

# Carbon and Climate Change

**Making Sense of the Big Picture**

# About Me



UNIVERSITY OF  
REGINA

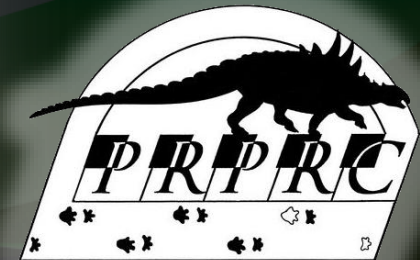


RSM

ROYAL  
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of  
Saskatchewan



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# The Background



# What is Climate Change?

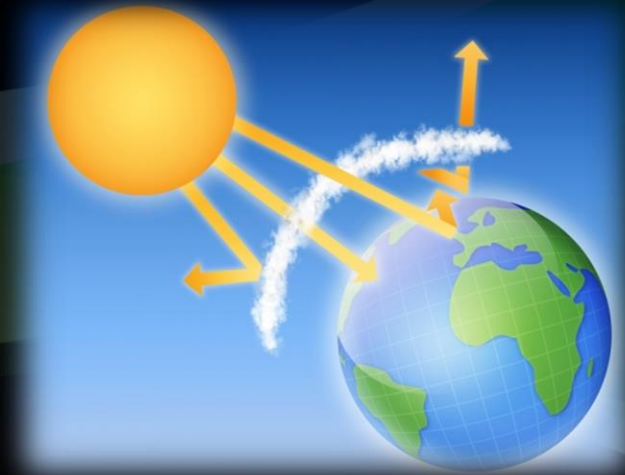
- **Def:** any significant change in the measures of climate lasting for an extended period of time (decades to millions of years).
- Includes major changes in:
  - Temperature
  - Precipitation
  - Wind patterns
  - Other effects
- **Not to be confused with Global Warming**





# What is Global Warming?

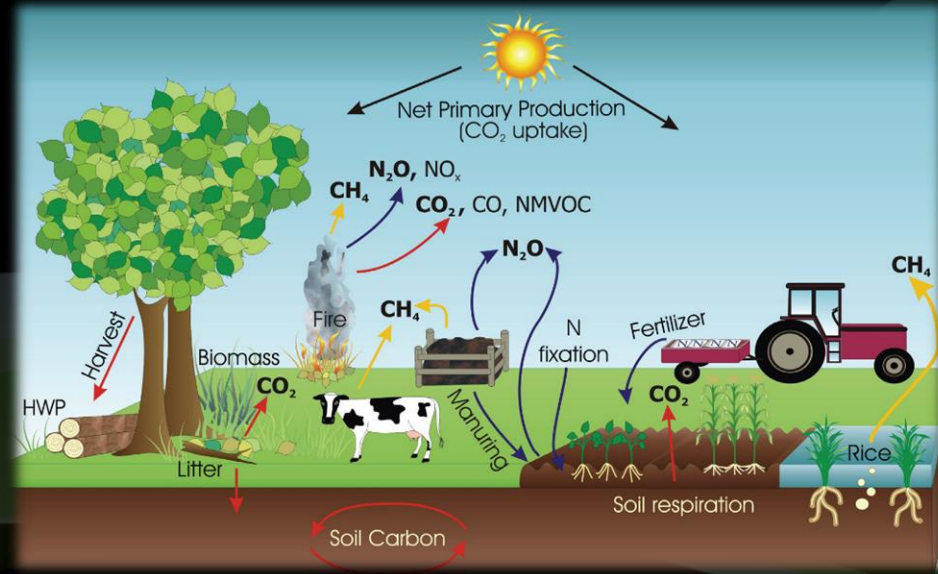
- **Def:** a rise in global average temperature near Earth's surface.
- Represents only one aspect of climate change.
- Caused by :
  - Variations in solar output
  - Variation in earth's orbit
  - Increasing concentrations of greenhouse gases in the atmosphere
- Global warming is causing climate patterns to change.



# Greenhouse Gasses (GHGs)

- **Def:** Gases that absorb and emit radiation in the infrared range including that re-emitted by earth.

- Water Vapor (H<sub>2</sub>O)
- Ozone (O<sub>3</sub>)
- Carbon Dioxide (CO<sub>2</sub>) most abundant
- Methane (CH<sub>4</sub>) – **25x** CO<sub>2</sub>e
- Nitrous Oxide (N<sub>2</sub>O) – **298x** CO<sub>2</sub>e
- CFCs and HFCs – **675x to 14,800x** CO<sub>2</sub>e



- 32.1 metric gigatons of CO<sub>2</sub> emissions yearly
- CO<sub>2</sub> concentrations in the atmosphere have reached **400ppm** after being only **280ppm** in 1750.

# The Problem



# Why is increasing GHGs a problem?

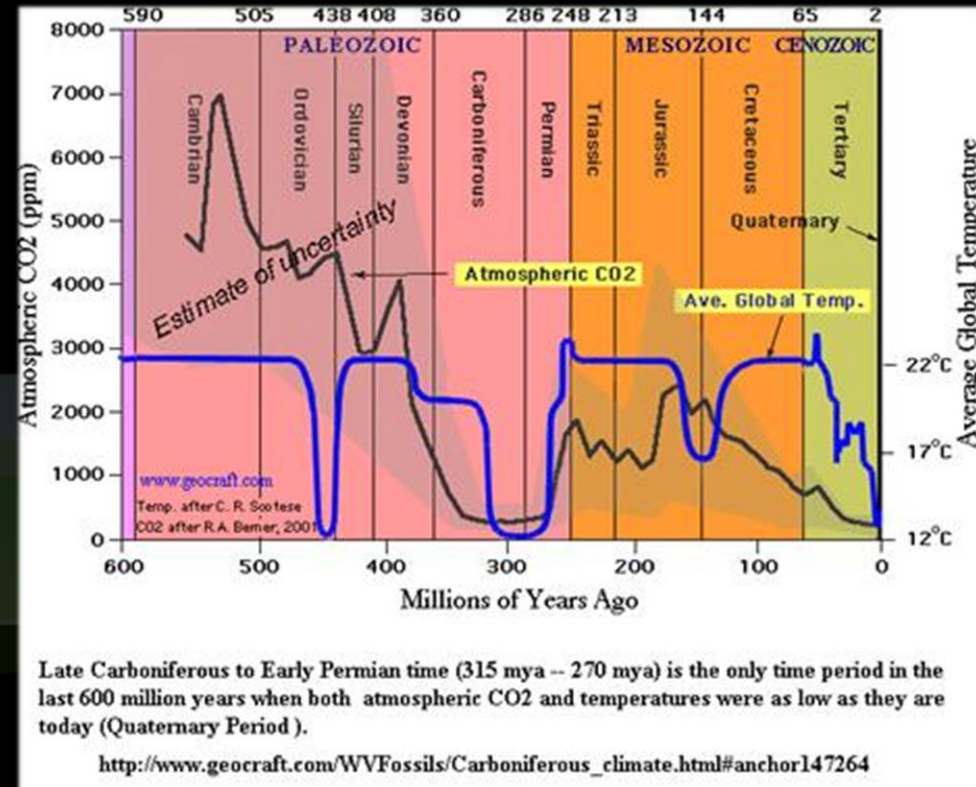
- **Increasing temperatures** (especially in continental interiors in northern hemisphere)
- **Altered precipitation patterns**
- **Increased extreme weather occurrences**
- **Melting polar ice caps and sea level rise**
- **Melting of permafrost** (holds 2x carbon currently in atmosphere)
- **Acidification of soils and oceans**
- **Changing oceanic currents**
- **Migrating habitat boundaries for problem species and diseases**



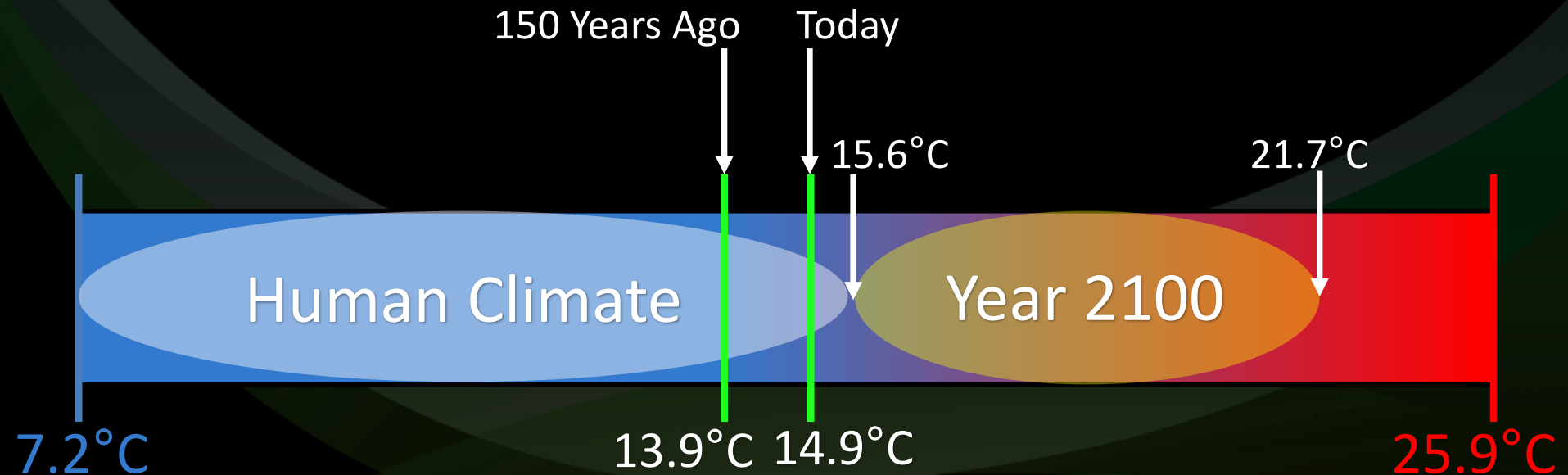


# Carbon Fertilization Effect

- More atmospheric CO<sub>2</sub> = increased photosynthesis
- Documented increases but highly dependent of soil moisture and nutrients
- Does not make up for emission levels



# The Global Thermometer



# The Proposed Solution:

Putting a Price on Carbon



# Carbon Tax vs. Cap and Trade

## Carbon Tax

- Tax on GHG emitters
- Increases over time to encourage GHG reductions
- Easy to implement and stable carbon price
- Decrease in emissions uncertain
- Supposed to be revenue neutral

## Cap and Trade

- Cap on emissions for large emitters
- Cap decreases over time to encourage GHG reductions
- Carbon offsets
- Prices subject to a volatile carbon market
- Guaranteed emission reductions



# Putting a Price on Carbon In Canada

- **December 11, 1997** – **Kyoto Protocol** signed Canada agreed to 6% total GHG reduction below 1990 levels by 2012
- **December 18, 2009** – **COP 15, Copenhagen Accord** signed by Canada. Canada agreed to reduce its GHG emissions by 17% from its 2005 levels by 2020
- **December 11, 2010** – At **COP 16** meeting Canada signed the **Cancun Agreement** reiterating same targets they had set in the Copenhagen Accord
- **December 13, 2011** – Canada became first signatory to announce its **withdrawal from the Kyoto Protocol**
- **April 22, 2016** – **Paris Agreement** Signed to limit global warming to less than 2 degrees Celsius and pursue efforts to limit it to 1.5 degrees Celsius above preindustrial levels. Canada agreed to cut GHG emissions by 30% below 2005 levels by 2030.
- **October 3, 2016** – **Canada announces carbon pricing scheme** with a minimum introductory price of \$10 per tonne rising to \$50 per tonne by 2022. The goal is to meet the original Copenhagen Accord.
- **November, 2017** – COP 23 in Bonn, Germany. **International price on carbon?**

# Current Carbon Taxation Systems

## British Columbia (Carbon Tax)

- \$10/tonne in 2008 and increased to \$30/tonne by 2012
- Administered to fuel wholesalers with trickle down effect to the consumers
- The carbon tax is revenue neutral by law

## Alberta (Hybrid System)

- 2007 Cap and Trade on high intensity emitters (100,000 tonnes) aimed at a 12% reduction
- \$20/tonne tax on fuels beginning in 2017 increasing to \$30/tonne in 2018

# Carbon Taxation Exemptions

## British Columbia

- There was no exemption for agriculture prior to 2014
- An exemption for farm fuel was granted
- Propane used by qualifying farmers for a farm purpose
- Also changed in 2014:
  - Annual rebate of up to \$200 to northern and rural homeowners
  - 80% rebate for greenhouse growers

## Alberta

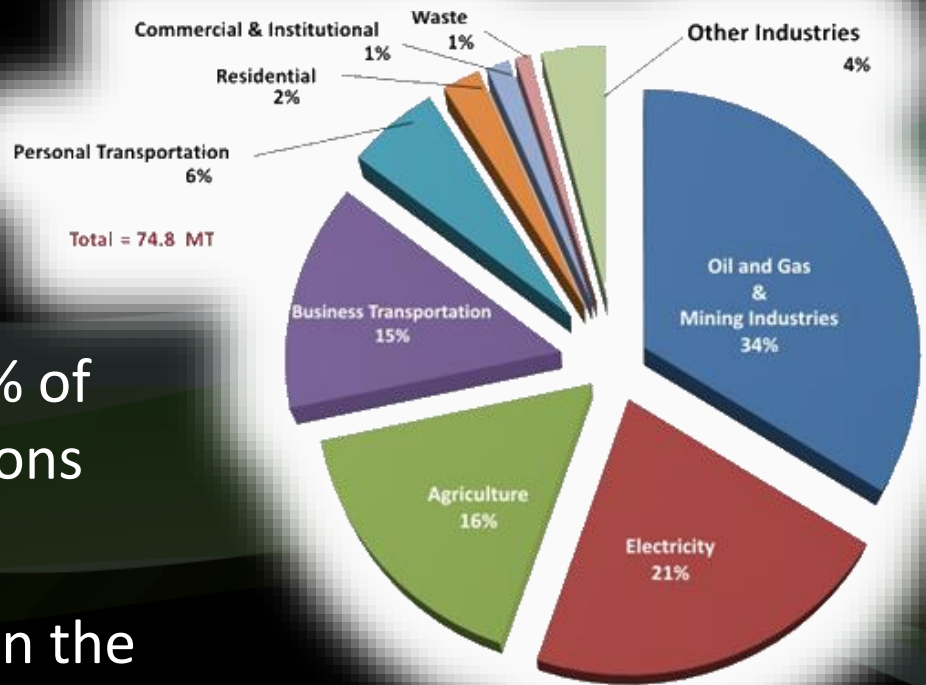
- Marked farm fuels are exempt

### Announced Besides:

- **\$10 million** in programs to help farm operations reduce their emissions and save on energy bills through efficiency upgrades

# GHG Emissions in Saskatchewan

- Saskatchewan accounts for 10% of Canada's GHG emissions with only 3% of the population
- Agriculture accounts for 16% of Saskatchewan's GHG emissions
- Agriculture GHG is emitted in the form of carbon dioxide, methane, and nitrous oxide



Source: Environment Canada National Inventory Report, 1990-2012



# What Could This Cost Me?

**\$10 – \$15/acre** (at \$50/tonne)

**Scott Moe** SK Minister of Env (March 3<sup>rd</sup>, 2017)

- **Farm fuel consumption** in field operations based on fuel usage from the provincial crop planning guide
- **Agriculture energy** (excluding farm fuel) – natural gas, electricity, propane and other fuels
- **Fertilizer** (nitrogen and phosphorous) based on emissions from the production, storage and transportation of fertilizer from the manufacturing plant to the farm gate
- **Pesticides** based on emissions from the production, packaging and transportation of pesticides from the plant to the farm gate
- **Grain transportation** from the farm gate to port position based on average fuel consumption

# What Could This Cost Me?

## IHARF Soil and Crop Management Seminar (February 1<sup>st</sup>, 2017)

**Dr. Mario Tenuta** Faculty of Agricultural and Food Science at the University of Manitoba

POTENTIAL TAX TO FARMERS*		
Level of carbon tax	Potential user tax per acre	Potential manufacturer's tax per acre*
\$20/tonne CO <sub>2</sub>	\$7.63	\$1.66
\$30/tonne CO <sub>2</sub>	\$11.45	\$2.49
\$50/tonne CO <sub>2</sub>	\$19.08	\$4.14
\$100/tonne CO <sub>2</sub>	\$38.16	\$8.29

Based on fertilizer use of 100 kg of N per hectare, or 89.2 pounds per acre. (\*This table was updated on March 21 to correct errors in the final row of the table).

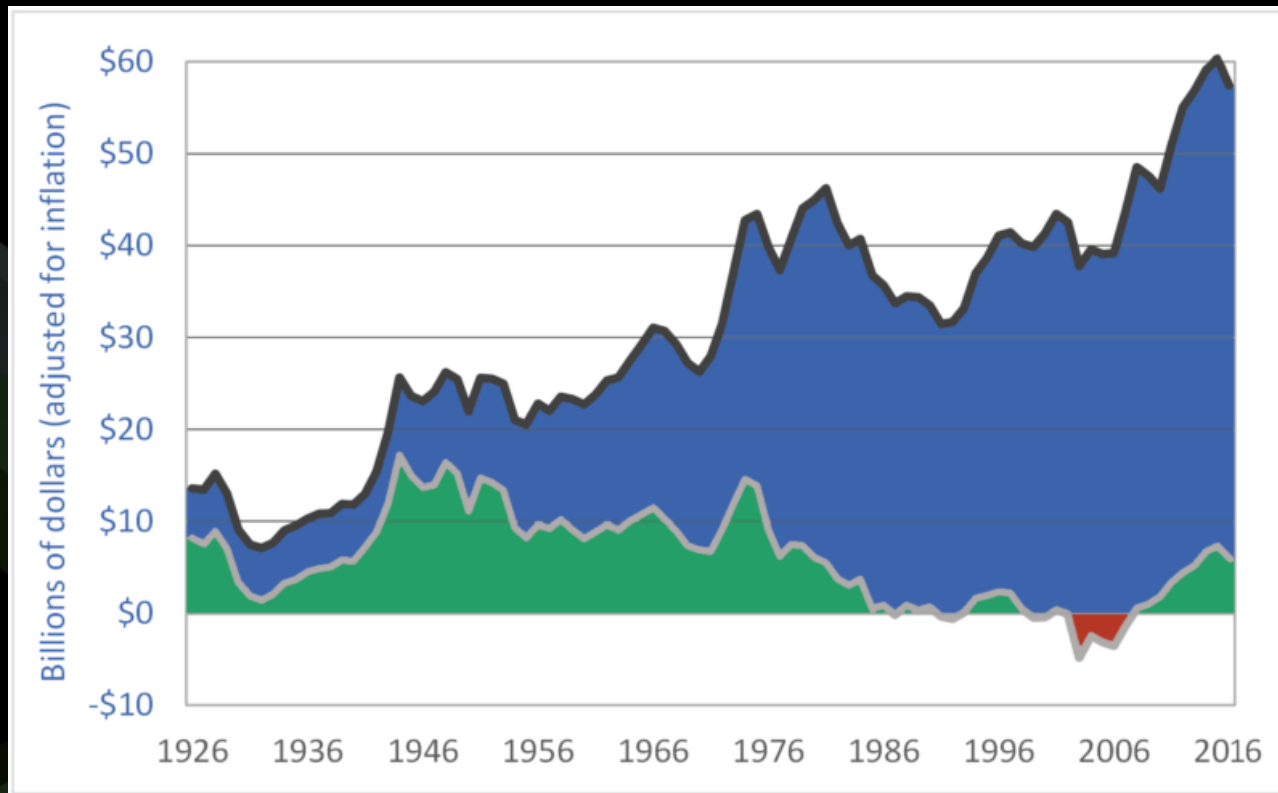
# What Could This Cost Me?

## Canadian Federation of Agriculture AGM (February 23, 2017)

**Dean Hubbard** Carbon Panel Member and Claresholm, Alberta Farmer

- Calculated that since his operation moved to zero till in 1995 he has doubled soil organic matter
- Estimated the carbon policy in Alberta will raise his this year costs by **6%**

# Canadian net farm income and gross revenue, inflation adjusted, net of government payments, 1926–2016.



Source: Stats. Can. CANSIM databases, esp. 002-0001, 002-0014, 002-0009, and 002-0076.

**Unlike other commodity groups, producers are unable to pass this additional cost along meaning it will come directly out of already thin profit margins**



# Agriculture: Part of the Solution



# APAS Official Stance

- APAS believes governments need to recognize the unique impacts of policy proposals like carbon taxes on the agricultural sector, including the negative impacts on our ability to compete internationally and the potential disincentive to produce food that the world needs. **APAS does not support the imposition of a carbon tax on fuel and other agricultural inputs**

Source: (Land and Environment Committee 2016)

# Agriculture in Sask and Alberta

## StatCan 2011 Land Use (Percentage of Canadian Total)

Use Type	Saskatchewan	Alberta
Land in Crop	42%	28%
Total Land for Pasture	34%	44%
Natural Pasture	33%	44%
Tame or Seeded Pasture	37%	43%

Source: Statistics Canada. Table 004-0203 - Census of Agriculture, land use, every 5 years, CANSIM (database).

# Cropland



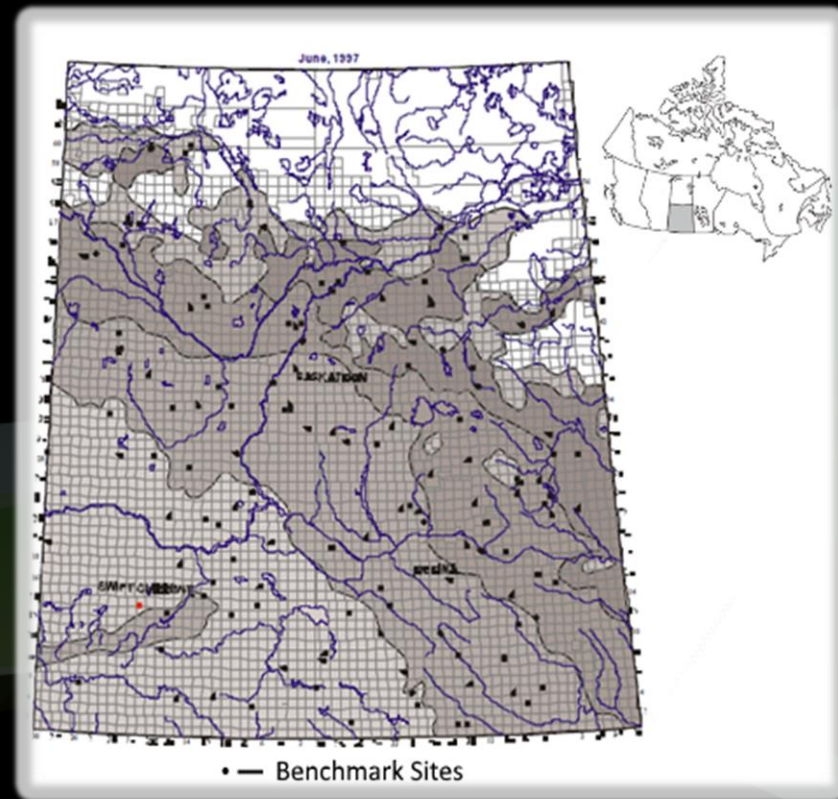
# Livestock and Grasslands





# Prairie Soil Carbon Balance Project

- Initiated in 1996 to determine how much carbon could be sequestered on agricultural land
- A benchmark network of **143 fields** was established representing combinations of soil and landform types across SK.
- 8 additional sites were selected across SK with paired fields using zero till and conventional tillage systems with crop rotations.
- Concluded using zero till is allowing growers to sequester **8.75 million new tons of CO<sub>2</sub> every year** on 23 million acres of farmland.
  - Equates to **0.38 tons of CO<sub>2</sub> per acre sequestered yearly**



Source: McConkey, Brian, et al. "Measuring Soil Carbon Change on Cropland: The Prairie Soil Carbon Balance Project."

# SSCA Carbon Advisory Committee





# SSCA Positions on Carbon

**If emitters of GHGs are penalized (carbon tax, ect.) then those who are removing GHGs, through carbon sequestration or capture, should be compensated in equal measure.**

- Follow the Vancouver Declaration commitment to **enhance carbon sinks**.
- **Establish a pan-Canadian offset protocols framework** would allow verified carbon credits (including soil carbon removals) to be traded internationally.
- Determine the management practices that will **maximize carbon sequestration in hay and pasture land** and the **annual sequestration rates for different soil types and under various weather conditions for grass**.
- Understand carbon emissions into the atmosphere **when some tillage is required** on fields that have been zero-tilled for many years or decades.
- Focus the research on nitrous oxide emissions in a manner that ensures **effective use of fertilizer to maintain production with minimized emissions**.
- Impact of pricing on **agricultural inputs**
- Canada's climate change plan needs to include an **export sensitivity** process to understand and **calculate the impact of carbon pricing on the competitiveness of Canadian exports**.

# Increasing Productivity and Sequestration on Cultivated Land

**Stephen Long** University of Illinois

- Increased efficiency of photosynthesis in modified tobacco plants by up to **30%**
- Increased yield in an experimental crop by **14-20%**

**Douglas Kell** University of Manchester

- Calculated breeding crops with roots extending to 2m depth instead of 1m will **double carbon sequestration and make them more drought resistant**



**The world will need to grow 70% more food by 2050**

# Cropland



# Livestock and Grasslands



# Livestock Production Efficiency

## From 1981 to 2006

- GHG emission per kg of milk have **declined by 35%**  
(Dyer et al., 2008)

## From 1981 to 2011

- GHG emissions per kg of beef animal have **declined by 14%**  
(Legesse et al., 2016)



# Grasslands Carbon Storage

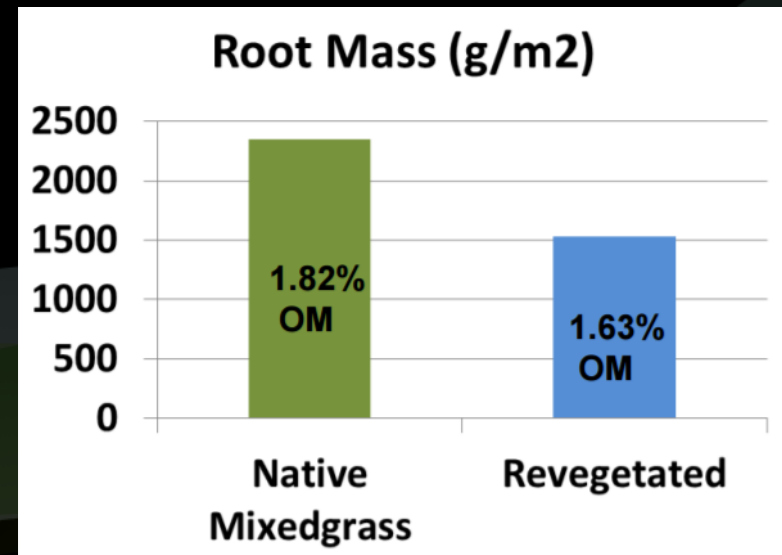
- Uncultivated grasslands in Western Canada contain as much as **2 to 3 billion tonnes of C to a depth of 1m**
- Grazed natural grassland functioned as a net C sink due to improved management
- Net C sequestration for soils:
  - Black 0.22 tonnes C/ha/yr
  - Dark Brown 0.14 tonnes C/ha/yr
  - Brown 0.09 tonnes C/ha/yr

Source: Wang et al. 2014



# Carbon Sequestration on Grasslands

- Breaking of Mixedgrass Prairie and immediate planting of perennial grasses led to no change in total Carbon after 13 years
- Continuous wheat cropping led to the loss of 19% of Carbon:
  - -1.7 tons C/ha/yr for first 4 years
  - -0.32 tons C/ha/yr for next 9 years
- **Once lost, re-establishing that soil organic carbon is a very lengthy process**



**Source:** Dormaar and Smoliak. 1985. Recovery of vegetative cover and soil organic matter during revegetation of abandoned farmland in a semi-arid climate. *J. Range Manage.* 38: 487-491.

**Source:** Wang et al. 2010. Cultivation and reseeding effects on soil organic matter in the Mixed Prairie. *Soil Sci. Society of America J.*, 74: 1348-1355.



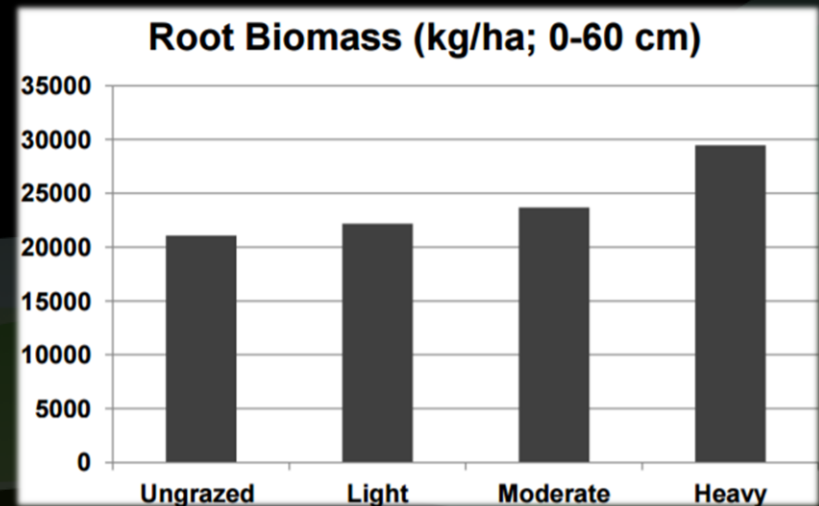
# Carbon Sequestration from Management Practices

- Evidence suggests grazing may increase root biomass and hence the amount of carbon sequestered

**Source:** Smoliak et al. 1972. Long-term grazing effects on *Stipa-Bouteloua* prairie soils. *J. Range Manage.* 25: 246-250.

- Digestion accelerates nitrogen turnover (mineralization) in the ecosystem, potentially stimulating plant growth and carbon accumulation

**Source:** Pineiro et al. 2010. Pathways of grazing effects on soil organic carbon and nitrogen. *Rangel. Ecol. Manage.* 63: 109-119.



# Recognition



# Agricultural Carbon Summit

**Agriculture is playing a significant role in sequestering carbon on the landscape and has the potential to play an even greater role in providing the solution to carbon and GHG emissions**

- Bringing together producers, researchers, policy makers, and other communities to discuss agricultural innovations, policy recognition, research and knowledge gaps to be addressed.

**Sequestering  
Carbon and  
Feeding the  
World**

**July 13-14 @ Saskatoon Inn  
(More details on registration to come)**