Can Grazing Species Be Used to Manipulate the Amount of Nitrogen Leaching to Groundwater?

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Can grazing species be used to manipulate the amount of nitrogen leaching to groundwater ?

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Introduction Regulatory limits on nitrogen (N) leaching from farmed land in the Lake Taupo catchment in New Zealand make the identification of effective N leaching mitigation strategies for land owners imperative .More N has been shown to leach from cattle than from sheep urine patches due to the greater volume of urine as well as the greater rate of N deposited in cattle urine patches (Williams and Haynes , 1994) .A field-scale study was undertaken to examine the potential for using different grazing species to reduce the amount of N leaching from grazed land .

Materials and methods The trial site was located on a highly porous pumice soil in the Lake Taupo catchment in New Zealand . In October 2003 a 4-year old ryegrass/cocksfoot/white clover pasture was divided into 9 (0 .5 ha) paddocks , and young (5-18 month old) sheep , cattle and deer treatments were assigned to the paddocks in a randomised complete block design .The paddocks were rotationally grazed by their assigned species when a target herbage mass was reached (2500 kg DM/ha) , and animals were removed when a target residual herbage mass was attained (1000 kg DM/ha) .The aim was to achieve identical grazing pressure by all three species on a stock unit (SU) equivalence (based on annual feed intake) .

Pre and post-grazing herbage mass was estimated by a rising plate meter calibrated each season for each animal species to obtain an estimate of dry matter intake (DMI) . Herbage on offer was analysed for N concentration by NIR to allow estimation of N intake (NI) .Animal grazing days were recorded at each grazing event and expressed as stock unit grazing days (SUGD) .From May 2004 until February 2007 , 40 ceramic cup samplers per paddock , placed 60 cm below the soil surface in a stratified random pattern , were used to sample soil solution for nitrate-N (NO_3-N) and ammonium-N (NH_4-N) concentration .The soil solution was sampled after each interval of approximately 60 mm of drainage as determined by a water balance model .

Results and discussion Mean rainfall for the 3 years of leaching measurements was 1584 mm/yr with the calculated drainage below 60cm averaging 951 mm/yr .Whilst the amount of NO_3-N and NH_4-N leaching below 60 cm differed significantly between years ($p < 0.001$) , there was no significant difference in the amounts of either N form that was leached between the three species of grazing animal overall , or in any of the three years .

Table 1 *Three-year mean annual dry matter and N intake , SUGD , and mineral N leached (2004 -2007) .*

Treatment	DM Intake (kg DM/ha .yr)	N Intake (kg N/ha .yr)	SUGD (days/yr)	NO_3-N leached (log .kg NO_3-N/ha .yr)	NH_4-N leached (kg NH_4-N/ha .yr)	Mineral N leached (kg) per kg N intake (%)	Mineral N leached per SUGD (gmN/SUGD)
Cattle	7218	267	7307 a	8 .17 (36 .6)[1]	2 .9	12 .3 a	5 .5 a
Deer	7620	284	8602 b	7 .59 (25 .1)	2 .9	7 .5 b	3 .4 b
Sheep	8628	320	10588 c	7 .79 (25 .9)	2 .8	7 .5 b	2 .9 b
probability	ns	ns	<0 .001	ns	ns	<0 .05	<0 .01
$LSD_{0.05}$			699	0 .89		3 .0	1 .5

[1] Values in brackets are arithmetic means (kg NO_3-N/ha .yr) .

Although there was no significant difference in the amount of mineral N leached between the three species , nor in the amount of DMI or NI apparently consumed , the number of stock units required to harvest the herbage on offer was significantly greater for sheep and deer than for cattle .Despite attempting to achieve identical grazing pressure on a SU equivalent basis , it became increasingly difficult to maintain sufficient control of pasture growth in doing so .More SU equivalents of sheep and deer than cattle were required to harvest the available herbage , especially in the late spring and summer period .This resulted in more SUGD's needed per ha to maintain adequate control for sheep and deer pastures than for cattle pastures . The amount of mineral N leached was less per sheep and deer SUGD than per cattle SUGD (Table 1) .However , the number of SUGD's required to harvest that herbage meant that the amount of total mineral N leached per SUGD and per kg N intake was significantly different between the three species .

This study gives valuable information on N leaching in this catchment and provides new data to assist in calculating the potential to mitigate N leaching losses using different grazing species .However , the extent of the potential reduction in N leaching through the use of different grazing species must be based on a whole-farm system analysis .

Reference

Williams , P .H .& R J .Haynes (1994) .Comparison of initial wetting pattern , nutrient concentrations in soil solution and the fate of ^{15}N-labelled urine in sheep and cattle urine patch areas of pasture soil .*Plant and Soil* , 162 , 49-59 .