Forest Science Institute of Vietnam

Research Center For Forest Ecology and Environment

Report
on
Site survey and analysis for mapping and recommendation of tree planting species composition in project areas of Tien Ha and Tien Cam communes

Prepared by Nguyen Duc Minh, Le Quoc Huy and Ngo Dinh Que

GCP/VIE/027/ITA/FAO Project

Hanoi September 28, 2005

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1. Introduction and objectives

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Site is defined as set of natural and environmental factors which are necessary for the growth and development of vegetation and plant system, directly effecting on their productivity.

In Vietnam, site survey has been applied German Guideline Procedure since 1960s, for for *Pinus merkusii* afforestation planning activities in the northern provinces. There are 6 units of preliminery: growth zone, growth area, growth subregion, mosaic scope, site group and site type.

Site type is the last unit of site divising system and defined for the target of agricutural and forestry land use of small adminitrative unit (commune or village) with the map scaled 1/10000 or 1/150000)

Site type following the German school applied in Vietnam is based on 6 decisive factors: soil type, original rock, terrain, and slope and soil depth and soil moisture. Site type is often designed for narrow area, therefore, climate factor is considered in the climate division of large area. Depending on land use targets and specific conditions of each zone, the site factors may be changed.

The agriculture and silvicuture combination Project following market orientation in Quang Nam province (GCP/VIE/027/ITA) is complemented at Tien Cam and Tien Ha communes within Tien Phuoc District to enhance capacity, encouraging forestry and assist agricultural and silvicutural development, increasing the living standard of local people within the project area and paticipating in sustainable land resource use management by mean of technical assistance in the cultivation system development

following agriculture and silvicuture combination way.

Before orientating the people in agriculture and silviculture production by using land resource appropriately, the soil survey and assessment and the site mapping tasks help project managers and farmer households in the area to grasp the land use status, land potentiality which are bases for building land use models and proposing the suitable crop cultivation structure for each model.

Objectices:

- To do soil survey & assessment for site quality classification and mapping of about 1500 ha in project areas in Tien Ha and Tien Cam communes.
- To make recommendation for planting species composition and different landuse models for specific project site type groups of the project.
- Make recommendation for technical fertilizer application on the basis of physical & chemical soil analyses, also on the results of site survey.

2. Methodologies & Activities

2.1. Methodologies

- To assess the land use status of project area following the site survey, site mapping outdoor method and process the maps by the MAP/INFOR software on the computer.
- To survey site and build the site map for project area following the site survey method used in some projects suchs as Vietnam-German Afforestation Project,World Bank Project, ADB Project and other forestry development projects

implemented by Research Center for Forest Ecology and Environment

- The determination of factors and site type division are based on the principles regarded below:
  - Choose the factors appropriate with natural and soid conditions of project area.
  - Choose the decisive or dominant factors determined to divide site. Within project site of Tien Ha and Tien Cam communes, slope may be considered as the decisive factor in site division.
  - The chosen site factors which are suitable and satisfiable to land use targets. In the GCP/VIE/027/ITA project, the target is to enhance the silvicutural expansion encouraging capacity, to build demonstration model to assist agricutural and sivilcutural development following maket orientation.

Based on site division principles and real conditions of Tien Ha and Tien Cam communes, the site factors is chosen and divided as follow:

(1) Soil type

According to soil map of Quang Nam province, there are 3 kinds of soil in project site of Tien Ha and Tien Cam communes including:

- Fa: reddish yellow soil developed on macma axit rock.
- Fs: yellowish-red or reddish yellow soil developed on clay rock or metamorphism rock.
- Fp: yellowish-grey or greyish- yellow soil developed on old alluvium.

(2) The soil depth : The soil depth is divided into 3 levels as follow:

- The soid depth > 50 cm : indicated by 1

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- The soil depth between 30 and 50 cm : indicated by 2
- The soid depth > 50 cm : indicated by 3

(3) Slope : Slope of soil is divided into 4 levels as follow:

- Slope < 8° signed I
- Slope between 8° and 15 indicated by II
- Slope between 16° and 25° indicated by III
- §é dèc > 25° indicated by IV

(4) Stoniness and rock emergence:

- Stoniness and rock emergence < 20% indicated by 1D
- Stoniness and rock emergence 20 – 40 % indicated by 2D
- Stoniness and rock emergence > 40% indicated by 3D

(5) Vegetation indicator

- Bare land, grass-plot, indicated by a
- Soil with low bushes <1.5 m, indicated by b
- Soil with high bushes > 1.5 m, indicated by c

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According to factors and level division of site factors regarded above, the site type signed FaIII1D2c means site type with Feralit developed on macma axit rock, slope between 16 and 25°, stoniness and rock emergence < 20%, soid depth between 30 and 50 cm, vegatation sector as well developed bushes with the heigh > 1.5 m.

Survey and assessment of soil were implemented following soil profile dig and description method for the soil physical factors such as softness, soil structure or stoniness. The soil samples were maked and analysed in the Soil analysis Lab of Forest Science Institute of Vietnam following standard methods appied in Soil analysis Labs of the Agricuture and Rural Development Ministry.

- Total humus was analysed follwing Wakley-Black method
- Total Nitrogen was analysed follwing Kjendalh method
- Available P_20_5 was analysed follwing Oniani method
- Available K_20 was analysed by burning sample on photometer mechine.

- The different kinds of maps were built with Map Infor software on computer and printed with A_0 colour printer at Research Center for Forest Ecology and Environment.

2.2. Site and soil survey and assessment (field/outdoor work)

- Surveying in the fields for topographic & land features, vegetation and soil characteristics,
- Soil profile making and analyses in the field for required characteristics.
- Soil sampling for physiscal and chemical analyses in the lab.
- Manually marking, demarcating, drawing and bordering on the maps in the fields for current land use and site maps.

2.3. Indoor work and lab work

- Soil sample analysis for physical and chemical characteristics (soil structure, pH, organic matter and available contents of N, P, K).
- Information compilation and data analyses for site classifications, site groups and recommendations of tree and crop species composition and planting models.
- Digitalization and production of current land use maps, site maps and planting model maps.

- Making report results.

3. Findings and results

3.1. The natural, population and social characteristics of Tien Cam and Tien Ha commune.

Tien Cam commune

- Tien Cam is in mountaineous midland area in the North of Tien Phuoc dictrict, far from the Center about 9 km. It is a road-junction of 614, 615 routes. The North is bordered by Thang Binh district, the east is bordered by Tam Ky town, the south is bordered by Tien Phong, Tien Chau communes and the west is bordered by Tien Ha commune.

- Tien Cam is a hilly commune. Most of resident areas lies at side and top parts of hills, on the orientation forwards to the south and south-east, elevation is going down with valley characteristics lying along sides of the Tien river. The average slope gradient is lower 10°.

- Tien Cam has 647 households with 2862 people and about 1000 work-people most of which are agriculture labours. The time-work average in year is from 6 to 8 months. The education level is quite low. Most of agriculture labour resource is female. The standard of living is still low. It is necessary to have mor project assissting local people in increasing productive, eliminating hunger and reducing poverty.

** Tiªn Hµ commune*

- Tien Ha is in mountaineous midland area in the northwest of Tien Phuoc dictrict, far from the Center about 15 km. It is on the 615 route. The North is bordered by Tien Son commune, the east is bordered by Tien Cam commune, the south is bordered by Tien Chau commune and the west is bordered by Hiep Duc commune.

- This commune is in semi hill and flat area with the hilly divided terrain which surroundes the valley. The local people and agricultural production parks concentrate on flat area along with the 615 route and two side of the Tien river.

- Tien Ha has 819 households with 4553 people and about 1593 labours contributing in agricultural and forestry sector.The quality of labour is quite low. Labours lack of scientific knowledge and technique so that there are still few of advanced models of production. The productive of production is low. The transform of economic structure of Tien Ha is now facing with many difficulties.

3.2. Results on current land use

3.2.1. Tien Cam commune

Total surveyed areas	1476.74 ha
of which:	
+ Open land or bare land	642.56 ha
	62 ha
+ Plantation	15.95 ha
Pine	46.05 ha
Acacia	69.37 ha
+ Forest garden	478.65 ha
+ Mixed garden	224.16
+ Agriculture land	170.89 ha
Paddy land	54.17 ha
Other crop land	

3.2.2. Tien Ha commune

Total surveyed areas	1420.31 ha
of which:	
+ Open land or bare land	1161.63 ha
	101.82 ha
+ Plantation	101.82 ha
Acacia	53.81 ha

+ Forest garden + Mixed garden + Agriculture land	103.05 ha

3.3. Surveyed results for site mapping

Based on the criteria for site classification on the attached procedure given to the contract, the field working group has implemented the survey and assessment of the fields, made and analysed 150 main soil profiles and hundred sub-profiles for soil depth, stoniness, soil structure, soil type. The soil samples also have been collected for analyses of soil pH, total organic matter, available K_2O & P_2O_5 and Nitrogen.

All the information and data come from the field work and indoor work/lab work were used for analysis & classification of target site areas into classes and groups then made compilation and recommendations of technical solutions regarding tree/crop species composition and planting models.

3.3.1. Tien Cam commune

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3.3.1.1. Site classes in Tien Cam commune

The compilation and classification of the site areas in Tien Cam commune have given the results into site classes as follows:

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- FaI1D1a FaII1D1a FaII2D1a
  FaI1D1b FaII1D1b FaII2D1b
  FaII1D1c FaII2D1c FaI1D1c FaIII1D1c
- FsI1D1© FsII1D1a FaII1D1b
  FsIII1D1c
- FaIII1D1b FaIII2D1b FaIII2D2b FaIII1D2b
  FaIII1D1a FaIII2D1a FaIII2D1c
- FsIII1D1a FsIII1D1b FsIII1D2b
- FaIV2D1a FaIV2D2a FaIV1D1a FaIV1D1b
  FaIV1D2a
  FaIV1D2b FaIV2D2b FaIV3D3b

FaIV2D1c FaIV2D2c FaIV3D2c

The process and results were also implemented and presented in the site maps with Map Info software management on computer.

Totally, in Tien Cam commune, it has as many as 35 site type classes in the checked areas for the project. In order to deal with the site classes and approach for utilization and management of the site quality for tree planting species composition and models, it is very difficult to do with many site classes like those, therefore, those site classes were grouped into 4 bigger categories of the site classification viz., site groups A, B, C & D on the basis that, some site type classes have same roles & purposes for utilization and similar characteristics. The principles for the grouping were as follows:

- Site type classes were same sources of originating with soil types or mother rocks.
- Site type classes have same production capacity with similar vegetation covers and planting crops,
- Site type classes, who have same roles & purposes for utilization,
- Site classes, who have some main similar characteristics.

3.3.1.2. Detail results of Site type groups in Tien Cam commune

- Site type group A: 9 site type classes
- Site type group B: 6 site type classes
- Site type group C: 9 site type classes
- Site type group D: 11 site type classes

Site type groups	Site type classes	Areas (ha)

A	$F_aI_1D_1a$ $F_aI_1D_1b$ $F_aI_1D_1c$ $F_sI_1D_1a$ $F_aII_1D_1c$ $F_aII_1D_1a$ $F_aII_1D_1b$ $F_sII_1D_1a$ $F_aII_1D_1b$	260.09
B	$F_aII_2D_1a$ $F_aII_2D_1b$ $F_aII_2D_1c$ $F_aIII_1D_1c$ $F_sIII_1D_1c$ $F_aIII_1D_1b$	81.66
C	$F_aIII_1D_1a$ $F_aIII_2D_2a$ $F_sIII_1D_1a$ $F_aIII_1D_2b$ $F_sIII_1D_1b$ $F_aIII_2D_1b$ $F_aIII_2D_2b$ $F_aIII_2D_1a$ $F_aIII_2D_1c$	203.79
D	$F_aIV_1D_1a$ $F_aIV_1D_1b$ $F_aIV_1D_2b$ $F_aIV_2D_1a$ $F_aIV_2D_2a$ $F_aIV_1D_2a$ $F_aIV_2D_1b$ $F_aIV_2D_1c$ $F_aIV_2D_2c$ $F_aIV_3D_2c$ $F_aIV_3D_3c$	97.02
Total	**35**	**642.56**

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3.3.1.3. Results of physical and chemical analyses of soil samples in Tien Cam Commune.

TT	Sampling code No.	Sampling depth (cm)	Site		physical characteristic			Soil chemical characteristics					
			Type	Group	Soil texture	Softness	Stoniness (%)	PH KCl	Org. C (%)	N (%)	C/N	Avilable Nutrients (mg/100gr soil)	
												P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Sampling 1. Cam Lanh Tien Cam	0 - 10 30 - 40	$F_sI_1D_{1b}$	A	Light Medium	Rather soft -	<20	4.09 3.98	2.85 1.23	0.115 0.064	14.37 10.34	3.70 3.40	1.14 3.12
2	Sampling 16. Cam Trung Tien Cam	0 - 10 30 - 40	$FsII_1D_{1a}$	A	Medium -	Rather soft -	<20	3.92 4.00	2.25 1.02	0.103 0.054	12.67 10.98	2.50 2.25	1.57 3.31
3	Sampling 17 Cam Trung Tien Cam	0 - 10 30 - 40	$FsII_1D_{1c}$	A	Light -	Soft Rather soft	<20	4.18 4.97	3.21 1.34	0.117 0.080	15.91 9.72	4.10 3.70	1.22 1.64
4	Sampling 25 Cam Tay Tien Cam	0 - 10 30 - 40	FsI_1D_{1c}	A	Light Medium	Soft Rather soft	<20	4.00 3.95	3.46 1.41	0.133 0.083	15.09 9.85	4.20 2.50	2.11 1.60
5	Sampling 33. CÈm PLS Tien Cam	0 - 10 30 - 40	FsI_1D_{1b}	A	Medium Light	Rather soft Soft	<20	3.89 3.74	2.69 0.98	0.102 0.059	15.29 9.63	2.90 2.25	1.98 0.52
6	Sampling 35. CÈm PLS Tien Cam	0 - 10 30 - 40	$F_sII_2D_{1a}$	B	Medium Medium	Rather soft Rather heavy	20 - 40	3.83 3.91	2.07 0.98	0.094 0.051	12.77 11.14	3.20 2.70	1.32 1.57
7	Sampling 27. Cam Tay Tien Cam	0 - 10 30 - 40	$F_sII_2D_{2a}$	B	Light Medium	Rather soft Rather heavy	20 - 40	3.78 3.84	1.98 0.92	0.095 0.060	12.09 8.90	1.97 2.02	2.05 1.17

TT	Sampling code No.	Sampling depth (cm)	Site		physical characteristic			Soil chemical characteristics					
			Type	Group	Soil texture	Softness	Stoniness (%)	PH KCl	Org. C (%)	N (%)	C/N	Avilable Nutrients (mg/100gr soil)	
												P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
8	Sampling 5. Cam Lanh Tien Cam	0 - 10 30 - 40	$FsIII_1$ D_{1c}	B	Light -	Rather soft -	<20	3.91 3.84	2.23 1.30	0.100 0.067	12.93 11.25	2.67 2.50	1.12 1.69
9	Sampling 6. Cam Lanh Tien Cam	0 - 10 30 - 40	$FsII_1D_{1b}$	B	Medium Medium	Rather heavy Soft	20 - 40	4.00 3.96	2.07 1.2?	0.048 0.064	12.25 11.69	2.46 2.71	1.37 1.54
10	Sampling 15. Cam Trung Tien Cam	0 - 10 30 - 40	$F_sII_2D_{2a}$	B	ThÞt TB -	Rather heavy Heavy	20 - 40	4.05 3.92	1.94 0.84	0.090 0.042	12.50 12.29	1.95 2.41	2.05 1.98
11	Samoling 35. CÈm PLS Tien Cam	0 - 10 30 - 40	$F_sIII_2D_{2a}$	C	Medium -	Rather heavy -	20 - 40	3.87 3.92	1.92 0.85	0.092 0.051	12.10 9.67	3.05 2.66	1.65 1.90
12	Sampling 10. Cam Lanh Tien Cam	0 - 10 30 - 40	$FsIII_1D_{1a}$	C	Medium -	H¬i chat -	<20	3.97	2.05 0.46	0.100 0.063	11.89 8.84	2.60 1.47	2.37 1.98
13	Sampling 11. Cam Lanh Tien Cam	0 - 10 30 - 40	$F_sIII_2D_{1b}$	C	Light Medium	Rather soft Rather heavy	20 - 40	4.04 4.16	2.16 1.03	0.107 0.070	11.71 8.53	1.84 2.24	1.65 3.00
14	Sampling 18. Cam Lanh Tien Cam	0 - 10 30 - 40	$F_sIII_2D_{2c}$	C	Light -	Soft Rather soft	20 - 40	4.93 3.97	2.27 1.11	0.113 0.059	11.65 10.91	3.15 3.00	2.34 2.65
15	Sampling 30. Cam Lanh Tien Cam	0 - 10 30 - 40	$F_aIII_1D_{1a}$	C	Medium -	Rather heavy Heavy	<20	4.47 4.07	1.86 0.84	0.090 0.058	11.98 8.40	2.65 2.82	2.27 2.15

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TT	Sampling code No.	Sampling depth (cm)	Site		physical characteristic			Soil chemical characteristics					
			Type	Group	Soil texture	Softness	Stoniness (%)	PH KCl	Org. C (%)	N (%)	C/N	Avilable Nutrients (mg/100gr soil)	
												P_2O_5	K_20
1	2	3	4	5	6	7	8	9	10	11	12	13	14
16	Sampling 37 CÈm ? Tien Cam	0 - 10 20 - 30	$F_sIV_2D_{1c}$	D	Light Medium	Soft Rather soft	20 - 40	3.79 4.02	204 1.16	0.102 0.083	11.60 8.11	2.43 2.74	2.05 2.36
17	Sampling 26. Cam Tay Tien Cam	0 - 10 20 - 30	$F_sIV_2D_{2a}$	D	Medium -	Rather heavy Heavy	20 - 40	3.95 3.87	1.93 0.97	0.089 0.047	12.58 11.97	1.48 1.76	1.97 2.65
18	Sampling 20. Cam Trung Tien Cam	0 - 10 20 - 30	$F_sIV_2D_{2c}$	D	Light Medium	Rather soft Rather heavy	20 - 40	3.84 3.76	2.47 1.07	0.108 0.064	13.26 9.70	2.37 2.65	2.69 2.81
19	Sampling 21. Cam Trung Tien Cam	0 - 10 20 - 30	$F_sIV_2D_{1a}$	D	Medium -	Rather heavy Heavy	20 - 40	4.00 3.91	1.84 0.85	0.096 0.051	11.12 9.67	1.63 0.98	2.00 2.15
20	Sampling 3. Cam Lanh Tien Cam	0 - 10 20 - 30	$F_sIV_2D_{1b}$	D	Light Medium	Rather heavy -	20 - 40	3.80 3.83	2.21 1.21	0.100 0.086	12.82 8.16	2.31 2.42	1.93 2.61
21	Cam Lanh forest garden Tien Cam	0 - 10 30 - 40			Light light	Soft Rather soft	<20	3.97 4.01	3.45 2.09	0.142 0.098	14.09 12.37	3.96 4.12	3.25 3.73
22	Cam Pho Forest garden Tien Cam	0 - 10 30 - 40			Medium -	Soft -	<20	3.86 3.93	2.92 1.80	0.131 0.090	12.93 11.60	3.45 3.74	2.97 2.63
23	Cam Tay forest garden Tien Cam	0 - 10 30 - 40			Light -	Soft Rather soft	<20	4.10 3.95	3.12 1.79	0.130 0.092	13.92 11.98	2.98 3.76	1.48 3.92

During the trip of soil survey and assessment, we concentrated on surveying and assessing soil potential but not yet to be used to build the production models of agriculture with silvicultue combination or the models of fruit-planting garden or forest garden.

The outdoor fast-assessed results along with the soil analysis results were presented in the table below (table…)

The data assessment and analysis in the lap showed that:

Generally, the soil not yet to be used in Tien Cam commune is still quite much, however, most of it had been strongly degenerated, resulting in the soil to be acidified, the PH<4.0. Most of vegetation cover are indicators for acid, arid and exhausted soil. The content of humus and nitrogen are lower than medium, there is not many samples having organic content at moderately good rate. Humus content is between 2 and 3 %. Total nitrogen is < 0.15%. However, the rate of C/N reachs the rate between 10 and 15, showing that the degeneracy is mainly due to the erosion process and the environmental condition here is quite good for activities of microorganism paticipating in humusized process in soil (table)

As we both know, organic Carbon (OC%) and nitrogen are the most significant factors for plants but they are easy to be eroded in the cultivation process, resulting in soil to be exhausted, reducing the ability to provide nutrient for plants. Organic substance effects to physical and chemical charateristic of soil, especially, it could improve the stoniness and ability to maintain humidity of soil. This thing could be seen clearly in Tien Cam commune:

Because soil of Tien Cam commune has been degenerated strongly, most of available nutrients in soil are lower than the rate of 5^{mg}/100g, both P_2O_5 and K_20 are poor. It is because the acidity of soil is high, PH< 4.0, most of P_2O_5 and K_20 ions are retained by Fe and Al ions which are abundant in soil adhesive, making difficult for plant to absorb them.

The results of site survey presents that: Most soil of A site type group have humus and nitrogen content reaching the medium and over rate (Humus>2.5%, Nitrogen > 0.1%). The soil texture is light and soft. The rate C/N of soil reachs the rate of 13-15 and reduces gradually corresponding with the depth.

In the B site type group, the content of humus in soil is between 1.9 and 2.2%, the content of nutrient is < 0.1%. The soil is poor in term of organic substance but still soft and has light texture at preliminery types having the bush cover.

In the C site type group, soil has slope between 15 and 25^0, the content of humus and nitrogen arranging from poor to medium(humus: 1.5 - 2.5 %, nitrogen : 0.09 - 0.100 %). Generally, the soid textute is light with the medium softness.

However, soil is highly acidic but poor in available substance., therefore, to build the models of agriculture with silvicultrue combination, it is necessary to increase the fertility of soil by planting legume trees and shrubs before planting crop or other economic valuable kinds.

In the D site type group including soil kinds with the slope> 25^0, the physical and chemical characteristics of soil are similar to othet preliminery types. This site type often lies at higher side parts and top parts of hill, far from

inhabitant and water source, therefore it may do business in afforestation serving for paper material or available substance. but with any bussiness solution, it is necessary to plant legume trees and shrubs for improving soil and to make green band for erosion reduction, especially, to apply highly extensive cultivation methods for increasing productivity.

3.3.2. Tien Ha commune

3.3.2.1. Site classes in Tien Ha commune.

Similar to the Tien Cam commune, The compilation and classification of the site areas in Tien Ha commune have given the results into site classes as follows:

- FsI_1D_1a, FsI_1D_1b, FsI_1D_1c, $FsII_1D_1a$, $FsII_1D_1b$, $FsII_1D_1c$,
  $FsII_1D_2b$, $FsII_2D_1c$, $FsII_2D_2c$.
  FpI_1D_1a, FpI_1D_1b, FpI_1D_1c, $FpII_1D_1c$, FaI_1D_1b, FaI_2D_1c.
- $FsII_2D_2a$, $FsII_2D_1a$, FsI_2D_1a, $FsII_2D_1b$, FsI_2D_2a,
  $FsIII_1D_1c$, $FsII_1D_2c$, $FsII_1D_2a$, $FaII_2D_1a$, FaI_2D_1a.
- $FaIII_1D_1a$, $FaIII_1D_1b$, $FaIII_2D_1a$, $FaIII_2D_2b$,
  $FsIII_2D_1b$, $FsIII_2D_2b$, $FsIII_2D_2a$, $FsIII_2D_1a$, $FsIII_1D_1a$,
  $FsIII_2D_3a$, $FsIII_1D_1b$, $FsIII_1D_2a$, $FsIII_2D_2c$, $FsIII_2D_1c$.
- $FaIV_1D_1a$, $FaIV_2D_2b$, $FaIV_3D_2b$,
  $FsIV_1D_1a$, $FsIV_1D_1c$, $FsIV_1D_2a$, $FsIV_2D_1a$, $FsIV_2D_1b$,
  $FsIV_2D_1c$, $FsIV_2D_2a$, $FsIV_2D_3a$, $FsIV_2D_2c$, $FsIV_3D_2c$.

Totally, in Tien Ha commune, it has as many as 52 site type classes in the checked areas for the project. Similarly to the situation in Tien Cam commune, it is very difficult to do with many site classes like those, so in order to deal with the site classes and approach for utilization and management

of the site quality for tree planting species composition and models, those site classes were also grouped into 4 bigger categories of the site classification viz., site groups A, B, C & D on the basis: some site type classes have same roles & purposes for utilization and similar characteristics. The principles for the grouping were the same as Tien Cam commune:

3.3.2.2. Detail results of Site type groups in Tien Hacommune

Based on the principles for grouping of site type classes, site classes in Tien Ha commune formed groups as follows:

- Site type group A: 12 site type classes
- Site type group B: 12 site type classes
- Site type group C: 15 site type classes
- Site type group D: 13 site type classes

Site groups	Site type classes	Areas (ha)
A	FsI1D1a, FsI1D1b, FsI1D1c, FsII1D1a, FsII1D1a, FsII1D1b, FsII1D1c, FsII1D2b, FsII2D1c, FsII2D2c. FpI1D1a, FpI1D1b, FpI1D1c, FpII1D1c, FaI1D1b, FaI2D1c.	505.68
B	FsII2D2a, FsII2D1a, FsI2D1a, FsII2D1b, FsI2D2a, FsIII1D1c, FsII1D2c, FsII1D2a, FaII2D1a, FaI2D1a.	243.98
C	FaIII1D1a, FaIII1D1b, FaIII2D1a, FaIII2D2b, FsIII2D1b, FsIII2D2b, FsIII2D2a, FsIII1D1a, FsIII2D3a, FsIII1D1b, FsIII1D2a, FsIII2D2c, FsIII2D1c.	283.04
D	FaIV1D1a, FaIV2D2b, FaIV3D2b, FsIV1D1a, FsIV1D1c, FsIV1D2a, FsIV2D1a, FsIV2D1b, FsIV2D1c, FsIV2D2a, FsIV2D3a, FsIV2D2c, FsIV3D2c.	137.93
Total	**52**	**1170.63**

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3.3.2.3. Results of physical and chemical analyses of soil in Tien HaCommune.

TT	Sampling code No.	Sampling depth (cm)	Site		physical characteristic			Soil chemical characteristics					
			Type	Group	Soil texture	Softness	Stoniness (%)	PH KCl	Org. C (%)	N. (%)	C/N	Avilable Nutrients (mg/100gr soil)	
												P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Sampling 1 Trung An Tiªn Hµ	0-10 30-40	$F_sI_1D_1c$	A	Light Medium	Soft Rather soft	<20 <20	3.69 3.76	3.66 2.05	0.13 0.08 1	16.38 14.67	3.70 3.0	1.91 2.52
2	Sampling 2 - Trung an Tiªn Hµ	0-10 30 -40	$F_sII_1D_1b$	A	Medium Medium	Rather soft Rather soft	<20 <20	3.82 3.85	2.75 1.97	0.106 0.082	15.05 13.93	3.57 3.20	1.67 2.05
3	Sampling 5 - Tó an Tiªn Hµ	0-10 30 -40	$F_sII_1D_1c$	A	Medium Medium	Soft Rather soft	<20 <20	3.79 3.80	3.46 2.02	0.133 0.079	15.11 13.02	4.10 3.50	2.17 1.91
4	Sampling 8- Phó Vunh Tiªn Hµ	0-10 30 -40	$F_sII_1D_1a$	A	Medium Medium	Rather soft Rather heavy	<20 <20	3.72 3.68	2.37 1.62	0.081 0.065	16.97 14.45	2.63 2.91	1.25 1.80
5	Sampling 15- Tiªn Tr¸ng Tiªn Hµ	0-10 30 -40	$F_sI_1D_1b$	A	Light Medium	Rather soft Soft	<20 <20	3.69 3.84	2.21 1.07	0.100 0.070	12.82 8.87	1.71 2.50	3.87 3.93
6	Sampling 17 - Tµi thµnh Tiªn Hµ	0-10 30 -40	$F_sI_1D_1a$	A	Light Light	Rather soft Soft	<20 <20	3.93 3.86	2.15 1.13	0.093 0.069	13.41 9.50	3.05 3.42	3.16 3.72
7	Sampling 20 - §¹i Tr¸ng Tiªn Hµ	0-10 30 -40	$F_sII_1D_1c$	A	Light Light	Soft Soft	<20 <20	4.05 3.89	3.15 1.86	0.123 0.076	14.85 14.19	3.52 3.20	3.46 2.93
8	Sampling 4- Trung An Tiªn Hµ	0-10 30 -40	$F_sII_1D_1b$	B	Light Medium	Medium soft Rather	<20 <2	3.77 3.82	2.45 1.39	0.094 0.05	15.12 14.4	2.34 2.50	1.95 2.07

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TT	Sampling code No.	Sampling depth (cm)	Site		physical characteristic			Soil chemical characteristics					
			Type	Group	Soil texture	Softness	Stoniness (%)	PH KCl	Org. C (%)	N. (%)	C/N	Avilable Nutrients (mg/100gr soil)	
												P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
						heavy				6	0		
9	Sampling 6 - Tó An Tiªn Hµ	0-10 30 -40	$F_sII_1D_1$ a	B	Medium Medium	Medium soft Heavy	< 20 < 20	3.95 4.05	1.97 1.12	0.092 0.057	12.42 11.39	3.96 1.71	1.57 2.20
10	Sampling 7 - Phó Vinh Tiªn Hµ	0-10 30 -40	F_s II_2D_1a	B	Medium Medium	Rather heavy Rather soft	20-40 20-40	4.10 3.87	2.05 1.21	0.100 0.064	11.89 10.96	2.98 1.92	2.85 2.40
11	Sampling 10 - Tiªn Tr¸ng Tiªn Hµ	0-10 30 -40	$F_sI_1D_2c$	B	Light Light	Soft Rather soft	20 20	3.75 3.84	2.67 1.32	0.125 0.080	12.06 9.57	1.32 2.43	2.50 1.48
12	Sampling 14 - Tiªn Tr¸ngTiªn Hµ	0-10 30 -40	$F_sII_2D_1$ b	B	Light Light	Rather softSoft	20-4020-40	3.85 3.88	2.27 1.30	0.10600.068	12.4211.09	2.451.37	2.002.15
13	Sampling 16 §¹i T¸i Thµnh Tiªn Hµ	0-10 30 -40	$F_aII_2D_1$ c	B	Light Light	Soft Soft	20 - 40 20-40	4.12 3.96	2.31 1.42	0.112 0.081	11.96 10.17	1.97 1.34	3.57 3.60
14	Sampling 22- §¹i tr¸ng Tiªn Hµ	0-10 30 -40	F_a II_2D_2a	B	Light Light	Soft Soft	20-40 20-40	3.84 3.68	2.05 1.45	0.097 0.073	12.26 11.52	2.27 2.47	3.80 3.67
15	Sampling 23 - §¹i tr¸ng Tiªn Hµ	0-10 30 -40	$F_sI_2D_1a$	B	Light Light	Rather soft Soft	20-40 20-40	3.40 3.84	2.00 1.67	0.085 0.059	13.65 10.88	1.99 2.17	3.42 3.20
16	Sampling 3 Trung an	0-10 20-30	F_sIII_1 D_1a	C	Medium Medium	Rather heavy	< 20	3.89 3.80	1.29 0.82	0.063	11.88	0.72 0.76	0.55 0.64

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TT	Sampling code No.	Sampling depth (cm)	Site		physical characteristic			Soil chemical characteristics					
			Type	Group	Soil texture	Softness	Stoniness (%)	PH KCl	Org. C (%)	N. (%)	C/N	Avilable Nutrients (mg/100gr soil)	
												P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Tiªn Hµ					Heavy				0.047	10.12		
	« sè 9 phó Vinh					Medium soft				0.097	11.66		
17	Tiªn Hµ	0-10 20-30	F_sIII_2 D_1b	C	Medium Medium	Rather heavy	20-40	3.77 3.82	1.95 1.05	0.056	10.88	1.91 0.96	0.64 1.28
	Sampling 12 TiÒn Tr¸ng					Rather heavy				0.106	12.31		
18	Tiªn Hµ	0-10 20-30	F_sIII_2 D_1a	C	Medium Medium	Heavy	20-40	3.78 3.84	2.25 1.00	0.052	11.15	0.85 0.78	1.34 0.33
	« sè 18 Tµi Thµnh					Medium soft				0.125	13.40		
19	Tiªn Hµ	0-10 20-30	F_aIII_2 D_2b	C	Light Medium	Heavy	20 - 40	3.69 3.75	2.84 1.12	0.067	9.69	0.72 0.47	2.91 2.54
	Sampling 19 Tµi thµnh					Medium soft				0.107	13.49		
20	Tiªn Hµ	0-10 20-30	F_aIII_1 D_{1b}	C	Light Medium	Heavy	< 20	3.81 3.79	2.44 1.08	0.059	10.62	0.91 0.70	2.44 2.50
	Sampling 21 §¹i tr¸ng					Medium soft				0.056	12.65		
21	Tiªn Hµ	0-10 20-30	F_aIII_2 D_{1a}	C	Light Light	Heavy	20-40	3.98 3.87	1.44 0.94	0.051	10.09	0.78 0.85	1.44 1.57
	Sampling 24 §¹i Tr¸ng					Medium soft Rather				0.096	13.59		
22	Tiªn Hµ	0-10 20-30	F_aIII_2 D_{1b}	C	Light Light	heavy	20-40	4.05 3.94	2.25 1.02	0.067	8.83	1.71 1.19	2.27 1.69
	Sampling 11 Tó An					Medium soft				0.125	15.49		
23	Tiªn Hµ	0-10 20-30	F_3III_2 D_1c	C	Medium Medium	Heavy	20 - 40	4.00 3.92	3.34 1.61	0.077	12.12	1.19 1.10	2.57 1.68
24	Sampling 25. Tiªn Nhóng	0 - 10 20 -	$F_sIV_2D_2$ b	D	Medium -	Rather soft	20 - 40	3.92 3.88	2.25 0.98	0.096	13.59	1.71 2.50	1.19 1.57

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TT	Sampling code No.	Sampling depth (cm)	Site		physical characteristic			Soil chemical characteristics					
			Type	Group	Soil texture	Softness	Stoniness (%)	PH KCl	Org. C (%)	N. (%)	C/N	Avilable Nutrients (mg/100gr soil)	
												P_2O_5	K_2O
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Ti^{a}n H$_{\cdot}$	30				Heavy				0.065	8.74		
	Sampling 26.	0 - 10				Rather				0.064	15.68		
	Ti^{a}n ?	20 -	$F_sIV_2D_2$		Medium	heavy	20 -	4.05	1.73	0.042	10.49	1.19	2.20
25	Ti^{a}n Hµ	30	a	D	-	Heavy	40	3.97	0.76			0.82	1.14
	Sampling 30.	0 - 10				Rather				0.076	14.57		
	§^{1}i ?	20 -	$F_aIV_1D_2$		Light	heavy		3.86	1.91	0.044		0.79	3.31
26	Ti^{a}n Hµ	30	a	D	Medium	Heavy	<20	3.78	0.67		7.90	0.76	2.20
	Sampling 31.	0 - 10				Rather				0.097	14.17		
	§^{1}i ?	20 -	$F_aIV_2D_2$		Light	soft	20 -	3.76	2.37	0.070		2.50	2.27
27	?	30	b	D	-	Soft	40	3.84	1.05		8.70	2.10	1.64
	Sampling 35.	0 - 1020 -	$F_aIV_1D_1$		Light	Rather soft		3.95	1.33	0.07 50.046	10.2 98.40	0.961	2.111
28	?Ti^{a}n Hµ	30	a	D	Medium	-	<20	3.79	0.87			.10	.60
	Sampling 36.	0 - 10				Rather				0.116	15.05		
	?	20 -	$F_aIV_2D_2$		Light	soft	20 -	3.77	3.01	0.062	10.57	1.75	1.98
29	Ti^{a}n Hµ	30	b	D	Medium	Soft	40	3.80	1.13			1.19	2.77
	Sampling 52.	0 - 10				Rather				0.064	14.96		
	Phó Vinh	20 -	$F_sIV_2D_2$		Medium	heavy	20 -	4.10	1.78	0.050	10.67	0.85	1.87
30	Ti^{a}n Hµ	30	a	D	Medium	-	40	3.86	0.92			0.76	2.20
	Sampling 53.	0 - 10				Rather				0.108	15.84		
	Phó vinh	20 -	$F_sIV_2D_1$		Medium	heavy	20 -	3.87	2.45	0.065		2.15	1.60
31	Ti^{a}n Hµ	30	b	D	Medium	-	40	3.92	1.02		9.10	2.25	1.69

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During the trip of soil survey and assessment, we concentrated on surveying and assessing soil kinds potential but not yet to be used to build the production models of agriculture with silvicultue combination or the models of fruit-tree garden or forest garden. We did not survey the wet-rice soil as well as forest soil.

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The outdoor fast-assessed results along with the soil analysis in the lab were presented in the table below (table…)

The data assessed outdoor and analysed in the lap shows that:

Generally, the open land in Tien Ha commune is still large areas (above 2600 hectares). However, due to the backward cultivation process and the lack of methods to reduce erosion, the soil of Tien Ha commune has been strongly degeneraced. The soil is too acid (PH<4.0) and arid. There are only drought tolerant bushes (the indicators for the acidic soil) which can grow.

The rate of C/N is between 12 and 16, showing that the soil of Tien Ha commune the degeneracy is mainly due to erosion process and the environmental condition and the climate here is suitabel for activities of microorganism paticipating in humusized process in soil.

Because the soil of Tien Ha commune is degeneraced, the content of available substance is poor, both P_20_5 and K_20 contents < 4^{mg}/100 g soil. Most of P_20_5 and K_20 ions are retained by Fe and Al ions in the adhesive soil. Therefore soil is getting more acidic and more acidic.

The results of preliminery survey presents that: Most soil of A site type have humus and nitrogen content reaching the medium and over rate (the humus

content at the first layer is between 2.2 and 3.7%, the nitrogen content is between 0.09 and 0.133%). Because the humus content in the soil is quite high, the soil texture is light and soft. The rate C/N of soil at the first layer is morderately good. However, the soil is strongly acidic and poor in available substance.

In the B site type, the humus content reaches the medium rate, above 2% at the first layer. The nutrient content also reaches the rate between 0.09 and 0.125%. The texture of soil is light or medium therefore the soil is softenss and the stoniness is quite high, from 20-40%. Similar to the soil of A site type, the soil of B site type is acidic (PH<4.0) and poor in available substance such as K_20 and P_20_5.

Soil in C and D site type of Tien Ha is similar to soil in C and D site type of Tien Cam in term of physical and chemical characteristic. The only difference is that the soil slope of Tien Ha is medium and high (from 15 to 25 ^{0} and over 25^0). In general, the soil is acidic, poor in available substance. Before implementing agricuature and forest production activities on Tien Ha soil types, it is necessary to improve and increase the fertility of soil by intercroping legume trees and shrubs with other kinds of plant.

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3.3. Recommendations for utilization of project areas for different site type groups.

3.3.1. For Tien Cam commune

- Characteristics of site type groups in Tien Cam and proposal for management and utilization:

	Group A	Group B	Group C	Group D
Slope	sites with	8 -15^o, some	sites with slope	Mainly sites

gradient	slope ≤ 8°, only some sites with slope 8 -15°	sites with slope 15 -25°	15 -25°	with slope ≥ 25°
Soil type and mother rock and texture	soil developed on Granit, light and soft texture, some soils developed on clay sandy-stone with light texture of sandy loam or loamy sand	soil developed on Granit, soft texture, some soils developed on clay sandy-stone with medium texture of sandy loam	soil developed on Granit, soft texture, some soils developed on clay sandy-stone	soil developed on Granit,
Soil depth	Soil depth ≥ 50cm	Thick soil depth ≥ 50cm	Medium to thick soil depth 30- 50cm	Medium soil depth 30- 50cm, some sites with thin soil depth of ≤ 30cm
Stoniness amd rock emergence	stoniness and rock emergence < 20%	stoniness and rock emergence: 20% -40%	stoniness and rock emergence: ≤ 20%; only some small areas with 20% -40%	stoniness and rock emergence: ≤ 20%; only some small areas with 20% -40%
Vegetation cover	Mainly medium & low bushes with scattered tree regeneration including some drought –tolerant grasses	Mainly medium & low bushes including some drought –tolerant grasses; indicators for acidic soil	Mainly grasses with scattered low bushes, the indicators for acidic soil	Mainly grasses with scattered poor bushes, the indicators for acidic soil; some site with good bushes and regeneration
Location/ position	Lower parts of hill, near resident areas	Lower parts of the hill, next to areas proposed for fruit planting	Middle parts of the hill.	Higher parts of the hill.
Proposed management/utilization	**Fruit planting garden**, **cash crops**	**Forest garden** combined with **fruit planting** or **NTFP crop**s under forest canophy	Mainly propose for Alley Cropping **models** combined with initial establichment of legume trees or bushes for soil improvement.	Mainly propose for **plantation models** with pines, acacia and some indigenous tree species

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3.3.2. For Tien Ha commune

- Characteristics of site type groups in Tien Cam and proposal for management and utilization:

	Group A	Group B	Group C	Group D
Slope gradient	sites with slope ≤ 8°	8 -15°, some sites with slope 15 -25°	sites with slope 15 -25°	Mainly sites with slope ≥ 25°
Soil type and mother rock and texture	soil developed on Granit, some soils developed on clay sandy-stone or old alluvium with light to medium texture of sandy loam	soil developed on Granit, some soils developed on clay sandy-stone or old alluvium with medium texture of sandy loam	soil developed on Granit, some soils developed on clay sandy-stone or old alluvium with medium texture	soil developed on Granit and old alluvium with medium texture
Soil depth	Soil depth ≥ 50cm	Thick to medium soil depth ≥ 40cm	Medium soil depth 30-50cm	Medium soil depth 30- 50cm, some sites with thin soil depth of ≤ 30cm
Stoniness amd rock emergence	stoniness and rock emergence < 20%	stoniness and rock emergence: 20% -30%	stoniness and rock emergence: 20% -30%	stoniness and rock emergence: ≤ 20%; only some small areas with 20% -40%
Vegetation cover	Mainly medium bushes with scattered tree regeneration including some grasses	Mainly medium & low bushes including some drought –tolerant grasses; indicators for acidic soil	Mainly grasses with scattered low bushes, the indicators for acidic soil	Mainly grasses with scattered poor bushes, the indicators for acidic soil; some site with good bushes and trees
Location/ position	Lower parts of hill, near resident areas	Low – medium parts of the hill,	Middle parts of the hill.	Higher parts of the hill.
Proposed management/utilization	**Fruit planting garden, cash crops**	**Forest garden** combined with **fruit planting** or **NTFP crops** under forest canophy	Mainly propose for **Alley Cropping models** combined with initial establichment of **legume trees** or **bushes** for soil improvement.	Mainly propose for **plantation models** with pines, acacia and some indigenous tree species

3.4. Land Use Models or Planting Models recommended for the project in two communes of Tien Cam & Tien Ha

3.4.1. Intensive crop cultivation models in low part areas

- Establishment of terraces or contoured green hedgerows with legume trees or bushes for soil erosion control, soil improvement and supporting to main crops.
- Use new improved varieties of crops those are suitable to grow in the site type groups like hybrid maize (VN10), pea, bean, groundnut, cassava, ginger or turmeric.
- Apply appropriate fertilizer technique regarding fertilizer types, technical application procedure that most suitable to the site type groups to support the main crops for high yield and productivity and ensure without or less damage to the environment.
- Apply inter-cropping, mix-cropping and alternative cropping to reduce the risks of pest & diseases and increase crop productivity.

3.4.2. Models of fruit planting and improvement of home garden

- Use legume plants as component for the improvement of site and soil conditions that favor the growth of fruit trees at early stages of the establishment as recommended as follows:

(a) Establishment of green hedgerows with legume trees and shrubs,

(b) Apply alley cropping, intercropping to supply shading and more favorable conditions for growth and development of the planted fruit trees at early stages, or

(c) Cover whole area with the legume trees or shrubs then planting the fruit trees in patch or line when favorable conditions come,

- Composition of legume trees and shrubs recommended for the fruit planting model in the project include:

  (i) Tephoria candida (cèt khÝ)

  (ii) Cajanus cajan (®Ëu triÒu Ên §é)

  (iii) Calliandra Calothyrsus (muång hoa ph¸o)

  (iv) Leucaena leucocephala (keo dËu)

  (v) Parasezianthes falcatazia (keo l¸ ph-îng)

  (vi) Sesbania grandifloza (so ®òa)

- Composition of fruit trees recommended for the application in the project areas include:

  (i) C©y Lßn Bon (Lansium)

  (ii) Green Dragon fruit (Thanh long)

  (iii) Piper (Hå tiªu)

  (iv) Annona (Na hay m·ng cÇu ta)

  (v) Areca palm (c©y cau)

  (vi) Banana (c©y Chuèi)

  (vii) Pieapple (Døa)

  (viii) Mango ((Xoµi)

  (ix) Longan (nh·n)

- Establishment of irrigation system for the gardens, each ha needs 2-3 water tanks with pipe systems. Use pump to supply irrigation water to the tanks or supply naturally if possible.

- Garden structure: to establish ecological fruit garden with multi-stories for respective species.

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- Apply intensive cultivation methods to the fruit garden by applying proper fertilizer techniques, irrigating, integrated pest and disease management

3.4.3. Models of forest garden

- Use legume plants as component for the improvement of site and soil conditions before establishment of mail crop plantation; and
- The establishment methods and legume tree composition recommended for the planting models were same as those of fruit planting model, viz.,

  (a) Establishment of green hedgerows with legume trees and shrubs,

  (b) Apply alley cropping, intercropping to supply shading and more favorable conditions for growth and development of the main tree crops at early stages, or

  (c) Cover whole area with the legume trees or shrubs then planting the forest tree components in patch or line when favorable conditions come,

- Composition of legume trees and shrubs recommended for forest garden model of the project include:

  (i) Tephoria candida (cèt khÝ)

  (ii) Cajanus cajan (®Ëu triÒu Ên §é)

  (iii) Calliandra Calothyrsus (muång hoa ph¸o)

  (iv) Leucaena leucocephala (keo dËu)

  (v) Parasezianthes falcatazia (keo l¸ ph-îng)

  (vi) Sesbania grandifloza (so ®òa)

- Composition of forest tree recommended for the model of forest garden includes:

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(i) Cinnamomun (C©y QuÕ)

(ii) *Aquilaria crassna* (giã TrÇm)

(iii) Melia azadarach (c©y xoan)

(iv) Bamboo for shoots (tre lÊy m¨ng)

(v) Areca (c©y cau)

(vi) Hybrid acacia (keo Lai)

(vii) Pineapple (Døa), Ginger (gõng), Turmeric (nghÖ)

- Apply intensive cultivation and tending technique with proper fertilizer application.

3.4.4. Models of Alley Cropping

This is the most important and expectative landuse model of the project:

- Use legume trees and shrubs as important component in the AF system for the improvement of site and soil conditions before establishment of mail crop plantation; they might be grown either to cover the whole areas before main cropping, strip- cropping or intercropping with main crops.
- Establishment of terraces or contoured green hedgerows with legume trees or bushes for soil erosion control, soil improvement and supporting to main crops. Use new improved varieties of crops those are suitable to grow in the site type groups like hybrid maize (VN10), pea, bean, groundnut, cassava, ginger, turmeric.
- Forest tree and NTFP species like Hybrid acacia, Bomboo for shoot production, *Canarium album*, *Aquilaria crassna*, *Hopea odorata* were recommended for the model of the project.
- Legume trees and shrus recommended for the AF models were: *Tephoria candida* (cèt khÝ), *Cajanus*

cajan (®Ëu triÒu Ên §é), *Leucaena leucocephala* (keo dËu), *Paraseziantheș falcatazia* (keo l¸ ph-îng).

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- Apply intensive cultivation for planting and tending of the AF models.

3.4.5. Models of forest plantation

- Intensive planting model with recommended species of Hybrid acacia, *Eucalyptus urophylla, Pinus merkusii, Melia azedarach, Dendrocalamus* spp.
- Mixed plantation models between Acacia-Eucalyptus, Acacia – Pine, Acacia – Dendrocalamus, Acacia - Melia-

4. Technical solutions recommended

Soil in project area of Tien Cam and Tien Ha communes has been strongly degenerated, eroded and become acid and exhausted due to the long cultivation process without the method to protect, improve soil and reduce the erosion rate.

Therefore, to develop the models of agroforestry, there is a need to implement steps listed below to improve, protect and increase the fertility of the soil:

- For the model to transform the mixed garden to valuable fruit-planting garden, there is a need to intercrop them with legume trees and shrubs such as *Tephoria candida, Cajanus cajan, Sesbania grandifloza*...to improve the soil and make the shade for plant at the begin period.

- For fruit-tree planting, it is necessary to dig the hole sized 1m x1m x 0,80 m and apply processed manure (put down basic application) with amount of 5 kg for each hole. And then, annually there is need to apply additional organic biofertilizer or synthetic

NPK fertilizer. The standard saplings have to reach the height of 1-1.5 m or over.

- There is a need to plant tree following multistage, multistorey texture to take advantage of nutritional space sush as : Texture of areca palm, mango, jack, pineapple or lansium, green dragon, ginger, tumeric....

- It is necessary to build the irrigation system for fruit-tree garden by establishing water tanks at different elevation levels for self-flowing or using water pump. Especially in the dry season, it is difficult for fruit-tree garden to grow well without the atering system.

- For the forest garden, it is necessary to apply highly intensive cultivation methods. The planting materials must be carefully chosen to meet qualified requirements and with height of 0.5 m or over.

- The hole has to be large enough (0.5 x 0.5 x 0.5 m) and is put down muck with a mount of 1 kg at least for each hole and 0.2 kg of organic biofertilizer plus 0.2 kg synthetic NPK 5:10:3 fertilizer in combination for each hole in next coming year.

- The forest garden also needs to be planted following the multistage, multistorey texture to take advantage of nutritional space. The texture may be*: Aquilaria crassna*, Cinnamomun, pipeapple, jack, ginger, tumeric and Hybrid acacia band fire break.

- For the alley cropping cultivation model: Firstly, cover the whole areas with planting of legume trees and shrubs such as *Tephoria candida, Cajanus cajan, Sesbania grandifloza*, and so on, or in contoured bands with wide of 5 meters alternated with 10 to 15 contoured bands of agricultural cash crops.

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- To build the models of cutivation on slopping soid following Salt model scaled 0.3-0.5 hectare for each model.

- To build the green band crop with beam family or to build stone jetty to reduce the erosion.

- It is need to put down musk for agricutural cultivation soil in the model.

-The structure of plant in the model is beam, corn, cassava, seasame and peanut. It may intercrop them with fruit-plant with sparse canopy such as custard-apple or special plant such as Cinnamomun, Aquilaria crassna, bamboo…

- It is need to apply highly extensive cultivation, rotational cultivation techniques to increase productivity and resist the pestilent insect.

- For the model of material plant, it is need to apply extensive cultivation method, to work the soil carefully and put down fertilizer appropriately.

5. Recommendations for fertilizer application

5.1. General problem statements:

- Most the sites were found to be very degraded with poor and acidic soils

- The soil pH was low, they all showed the values lower 4. In the acid soil, the cations of Al^{+3} & Fe^{+3} were very mobile and their contents were also high. In addition, the water runoff and soil erosion were highly and regularly occurred. So, if the fertilizer application is carried out in conventional way, viz., single chemical fertilizer application, not in combination or mixture with organic/ biofertilizer components, the efficacy/effective response of the fertilizer application will be very limited.

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Factually, only after one month of the application (single chemical fertilizer application, even with only NPK application) on the above-mentioned problem sites, almost all the available contents of the phosphorus in the fertilizer will be transformed into unavailable form, that permanently can not be used by the plants, due to the affect of adverse factors like Al^{+3} & Fe^{+3}, therefore,

- In order to assure the effectiveness of the fertilizer application on the adverse site conditions, it is very important to apply the fertilizer in mixture/combination between chemical inorganic fertilizer/NPK and organic manure/organic biofertilizer. By the way of the application, so that the adverse affects could be significantly controlled for higher responses.

5.2. Proposed technical fertilizer application for respective models

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(i) for home garden model: each plant/hole would be applied with

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- 5-10kg processed organic animal manure + 200g NPK 5:10:3 for bed dressing application
- 100g NPK 5:10:3 + 100g organic biofertilizer as top dressing application, combining with tending and weeding activities,
- 5-10kg processed organic animal manure + 200g NPK 5:10:3 for bed dressing application for additional application for each after harvesting combined with tending and weeding activities (for fruit and bamboo shoot components).

(ii) for Forest Garden Model:

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- 5-10kg processed organic animal manure + 200g NPK 5:10:3 for bed dressing application

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- 100g NPK 5:10:3/or 16:16:8 + 100g organic biofertilizer as top dressing application, combining with tending and weeding activities,

- 5-10kg processed organic animal manure + 200g NPK 5:10:3 for bed dressing application for additional application for each after harvesting combined with tending and weeding activities (for fruit and bamboo shoot components).

(iii) for Alley Cropping Models

- Cash crop component: Spreading fertilizer application at rate of 10-20 tons/ha (1-2 kg/m^2) of processed animal manure, if planting with cassava: apply 1 kg the manure per hole or combined with NPK 5:10:3 at rate of 1 kg manure + 50g NPK.
- Special yielding product component like *Canarium album, Aquilaria crassna, Cinamomum, so on*: applied same as that of forest garden as follows:

  5-10kg processed organic animal manure + 200g NPK 5:10:3 for bed dressing application

  100g NPK 5:10:3/or 16:16:8 + 100g organic biofertilizer as top dressing application, combining with tending and weeding activities,

  5-10kg processed organic animal manure + 200g NPK 5:10:3 for bed dressing application for additional application for each after harvesting combined with tending and weeding activities (for fruit and bamboo shoot components).

- Forest plantation component: Acacia, Hopea, ..:

  100g NPK 5:10:3 + 100 organic biofertilizer as bed dressing application and also

  200g NPK 5:10:3 + 200g organic biofertilizer as top dressing application for 3 years continuing after that, combining with tending and weeding activities,

(iv) for plantation model:

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- 100g NPK 5:10:3 + 100 organic biofertilizer as bed dressing application and
- 200g NPK 5:10:3 + 200g organic biofertilizer as top dressing application for 3 years continuing after that, combining with tending and weeding activities,

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6. Conclusions

The project "Site survey and analysis for mapping and recommendation of tree planting species composition in project areas of Tien Ha and Tien Cam communes" complemented in the context that the GCP/ VIE/ 027/ ITA project had not built the land use microscropic map for Tien Ha and Tien Cam communes and surveyed the effective models of land use in Tien Phuoc district yet while microscropic map and effective models of land use are the bases of site survey and plant structure determination.

However, the project has been fulfiled within 2 months, from August 10th , 2005 to October 10th , 2005 and with the greatful help of Mr. Mazcelino V. Dalmacio, the technical consultant Chief of (GCP/ VIE/ 027/ ITA) project, the Project management board of Quang Nam Province, the Project management board of Tien Phuoc district, the Tien Ha and Tien Cam People's Committee and especially, the help of FAO Project office at Ha Noi which had created the best condition in financial aspect, assisting the project implemented fast and effectively. The results of project is presented as below:

- The project was surveyed and assessed the land use status in project area of Tien Ha and Tien Cam communes, built 2 land use status maps for project area of Tien Ha and Tien Cam communes.

- The project was compeleted site survey, built land use status maps for project area of built the Tien Ha and Tien Cam communes with total area of 2000 hectares, built the Tien Ha and Tien Cam communes' site maps which are the bases for proposing plant structure and models of land use for 2 communes.
- The project was surveyed, analyzed soil by digging a hundreds of soil profile as well as soil sub-profile, describing the soil profile to determine the soil type, stoniness, soil texture…, taking a hundreds of soil sample back to analize content of humus, total nitrogen, P_2O_5 vµ K_2O, PH, KCl for proposing technical solution and effective models of land use for project area of Tien Cam an Tien ha communes. Finally, the project was built the model of land use and the adaptability of plant for the 2 communes.
- The project was also built the summary report and presented in the Conference held in Tien Phuoc district on September 9^{th} , 2005. The relevant managers and technical staff of the district and commune as well as the key staff of 2 communes were agreed and contributed their meaningful ideas for the report. The project was received such ideas to complete and fulfill the summary report.

However, to bring the resutls of project to famer household who will implement the project, we have some suggestions regarded below:

- The project need hold trainning course for technical staff and people participating in the project of 2 communes, Tien Cam and Tien Ha, assisting them in applying the project results into production in the context of local.

- The project need to have experts in land use to guide and farmer households participating in buiding the appropriate models of land use in the specific conditions of their locals.
- The suggestions of the ways to use land resource and to determine the structure of plant for each model of land use of the project are bases for farmer households to choose one model which is both suitable with site type of local and appropriate to cultivation customs.

The results of soil survey and assessment process implemented on project area in Tien Cam and Tien Ha commune show that:

- These are two communes in the mountaineous midland area of Tien Phuoc District, Quang Nam province. Here is Anti-American and anti-France Revolution base with many advantages in term of soil such as slope soil is low, climate is suitable for agricuture and forest production. Not to mention the potentation in human resource with many experiences in cultivation on their own land.
- Within the two communes, there are a lot of households who have the models of economic valuable plant. This is really favourable for 2 communes to develope their plant structure.
- The project in Tien Ha and Tien Cam communes is highly feasible and if the steps are implemented properly, the project will bring good resutls and have been multiplied throughout the province.

There are the results of project implementation after 2 months. We express heartfelt thanks for the helps and the cooperation of the technical consultant Chief, the Project management board of Quang Nam Province, the Project management board of

Tien Phuoc District and People’s Commitees of Tien Ha and Tien Cam cummune, as well.

Appendix 1: Compilation of site characteristics and proposal of planting species composition for different site groups in TIen Cam and Tien Ha communes

Site groups	Site parameters							Land use model	Planting species composition (in ranking order)
	Slope	**Soil types**	**Soil thickness**	**Stoniness**	**Softness**	**Soil texture**	**Vegetation cover**		
A	< 8^{o} 8-15^{o}	Fa , Fs, Fp	> 50cm	< 20%	Soft	Loose to medium	a*,b,c	Home garden	Lon bon, Pomelo, Green Dragon, Duriant, Banana, Longan, Annona
B	8-15^{o} 16-25^{o}	Fa , Fs, Fp	> 50cm	< 20% 20-40%	Medium soft	Loose to medium	a,b,c	Forest garden	Cinamomun, *Aquilaria crassna*, "Xua" , Melia azedarach, Hybrid acacia, Bamboo (for shoot)
C	16-25^{o}	Fa , Fs, Fp	> 50cm 30-50cm	< 20% 20-40%	Medium soft	Loose to medium	a,b,c	Alley Cropping Model	- Legume trees and shrus: *Tephoria candida, Cajanus cajan, Leucaena leucocephala, Parasezianthes falcatazia* - Cash crops: maize, Beans, Peas, - Under shading planting with Ginger, Turmeric, - Forest plantation with *Aquilaria crassna*, Hybrid acacia, *Hopea odorata*, Bamboo

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									(for shoot),
D	25^{o}	Fa , Fs, Fp	> 50cm 30-50cm <30cm	< 20% 20-40% > 40%	Medium soft	Loose to medium	a,b,c*	Forest Plantation	- Hybrid acacia, *H. odorata*, *P. merkusii*, ,

Note: a*: Some flat sites very near resident and fruit garden area with a vegetation; b*: Some very steep sites (>30^{O}) with a good vegetation (c)

Forest Science Institute of Viet Nam

Research Center For Forest Ecology and Environment

report

on

Site survey and analysis for mapping and recommendation of tree planting species composition in project areas of Tien Ha and Tien Cam communes

GCP/VIE/027/ITA/FAO Project

Hanoi September 28, 2005

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