

Precision Zonal Management Creates Within Field Zones of Functional Specialization: Evidence from On-Farm Sites

Patrick Ewing, Nick Jordan, Tony Yannarell, Adam Davis, Stuart Grandy, Roger Koide, Dave Mortensen, Rich Smith, Sieg Snapp, Kurt Spokas, Leslie Atwood, Amanda Daly, Andrea Jilling, Dan Kane, Meng Li, Yi Lou



Outline

Precision Zonal Management and Climate Change Resilience

Questions, Sampling Scheme, Measurements

Evidence





Conservation agriculture (CA)

for coping with water / labor scarcity and managing risk

CA is a **SYSTEM** – the parts (tillage, residue, rotation) complement each other

Minimum or zero tillage
Residue retention
Crop Rotation

Reduced costs

Water use efficient

Improved soil quality

Resilience to climate risks

Higher, more stable yields

Increased profitability



Catalyst for sustainable intensification

CIMMYT

Nick Jordan, UMN

Precision Zonal Management



Precision Zonal Management

ACTIVE TURNOVER

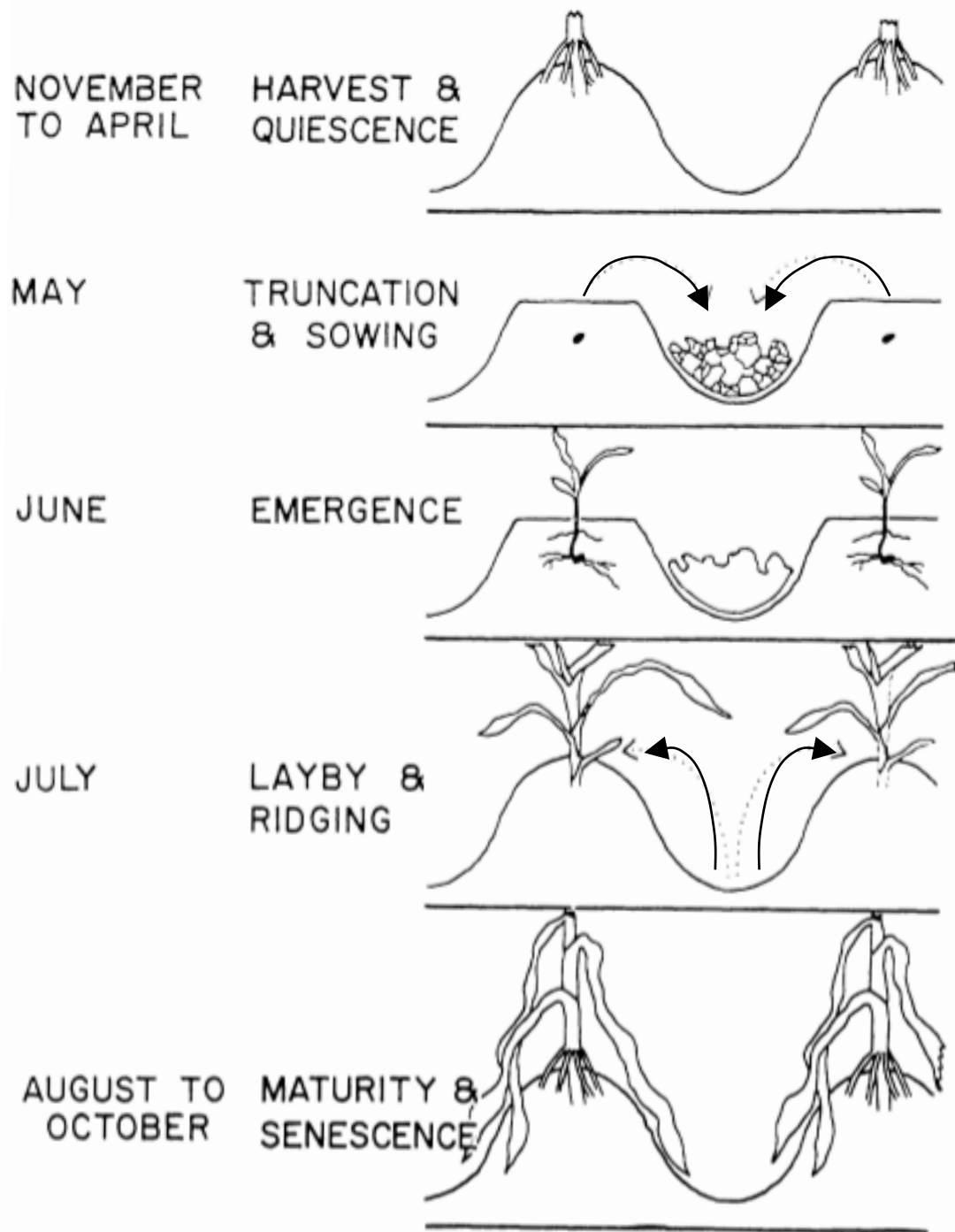
SOIL BUILDING

ACTIVE TURNOVER

Precision Zonal Management



What is Zonal Management?





Instability From Climate Change

More Drought

Lower Microbial Activity
Lower Mineralization Rates
Lower Nutrient Availability

Heavier Rains

More Leaching
More Runoff
More Denitrification

Wetter Springs

Later Planting and Maturity
Slower Root Growth
Lower Mineralization Rates

Wehner et al. (2011) *J. Hydrometeorol.*

Diffenbaugh et al. (2005), *Proc. Natl. Acad. Sci. USA*

NOAA RISA Southern Climate Impacts Planning Program (2013)

Driving Questions

Zonation

Do we see evidence of *soil building* and *active turnover* zones?

Evidence

Differences in soil resources, microbial activity between zones

Overall Function

Do we see evidence of higher functioning in PZM fields?

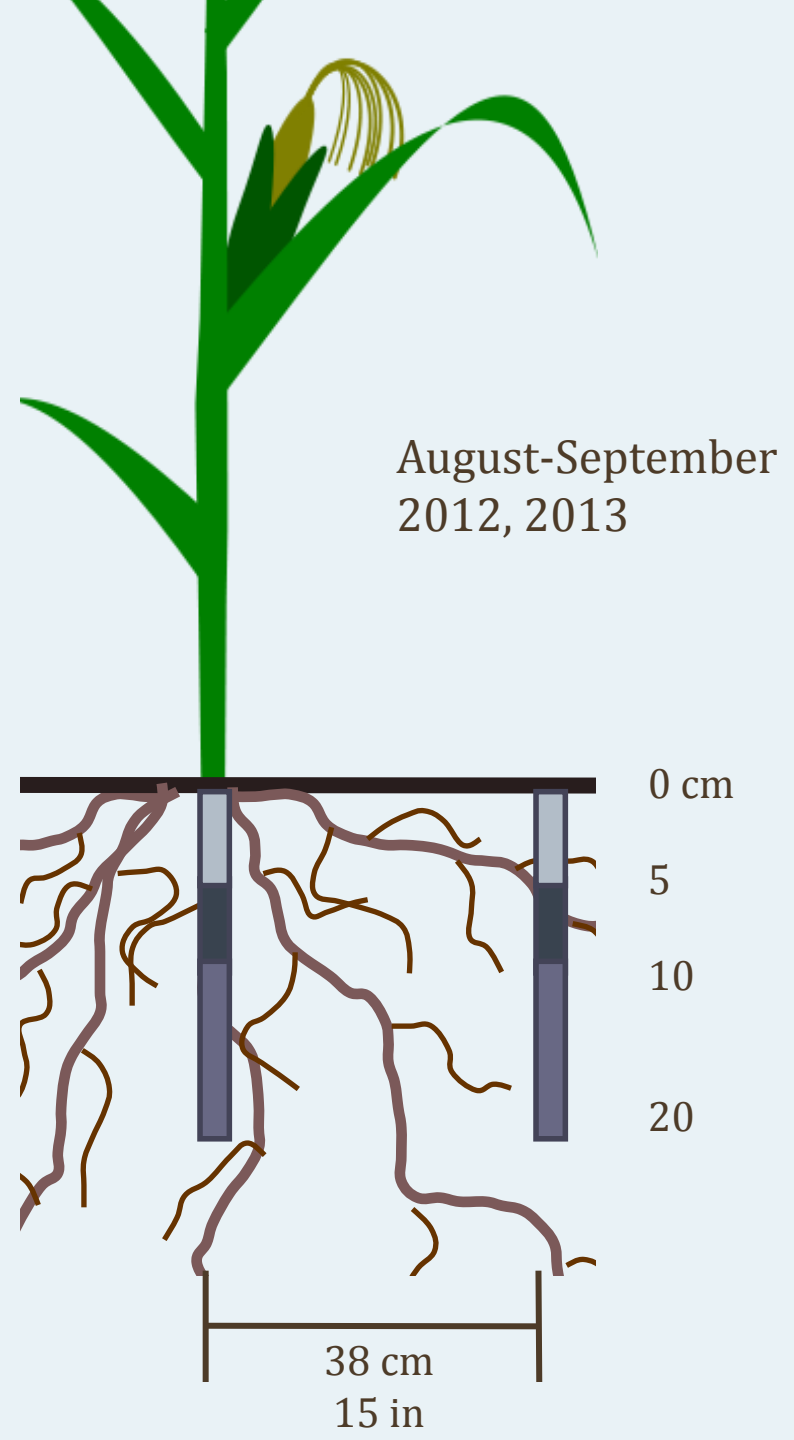
Similarities of soil properties to grass

Sampling

Sampling in late season, 2011-2012
Up to 50 years under single management
Ridge till and chisel plow within 2 km
Conventional corn-soy rotation
Accompanying grassy strips

GROUPS:
Chisel Plow (CP)
Disturbed Ridge Till (RT-0)
Stable Ridge Till (RT-10)

Sampling



Measurements

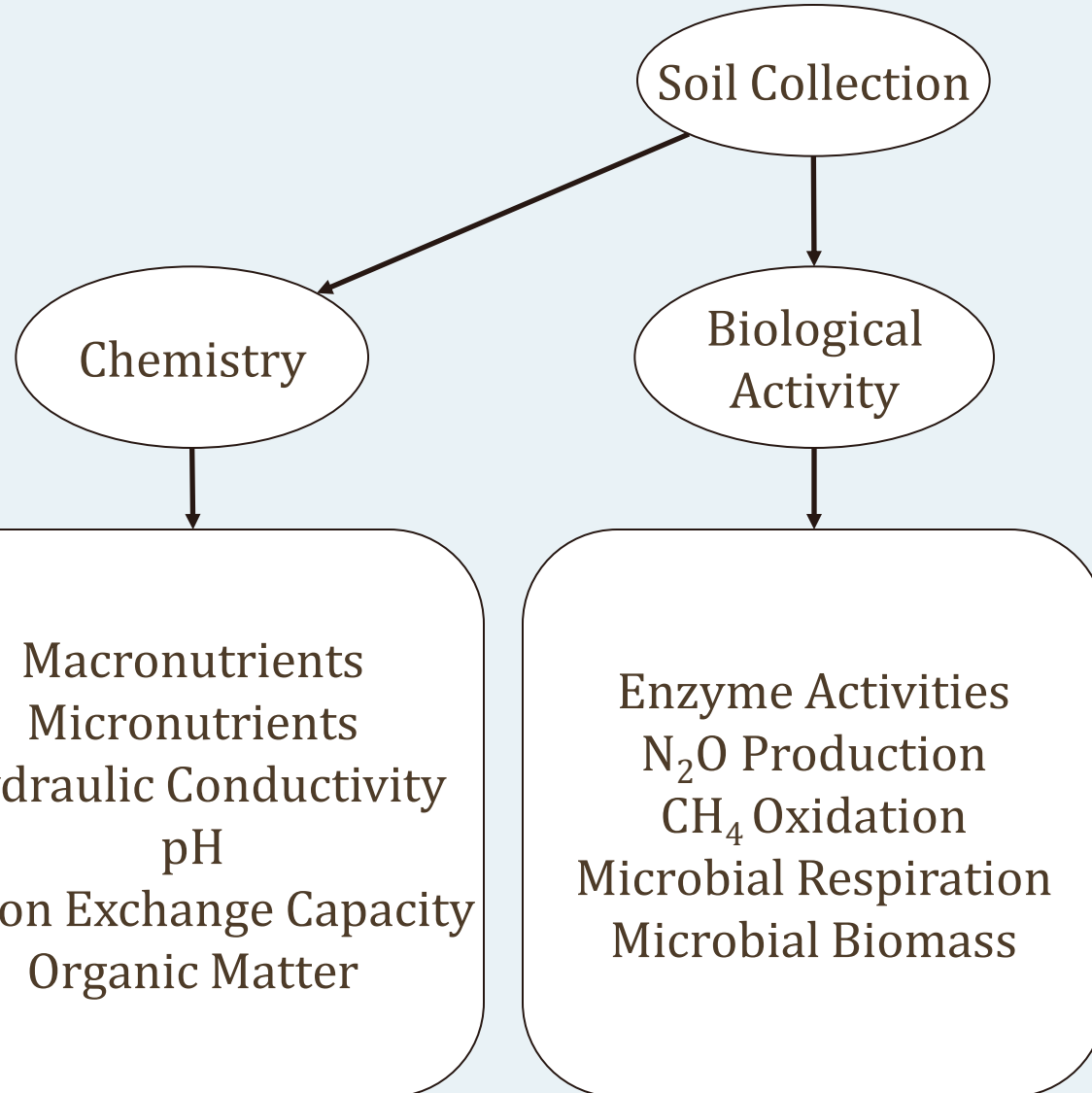
Soil Collection

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graph TD; A([Soil Collection]) --> B([Chemistry]); B --> C[Macronutrients<br/>Micronutrients<br/>Hydraulic Conductivity<br/>pH<br/>Cation Exchange Capacity<br/>Organic Matter];
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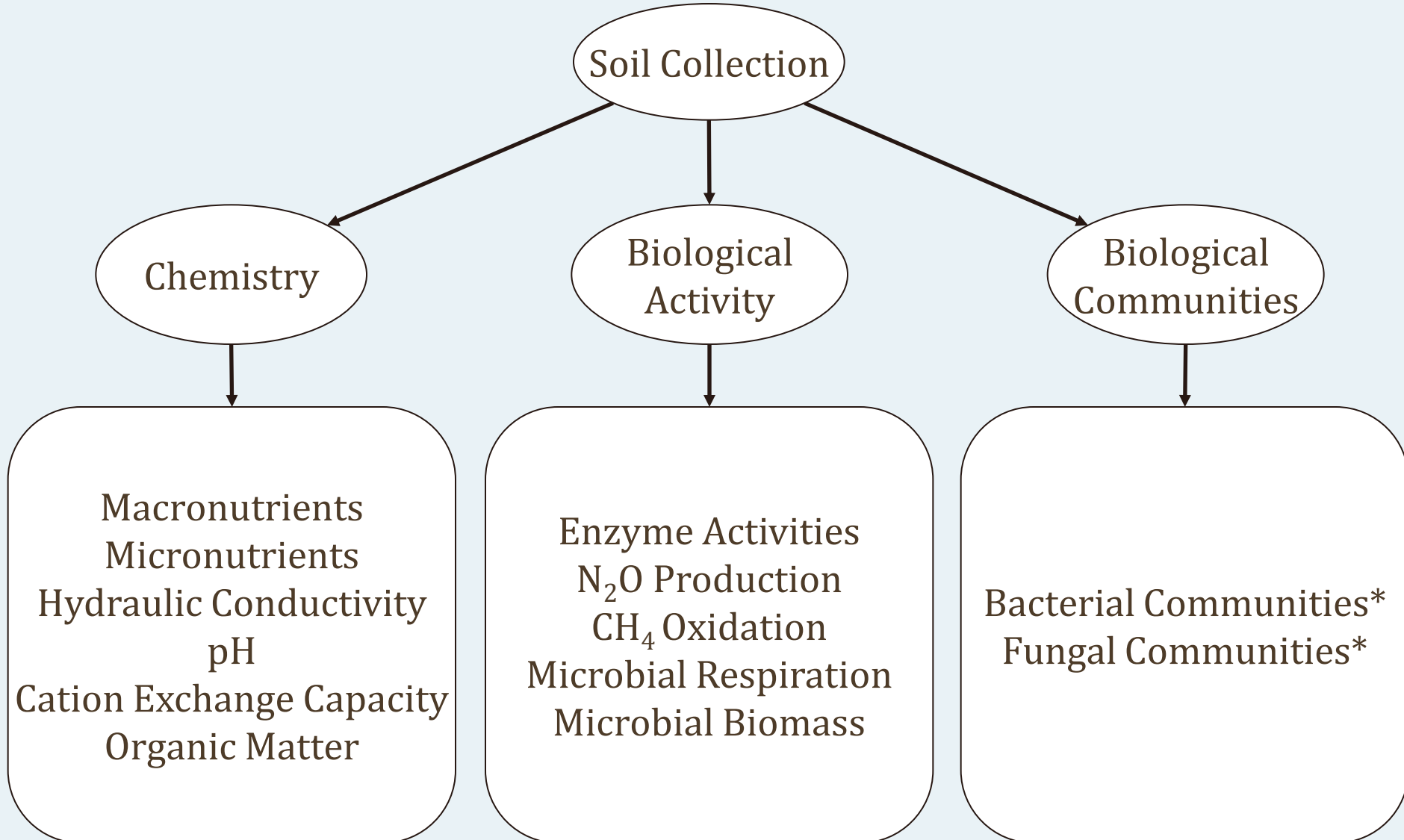
Chemistry

Macronutrients
Micronutrients
Hydraulic Conductivity
pH
Cation Exchange Capacity
Organic Matter

Measurements



Measurements



*Automated Ribosomal Interspace Analysis (ARISA); Yannarell *et al* (2003), *Microb. Ecol.*

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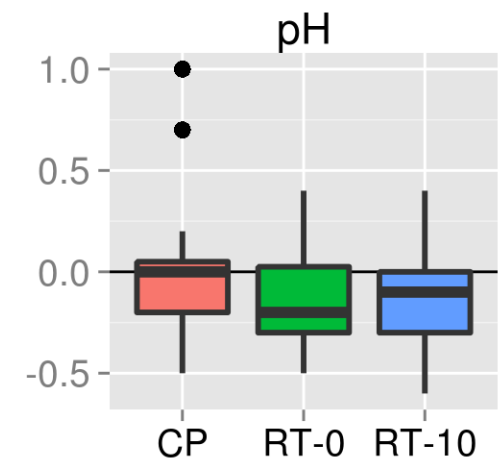
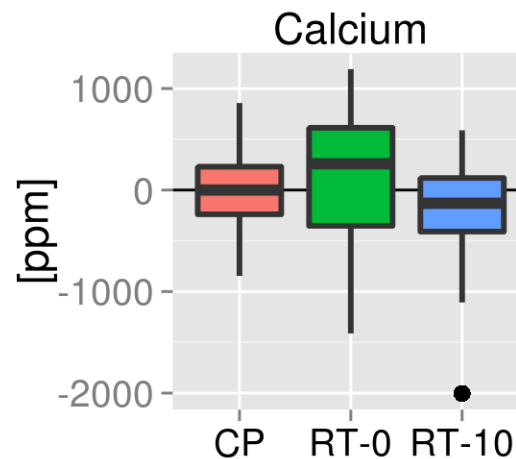
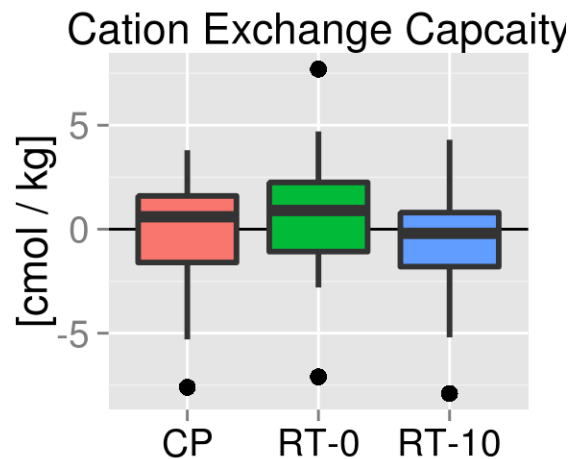
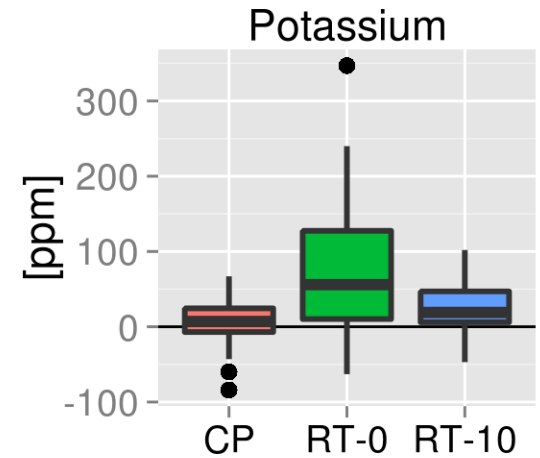
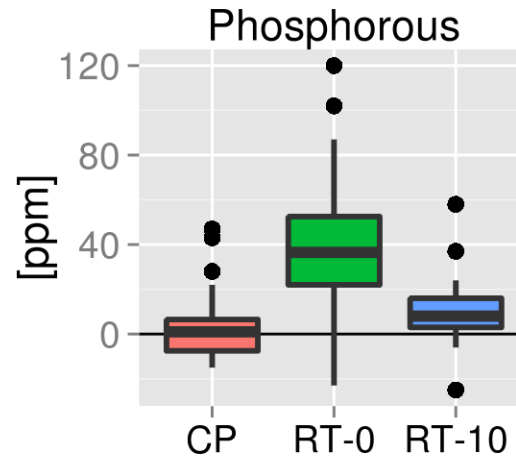
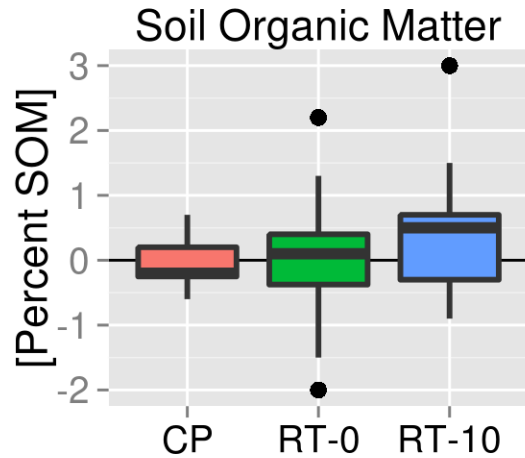
Similarities of soil properties to grass

Soil properties don't differ much.

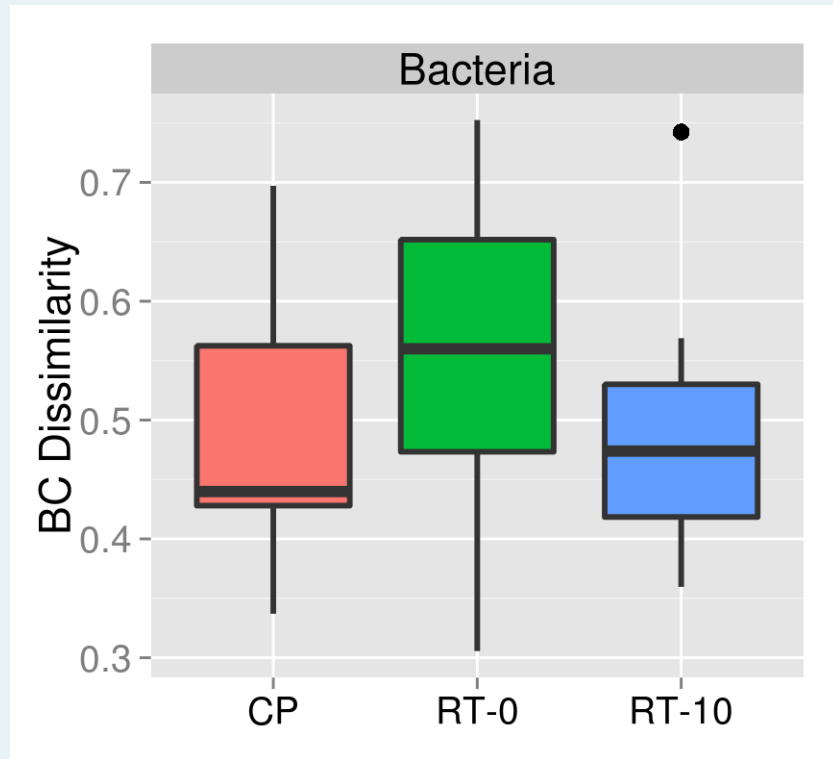
CP: Chisel Plow

RT-0: Disturbed Ridge Till

RT-10: Stable Ridge Till



Microbial communities differ

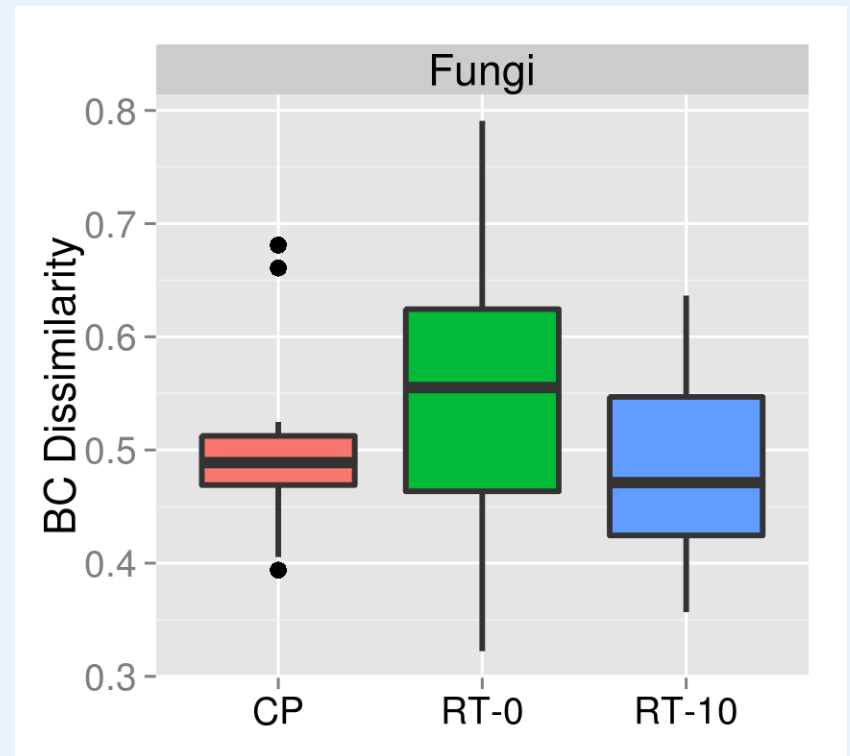


Group Significant (ANOVA $p=0.002$; 2,101 *df*)

CP: Chisel Plow

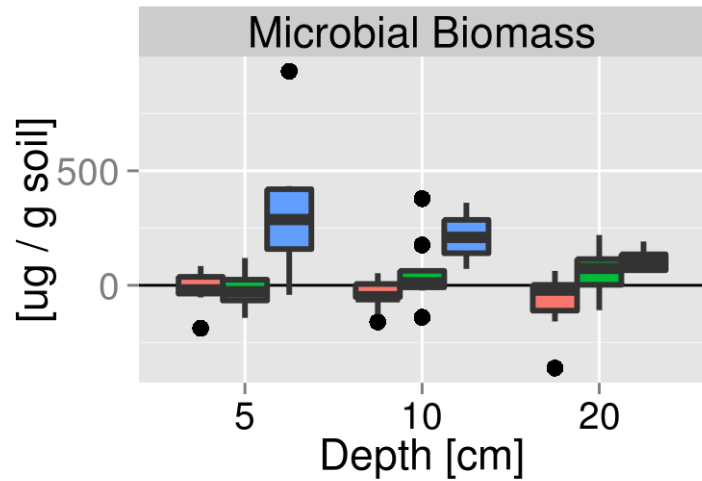
RT-0: Disturbed Ridge Till

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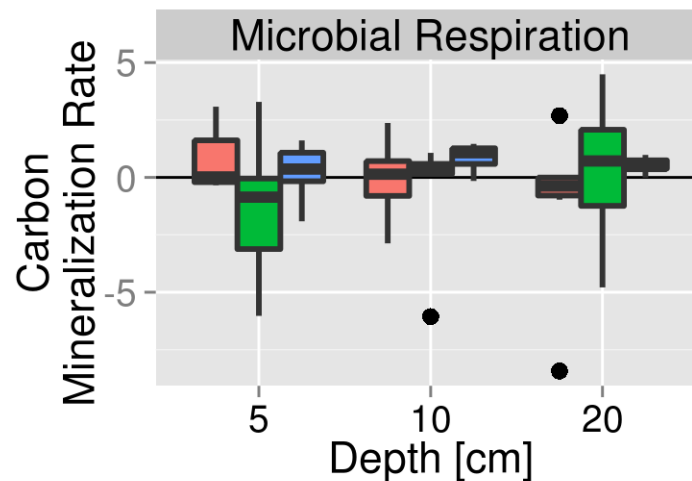


Group Significant (ANOVA $p=0.04$; 2,101 *df*)

Biological activity is higher in rows.



Group*Depth Significant (ANOVA $p=0.04$; 2,32 df)

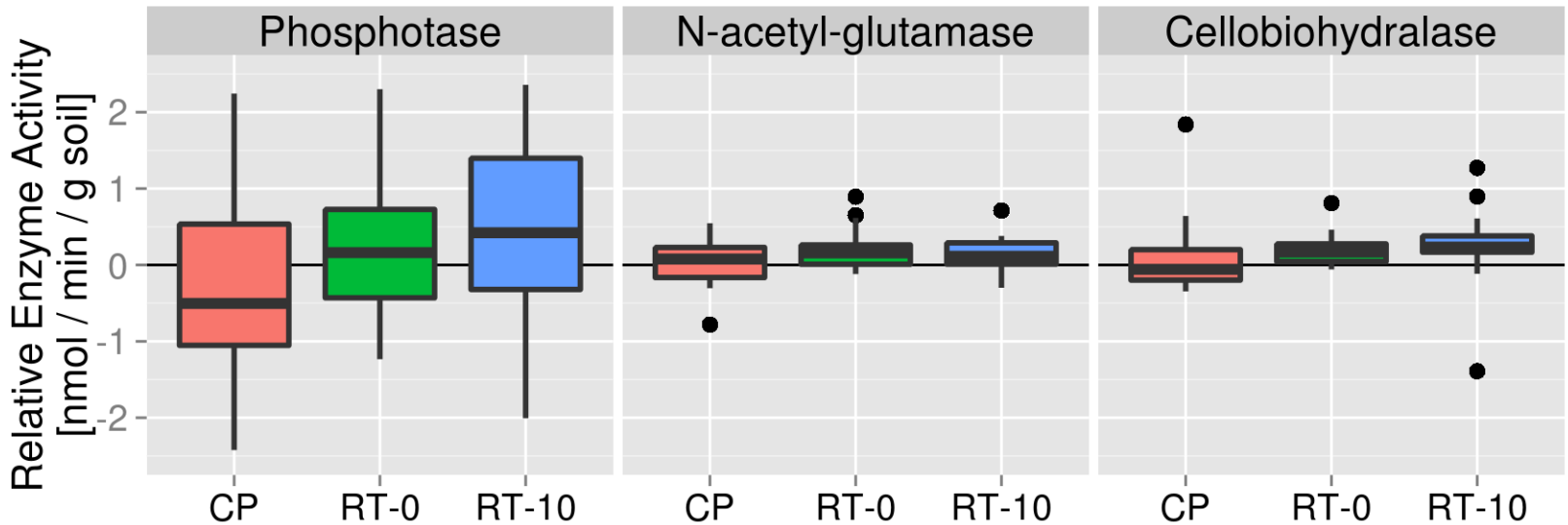


Group*Depth Significant (MANOVA $p=0.03$; 2,61 df)

CP: Chisel Plow

RT-0: Disturbed
Ridge Till

RT-10: Stable
Ridge Till



Group Significant (MANOVA $p=0.04$; 2,50 df)

Precision Zonal Management

ACTIVE TURNOVER

SOIL BUILDING

ACTIVE TURNOVER



Driving Questions

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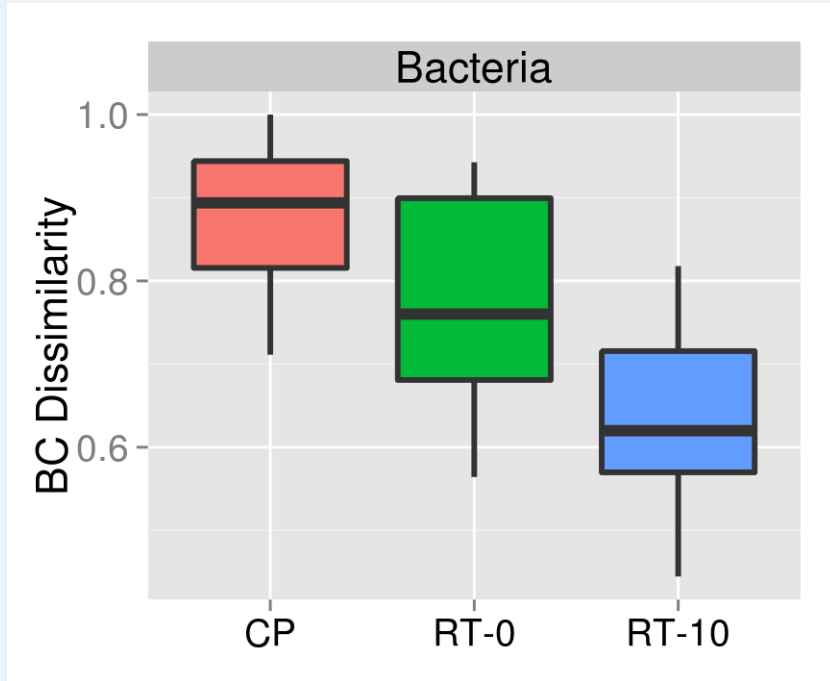
Differences in soil resources, microbial activity between zones

Overall Function

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Similarities of soil properties to grass

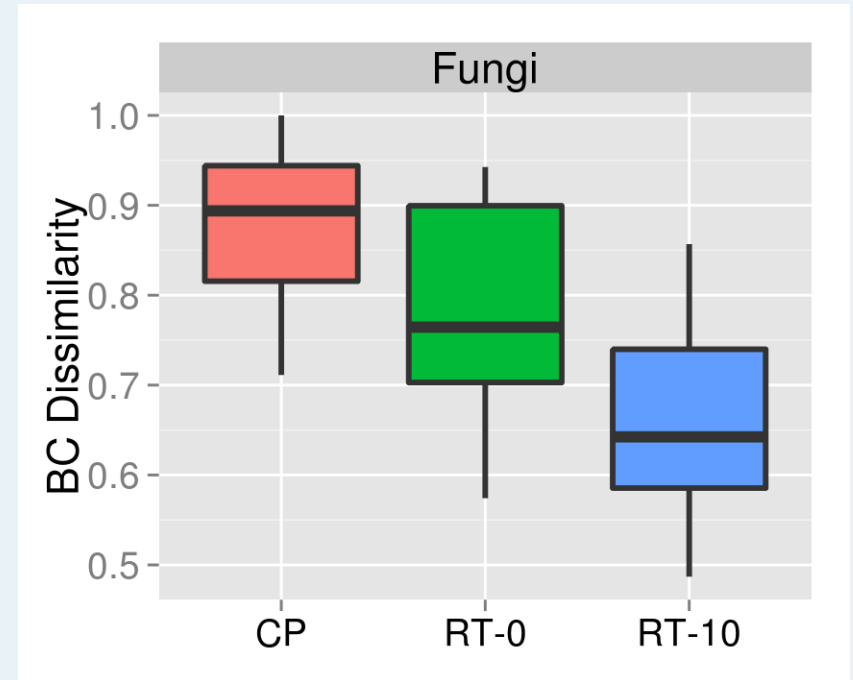
PZM microbes are similar to grass.



CP: Chisel Plow

RT-0: Disturbed Ridge Till

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Driving Questions

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Similarities of soil properties to grass

A photograph of a cornfield with rows of green corn plants. The ground is dark brown soil with some dry straw mulch in the foreground. Three white labels with black text are placed on the ground: 'ACTIVE TURNOVER' on the left, 'SOIL BUILDING' in the center, and 'ACTIVE TURNOVER' on the right. The labels are tilted to follow the perspective of the rows.

ACTIVE TURNOVER

SOIL BUILDING

ACTIVE TURNOVER



Thanks!

PZM PIs

Adam Davis (UIL)
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Nick Jordan (UMN)
Dave Mortensen (PSU)
Rich Smith (UNH)
Sieg Snapp (MSU)
Kurt Spokas (UMN)
Tony Yanarrell (UIL)

Grad Students

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Dan Kane (MSU)
Meng Li (UIL)
Yi Lou (UIL)
Leslie Atwood (UNH)

Research Scientists

Martin Du Sare (UMN)
Vince Filicetti (UIL)
Sheri Huerd (UMN)
Matt Peoples (PSU)
Rich Price (MSU)

Soil-Sharing Farmers



United States Department of Agriculture
National Institute of Food and Agriculture

ewing069@umn.edu

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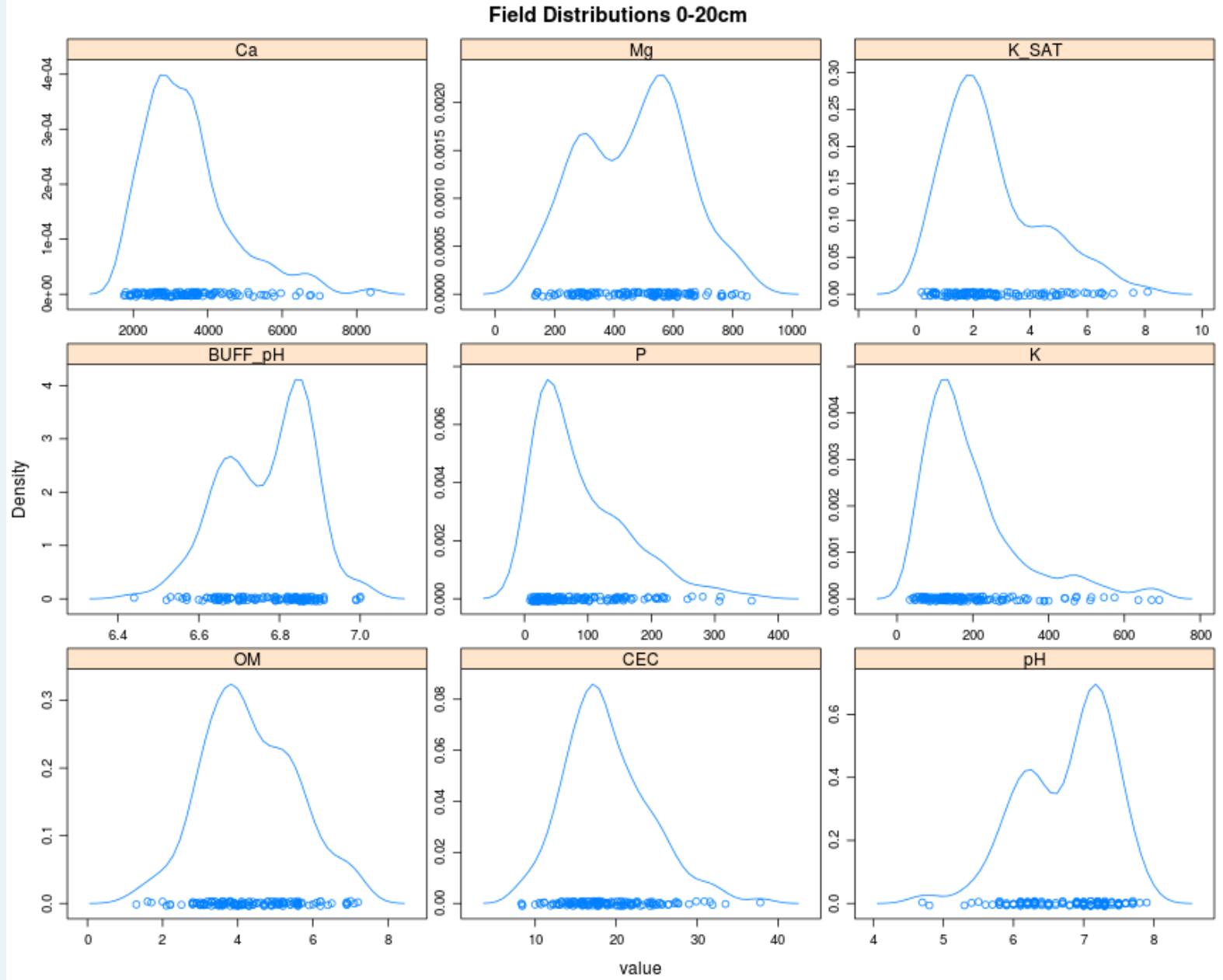


United States Department of Agriculture
National Institute of Food and Agriculture

ewing069@umn.edu

Detailed Sampling Table

Overview of Physical Properties



Overview of Biological Properties

