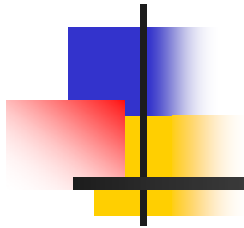


# Carbon in Vietnamese soils and experiences to improve carbon stock in soil



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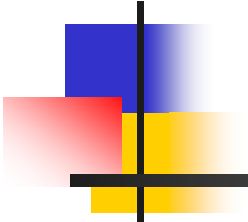
# Content

- Introduction of Vietnam
- Agricultural soils/ Soil fertility status
- Food production in Vietnam
- Fertilizer / Farm yard manure/ Resources and Use
- Balance fertilization in relation to organic fertilizer as a solution to improvement of soil productivity and carbon sequestration. A case study of sandy soil management

# Location



# Introduction of Vietnam

- 
- 86Millions inhabitants
  - 60 % are farmers
  - 33 millions ha of land
  - 9.4 millions ha of land for crops
  - 14.7 millions ha of land under forestry
  - Agriculture counts 24% of GDP



# 1. Introduction

**Table 1. Land use in Vietnam**

<b>Areas as classified by land used (2008)</b>	<b>Area (ha)</b>	<b>%</b>
Agriculture land	9,420,300	28.4
Forestry land	14,816,600	44.7
Non-Agricultural land	3,385,800	10.2
Aquaculture land	728,600	2.2
others lands	3,666,300	11.1
Water surface	1,097,400	3.3
Total of Vietnam Areas	33,115,000	100

*Vietsat (2008)*

# 1. Introduction

**Table 2. Main crops production in Vietnam**

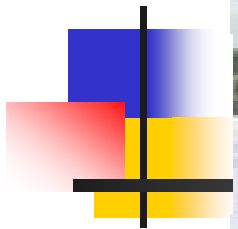
		<i>1000 ha</i>	<i>1000 tons</i>	
<b>N.</b>	<b>Crops</b>	<b>Planted area</b>	<b>Production</b>	<b>Crop classification</b>
1	Rice	8,304,700	35,942,700	Food
2	Maize	1,096,100	4,303,200	Food
3	Cassava	495,500	9,395,800	Food & cash
4	Peanut	254,500	510,000	Food & cash
5	Soybean	187,400	275,200	Food & cash
6	Sweet potato	175,500	1,437,600	cash
1	Rubber	556,300	605,800	Industrial
2	Coffee	509,300	915,800.00	Industrial
3	Cashew nut	439,900	312,400	Industrial
4	Sugar Cane	293,400	17,396,700	Industrial
5	Coconut	135,300	1,034,900	Industrial
6	Tea	126,200	705,900	Industrial
7	Pepper	48,400	89,300	Industrial

(Vietsat, 2008)

## 2. The Distribution of Major Soil Groups and Soil characteristics

**Table 4. Soil in Vietnam, distribution and dominant crops**

No	Main soil types	Main distribution areas	Dominant crops types	Annual harvesting seasons
1	Sandy soil	Coast central	Rice, peanut & cash crops	> 2
2	Saline soil	Coastal north and south	Rice, cassava & cash crops	1-2
3	Acid sulfate soil	Red & Mekong Rivers Deltas	Rice, cassava & cash crops	1-2
4	Alluvial soil	Mekong (MKRF) and Red Rivers (RRF) and others (ORF)	Rice, maize & cash crops	>2
5	Red Soil	Central high plateau; North hills & mountains	Maize, coffee, rubber & other industrial crops	1-2
6	Grey Degraded soil	Midlands of north & southeast	Rice, maize, & cash crops	>2
7	Ferralitic Soils	Hills & mountainous areas	Forestry & cash crops	1-2

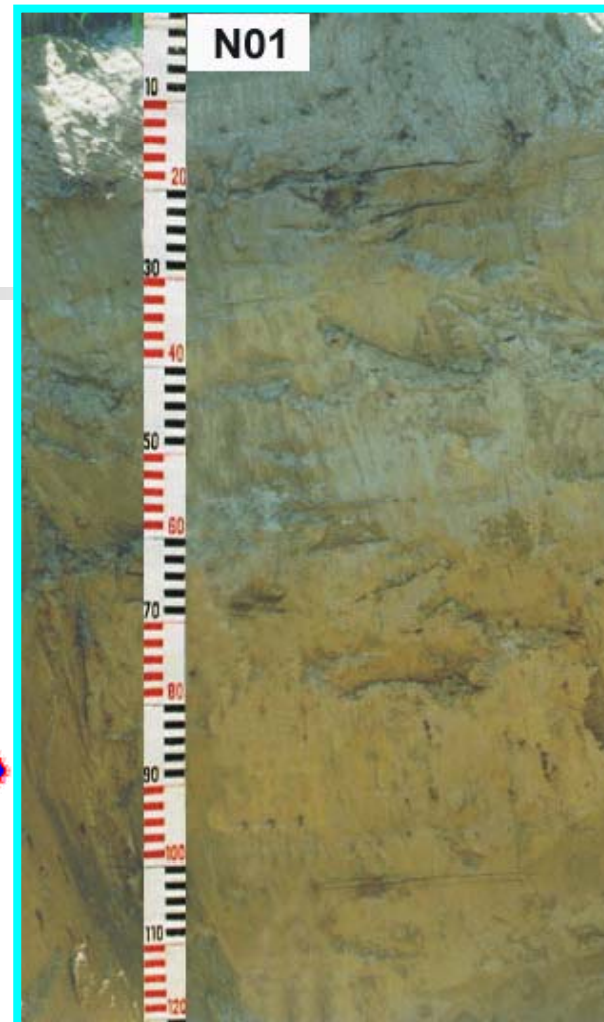






**Location:**  
**Hung Xa village,**  
**Hung Nguyen district**  
**Nghe An province**  
**Latitude : 18° 37' 03"**  
**Longitude : 105° 36' 16"**

**Group Soils:**  
**FAO – UNESCO**  
**DYSTRIC FLUVISOLS**  
**VIETNAMESE**  
**Phu Sa Song Lam**  
**Plant carpet : Rice**





**Location:**

**Eale village, Easoup  
district, Dac Lac  
province**

**Latitude: 13° 07' 07"**

**Longitude: 107° 52' 37"**

**Group Soils:**  
**FAO – UNESCO**  
**SKELETIC ACRISOLS**  
**VIETNAMESE**  
**Dat Xam Bac Mau**  
**Plant carpet: Peanut**

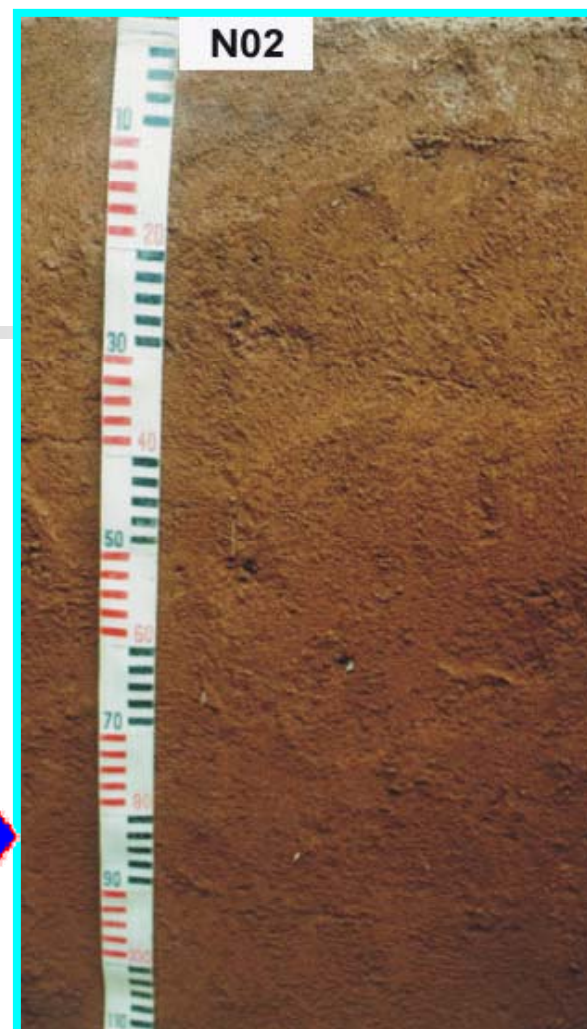






**Location:**  
**Nghia Quang, Nghia Dan,**  
**Nghe An**  
**Latitude : 19° 19' 32"**  
**Longitude : 105° 24' 11"**

**Group Soils:**  
**FAO – UNESCO**  
**RHODIC FERRALSOLS**  
**VIETNAMESE**  
**Dat do tren da Bazan**  
**Plant carpet : Rubber, coffee**





**Mui Ngoc Commune, Mong Cai  
District, Quang Ninh Province**

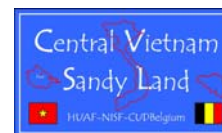
**Latitude: 15° 12' 51"**

**Longitude: 108° 47' 21"**

**FAO-UNESCO: Haplic Arenosols  
Vietnam: Dat Cat Bien (C)**







**Hong Phong Commune, Bac Binh  
District, Binh Thuan Province**

**Latitude: : 11° 03' 03"**

**Longitude: 108° 17' 57"**

**FAO-UNESCO: Rhodic Arenosols**

**Vietnam: Dat cat do (Cd)**





**Tinh Phong Commune, Son Tinh  
District, Quang Ngai Province**

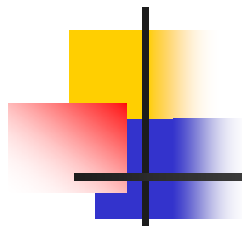
**Latitude: 15° 12' 51"**

**Longitude: 108° 47' 21"**

**FAO-UNESCO: Haplic Arenosols  
Vietnam: Dat cat bien (C)**



## 2. The Distribution of Major Soil Groups and Soil characteristics

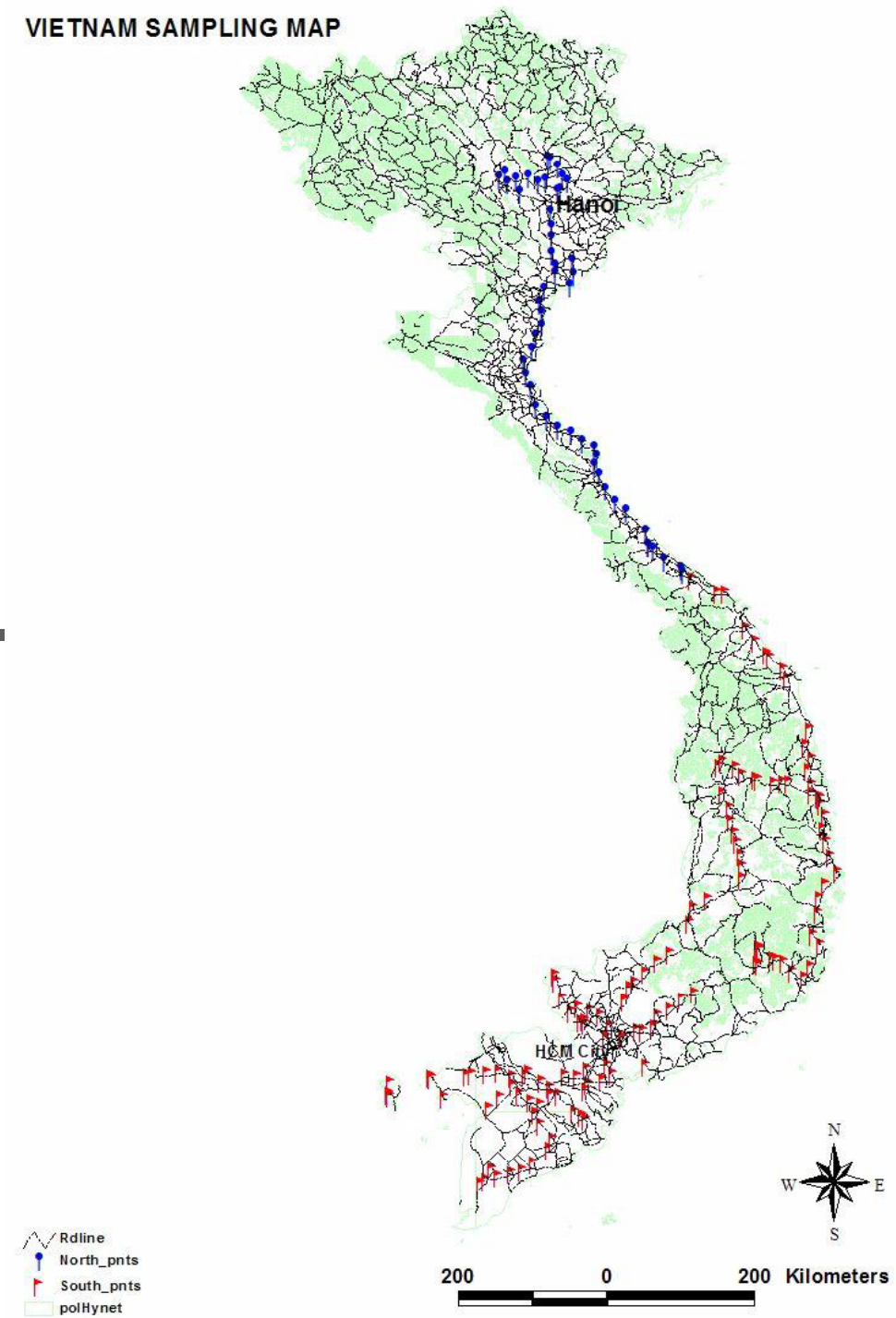
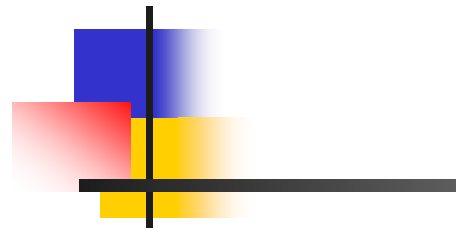


**Table 3. Soils in Vietnam selon Fao-Unesco or local classification**

No	Main soil types/ local name	FAO- Unseco	Area (ha)	%
1	Sandy soil	Arenosols	533,434	1.6
2	Saline soil	Salic fluvisols	971,356	2.9
3	Acid sulfate soil	Thionic Fluvisols	1,863,128	5.6
4	Alluvial soil	Fluvisols	3,400,058	10.3
5	Red Soil	Ferralsols	3,010,594	9.1
6	Grey Degraded soil	Haplic Acrisol	1,791,021	5.4
7	Ferralitic Soils	Other Acrisol	18,179,621	54.9
8	Other lands/areas	Other	3,365,788	10.2
<b>Total of Vietnam Areas</b>			<b>33,115,000</b>	<b>100</b>

*Vietnam soil (1996)*

# VIETNAM SAMPLING MAP





## 2. The Distribution of Major Soil Groups and Soil characteristics



**Table 5. Selected characteristics of main soil types/groups for agricultural purposes**

No	Main soil types	pH <sub>KCl</sub>	N%	Clay (%)	Bulk density (g/cm <sup>3</sup> )
1	Sandy soil	4.76-5.74	0.05-0.06	2.9-6.2	1.20-1.67
2	Saline soil	5.05-5.35	0.15-0.16	38-58	0.92-1.38
3	Acid sulfate soil	3.54-3.79	0.22-0.25	42-57	0.79-0.99
4	Alluvial soil	4.51-4.67	0.17-0.19	33-41	0.82-0.97
5	Red Soil	3.99-4.10	0.17-0.18	49-55	1.02-1.09
6	Grey Degraded soil	4.26-4.41	0.09-0.11	11-18	1.32-1.35

### 3. Carbon stock in soils as affected by soils types and soil characteristics



**Table 6. Organic carbon in main groups of agriculture soils (OC%)**

TT	Parameters	Alluvial soil	Red soil	Grey degraded soil	Sandy soils	Saline soil	Acid sulfate soils
1	N. of samples (n)	211	233	229	212	230	156
2	Mean, OC %	1.99	2.22	1.08	0.68	1.72	3.8
3	Min, OC %	0.31	0.60	0.078	0.116	0.293	0.515
4	Max, OC %	4.04	4.14	3.22	1.698	3.694	7.294
5	Standard deviation	0.80	0.7	0.62	0.368	0.638	1.56

### 3. Carbon stock in soils as affected by soils types and soil characteristics



**Table 7. Linear regression considering organic content in soils as dependent variable**

<b>Predictor variable</b>	<b>Coefficient</b>	<b>Standard error</b>	<b>P (accepted)</b>
Constant	1.18	0.40	0.004
CEC	0.01	0.01	0.381
K	-0.12	0.09	0.216
N	10.4	0.76	0.000
P	0.55	1.31	0.675
pH <sub>H2O</sub>	-0.004	0.167	0.997
pH <sub>KCl</sub>	-0.207	-1.28	0.201

#### 4. Carbon stock in soils as affected by cropping systems

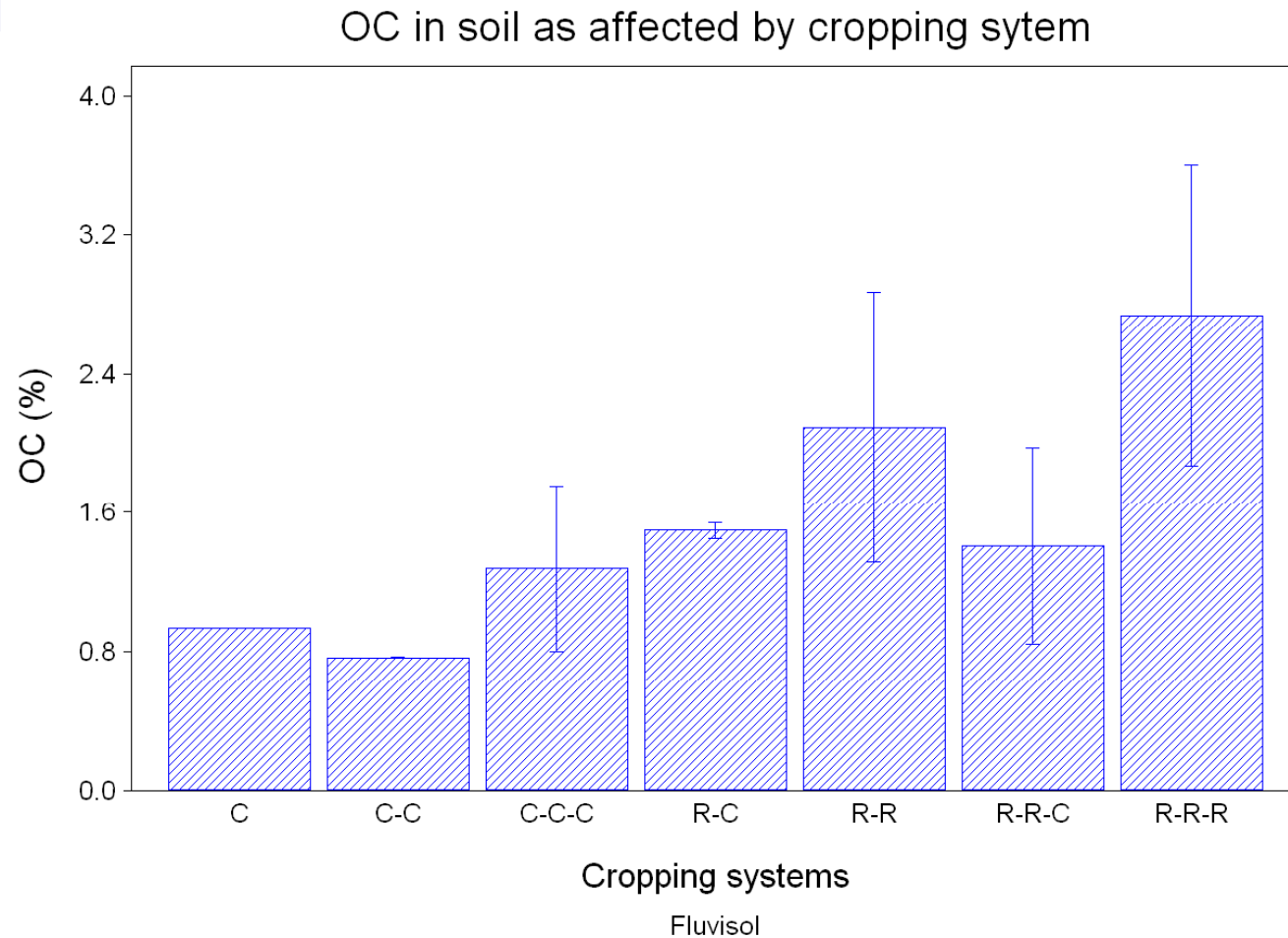


**Table 8. Organic carbon in soils selon different cropping systems in fluvisol**

<b>Plant growth</b>	<b>Cropping systems</b>	<b>OC%</b>	<b>STD</b>
Mulbery (cash crop)	C	0.93	-
Non rice annual crops such as vegetable, maize, leguminous (Cash crops)	C-C	0.76	0.01
Three cash crops	C-C-C	1.28	0.47
1 Rice-1 cash crops	R-C	1.49	0.05
Two rice crops	R-R	2.09	0.77
Two rices + 1 cash crops	R-R-C	1.40	0.56
Three rice crops	R-R-R	2.13	0.77

## 4. Carbon stock in soils as affected by cropping systems

**Fig 2. Organic carbon in Fluvisol as affected by cropping systems**



## 5. Improvement soil productivity an integrate solution to carbon stock in sandy soils



### 5.1 Vietnam Sandy Soil fertility status

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Beside two alluvial soils of Vietnam (Red river fluvial soil and Mekong river fluvial soil), soil fertility in Vietnam is not very high. The widespread soils in Vietnam have low pH, low C, low N and very low CEC. It is especially true for soil with light texture as sandy soil or Acrisol. The dominant feature of the central coastal sandy soil (Haplic Arenosol) was shown in the next slide.

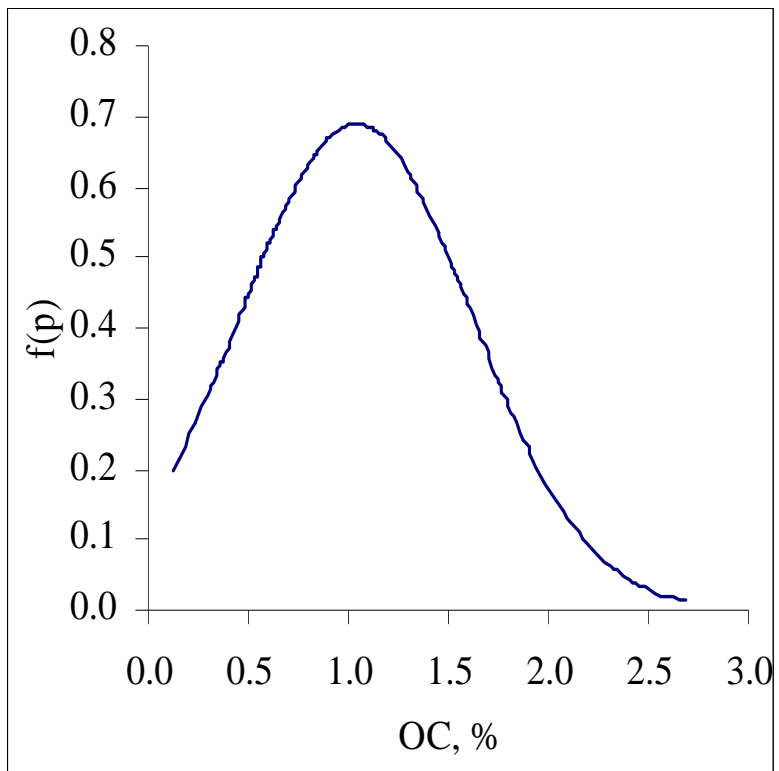
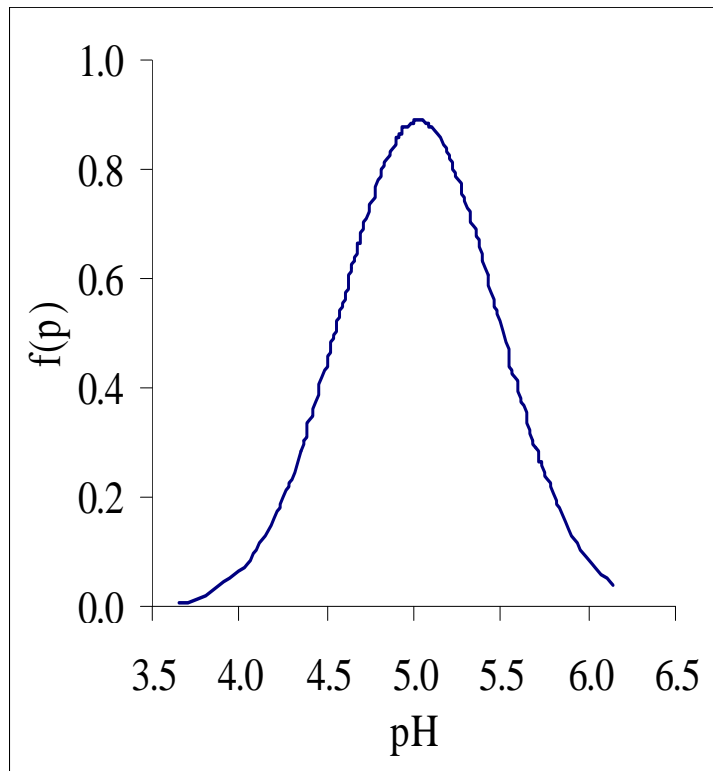
## 5.2 Soil acidity and organic content in soil as key limiting factors

Table 9: Selected physico-chemistry of representative Vietnam sandy soil

No	Item	Unit	Mean	Std	n
1	pH <sub>H2O</sub>		4.61	0.48	75
2	pH <sub>KCl</sub>		4.10	0.47	75
3	Bulk density	gram/cm <sup>3</sup>	1.51		24
4	Density	gram/cm <sup>3</sup>	2.65		24
5	Porosity	%	43.0		24
6	Texture				
	2-0.2mm	%	66.60	18.15	75
	0.2-0.02mm	%	19.85	10.26	75
	0.02-0.002mm	%	7.08	6.35	75
	<2mm	%	5.59	5.36	75
7	OC	%	1.08	0.67	300
8	CEC	cmolc/kg	4.52	3.79	75
9	Ca <sup>++</sup>	cmolc/kg	0.69	0.74	75
10	Mg <sup>++</sup>	cmolc/kg	0.25	0.36	75
11	K <sup>+</sup>	cmolc/kg	0.03	0.16	300
12	Na <sup>+</sup>	cmolc/kg	0.28	0.79	75
13	Al <sup>3+</sup>	cmolc/kg	0.59	0.67	75
14	H <sup>+</sup>	cmolc/kg	0.06	0.09	75
15	N	%	0.06	0.03	300
16	P	%	0.02	0.01	300
17	K	%	0.18	0.24	75
18	P (bray II)	mgP/kg	28.8	21.9	75

## 5.2 Soil acidity and organic content in soil as key limiting factors

*Fig. 3 Density function of OC (right) and pH (left) of sandy soil as indicated by Normal distribution*





## 5.3 Management of sandy soil in Vietnam is usually sequenced in different steps



### 5.3.1 Land use planning

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## 5.3 Management of sandy soil in Vietnam is usually sequenced in different steps

### 5.3.2 Field engineering and management

*Table 10. Sandy soil use planning projection in 2010 for three provinces (Quang Binh (QB), Quang Tri (QT), Thua Thien Hue(TTH)).*

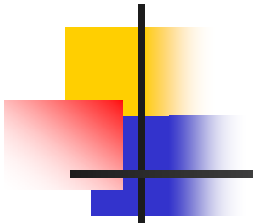
Land use type	Total (ha)	%	QB (ha)	QT (ha)	TTH (ha)
Rice-Rice	11,150	9.4	3,000	1,750	6,400
2 Rice + 1cash crop	1,000	0.8	200	500	300
1 Rice + 2cash crops	1,900	1.6	1000	700	200
Rice + cash crop	1,250	1.1	700	400	150
Cash crop only	6,000	5.1	1000	2500	2500
Perennial/ fruit tree	250	0.2	150	50	50
Fishery_ Shrimps	550	0.5	100	100	350
Forestry					
<i>Eucalyptus, Casunarinas</i>	72,104	60.8	25,512	21,782	24,810
<b>Total</b>	118,504	100	37,162	34,582	46,760

*Source: Nguyen Thuc Thi, 2003*

## 5.3 Management of sandy soil in Vietnam is usually sequenced in different steps

### 5.3.3 Choice of suitable crops and cropping systems

*Table 11: Cropping system in Vietnam sandy soil by 2004*



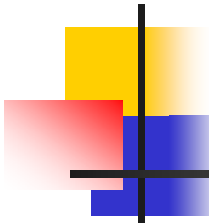
Crops	Percentage
Rice- Rice	7.8
1 Rice	0.9
1 Rice- 1 cash crop	8.2
Cash crop only	13.5
Fruit and perennial tree	5.0
Fishery	0.14
Forestry	27.1
Others	10.5
Total used	72.5
Non used	27.5

*Source : Vu Nang Zung et al. 2005.*

## 5.3 Management of sandy soil in Vietnam is usually sequenced in different steps

### 5.3.3 Choice of suitable crops and cropping systems

*Table 12: Detail of crop yield and cash value equivalent*



Crop/items	Yield range (ton/ha/year)	Cash value in Vietnam 10 <sup>6</sup> \$/ ha/year
Spring rice <sup>(1)</sup>	4-6	8 - 12
Summer Rice <sup>(1)</sup>	3-5	6 - 10
Peanut <sup>(1)</sup>	1.2-1.8	0.96 – 1.4
Soybean <sup>(2)</sup>	4.0 – 6.5	3.5 – 5.7
Sesame <sup>(1)</sup>	0.8-2.3	16 - 46
Maize <sup>(1)</sup>	2.5-3.5	3.8–5.3
Sweet potato <sup>(2)</sup>	2.48 – 18.2	2.5 – 18.2
Cassava <sup>(2)</sup>	4.7 – 22.2	5.6 – 26.6
Dragon fruit <sup>(2)</sup>	15 -30	90 – 180
Cashew <sup>(2)</sup>	1.0-1.5	17 – 25.5
Vegetable <sup>(1)</sup>	30-50	30 - 50
Shrimps <sup>(2)</sup>	0.9 - 30	9 - 300
Salt field <sup>(2)</sup>	45000 - 90000	15.8 - 36

Source: (1). Pham Quang Ha, 2005 (un publised data)

(2). Statistical data in Website: <http://www.mard.com.vn>

## 6. Multipurpose approaches for increasing soil productivity and carbon stock



There are four main integrating approaches to improve soil productivity and carbon stock in soils:


- Plant crops adapted to indigenous soil nutrient supply
- Improve the soil fertility to meet the crop's requirement
- Fertilization with organic and inorganic materials
- Using crops residues and minimized tillage

***Table 13. Crop yield (tone /ha) as affected by Farm yard manure (FYM)***

<b>Treatment</b>	<b>Sesame</b>	<b>Peanut</b>	<b>Rice</b>	<b>Maize</b>
N P K	0.6 (0.2)	1.2 (0.5)	2.5 (0.3)	1.8 (0.2)
N PK + FYM	1.2 (0.4)	1.9 (0.3)	4.3 (0.6)	3.4 (0.3)
Percentage (%)	200.0	158.3	172.0	188.8

*Source: NISF, unpublished data (1996-2000)*

## 6. Multipurpose approaches for increasing soil productivity and carbon stock



*Table 14. Carbon and nutritive values of selected materials considered as input for fields (expressed in dry matter)*

Types of materials	N. of samples	C %	N %	P%	K%
Buffalo manure	14	11.7	0.64	0.16	0.33
Cattle manure	8	17.8	0.95	0.24	0.62
Pig manure	33	19.2	1.23	0.38	0.54
Chicken manure	6	14.2	1.36	0.60	0.40
Duck manure	5	10.9	10.9	0.24	0.41
Plant residues	22	38.8	1.61	0.17	0.39
Ash	5	3.9	0.25	0.35	1.34

*Source: Hoang Thi Thai Hoa (2008)*



# Nutrient recycling for productivity and the environment

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- How to continue in the future?
- To increase soil productivity
- To protect the environment
- ➔ balance fertilization is probably one of solution.



# Rice based cropping systems

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- 1 or more rice / flooding periods
- Vegetable or other food crops/ dry periods
  - Consequence → different agricultural practices
  - Varieties/ rice and cash crops





# WHAT PRACTICES

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- Principle solutions/ integrated management (from variety/land management/crop and crop residues management/ pest management/ fertilizers management/ harvest management/ save input and less wastes
- Vietnam experiences: Farmers' needs first
- ==> Increase soil productivity; looking for key factor limiting;
- Water management
- Crop management ( game of weather ==> Temperature)
- C-sequestration link with productivity and farmers incomes
- Mitigation together with Adaptation



Thank you

