Impacts of Tame Forage Management on Ecosystem Flux and Soil Carbon Stores for Black Soil in Central Alberta

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Presentation Order

1. C- sequestration on an old grass stand vs Barley silage baseline over 20 yr.

2. Annual Net Ecosystem Exchange (NEE) and net-Biome-C from establishment to breaking a meadow bromegrass stand (2002 to 2010).

3. Short-term C-stores of Meadow bromegrass hay and pasture planted into the barley silage baseline in 2006 compared to old grass baseline.

SOC-Mass Equivalent Weight at Two Depths in 1995 and 2010 for Old Grass and an Annual Pasture Baseline at Lacombe, AB

Grassland Type	1995	2010	Δyr^{-1}
	Mg ha^{-1}		
	0 – 5 cm		
Old – Meadow Brome	35.7	36.0	----------
Annual pas. – Bar. silage	36.3	28.2	- 0.50
	0 - 15 cm		
Old – Meadow Brome	95.4	96.4	--------
Annual pas. – Bar. - Silage	96.1	80.3	-0.83

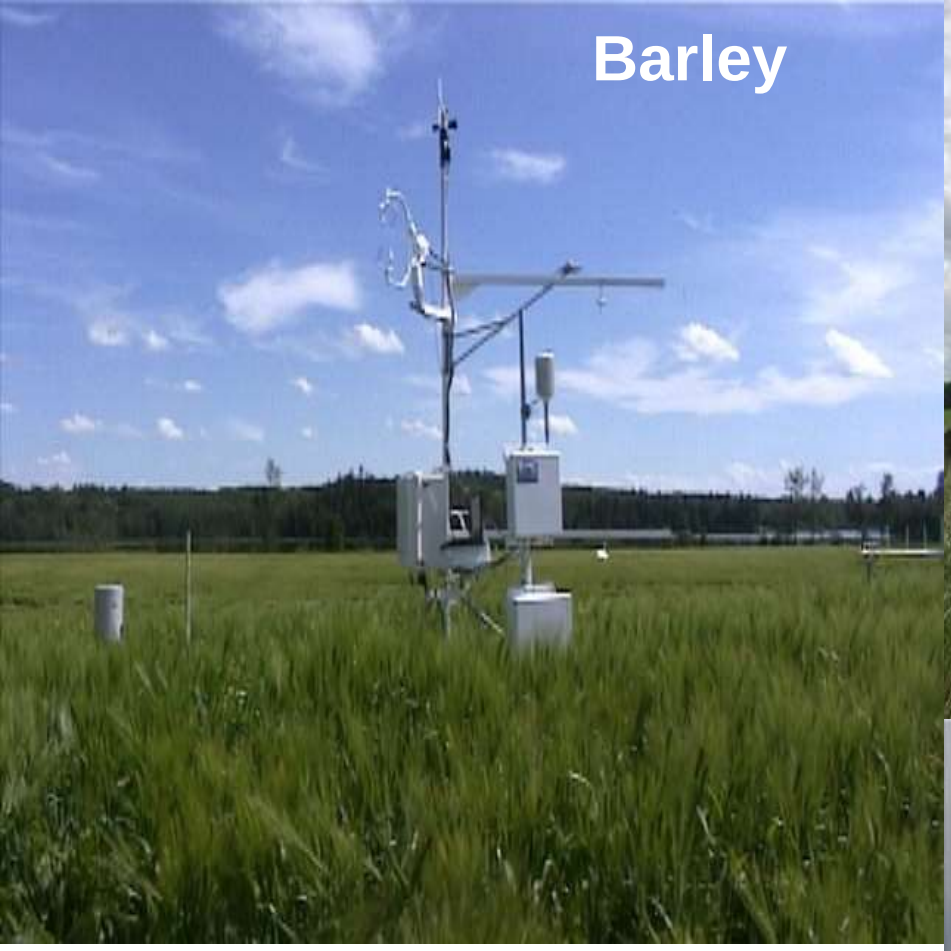
Sandy loam soil ranging from 4.3 to 5.6% soil organic carbon at 0 – 5 cm depth in 2010.

Annual pasture was followed by barley silage.

Baron, V.S., E. Mapfumo, M.A. Naeth, and D.S. Chanasyk. 1999. Sustainable grazing systems for perennial and annual forages on sloped lands. Canada-Alberta Environmentally Sustainable Agr. Agreement Final Rep. 161 pp.

The loss rate per year from annual pasture similar to predicted by CENTURY Model for conversion of grassland to cropland (NIR 2011).

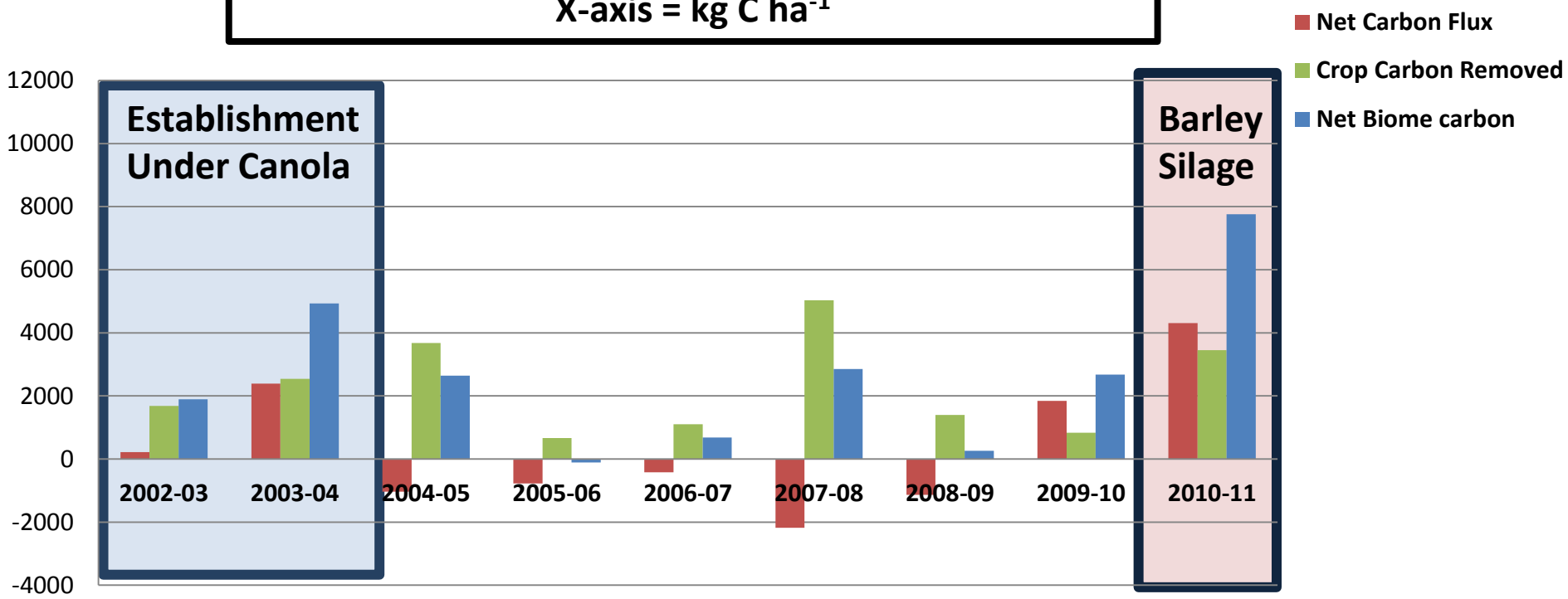
National Inventory Report (NIR) 2011. Part 2. Annex 3-Additional methodologies. In *Canada's 2011* 44 *UNFCCC Submission 1990-2009*; pp. 50–163.



Measuring CO_2 flux year round in more than one crop type in adjacent Fields using BREB method.

Annual NEE-C Flux, Crop-C Removed and Net Biome-C From a Sequence of Establishment and Production Years For a Meadow Bromegrass (Hay-Graze) and Conversion to Barley Silage From 2002 until 2010 at Lacombe, AB

GPP – Re = NEE; NEE measured with BREB.
NEE-C – Harvested C = Net Biome-C
X-axis = kg C ha^{-1}



2002, 2003, 2008 and 2009 were dry or drought-years;
M. Bromegrass planted in 2002.

Forage and Pasture BMP vs Baselines

Baseline:

1. Old grass 22-yr-old no inputs (1993)
2. Direct Seeded Barley-Fert-N (2006 -2012)
   BMP (2006)
3. BMP Hay – Meadow Brome
   – Fert-N; Alf-Mix; Control
4. BMP Rotational Pasture Meadow Brome
   _ Fert-N and control
   _ Alfalfa Mix and control

Mean Mass Equivalent SOC at Three Depths Under Four Forage Management Systems at Lacombe, AB (2008 to 2012 average)

System	Planted	Soil Depth (cm) 0-5		0-15		0-30	
		Mg SOC ha^{-1}					
Old Grass Hay	**1993**	**36.0**	**a**	**96.4**	**a**	**138.0**	**a**
Barley Silage	**Annually**	**28.2**	**b**	**80.0**	**c**	**117.0**	**b**
MB Hay	**2006**	**29.6**	**b**	**84.2**	**bc**	**127.0**	**ab**
MB Pasture	**2006**	**30.7**	**b**	**88.8**	**ab**	**136.0**	**ab**

abc - LS comparisons P. < 0.01.

Mean Light Fraction Mass Equivalent SOC at Three Depths Under Four Forage Management Systems at Lacombe, AB (2008 to 2012 average)

System	Planted	Soil Depth (cm) 0-5		0-15		0-30	
		Mg SOC ha^{-1}					
Old Grass Hay	1993	2.9	a	4.6	a	6.3	a
Barley Silage	Annually	1.3	d	2.2	c	2.7	c
MB Hay	2006	1.9	c	3.3	b	4.3	b
MB Pasture	2006	2.4	b	3.8	ab	4.9	b

abc - LS comparisons P. < 0.01.

1. **At 0-5 cm MB Hay and Pasture with Fert-N > MB Control**
2. **At 0-15 and 0-30 cm MB Hay and Pasture with Fert-N > MB-alfalfa mix.**
3. **At 0-15 cm MB Hay and Pasture Control > MB-alfalfa mix**

Mean Carbon Mass Input or Output Under Four Forage Management Systems at Lacombe, AB (2008 to 2012 average)

System	Planted	C-Mass Input - Output					
		Root		Residue		Harvested	
		——Mg C ha^{-1}——					
Old Grass Hay	1993	1.9	a	0.47	b	1.7	c
Barley Silage	Annually	1.0	b	0.75	b	3.3	a
MB Hay	2006	1.8	a	0.75	b	2.3	b
MB Pasture	2006	1.9	a	1.60	a	1.6	c

abc - LS comparisons P. < 0.01.

1. **Root–C MB Fert-N Hay and Pasture > MB Control**
2. **Residue-C MB-alfalfa mix Hay and Pasture > MB Fert-N > MB Control**
3. **R plus Res. MB-alfalfa mix Hay and Pasture > MB Fert-N > MB Control**

Does high productivity result in high rates of SOC sequestration?

Conclusions

1. A long-term grassland cover without inputs may not have a significant year to year SOC gain. Annual cropping without replacement of carbon removed can result in significant SOC loss.
2. Establishment, breaking, crop removal and dry weather reduce the probability of net SOC sequestration over the perennial grass sequence in a rotation.
3. Rotational pasture, where residue and root C inputs can be maximized appears to replenish light fraction C to the level of the old grass baseline. N-fertilizer seems to enhance this.