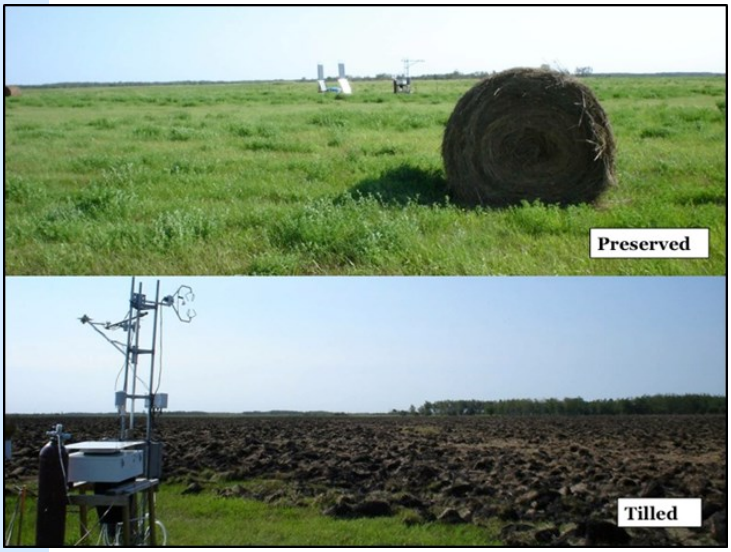
# PRESERVATION OF PERENNIAL FORAGE LANDS IN THE EASTERN PRAIRIES

BENEFICIAL MANAGEMENT PRACTICE (BMP) FOR GREENHOUSE GAS MITIGATION

## WHAT SHOULD WE DO?

- Preserve lands that have perennial forages, including pasture and land for hay and forage seed production. Include nitrogen-fixing perennial forages such as alfalfa where possible.




An example of research where the exchange of carbon was measured over a preserved perennial (hay) field (top) and over a previously perennial field that was recently tilled to plant annual crops (bottom). The instruments in the photograph were used to measure the rate of the carbon exchange continuously.
(photos: B.D. Amiro)

## WHY SHOULD WE DO IT?

- Agricultural lands that were inherently rich in soil organic matter, such as the chernozems of the Prairies, evolved under perennial vegetation dominated by grasses. Long-term measurements have demonstrated that some of this soil organic matter has been lost in Canada following decades of cultivation and planting of annual crops. This carbon loss has increased atmospheric carbon dioxide. Maintenance of existing perennial lands helps to remove carbon dioxide from the atmosphere.

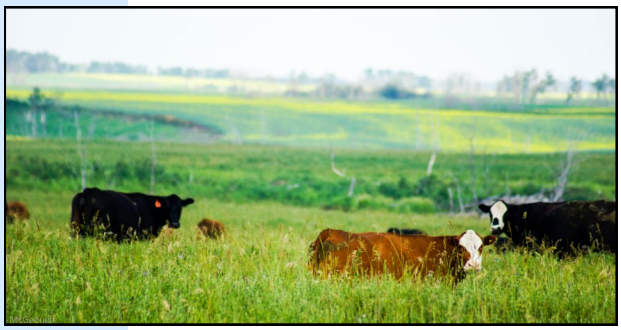
## HOW SHOULD WE DO IT?

- The choice of land use is normally up to the producer, and land classification, economics, and operations are all considered. However, the value of the carbon stocks in perennial lands needs an improved assessment to reward producers who manage perennial lands for ecological benefits.

Forage lands for cattle near Brandon, Manitoba (photo: A.M. Taylor)

Forage lands for cattle in western Canada (photo: E. McGeough)

## WHERE SHOULD WE DO IT?



Forage lands for cattle overlooking fields sewn with canola (photo: E. McGeough)

- Many ecosystems will preserve carbon if they remain in a perennial state.
- The most gain is probably in agricultural areas where there is still inherently high soil organic matter: these areas have the most to lose, whereas soils with low organic matter have less potential loss.

## POTENTIAL ADVANTAGES:

- Reduced carbon loss: one recent study estimates a saving of as much as 1 tonne carbon per ha per year
- Maintaining organic matter benefits soil organisms and water holding capacity
- Including nitrogen fixing perennial legumes like alfalfa reduces the need to add nitrogen fertilizer which can increase nitrous oxide emissions
- Vegetation on the land during spring and fall seasons provides a longer growing season to capture sunlight and carbon dioxide
- No need for annual planting
- Increased evapotranspiration, especially in spring and fall may reduce flooding
- Deeper roots increase water infiltration, creating deep water storage and less ponding
- Increased biodiversity of the agricultural ecosystem

*"one recent study estimates a savings of as much as 1 tonne carbon per hectare per year"*

## POTENTIAL DISADVANTAGES AND UNCERTAINTY:

- Carbon loss may be greater with certain grazing practices, or with multiple hay cuts in a season
- Perennial forages need to be consumed by ruminants such as cattle and sheep, and ruminants emit enteric methane
- Producers may need to change their management strategy because of markets
- In some cases, additional carbon can tie up nitrogen in the soil, making nitrogen less available to plants

## HOW DO WE KNOW THIS?

- There are two basic techniques to measure the effects of a management practice on soil carbon. One method is to measure soil carbon inventories at two points in time, typically several years apart. This method integrates over different weather conditions, but it requires a treatment to be in place over a long time (often at least a decade) to be able to pick up differences.
- The second method is to measure the carbon dioxide exchange between the atmosphere and a field, either using enclosed chambers or a meteorological method that tracks the vertical transport of carbon dioxide in the atmosphere. The advantage here is that we can get carbon gains or losses for each season and for specific crops in an annual rotation. However, the results may depend on the weather conditions in each year.

## RESEARCH HIGHLIGHTS

**Examples of studies that included measurements and modelling of carbon stock changes following conversion of native ecosystems to annual cropping systems:**

Gregorich, E.G., et al. 2005. Greenhouse gas contributions of agricultural soils and potential mitigation practices in Eastern Canada. Soil Tillage Res. 83:53-72.

- Calculations for soils in eastern Canada that were converted from native ecosystems to annual cropping systems suggest a loss of 22% of the original soil organic carbon, which is about 123 million tonnes of carbon lost to the atmosphere.

VandenBygaart, A. J., et al. 2010. Soil organic carbon stocks on long-term agroecosystem experiments in Canada. Can. J. Soil Sci. 90: 543-550.

- Comparisons of carbon stock changes at some western Canadian long-term plots indicate that perennial crops have a carbon gain advantage of about 0.6 tonnes carbon/ha/year.

**Micrometeorology measurements of greenhouse gases in Manitoba:**

**Data on the comparative carbon exchange over preserved and tilled fields in Manitoba:**

Taylor, A.M., et al. 2013. Net $CO_2$ exchange and carbon budgets of a three-year crop rotation following conversion of perennial lands to annual cropping in Manitoba, Canada. Agric. Forest Meteorol. 182-183: 67-75.

Fraser, T.J. and B.D. Amiro. 2013. Initial carbon dynamics of perennial grassland conversion for annual cropping in Manitoba. Can. J. Soil Sci. 93: 379-391.

- A Manitoba field converted to annual crops from perennial crops lost between 0.5 and 1.5 tonnes carbon/ha/year, whereas a preserved perennial field gained about 0.3 to 0.4 tonnes carbon/ha/year. This included harvest removals and manure additions to the annual crops.

**Data on the carbon and nitrous oxide exchange differences when a field is converted from annual cropping to alfalfa:**

Maas, S.E., et al. 2013. Net $CO_2$ and $N_2O$ exchange during perennial forage establishment in an annual crop rotation in the Red River Valley, Manitoba. Can. J. Soil Sci. 93: 639-652.

- Establishment of an alfalfa crop (perennial) on land that was annually cropped in Manitoba showed an annual greenhouse gas sink of about 4 tonnes $CO_2$ equivalents/ha/year whereas the annual crop emitted about 2 tonnes $CO_2$ equivalents/ha/year.

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