Carbon Sequestration 101: The Value of Native Prairie for Carbon Storage

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Intuitively, ranchers know that native prairie grasslands provide a range of beneficial ecosystem services, including carbon sequestration, but it can be confusing to sort out exactly how carbon dynamics and grasslands are related. How much carbon is stored below ground? Can different land management practices impact carbon sequestration? Does grazing help or harm carbon storage?

Every industry around the globe, including the beef and forage value chain, has a carbon cycle with both *carbon sources* and *carbon sinks*. Carbon sources emit more carbon than they capture, for example, carbon dioxide (CO_2) emissions from burning fossil fuels to plant, harvest or feed forage. A carbon sink is a part of the system that stores or sequesters more carbon than it gives off over time, such as grasslands and perennial forages, forests and wetlands.

Grasslands are the cornerstone of Saskatchewan's cow-calf operations; however, they also represent a critically-important source of carbon sequestration for Canada and around the world. Grassland ecosystems represent the predominant global agricultural land use and more than one third of the planet's carbon stocks are stored in grassland habitats. Here in Canada, scientists estimate there are between 50 and 200 tonnes of carbon per hectare stored belowground in perennial grasslands with another three to 12 tonnes of carbon per hectare stored in plant litter and above-ground plant growth.

During Prairie Conservation Action Plan's (PCAP) Prairies Got the Goods Week in March 2021, Dr. Edward Bork, University of Alberta's Mattheis Chair in Rangeland Ecology and Management, discussed carbon dynamics in grasslands.

"Here's what we do know — if you take these long-lived, long-established perennial grasslands and you turn them into cropland, you lose a lot of carbon," Bork explained.

He added that tame perennial forage sequesters more carbon than annuals, but native prairie is the gold standard for carbon storage.

"The bottom line is these native grasslands store a significant amount of carbon — much more so than many of our agronomic systems, whether they are planted domestic forages or they are annual cropped areas," Bork said.

Grassland carbon sequestration is a dynamic process. During peak plant growth in spring and summer months, plants take in CO_2, a greenhouse gas, for plant growth. When soil microbes and enzymes break down plant litter in late summer and fall, or in moist settings, the system experiences weak carbon loss through CO_2 emissions. Methane (CH_4), another greenhouse gas, can also be absorbed and emitted by grasslands.

Grazing benefits carbon storage

Bork noted that a network of long-term ungrazed and grazed study sites in Alberta demonstrated that carbon storage improved with grazing.

"The presence of grazing animals actually maintains or even increases soil carbon concentration by up to 12 per cent," Bork explained. "If we remove grazing, our data is showing that we actually lose carbon."

Bork said that in order to be effective, grazing has to occur at sustainable levels. He said that defining sustainable grazing management is a challenge and management is a continuum, "Simple categories of management do not represent real-world variation."

A team of researchers embarked on a study of sites across Alberta, Saskatchewan and Manitoba to compare specialized rotational grazing systems to conventional grazing. The study referred to rotational grazing as adaptive multi-paddock (AMP) grazing; though, producers may know it as mob grazing, high-intensity/low-frequency, or holistic grazing.

More carbon is sequestered in forests than in grasslands; however, it is primarily stored above ground where it is vulnerable to forest fires which release CO_2 back into the atmosphere. In contrast, grasslands and perennial forage store up to 97 per cent of their carbon below ground where it remains stable.

"Regardless of what you call it, these are all specialized rotational grazing systems," Bork said.

The collaborative study was intended to determine whether AMP management would improve carbon storage and increase greenhouse gas uptake.

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The study paired 30 AMP sites with 30 neighbouring conventional sites within the same soil polygon and with similar cultivation history, including uncultivated grassland. The sites represented a range of climate and soil types across the Prairie Provinces. A subset of paired sites was further sampled to assess soil carbon and greenhouse gas emissions. Key findings were shared during Prairie's Got the Goods and the recording are posted at **https://www.pcap-sk.org/upcoming-events/prairies-got-the-goods-week**.

In addition to Bork's work, Dr. Bharat Shrestha, Agriculture and Agri-Food Canada, presented that soil greenhouse gas fluxes did not differ between AMP and conventional grazing sites; however, greenhouse gases were impacted by factors like cattle stocking rate and cultivation history. For example, grasslands that had never been cultivated had a higher uptake of CH_4 in their systems.

"AMP grazed grasslands had greater carbon sequestration in the topsoil," explained Dr. Shrestha.

He attributed the improved carbon storage in the top 15 centimetres of soil to the increase in cattle stocking rates combined with a longer rest period after grazing. Increased carbon comes from animal impact from grazing which tramples litter into soil; from plants that have a grazing-induced tendency toward setting down additional shallow roots; and from grazing-tolerant plants that increase production.

Bork said using local knowledge and experience and understanding the impacts of management practices will be key if there is going to be a type of offset payment for carbon storage or reduced greenhouse gas emissions. Every sector has a carbon footprint; however, managing grasslands with sustainable grazing is part of the solution.