Modelling urine nitrogen production and leaching losses for pasture-based dairying systems

I.M. Brookes and D.J. Horne

College of Sciences, Massey University, Private Bag 11 222, Palmerston North, New Zealand, Email: I.Brookes@massey.ac.nz

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Introduction Urine from dairy cattle grazing pastures with high crude protein (CP) concentrations is a major source of N lost in drainage water from New Zealand farms. This paper provides predictions of urinary N leaching losses for a range of stocking rates and levels of supplementation.

Method Urinary outputs (kg N/ha) were estimated for dairy herds on notional 100 ha farms stocked at 2.35 (L), 3.00 (M) or 5.00 (H) cows/ha. Farm L was assumed to grow 13,000 kg pasture dry matter (DM)/ha annually. For farms M and H, 100 and 200 kg fertiliser N/ha were applied, to give annual pasture yields of 14,080 and 15,160 kg DM/ha, respectively. A feed budget identified periods when pasture (P; 20% CP) required supplements of either maize silage (MS; 7% CP) or pasture silage (PS; 16% CP) to maintain at least 1,700 kg grass DM/ha. Supplements were fed from Feb. to Sept. on farm M and in all months on farm H, accounting for 16% and 47% of the total DM intakes. Urinary N outputs were estimated by the Cornell Net Carbohydrate and Protein System model (Fox *et al*., 2004), and leaching losses by the Nitrogen Leaching Estimation (NLE) model of Di & Cameron (2000).

Table 1 Annual N intake, urine N output and N leached

Stocking rate/Supplement		L	MMS	MPS	HMS	HPS
Dietary CP	(% DM)	20.0	17.9	19.1	13.9	17.4
Dietary N intake	(kg/cow)	150	136	145	107	135
Urine N output	(kg/cow)	72	58	67	39	59
	(kg/ha)	169	174	200	196	296
N in urine patches*	(kg/ha)	889	725	833	490	740
N leached	(kg/ha)	7	16	21	23	44

* Assumes urine from a cow covers ~ 0.08 of the area

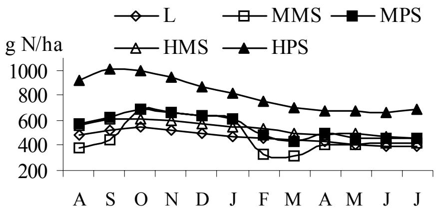

Figure 1 Monthly urine N outputs per ha

Results Dietary CP %, urinary N outputs and N leaching losses are given in Table 1 and Figure 1. Although the CNCPS model is reported to under-predict the ratio of urinary to faecal N, the results described here are supported by Mulligan *et al*. (2004), who showed a positive linear relationship between urinary N output and N intake, in cows fed supplements with high or low CP%. They also observed a decrease in the proportion of urinary N in the total excreta N when the supplement CP% concentration was reduced. Replacing pasture with a supplement of lower CP% can reduce the concentration of N under urine patches. On farm M, this occurs mainly in early spring and autumn, as no supplements were required in late spring and summer. The extent of N leaching was related to N fertiliser use and N concentration in the urine patches. Despite a two-fold increase in stocking rate and the higher N fertiliser usage, N concentration under urine patches was 50% lower on farm H with MS than on farm L. The reduction in urinary N production per cow and the increased area of urine deposition on the HMS farm results in N leaching losses that are not much greater than those for the M systems. However, when pasture silage was fed on farm H, N leaching losses were much higher.

Conclusions This analysis suggests that where increases in stocking rate are accompanied by the use of maize silage, intensification may not pose an increased risk of nitrogen leaching from dairy farms. There is a need for quantification of urine N output on farms as affected by stocking rate and diet, and for measurement of the exact area occupied by urine patches.

References

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