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Canada

Response of greenhouse gas emission and soil carbon storage to cattle grazing practice on a rough fescue grassland

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Grassland Carbon Workshop

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Our Vision

Driving innovation and ingenuity
to build a world leading agricultural and food economy
for the benefit of all Canadians.

Our Mission

Agriculture and Agri-Food Canada provides leadership
in the growth and development of a competitive, innovative
and sustainable Canadian agriculture and agri-food sector.

1 . Background

- Cow-calf grazing on rangeland generates 80% and feedlot only 20% of total greenhouse gas emissions from beef production in Western Canada
- Rangeland soils are small sinks for methane (CH_4) and a source of nitrous oxide (N_2O)
- Emissions associated with livestock grazing excreta on rangeland are uncertain
- Very little data are available for native rangelands on the Canadian prairies

2 . Objectives

- Determine the GHG emission from cow-calf production on rangeland as influenced by management practices
- Explore potential to increase soil C sequestration and storage in rangeland

3 . Experimental Approach

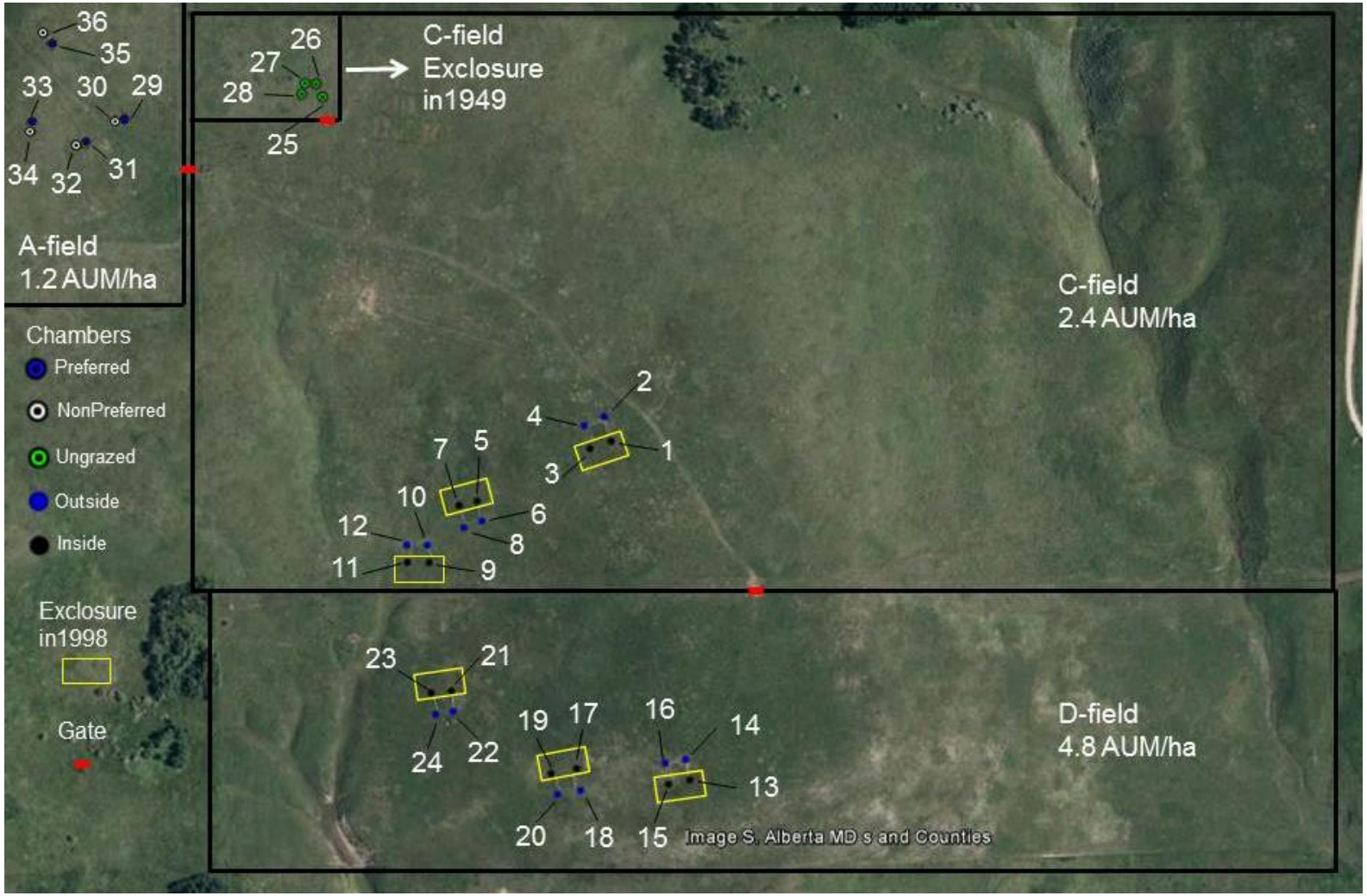
Four experiments were conducted

- Expt 1: Effect of long-term cattle stocking on GHG emission and soil C storage (Stavely)
- Expt 2: GHG emission from producer site (Little Bow)
- Expt 3: Effect of soil texture on GHG emission under rotational grazing system (Duchess)
- Expt 4: Contribution of dung and urine on tame pasture (Lethbridge)

3.1 Cattle stocking rate

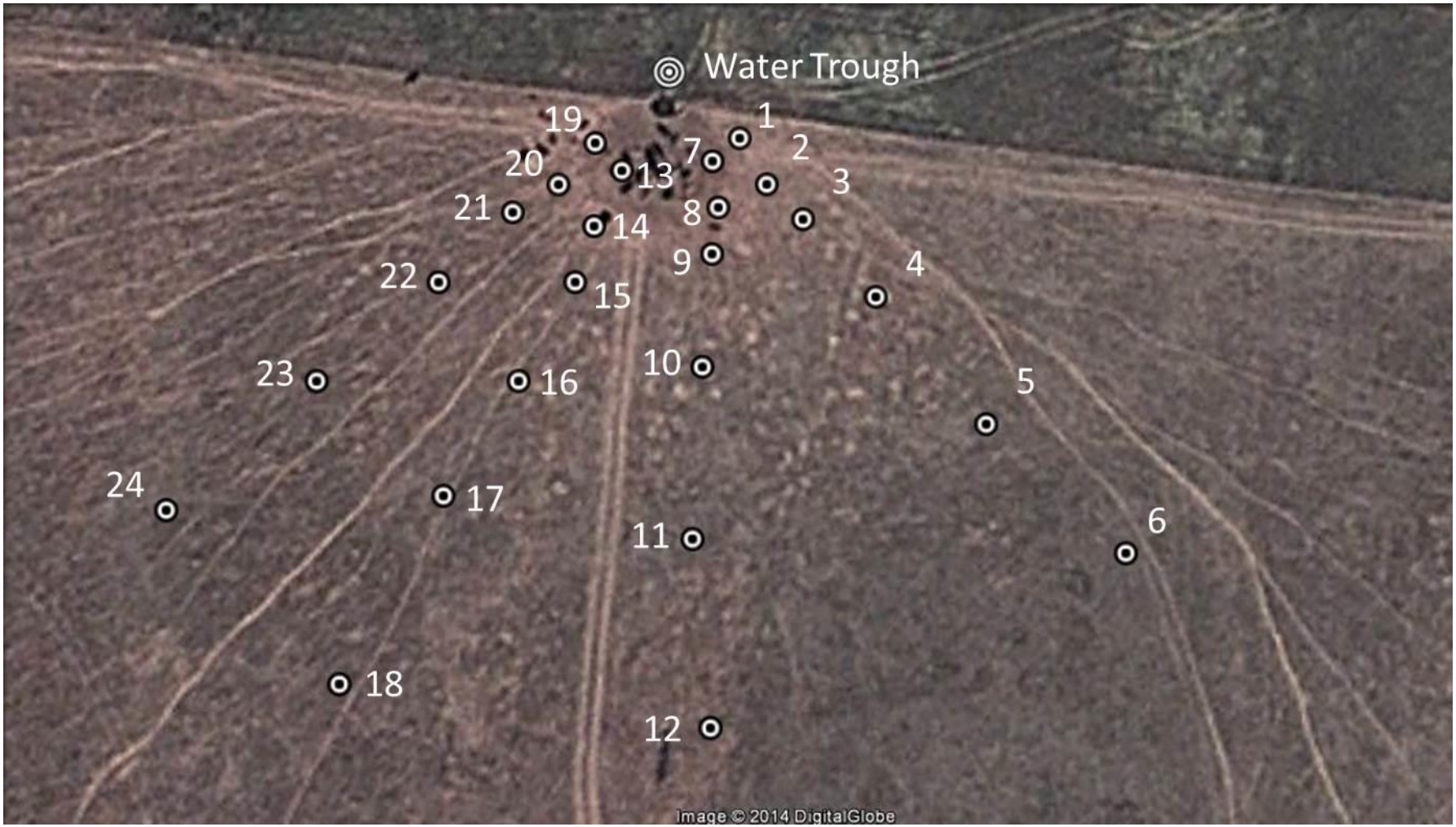
- Three years study (2013 to 2016)
- Four non-replicated cattle stocking rates on the rough fescue grassland established at Stavely in 1949
- The adjacent fields (C and D) with 2.4 (MG) and 4.8 AUM ha^{-1} (HG) stocking rates, and nearby field at 1.2 AUM ha^{-1} (LG)
- A permanent exclosure since 1949, 0 AUM ha^{-1} (CK)
- April 1998, three **exclosures** were installed in each of the adjacent fields (C and D)

3.1 Cattle stocking rate – Rangeland recovery



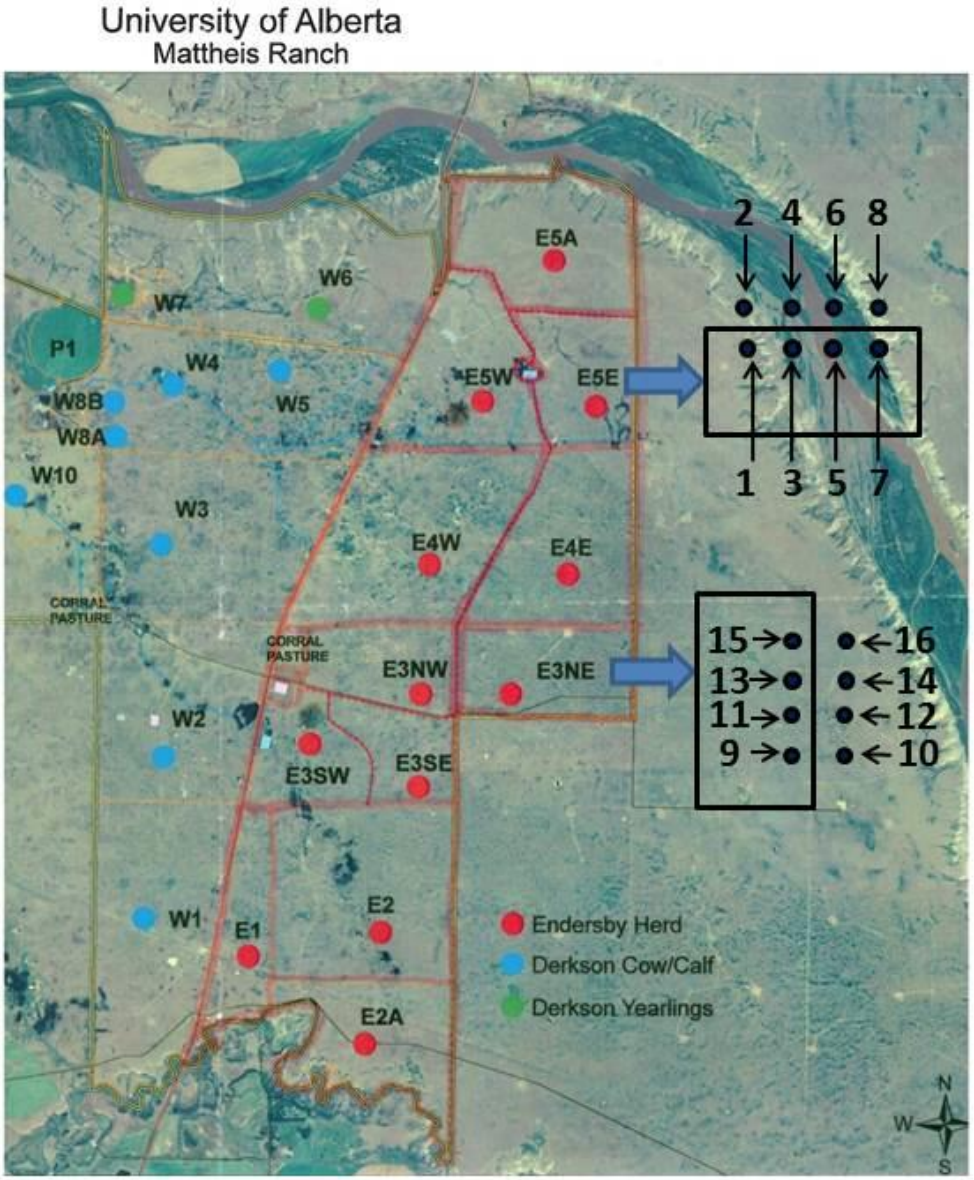
Chambers placement at Stavely

3.2 Producer site - Piosphere



Chamber placement at the Little Bow producer site

3.3 Rotational grazing - Soil texture



Duchess Chamber set:

- **E5E**: 1-8;
- **E3NE**: 9-16;
- **Inside the exclosure:**
- 1, 3, 5, 7, 9 ,11, 13, 15;
- **Outside the exclosure:**
- 2, 4, 6, 8, 10, 12, 14,16;

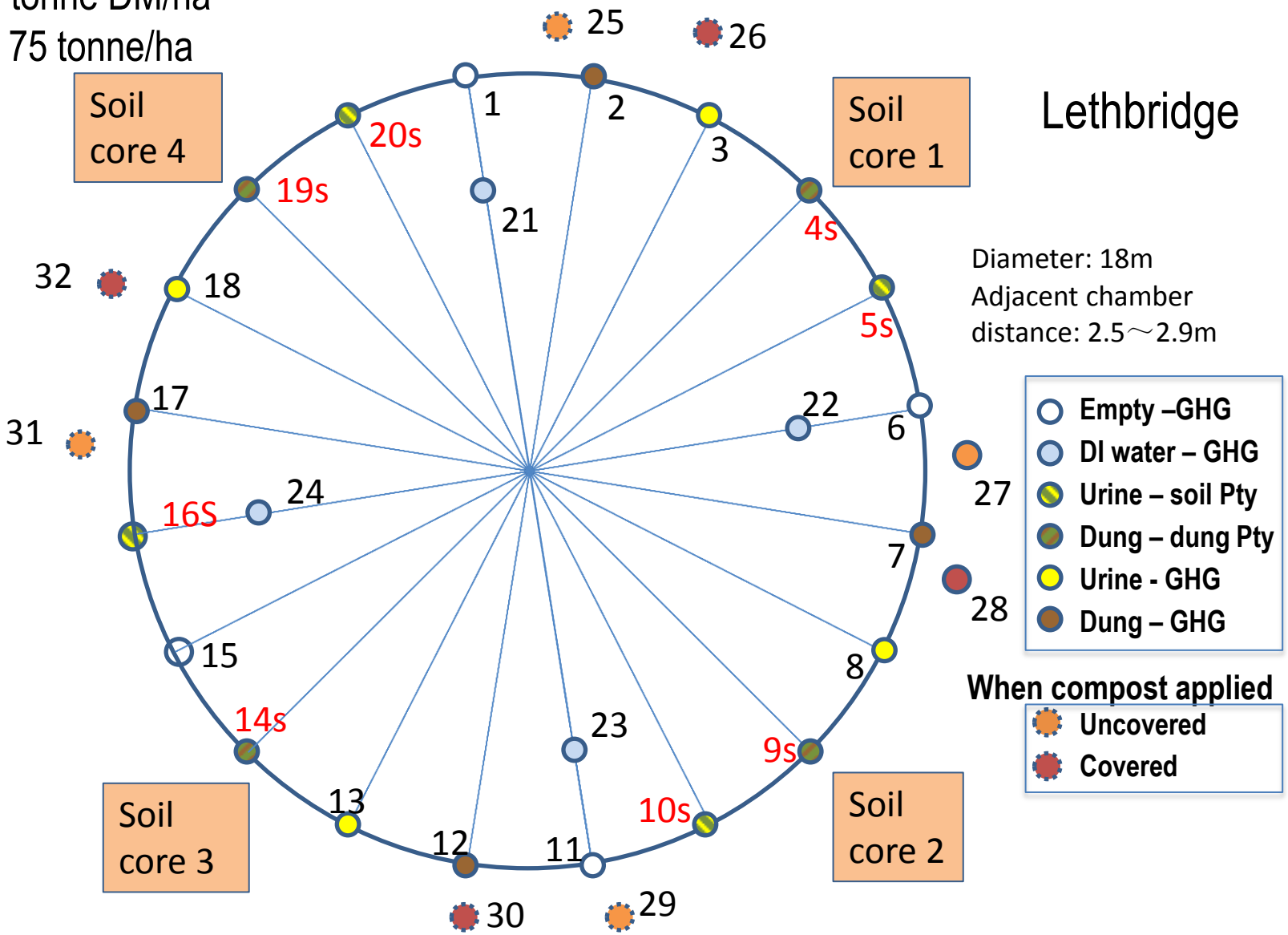
● Chamber

Exclosure 2010

Exclosure 2010

3.4 Tame Pasture - Dung & urine

Urine = 75 tonne/ha = 750 kg N/ha
Dung = 65 tonne DM/ha
DI water = 75 tonne/ha



4. Measures

- Weekly gas sampling (May to Oct)
- Monthly surface soil (0-15 cm) sampling:
  - For analysis of available N and P, and microbial assessment,
- One-time soil profile sampling:
  - 0-15, 15-30 and 30-60 cm
  - macro organic matter (MOM),
  - bulk density (BD)
  - TOC, TN and TP
  - , Water-OC and soluble ions
- Annual herbage sampling (peak NPP)

Cage

Gas sampling

5 . Key Outcomes

Cumulative GHG emission (Stavely site)

	CO_2 (kg C ha^{-1} yr^{-1})		CH_4 (kg C ha^{-1} yr^{-1})		N_2O (kg N ha^{-1} yr^{-1})	
	2013	2014	2013	2014	2013	2014
CK	3,308	3,408	-1.6	-2.0	45	37
1.2 AUM	4,793	5,297	-0.9	-1.7	90	79
2.4 AUM						
Inside	3,123	4,094	-1.0	-1.9	68	70
Outside	4,362	4,593	-1.0	-1.7	516	130
4.8 AUM						
Inside	3,569	4,208	-1.0	-2.0	61	29
Outside	4,276	5,451	-1.0	-1.8	153	85

* Gas flux was measured from May 28 to September 17 in 2013 (113 days) and from May 15 to October 22 in 2014 (160 days).

5 . Key Outcomes

Carbon storage on a rough fescue grassland at Stavely site (2014)

	Aboveground Plant carbon (kg ha^{-1})	Macro organic carbon (kg ha^{-1})	Soil organic carbon (kg ha^{-1})
CK	1,240	4,093	96,156
1.2 AUM	1,634	4,893	97,380
2.4 AUM			
Inside	1,351	6,092	105,990
Outside	1,884	6,199	82,200
4.8 AUM			
Inside	1,600	4,526	73,157
Outside	1,295	4,614	88,824

* Macro organic carbon (85%) and soil organic carbon (51%) are located in the 0-15 cm depth

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Thank you!