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LEGUME BASED PASTURE REJUVENATION FOR GREENHOUSE GAS OUTCOMES

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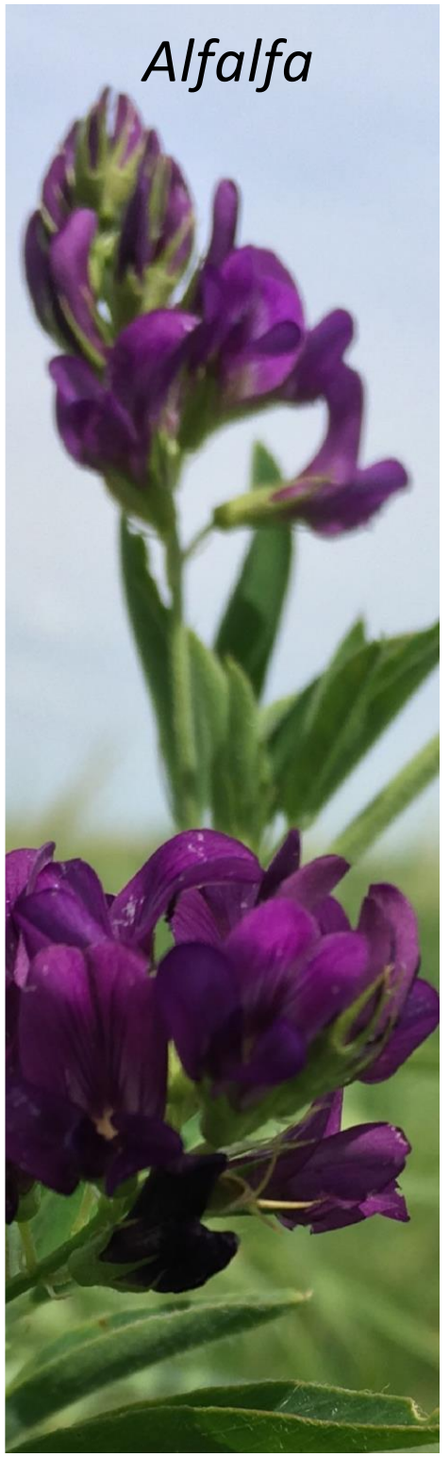
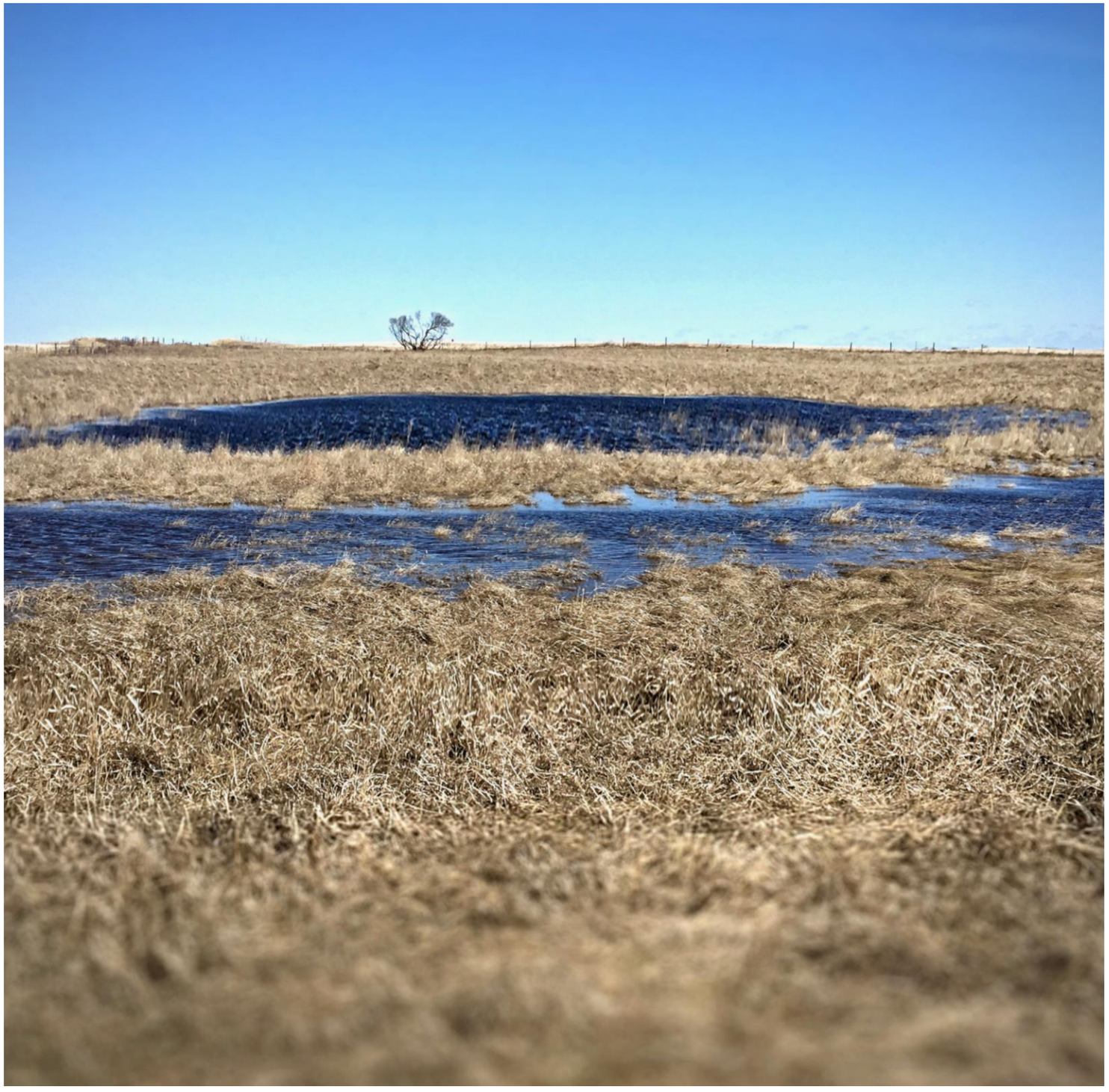


The premise

Pasture rejuvenation with sod-seeded non-bloat legumes may offer increased income through higher forage volume and nutrition at the same time as reducing greenhouse gas emissions.

SOD-SEEDING ESTABLISHMENT

- High benefit/cost ratio pasture rejuvenation method
- Apply herbicide in strips
  - Alternating at 50cm width
- Direct seed legumes into treated strips
- Most work done with alfalfa
- Sainfoin and Cicer milkvetch
  - Non-bloat
  - May have different greenhouse gas outcomes



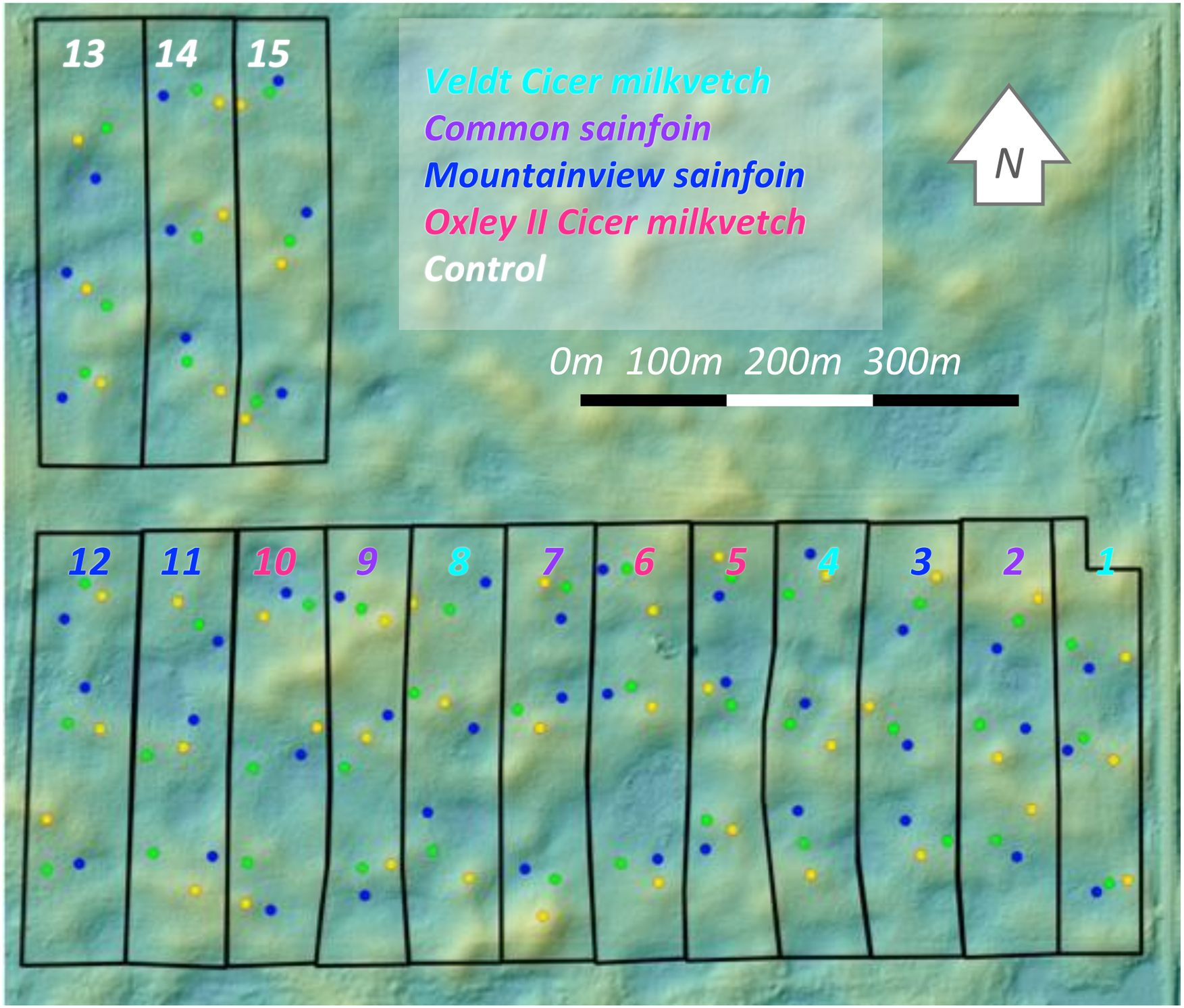
The site

Pasture, east of Lanigan, converted to pasture in 1998 and sod-seeded with non-bloat legumes in 2015.

Grazed seasonally according to forage production.

The project

Measure greenhouse gas (carbon dioxide, methane, nitrous oxide) balance of all components of the soil, pasture, animal atmosphere system.

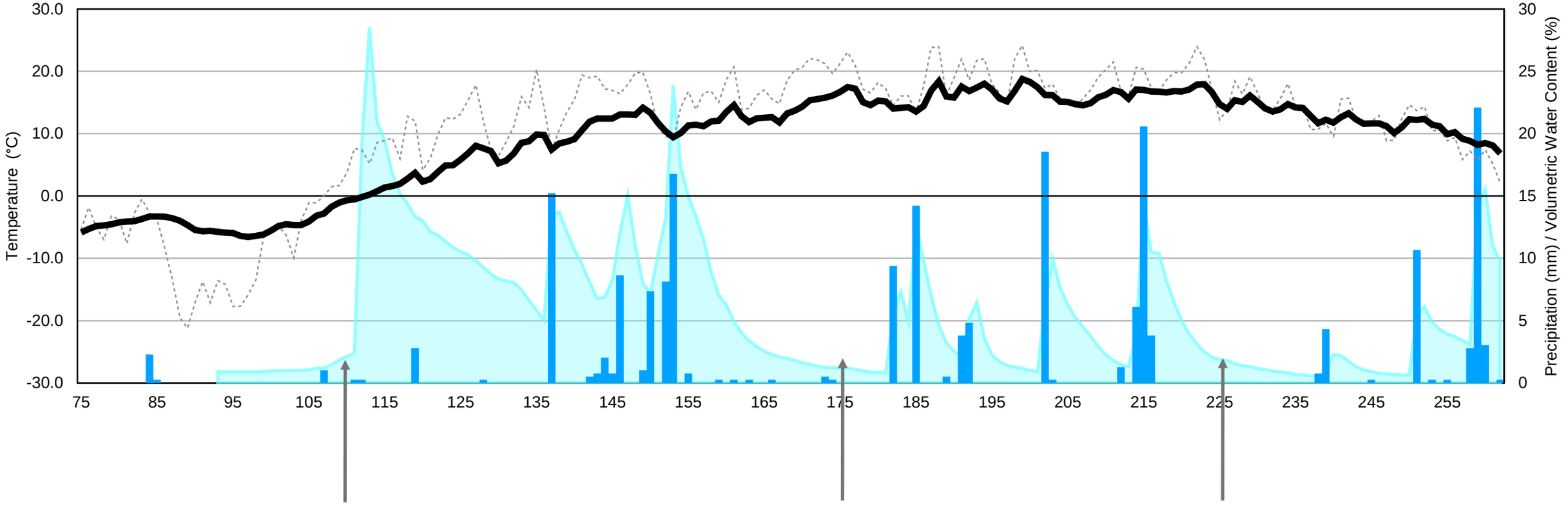


The experiment

4 treatments (2 x sainfoin, 2 x Cicer milkvetch) + control x 3 replicates = 15 paddocks

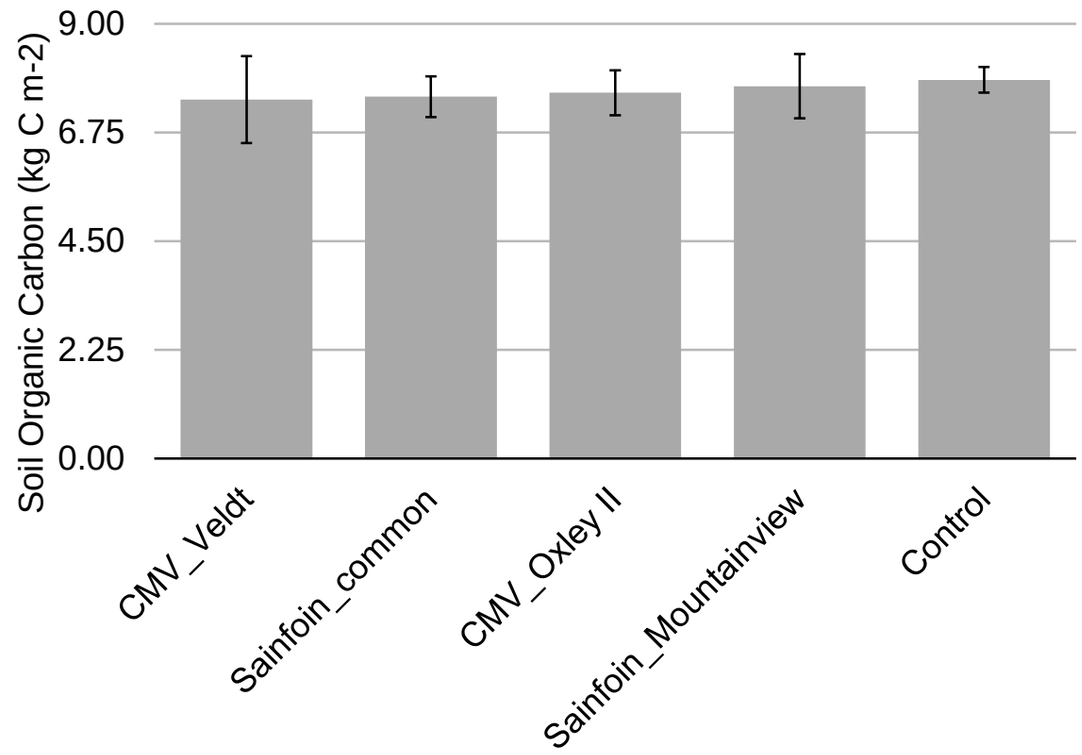
Sampled by topographic position (upper slope, mid-slope, lower slope)

Mean %VWC Daily Precip. Mean Air Temp. Mean Soil Temp.



SOIL CARBON BUDGET

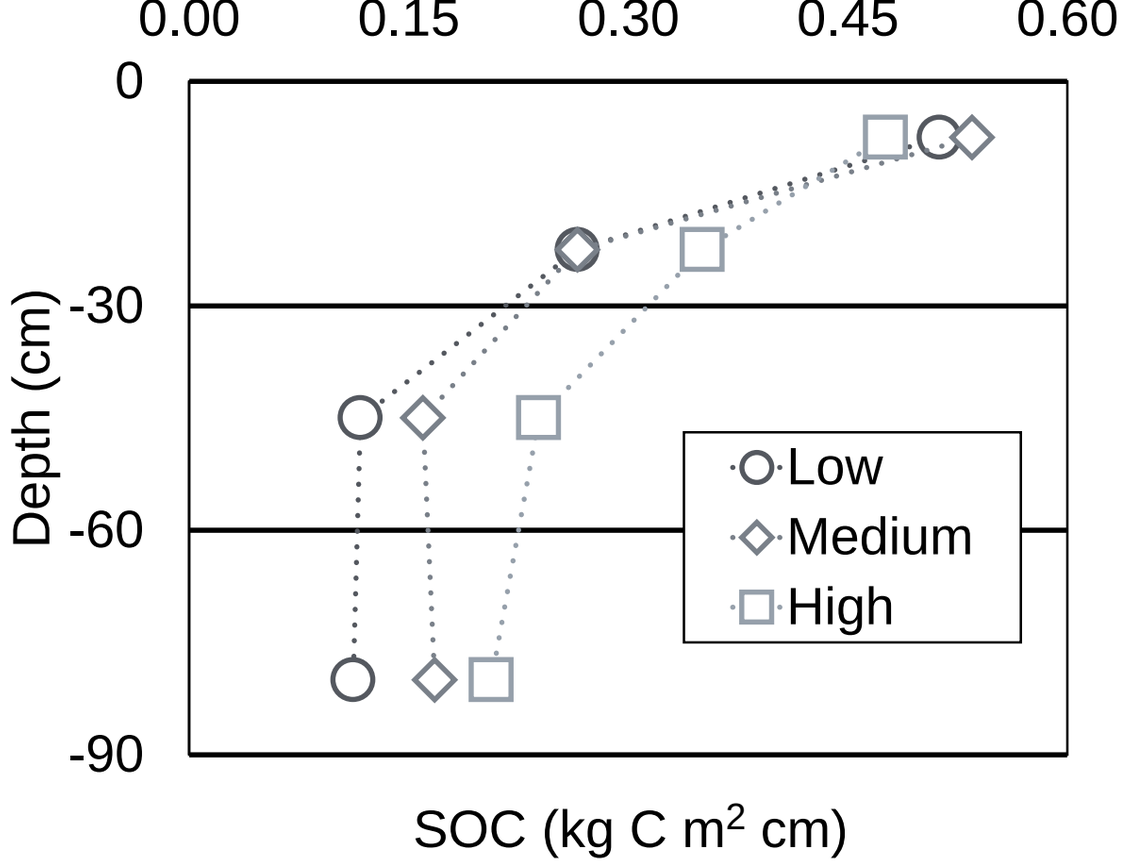
- Sod-seeding minimizes soil disturbance
  - Retain sequestered C in soils



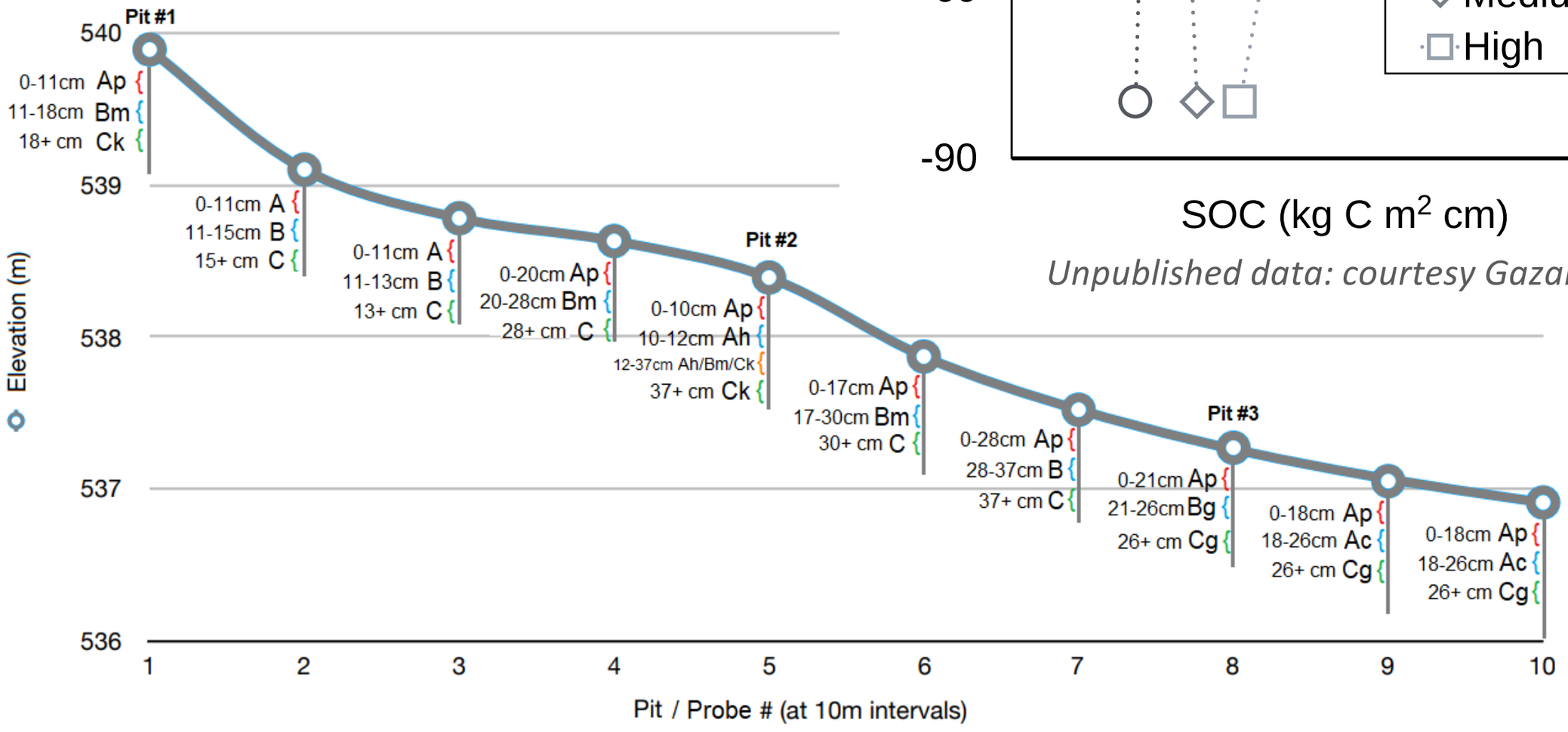
0-15 cm SOC, unpublished data: courtesy Gazali Issah

- Conversion from cultivation to pasture typically increases soil C

A RETROSPECTIVE LOOK AT SOIL CARBON



Unpublished data: courtesy Gazali Issah



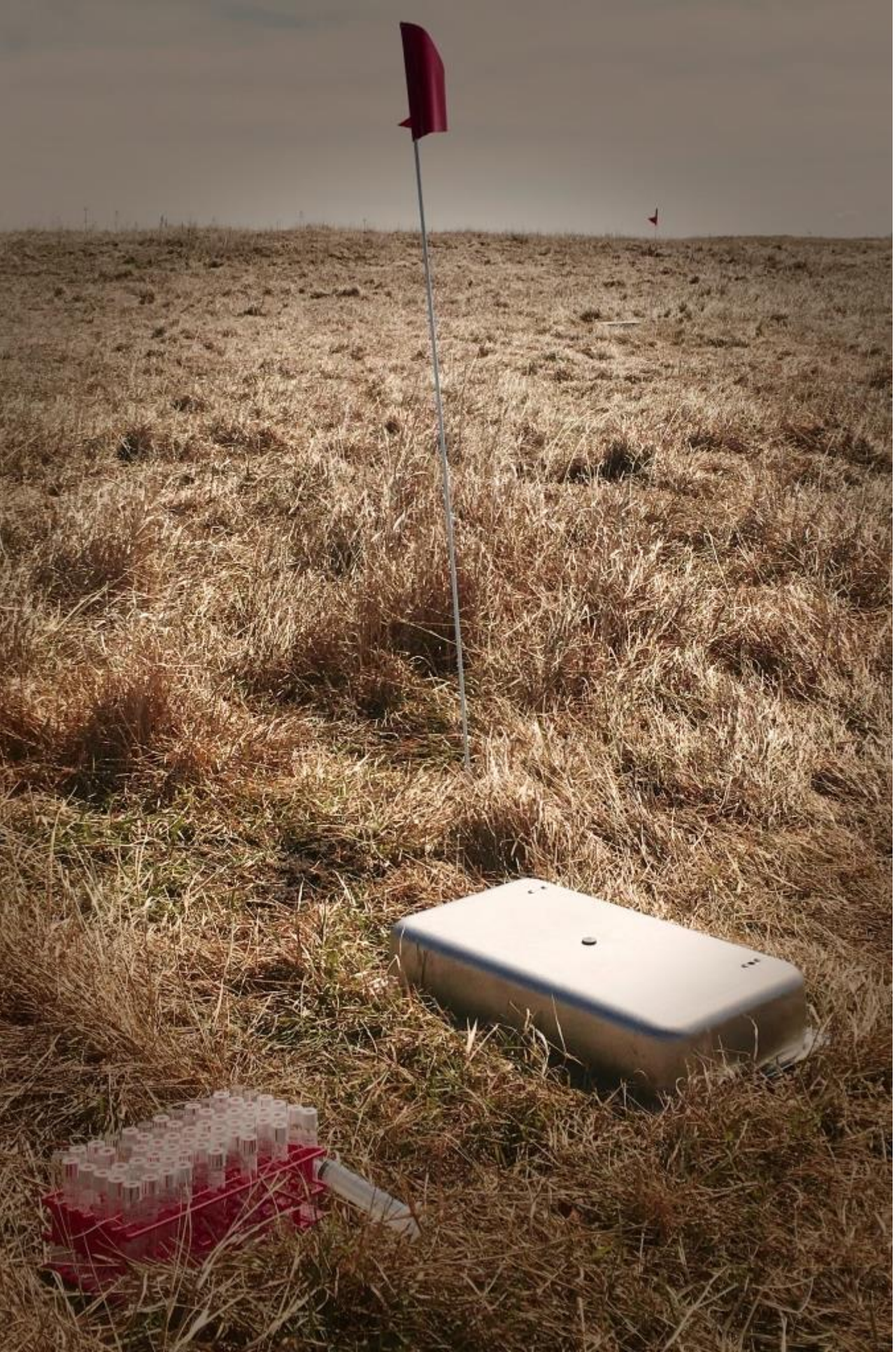
Unpublished data: courtesy Andrew Hill

Introducing Prairie Burrowing Animal Condominiums!

The view is great but I'm not so sure about badgers for neighbours!

Did you know some gophers moved into the penthouse?

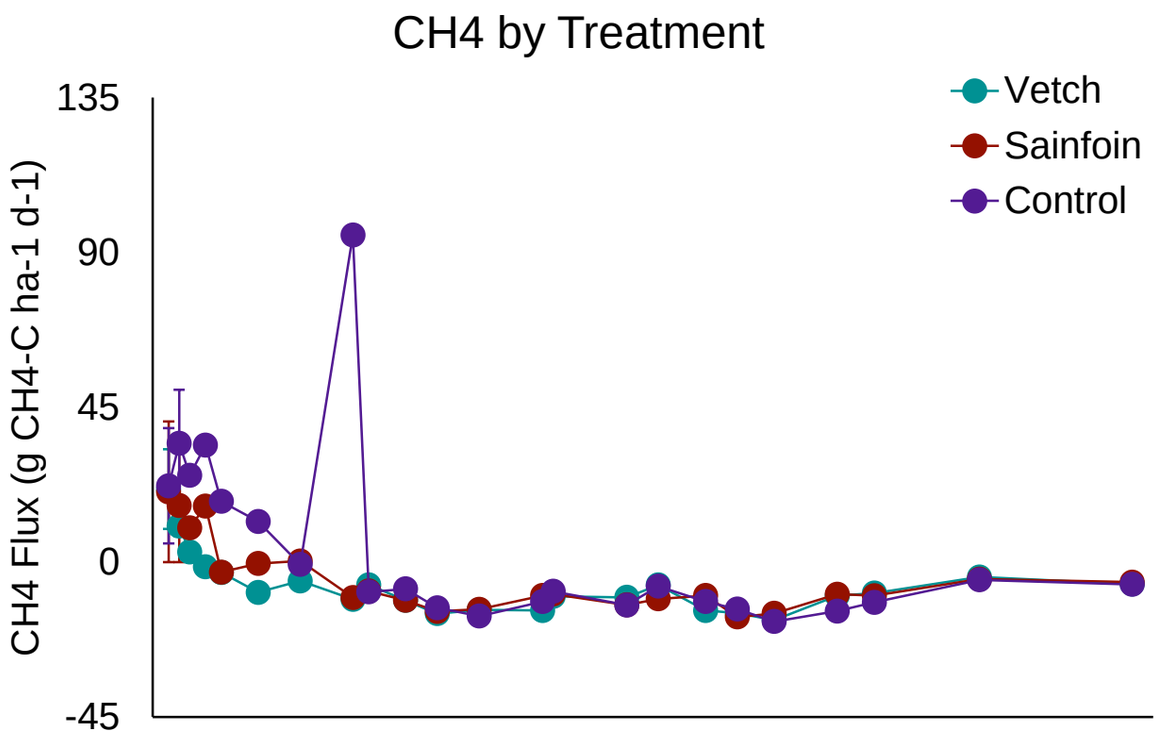
That's great! We should invite them over for lunch…

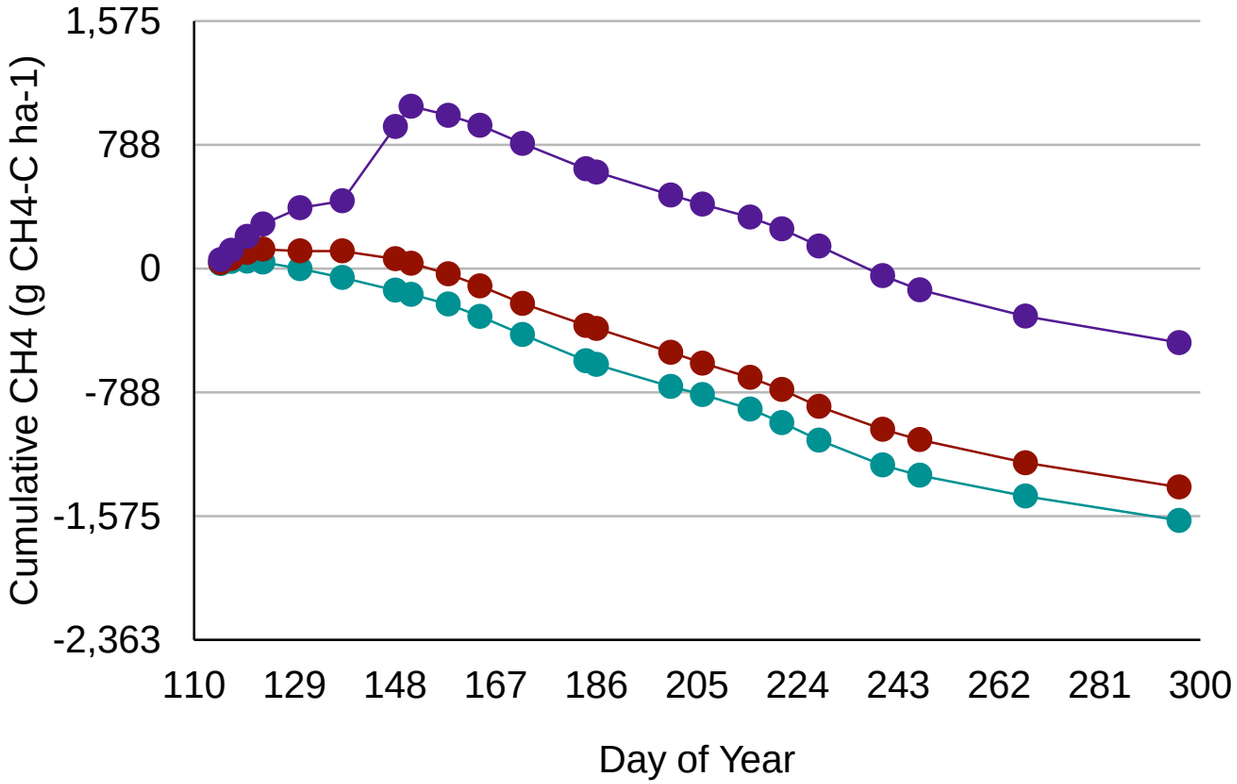


SOIL GAS EXCHANGE GHG BUDGET

- Soil C balance, Nitrous Oxide (N2O) emissions, net methane (CH4)
- change in concentration into or out of chamber

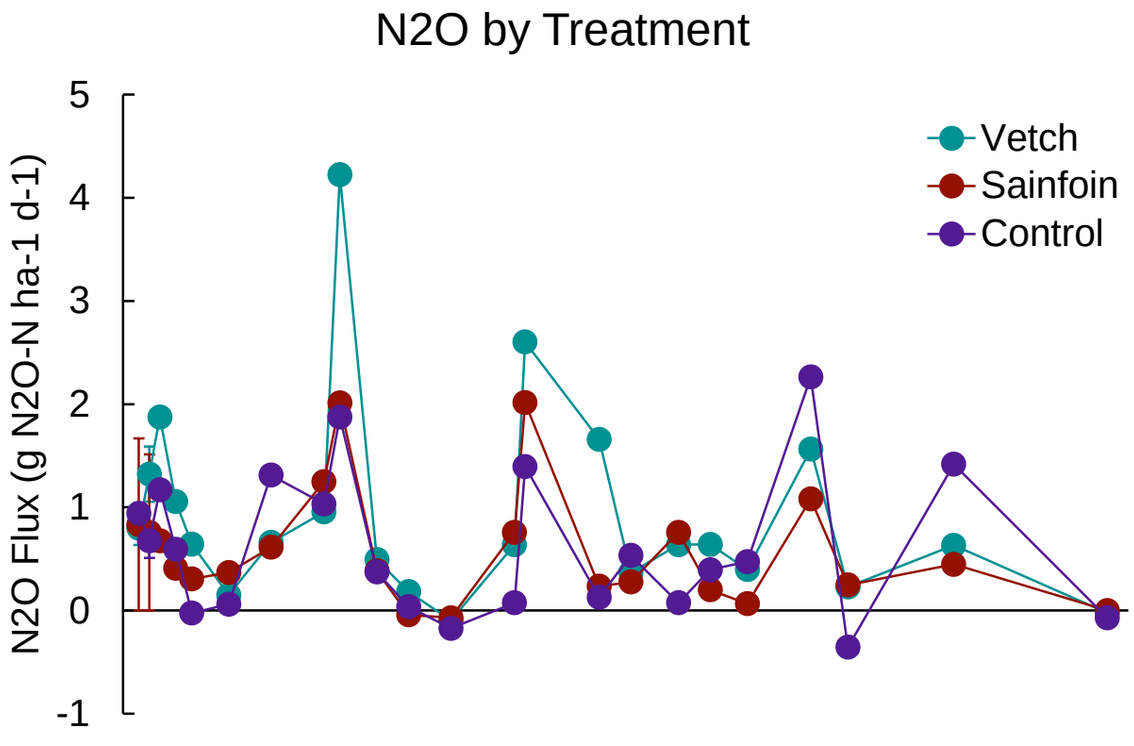
SOIL GAS EXCHANGE GHG BUDGET

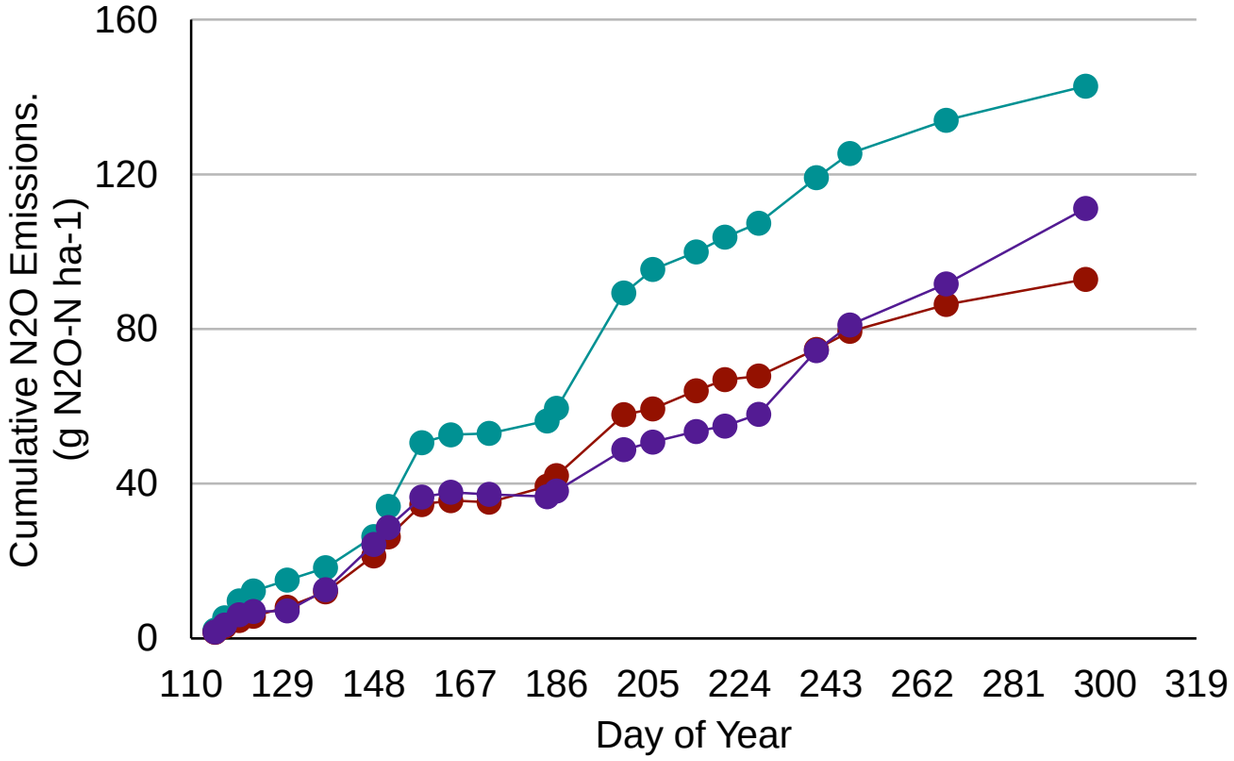




Unpublished data: courtesy Jiancan Liu

- Soil C balance, Nitrous Oxide (N_2O) emissions, net methane (CH_4)
- change in concentration into or out of chamber
- All treatments are sinks for CH_4





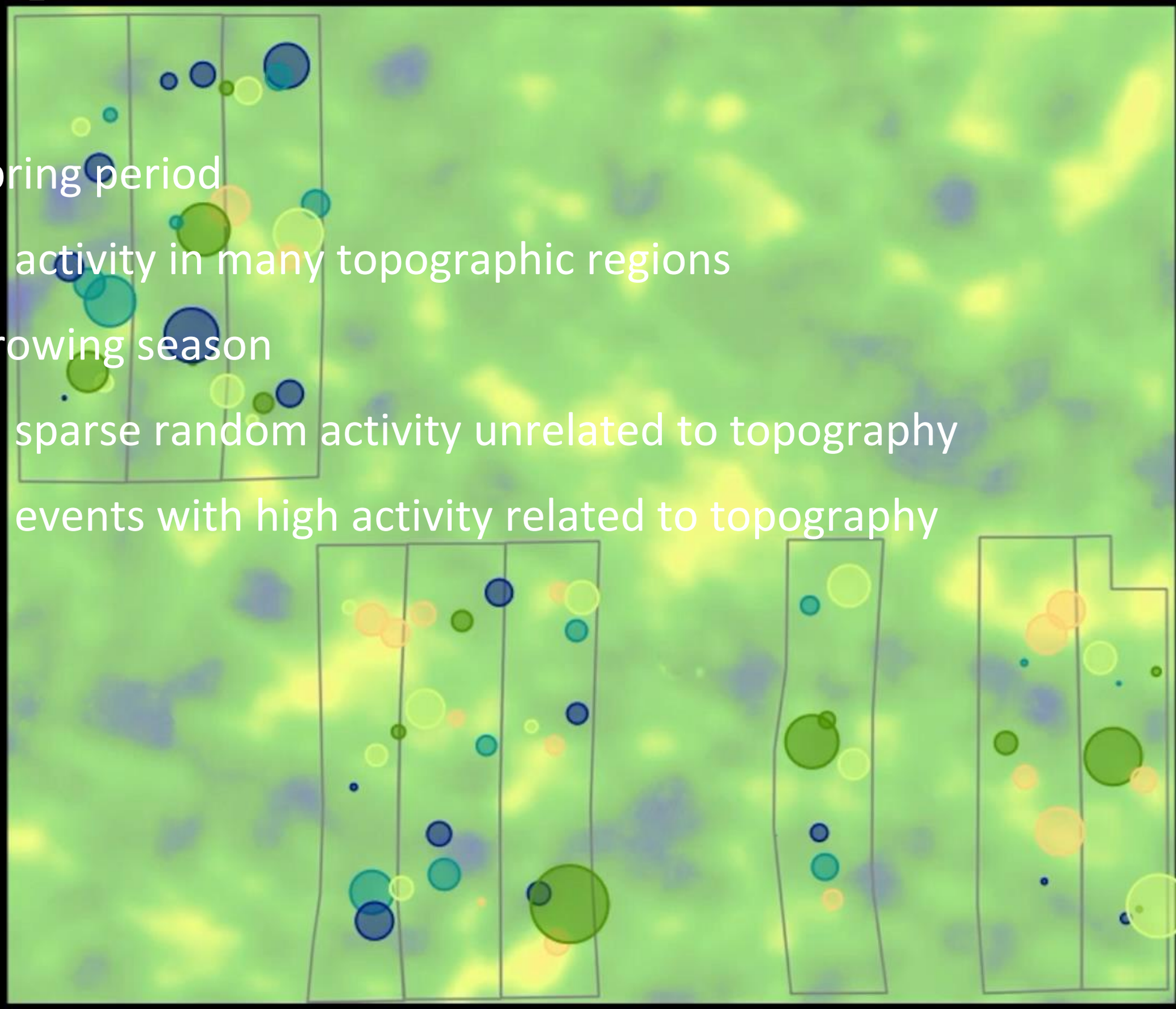
Unpublished data: courtesy Jiancan Liu

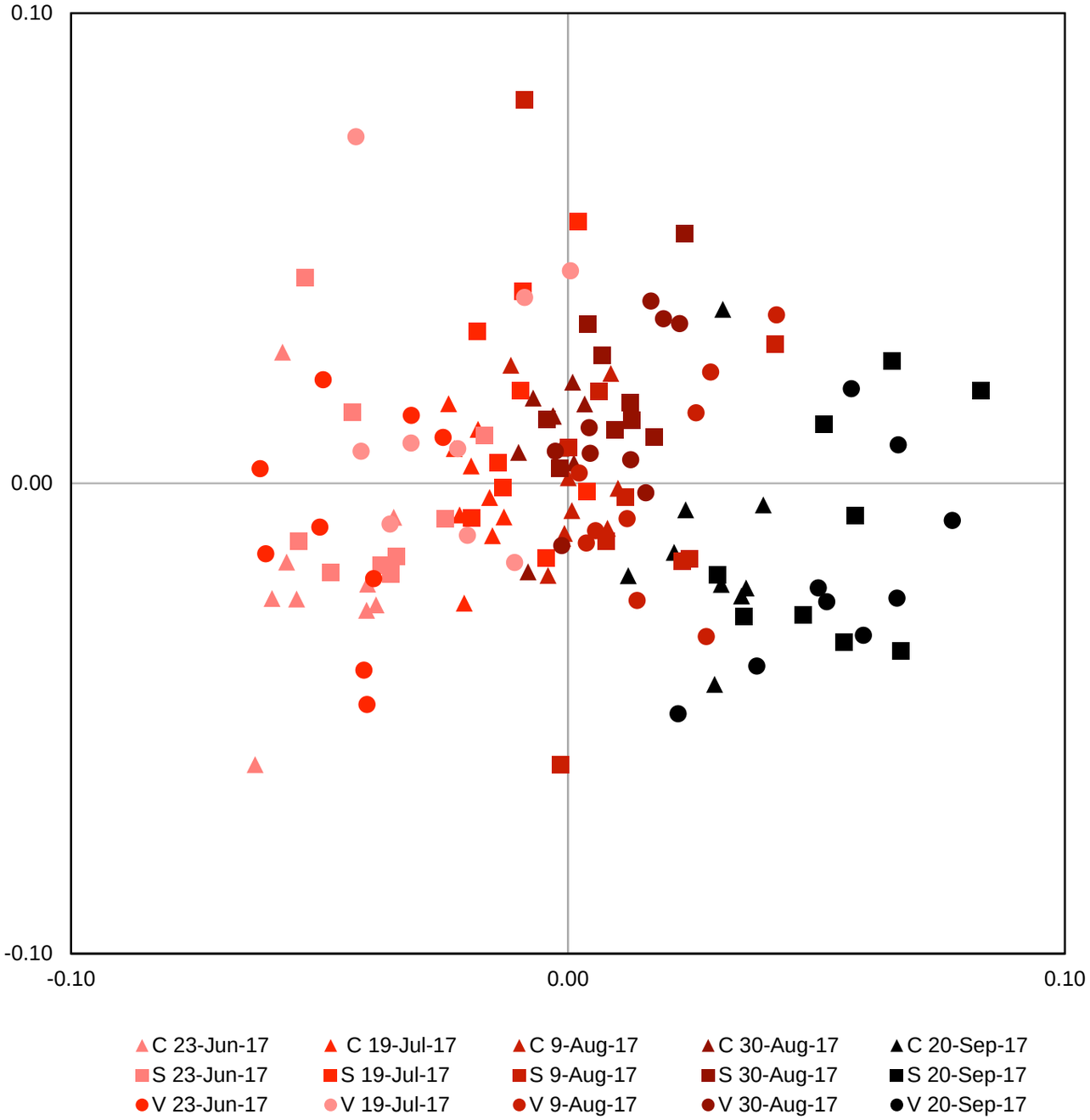
SOIL GAS EXCHANGE GHG BUDGET

- Soil C balance, Nitrous Oxide (N_2O) emissions, net methane (CH_4)
- change in concentration into or out of chamber
- All treatments are sinks for CH_4
- N_2O emissions are small but may be greater with Cicer milkvetch
- N-supply typically V>S>C

N_2O EMISSIONS BY TOPOGRAPHIC POSITION INDEX

- Spring period
  - activity in many topographic regions
- Growing season
  - sparse random activity unrelated to topography
  - events with high activity related to topography



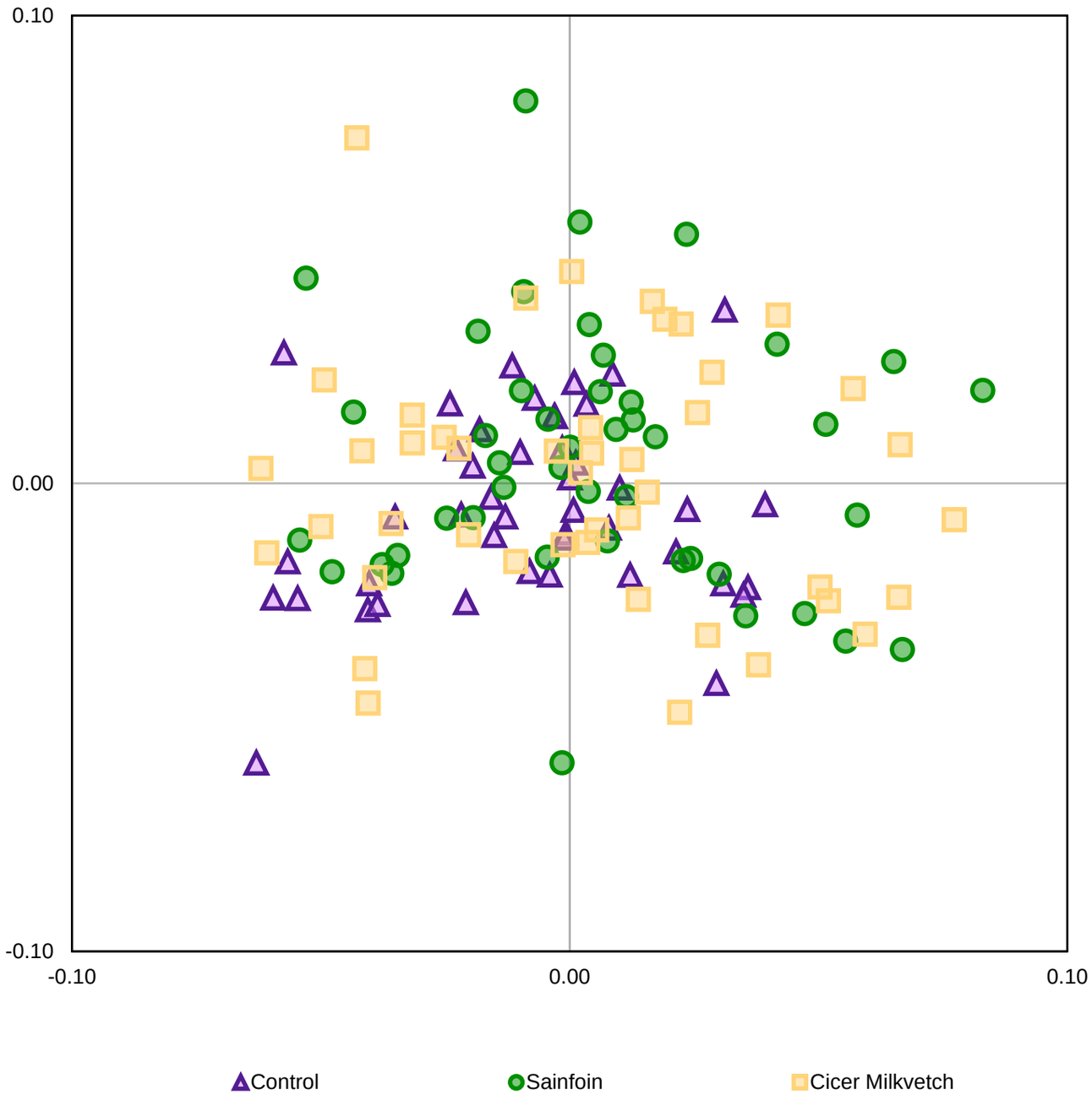


Non-metric Multidimentional Scaling

courtesy Jesse Reimer

SOIL MICROBIOLOGY

- Microbes are responsible for soil GHG processes
- Abundance and community structure shift over time
  - Moisture, temperature, substrate



Non-metric Multidimentional Scaling

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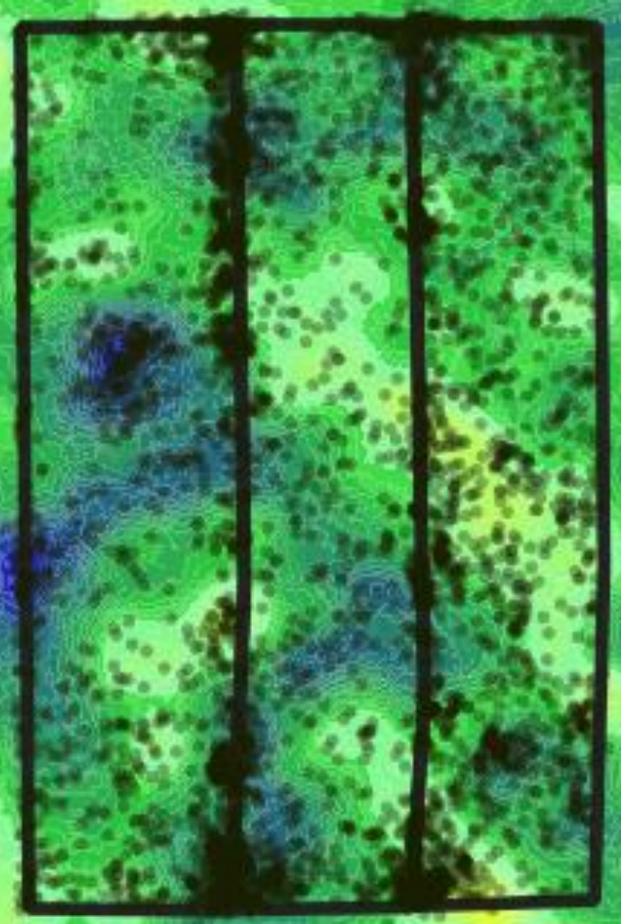
SOIL MICROBIOLOGY

- Microbes are responsible for soil GHG processes
- Abundance and community structure shift over time
  - Moisture, temperature, substrate
- No clear directional response to treatments
  - Legume treatments tend to be more varied

HOT-SPOTS

- Topography
- Seasons and weather
- N-loading
- What is the potential? How much does this contribute to the total?



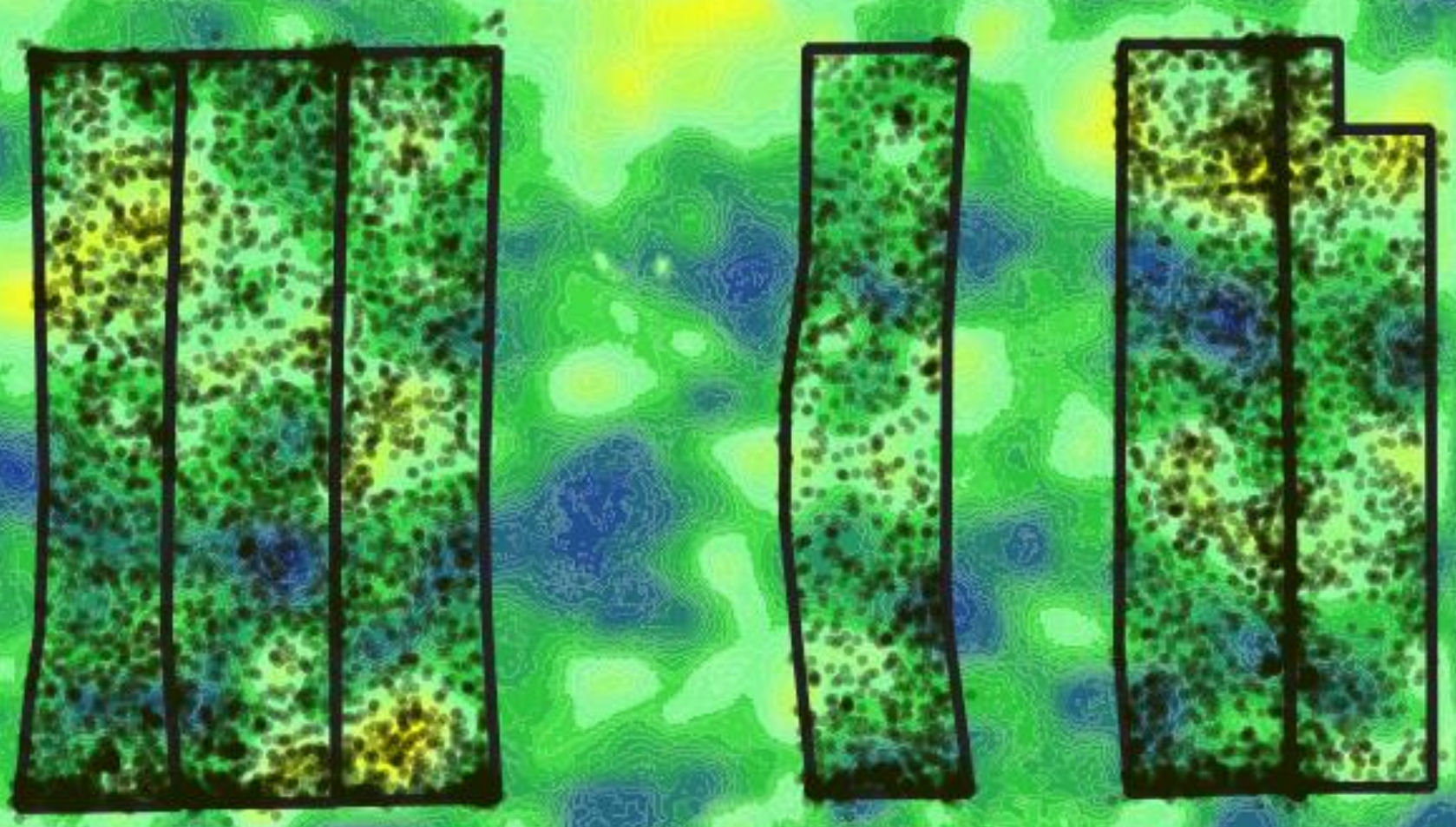
Probabilistic approach to scaling empirical hot-spot observation to the landscape scale

- apply urine and dung to high and low locations and measure greenhouse gas emissions

- estimate the likely number of events across landscape

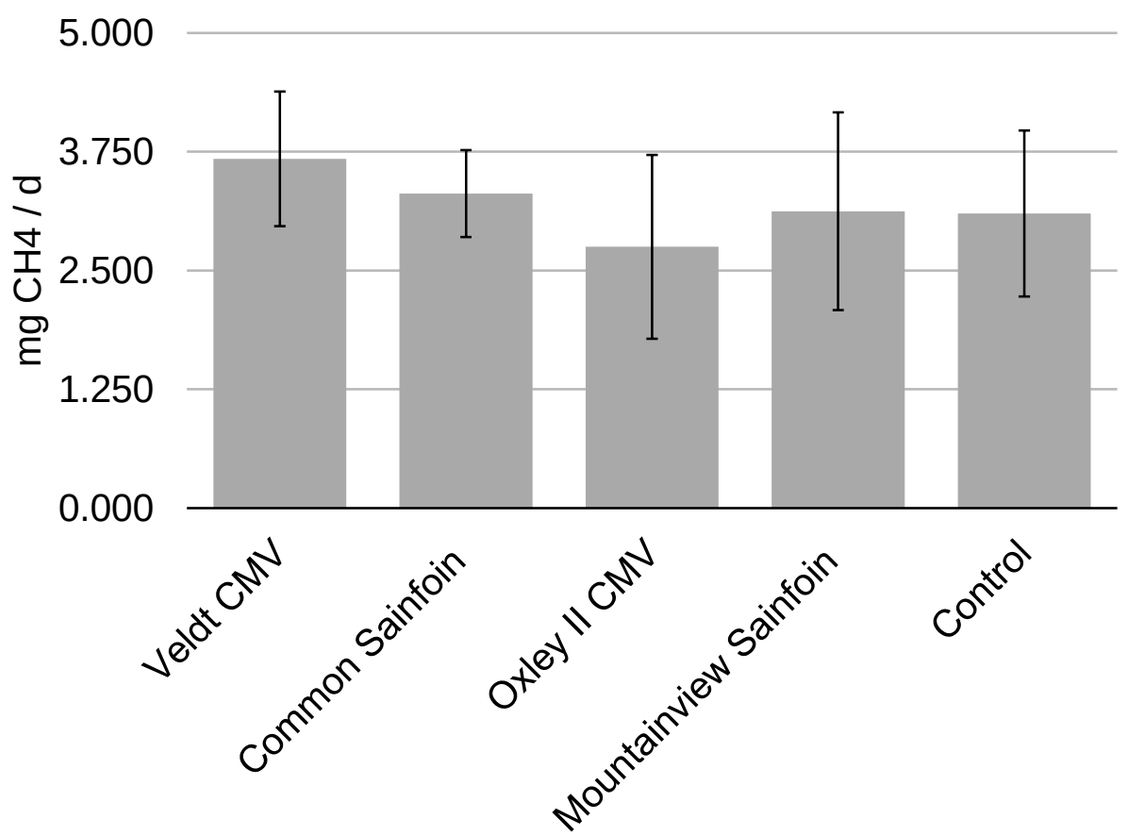
Estimated (2018) 4-5% of total area is urine patch

- N loading may exceed 1000 kg N ha^{-1}



METHANE FROM CATTLE

- Estimated by SF6 tracer method
- Needs calibration by dry matter intake and animal weight gain to be useful

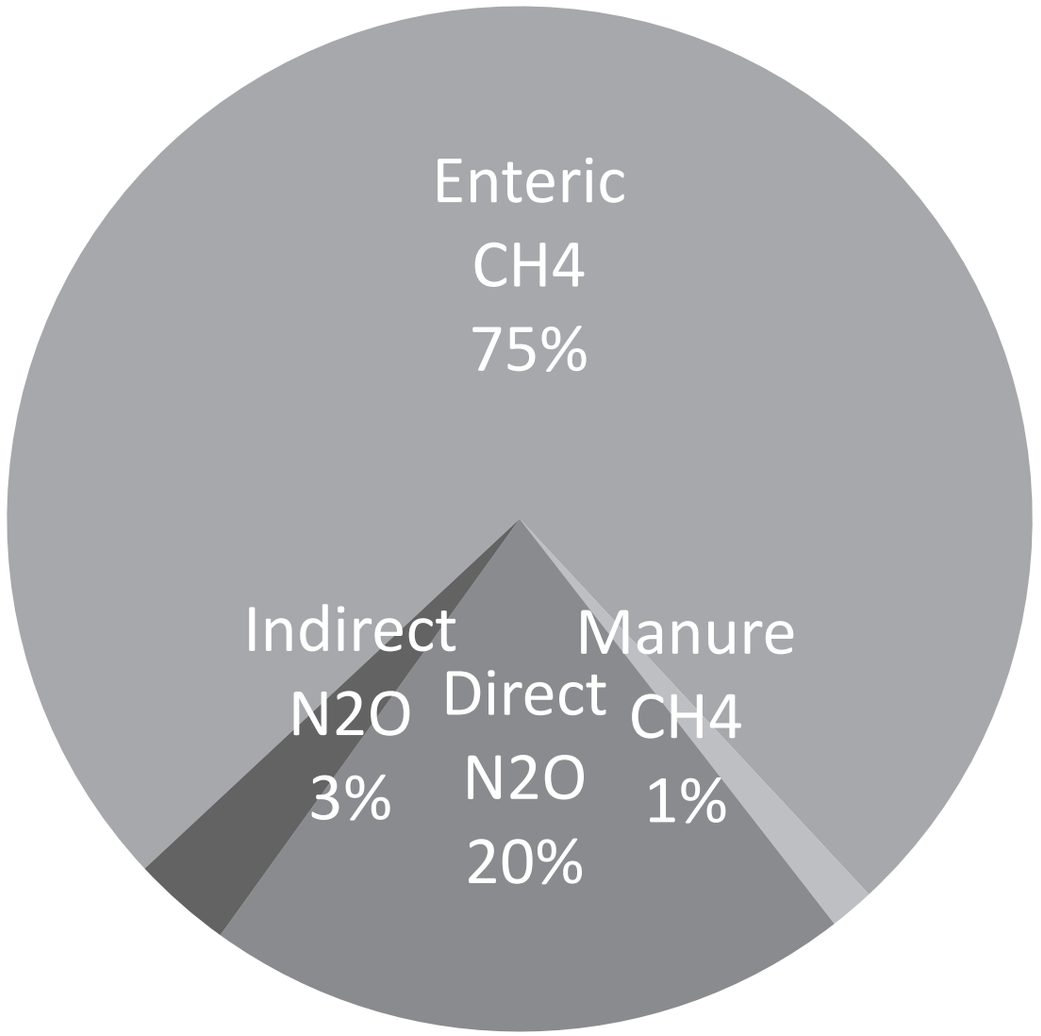


Unpublished data: courtesy Bree Kelln, H.A. Lardner

NET RESULTS AND CONCLUSIONS (PRELIMINARY)

- Soil C and GHG not greatly altered
  - Retain soil C
  - No N_2O or energy cost from fertilizer
- Increased microbial diversity
- Net GHG effect largely dependent on CH_4 from enteric fermentation
- Cost/benefit ratio best option
  - GHG outcomes likely improve

Components of GHG emissions (modelled with HOLOS)



ACKNOWLEDGEMENTS

- Agriculture and Agri-food Canada: Agricultural Greenhouse Gas Program
- College of Agriculture and BioResources – Martin Trust
- Darin, Frank, Sharon, Mark and everyone else in Lab 5E19

Thank-you!

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