

Livestock production, manure management and plant nutrient recycling on animal farms in Vietnam

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Summary

The Vietnamese and Asian livestock production is increasing these years. In consequence large amounts of manure are produced, which may be a hazard to the environment because the traditional technology and the management practise of manure is not adapted to specialised livestock production. Further, there is little knowledge about the plant nutrient value of animal manure, and about technologies for environmentally-friendly manure management. This lack of knowledge enhances the risk of polluting the environment by inappropriate use of livestock manure and is also a potential risk for transferring pathogens between livestock and from livestock to humans (zoonoses). The objective of this article is to describe manure management at livestock farms in Vietnam. The focus is on presenting the most typical farming concepts, manure management on these farms, environmental and hygienic risks related to the present manure management. Further we will in brief give the perspectives for alternative environmental safe management of the manure. The underlying idea for the proposed manure management is to enhance a safe and sustainable recycling of the manure and its nutrients for plant and fish production. The perspectives presented may contribute to discussions, research and development of livestock production in Vietnam and in other Asian countries.

Keywords: Animal manure, environment, sanitation, management, pathogens.

Introduction

Livestock manure represents a valuable resource, which if used appropriately with minimal loss, can replace significant amounts of mineral fertilizer in areas with intensive livestock production (Le Ha Chau ,1998).

On the other hand, large volumes of animal manure are not only a source of valuable plant nutrients but also a source of air pollution and a threat to aquifers and surface water (Burton and Turner 2003). In Asia, manure may be discharged into waterways and liquid manure is leaching to groundwater that may be used by water abstraction plants. This poses a great risk to human and animal health, as livestock manure contains numerous pathogens (bacteria, viruses, parasites). It is also likely that pathogens, e.g. foot and mouth disease virus, may be transported with animal effluent into waterways. Thus, an infected farm may cause infection of farms downstream.

Livestock production units emit gases that contribute to global warming, eutrophication and malodours. European emission inventories show that livestock production constitutes 70-80% of the total ammonia emissions (ECETOC, 1994). The atmospheric concentration of methane

(CH₄) a greenhouse gas, has increased with 45% since 1850 (Lelieveld *et al.*, 1998) and livestock manure is estimated to contribute 5% to the total emission of CH₄ in the 1990s (Lelieveld *et al.*, 1998; Steinfeldt *et al.* 2006.). Nitrous oxide (N₂O) which is a very potent GHG, emission has increased from 11 Tg year⁻¹ in 1850 to 18 Tg year⁻¹ in mid 1990s, mainly due to increase in agricultural sources (Khalil and Rasmussen, 1992) and manure have contributed significantly to this increase.

The environmental hazards described above can be mitigated by the environmental friendly recycling of animal manure. Recycling will contribute with plant nutrients to crop fertilization, thereby reducing the need for nitrogen, phosphorus, potassium and micro nutrients applied to the fields in mineral fertilizers.

Livestock production in Vietnam like in most Asian countries has increased significantly by the end of the 20th century and this trend is expected to continue as it is the policy to increase milk and meat production (Nguyen Xuan Trach 1998, Gerber *et al.* 2005). The production of livestock is very important to the Vietnamese economy as agriculture provides the income for approximately 70 percent of the Vietnamese population (Ogle and Bui 1997). Most livestock is produced by smallholders (85%, Tran *et al.* 2003a), but in future large specialised livestock production units may supply the rapidly increasing demand for livestock products.

The increasing livestock production on small farms and specialisation on large production units will increase the risk of pollution, because there is no need for all the plant nutrients in the manure for the local plant and fish production. In this article we present our experience about manure management on Vietnamese farms originating from studies carried out in the SUSANE research project (see <http://www.susane.info/en>). The experiences include surveys of animal production and manure management in Northern Vietnam (Vu *et al.* 2007). The focus is on housing systems, manure management, fertilizer value of manure and pollution risks related to the management of manure. In perspectives we present what we think could be the focus points for improving manure management.

Manure management

The most important tool for improving management of manure is reliable information about practise for managing manure on farms.

In Vietnam, manure on all sizes of farm holdings is mainly separated manually in solid and liquid fractions inside the animal house. Urine from the housing diluted with washing water, i.e. liquid manure, is transported through open channels to outside the animal houses. On smallholder farms, pigs, dairy cows and buffalo may be raised under confinement on floors bedded with rice straw, thereby producing manure with a high carbon content, which may contribute to improve soils poor in organic matter. Poultry manure is collected in a solid dry form.

Solid manure is composted but for cattle manure the composting process will only take place if the manure is mixed with e.g. straw to increase the porosity, thereby facilitating air exchange between manure and the atmosphere. Solid manure on most livestock farms is composted in quantities so small that only a limited temperature increase is achieved. On a few farms the manure is covered with plastic or composted in-doors. The advantages of composting are a reduced risk of spreading pathogens and weed seeds, a reduction of volume, stabilization of the manure and the reduction of hatching of insects. It has been observed that hatching insects can be a problem even after the application of manure. Solid manure is in some regions a commodity sold to farmers producing high value crops such as vegetables, coffee, or to fish producers.

Liquid manure is in North Vietnam discharged to fish ponds or rice fields. In the Red River Delta small-scale livestock farmers own 1000 to 3000 m² of land, typically used for fish and rice production. In the South, small livestock farmers own more land (average 1 ha) and liquid manure is channelled or hosed onto the crops on fields. The liquid is also spread to fields manually, a practice that is demanding much manpower and is unpleasant. Further neighbours

complain when the manure is transported through villages to the fields (Porphyre et al. 2006). Some medium and large-scale farmers are discharging the liquid manure into canals or rivers after anaerobic treatment in lagoons, coupled in series.

About 20% of a total of 25 millions m³ liquid manure produced in Vietnam is used for energy production in biogas plants having a reactor volume of 4-6 m³ (Bui Xuan An et al. 1997). The smallest reactors are constructed of brick walls with covers of concrete. Larger digesters are made of PVC. Liquid manure is transferred through a small sedimentation tank (approx. 0.1 m³) to the reactor. The solids are removed manually from the sedimentation tank. On a few farms gas is collected in flexible PVC gas containers but gas production is low and gas is only used for food production. It is the impression that sedimentation may reduce the efficiency of the reactors, and it has been observed that not all reactors are producing gas probably due to sedimentation and unstable gas production.

Nutrient flows in manure handling systems

For the purpose of assessing the amount of plant nutrients available in manure, information is needed about the excretion of N and P by animals, and of fractionation of plant nutrients in solid and liquid manure. To date, there are no precise data of N and P excretion from Vietnamese animal production. Neither there is information about the composition of N and P in liquid and solid manure fractions as affected by treatment. The N and P concentration may well be affected by water used to clean animal houses and to cool the animals, thus it is estimated that between 30 and 50 L water is used per pig and cattle (Vu et al. 2008; Sommer et al. 2005). There is no information about leaching losses of N and P from solid manure and from liquid manure stored in lagoons and surface runoffs.

Solid as well as liquid manure is frequently used for crop production. Presently, composted manures may be applied for either fruit orchards or vegetables, whereas for wetland rice. To some extent the manure may be applied directly onto the field without composting. Normally mixing with human waste is not recommended, but in some villages this practise may be carried out, as toilet or latrine waste is diverted into manure biogas digesters or waste ponds.

Farms are using the liquid manure as fertilizers for crops although it is the impression that in North Vietnam most liquid manure is discharged to fish ponds, where it contributes as feed for the fish and as fertiliser for the plants that is eaten by the herbivorous fish.

It is our impression that there is little recognition of the risk for transmission of pathogens with animal manure and little is done to reduce the risk of diseases, e.g. to farmers, that is caused by inappropriate management of manure.

Perspectives - options for manure handling

The changing socioeconomic situation in Vietnam are drawing a larger part of the working force to the cities and therefore less manpower is available for farming operations, including manure handling and crop management. In consequence, the present lack of technologies for transport and application of animal manure is a barrier for an efficient use of plant nutrients in animal wastes and therefore become an increasing risk for the environment. These structural changes should be followed up by regulations. The regulations should be based on research, and policies focusing on the development of manure handling systems, that support a harmonious relationship between plant nutrients present in manure and crop/fish pond requirements. Further, there may be a need to prohibit direct discharge of untreated effluents into rivers and lakes.

It appears that manure processing with the objective of reducing the risk of pathogen transmission is only carried out if there is no imminent need of the manure as a fertilizer. Otherwise, manure is spread directly without storage or pre-treatment. Thus, the research and development of appropriate manure handling technologies should focus on man power requirements, plant nutrient availability and pathogen reduction. Outcome should be guidelines for efficient and sanitary safe use of animal manure, which include

recommendations for introducing technologies to reduce nitrogen losses and improve the utilisation of organic nitrogen from manure. Furthermore, farmers should be familiar with the capacity of manure as a fertilizer. If manure is used efficiently this would increase farmer incomes.

Conclusion

It is our impression that the knowledge of Vietnamese farmers about the fertilizer value of the liquid and solid manure should be strengthened and that there is an urgent need to optimize manure handling to fully exploit the P and N fertilizer value of the manure. Methods to treat the manure should be improved to increase the fertilizer value, but also to reduce the occurrence and transmission of pathogens.

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Animal number per livestock unit (LU) and slurry composition						
	Animals LU⁻¹	Slurry prod. Ton pLU⁻¹	DM	VS	P	N
			kg ton⁻¹			
Pigs - fatteners	30	15	65.00	52	1	5.60
Cattles	1	23	91.00	72.8	1	5.00

Biogas production – energy pr kg VS in slurry and per livestock unit (LU)			
	m³ CH₄ per kg VS	MJ per LU	Ltr oil per LU
Pigs - fatteners	0.29	7917	226
Cattles	0.21	12307	352

GHG emission from slurry and reduction due to biogas production			
	Untreated	Biogas treated	Reduction
	Kg CO₂ eqv per LU		
Pigs - fatteners	842	327	515
Cattles	1289	368	921

N and P content per Livestock Units		
	N	P
	KG per LU	
Pigs - fatteners	84	15
Cattles	115	23