Magnitude and routes of nitrogen and carbon losses from solid cattle manure subjected to various storage conditions

Ghulam A. Shah[1], Jeroen C.J. Groot[1], Oene Oenema[2], Egbert A. Lantinga[1]
(1) Farming Systems Ecology, Wageningen University, P.O. Box 563, 6700 AN, Wageningen, NL
(2) Department of Soil Quality, Wageningen University, P.O. Box 47, 6700 AA, Wageningen, NL
ghulam.shah@wur.nl

Introduction

Ammonia (NH3) and greenhouse gases like nitrous oxide (N2O), methane (CH4) and carbon dioxide (CO2) emissions from livestock farming systems are a concern due to their possible/potential adverse environmental effects. Emission of all these gases may occur in each component of the solid cattle manure management chain, i.e. animal housing, manure storage and manure application, but the highest losses are likely associated with the storage phase[1]. The objectives of our study were to quantify the effects of contrasting storage methods of solid cattle manure on: (i) emissions of NH3, N2O, CH4 and CO2, (ii) total carbon (C) and nitrogen (N) balances during storage, and (iii) crop apparent N recovery (ANR) following manure application to arable land with maize as test crop.

Materials and Methods

Portions of 10 Mg of fresh solid cattle manure were stored for five months in three replicates as: (i) stockpiled heaps, (ii) roofed heaps, (iii) covered heaps and (iv) composted heaps. Surface emissions of NH3, N2O, CH4 and CO2 were measured regularly using a static flux chamber system with internal gas recirculation connected to a photoacoustic gas monitor. Total C and N losses during storage were determined through the mass balance method. After storage, the manures were surface-applied and incorporated in a sandy soil, and maize ANR was measured both as a proportion of field applied N (ANRF) and collected N from the barn (ANRB).

Results

During the storage period, on average 6% of the initial Ntotal was lost from the covered, 12% from the roofed, 21% from the stockpiled and 33% from the composted heaps. Of the total N losses, 2-9% was lost as NH3-N, 1-4% as N2O-N and 16-32% through leaching. However, the greater part of the total N loss from the four storage methods was unaccounted for and constituted in all probability of harmless dinitrogen gas. Of the initial C content, about 13, 14, 17 and 22% was lost from the covered, stockpiled, roofed and composted heaps, respectively. Maize ANRF was highest from covered (39% of the applied N) followed by roofed (31%), stockpiled (29%) and composted manure (20%). The respective values in case of maize ANRB were 37, 27, 23 and 13%.

Conclusion and perspectives

It is concluded that from a viewpoint of on-farm N recycling the storage of solid cattle manure under an impermeable plastic cover is much better than traditional stockpiling or composting in the open air. Currently, there are no formal regulations for covering solid manure heaps, while they exist for liquid and slurry manures in countries like The Netherlands and Denmark. The results of this study warrant the need to reconsider this.

References

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Keywords

Solid cattle manure, Manure storage, Ammonia, Greenhouse gases, Leaching, Manure incorporation, Maize N recovery