59th Annual Meeting European Association Animal Production - EAAP 2008
Vilnius, Lithuania, August 24th-27th.

Comparison of the mass balance method with the N to P ratio marker method to estimate nitrogen volatilisation in dairy cow barns

Atzori A.S., A. Cannas, G. Spanu, and A. Fenu

Dipartimento di Scienze Zootecniche - Università degli Studi di Sassari - Via E. De Nicola 9, 07100, Sassari, Sardinia, Italy
e-mail: asatzori@uniss.it

Session 05: The impact of livestock on the environment. Abstract n° 2319

INTRODUCTION

Considering the phosphorus (P) in the manure as an internal non volatile marker, changes in the N to P ratio (N:P) from feed to manure can be used to estimate N gaseous emission, as suggested by Moreira and Satter (2006-JDS v.89). Validation of the N:P method in warm climates and for conventional manure storage times could allow its use for the determination of N volatilisation losses (**Nvol)** at local level, by utilising the chemical analyses and productive information routinely collected by farmers and policy agencies.

Thus, the aims of this work were i) to study the **Nvol**, from the moment of excretion to the end of manure short-term storage in buried-uncovered tanks located at the end of the feeding area, in dairy cow farms in Mediterranean climatic conditions and ii) to compare the estimates of the N:P method (N:P) with those of the well-established mass balance method (MB).

MATERIALS AND METHODS

Nvol were measured in cubicles free-stall barns of 4 farms, on the West-Coast of Sardinia, Italy (city of Arborea: lat. 39°46'26" N; long. 08°34'53" E; alt. 7 m a.s.l.), for one year between 2006 and 2007.

Nvol within each tank filling cycle was indirectly calculated as:

MB method

$$\text{Nvol} = \frac{\text{kg of } N_{excreted} - [N_{manure}] \times \text{kg of manure in tank}}{\text{kg of } N_{excreted}} \times 100$$

$N_{excreted}$ = N in feed– N in milk
N and P in manure = chemical analysis

N:P method

$$\text{Nvol} = \ = 1 - ([N{:}P_{manure}] \ / \ N{:}P_{expected}) \times 100$$

N and P in manure = chemical analysis
$N{:}P_{expected}$ = $N_{excreted}$ adjusted for N added with bedding materials

Animal performances, manure treatments and meteorological variables were recorded and related with observed values of **Nvol**. All calculated and recorded data refer to the mean of each storage period.

Estimates of the two methods used to quantify **Nvol** were compared by:

- calculating simple Pearson correlation coefficients, and
- using the statistics of the Model Evaluation System (MES 3.0.10; Tedeschi, 2006-Agric. Syst. 89), assuming that the MB method was the reference method and the N:P method was the method to be evaluated.

RESULTS

Even if the 4 barns differed in herd size, facility type, nutrition management and milk production levels, the N and P excretions were in accordance with those reported in literature (Table 1).

Table 1. Nitrogen and phosphorus balance, animal performances, manure characteristics and Nvol of the 4 barns studied.

Variable	Farm 1	2	3	4	SEM
Cows, number	117.1^A	53.9^B	123.7^A	92.5^C	3.87
DMI, kg/d per cow	21.7^B	22.3^B	21.2^B	24.7^A	0.28
Dietary N, % of DM	2.56^B	2.39^C	2.60^B	2.72^A	0.02
Dietary P, % of DM	0.42^A	0.36^C	0.39^B	0.42^A	0.004
Milk yield, kg/d per cow	29.5^B	27.6^{BC}	31.3^B	35.8^A	0.56
Milk N, %	0.52^A	0.52^A	0.51^B	0.51^B	0.01
N excretion, g/d per cow	403^B	390^B	392^B	493^A	7.90
N_{milk}/N_{intake} x100 (EUN)	27.7	26.8	28.7	26.9	0.32
P excretion, g/d per cow	65.9^A	54.1^B	54.3^B	70.5^A	1.36
$N{:}P_{excreted}$	6.1^B	7.2^A	7.2^A	7.0^A	0.09
$N{:}P_{expected}$	6.0^B	7.13^A	7.17^A	6.21^B	0.09
Storage length, days	18.7^A	37.5^B	19.9^A	8.0^C	1.73
Storage length index*	0.12^A	0.68^B	0.13^A	0.13^A	0.04
Manure DM, %	8.50^a	9.00^a	7.31^{bc}	8.54^{ac}	0.20
Manure N, % of DM	3.38	3.15	3.29	3.13	0.05
Manure P, % of DM	0.98^a	0.85^b	0.85^b	0.92^{ab}	0.02
Manure N:P, ratio	3.45	3.84	3.97	3.47	0.10
N losses, MB method %	43.0	45.7	41.7	44.0	1.59
N losses, N:P method %	42.6	47.7	43.8	43.9	1.52

a,b ($P < 0.05$); A,B,C ($P < 0.01$). *calculated as: (days of storage/m² of tank × number of cows)/100.

The **Nvol** coefficient was positively correlated to air temperature and THI, whereas it was negatively correlated to relative humidity, EUN, and manure N content. In general, the correlations were higher when the MB method, rather than the N:P method, was used, suggesting that the former was more reliable (Table 2).

Table 2. Correlation coefficients between Nvol and weather, animal and manure variables.

Variables	Mass Balance	*P<*	N:P ratio	*P<*
Mean air temperature*, °C	0.76	0.01	0.67	0.01
Relative humidity*, %	- 0.76	0.01	- 0.69	0.01
Temperature humidity index (THI)*	0.76	0.01	0.67	0.01
Rainfall**, mm/m² tank	- 0.30	0.04	- 0.29	0.04
N excretion*, g/d per cow	0.15	0.37	0.10	0.49
N in milk/N intake (EUN), %	- 0.68	0.01	- 0.61	0.01
Manure N, % of DM	- 0.61	0.01	- 0.66	0.01

*mean of the storage periods. ** sum of storage periods.

The amount of **Nvol** was significantly affected by seasons but not by farms. **Nvol** values calculated with the two methods were not significantly different (mean of the 4 farms: 43.3% vs. 44.5%, for the MB and the N:P methods, respectively; $P > 0.1$). The N:P method slightly overestimated N losses at low N volatilisation levels and underestimated it at high volatilisation levels (Figure 1).

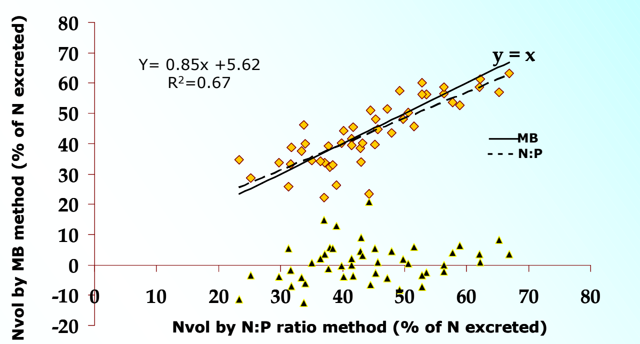

Figure 1. Comparison between N losses estimates with the N:P ratio method and the mass balance (MB) method. Triangles represent deviations in the estimates between the N:P and MB method. The continuous line represents the equivalence line.

Nvol was estimated with a mean bias equal to 0.79% of N excreted, and a root of the mean square error of prediction (RMSEP) equal to 6.42% of N excreted. Overall, the N:P method was highly accurate (Cb = 0.99) and sufficiently precise (r^2 =0.67), with high overall concordance correlation coefficient (r_c = 0.81).

CONCLUSIONS

- The two methods tested gave similar estimates of **Nvol**, even though the MB method was consistently more closely associated with meteorological variables.
- The N:P method is less laborious and can be considered sufficiently precise and accurate for applied measurements.

ACKNOWLEDGEMENTS

The research was supported by the Municipality of Arborea. The participation to this meeting was supported by a EAAP scholarship.