# Estimating the contribution of soil microbiome the crop rotation effect

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January 16th
Wisconsin Agribusiness Classic

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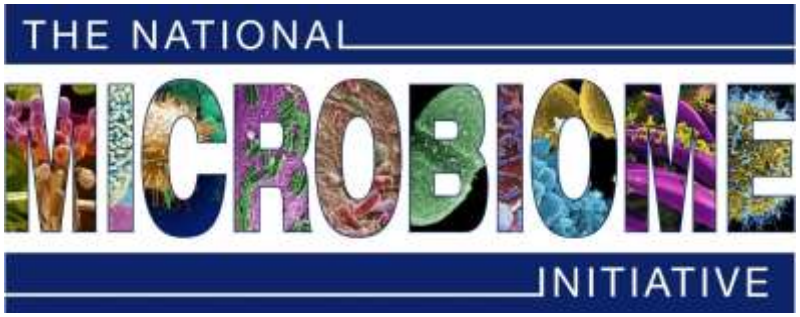
# Why should we care about the soil microbiome?





# What roles do soil microbes play in plant health and productivity?

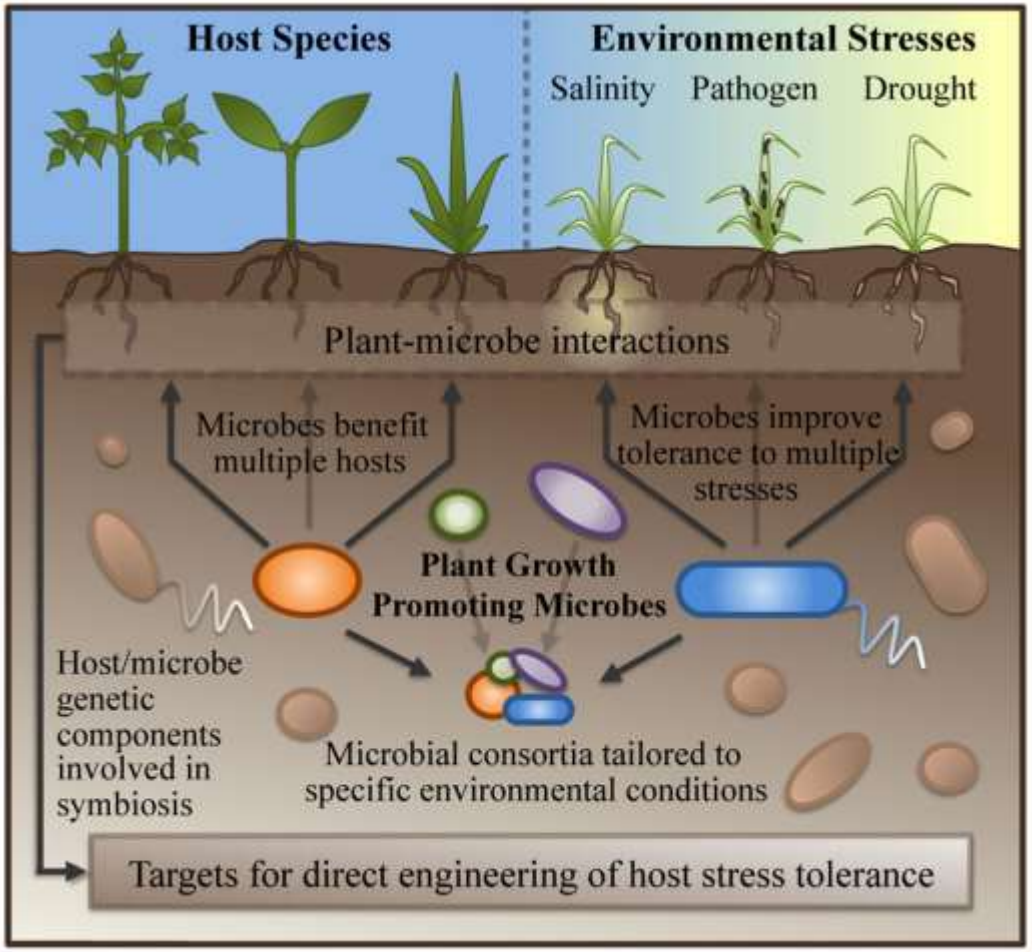
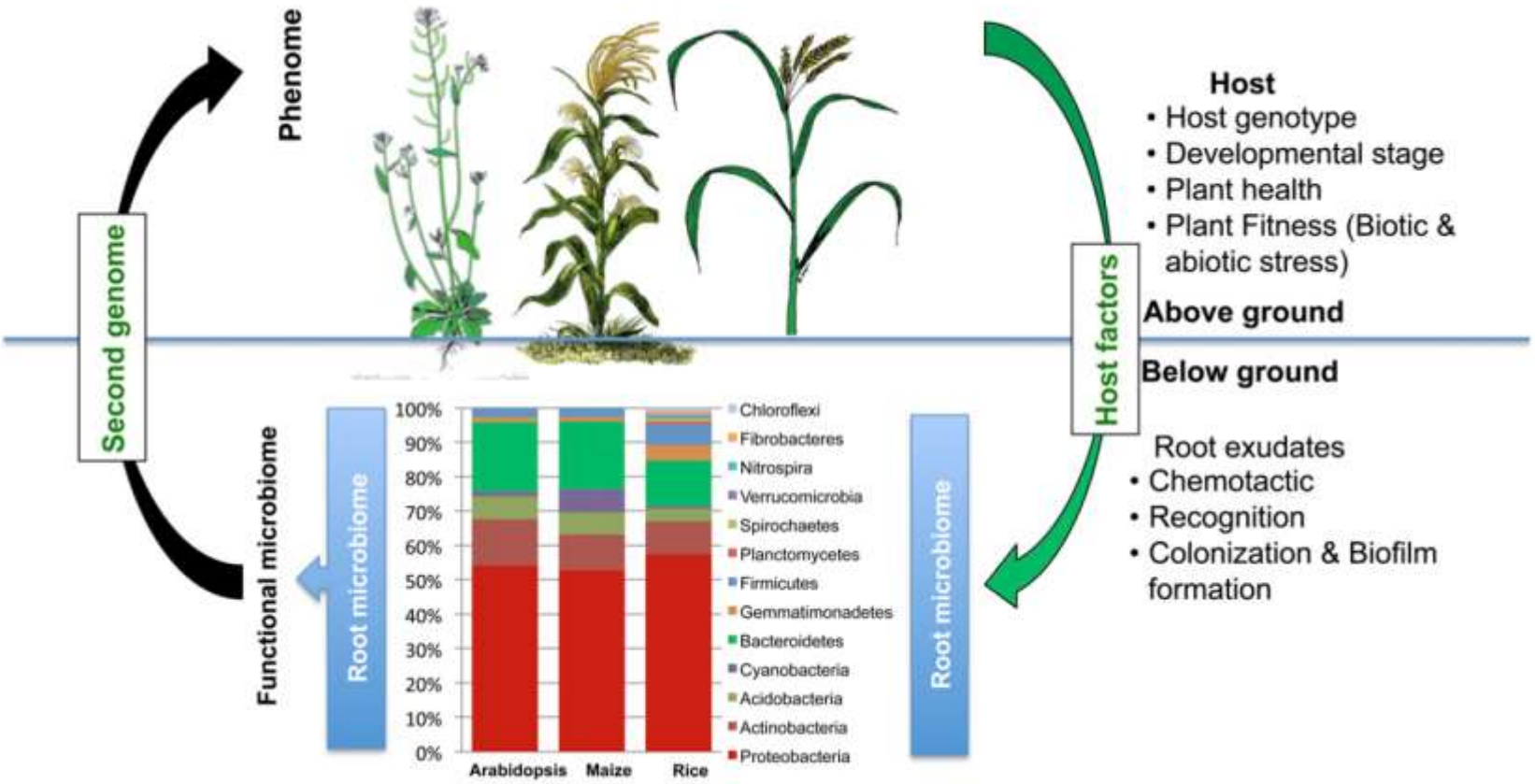


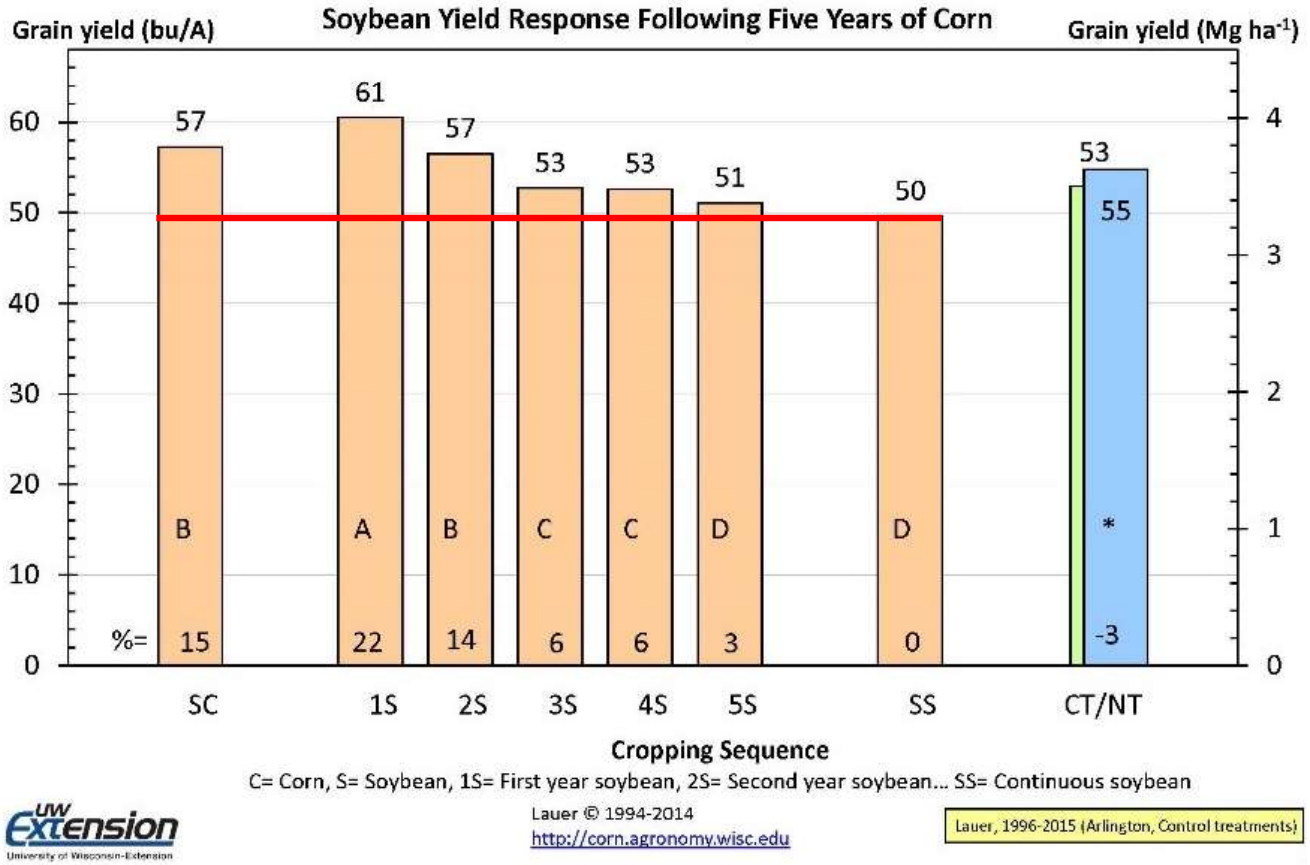

Image from: Tringe, Joint Genome Institiute

# What factors influence soil microbial communities?




Lakshamanan *et al.,* 2014

# How does the soil microbiome play a role in the crop rotation effect?

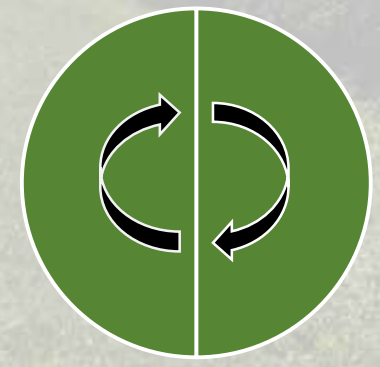


# Long-Term Corn-Soy Rotation Experiment

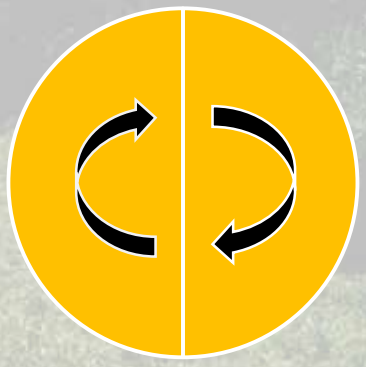
- Arlington Research Station (since 1983)
- 14 total rotation phases present each season
- Four replications of each rotation phase
- No tillage plots

Rotation Schemes

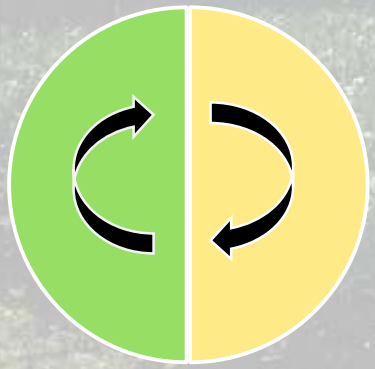
Continuous Soy




Continuous Corn




Annual Corn Soy




Five-Year Corn-Soy Rotation

# Research Objectives

**Objective 1:**

**a.** Determine if rotation phase impacts soil bacterial community composition and structure.

**b**. Determine if differences in bacterial community composition relate to differences crop yield.

**Objective 2:** Determine if rotation phase differentially impacts soil carbon usage of microbial communities.

# Soil data collection and bacterial community analysis

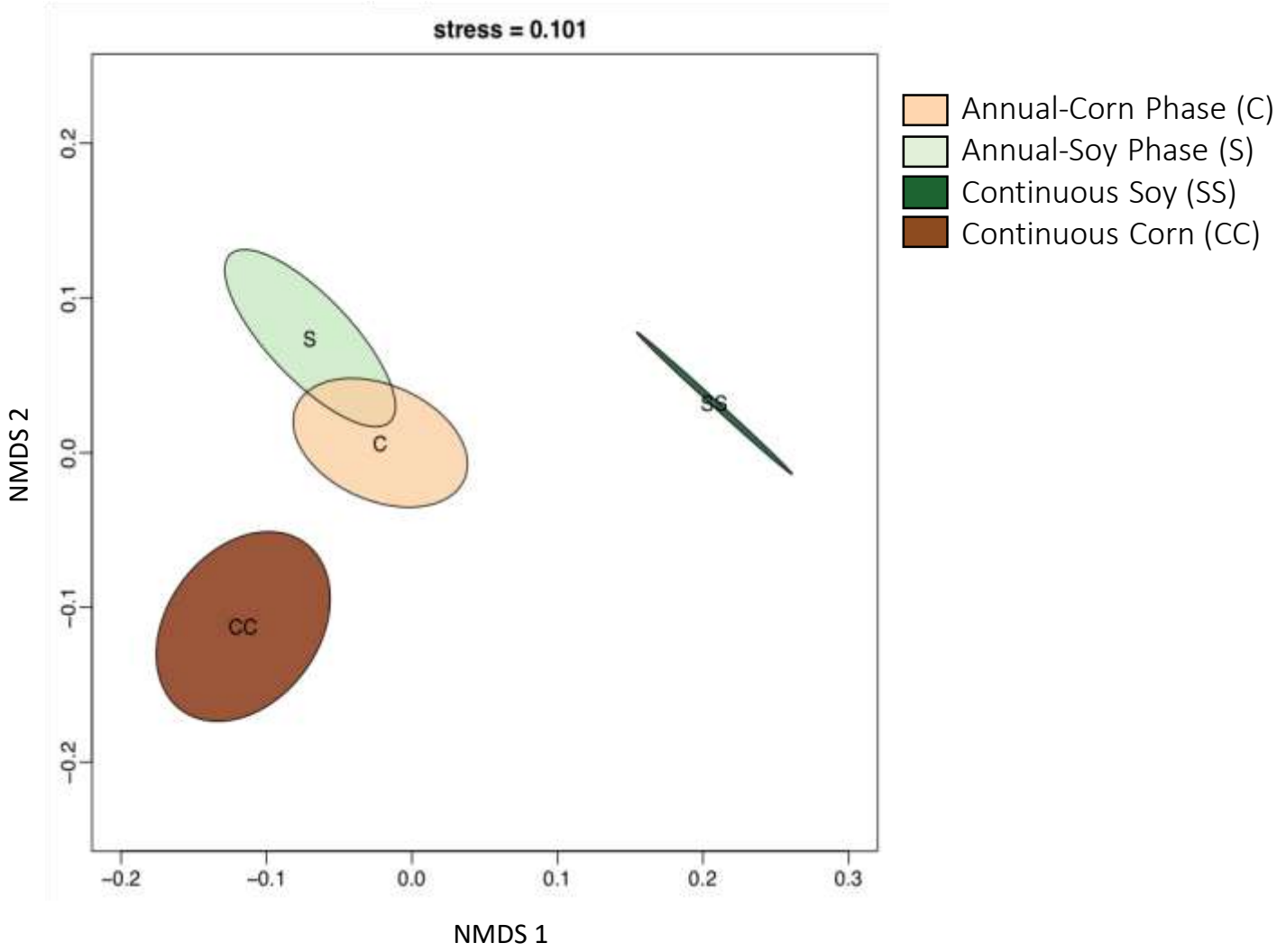
1. Soil sampling timepoints

Planting

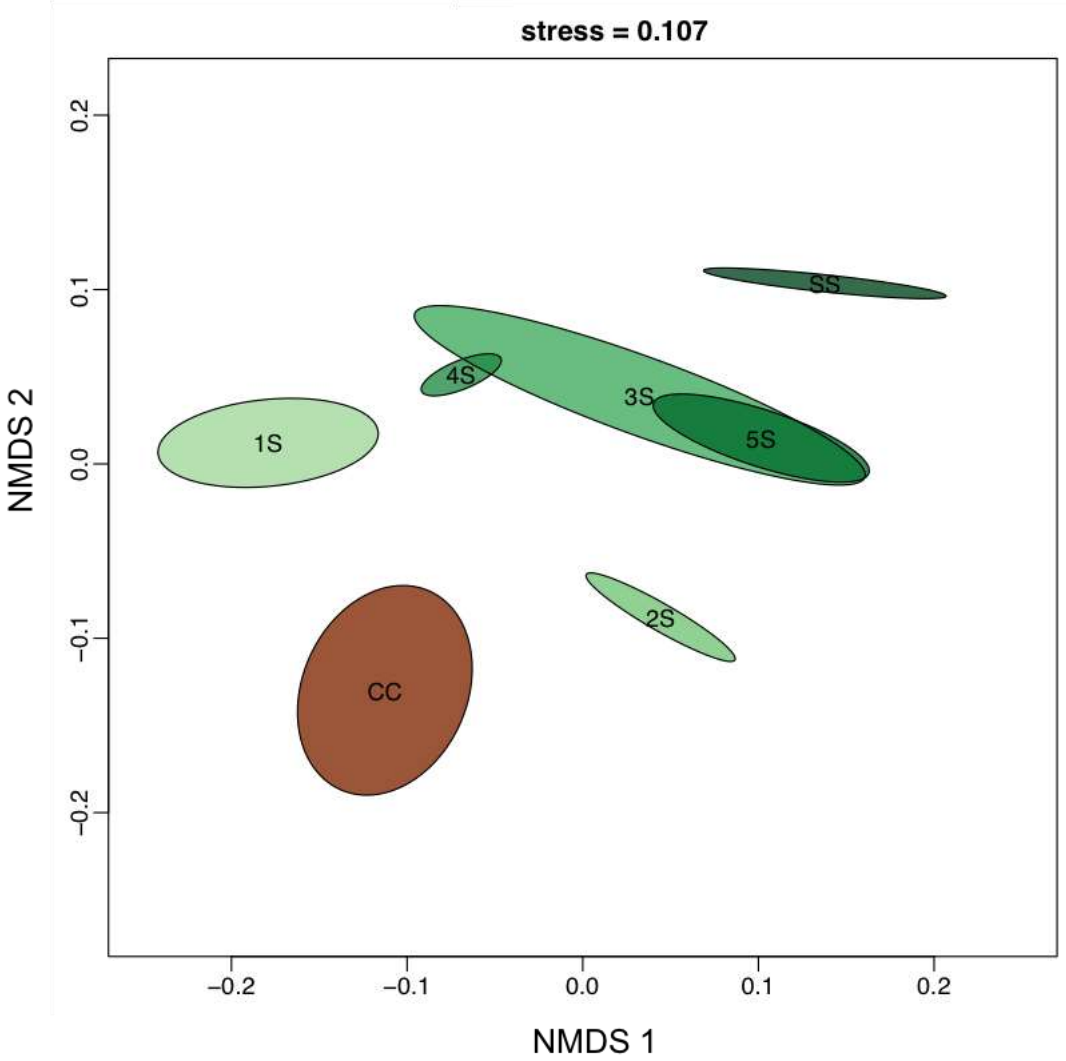
Midseason

Harvest

# Bacterial communities differ between continuous rotations but not between phases of annual rotations

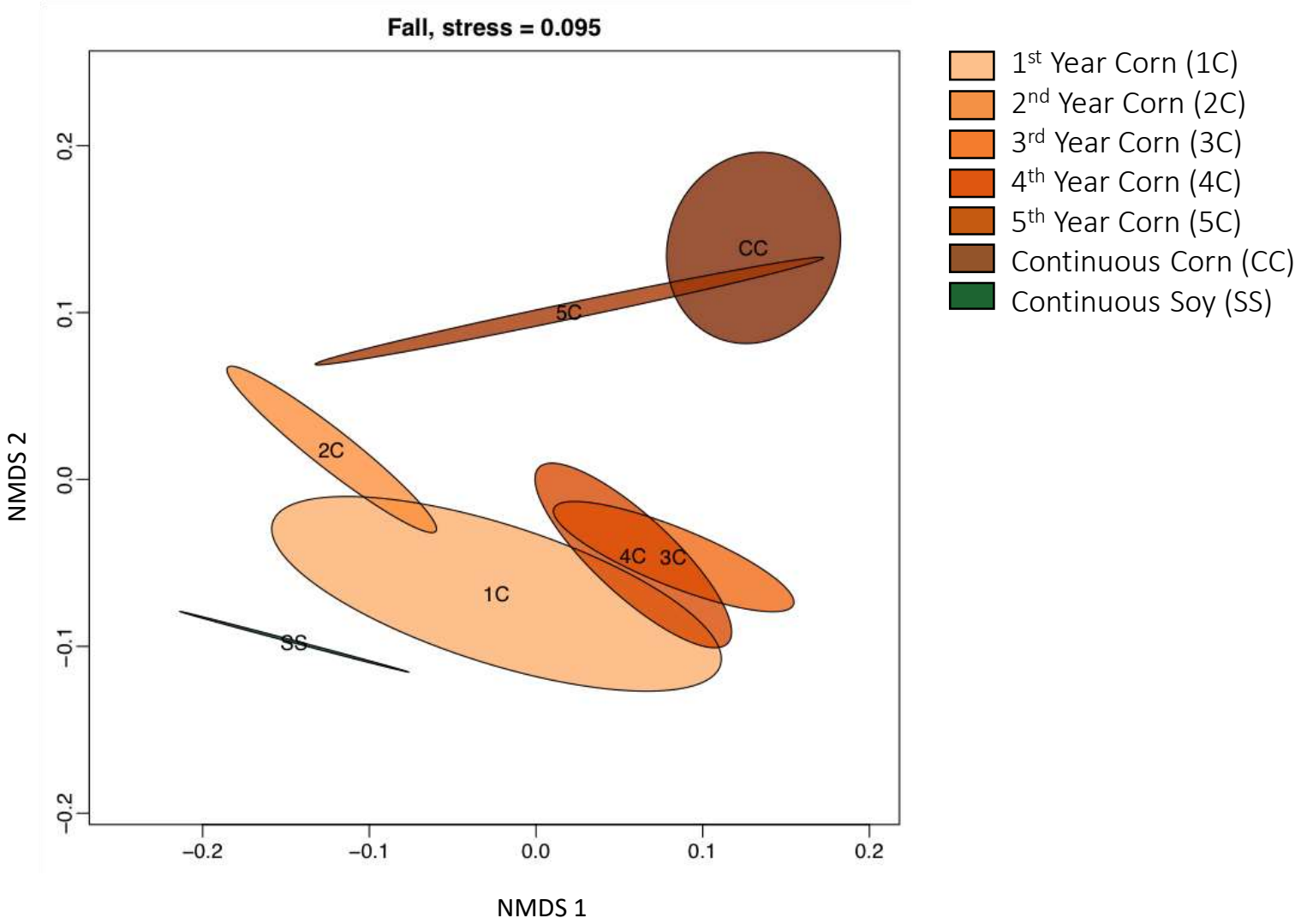


# As years of soy increase, communities shift from a more “corn-like” to a more “soy-like” community

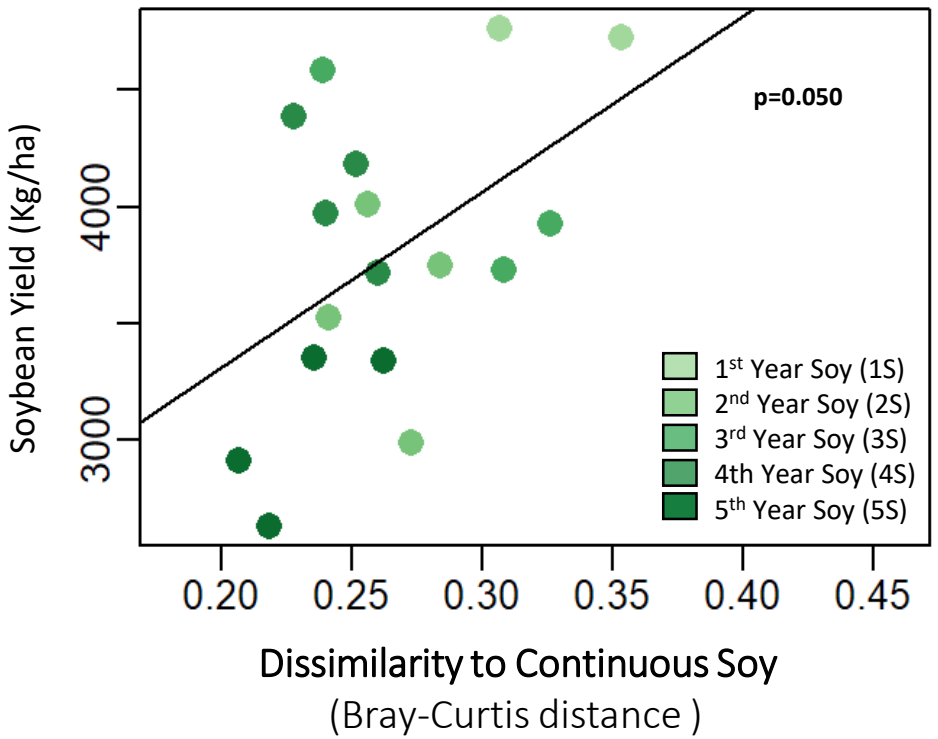



- 1st Year Soy (1S)
- 2nd Year Soy (2S)
- 3rd Year Soy (3S)
- 4th Year Soy (4S)
- 5th Year Soy (5S)
- Continuous Soy (SS)
- Continuous Corn (CC)

# Bacterial communities of 5-year corn rotations shift later in rotation phase to “corn-like” community



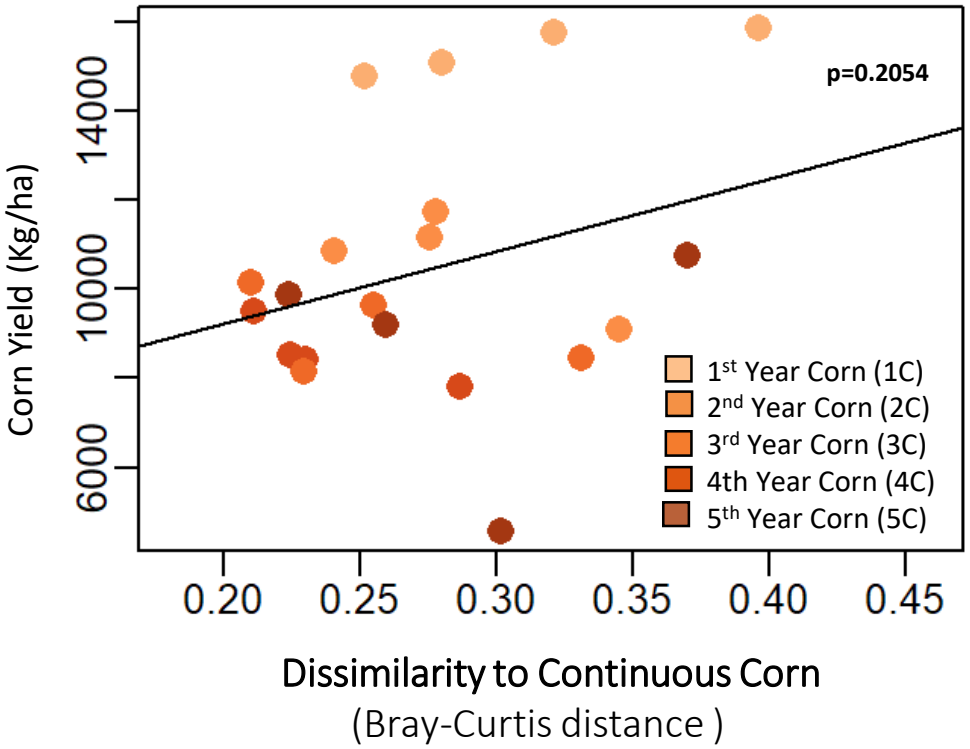
# How do differences in bacterial communities relate to differences in soybean yield?




- The more bacterial communities differ from a "continuous soy (SS)-like" community, the higher the soybean yield.

- As years of soy planted increase, the more bacterial communities resemble the bacterial community of a continuous soy system.

# How do differences in bacterial communities relate with differences in corn yield?




- **They don't correlate well…** no significant trend between how similar or dissimilar a bacterial community is from CC and corn yield.

# Objective 1 Conclusions

1. The bacterial communities of CC and SS are significantly different from each other, while the bacterial communities two phases of the annual rotation are not.

2. As years of monoculture increase, the more the bacterial communities resemble that of a continuous monoculture system.

3. The more bacterial communities differ from a "continuous soy (SS)-like" community, the higher the soybean yield.

# Research Objectives

**Objective 1:**

**a.** Determine if rotation phase impacts soil bacterial community composition and structure.

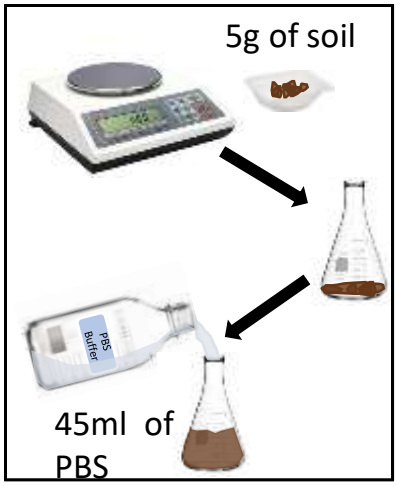
**b**. Determine if differences in bacterial community composition relate to differences crop yield.

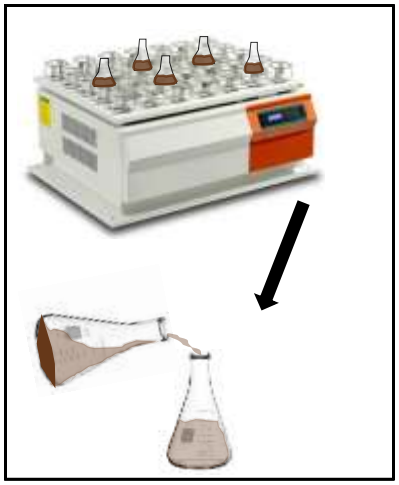
**Objective 2:** Determine if rotation phase differentially impacts soil carbon usage of microbial communities.

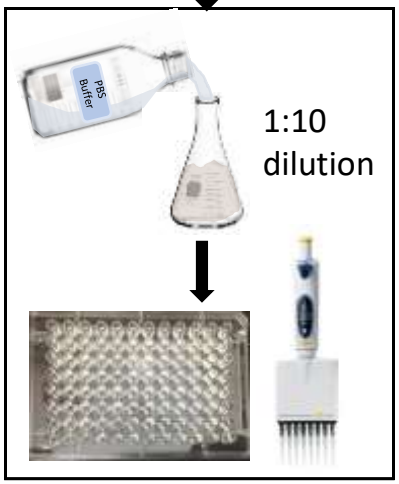
# Methods for analysis of microbial carbon usage diversity

2017: Midseason & harvest

2018 Spring, midseason & harvest






Biolog EcoPlate technology

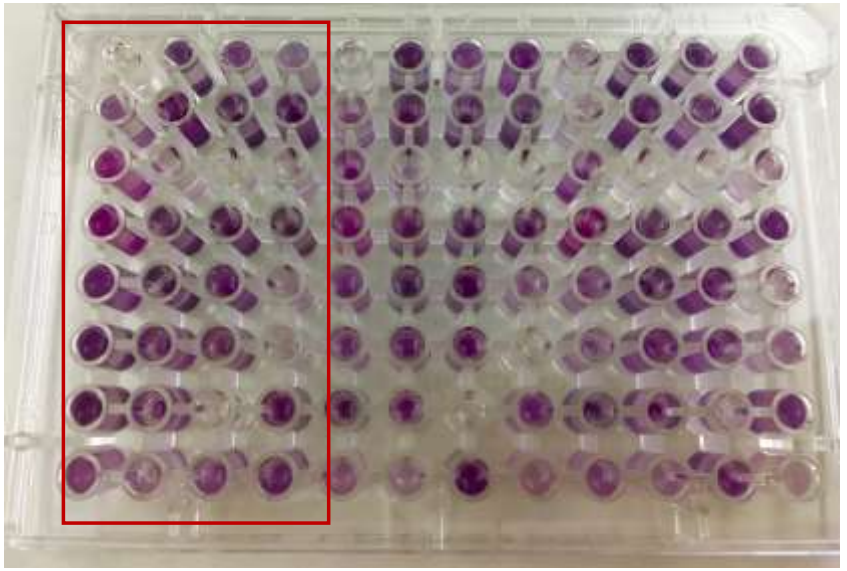
Measure the changes in the indicator dye for carbon usage based on rotation phase

# Does carbon usage differ between microbial communities of different rotation phases?

| Biolog EcoPlate | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| A | Water | β-methyl-D-glucoside | D-galactonic acid γ-lactone | L-arginine |
| B | Pyruvic acid méthyl ester | D-xylose | D-galacturonic acid | L-asparagine |
| C | Tween 40 | i-erythritol | 2-hydroxy benzoic acid | l-phenylalanine |
| D | Tween 80 | D-mannitol | 4-hydroxy benzoic acid | L-serine |
| E | α-cyclodextrin | N-acetyl-D-glucosamine | γ-hydroxy butyric acid | L-threonine |
| F | Glycogen | D-glucosamic acid | Itaconic acid | Glycyl-L-glutamic acid |
| G | D-cellobiose | Glucose-1-phosphate | α-ketobutyric acid | Phenylethyl-amine |
| H | α-D-lactose | D,l-α-glycerol phosphate | D-malic Acid | Putrescine |

Amines
Carbohydrates
Complex carbon sources
Carboxylic acids
Amino acids
Phosphate-carbon

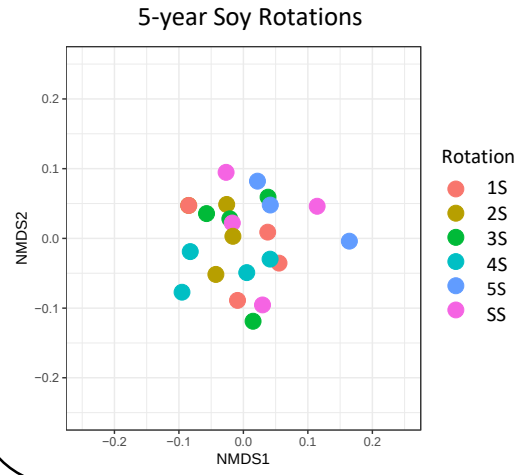
Each plate represents ONE soil sample

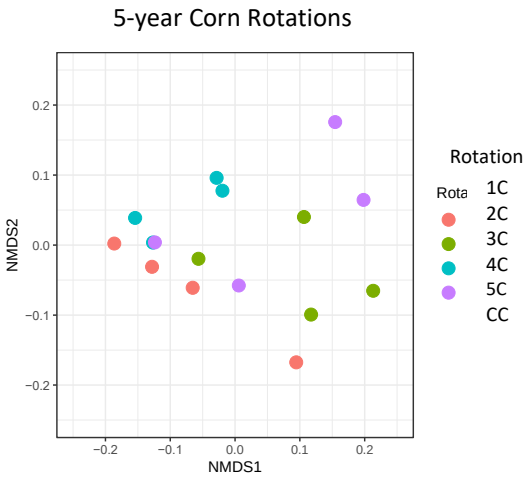


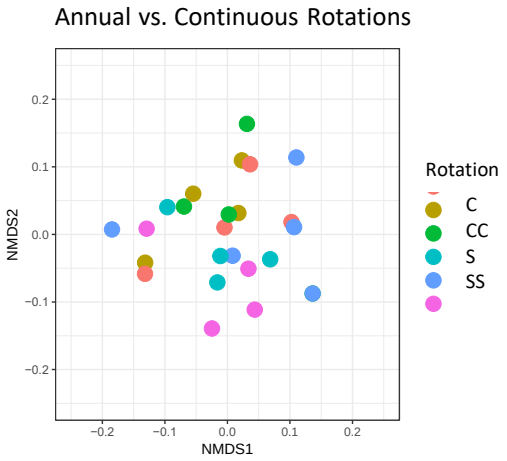
- The more the compound is consumed by the microbial community the darker the indicator dye becomes

# Differences in carbon use based on rotation scheme and time of season

Midseason (July)



# Objective 2 Conclusions

1. The microbial communities do not significantly differ in their carbon usage based on rotation phase at either midpoint or harvest.

2. Environmental selection pressure of the Biolog EcoPlate could be playing a role.

# Take-home points

1. Soil bacterial communities differ based on rotation phase and in the case of soybean these differences can explain a portion of the variation in soybean yield.

2. More data is needed to really see if these relationships hold throughout the growing season and over years.

3. 2017 and 2018 data (six total timepoints) are in the process of analysis now…so stay tuned!

1. Soil microbial communities do not significantly differ in their carbon usage based on rotation phase at either midpoint or harvest.

# Acknowledgements


Committee Members

- Jean-Michel Ané
- Shawn Conley
- Thea Whitman
- Richard Lankau
- Garret Suen
- Caitilyn Allen

Ané Lab

- Raul Masteling Pereira
- Shivangi Vayla

Conley Lab

- Lindsay Chamberlain
- Spyridon Mourtzinis

Suen Lab

- Madison Shay-Cox
- Joseph  Skarlupka

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