

# Assessment of the efficiency of organic amendments in coastal sandy soil area of Thua Thien Hue province, Central Vietnam

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## Abstract

The living standards of rural households in Central Vietnam are limited by low crop production on coastal sandy soils. In Thua Thien Hue province, these soils cover most of the agricultural land. The aim of this study is to assess the efficiency of organic amendments on crops yield, soil fertility improvement and economic indicators in coastal sandy soils. Field trials were carried out in 2005 and 2006 with different types and rates of organic amendment applied on rice and peanut crops. Increase of yield was noticed in all cases. The maximum economic income was obtained with the application of 10 tons farmyard per hectare on rice crop. The effect of the type of manure was tested on peanut crop; seagrass and peanut manures (8 tons per ha) proved to be more efficient than farmyard manure at economic viewpoint, although similar grain yields were obtained for the three kinds of amendments.

*Key words: organic amendments, sandy soil, soil fertility, crop yield, economic efficiency*

## I. Introduction

Sandy soils make up more than 200,000 ha in the coastal zone of the North Central region of Vietnam. These soils in Thua Thien Hue province belonging in the south of this region cover about 50,000 ha of the 84,000 ha of cultivated land (Nguyen Van Toan, 2004). Most of the population lives in the coastal area so that people's living standards and food security are largely dependent on very poor soils.

In order to meet the increasing requirement of human food with the limited land resource, people have used many methods to improve the crops yield of which fertilizer application is one of the important practices. Due to shortage of farmyard manure, farmers in Central Vietnam, especially in coastal sandy area, have utilized little organic amendment for crops. Generally, crops yield in the area is often low as compared with the yield potential of crop varieties. According to P.Y Ancion (2005) there are abundant of organic sources in the coastal sandy area such as the Tam Giang lagoon which covers about 22,000 ha and where a lot of aquatic plants (13 species) may help the agricultural production.

In sandy soils with low inherent fertility, optimizing organic matter management is probably the most important way to improve crop production, both by increasing the soil organic matter content in the long term and by providing nutrients to plants through the short-term mineralization of crop residues and/or farmyard manure. These experiments were conducted to determine the influence of organic amendments on crop yield, soil properties and economic efficiency.

## II. Materials and methods

Studied sites for implementing field trials were based on the frame of a general survey which was conducted in 2004. We have chosen 3 villages namely Duc Phu (Phong Hoa commune), Thuy Lap (Quang Loi commune), Vinh Luu (Phu Luong commune), Thua Thien Hue province. Field trials were conducted on rice and peanut which are two main crops in the coastal sandy soil.

Composite soil samples were collected (0-20 cm depth) at two different times (before and after experiment). They were air dried and sieved at 2 mm immediately after sampling. Chemical characterization of these soil samples were carried out according to classical laboratory procedures that are described in the extended soil analyses book of Page *et al.* (1996). The following characteristics were measured: pH of soil-water and soil-1M KCl suspensions (1:5 ratio), organic carbon (C, Walkley and Black method), total nitrogen (N, Kjeldahl method), total phosphorus ( $P_{tot}$ , extraction with aqua regia), available phosphorus ( $P_{av}$ , Bray II method), exchangeable Ca, Mg, K, Na and cation exchange capacity (CEC, extraction of exchangeable cations by 1M  $NH_4Ac$ , pH 7, desorption of  $NH_4^+$  by 1M KCl).

Samples of organic sources were also collected before applying them in these trials. The following characteristics were measured: total nitrogen (Kjeldahl method), total phosphorus and total potassium ( $HNO_3:HClO_4$  digestion), calcium and magnesium (dry ashing); approximate organic carbon was estimated by loss to ignition at 550°C; carbon was considered to represent 55% of weight loss, according to Richard (1992). All analyses were carried out in the Soil Science Department of Hue University of Agriculture and Forestry.

In brief, there were 5 treatments applied for rice trial in Quang Loi, Phong Hoa communes (2005) and Phu Luong commune (2006) in which there were 4 different rates of farmyard manure (FYM 0, 5, 10 and 15 tons  $ha^{-1}$ ) combined with 100 kg N, 60 kg  $P_2O_5$ , 60 kg  $K_2O/ha$  and 500 kg lime/ha in comparison with the control (without fertilizer). A Chinese variety of rice namely Khang Dan 18 frequently used in Central Vietnam was grown directly by sowing in these trials.

There were also five treatments applied for peanut trials in Quang Loi and Phong Hoa communes (2005) in which there were three kinds of organic fertilizers (farmyard manure, peanut manure and sea grass manure) combined with 40 kg N, 60 kg  $P_2O_5$ , 60 kg  $K_2O$  and 500 kg lime/ha in comparison with only 40 kg N, 60 kg  $P_2O_5$ , 60 kg  $K_2O$  and 500 kg lime/ha application and control (no fertilizer) used for peanut crop. A local variety of peanut namely Du Tay Nguyen frequently used in Central Vietnam was grown directly by sowing in these trials.

At maturity stage (18-20% grain moisture), a sample of 1  $m^2$  was harvested from each experimental unit, and grain yield was measured. Economic indicators were also calculated to examine the efficiency of fertilizer utilization.

The effectiveness of fertilizer application is calculated including total revenue (total production in kg multiplied by price per kg), total variable cost (sum of labor cost, land preparation, fertilizer cost, seed cost, pesticide cost and irrigation cost), and gross margin (total revenue minus total variable cost). The currency used in calculating for total revenue, total variable cost and gross margin is Vietnamese currency (VND). One USD was approximately equal to 16,000 VND. Beside this, VCR (Value Cost Ratio) is ratio of increased total revenue due to fertilizer application and increased costs of fertilizer which is also calculated

## III. Results and discussion

### 3.1. Characteristics of soils used before experiment

Soils used in these experiments are typical of the sandy coastal area of Thua Thien Hue province, with acid, low organic content and low exchangeable cations and CEC (Table 1).

Table 1. Some soil characteristics before experiments

Crop	Commune	pH <sub>KCl</sub>	pH <sub>H2O</sub>	OC (%)	N (%)	P <sub>2</sub> O <sub>5</sub> (%)	Exchangeable cations (cmolc/kg)				CEC (cmolc/kg)
							Ca	Mg	K	Na	
Rice	Quang Loi	4.11	4.65	1.18	0.050	0.035	0.283	0.050	0.029	0.060	2.50
Rice	Phong Hoa	4.20	4.76	1.30	0.070	0.060	0.913	0.045	0.030	0.043	4.80
Rice	Phu Luong	4.40	4.79	1.30	0.070	0.050	0.932	0.215	0.043	0.107	3.06
Peanut	Quang Loi	4.40	4.98	0.85	0.050	0.040	0.393	0.033	0.035	0.040	2.30
Peanut	Phong Hoa	4.70	5.23	0.60	0.045	0.030	0.593	0.027	0.025	0.048	1.78

### 3.2. Assessment of the efficiency of organic amendments on crops yield

#### 3.2.1. Rice yield

As presented in Table 2, rice yield when neither fertilizers nor FYM were applied, ranged from 3.87 to 5.11 t ha<sup>-1</sup> across sites and years (Table 2). Such yields are typical on these coarse textured, infertile soils (Linguist et al., 1998). In all sites, yields show significant response to the application of inorganic fertilizers as compared with the control (no fertilizer application). In Quang Loi and Phong Hoa communes, yields increased by 1.86 and 1.74 t ha<sup>-1</sup>, respectively, while only 0.98 t ha<sup>-1</sup> at Phu Luong commune.

Table 2. Mean yield of rice in different communes from 2005 to 2006

No.	Treatment	Mean yield (t/ha)		
		Quang Loi	Phong Hoa	Phu Luong
1	0 N - 0 P <sub>2</sub> O <sub>5</sub> - 0 K <sub>2</sub> O	3.87 a	4.11 a	5.11 a
2	100 N - 60 P <sub>2</sub> O <sub>5</sub> - 60 K <sub>2</sub> O	5.72 b	5.85 b	6.09 b
3	5 tons FYM	5.99 c	6.05 b	6.31 bc
4	10 tons FYM	6.39 d	6.45 c	6.80 bc
5	15 tons FYM	6.43 d	6.50 c	7.01 c

Means followed by the same letter(s) within the columns do not differ significantly at  $P < 0.05$

When farmyard manure (FYM) was applied, yield increased following the rate of FYM from 0 to 15 tons ha<sup>-1</sup> at three sites. There are positive relationship between rice yield and FYM levels (Figure 1).

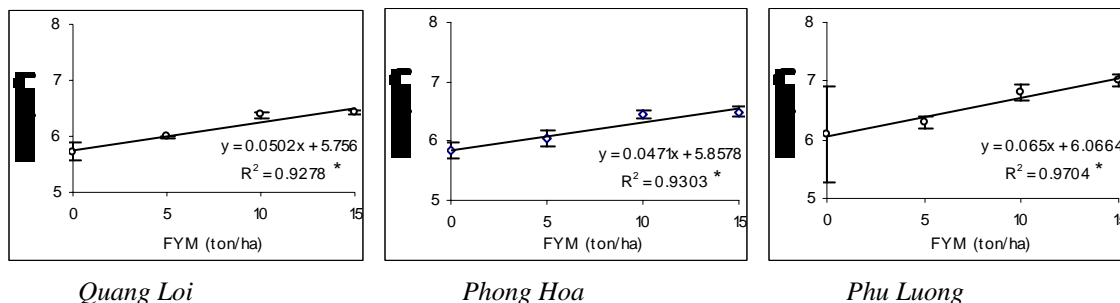


Figure 1. Relationship between FYM level and rice yield in Quang Loi, Phong Hoa and Phu Luong communes from 2005 to 2006 (Vertical line presents standard deviation).

#### 3.2.2. Peanut yield

As shown in Table 3, the mean yield of peanut at the control is very low ranging from 1.26 to 1.43 t ha<sup>-1</sup> across sites due to low soil fertility. At treatment with only N, P, K application, mean yield of peanut increases significant as compared with the control and fluctuates from 1.95

to 2.07 t ha<sup>-1</sup>. Application of organic and inorganic fertilizers has higher response on mean yield of peanut as compared with the control. There are only small differences of peanut yield among the three kinds of organic admenments in both sites.

Table 3. Mean yield of peanut in different communes in 2005

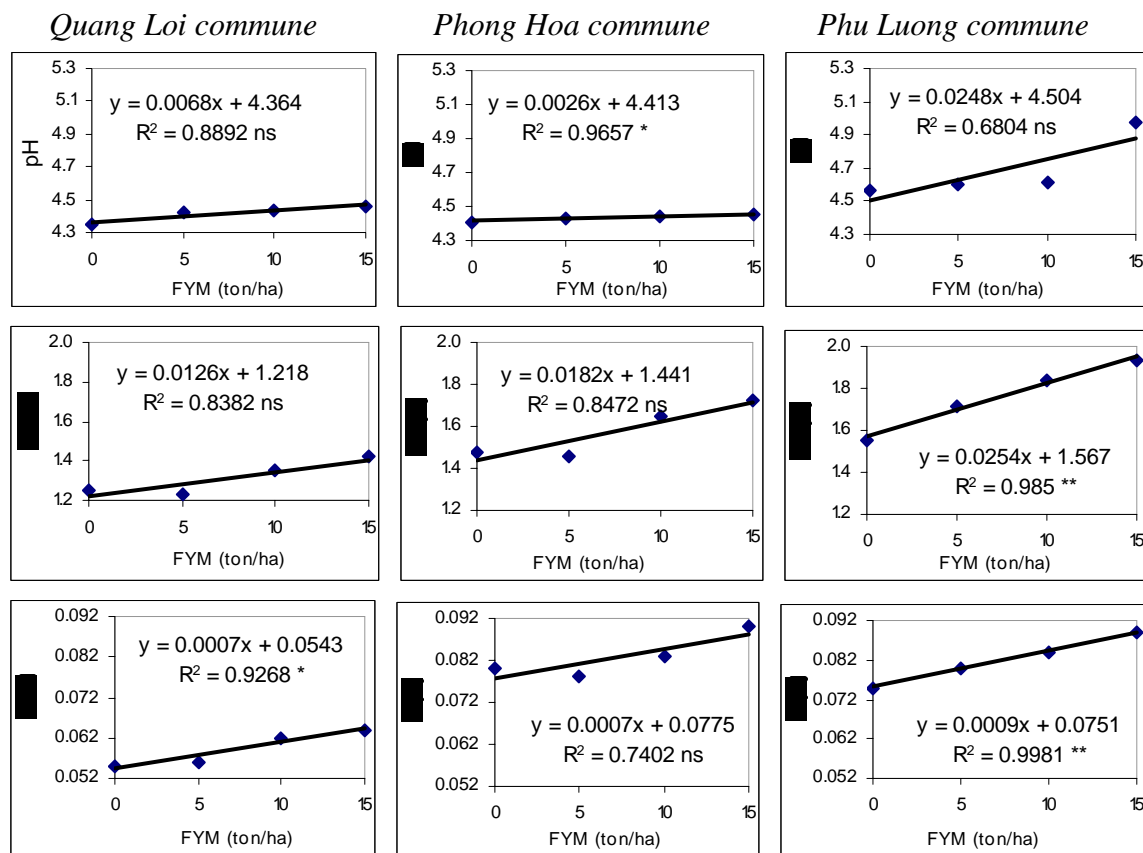
No.	Treatment	Mean yield (t/ha)	
		Phong Hoa	Quang Loi
1	0 N - 0 P <sub>2</sub> O <sub>5</sub> - 0 K <sub>2</sub> O (T1)	1.26 a	1.43 a
2	100 N - 60 P <sub>2</sub> O <sub>5</sub> - 60 K <sub>2</sub> O (T2)	1.95 b	2.07 b
3	8 tons FYM (T3)	2.31 c	2.56 c
4	8 tons peanut manure (T4)	2.52 d	2.73 cd
5	8 tons sea grass manure (T5)	2.42 cd	2.68 d

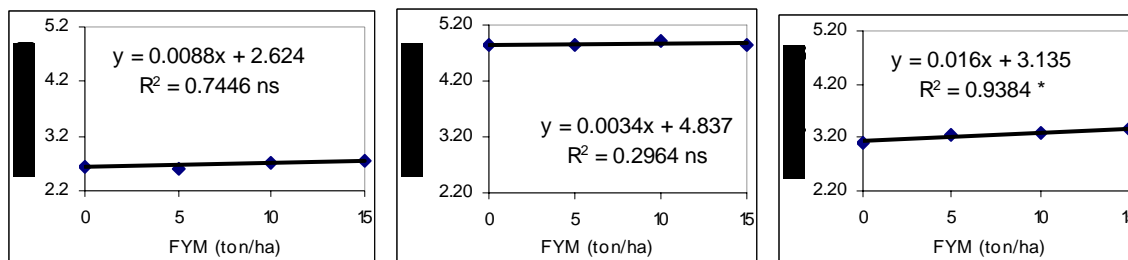
Means followed by the same letter(s) within the columns do not differ significantly at  $P < 0.05$

### 3.3. Assessment of the effect of organic amendments on soil characteristics

#### 3.3.1. Rice soil

The chemical properties were determined from soil samples collected after rice harvest. Relationships of major chemical properties with different levels of FYM are presented in Figure 2. In general, increasing FYM rates tend to increase pH, OC, N and CEC, although part of these relationships does not prove statistically significant. As a consequence, residual fertility improvement can be expected for the next crop.





\*\* : significant at 1% level by correlation test of Pearson

\* : significant at 5% level by correlation test of Pearson

ns : Not significant

Figure 2. Relationships between different levels of FYM and soil properties

### 3.3.2. Peanut soils

Soil properties after peanut harvest are presented in Table 4. Only few significant changes in soil properties are noticed. In Phong Hoa, pH increases following organic amendments, but not in Quang Loi. Organic C content also increases in Phong Hoa, but much less in Quang Loi, whereas the effect on CEC is more marked in Quang Loi than in Phong Hoa.

Table 4. Characteristics of soils after experiment

Treatments	Properties	pH <sub>KCl</sub>	OC %	N %	P <sub>2</sub> O <sub>5</sub> <sub>tot</sub> %	K <sub>2</sub> O <sub>tot</sub> %	CEC cmoc kg <sup>-1</sup>
<i>1. Quang Loi commune (kg/ha)</i>							
0N-0P <sub>2</sub> O <sub>5</sub> -0K <sub>2</sub> O		4.50 a	0.87 a	0.055 a	0.040 a	0.20 a	2.30 a
40N-60P <sub>2</sub> O <sub>5</sub> -60K <sub>2</sub> O		4.66 a	0.98 ab	0.060 ab	0.053 b	0.23 a	2.61 ab
8 tons FYM		4.66 a	0.99 ab	0.058 ab	0.051 b	0.25 a	2.43 ab
8 tons peanut manure		4.67 a	1.02 ab	0.060 ab	0.057 b	0.27 a	2.67 bc
8 tons sea grass manure		4.72 a	1.13 b	0.065 b	0.052 b	0.25 a	2.93 c
<i>2. Phong Hoa commune (kg/ha)</i>							
0N-0P <sub>2</sub> O <sub>5</sub> -0K <sub>2</sub> O		4.60 a	0.66 a	0.045 a	0.036 a	0.21 a	1.80 a
40N-60P <sub>2</sub> O <sub>5</sub> -60K <sub>2</sub> O		4.72 ab	0.82 ab	0.050 a	0.040 a	0.23 a	1.88 a
8 tons FYM		4.77 abc	1.01 bc	0.052 a	0.045 a	0.26 a	1.90 a
8 tons peanut manure		5.01 c	1.32 d	0.055 a	0.048 a	0.25 a	2.01 a
8 tons sea grass manure		4.89 bc	1.22 cd	0.059 a	0.047 a	0.24 a	2.12 a

Means within column followed by different letters are significantly different at  $P < 0.05$

### 3. 4. Assessment of the efficiency of organic amendments on economic

In fact, all treatments with fertilizer and FYM application gave higher net income than without fertilizer. The highest net incomes of rice growing were observed at the rate of 10 tons of FYM/ha with 3.125.000 VND and 3.625.000 VND in Quang Loi and Phong Hoa communes, and 15 tons of FYM in Phu Luong commune (4.835.000 VND). For peanut growing, the highest incomes were found both in Phong Hoa and Quang Loi communes as application of 8 tons peanut manure. Results from Table 5 also indicate that treatment which applied 10 tons of FYM or rice had greater VCR than others. While VCRs were found highest in Quang Loi and Phong Hoa communes as application of 8 tons peanut manure and 8 tons sea grass manure, respectively.

Table 5. Economic efficiency of organic amendments application

Indicator	Commune	Quang loi commune		Phong Hoa commune		Phu Luong commune	
		Gross margin (1000 VND)	VCR	Gross margin (1000 VND)	VCR	Gross margin (1000 VND)	VCR
<i>1. Rice growing</i>							
0 N - 0 P <sub>2</sub> O <sub>5</sub> - 0 K <sub>2</sub> O		594.1	-	1,146.1	-	3,822.5	-
100 N - 60 P <sub>2</sub> O <sub>5</sub> - 60 K <sub>2</sub> O		2,597.9	-	2,890.0	-	4,037.5	-
5 tons FYM		2,716.6	1.24	2,835.5	0.90	4,065.0	1.06
10 tons FYM		3,125.1	1.53	3,265.4	1.38	4,802.5	1.77
15 tons FYM		2,719.4	1.08	2,885.0	1.00	4,835.0	1.53
<i>2. Peanut growing</i>							
0N-0P <sub>2</sub> O <sub>5</sub> -0K <sub>2</sub> O		850.0	-	- 170.0	-		
40N-60P <sub>2</sub> O <sub>5</sub> -60K <sub>2</sub> O		3,099.0	-	2,355.0	-		
8 tons FYM		5,245.0	2.72	3,733.0	3.68		
8 tons peanut manure		6,453.0	5.71	5,181.0	6.59		
8 tons sea grass manure		6,283.0	5.65	4,681.0	7.37		

#### IV. Conclusion

This study provides results on the efficiency of organic amendments on crops yield and soil fertility in coastal sandy soil of Thua Thien Hue province. These experiments were conducted including different levels of FYM applied for rice and different kind of organic materials applied for peanut. Organic matter management is likely to be the most important step towards improving food crop productivity. Despite drastic differences in the efficiency of the organic amendments examined, we observe that FYM levels and kind of organic materials had impact positive both in crops yield and soil fertility improvement and also economic efficiency. A very regular addition of organic amendment in the soils may generally improve soil productivity and sustainability of the general cropping systems. Therefore, it seems highly beneficial to conduct more detailed research on the relationship between quality of available organic materials and all components of local farming systems.

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