Changes in Alberta's grasslands soil pH by adopting the adaptive multi-paddock grazing system

Leah Stachniak[1], Laio Silva Sobrinho[1], Sarah Breitkreuz[1], Scott Chang[1]

[1]Department of Renewable Resources, Faculty of Agriculture, Life, and Environmental Sciences, University of Alberta

Abstract

Grasslands account for a large percentage of earth's terrestrial area. Soil is an important aspect of the global carbon cycle and plays a critical role in mitigating climate change. Due to poor land management, the grasslands have been greatly degraded, resulting in the grasslands becoming the most endangered ecosystem on the planet. Fortunately, there are several new techniques that can be implemented in order to help alleviate the negative impacts that the depleted grasslands have had on the earth. The Adaptive-Multi Paddock (AMP) grazing system is an innovative technique that has been introduced as a way to increase plant regrowth, improve animal performance, and increase soil organic carbon (SOC) levels. As SOC has been shown to be correlated to soil pH, there is potential for the AMP system to affect soil pH. To implement the AMP system, a rancher's land would be divided into multiple small paddocks, and the cattle would be rotated between the paddocks more frequently. Non-AMP managed ranches include any ranch that uses traditional grazing techniques, such as low or high continuous grazing. The purpose of this project was to study the effects of the AMP grazing system on the pH of Alberta's grassland soil. Soil samples were collected from AMP and Non-AMP managed ranches in Alberta. After the samples were separated into several layers, weighed, dried, and sieved, the pH of each soil section was recorded and analyzed. Using the data from the Albertan ranches, the AMP and Non-AMP managed ranches were compared. From this data, it appears that by using the AMP system, the pH was slightly lower across all soil depths. Soil also appeared to become more basic with each successive layer. Between Alberta's four ecoregions, the average soil pH seemed to vary. In both AMP and Non-AMP managed ranches, the subsoil was more alkaline while the topsoil was more acidic, which could be a result of possible higher SOC concentrations. In future studies, the pH data from Alberta's soils will be compared to the Saskatchewan and Manitoba data, which will represent all of Canada's grassland soil. When the SOC data is collected, the pH and SOC concentration will be analyzed to establish a correlation. Ultimately, farmers might be reimbursed for the additional costs of adopting the AMP system because of the environmental benefits the system could have.

Key words:

soil, pH, Alberta, grasslands, ecoregions, carbon sequestration, AMP, Non-AMP, Adaptive-Multi Paddock, grazing systems, soil pH, conventional grazing

Cite as: Stachniak L., Sobrinho L.S., Breitkreuz S., Chang S. 2019. Changes in Alberta's grasslands soil pH by adopting the adaptive multi-paddock grazing system. Alberta Academic Review, Vol 2 (2) 71-72, WISEST Special Issue (non peer-reviewed), DOI 10.29173/aar71.

ISSN 2561-5327 (print)
ISSN 2561-5335 (online)

Changes in Alberta's Grasslands Soil pH by Adopting the Adaptive Multi-Paddock Grazing System

Leah Stachniak, Laio Silva Sobrinho, Sarah Breitkreuz, Scott Chang

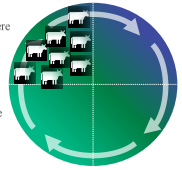
Department of Renewable Resources, Faculty of Agriculture, Life, and Environmental Sciences, University of Alberta

Supported By:

Introduction

- Natural grasslands correspond to ~50% of Earth's terrestrial area and store ~30% of the world's soil organic carbon (SOC). As the largest terrestrial carbon sink, soil plays a vital role in carbon sequestration and in mitigating climate change (Derner & Schuman, 2007).
- Despite its global significance, ~70% of Canada's original grassland habitats have been degraded as a consequence of poor land management (Gauthier & Wiken, 2003). As a result of this, the temperate grasslands are the most endangered ecosystem on the planet (Dodds et al., 2004).
- Fortunately, ranchers can sustain productivity, decrease the negative effects on the environment, improve animal performance, and help restore the grasslands by adopting the Adaptive Multi-Paddocks (AMP) system, an improved, innovative grazing practice [Fig. 1] (Teague et al., 2013).
- Under the AMP system, it has been found that there are less unwanted plants and barren ground as well as an increase in plant regrowth and pasture biomass production (Williams, 2017). The AMP system has also been found to increase SOC levels (Teague et al., 2013). Other soil properties, such as soil pH, have the potential to be impacted by implementing the AMP system.
- Since SOC has been shown to be correlated with soil pH, it might be used to indicate whether or not the AMP system affects SOC sequestration in AMP study areas (Jin & Wang, 2018).

Figure 1: AMP grazing system where the land is divided into multiple small paddocks. Cattle graze for shorter periods, are not allowed to consume >50% of the plant biomass, and are rotated more often.



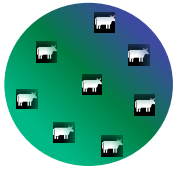


Figure 2: Non-AMP (i.e. conventional) grazing system where cattle graze freely in a single, large, open paddock for a prolonged period of time until most of the grass has been consumed.

Objective

To study the effect of the AMP grazing system on grasslands soil pH within Alberta's different ecoregions and across the soil profile.

Methods

- Samples were collected in 12 study sites within Alberta and each site consisted of a pair of neighbouring AMP and Non-AMP managed ranches [Fig. 3]. From each ranch, 15 soil cores (1 m x 5 cm) were taken using a hydraulic soil probe.
- Each soil core was sectioned into 3-5 layers at various depth increments.
- After being weighed and dried, each core section was filtered with a 2 mm sieve to remove all visible roots and gravel, after which only soil remained.
- 5 g of soil from each soil section was added to 25 mL of milli-Q water (Kalra & Maynard, 1991).
- Soil solutions were mixed in a shaker machine for 30 minutes [Fig. 4].
- Using a digital pH meter, the pH of samples were analyzed [Fig. 5].

Figure 3: Study sites locations in Alberta, Saskatchewan, and Manitoba.

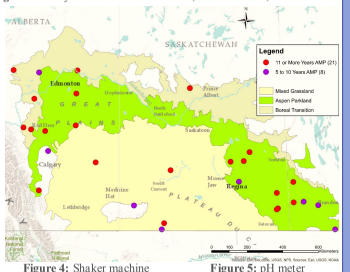


Figure 4: Shaker machine

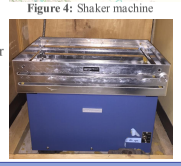


Figure 5: pH meter

Results

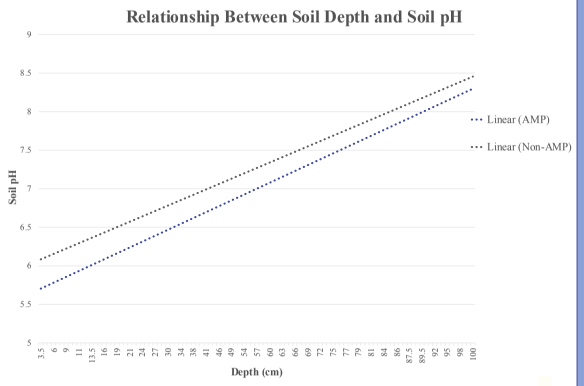


Figure 6: Relationship between soil depth and soil pH from AMP and Non-AMP systems within Alberta.

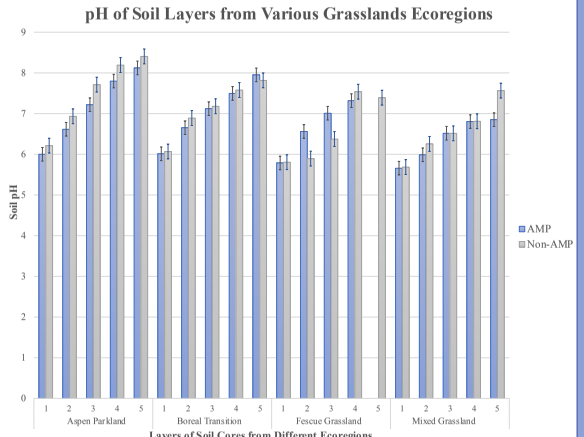


Figure 7: Average soil pH at each depth increment in AMP and Non-AMP grazing systems within the ecoregions of Alberta's grasslands (i.e., Aspen Parkland, Boreal Transition, Fescue Grassland, and Mixed Grassland).

Conclusions

- Areas where error could have occurred resulting in an alteration of data:
  - Faulty or imprecise pH meter.
  - Incorrect data entry or data analysis.
  - AMP practice not being utilized long enough in order to have a significant effect.
- Trends that can be seen throughout the data:
  - Soil pH increases with increasing soil depth.
  - Across all soil depths, the AMP system seems to have slightly lower pH than Non-AMP.
  - Average soil pH seems to differ between the four ecoregions.
  - In both AMP and Non-AMP systems, topsoil is acidic (possible higher SOC concentration) while subsoil is more alkaline (higher concentration of carbonates).
  - The type of grazing system does not appear to considerably impact Alberta's grassland soil pH regardless of soil depth or ecoregion.
- Moving forward:
  - Once SOC data is acquired, the actual correlation between pH and SOC will be established.
  - After all of our samples, which are representative of the entire Canadian grasslands ecosystem, have been analyzed, we will be able to know the potential of the AMP system in increasing carbon sequestration in grasslands soils and alleviating climate change.
  - Ultimately, ranchers who implement improved grazing practices such as the AMP grazing system might be financially compensated for doing so.

Literature Cited

Derner, J. D., & Schuman, G. E. (2007). Carbon sequestration and rangelands: a synthesis of land management and precipitation effects. *Journal of soil and water conservation*, *62*(2), 77-85. Retrieved from http://www.jswconline.org/content/62/2/77.full.pdf+html

Dodds, W. K., Gido, K., Whiles, M. R., Fritz, K. M., & Matthews, W. J. (2004). Life on the edge: the ecology of Great Plains prairie streams. *BioScience*, *54*(3), 205-216. https://doi.org/10.1641/0006-3568(2004)054[0205:LOTETE]2.0.CO;2

Gauthier, D. A., & Wiken, E. B. (2003). Monitoring the conservation of grassland habitats, Prairie Ecozone, Canada. *Environmental Monitoring and Assessment*, *88*(1-3), 343-364. https://doi.org/10.1023/A:1025585527169

Jin, S., & Wang, H. (2018). Relationships between soil ph and soil carbon in china's carbonate soils. *Fresenius environmental bulletin*, *27*(1), 605-611. Retrieved from https://www.researchgate.net/publication/323846896_Relationships_between_soil_pH_and_soil_carbon_in_China's_carbonate_soils

Kalra, Y. P., & Maynard, D. G. (1991). *Methods manual for forest soil and plant analysis* (Vol. 319). Retrieved from http://cfs.nrcan.gc.ca/pubwarehouse/pdfs/11845.pdf

Teague, R., Provenza, F., Kreuter, U., Steffens, T., & Barnes, M. (2013). Multi-paddock grazing on rangelands: why the perceptual dichotomy between research results and rancher experience? *Journal of Environmental management*, *128*, 699-717. Retrieved from https://www.sciencedirect.com/science/article/pii/S0301479713004131

Williams, A. R. (2017). In Defense of Soil Health. Retrieved from https://uknowledge.uky.edu/cgi/viewcontent.cgi?article=1143&context=ky_grazing

Acknowledgements

Thank you to Laio Silva Sobrinho for all of his help and guidance. To Dr. Scott Chang and everyone in my lab, thank you for allowing me to be a part of your team. I also want to thank my lab partner Sarah, and WISEST for this incredible opportunity. Special thanks to Isomass and the Faculty of ALES for sponsoring my lab placement. This project is being funded by the Agricultural Greenhouse Gases Program (AGGP), a federal initiative by Agriculture and Agri-Food Canada (AAFC).