CAN WE MINIMIZE NITROGEN EXCRETION IN DAIRY HERDS WHILE MAINTAINING PERFORMANCES?

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Introduction

In the last decades intensive animal production systems were encouraged. However, they generate considerable excess of N, the role of which being now well established in some environmental risks. The EC Directives make the management of animal excreta on farms more difficult and they will be reinforced in the future. In this context, reducing N excretion from the cows is one way among others to limit the impact of dairy herd to the N cycle on the farm. The paper directs attention to recent advances upon (i) the main factors affecting N excretion in the dairy cows, (ii) the role of protein feeding to promote balanced solutions between performances and N excretion and iii) the restitution of N on the grazing area.

Main factors affecting N excretion

<u>Origin and composition of N excreted</u>

In dairy cows, the quantities of excreted N (g/d) can be calculated by difference between N intake (NI) and N exported in milk (NM) as N retained is negligible. N excreted in faeces (NF) is mainly organic. NF only marginally varies with the composition of the diet and averaged 7.2 g/kg DM intake (DMI). On the contrary N excreted in urine (NU) is directly affected by the level and composition of ingested protein. Increased NU may originate from an excess of degradable N *vs.* rumen microbial requirements or from an excess or unbalanced amino acid supply *vs.* cow requirements. Both lead to the production of urea that is excreted in urine. Urea-N can easily be volatilised or leached. NU can be calculated as NI – NM – 7.2 DMI.

<u>Quantification of N excretion per cow per year</u>

Using the French feeding systems (INRA, 1988), Delaby et al (1995) have calculated the variations of annual N excretion. A dairy cow (7500 kg milk) fed with a well balanced maize silage based diet ingests 131 kg of N of which 50% come from the concentrate, secretes 40 kg of N in milk and excreted 42 kg in faeces and 49 kg in urine. N excreted equals 70% of NI, which is also equivalent to 12.1 kg per tonne of milk produced.

N excretion per tonne of milk produced decreased as the cow potential increases due to a dilution of maintenance requirement. With the same maize silage diet, excreted N decreases from 13.3 to 11.2 kg/t between 6000 and 9000 kg of milk. Consequences at the farm scale are difficult to extrapolate. Total N excretion per cow increases (from 80 to 101 kg), as does N excretion per ha of forage because extra amount of milk is mainly produced with concentrates. But in the same time the number of cows and the stocking rate will decrease to fulfil the quota.

N excretion varies with the forage system. Compared to the maize silage diet, a grass silage diet (15% CP) increased N excretion up to 153 kg from which 38 and 75 kg are excreted in faeces and urine. This high N excretion cannot be assimilated to a higher level of N losses at the farm scale because N exported per ha is higher for grass than for maize (Peyraud et al, 1995). Moreover the grass silage diet requires less N from purchased concentrate (49 vs. 61 kg). N excreted dramatically increased (from 14 to more than 20 kg per tonne of milk) with the level of intensification of grass production and this can lead to huge losses as stocking rate also increases.

N excretion depends of the feeding practice. Using security margins will increase N excreted. A 10% increase of the PDIE supply above needs will increase N excreted by 13 kg, whereas an 200 g/day excess of degradable N (PDIN > PDIE) will lead to an increase of 18 kg in N annually excreted (Peyraud et al, 1995).

<u>Practical assessment of annual N excretion</u>

The total amount of N annually excreted according to the major type of diets given to dairy cow (maize silage, conserved grass - 15% CP, pasture – 18% CP) and various durations over the year of the feeding sequences were calculated (Delaby et al, 1995, table 1). The calculations are based on a monthly basis and assume an optimised N supplementation.

Increasing maize silage decreases the total amount of N emitted indoors. Introduction of grazing increases the total amount of N excreted but reduces the amount of N to be collected indoors. The effect of the level of production may be integrated assuming a variation of 5% per 1000 kg of milk. When feeding is composed of mixed ration including grazing the distribution of the excreta between indoors and paddocks are fixed at 85/15 as long as the conserved forages represent less than 50% of the ration and at 65/35 beyond 50%.

Table 1: Effect of the forage system on annual excreted N for a cow producing 6000 kg milk

Restitution (kg N/year)		Indoors					Pasture
Maize silage (months*)		0	3	6	9	12	
Grazing (months*)	0	109	102	95	88	80	0
	3	87	80	73	65		29
	6	65	58	50			57
	9	43	35				86

The sum of months with maize silage and months with grazing is make up 12 months by adding months with conserved grass

Protein supplementation to reduce N excretion while maintaining performances

<u>Supply of degradable protein</u>

The degradable N supply is entirely recovered in urine and does not improve cow performances unless a large PDIN deficit occurs, which is rarely the case in usual dairy diets. In practice PDIN does not exceed PDIE supply to avoid unnecessary N loses and an 8% deficit in PDIN supply remains tolerable (Vérité et Peyraud, 1989) even for high producing dairy cows.

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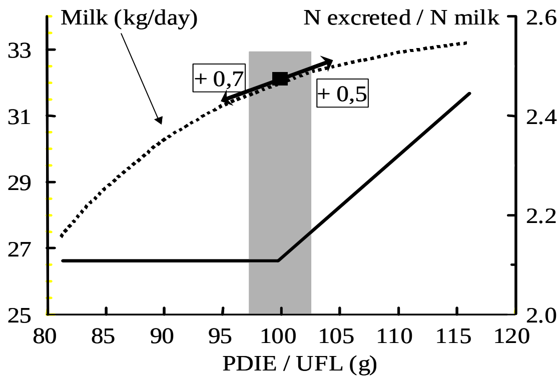
Supply of metabolisable protein (i.e. PDI supply)

Milk yield increases with the PDI supply as described in the PDI system (Vérité et Peyraud, 1989). To enlarge the response curves over a wider range of situations, 5 experiments were conducted in our station (Vérité et Delaby, 2000). Different protein to energy ratio varying from 85 to 115 g PDI/UFL were tested on a total of 250 dairy cows fed ad libitum with maize silage diets. The effects of PDI supply are very large as the responses between the extreme levels were 4.2 kg for milk yield, 1.4 g/kg for milk protein content and 1.6 kg/day for DM intake.

The response curves are curvilinear. Near the recommendations (100 g PDI/UFL), the marginal responses are 0.6 kg milk, 0.2 point of protein content and 0.25 kg DM intake and 7% for the global efficiency (kg milk/kg DM intake) for 5 g increase of PDIE/UFL. Above the recommendations these responses are very small. On the contrary feeding low PDI ration to reduce N excretion rapidly leads to large negative effects for all the parameters. The marginal responses are doubled for a 10% deficit.

Figure 1: Milk and N excretion responses to variation in PDIE/UFL ratio in the diet



N excretion is increased. NU increases linearly at a rate of 15 g/day for a 5 g increase of PDIE/UFL. However, the relative N losses (excreted N / milk N) stay at a minimum as long as the PDI/UFL is below 100 and increases rapidly for higher supply of PDI.

The level of PDI is therefore an important way to control performances and N excretion. The average value of 100 g PDI/UFL is really a threshold. Any reduction of PDI supply below this value rapidly reduces performances whereas increased supply above this value dramatically increased N excretion with only marginal responses in animal performances.

Restitution of N on grazing area

Effect of the level of N fertilisation

N fertilisation modifies both the CP content of grass, the herbage production and the number of grazing days per ha (GD). In a 5 years experiment Delaby and Peyraud (1998) have shown that decreasing N fertilisation level from 320 to 100 and 0 kg/ha provides a decrease in milk output per ha (16050, 12600 and 10700 kg) which is proportional to the decrease in GD (689, 550 and 456). But the N excretion per ha decreased more rapidly (368, 236, 174 kg N/ha), especially urinary N (276, 162, 112 kg/ha). Finally the relative N excretions were reduced from 22.9 to 18.7 and 16.3 kg N/ t milk. Excreta being for the most part emitted directly on the paddock, the risk of N leaching is sharply decreased by reducing N fertilisation rate. From a quantitative description of the fate of N excreted, Decau et al (1997) showed from these data that the amount of N, which will be able to leach at the end of the grazing season, decreases from 161 to 44 and 28 kg/ha.

Reducing stocking rate at a given level of fertilisation also allows to reduce urinary N excretion per ha but the amplitude of the variation for a variations of 100 GD is two time less than that previously observed (30 vs 60 kg N, Vérité et Delaby, 2000) because stocking rate do not modify CP content of grass.

Effect of feed supplementation

The use of cereal-based concentrates has almost no consequences on N excretion per cow and per ha so long it does not modify the number of grazing days. The use of a concentrate rich in protein increases NI per cow and per ha for a same number of grazing days. N excretion is then increased while the milk response remains very low unless the CP content of grass is below 14% (Delaby et al 1996). On a complete grazing season, Soegaard and Aaes (1996) reported a 145 kg/ha increase in N excretion when the CP content of concentrate increases from 14 to 32%.

Supplementation with maize silage is an efficient way to reduce N excretion per cow (see above) but the advantage is less obvious considering the N restitution per ha. In fact maize silage allow to increase the number of grazing days as cow eat less grass and it transfers N from maize area to grass area.

Conclusion

N excretion is variable but these variations are not directly linked to risk of environmental pollution especially between different forage systems. Protein nutrition (and utilisation of the PDI system) allow to control feed N efficiency. Reducing N fertilisation allow to limit the risks of N leaching while maintaining reasonable milk production per ha.

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