Manure nitrogen excretion from dairy cattle on the valley floor of Valle d'Aosta (NW Italy)

Bassignana M., Machet F., Madormo F.

in

Baumont R. (ed.), Carrère P. (ed.), Jouven M. (ed.), Lombardi G. (ed.), López-Francos A. (ed.), Martin B. (ed.), Peeters A. (ed.), Porqueddu C. (ed.).
Forage resources and ecosystem services provided by Mountain and Mediterranean grasslands and rangelands

Zaragoza : CIHEAM / INRA / FAO / VetAgro Sup Clermont-Ferrand / Montpellier SupAgro
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 109

2014
pages 627-630

Manure nitrogen excretion from dairy cattle on the valley floor of Valle d'Aosta (NW Italy)

M. Bassignana*, F. Machet and F. Madormo

Institut Agricole Régional,
Rég. La Rochère 1/A, 11100-Aosta (Italy)
*e-mail: m.bassignana@iaraosta.it

Abstract. The determination of nitrogen excretion in breeding systems is essential for establishing suitable agro-environmental measures. In 2013, a study was carried out to evaluate the amount of N excreted by livestock on the valley floor in Valle d'Aosta, where cattle breeding is based on cow milk production for cheese making. Data were collected through a survey carried out on 32 farms, representing 6.5% of the cows bred in the region, mostly of rustic local breeds Aosta Red Pied, Black Pied and Chestnut. N excretion in the manure was determined as the difference between inputs (forages + concentrate feeds) and outputs (milk + liveweight gain), assuming that N loss by volatilization was 28% of the total N excreted. Mean weight of cows was 512 ± 72.7 kg and lowland milk production was 2,430 ± 912 kg per cow. Average diet for milking cows was 7.9 ± 1.7 kg DM d^{-1} of first cut hay, 3.3 ± 1.5 of second cut hay and 3.3 ± 1.3 of concentrate feeds, with 121 ± 12 g kg^{-1} DM of Crude Protein. The mean N excretion per Livestock unit (LU) onto the valley floor of Valle d'Aosta was 37 ± 12.6 kg LU^{-1}.

Keywords. Nitrogen excretion – Dairy cattle – Indigenous breeds – Mountain farming.

Excrétion d'azote dans les déjections des bovins laitiers dans le fond de vallée en Vallée d'Aoste (Italie du Nord-Ouest)

Résumé. *L'évaluation des excrétions d'azote dans les systèmes d'élevage est fondamentale pour établir des mesures agro-environnementales appropriées. En 2013, une étude a été menée pour évaluer la quantité d'azote dans les effluents de ferme dans le fond de vallée en Vallée d'Aoste. Les données ont été récoltées par une enquête menée dans 32 exploitations, réunissant 6,5% des vaches laitières de la région, dont la plupart appartiennent aux races locales Valdôtaine Pie Rouge, Pie Noire et Châtaigne. L'excrétion d'azote par les déjections animales fut déterminée comme la différence entre les intrants (fourrages, aliments concentrés) et les sorties (lait, gain de poids vif), en faisant l'hypothèse d'une perte par émission gazeuse de 28% de l'azote excrété. Le poids moyen des vaches était de 512 ± 72,7 kg et la production de lait dans le fond de vallée de 2430 ± 912 kg par vache. Les vaches en production laitière recevaient en moyenne 7,9 ± 1,7 kg MS* d^{-1} *de foin de première coupe, 3,3 ± 1,5 de foin de deuxième coupe et 3,3±1,3 d'aliments concentrés, avec une teneur moyenne de 121 ± 12 g* kg^{-1} *MS de Matières Azotées Totales. L'excrétion moyenne dans le fond de vallée s'avéra être de 37 ± 12,6 kg* UGB^{-1}.

Mots-clés. *Excrétion d'azote – Bovins laitiers – Races locales – Agriculture de montagne.*

I – Introduction

The Nitrates Directive (91/676/EEC) limits the amount of nitrogen (N) spread onto agricultural land to a maximum of 170 kg ha^{-1} y^{-1}. Therefore, it is necessary to know the actual amount of N excreted from livestock to evaluate its environmental impact and establish suitable agro-environmental measures. In Italy, Ministerial Decree 07/04/2006 established standard values of excreted N for different species and categories of animals, stating that the N on land, deriving from dairy cow manure, is equal to 83.5 kg $head^{-1}$ y^{-1}, assuming a 28% N lost in atmosphere during waste removal and storage. This value derives from research studies in northern Italy, carried out mainly on specialized dairy breeds such as Holstein and Brown Swiss (Xiccato *et al*., 2005).

In Valle d'Aosta, livestock is mainly made up of dairy cattle whose milk is primarily utilized for the production of Fontina PDO cheese. The production specifications for this cheese impose that the milk must come from the local cow breeds i.e. the Aosta Red Pied (ARP), Black Pied (ABP) and Chestnut (AC), whose diet must be based on local forage (hay and grass). These breeds have a low milk production, but they are able to take advantage of the rough forages offered by the permanent meadows and the mountain summer pastures which almost entirely account for the agricultural land in Valle d'Aosta. Responding to a request put forward by the regional administration, we carried out a research study aimed at determining the nitrogen production in manure from dairy cattle on the valley floor in Valle d'Aosta.

II – Materials and methods

In 2013 a sample of 32 farmers distributed throughout all over Valle d'Aosta was interviewed to collect data on input and output of the farming system, so that the following equation could be calculated:

$$N_{manure} = N_{diet} - N_{products} - N_{gaseous\ losses}$$

According to the formula proposed by ERM (2002), we considered N in forage and feed as N_{diet} and N in milk and in liveweight gain as $N_{products}$.

In spring and autumn, before and after being moved to the upper mountain pastures, many of the animals graze pastures on the valley floor, always being housed in cowsheds during the night. Since it was not possible to determine the quality and the quantity of the grazed grass on the different farms, we assumed that, during the whole period spent on the valley floor, N_{diet} was equivalent to that of a ration based on hay and concentrate feed given in the cowshed. Crude Protein (CP) contents in first and second cut hay were determined by Near Infrared Reflectance Spectroscopy, while CP in feed was recorded from the label. Only milk produced on the valley floor was taken into account to determine $N_{products}$, and as far as quantity and quality were concerned, N in meat was considered to be 24 g kg^{-1} LW (Grignani, 1996). To compare our results to the national standard values, N lost through gaseous emission was assessed as being 28% of total N in excreta, according to Xiccato *et al.* (2005). Since the heart girth circumference is quite an accurate way of determining an animal's actual weight (Wanderstock and Salisbury, 1946), we measured it in a sample of 225 cows and then converted the measurements to estimate body weight. For the transformation of animal heads into Livestock Units (LU), according to the criteria adopted by the Regional Government in the Rural Development Programme, we considered 1 LU for bovines more than 2 years old, 0.6 LU for bovines from 6 months to 2 years, 0.4 LU for calves less than 6 months old and 0.15 LU for sheep and goats.

The 32 farms were classified, using the SPSS® software, by cluster analysis based on herd size, meadow surface on the valley floor and the length of the summering period. Data were standardised using Z-scores and we used Ward's method for the clustering and the squared Euclidean distance as a measure of similarity. The variables were then submitted to the Kruskal-Wallis one-way analysis of variance and Spearman's correlation was calculated on the data set.

III – Results and discussion

The 32 sample farms raise 1,943 bovines, 1,121 of which are dairy cows, which respectively represent 5.9% and 6.5% of the total number bred in Valle d'Aosta. Herd sizes varied from 10.1 to 145.5 LU, with an average of 54.0 LU per farm; 23 farms usually send animals to subalpine pastures in summer for a period of around four months.

As expected, the cow diet differed during lactation and dry periods (Table 1). Lactating cows received 7.9 kg DM d^{-1} of first cut hay, 3.3 kg DM d^{-1} of second cut and 3.3 kg DM d^{-1} of feed, with a CP content of 121.1 g kg^{-1} DM, while dry cows received more first cut hay, little second cut hay and hardly any concentrate feed.

Since the summer production of milk from subalpine pastures was not recorded, the mean production per cow on the valley floor resulted as being about 2,400 kg of milk. This value is lower than the breed standard (Madormo *et al*., 2012), but consistent with lowland milk production in Valle d'Aosta (Bassanino *et al*, 2011). The CP content in milk was about 33.0 g kg^{-1}.

Table 1. Main features of the diet and production of dairy cows in the sample

	Lactating cows		Dry cows	
	Mean	SD†	Mean	SD†
First cut hay (kg DM d^{-1} cow^{-1})	7.9	1.7	9.2	2.5
Second cut hay (kg DM d^{-1} cow^{-1})	3.3	1.5	1.2	1.8
Concentrate feed (kg DM d^{-1} cow^{-1})	3.3	1.3	0.4	0.7
CP in the diet (g kg^{-1} DM)	121.1	11.9	106.0	15.4
Milk production on the valley floor (kg cow^{-1})	2,430	912.3		
CP in milk (g kg^{-1})	33.0	1.1		

† SD: standard deviation.

Mean weight of cows resulted as being 512 ± 72.7 kg, with significant difference (p = 0.002) between lighter ARP (505 ± 72.3 kg; n = 184), on the one side, and heavier AC and ABP, which are registered in the same Herd Book, on the other (542 ± 67.5 kg; n = 41).

The cluster analysis divided farms into three groups (Table 2). Cluster A groups smallest farms, with an average of about 30 LU and 9 ha of lowland grassland, sending their animals to highland pasture for 117 days in summer. Farms in cluster B are intermediate (45 LU and 19 ha of meadows) and their livestock stays on the valley floor all year long, while the biggest farms in cluster C (82 LU and 31 ha) send it to mountain summer pastures for about 130 days.

Table 2. Main features of the sample and of the three groups of farms classified by cluster analysis

	Total sample (32 farms)		Cluster			Kruskal-Wallis test p-values
	Mean	SD†	A (11 farms)	B (9 farms)	C (12 farms)	
Livestock Units (LU)	53.2	31.4	29.5	44.6	81.5	0.000
Dairy cows	35.0	22.6	18.6	28.7	54.8	0.000
Lowland grasslands (ha)	20.1	15.7	9.0	19.1	31.0	0.000
Summering period (d)	89.5	59.6	116.8	0.0	131.7	0.000
Nitrogen input and output on the valley floor (kg LU^{-1})						
N_{diet}	60.3	19.2	51.9	84.2	50.1	0.000
$N_{products}$	9.5	3.4	7.5	10.8	10.4	0.056
N_{manure}	36.6	12.6	32.0	52.8	28.6	0.000

† SD: standard deviation.

The mean production of N_{manure} during the period spent on the valley floor resulted to be 36.6 kg LU^{-1}, with significant differences between the three groups of farms, ranging from a minimum of 28.6 kg LU^{-1} in cluster C to a maximum of 52.8 in cluster B (Table 2).

As expected, the production of N_{manure} on the valley floor was positively correlated to the length of the period spent in lowland areas (Table 3). It was also significantly correlated to the quantity of N deriving from forage in the diet but neither to that deriving from concentrate feed nor to the proportion of CP in the diet nor to the production of milk.

Table 3. Coefficients of Spearman's correlation between N_{manure} excreted on the valley floor and some of the main variables

	N_{manure} on the valley floor (kg LU^{-1})	*p*-values
Period spent on the valley floor (d)	0.796	0.000
N in the diet of lactating cows, deriving from forage (kg d^{-1})	0.495	0.004
N in the diet of lactating cows, deriving from feed (kg d^{-1})	-0.051	0.783
CP in the diet of lactating cows (g kg^{-1} DM)	0.332	0.068
Milk production on the valley floor (kg cow^{-1})	0.349	0.051

IV – Conclusions

The weight of the cows and the quantity of N excreted in the manure on the valley floor of Valle d'Aosta by the cattle belonging to the local breeds resulted to be quite lower than those of more specialized dairy breeds (Dal Maso *et al*., 2009). This can be linked to the custom of sending cattle to highland pastures during summer but, since we also found this difference on farms which keep animals on the valley floor all year long, we deem it depends mainly on the animals diet, based on forage from permanent grasslands, with a moderate complementation of concentrate feed.

References

Bassanino M., Sacco D., Curtaz A., Bassignana M. and Grignani C., 2011. Nutrient flows in lowland dairy farms in the Italian Alps. In: *Italian Journal of Agronomy*, 6:e28, p. 176-182.

Dal Maso M., Tagliapietra F., Cattani M., Fracasso A., Miotello S. and Schiavon S., 2009. Characteristics of dairy farms in the North-Eastern part of Italy: rations, milk yield and nutrients excretion. In: *Italian Journal of Animal Science*, 8 (Suppl. 2), p. 295-297.

ERM, 2002. *Nitrogen Equivalents in Livestock Manure*. Luxembourg, Office for Official Publications of the European Communities, 25 p.

Grignani, C., 1996. Influenza della tipologia di allevamento e dell'ordinamento colturale sul bilancio di elementi nutritivi di aziende padane. In: *Rivista di Agronomia*, 30, 3 Suppl., p. 414-422.

Madormo F., Vernetti-Prot L. and Francesia C., 2012. Un set di indicatori utili nell'analisi predittiva della sostenibilità delle aziende zootecniche valdostane. In: *Quaderni SoZooAlp N. 7/12 – Sistemi agro-zootecnici biologici ed ecocompatibili in ambiente montano*, p. 163-174.

Wanderstock J.J. and Salisbury G.W., 1946. The relation of certain objective measurements to weights of beef cattle. In: *Journal of Animal Science*, 5, p. 264-271.

Xiccato G., Schiavon S., Gallo L., Bailoni L. and Bittante G., 2005. Nitrogen excretion in dairy cow, beef and veal cattle, pig, and rabbit farms in Northern Italy. In: *Italian Journal of Animal Science*, 4, p. 103-111.