Transitioning Cereal Systems to Adapt to Climate Change

November 13-14, 2015

Funded through Award #2011-68002-30191 from USDA National Institute of Food and Agriculture

Constraining soil-emitted GHGs from crop production on the Canadian semiarid prairies

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Constraining Soil-Emitted GHGs from crop production on the Semiarid Canadian Prairies

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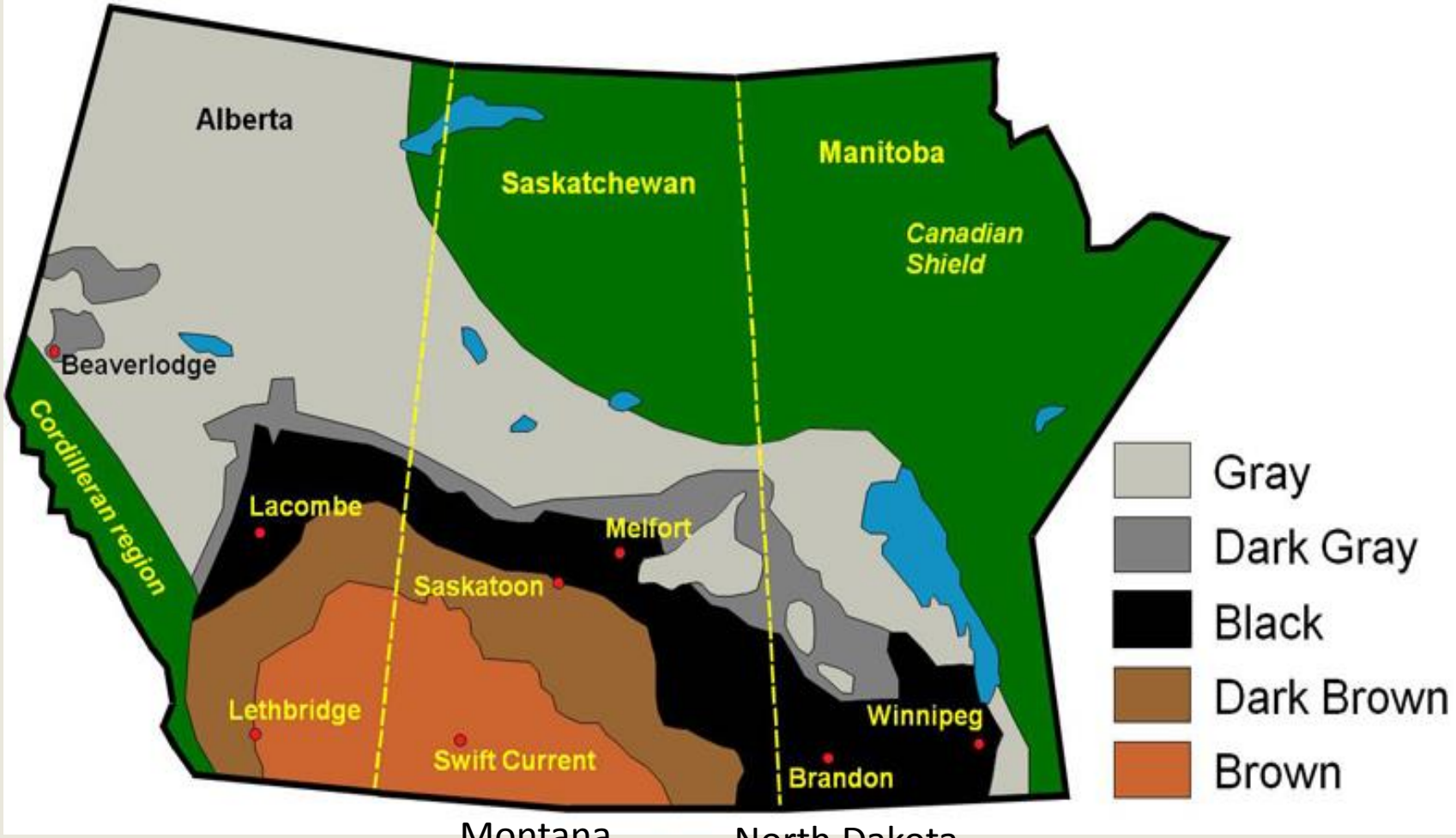
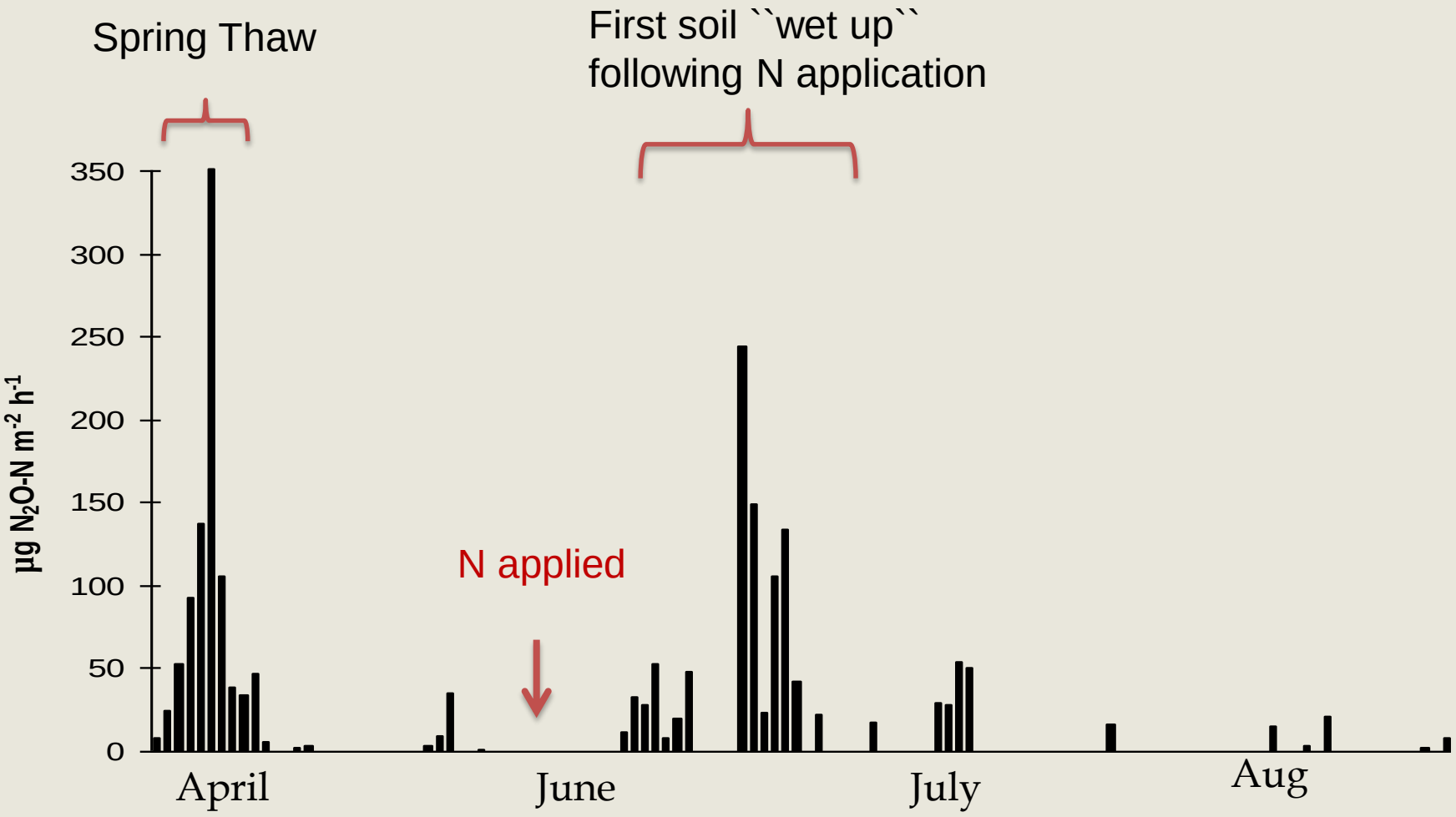
Major soil zones of the Prairie Region



Seasonal Pattern of soil-emitted N_2O

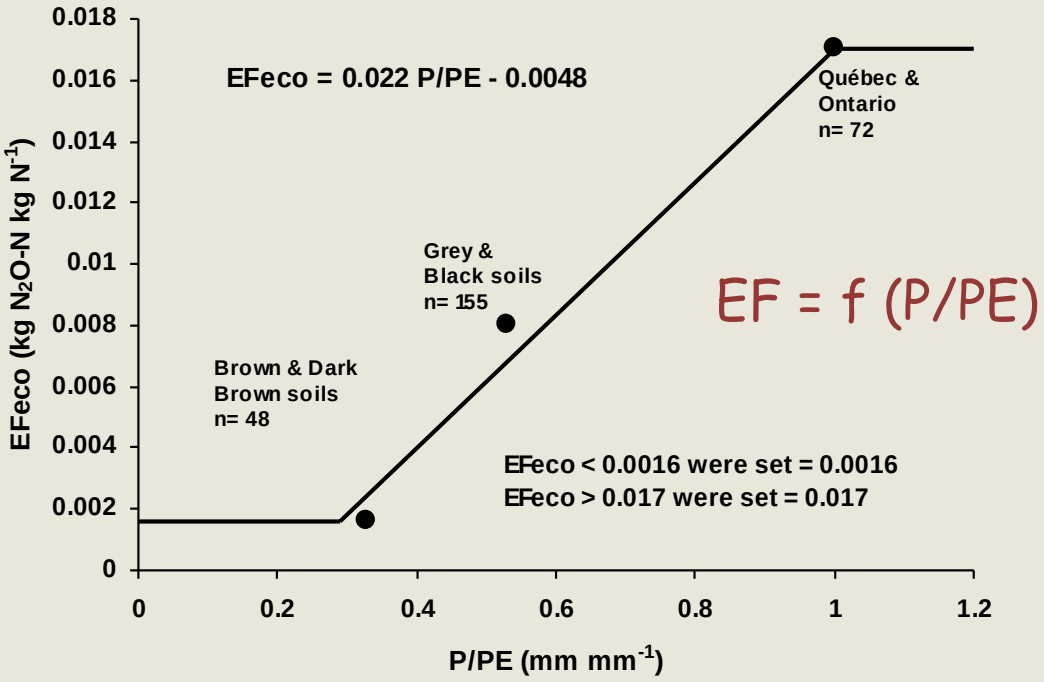


Emission factor as a function of local climate

Soil_N_2O = Ninputs_N_2O x "modifiers"

Ninputs_N_2O = (Fertilizer N + Residue N + Manure N)*EF

EFeco = EF calculated specifically for each ecodistrict



(Source: Rochette et al., 2008)

Estimating N_2O Emissions: Canadian Semiarid Prairies

Soil_N_2O = Ninputs_N_2O x “modifiers”

Modifiers = Tillage, slope position, irrigation, soil texture

Reference situation = ‘‘a non-irrigated soil located in well-drained portions of the landscape under conventional tillage practices’’

~ 80-90% data collected from Hard Red Spring Wheat

Crop Mix: Canadian Semiarid Prairies

- 2014 Estimated Seeded Acreages for Saskatchewan
  - 38% spring wheat, (24% hard red spring wheat)
  - 36% oilseeds (31% canola)
  - 17% pulses (lentil, field pea, chickpea)
  - 7% summerfallow & “misc.”

- Current Crop Sequences:
  - Oilseed-Cereal **or** Pulse-Cereal
  - Oilseed-Pulse-Cereal **or** Fallow-Oilseed-Cereal

Case Study: Pea-Canola Frequency Study

- Field experiment established in 1998
- Treatments with various crop sequences of field pea (*Pisum sativum L.*), wheat (*Triticum aestivum L.*) and canola (*Brassica napus L.*)

W [±N]	- hard red spring wheat grown each year with or without added N
P	- pea grown every year
P-W	- pea-wheat
C-W	- canola-wheat
P-C-W	- pea-canola-wheat

- All phases of each rotation present each year

Pea-Canola Frequency Study

- Nitrogen (urea) side banded at 75, 65 and 7.5 kg N ha^{-1} for canola, wheat, and pea, respectively
- Plexi-glass non-flow through, non-steady state chambers (22 cm × 45.5 cm and 15 cm high)
- The annual precipitation was 385, 285 and 637 mm in 2008, 2009 and 2010 respectively. (30-yr mean = 360 mm)

Cumulative N_2O and Yield-Scaled N_2O from selected crop-residue combinations Scott, Saskatchewan, Canada

Direct N_2O		
Residue Type	Crop Grown	3-year cumulative ($g\ N_2O\text{-}N\ ha^{-1}$)
C	W	2120 a
W	C	1440 b
W	W	1360 b
W	P	1270 bc
P	W	1120 bc
W(-N)	W (-N)	1110 bc
P	C	1100 bc
P	P	990 c

Yield-Scaled N_2O		
Residue Type	Crop Grown	3-yr Cumulative ($g\ C/g\ N_2O\text{-}N$)
P	W	0.33 a
P	C	0.28 ab
P	P	0.28 ab
W	P	0.27 ab
W (+N)	W (+N)	0.22 bc
W (-N)	W (-N)	0.21 bc
W	C	0.20 bc
C	W	0.16 c

Cumulative N_2O and Yield-Scaled N_2O on a rotational basis: Scott, Saskatchewan

N_2O Loss	
Rotation	3-yr cumulative ($g\ N_2O\text{-}N\ ha^{-1}$)
C-W	1780 a
W	1360 ab
P-W	1190 bc
W (-N)	1110 bc
P	990 c

Yield scaled N_2O Loss	
Rotation	3-yr cumulative ($g\ C\ /\ g\ N_2O\text{-}N$)
P-W	0.31 a
P	0.28 ab
W	0.22 bc
W (-N)	0.21 c
C-W	0.17 c

Summary

- **On the Canadian semiarid prairies the magnitude of emissions largely governed by N inputs and soil water status**
- **Crop sequence/crop type does influence “per area” and “yield-scaled” emissions**
- **Including a pulse in the crop sequence benefits the overall rotation on both “per area” and “yield-scaled” emissions**
- **Including an oilseed, particularly canola, in the crop sequence “costs” the overall rotation on both “per area” and a “yield-scaled” emissions**

Future Needs…

- **What is the influence of crop type (e.g. winter wheat), particularly long-term influence?**
- **Spring thaw period – who's doing what, when and why?**
- **Can we manage cropping systems to stimulate N_2O consumption?**
- **What is the appropriate intensity metric to assess emissions?**
- **Continued development of models, particularly for scenario testing**
- **Concerted, integrated effort to identify/develop mitigation and "environmentally optimal" crop production strategies**

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Thank you!

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