Introduction Paragraphs

1. *Background*
   1. *Maintaining and improving the health of environments within agro-ecosystems is important for sustainable agricultural production.*
   2. *Following the green revolution, use of synthetic fertilizers has contributed to the intensification of agricultural production.*
   3. *This intensification has been associated with negative environmental side effects, contributing to degraded ecosystems.*
   4. *Organic agriculture and other alternative management practices are increasingly being shown to have positive environmental benefits, such as improved water quality.*
   5. *Organic agriculture offers an avenue for more sustainable and efficient production while minimizing impacts on the environment.*
2. *Problem*
   1. *Production in organic agriculture requires the use of organic approved amendments for fertilization, these in include: compost, manure, green manures and naturally occurring sources of nitrogen fertilizer.*
   2. *Organic production is dependent of the soil microbial community to convert amendment organic matter to plant available nutrients, the eye of the SOM needle, in contrast to conventional ag, which is able to use synthetic fertilizer that is plant available.*
   3. *The benefits to soil health from the heterogenous and recalcitrant forms of nutrients in organic amendments present challenges for nutrient timing.*
   4. *This dependence offers challenges to organic producers but opportunities for understanding soil ecology.*
   5. *Organic amendments often offer wide ranging benefits to soil health associated with organic matter additions.*
3. *Solution*
   1. *By better understanding the bacterial response in soil to amendment, knowledge of import bacterial interactions and dynamics will inform identification of important species.*
   2. *This characterization will inform our understanding of possible bacterial species that are amendment specific responders.*
   3. *Utilizing knowledge of responders for bio-stimulation or bio-augmentation of the soil bacteriome in agroecosystems will facilitate adoption of organic fertilizers.*
   4. *By leveraging NGS with a controlled longitudinal microcosm incubation experiment, we will ID ideal targets for bio-augmentation/stimulation.*
4. *Lit and justification*
5. *Aims/Hypothesis and methods*

Problem statement draft:

Incorporate both aspects described in the problem statements

First draft:

Ideally farmers would be able to use organic amendments with the same predictability of nutrient availability as synthetic fertilizers. However, adoption is challenged by our lack of understanding of the microbially mediated conversion of the compounds in plant residues or organic matter into plant available nutrients...

Second draft:

Bio-augmentation of microbial communities towards a desired function has been successful in bio-remediation...need to develop techniques to identify species for construction bio-augmentation solutions for agricultural sustainability.

Nitrogen bearing compounds from plant litter, microbial cells and animal wastes are the primary input of organic nitrogen in agroecosystems. Plants require mineral nitrogen for growth and cycling nitrogen between organic and mineral forms is a crucial process to understand for efficient use of compost, manures and green manures. The soil nitrogen cycle from organic to mineral/inorganic N is at least partially mediated by the microbial community; however, little is known about the specific bacteriome dynamics in soils amended with organic nitrogen materials. The rate at which mineral nitrogen is converted from organic forms is an important consideration for crop production and environmental quality, the timing between mineralization and nutrient uptake, dictates weather a nutrient is used by the crop or lost from the agroecosystem.

In tile drained Midwestern agroecosystems, nitrate leaching is of particular interest. to address multiple concerns in agroecosystems and the wider environment. In recent decades intensification of agricultural management has led to decreases in soil health through cultivation and fertilization that has led to losses in organic matter and nutrients from agroecosystems

Agricultural output of crops with high nutrient demand (e.g., maize) requires soils to

be amended with nitrogen fertilizers for economical production. Following the green

revolution and development of the ability to synthesize mineral fertilizers, agricultural output

has increased significantly to feed the growth of the human population. This increase in

mineral fertilizer usage and agricultural output has had environmental side effects. Soluble

mineral fertilizers are prone to leaching and losses to water ways, where they contribute to

eutrophication and degraded water quality. Additionally, fossil fuel use in the production of

fertilizers contributes to increases in atmospheric greenhouse gases. To cope with the

demands of an increasing human population, agricultural production must become both

more sustainable and more efficient to minimize impacts on the environment.

An alternative method to provide nutrients for agriculture is fertilization of soils with

inputs approved for organic management. These organic managements techniques exclude

the use of synthetic mineral fertilizers and instead rely on addition of nitrogen via

amendments with compost, manure, or green (plant-based) manures. To use the nitrogen

from these amendments, crops rely on biological transformation nitrogen in organic forms

into plant available nitrogen. Currently, little is known about the microbial community

during these processes in organic agriculture, especially how to optimize the amounts of

nitrogen available to plants post amendment with organic fertilizers. Further, nutrient

availability varies by the type and nutrient ratios of organic fertilizers. For example, the

carbon to nitrogen ratio of organic amendments impacts the decomposition rate and whether

N is mineralized into plant available forms or immobilized by the soil microbial biomass.

A better understanding of the microbial communities and their responses to nutrients

available from organic amendments will help improve its effective adoption and usage.

~~Previously, the use of organic management has been observed to reduce nitrogen~~

~~losses to sub-surface waters. For example, in a study comparing an organic corn soybean~~

~~production system utilizing extended crop rotations and animal manures for nitrogen~~

~~fertilization, to a conventional corn-soybean system fertilized with synthetic urea, reduced~~

~~losses of nitrates were observed in the tile drainage water from the organic system compared~~

~~to the conventional system. This is evidence to the potential of organic agriculture to~~

~~ameliorate environmental degradation associated with intensive chemical agriculture. Within~~

~~this study, reduced nutrient losses into the environment was associated with high variability~~

~~and reduction in yields, which may be linked to the ability of the soil microbiome to liberate~~

~~nitrogen bound in complex organic compounds, transforming it into mineral forms and~~

~~ultimately making it available for plant uptake and growth.~~ This biologically mediated

process where plant available nitrogen is released from organic sources is known as

mineralization and has been associated with litter/amendment C: N ratios below 25:1. When

C: N ratios of more than 25:1 are observed in litters and amendments, immobilization has

been observed, which is the utilization of nitrogen compounds for microbial growth at the

expense of plant available mineral nitrogen. Thus C: N ratios are a critical factor affecting

the impact of organic fertilizers on levels of plant available nitrogen in the soil.

Improving our understanding of the biological players involved in nutrient release

could help improve agricultural production while still maximizing environmental benefits from complex amendments. A key knowledge gap for varying organic management strategies is understanding the soil nitrogen (N) pool and the role of associated microbial communities as drivers of N cycling. In this study, we study the impacts of amendments of both alfalfa and compost, provided at 3 equal rates of total nitrogen, to a soil but with differing C: N ratios chosen to result in immobilization (compost) or mineralization (alfalfa). We characterize both the chemical and microbial response to these amendments and hypothesize that specific microbial communities will respond to initial nitrogen and carbon availability and that this membership will be specific to varying amendments. We expect that these distinct early microbial responders will dominate soil microbial communities in response to organic amendments and will decrease in abundance through time. Our objective was to characterize these early responding microbial communities for various organic amendments and to identify potential microbial membership within organic amendments that may be involved in plant nutrient availability.