SUSANE - Sustainable, sanitary and efficient management of animal manure for plant nutrition

During the spring 2008, PhD students Tran Minh Tien and Vu Thi Khanh Van have carried out a study with focus on assessing nutrient contents in and losses of Nitrogen from pig manure. The study quantified loss of nitrogen from manure in pig houses and from stored liquid and composting solid manure. The study was carried under typical Vietnamese condition. This newsletter present preliminary result of their study.

Introduction

Traditional methods for manure management such as storing (covered or not), composting, use in fish farming and for biogas production are commonly observed in Vietnamese small and medium scale farms. Lack of understanding about quality of manure and how to manage manure efficiently result in environmental problems. Furthermore, it is a common perception by farmers that animal manure is poor in plant nutrients, and that poor nutrient content and loss may be due to improper management is not understood by most of farmers. Storing manure without cover increases oxygen access to solid manure, which enhances coupled nitrification, denitrification and ammonia volatilization processes. These processes cause nutrient loss and produce gases that are harmful for human and animal health as well. The objective of this study was therefore to provide experimental data about N changes and losses during different storage and composting condition commonly used amongst farmers.

Picture 1. To the lift is a picture showing pig liquid manure stored in containers with cover (Red) and without cover (Blue) and to the right solid pig manure composting.

Experimental design

Twelve Landrace-Yorkshire pigs with average bodyweight at 77 kg were raised individually in conventional pens, and fed three different diets (high, medium and low protein). Manure collection periods for storing slurry and composting solid were from 11 to 23 January 2008 and 24 January to 03 February 2008, respectively. Results are here presented as average of all diets. The resulting slurry was a combination of urine, a small part of faeces, and 20 liters water used for cleaning in each pen. The slurry was stored in plastic containers with and without PVC cover for a period of three months. Three containers were designed for each of the three diets and for each of two storing methods. The containers were identical in shape with a bottom diameter of 0.41m, a top diameter of 0.51 m, and a depth of 0.63m. The containers were filled to 45 cm from the bottom (Picture 1).

The solid faeces fraction was collected separately and subsequently composted in 0.033 m^3 boxes, with treatment of three additives which are commonly used in Vietnam, adding straw (straw), straw + 2% lime (lime), and straw + 5% single super-phosphate (SSP). Three replications for each of 3 diets and 3 storage methods were carried out. The boxes were made by 0.08 m thick plates of expanded polystyrene. The box had the following dimension; length of 0.28 m, width 0.28 m, and depth of 0.44 m (Picture 2). Composted samples were taken at initial, after peak of temperature and final of composting.

Results

Liquid manure Storage

There were no gaseous N losses from liquid manure stored in covered containers during the first 2 months following the onset of the storage period (Table 1). The total N slightly increased due to development of maggots during storage time. Thereafter, about 19% of the total N was lost after three months of storage. During the initial 2-month storage period the NH_4-N concentration in the covered container increased by about 50% compared to the initial level, indicating that significant amounts of organic N was mineralized during this period of storage. After 3 months of storage, NH_4-N was lower compared with after 2 months, although still higher than initial. The total N content in slurry stored in uncovered slurry declined gradually during the 3-month storage period. In total, about 60% of the initial N content was lost from uncovered containers during the 3-month storage period. The reduction in NH_4-N content from uncovered slurry reduces the fertilizer efficiency of nitrogen in slurry, because NH_4-N is readily available N for plant uptake.

The slurry was not covered with a surface crust, in which coupled nitrification-denitrification can take place. Therefore, it is assumed that little N was lost due to denitrification and most was lost due to NH_3 volatilization. Ammonia loss is much dependant on slurry pH, temperature and air exchange across the slurry surface. The pH increased up to 8.5 in both uncovered and covered stored slurry. Thus, the high loss of NH_3 from uncovered slurry was related to a high pH, open air exposure and high temperatures during the storage period, especially the high temperature in the last storing month.

Table 1. Changes in total N and NH_4-N contents during 3 months of storage, either covered or uncovered

	N (% of increase/ decrease compared to initial)		NH_4-N (% of increase/increase compared to initial)		pH levels	
Methods	Cover	No Cover	Cover	No Cover	Cover	No Cover
Month 0	0	0	0	0	6.7	6.8
Month 1	9	-8	2	-18	7.6	7.5
Month 2	14	-12	50	-26	8.2	8.0
Month 3	-19	-61	30	-45	8.6	8.6

Solid manure composting

In spite of careful insulation, the temperature in all composting treatments was not high compared to other research studies, where temperature have increased up to 60-70^oC. The low temperatures in this study can be ascribed to small amount of compost materials in each box (around 10 kg) and low ambient temperature (10^oC in initial phase). The temperature increased and reached to the peak (from 32-38^oC) after 7 days, highest temperature was in the compost added lime and lowest was in compost added 5% single super-phosphate (SSP) treatment (Fig 1). Although in a later composting period, the temperature in the SSP compost was higher than the others.

pH values were different between treatments (6.0, 7.4 and 5.5 in straw, lime and SSP treatments, respectively) and all had an increasing trend during composting time, pH of straw, lime and SSP treatments after composting were 8.4, 8.8 and 7.2 respectively.

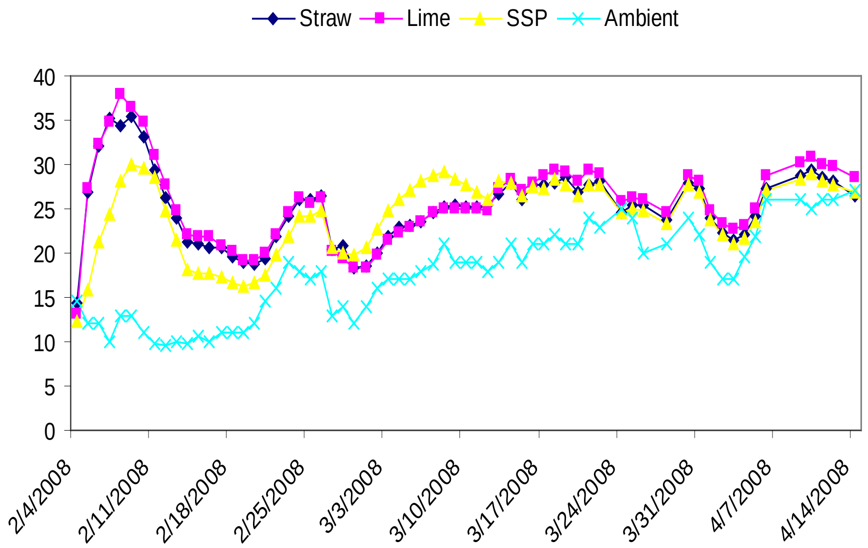
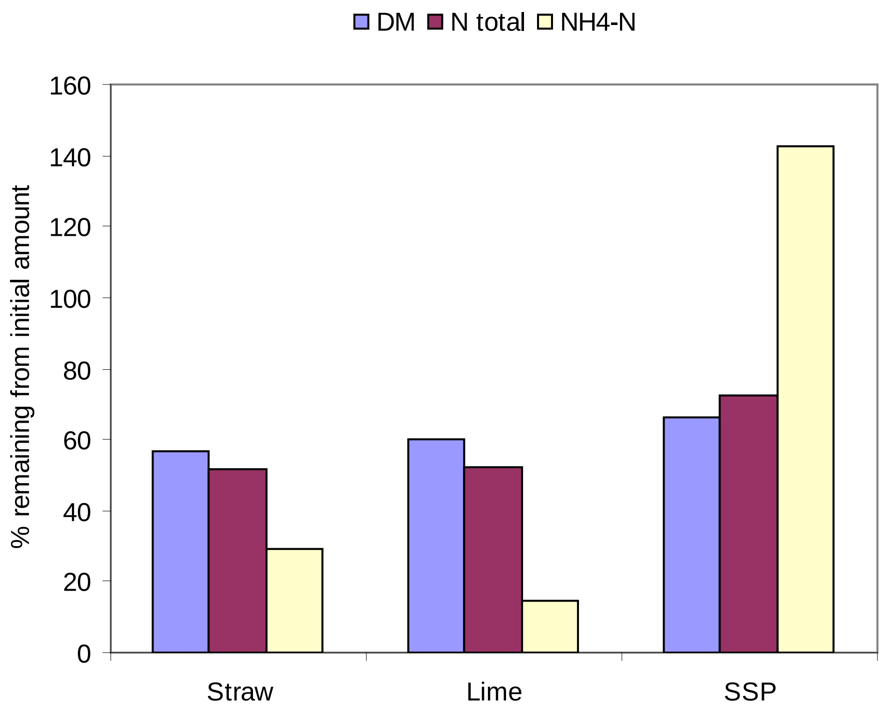


Fig 1. Temperature during composting

Temperature as well as pH value affect volatilization loss of nitrogen during composting. Ammonia volatilization was assessed as reduction in total N of the compost during the study. For the entire composting period ammonia volatilization was around 50% of initial total N from straw and lime treated compost and 30% for SSP treated compost (Fig 2). NH_4-N concentration developed very differently during composting, in straw and lime treatments NH_4-N loss by volatilization and immobilization reached 70 and 85% of the initial amount, while NH_4-N in SSP treatment remarkably increased by 40% relative to initial amount of NH_4-N (Table 2 and Fig 2) due to mineralization.

Table 2. Nutrient concentration in composts before and after composting [SE in bracket (n=9)]

Sampling occasion	Treatment	DM (%)	Ash (%)	pH	N total (% in DW)	NH_4-N (g/kg DW)
Before composting	Straw	30.9 (1.1)	17.9 (3.2)	6.0 (0.5)	2.58 (0.35)	4.04 (0.63)
	Lime	31.6 (1.0)	21.4 (1.7)	7.4 (0.4)	2.41 (0.33)	4.06 (1.60)
	SSP	32.9 (1.2)	24.1 (2.0)	5.5 (0.1)	2.38 (0.35)	4.13 (0.85)
After composting	Straw	30.6 (3.0)	28.8 (0.8)	8.4 (0.3)	2.35 (0.51)	2.07 (0.97)
	Lime	32.6 (3.0)	34.7 (1.7)	8.8 (0.2)	2.09 (0.28)	0.98 (0.24)
	SSP	33.0 (2.6)	36.2 (1.4)	7.2 (0.2)	2.61 (0.33)	8.93 (1.27)



Figur 2. Amount of dry matter (DM), total N and NH_4-N after composting in pct. of the amount at start of composting

Implications

The results clearly indicate that some of the manure management practises commonly used by farmers is likely to result in significant nitrogen losses and hence in poor manure quality with very low content of plant available nutrients. This is not a sustainable management of manure and the following advice for proper storage and composting can be given:

- Liquid manure storage tanks should always be carefully covered to avoid losses
- Composting will always result in some nutrient losses, but these can be minimised by composting with superphosphate, which lowers pH in the initial phase, and produces a high content of plant available NH_4-N
- Composting with lime, commonly used to prevent odour and reduce pathogen spread, should be avoided, as it promotes nitrogen losses greatly.
- In a earlier study (Son, newsletter 9) it was shown that the composting process in itself, whether only mixed with straw, or mixed with lime or superphosphate, is highly efficient in reducing pathogen levels in manure. Therefore addition of lime is not necessary, and as shown here, is detrimental to manure quality

Author: PhD students Tran Minh Tien and Vu Thi Khanh Van
Edited by: Sven G. Sommer