
	3	12	1.3	0.12	1.35	162	2.08	0.19	837		
	4	12	1.5	0.15	1.35	162	2.47	0.24	358		
	5	20	1.3	0.14	1.35	270	3.64	0.37	455		
	6	15	1.3	0.15	1.35	202.5	2.57	0.29	391		
	7	12	1.1	0.12	1.35	162	1.79	0.19	3178		
Y2-kv	1	20	0.9	0.1	1.35	270	2.35	0.27	1688		
Y3-kv	1	20	0.6	0.09	1.35	270	1.54	0.24	3275		
	2	20	0.7	0.09	1.35	270	2.02	0.25	777		
	3	20	1.2	0.13	1.35	270	3.2	0.35	453		
	4	20	1.2	0.13	1.35	270	3.18	0.34	1000		

Table 4.49: Stock of Corg and Nt of the topsoil for all fields of Mr. Hac (poor farmer)

Field	Auger	Topsoil Depth (cm)	Corg %	N %	Bulk (g/cm3)	Mass (kg/m2)	Corg (kg/m2)	N kg/m^2	Area (m2)	Weighted mean-Corg (kg/m2)	Weighted mean-N (kg/m^2
H1	1	25	0.7	0.09	1.35	337.5	2.21	0.31	548	2.33	0.24
	2	18	1.1	0.09	1.35	243	2.56	0.21	277		
	3	18	2.3	0.1	1.35	243	5.52	0.24	276		
	4	15	0.6	0.08	1.35	202.5	1.19	0.17	326		
H2	1	12	0.9	0.11	1.35	162	1.41	0.18	412		
	2	18	0.8	0.1	1.35	243	1.96	0.25	1144		
	3	20	1.5	0.11	1.35	270	3.98	0.3	755		
H3	1	20	0.8	0.1	1.35	270	2.22	0.26	938		
	2	15	1	0.1	1.35	202.5	1.94	0.2	1320		
	3	25	1.2	0.12	1.35	337.5	4.17	0.4	771		
	4	25	0.9	0.1	1.35	337.5	3.16	0.34	1174		
	5	20	1	0.1	1.35	270	2.74	0.28	1200		
H4	1	5	0.9	0.1	1.35	67.5	0.59	0.07	1122		
	2	12	0.9	0.11	1.35	162	1.45	0.18	1141		
	3	15	1	0.12	1.35	202.5	2.01	0.24	559		

Table 4.50: Stock of Corg and Nt of the topsoil for all fields of Mr. Bien (rich farmer)

Field	Auger	Topsoil Depth (cm)	Corg %	N %	Bulk (g/cm3)	Mass (kg/m2)	Corg (kg/m2)	N kg/m^2	Area (m2)	Weighted mean-Corg (kg/m2)	Weighted mean-N (kg/m^2
	1	16	1.2	0.11	1.35	216	2.5	0.25	1040		
	2	20	1.5	0.13	1.35	270	3.94	0.34	1368		
	3	12	1.1	0.12	1.35	162	1.85	0.2	1045		
	4	18	1	0.12	1.35	243	2.54	0.28	2141		
B1	5	20	1	0.06	1.35	270	2.68	0.15	1031		
	1	15	0.9	0.05	1.35	202.5	1.83	0.11	963		
	2	12	1.2	0.07	1.35	162	1.88	0.12	1461		
	3	15	1.2	0.08	1.35	202.5	2.51	0.16	405		
	4	25	1.3	0.08	1.35	337.5	4.43	0.27	396	**2.41**	**0.19**
B2	5	17	1.3	0.08	1.35	229.5	2.93	0.19	1517		
	1	10	1.1	0.06	1.35	135	1.47	0.08	846		
B3	2	15	1.1	0.07	1.35	202.5	2.28	0.14	900		
	1	15	1.2	0.07	1.35	202.5	2.46	0.14	383		
	2	15	1	0.06	1.35	202.5	2.02	0.13	581		
	3	12	1	0.06	1.35	162	1.57	0.1	650		
B4	4	12	0.9	0.05	1.35	162	1.43	0.09	731		

Table 4.51: Stock of Corg and Nt of the topsoil for all fields of Mr. Yen-nt (poor farmer)

Field	Auger	Topsoil Depth (cm)	Corg %	N %	Bulk (g/cm3)	Mass (kg/m2)	Corg (kg/m2)	N kg/m^2	Area (m2)	Weighted mean -Corg (kg/m2)	Weighted mean-N (kg/m^2
	1	18	0.9	0.09	1.35	243	2.3	0.34	727		
	2	15	0.9	0.09	1.35	202.5	1.75	0.34	1005		
	3	20	1.2	0.11	1.35	270	3.14	0.34	721		
Y1-nt	4	15	1.2	0.12	1.35	202.5	2.52	0.34	1071		
	1	22	1.1	0.11	1.35	297	3.17	0.34	814		
	2	25	1.7	0.15	1.35	337.5	5.62	0.34	707		
Y2-nt	3	25	1.1	0.11	1.35	337.5	3.69	0.34	767	**2.37**	**0.25**
	1	10	0.8	0.07	1.35	135	1.06	0.1	3059		
	2	10	0.9	0.09	1.35	135	1.27	0.12	410		
	3	12	1.1	0.11	1.35	162	1.85	0.18	384		
	4	20	1.2	0.11	1.35	270	3.13	0.29	725		
Y3-nt	5	18	1.2	0.11	1.35	243	2.94	0.26	247		

Table 4.52: Stock of Corg and Nt of the topsoil for all fields of Mrs. Bau (rich farmer)

Field	Auger	Topsoil Depth (cm)	Corg %	N %	Bulk (g/cm3)	Mass (kg/m2)	Corg (kg/m2)	N kg/m^2	Area (m2)	Weighted mean -Corg (kg/m2)	Weighted mean-N (kg/m^2
	1	14	1.9	0.16	1.35	189	3.54	0.29	1891		
	2	12	1.6	0.15	1.35	162	2.58	0.24	1635		
	3	16	2	0.18	1.35	216	4.21	0.39	637		
	4	10	1	0.13	1.35	135	1.41	0.18	1432		
BA1	5	10	1.5	0.15	1.35	135	1.98	0.2	2179		
	1	20	3.3	0.21	1.35	270	9.02	0.57	820		
	2	15	2.1	0.22	1.35	202.5	4.26	0.44	722		
	3	25	2.4	0.2	1.35	337.5	8.08	0.67	806		
BA2	4	15	2.5	0.22	1.35	202.5	5.14	0.44	1015	**3.98**	**0.34**
	1	20	2.1	0.18	1.35	270	5.55	0.48	559		
BA 3	2	12	1.8	0.15	1.35	162	2.88	0.24	517		
	1	10	1.6	0.16	1.35	135	2.22	0.22	551		
	2	14	2.1	0.16	1.35	189	4.06	0.31	600		
	3	20	1.5	0.15	1.35	270	4.13	0.4	482		
	4	18	2.7	0.17	1.35	243	6.52	0.42	556		
	5	14	1.6	0.17	1.35	189	3.11	0.31	226		
	6	25	1.7	0.12	1.35	337.5	5.67	0.41	1000		
BA 4	7	20	1.5	0.12	1.35	270	3.96	0.33	965		

Table 4.53: Stock of Corg and Nt of the topsoil for all fields of Mr. Tuan (poor farmer)

Field	Auger	Topsoil Depth (cm)	Corg %	N %	Bulk (g/cm3)	Mass kg/m2	Corg (kg/m2)	N kg/m^2	Area (m2)	Weighted mean -Corg (kg/m2)	Weighted mean-N (kg/m^2
	1	20	1.7	0.16	1.35	270	4.64	0.44	1481		
	2	18	1.9	0.16	1.35	243	4.5	0.39	800		
	3	18	1.6	0.14	1.35	243	4	0.34	670		
T1	4	20	1.4	0.11	1.35	270	3.73	0.3	1394	**5.29**	**0.37**
	1	20	1.3	0.11	1.35	270	3.45	0.3	611		
	2	15	1.3	0.12	1.35	202.5	2.65	0.23	558		
T2	3	25	3	0.14	1.35	337.5	10.1	0.46	1514		

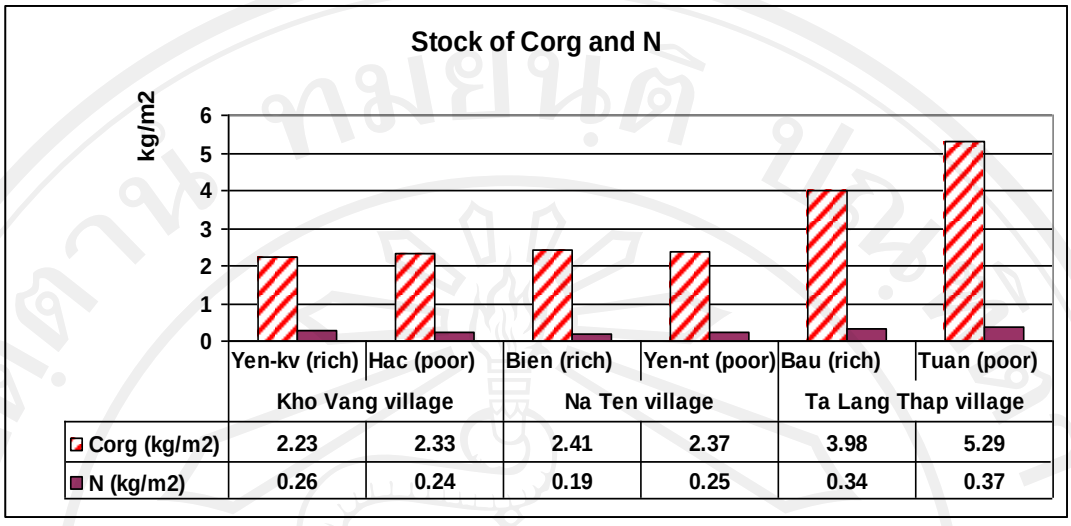


Fig 4.40: Comparison stock of Corg and N of the topsoil of 20 fields of six selected farmers

Fig 4.40 shows that the stock values of Corg in the topsoil of the upland fields of four selected farmers (Yen-kv, Hac, Bien and Yen-nt) are nearly the same, ranging from 2.23 to 2.41 kg/m^2. The Corg stock values in the fields of Mrs. Bau and Tuan are higher than those of other farmers: 3.89 kg/m^2 and 5.29 kg/m^2. The N stock values in the fields of the six farmers are low, ranging from 0.19 to 0.37 kg/m^2. In general, the N stock in the 20 fields of the six farmers was low and not much different.