

“Biochar as an Addition to Cattle Feed and its Influence on Greenhouse Gas Emissions During Manure Composting”

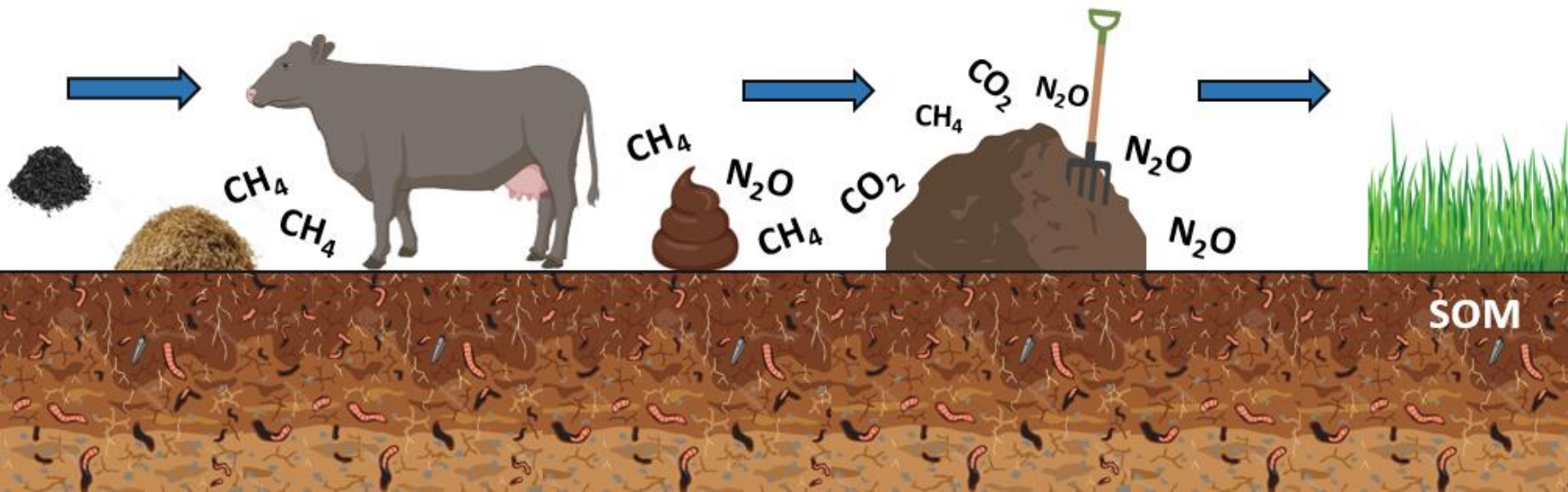


Compost Matters in Alberta
The Compost Council of Canada
Calgary, AB - March 3, 2020



Xiying Hao, PhD; Paul Hazendonk, PhD; Tim McAllister, PhD; Erasmus Okine, PhD

Carlos M. Romero, PhD
carlos.romero@uleth.ca



Presentation - Overview



BIOCHAR IN AGRICULTURE

MANURE

COMPOST

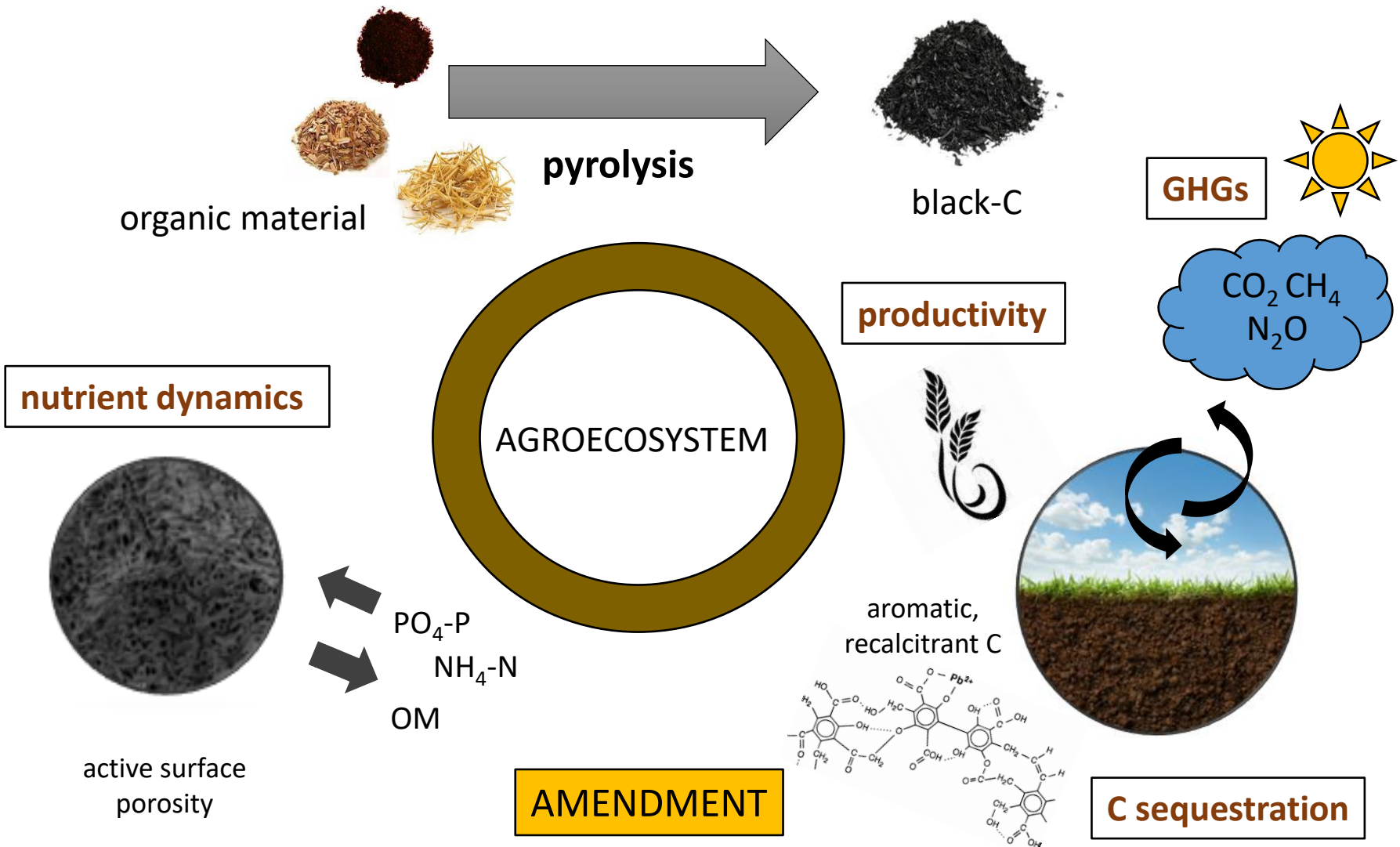
1 background

3 compost trial

2 manure trial

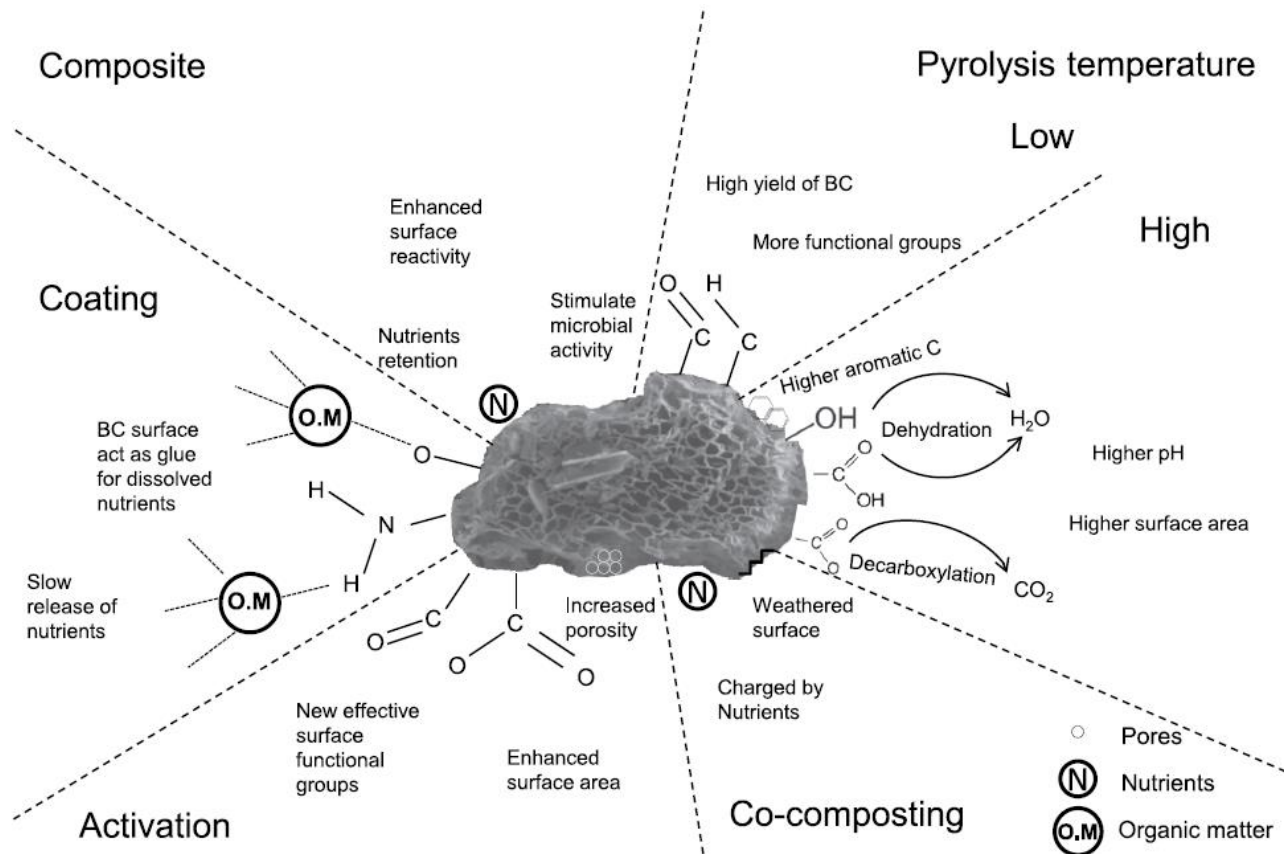
4 future work

Biochar – Background



Biochar – Background

Optimal strategies of biochar application to low fertility soils



El-Naggar et al., 2019. Geoderma 337: 536-554.

*Liming agent
Increase nutrient levels*

Biochar – Background

feed additive



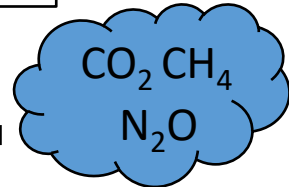
The use of biochar in animal feeding

Hans-Peter Schmidt¹, Nikolas Hagemann^{1,2}, Kathleen Draper³ and Claudia Kammann⁴



biochar manure

GHGs

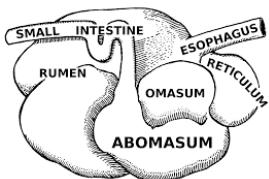


Use of biochar as feed supplements for animal farming

Ka Yan Man^a, Ka Lai Chow^b, Yu Bon Man^a, Wing Yin Mo^c, and Ming Hung Wong^d

Feeding Biochar to Cows: An Innovative Solution for Improving Soil Fertility and Farm Productivity

Stephen JOSEPH^{1,2,3,10,*}, Doug POW⁴, Kathy DAWSON⁵, David R. G. MITCHELL³, Aditya RAWAL⁹, James HOOK⁹, Sarasadat TAHERYMOOSAVI², Lukas VAN ZWIETEN⁶, Joshua RUST⁶, Scott DONNE¹, Paul MUNROE³, Ben PACE², Ellen GRABER⁸, Torsten THOMAS⁷, Shaun NIELSEN⁷, Jun YE⁷, Yun LIN¹, PAN Genxing¹⁰, LI Lianqing¹⁰ and Zakaria M. SOLAIMAN¹¹



ANIMAL FE

body weight ↑

CH₄ ↓

Biochar – Background

Agronomic value of biochar-manure or biochar-compost?

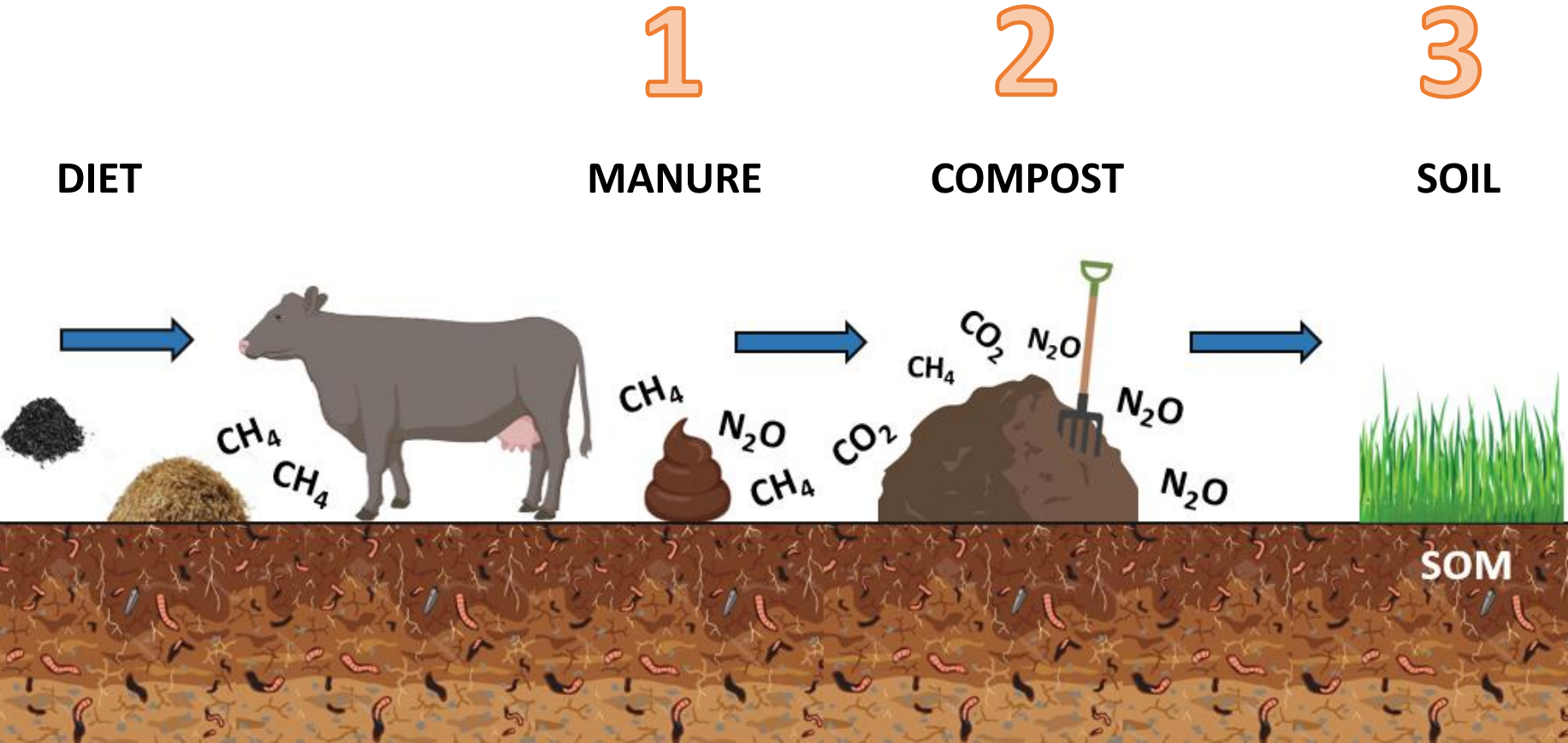
NUTRIENT RETENTION – GREENHOUSE GAS EMISSIONS



FIELD STUDIES

“Assessment of the Potential of Biochar Added to Beef Cattle Diets to Reduce Greenhouse Gas Emissions in Agriculture”

FIRST STUDY IN NORTH AMERICA



Presentation - Overview



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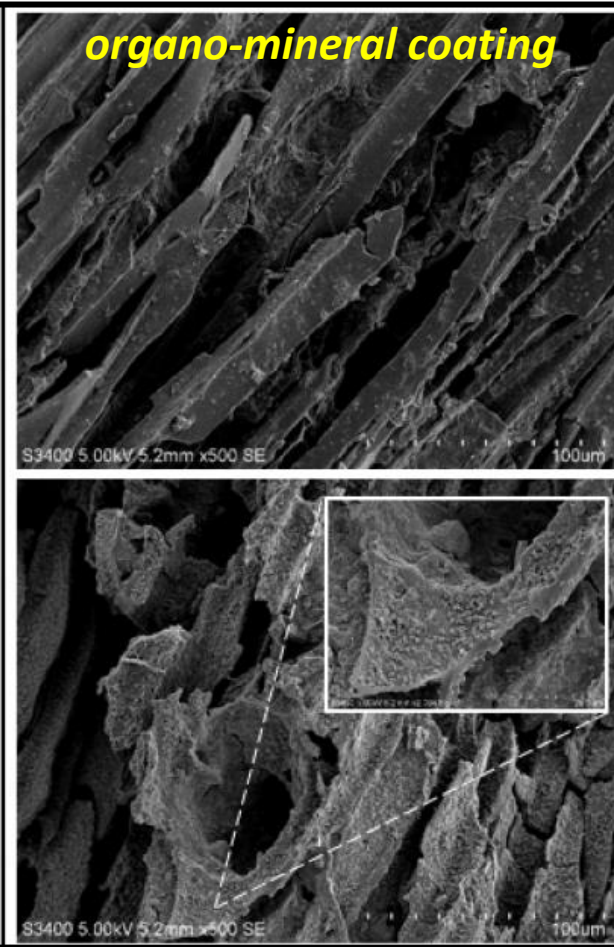
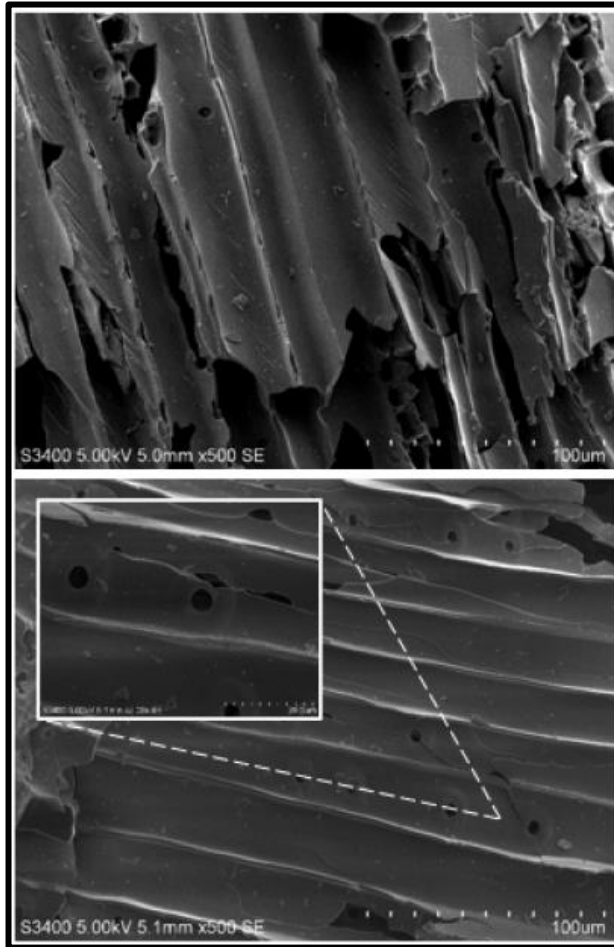
2 manure trial

4 future work

BIOCHAR & MANURE

Fresh Biochar

Cattle Digested Biochar



organo-mineral coating



Romero et al., 2019. Pedosphere. In press.

BIOCHAR & MANURE

Treatments – Diets (Biochar as dry matter)

0.0%

0.5%

1.0%

2.0%

Monthly Sampling – January to July
n=112

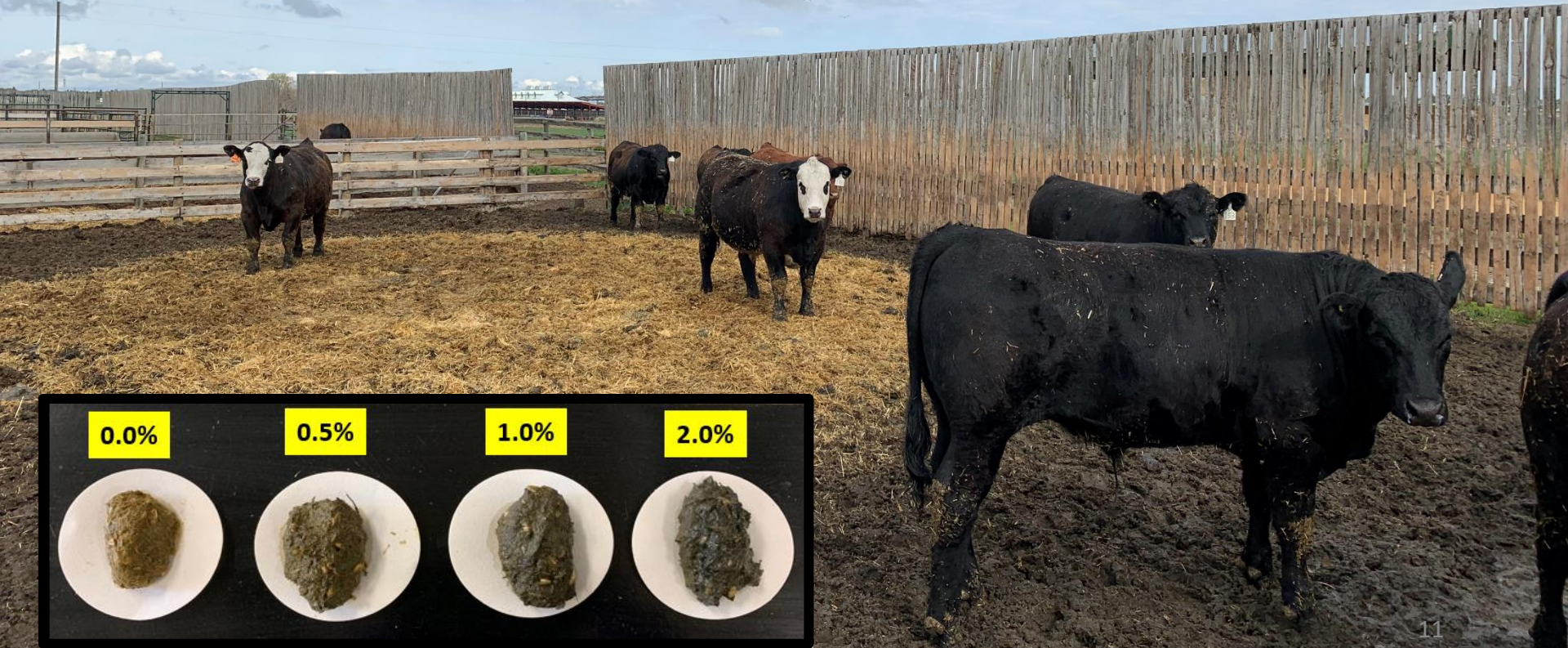
Biochar 2.0%



BIOCHAR & MANURE

NUTRIENT QUANTITY

NUTRIENT TYPE - CARBON



0.0%

0.5%

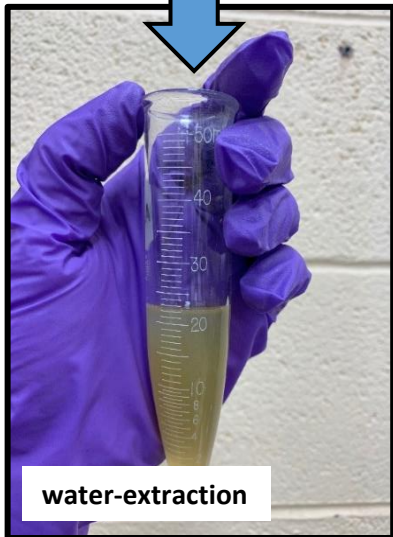
1.0%

2.0%

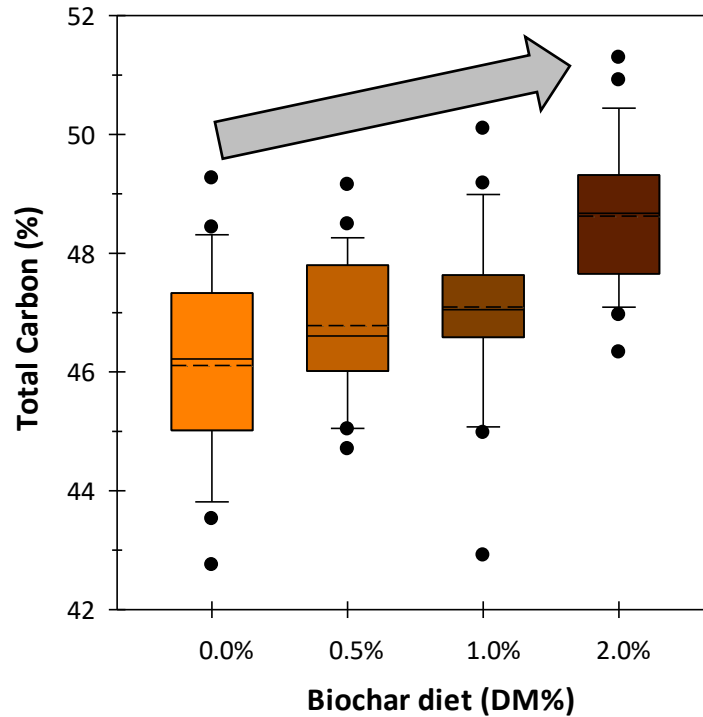


BIOCHAR & MANURE

Manure Analysis



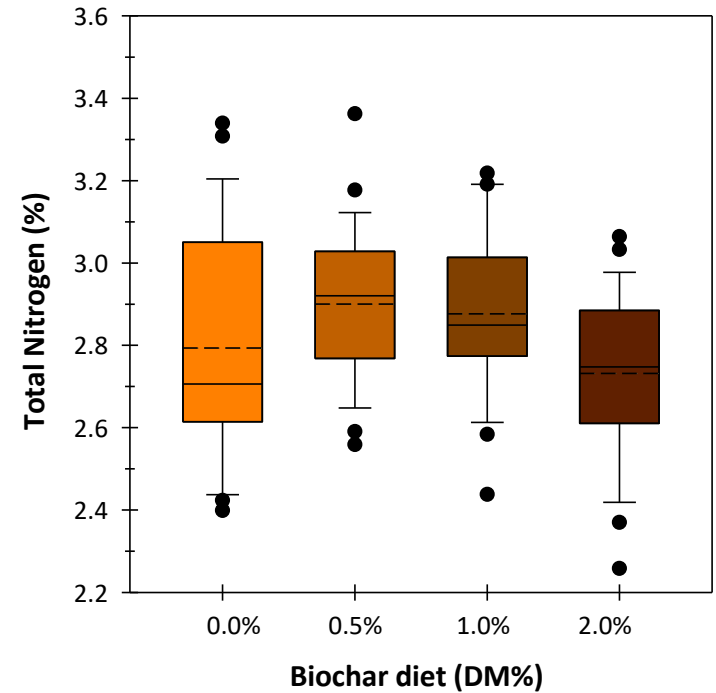
Total Carbon



75% (dry weight) of biochar is carbon!

NUTRIENT QUANTITY

Total Nitrogen



0.2% (dry weight) of biochar is nitrogen!

BIOCHAR & MANURE

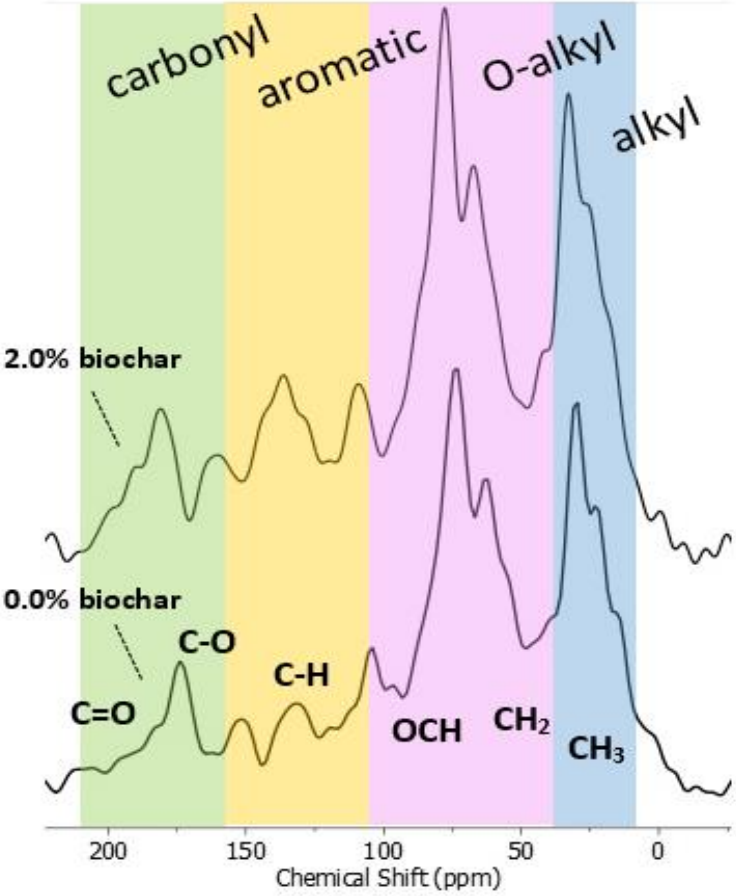
NUTRIENT TYPE - CARBON

Carbon Speciation by NMR

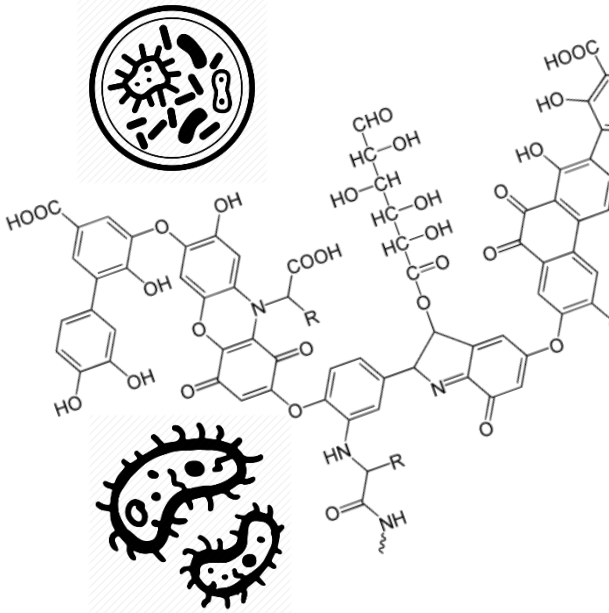
RECALCITRANCE - AROMATICITY

2.0% > 0.0%

biochar-manure less attractive to microbes!



¹³C EASY DP MAS spectra



BIOCHAR & MANURE

BIOCHAR AFFECTS THE CARBON QUANTITY OF MANURE

BIOCHAR INCREASES THE RECALCITRANCE OF MANURE



Presentation - Overview



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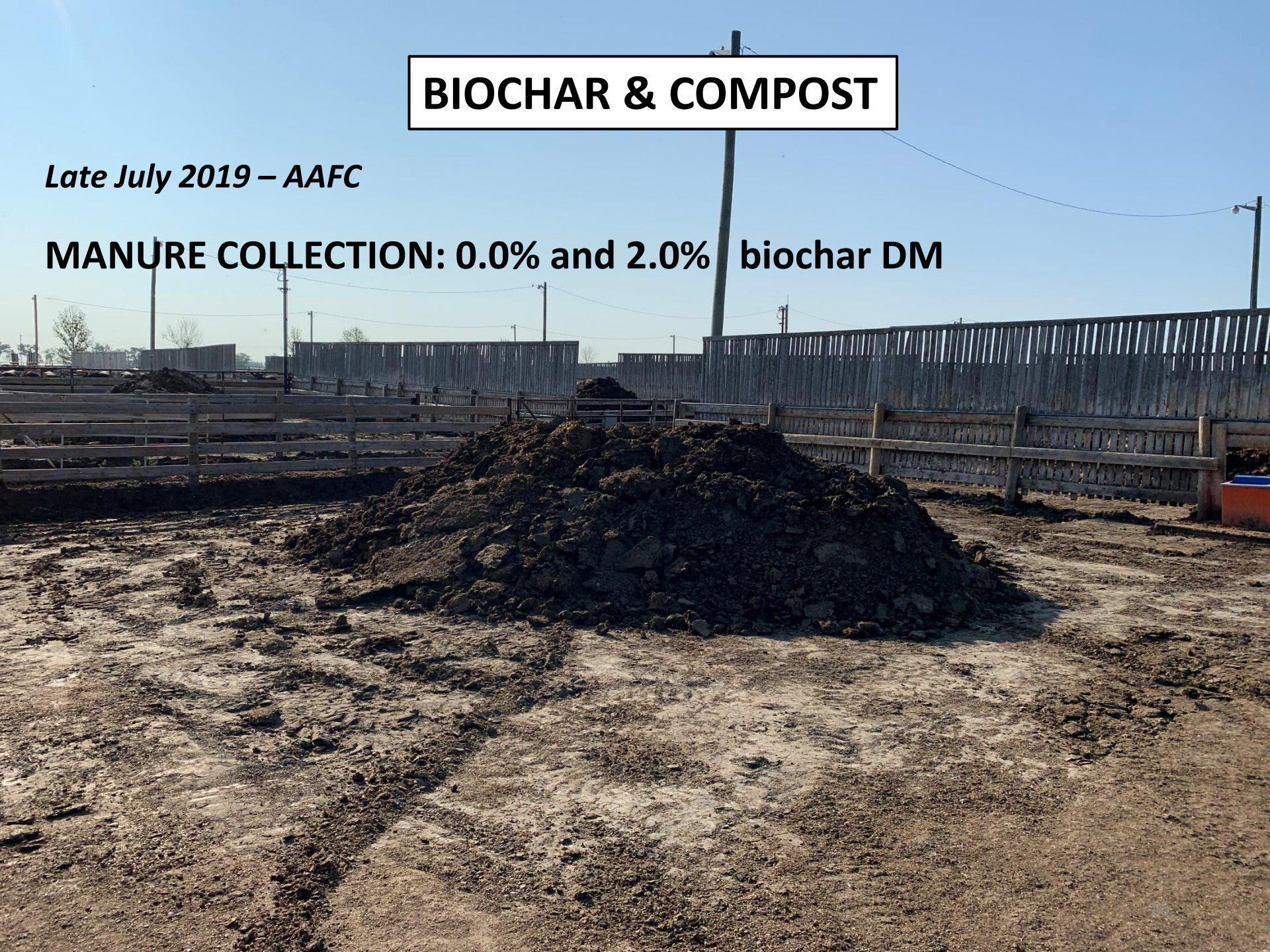
2 manure trial

4 future work

BIOCHAR & COMPOST

Late July 2019 – AAFC

MANURE COLLECTION: 0.0% and 2.0% biochar DM



BIOCHAR & COMPOST

Early August 2019 – AAFC

STOCKPILE (no turning) – COMPOST (three turnings)



BIOCHAR & COMPOST

August – November (85 days trial)

Sampling Regime

Hourly: Temperature

surface or depth profile (30, 60, 90 cm)

Weekly: Gas sampling

surface or depth profile (30, 60, 90 cm)

Every turning event: Manure sampling



Buried bags of biochar (3 depths)
Nutrient sorption?



BIOCHAR & COMPOST

Early August 2019 – AAFC



Early September 2019 – AAFC

COMPOST WINDROWS

9000 kg windrow⁻¹



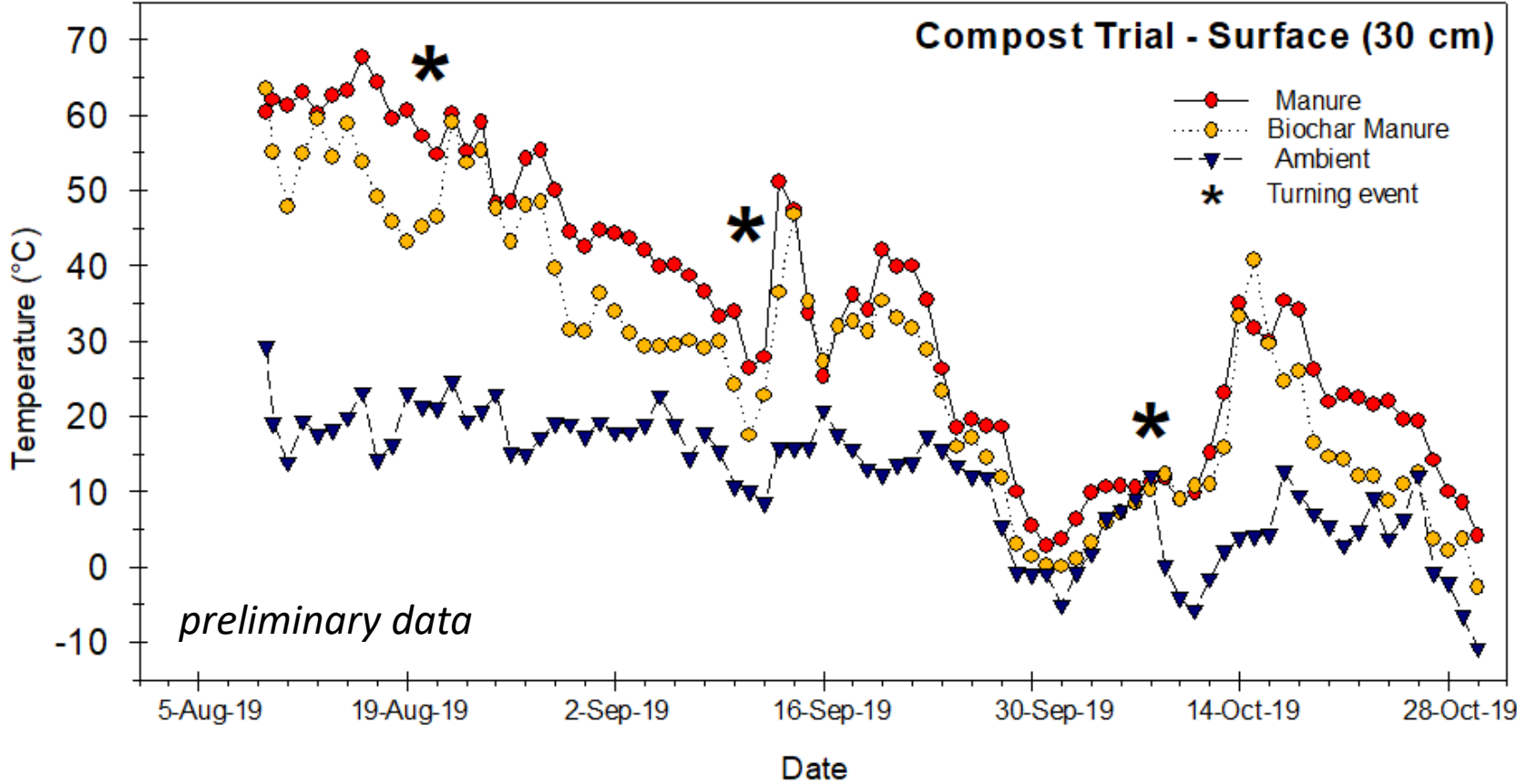
8.0 m

1.2 m



BIOCHAR & COMPOST

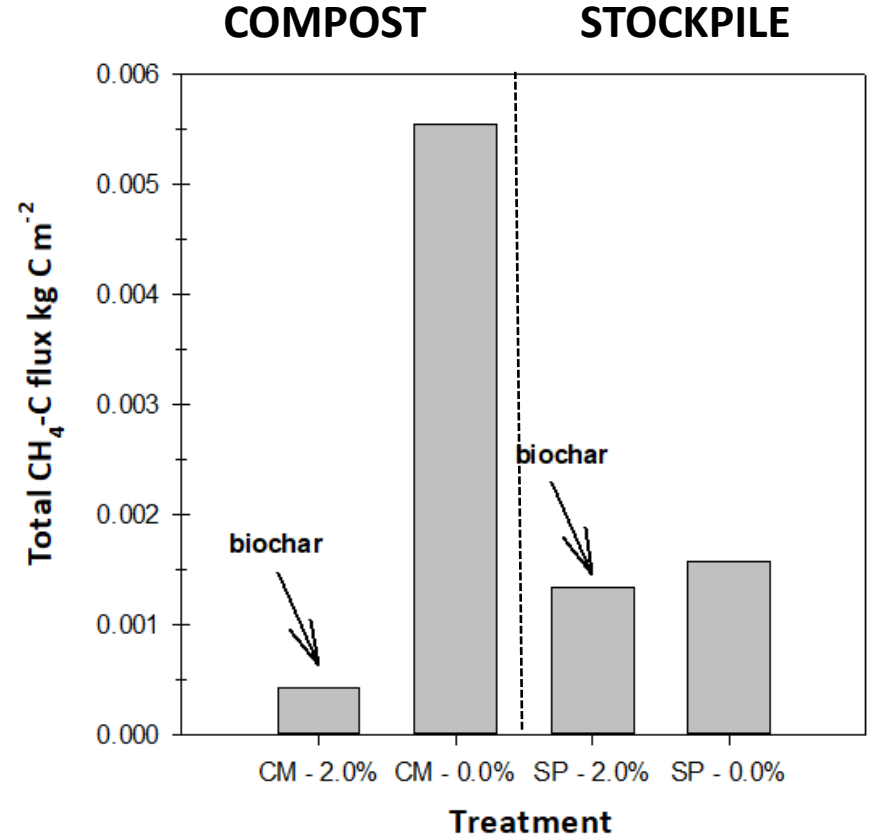
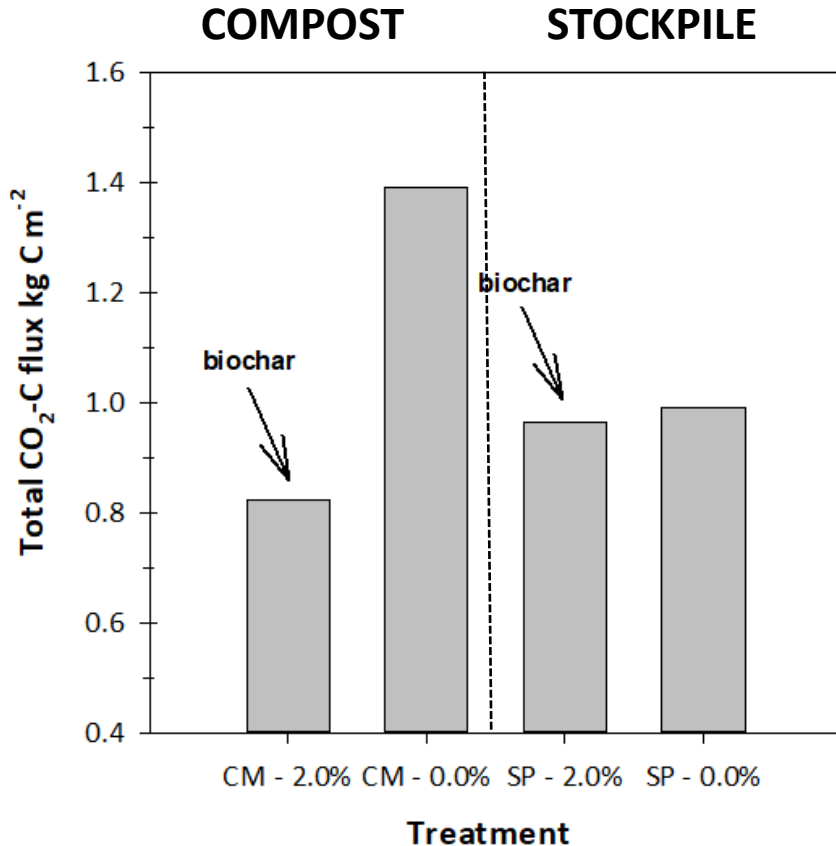
TEMPERATURE



BIOCHAR AFFECTS COMPOSTING TEMPERATURE

BIOCHAR & COMPOST

GREENHOUSE GAS EMISSIONS



preliminary data

BIOCHAR AFFECTS COMPOST GREENHOUSE GAS EMISSIONS

BIOCHAR & COMPOST

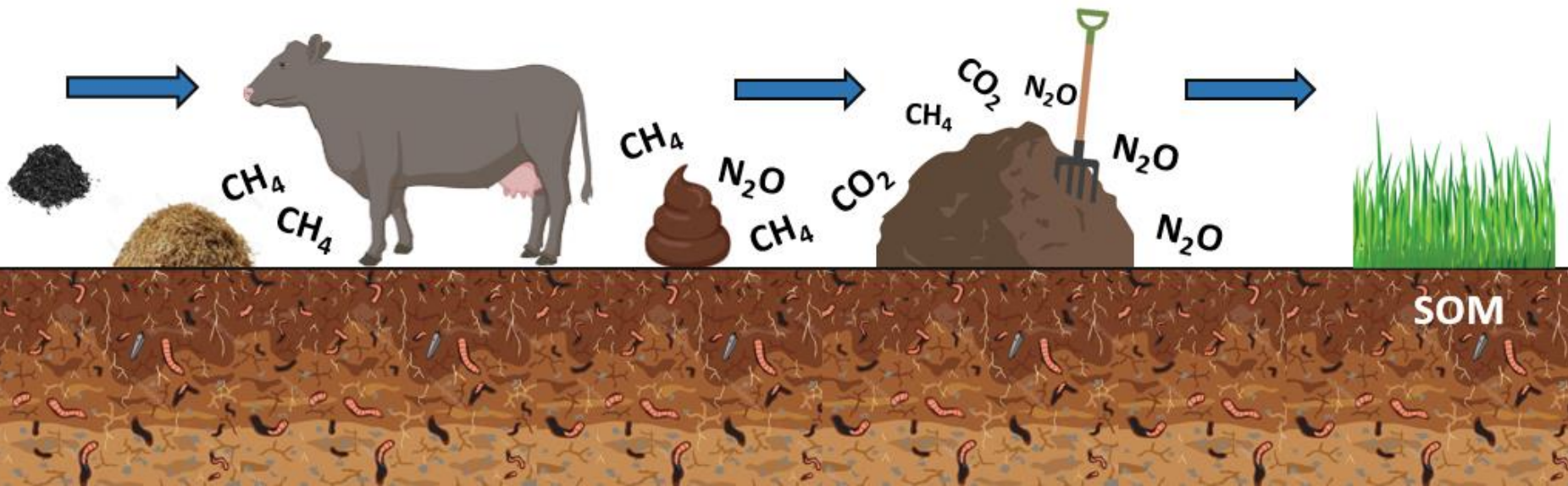
BIOCHAR AFFECTS COMPOSTING BY ALTERING THE CARBON QUALITY OF MANURE

BIOCHAR REDUCES COMPOSTING TEMPERATURES AND ASSOCIATED CO₂ AND CH₄ EMISSIONS



THE MATURITY OF THE RESULTING COMPOST WILL BE EVALUTED

“Biochar may provide an alternative for carbon-neutral farming within densely populated livestock regions as it increases the stability of animal organic matter in manure-compost transformations”



Presentation - Overview



BIOCHAR IN AGRICULTURE

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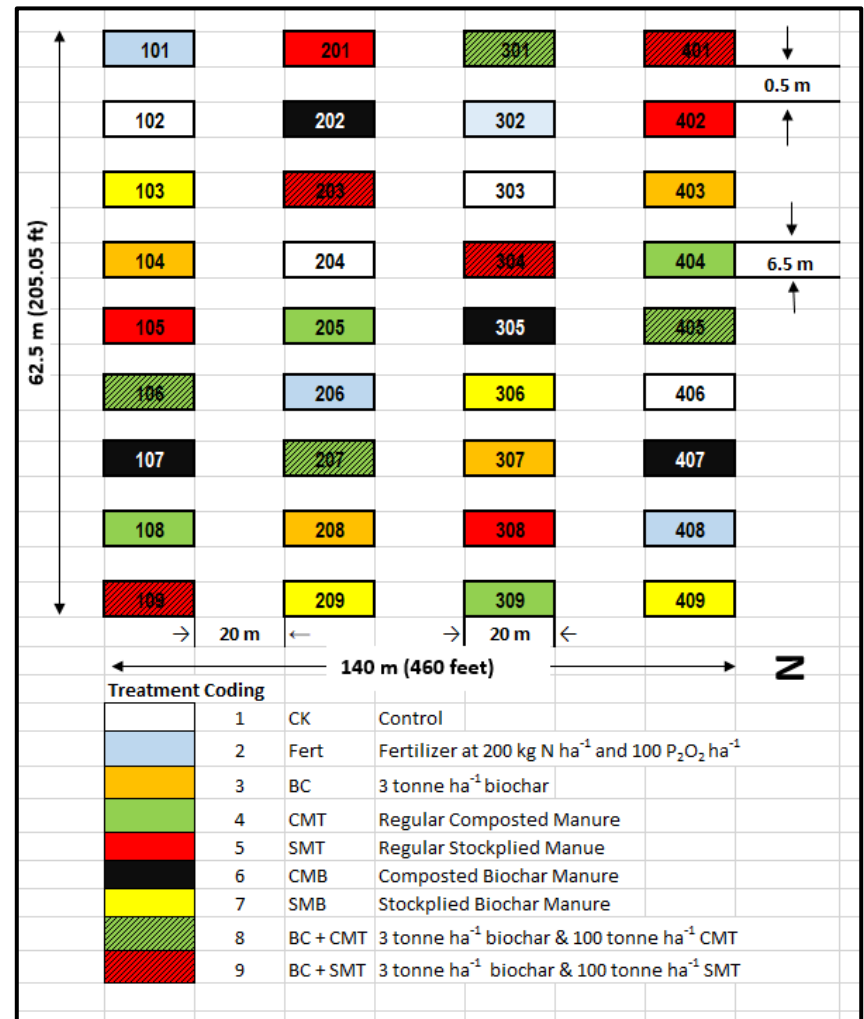
4 future work

2020 BIOCHAR FIELD TRIAL

Barley silage.

Spring application of compost and stockpile.

Spring application of fertilizer.



ACKNOWLEDGEMENTS

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Chunli Li, PhD - AAFC

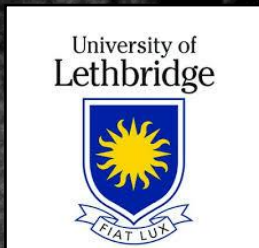
Jen Owens, PhD – AAFC

Hongjie Zhang, PhD - AAFC

Gabriel Ribeiro, PhD – University of Saskatchewan

Michael Opyr, University of Lethbridge

Tony Montana, University of Lethbridge



THANK YOU!

COMMENTS? QUESTIONS?



Romero et al., 2019

S3400 5.00kV 5.2mm x500 SE

100um