Effects of Rotational Grazing on the Dynamics of Soil Carbon and Nitrogen on Commercial Dairy Farms

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Introduction

Pasture is an important crop in the Atlantic Region. Dairy farm economic performance may be improved through adoption of management intensive grazing (MIG). Limited information is available, however, on the potential for soil organic carbon (SOC) sequestration through management of pastures in humid temperate Atlantic Canada.

Study objectives were to assess the impact of MIG on; (1) total SOC and N pools and fractions, and (2) soil inorganic N and nitrate leaching potential.

Materials and Methods

Four sites were selected, including 3 Nova Scotia dairy farms and AAFC Nappan, which provided comparisons, between medium to long-term (10-50y) MIG versus hayed or cultivated cropping, in adjacent fields of uniform soil series. Samples were recovered from 4 zones per field, each comprised of 6 sampling sites located along a 10m x 30m grid.

Above-ground litter and soil (up to 85cm depth) was sampled in fall 2001. Soil bulk density, C, N and particulate C (POM) content, plus microbial biomass C, and labile C and N (28 d; 25°C) were determined. Soil inorganic N content to 90cm depth was measured repeatedly until spring 2003.

Results and Discussion

Table 1. Soil total C, POM-C and labile C as affected by land management at four locations in Nova Scotia.

Site	Management	Soil C (Mg C ha^{-1})[1]	POM C (% of total)[2]	Labile C (% of total)[3]
Farm 1	MIG -30y	83.5	39.2	2.0
	MIG - 12y	62.3	42.5	2.5
	Hayed	70.6	38.4	2.3
Farm 2	MIG - 50y	99.3	52.6	1.3
	MIG - 10y	93.2	49.7	1.9
	Hayed	90.1	52.9	1.3
Farm 3	MIG - 30y	96.0	nd	1.3
	MIG - 12y	60.7	nd	1.5
	Hayed	94.6	nd	1.6
AAFC Nappan	MIG - 12y	69.6	44.3	2.4
	Hayed	63.1	49.6	2.1
	Cropped	71.8	42.7	2.0

[1] For 0-25cm depth increment, normalized to equivalent soil mass basis.
[2] Average for 0-25cm depth.
[3] Average (0-25cm depth) C mineralized over 28d at 25°C ± 1°C.

•Grazing reduced soil bulk density and altered the soil profile distribution of SOC and N. Surface residue (thatch) represented up to 10% of SOC and N.

•Surface soil (0-25cm; excluding thatch) represented >80% of total SOC. After 30y of MIG, surface SOC was greater by 12.9 and 8.4 Mg C ha^{-1} at 2 of 3 farm sites.

•MIG had no consistent effect on organic matter quality (soil C:N; fraction SOC as POM-C; labile C or microbial biomass C).

•Soil inorganic N (N_{min}) content decreased with depth, with surface soil (0-30cm) accounting for most of the profile N_{min} at all sampling dates.

•In Spring 2002, a consistent trend towards greater N_{min} (92 –153 kg N ha^{-1}) under older pastures was evident, whether fertilized with manure (farm 1) or mineral fertilizer (farms 2 and 3). By late season (September) at all farm sites, N_{min} decreased to < 50 kg N ha^{-1} but increased to > 100 kg N ha^{-1} by late fall (Oct-Dec).

Conclusions

•In humid temperate Atlantic Canada, MIG appears to promote significant soil C (0.4 Mg C ha^{-1}) and N (39 kg N ha^{-1}) deposition compared to haying or cropping.

•Gains in SOC are difficult to detect in the short term (<10y) and unless accompanying changes in soil bulk density are accounted for. Surface residue represents an important pool of C and N in these systems.

•On older or heavily fertilized pastures, to reduce the potential for NO_3-N losses, fall grazing should be avoided.

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