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N-mineralisation and phosphorous: important elements in decision support for grassland systems

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Introduction Leaching of N and P from extensively managed grasslands on organic soils varies considerably. In environmentally sensitive areas it is important to diminish leaching by appropriate agricultural management. In Denmark low grazing intensity and management without fertilisation have been given a high priority. The type of soil has not been equally in focus, and it seems that the effect of cutting, compared with grazing, results in a higher removal of nutrients (e.g. Benke *et al.*, 1992) can be used more strategically. The objective of this case study was to combine data from management strategies with data from leaching studies on organic soils to elucidate the differences between type of management and type of soil for the potential leaching of N and P.

Materials and methods The study was carried out at two separate sites 2 km apart, referred to as ‘West’ and ‘East’. At ‘East’ the effect of three management strategies on soil mineral N was examined in a block design with three replicates: a) continuous grazing with steers (compressed sward height (CSH): 6 cm), b) two cuts, c) two cuts with deep litter (20 t/ha) average 83 kg N of which 6 kg NH₄N, 17 kg P and 134 kg K. Leaching of N and P was recorded at high and low grazing intensity in ‘West’ and ‘East’. Continuous high intensity grazing with steers and sheep in separate paddocks aimed at a CSH of 6 cm. At low grazing intensity the number of animals/ha was 50% (steers) or 65% (sheep) of the number at high intensity. The lowest level of the water table varied between 30 and 55 cm below soil surface in the years of the experiment (Hald *et al.*, 2003a).

Results Initial soil analyses for, respectively, ‘West’ and ‘East’ were pH(CaCl₂) 5.6 and 4.7, total N (%) 1.8 and 2.7, soil organic matter (%) 49 and 66, C:N-ratio 15.6 and 13.9, N-mineralisation measured by incubation at 20°C 2.0 and 4.6 kg N/ha per day. Soil mineral N increased through the growing season on the grazed plots compared with the cutting treatments and soil mineral N in spring was lower in plots with cutting and deep litter compared with the other treatments (Table 1). Leaching of N and P was considerably higher in ‘East’ compared with ‘West’ (Table 2). There was no difference in N and P leaching between high and low grazing intensity.

Table 1 Soil mineral N (kg N/ha) with three management strategies (‘East’), average of 1998-2000

	Soil sampling	Continuous grazing	Two cuts	Two cuts, deep litter	LSD*	Average of 20 grasslands**
Change through the growing season	0-20 cm	21.0	0.9	-1.0	20.8	-1
	20-40 cm	2.1	3.6	1.9	(7.2)	9
Mineral N in spring	0-20 cm	30.0	33.8	28.1	(9.6)	42
	20-40 cm	30.6	30.1	22.5	7.5	14

*LSD: Management, least significant difference ($p < 0.05$), **Different management intensity (Hald *et al.* 2003b)

Conclusions This case study demonstrates that the level of N-mineralisation is important when making decisions about management. Where the level of N-mineralisation is high it is possible to remove N from soil when supplying the correct amounts of limiting nutrients. Where depletion of nutrients is required for the environment, cutting can be used for a number of years, but managements should be adjusted according to changes in soil conditions and the intentions for the area.

Table 2 Concentration of N and P in field drains*

	Mean	Std. Error	N**	
Total N mg/l	‘West’	2.6	0.13	69
	‘East’	11.1	0.41	69
Total P mg/l	‘West’	0.4	0.03	58
	‘East’	1.8	0.14	58

*Data from two similar grasslands with 1.3 mg N/l and 0.13 mg P/l (Grant, R., pers. communication)

**N, number of samples

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