Can the adaptive multi-paddock grazing system increase carbon sequestration in Alberta's grassland soils?

Sarah Breitkreuz[1], Laio Silva Sobrinho[1], Leah Stachniak[1], Scott Chang[1]
[1]Department of Renewable Resources, University of Alberta

Abstract

Natural grasslands cover around 40% of the Earth's surface and play an important role as a source of ecological goods and services. By sequestering around 30% of terrestrial global carbon, grasslands play a critical part in the alleviation of climate change. Despite their ecological significance, grasslands have been reduced to a fraction of their original extent. In Canada, up to 70% of grasslands have been destroyed, making it the most endangered ecosystem in North America. What remains is often intensely grazed and a diverse ecosystem of wild animals is replaced by domestic livestock. The continuous application of poor grazing management by ranchers is one of the main causes for the depletion of natural grasslands, resulting in the release of stored soil carbon back into the atmosphere. Fortunately, 60-70% of the depleted carbon can be re-sequestered through the adoption of improved grazing management, thus improving grassland ecosystems. The Adaptive Multi-Paddock (AMP) grazing system is an example of improved grazing management. AMP grazing is a system in which livestock is frequently rotated between multiple fenced paddocks. Compared to conventional grazing practices (Non-AMP), the AMP system is a favorable solution which can improve carbon sequestration in world wide grasslands soils– and in turn, contribute to the mitigation of climate change. By regenerating grassland ecosystems, AMP grazing could potentially aid in creating a more sustainable, resilient agroecosystem. Our goal is to study the effect of AMP grazing on soil organic carbon (SOC) sequestration in Canadian grasslands. First, we collected soil cores from 30 study sites located throughout the grassland ecoregions in Canada. Each site consisted of a pair of ranches: one AMP and one Non-AMP. Second, we analyzed the soil cores for total carbon using an elemental analyzer. There does not seem to be any substantial difference in total carbon between AMP and Non-AMP systems, however we have yet to differentiate between soil organic carbon and soil inorganic carbon. Once we distinguish the two variables we will be able to confirm the effectiveness of the AMP grazing system in increasing carbon sequestration in Canadian grasslands.

Key words:
adaptive management, adaptive multi paddock, carbon sequestration, soil organic carbon, Canadian grasslands, soil carbon, grasslands, grazing

Cite as: Breitkreuz S., Sobrinho L.S., Stachniak L., Chang S. 2019. Can the adaptive multi-paddock grazing system increase carbon sequestration in Alberta's grassland soils? Alberta Academic Review, Vol 2 (2) 13-14, WISEST Special Issue (non peer-reviewed), DOI 10.29173/aar52.

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

Can the Adaptive Multi-Paddock Grazing System Increase Carbon Sequestration in Alberta's Grassland Soils?

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

Department of Renewable Resources, University of Alberta

Supported By:

Threshold Impact

Introduction

- By sequestering around 30% of atmospheric carbon (C) into their soils, grasslands effectively promote the alleviation of climate change [1].
- Despite their importance, grasslands are one of the most degraded biomes. In Canada, it is estimated that up to 70% of the original grassland habitat has been destroyed [2], which makes it the most endangered ecosystem in North America [3].
- What remains is often intensely grazed and a diverse ecosystem of wild animals is replaced by domestic livestock [4].
- The continuous application of poor grazing management by ranchers is one of the main causes for the depletion of natural grasslands, resulting in the release of stored soil C back into the atmosphere.
- Fortunately, up to 60-70% of the depleted C can be re-sequestered through the adoption of improved grazing and crop management [5], thus improving grassland ecosystems.
- The Adaptive Multi-Paddock (AMP) grazing system is a favorable solution which can improve C sequestration in world wide grasslands soils– and in turn, contribute to the mitigation of climate change. By regenerating grassland ecosystems, AMP grazing could potentially aid in creating more sustainable, resilient agroecosystems [6].

a) b)

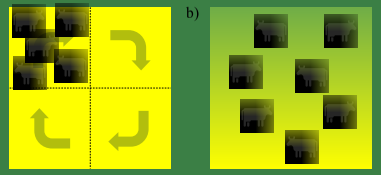

Figure 1: a) AMP grazing is a system in which livestock are frequently rotated between multiple paddocks [7]. b) Non-AMP (N-AMP) grazing system (i.e. Conventional).

Objective

To study the effect of the AMP grazing system on soil organic carbon (SOC) sequestration in Alberta's grasslands.

Methods

- Soil cores were collected from 30 study sites located throughout the grasslands ecoregions in Canada [Fig. 2]. Each site consists of a pair of ranches: one AMP and one Non-AMP located within 1 km of each other.
- 15 soil cores (1m x 5cm) were collected from each ranch using a hydraulic soil probe. The cores were then sectioned into approximately 4 depth ranges (i.e., 0-15cm; 15-35cm; 35-60cm; 60-100cm).
- After being air-dried for 4 days at room temperature, soil from each core section was sieved (2mm) to remove visible roots and gravel.
- Soil was then ground to 0.1mm in an electric ball mill, weighed on a microscale, and finally analyzed for total carbon (TC) by dry combustion in an elemental analyzer.
- Currently, we are working on distinguishing TC into SOC and soil inorganic carbon (SIC).

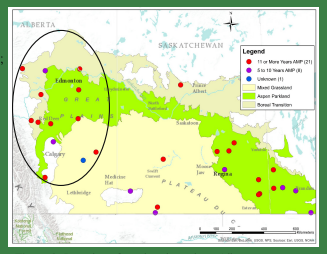

Figure 2: Location of ranches throughout Alberta, Saskatchewan and Manitoba.

Results

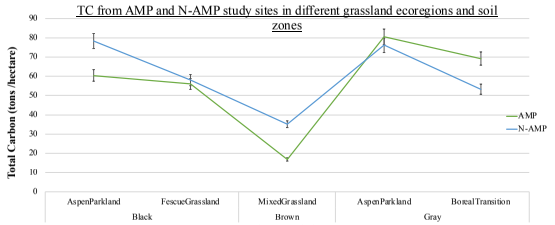

Figure 3: TC in the different Alberta grassland ecoregions and soil zones from which the soil cores were collected.

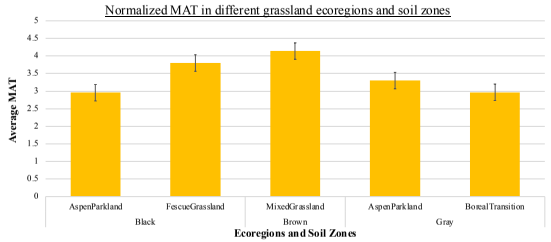

Figure 4: Normalized mean annual temperature (MAT) in different Alberta grassland ecoregions and soil zones.

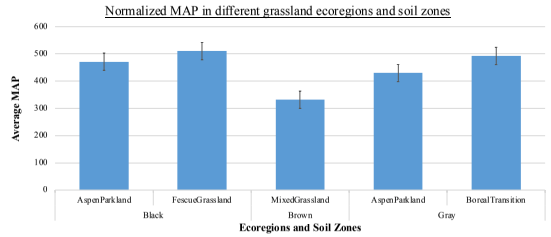

Figure 5: Normalized mean annual precipitation (MAP) in different Alberta grassland ecoregions and soil zones.

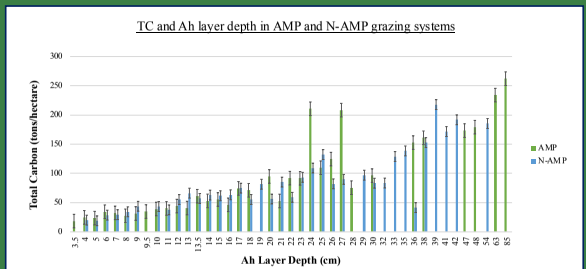

Figure 6: Relationship between TC and Ah layer depth in AMP and Non-AMP grazing systems.

Conclusion

- Some trends that can be seen in the data are as follows:
  - Figure 3:
    - TC varies between ecoregions and soil zones. There does not seem to be substantial difference in TC between AMP and N-AMP systems, however we have yet to differentiate between SOC and SIC within the data.
    - TC appears to follow a positive correlation with normalized MAP [Fig.5] and a negative correlation with normalized MAT [Fig.4]. This indicates that in regions of higher average temperature and lower average precipitation – such as in the Mixed Grassland ecoregion – TC in soil is reduced.
  - Figure 6:
    - As the Ah layer increases in depth, the average TC increases.
- Moving forward:
  - Further soil analysis will allow us to separate SOC and SIC from TC.
  - Additionally, once SOC and SIC analysis is complete for samples from all of our study sites, we will be able to confirm the effectiveness of the AMP grazing system in increasing C sequestration in Canadian grasslands.
  - In terms of agricultural application, our results could support the creation of policies and mechanisms through which ranchers could be given monetary compensation for adopting improved grazing practices such as the AMP system [8].

Acknowledgements

- I would like to thank Dr. Scott Chang for allowing me to work in his lab. Thank you to my supervisor Laio Silva Sobrinho for helping me throughout my program, as well as my partner Leah and the rest of my lab. Special thank you to Threshold Impact and the Faculty of ALES for sponsoring my lab placement. Additionally, I would like to thank WISEST for organizing this program.
- This project is being funded by the Agricultural Greenhouse Gases Program (AGGP), a federal initiative by Agriculture and Agri-Food Canada (AAFC).

Literature Cited

[1] 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.
[2] Gauthier, D. A., & Wilken, E. B. (2003). Monitoring the conservation of grassland habitats, Prairie Ecozone, Canada. *Environmental Monitoring and Assessment*, *88*(1-3), 343-364.
[3] Samson, F., & Knopf, F. (1994). Ranchland: prairie conservation in North America. *BioScience*, *44*(6), 418-421.
[4] Kraus, D. (2016). Why Canada's Prairies are the World's Most Endangered Ecosystem. Retrieved from: http://www.natureconservancy.ca/en/blog/archive/grasslands-the-most.html#.XUmE-hK370
[5] Lal, R. (2002). Soil carbon dynamics in cropland and rangeland. *Environmental pollution*, *116*(3), 353-362.
[6] Teague, W. R. (2018). Forages and pastures symposium: Cover crops in livestock production: Whole-system approach: Managing grazing to restore soil health and farm livelihoods. *Journal of animal science*, *96*(4), 1519-1530.
[7] 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.
[8] Manning, L. (2019). Montana Ranchers Can Now Get Paid to Sequester Carbon Using Rotational Grazing Practices. Retrieved from: https://agfundernews.com/rotational-grazing-pays-montana-ranchers.html