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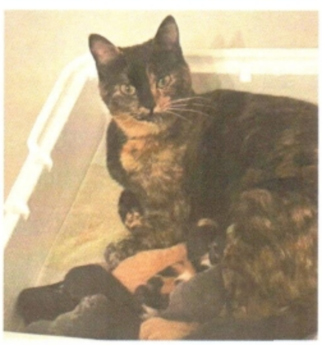
Spring, Babies & Emergence

Top: Spring grazing at Ward's

Side: Grass emergence at Frost's

Bottom: Spring babies at Bondaroff's

Bottom right: Fodder Galega emergence at the Beaverlodge Research Farm



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Adaptive Multi-paddock Grazing in Western Canada, Series

Installment #3

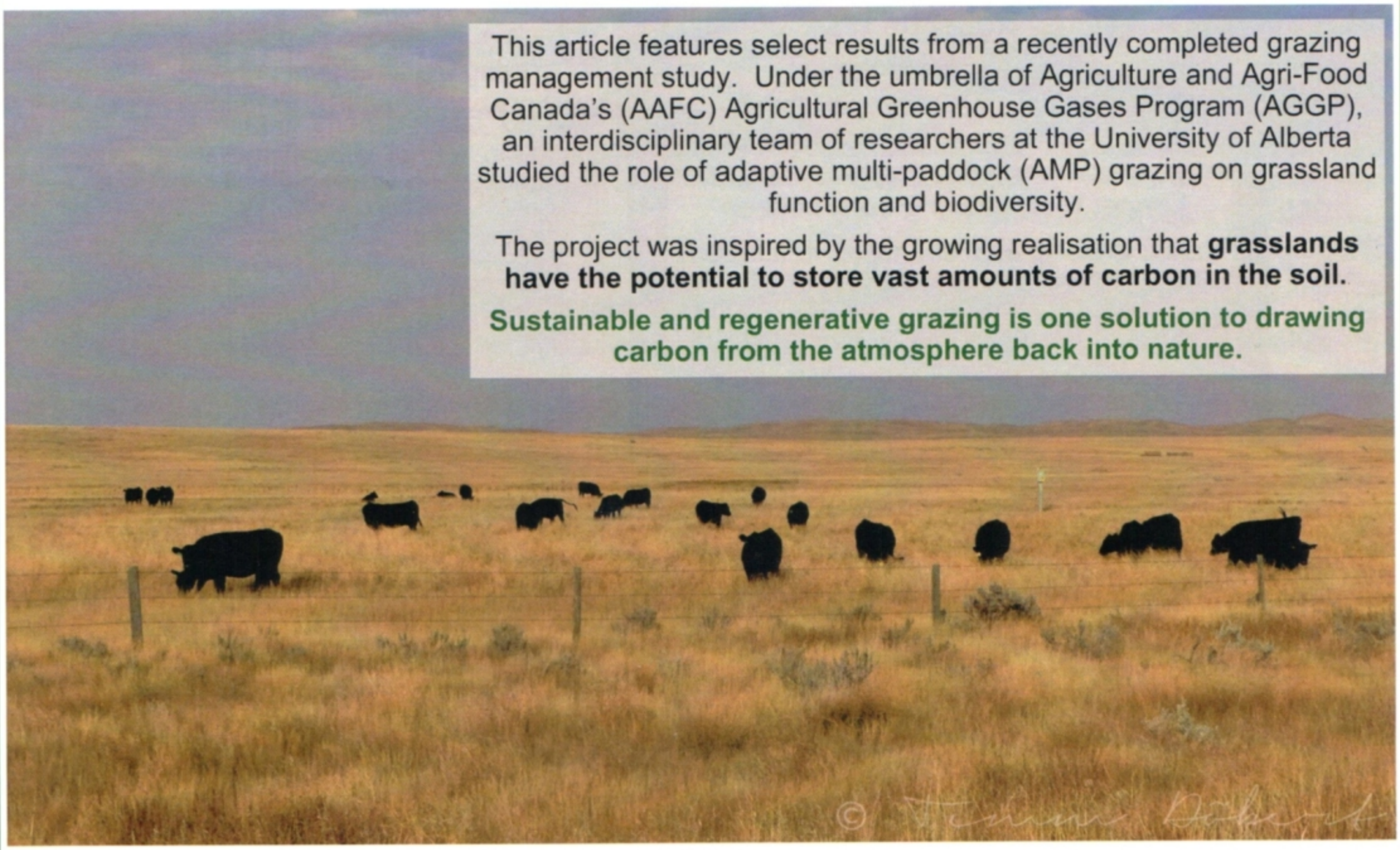
The Influence of Management Practice on Water Infiltration in Grazed Grasslands

by Dr. Timm Döbert

Across Canada about 3-10% of cattle producers use some form of adaptive multi-paddock grazing.

With Adaptive Multi-Paddock (AMP) grazing producers:
1. subdivide the land into **many smaller paddocks**,
2. use **high animal densities for short periods** to attain 'more uniform' forage use, and
3. allow for **long recovery prior to re-grazing** to promote plant growth and vigour.

Suggested benefits with AMP grazing include an improved net carbon balance, more above & below ground biomass and higher water infiltration. Together, this should lead to healthier and more fertile soils, with trickle down benefits for grassland productivity and function.



This article features select results from a recently completed grazing management study. Under the umbrella of Agriculture and Agri-Food Canada's (AAFC) Agricultural Greenhouse Gases Program (AGGP), an interdisciplinary team of researchers at the University of Alberta studied the role of adaptive multi-paddock (AMP) grazing on grassland function and biodiversity.

The project was inspired by the growing realisation that **grasslands have the potential to store vast amounts of carbon in the soil.**

Sustainable and regenerative grazing is one solution to drawing carbon from the atmosphere back into nature.

Investigating Water Infiltration

WHERE: To test the hypothesis of improved water infiltration, we selected **52** beef cattle ranches for data collection. These ranches were distributed across the three prairie provinces Alberta, Saskatchewan and Manitoba. The large study scale allowed us to capture the natural variation in climate, soils and vegetation. Sampling across such broad gradients was important to account for the natural and management diversity.

RANCH PAIRS: The ranches were organised as pairs by matching an AMP-grazed ranch with a ranch neighbour using different (& often more conventional) grazing practices. A neighbouring ranch was deemed a suitable study match if soils and cultivation history were comparable to the AMP grazer.

HOW: We used a so-called dual head infiltrometer to record the ease with which water infiltrated the soil. **Plant litter, soil texture and bulk density** are known to **influence the movement of water in grassland** ecosystems. To account for these biophysical parameters in our analyses we also collected soil and vegetation samples.

The Influence of Management Practice on Water Infiltration in Grazed Grasslands continued...

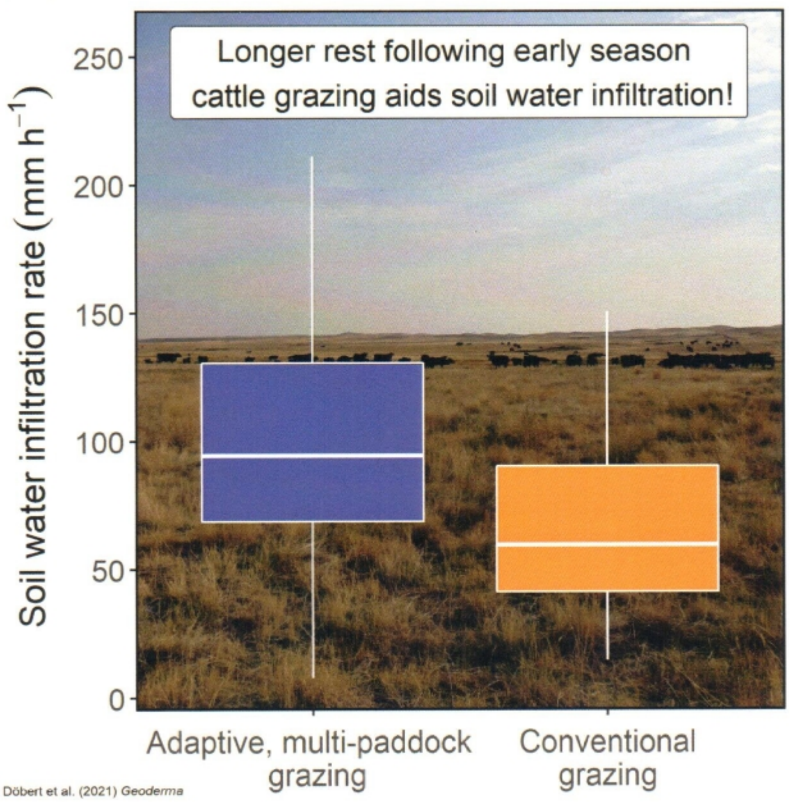
Impact of Plant Litter, Soil Texture & Soil Density on Water Infiltration

We first tested the relationship between water infiltration and the three biophysical parameters.

* Results showed a positive relationship between water infiltration and plant litter, a finding that was expected. Bare soil can lead to run-off, erosion and evaporation. Vegetation cover, in contrast, traps water and snow, which benefits the infiltration of water into the soil.
* Bulk density is a measure of soil compaction. Our finding of reduced water infiltration under higher bulk density was therefore expected.
* More difficult to interpret was the higher rate of infiltration under clay-rich compared with sandy soils. Clay-rich fine soils have smaller pore sizes but also a higher water holding capacity. We speculate that the latter may increase infiltration under water-saturated conditions.

Impact of Grazing Management on Water Infiltration

The primary focus of our research was to explore the influence of grazing management on water infiltration. We first tested how grasslands with Adaptive Multi-Paddock (AMP) grazing compared to neighbouring properties.



Döbert et al. (2021) *Geoderma*

Early Season Grazing refers to grazing prior to August 1st

Our findings showed that, **water infiltration rates on AMP ranches were on average 30% higher.**

This finding suggests that AMP systems may favour water capture and retention, and in turn increase opportunities for plant growth.

Grazing management is complex but also individual in that every ranching operation is unique.

It is therefore important to understand what characterises AMP grazing and the role of actual management practices.

In a second step, we tested the effects of more nuanced grazing practices on water infiltration, in addition to climate and soil. For this purpose, our research team developed a number of parameters describing historical and contemporary management metrics. These were based on ranch management surveys collected from every rancher participating in our study. A more detailed comparison of these grazing practices was published by Dr. Edward Bork in a fall edition of this newsletter (2021 Fall Newsletter, #88).

A complete summary of Dr. Bork's findings can be found in Comparative Pasture Management on Canadian Cattle Ranches With and Without Adaptive Multipaddock Grazing by Bork and others (2021), recently published in the journal Rangeland Ecology and Management.

The Influence of Management Practice on Water Infiltration in Grazed Grasslands continued...

We selected four of the detailed management parameters for our analyses: cultivation history, stocking rate, stock density and rest-to-grazing ratio.

* Grassland cultivation, which is usually associated with seeding to tame pasture, profoundly alters environmental processes. Understanding the land use history is important so that legacy effects can be considered.
* Stocking rate is commonly used as a measure of carrying capacity. However, this metric fails to account for the herd-effect used in AMP grazing, which instead is represented by stock density.
* The other unique characteristic of AMP grazing is a significantly longer grassland recovery period following early-season grazing. The rest-to-grazing metric expresses this relationship.

Dual head infiltrometers record the ease with which water infiltrates the soil and provide a vertical flow rate metric.
Photo credit: Patrick Daniels

What is it about AMP Grazing that impacts Water Infiltration?

* Our analyses showed that soil density had a stronger influence on water infiltration than plant litter or soil texture.
* Among the grazing practices, the **extended recovery period** proved **most critical** resulting **in higher water infiltration rates.**
* In contrast, we found no evidence that the herd effect, as regulated by animal stock density, leads to improved water infiltration. Instead, we detected a negative trend between water infiltration and stocking rate.

Take home Message about Water Infiltration & AMP Grazing

The **benefits of Adaptive Multi-Paddock (AMP) grazing are tied to how cattle graze** and not the amount of grazing. In other words, we show **the importance of rest periods on water infiltration,** rather than an effect of livestock presence directly.

"If we can adopt certain changes like a longer rest period, then this might be very beneficial for having more water. It stimulates more productivity, which is good for the producer, but at the same time reduces the carbon footprint. So we're sparking some ideas of what could be done."

Water Infiltration Study links:

SKPrairieConservationActionPlan(SKPCAP) webinar
https://www.youtube.com/watch?v=KazxPNFPkFA

Rural Routes to Climate Change podcast
https://rr2cs.ca/ep40-grazing-for-water-infiltration/

Rural Routes to Climate Change webinar
https://rr2cs.ca/grazing-for-water-management-january-21st-2022/

The Western Producer article
https://www.producer.com/livestock/rotational-grazing-boosts-water-use/

Geoderma paper:
https://www.sciencedirect.com/science/article/pii/S0016706121003943

The Influence of Management Practice on Water Infiltration in Grazed Grasslands continued...

Bringing Together: Grazing, Water/Carbon Cycles, Ecosystem Models and Carbon Offsets

As part of this larger AGGP study, we also looked at the influence of grazing management on greenhouse gas emissions on the ranch. What we found was that carbon dioxide (CO_2) emissions go up as the stocking rate increases, especially under high moisture conditions. This finding reinforces that high stocking rates not only suggest a negative trend for water infiltration but also higher CO_2 emissions from the soil.

These two studies show that water is not only critical as a resource for plants but also closely tied to carbon dynamics. In fact, **the movement of water strongly influences the fate of organic carbon in the soil.** Processes like erosion, leaching, runoff and other forms of vertical and horizontal water movement transport soil and with it organic carbon. The **water and carbon cycles are inseparable** & **understanding trade-offs as a consequence of land management is increasingly important**. This is particularly true for western Canada's drought-prone regions.

Western Canada's prairie grasslands are increasingly recognised for their potential as nature-based solutions. In addition to carbon sequestration and storage, these grasslands are important for biodiversity conservation and for food security. Managing land for different purposes is challenging in that different goals need to be carefully balanced.

In my current role as a postdoctoral fellow, I work with the Watershed Science & Modelling Laboratory team under guidance of Dr. Monireh Faramarzi. Over the past few years, Dr. Faramarzi and her students have developed a process-based hydrological model of the Nelson River Basin (NRB). The NRB extends from the eastern slopes of the Rockies into western Ontario and the northern United States. The building blocks for this complex watershed representation included soil, climate, topography and streamflow data. The next step is to calibrate this model for soil organic carbon (SOC). Calibration means, we are comparing model predicted SOC data to field-sampled SOC reference data. These reference data are necessary to improve the model, so that after many simulations and fine-tuning of model parameters, the predicted data are as close of a representation as the field-sampled data as possible. Once this model building has been completed we can run so-called scenarios. These scenarios allow us to explore how SOC would be influenced by land use or management changes. For example, **we are specifically interested to understand the fate of SOC as a result of avoided conversion of grassland** ('conservation scenario') **and cropland to perennial grassland** conversion ('restoration scenario'). This research is a puzzle piece towards generating **mapping products** that **will allow us to determine how a certain change in land use or management will influence water, carbon or biodiversity**. In other words, we will be able to consider trade-offs, with the goal of maximising the benefits of land resources.

Carbon market mechanisms through which ranchers can be rewarded for protecting, restoring and well-managing grasslands are of growing interest. Carbon offset protocols are needed to outline and regulate the details of carbon trading. The development of such protocols requires an improved understanding of the fate of SOC under different land use and management scenarios. Field-based carbon measurements are not economic at regional scales. **Predictive modelling is** therefore a **critical tool for accelerating the implementation** of **grazed grassland carbon offset schemes**.

While this particular project focuses on the NRB, Dr. Faramarzi's research also addresses other watersheds in western Canada. More information on her work in the context of water quality and quantity, climate change and food security can be found here: https://cms.eas.ualberta.ca/faramarzilab/

Dr. Timm Döbert is a postdoctoral fellow at the University of Alberta. He currently works with Dr. Monireh Faramarzi who heads the Watershed & Science Modelling Lab. His research focuses on process-based modelling of soil organic carbon in western Canada's prairie grasslands. Previously, he worked with Prof. Mark Boyce on a large-scale grazing management study. In collaboration with an interdisciplinary team of scientists, he investigated the influence of adaptive multi-paddock grazing on ecosystem function and biodiversity. Dr. Döbert is a tropical ecologist by training and previously studied human impacts on tropical forest ecosystems in Southeast Asia. His next project will see him cycle from Alaska to Patagonia in the context of a migratory bird conservation-education initiative called Flyway Heroes https://flywayheroes.com/.
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