The effect of agricultural practices on a dairy farm on nitrate leaching to 1m

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Introduction Dairy farms, in Ireland, carry the highest stock densities and use the highest rates of fertiliser nitrogen (N). They constitute the highest risk of nitrate leaching, especially where soils are thin or free-draining. The effect of 4 grass managements on leaching was studied on a dairy farm having free-draining soils overlying Karst limestone. This was a new, farm-comprehensive approach to nitrate leaching which had not been carried out previously.

Materials and methods Leaching was measured over three years (2001-2004) under 4 managements: grazing (dirty water + N fertiliser); 2-cut and 1 cut silage & grazing (slurry (S) + fertiliser N). The mean N inputs were as shown in Table 1. Eight ceramic cups per plot, in 3 replicate plots of each management were used to collect water from1 m deep using 50 k Pa suction over the winter drainage seasons.

Table 1 N inputs (kg/ha) to 4 management systems on dairy farm, 2001-2003

	Fertiliser	S/DW	Total	*Organic
DW	244	54	298	227
2 cut	337	25	362	79
Grazed	266	--	266	230
1 cut	296	22	318	146

*Organic = Recycled N in grazing @ 108 kg/LU/yr

Results Mean, drainage water, nitrate-N concentrations for 2 of the three years are shown in Table 2.

Table 2 Effect of management on mean, drainage water, nitrate-N concentrations (mg/l)

	2001-02			2002-03		
	Mean	Maximum	Drainage (mm)	Mean	Maximum	Drainage (mm)
Dirty water	12.1	24.7		8.1	20.3	
2 cut silage	11.8	22.0		5.3	26.9	
Grazed	4.9	11.1		2.1	5.0	
1 cut silage	1.9	4.8		0.9	3.5	
Overall mean	7.9	15.7	440	4.2	13.9	539

A repeated measures ANOVA of the data showed statistically significant effects ($p<0.05$) of management in both years. Grazed and 1 cut had lower mean concentrations than DW or 2 cut;1 cut had lowest while DW had highest concentrations.

The results relate to the extreme soil conditions that might be experienced on a dairy farm, i.e., very free-draining soil and mean annual total overall N inputs (including recycled N) of 482 kg/ha. Based on 2001-02, the nitrate-N concentrations in the DW and 2 cut treatments are of concern. All mean and maximum values for 2001-02 were higher than those for 2002-03. This shows the importance of collecting data over a number of years to gauge the range of nitrate-N concentrations in drainage water.

Conclusions: Overall mean nitrate-N concentrations recorded were < MAC (11.3 mg/l) for drinking water but may exceed environmental water quality standards. Dirty water management had the highest nitrate-N concentrations in both years, but improvements, i.e., reduced load and less fertiliser N can reduce its impact. High nitrate-N in the 2-cut silage management in year 1 reflected a pre-experimental history of high N inputs. The results relate to drainage water at the 1 m depth and are indicative only as to what may occur in the groundwater. Bartley (2003) studied nitrate-N concentrations in the groundwater on the same farm and confirmed the designation of the area as having an important aquifer of extreme vulnerability.

References

Bartley, P. 2003. Nitrate responses in groundwater under grassland dairy agriculture. Ph.D, Thesis, Trinity College, Dublin.