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RESEARCH REPORT

Assessing chronology of soil nutrient status in pastures across a topographic gradient

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Farmer-Researcher

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IN A NUTSHELL

To help him optimize pasture growth, Andy assessed soil nutrient status from the top slope, side slope and bottom slope of a 50–year old pasture and a hay field that he will start grazing in 2021.

- Organic matter was higher in the older pasture but did not change significantly with topography.
- Potassium, phosphorus and iron were also higher in the old pasture and potassium was higher on the top slope. Andy observed variations in manganese and copper for reasons that are unknown.
- Andy's observations of better soil health at the top of the hills weren't supported by the basic assessment of soil nutrient status used in this study.

MOTIVATION

Topography and animal behaviour exert differential effects on grazing and excretion behavior, leading to heterogeneity in nutrient distribution in pastures (reference 1).

Highland Farm in Minto is around 140 acres, of which 60 are currently being grazed. Andy has divided the 60 acres into 17 paddocks that he uses to rotationally graze 95 head of stocker cattle. In early spring he moves the cattle daily and in summer through fall he moves them every 2-3 days.

The farm is hilly such that almost every paddock has slopes. Cattle tend to congregate in small areas of the pasture near shade and watering. Since hilltops are the favourite overnight resting place for the cattle, a greater proportion of manure - and nutrients - is excreted at the top of the hills. Nutrient deposition on the top slope is counter to how nutrients are displaced topographically - from top slope to bottom slope (reference 2). With topographic factors and animal behaviour differentially affecting soil nutrient status, it is difficult for Andy to know how to amend pastures for optimal growth. To address this challenge, Andy quantified the nutrient profile along a topographic gradient (top slope, side slope, bottom slope) in both new and old pastures.

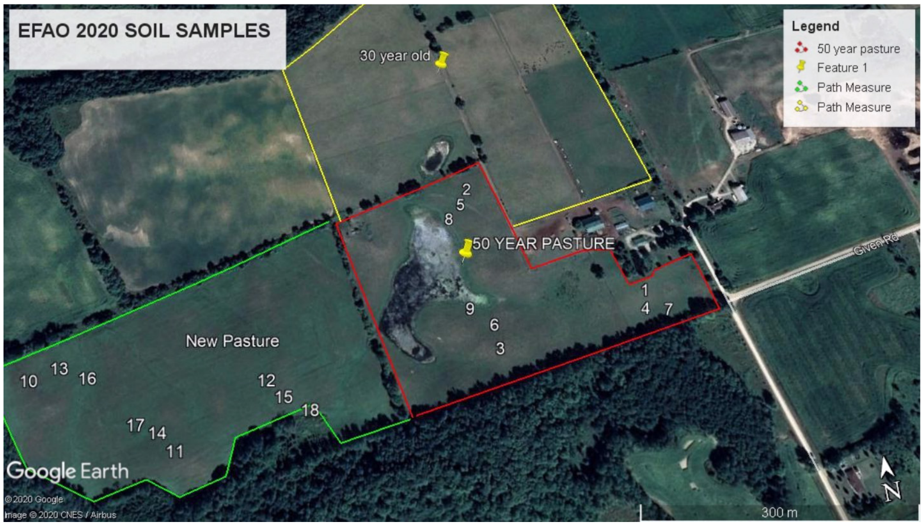

Figure 1. Aerial view of Highland Farm. Andy's new pasture is outlined in green and the 50-year old pasture is outlined in red. The farm has slopes that are around 20-30°and on average 20-30 feet from top to bottom.. Numbers in the pasture denote the 18 plots that he sampled for this study.

DESIGN

Andy planted the new pasture to hay with a grass-heavy mixture in 2017. The intention was to take hay for a couple of years and then convert it to a pasture, making use of the established grasses and clovers, and let the alfalfa die out quickly from the grazing pressure.

The field was fertilized once a year in 2018, 2019 and 2020 with a basic hay fertilizer at a rate of about 200 lbs/ac. Because hay has become so expensive, Andy kept the field in hay and will convert to a rotationally grazed pasture in 2021. The measurements taken this year will serve as a baseline for future measurements.

On July 18, 2020, Andy located 3 plots each on the top slope, side slope and bottom slope of the 50-year old pasture and the ungrazed pasture for a total of 18 plots (2 fields x 3 topographic locations x 3 replicate plots), as shown in **Figure 1.**

From each 4m x 4m plot, he took 10 soil cores (2.2 diameter x 15 cm deep) and combined all cores from a plot into pre-labeled plastic bags. He stored the bags out of direct sunlight in a cooler until he shipped them to A&L Canada Laboratories Inc. for analysis within three days of sampling.

FINDINGS

Using the S1B + S7 package from A&L Canada Laboratories Inc., we ran a simple statistical model called analysis of variance (ANOVA). We considered a nutrient to be significantly different between new and old or among top, middle and bottom if the P-value was below 0.05, meaning there is a 5% or less chance of obtaining this result because of random chance.

EFFECTS OF AGE ($P<0.05$)

Organic matter (OM), potassium (and %K), phosphorus (P; measured using the bicarb method) and **iron (Fe)** were higher in the old pasture relative to the new pasture.

- Higher OM in the old pasture is likely the result of many years of manure deposition and stimulation of root turnover via rotational grazing in the long-term pasture.
- This data also indicates that, although growing forage species extract nutrients from the soil, P and K are staying in the system through cattle excreta.

Manganese (Mn) and **copper (Cu)** were higher in the new pasture.

- Reasons for this observation are unknown. Mn and Cu were not in the fertilizer mix that Andy applied and there is no indication from the literature that this is to be expected.

EFFECTS OF TOPOGRAPHY ($P<0.05$)

K and %K were higher on the top than the bottom for the old pasture.

- This may be due to animal preference for high sites, although in this case we would also expect OM to be higher at the top of the slope.
- There's some indication in the literature that soil moisture makes K more available. In this case, cattle excreta may be leading to higher soil moisture and more K (reference 3).

Mn and Cu were higher on the bottom than top for the new pasture.

- Reasons for this observation are unknown.

NO DETECTABLE EFFECT ($P>0.05$)

- Topography did not influence OM levels across the slope. It is possible that cattle excretion at the top of the hill was offset by erosion, thus leaving a similar level of OM at the top and the bottom.
- P (measured using Bray's method), Magnesium and % g, Calcium and % Ca, Sodium and %Na, pH, CEC, Sulfur, Zinc, Iron, Boron and Aluminum.

TAKE HOME MESSAGE

Age and topography influenced the status of OM and some nutrients in Andy's 50 year-old pasture and a new pasture that has not yet been grazed.

Andy's on-the-ground observations of better soil health at the top of the hill weren't supported by the basic assessment of soil nutrient status used in this study. It appears that something else is at play in Andy's pastures.

Andy sees the benefit of concentrating fertilization efforts in the middle of the slopes vs. top and bottom of this pasture.

Table 1 continued on page 3.

REFERENCES

1. Vendramini, J. 2012. Nutrient Cycling in Pastures. https://rcrec-ona.ifas.ufl.edu/in-focus-archives/nutrient-cycling-in-pastures/8.
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Table 1: Results of OM and nutrient status in Andy's pastures. *Italics* denote a general difference in nutrient status between old and new pastures irrespective of topographic position; **bold** denotes specific differences in nutrient status with topography.

		OM	P-bicarb	P-bray	K	Mg	Ca	Na	pH	CEC	%K	%Mg	%Ca	%Na	S	Zn	Mn	Fe	Cu	B	Al
OLD	Top	*5.7 (0.2)*	*11.0 (6.6)*	16.0 (12.3)	***180.7 (85.0)***	419.0 (17.3)	1816.7 (25.2)	14.3 (2.1)	7.6 (0.2)	13.1 (0.3)	***3.5 (1.6)***	26.7 (0.9)	69.6 (1.0)	0.5 (0.1)	7.7 (0.6)	5.9 (3.7)	*43.0 (7.0)*	*70.7 (5.1)*	*1.0 (0.3)*	0.6 (0.1)	678.0 (90.6)
	Middle	*4.6 (0.5)*	*4.7 (0.6)*	5.7 (1.5)	*48.0 (28.6)*	383.3 (86.4)	1676.7 (196.0)	14.3 (2.9)	7.7 (0.3)	11.7 (1.7)	*1.0 (0.4)*	27.1 (2.6)	71.7 (3.0)	0.5 (0.1)	6.0 (0.0)	2.9 (0.7)	*43.3 (15.0)*	*74.3 (12.1)*	*1.0 (0.1)*	0.5 (0.1)	749.7 (138.9)
	Bottom	*5.5 (1.2)*	*4.7 (0.6)*	5.7 (0.6)	***32.0 (10.8)***	358.7 (9.6)	1876.7 (202.1)	13.3 (1.5)	7.6 (0.1)	12.5 (1.0)	***0.7 (0.3)***	24.0 (2.0)	75.1 (2.0)	0.5 (0.1)	5.7 (0.6)	2.6 (0.3)	*51.0 (14.7)*	*74.0 (2.6)*	*1.1 (0.1)*	0.5 (0.1)	640.3 (11.5)
NEW	Top	*2.3 (0.4)*	*3.7 (0.6)*	4.0 (1.0)	*33.0 (16.4)*	307.0 (91.9)	2313.3 (462.6)	14.3 (1.2)	8.0 (0.2)	14.2 (1.8)	*0.6 (0.4)*	18.4 (7.0)	80.7 (7.4)	0.4 (0.1)	6.0 (1.0)	2.5 (0.2)	***79.0 (7.9)***	*58.7 (4.0)*	***0.9 (0.1)***	0.4 (0.1)	608.7 (177.8)
	Middle	*2.9 (0.2)*	*3.7 (0.6)*	4.0 (1.0)	*42.3 (10.1)*	415.7 (64.0)	1720.0 (294.6)	12.3 (1.2)	7.9 (0.1)	12.2 (2.0)	*0.9 (0.1)*	28.5 (0.9)	70.6 (0.9)	0.5 (0.1)	6.3 (1.2)	3.8 (0.7)	***111.3 (11.6)***	*63.0 (4.4)*	*1.3 (0.1)*	0.5 (0.1)	710.3 (89.0)
	Bottom	*3.3 (0.3)*	*4.7 (1.2)*	5.0 (1.7)	*30.3 (3.1)*	408.0 (37.7)	1853.3 (197.6)	13.0 (1.0)	7.9 (0.1)	12.7 (1.3)	*0.6 (0.1)*	26.7 (1.2)	72.6 (1.1)	0.4 (0.1)	7.7 (1.5)	3.3 (0.4)	***123.0 (19.7)***	*65.0 (3.0)*	***1.7 (0.4)***	0.5 (0.1)	690.7 (32.0)