Management Practices to Conserve the Fertilizer N Value of Dairy Manure in Vakinankaratra Region, Madagascar

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Introduction

Madagascar is an island with high agricultural potential, where a great part of the population depends on the primary sector (28% of the GDP; FAOstat, 2011).In Vakinankaratra region, inappropriate agricultural practices forced by an increasing pressure on land led toerosion and decreased soil fertility(Ratsivalaka, 2007).This phenomenon is amplified by the reduced use of mineral fertilizers due to the high prices.But the Vakinankaratra region has the advantage of concentrating large dairy cattle herds, high producers of organic manure.The characterization of manure quality is often addressed by agricultural stakeholders, but it has been little documented in the south countries (Rufino *et al.*, 2006).

Stakeholders involved in agricultural development and research agree on the need to make crop and animal production systems more efficient through smart use of the plant and animal biomass produced on farms, or available in the surrounding environment. Above all, farmers are now aware of the need to restore or maintain the long term fertility of their fields if they want to ensure their own food security or boost their income. In this context, animals are anessentialpathway to improve soil fertility by virtue of their ability to collect, convert, use and recycle nutrients.

The objective of this study is to characterize the variation factors that affect manure quality on dairy cattle farms in Vakinankaratra region and to identify practices that increasefertilizer nitrogen value of dairy manure.

Materials and methods

A typology (PCA and hierarchical clustering) of dairy farms in Vakinankaratra region was realised based on data collectedon 300 farms.Sixty farms equally sampled in the groups of typology were selected to represent the variability of manure management practices. Three

groups of factorsliable to vary manure quality were identified: (i) dairy herd and feed (16 factors), (ii) type of stable and litter management practices (12 factors) and (iii) mode and practices of manure storage (28 factors).The experimental field protocol includes an interview with the herd manager, observations on management practices and samplings.Several hundred samples (65 samples of feeds, 82faeces, 124litters and329manures) were collected and stored in a freezer.After drying in the oven (24 to 72 hours, at 48 °C) and milling (1 mm), samples were scanned using a near-infrared spectrometer (NIRS) to predict their chemical composition (nitrogen and carbon) and their nutritional and/or fertilizer value (nitrogen).

ADiscriminant Correspondence Analysis (Greenacre, 1993) was used to determine management practices specifically associated with the variations of the nitrogen content of organic matter (faeces litter and manure).

Results and discussion

A herd with high number of calves and heifers, adult cows receiving only one meal per day, rice straw as the main forage of the diet and the lack of concentrate feed were linked to the production of faeces with high nitrogen content (low nitrogen digestibility). Jarrige*et al.* (1988) have shown that the use of nitrogen and its digestibility vary according to the age of the animals.The digestive system of young animals is under development and they have a lower digestive capacity, especially for fibrous feeds, compared to that of adult animals.Robison andSniffen, (1985), showed that increasing meal frequency decreases dietary nitrogen excretion in faeces and urine. Rumen microflora efficiency, and consequently nutrient digestibility, depends on the combined supply of energy and protein.These supplies must be sufficient, equal, simultaneous and continuous throughout the day.Ruminants that receive only one meal per day or a diet based on rice straw and without supply of concentrates have a non-optimal microbial activity, a decrease ofthe microbial digestion efficiency and therefore a low digestibility of dietary nitrogen.

The highest nitrogen content (1.9 to 2.6% DM) of scrapped litters appearsmost often on farms with rice straw litters and stables with paved floor.The fiber composition of the plant biomassused as litter plays a role in the absorption of urine during storage and scraping(Lekasi*et al.*, 2003). Nzumaand Murwira (2000) have demonstrated that the addition of straw to the litter allowed reducing losses of urinary nitrogen by ammonia volatilization up to 85%.Compared with bare soils, paved soils avoid that faeces and urine infiltrate into the soil and thereby allows moistening and enriching the straw used in the litter. Plant litter is

easier to decompose thanks to urea in particular (biological action), but it is also degraded thanks to trampling by cattle against the paved floor (mechanical action).

The highest nitrogen content (2.0 to 2.6% DM) of manure come from farms where we observe most often manure storage in ditches, the addition of pig nitrogen-rich manure (> 3% DM), the addition of poultry litter and a manure storage period of less than 90 days. Rufino *et al.* (2006) demonstrated that a manure heap uncovered is much more exposed to losses by leaching and/or evaporation.The air, the rain and the wind amplify the nitrogen volatilization phenomenon in ammoniacal form; the greater the manure surface in contact with air and wind, the greater arethe losses.

Conclusion

Adding-value to manure and to other livestock effluents has become essential to maintain soil fertility in Vakinankaratra region.The composition and the fertilizer value of manure are highly variable from one farm to another, and are strongly related to farming systems and to management and storage practices of organic matter.Some practices considered by farmers as capable to improve manure quality, were not recognized as such.They correspond more to a desire, widespread among farmers, of adding-value to all organic matter resources available at the farm level (residues, waste, leaves, etc.) and to recycle everything that is considered "waste" in order to limit input purchase.

These results are important for advising farmers on how to produce quality organic fertilizer and improve fertilization techniques in low-input farming systems. These improvements not only help to increase food self-sufficiency and income levels among farming households, but also to reduce their reliance on outside inputs, the price of which greatly depends on market volatility. Moreover, reducing mineral fertilizer use helps to improve the environmental efficiency of agricultural activities (reduction in greenhouse gas emissions and fossil fuel consumption).

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