Nutrient Dynamics:

IMPROVING NUTRIENT EFFICIENCIES IN A BIOLOGICALLY ACTIVE SOIL

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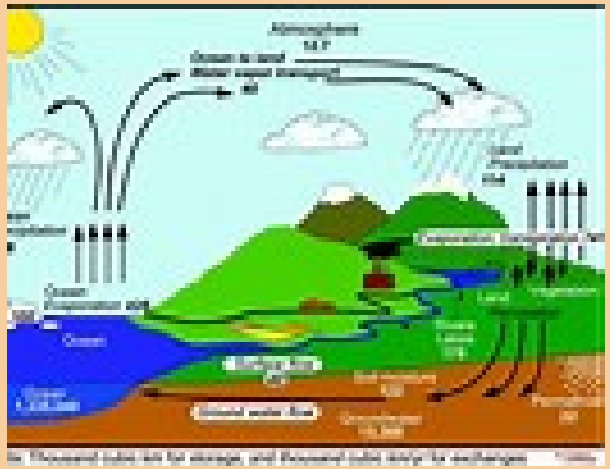
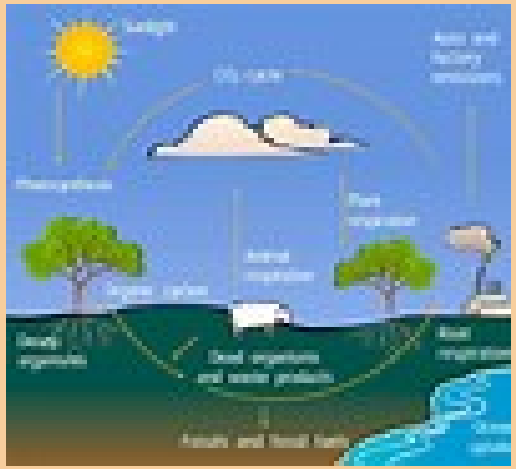
Basics

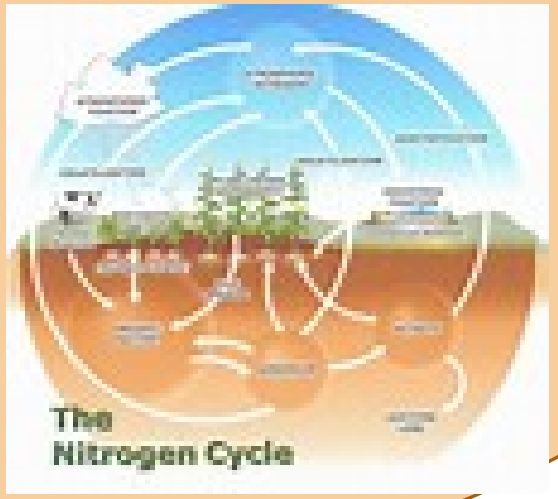
Water



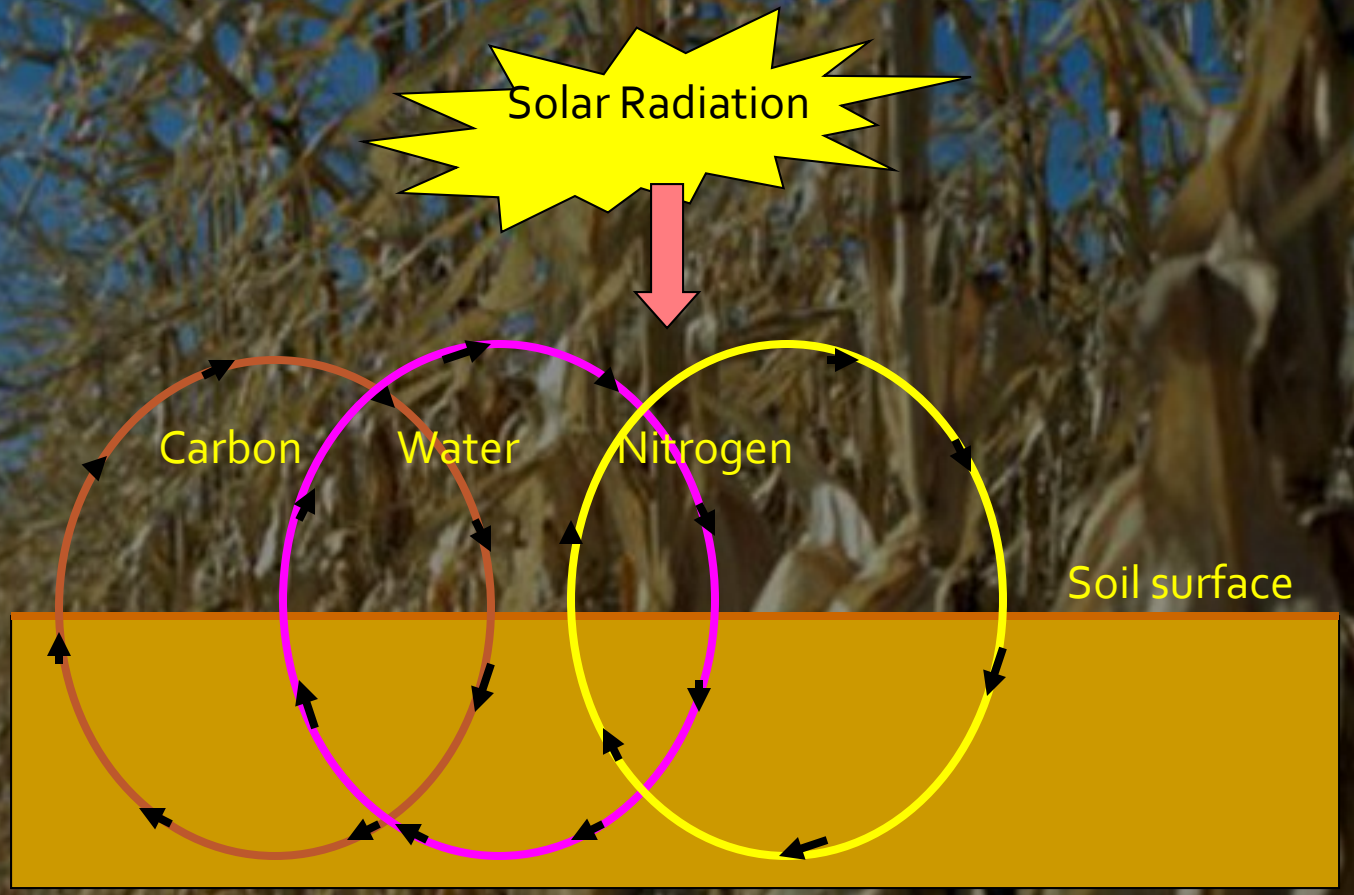
Carbon



Nitrogen



These cycles overlap and interact and yet we consider them each separately

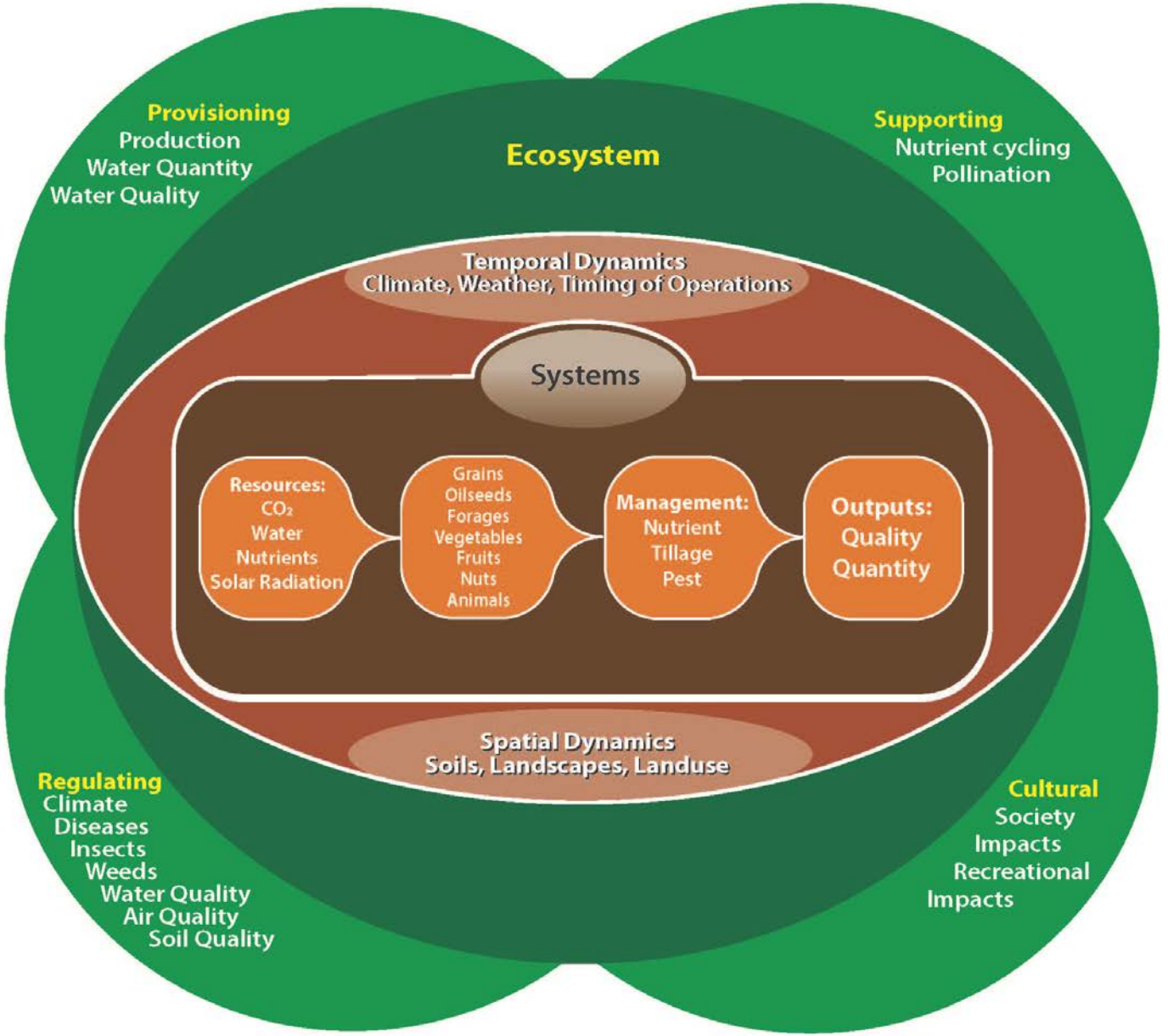


Key Processes

Photosynthesis	Precipitation	N Fixation
Respiration	Evaporation	Mineralization
Org Matter decomp	Infiltration	Denitrification
Plant decomposition	Runoff	Plant decomposition
	Percolation	

Cycles interact over time and space with different rates

Reality



Updated 6.19.18


Soil Aggradation Climb
Visible Outcomes
Improved Water Availabilty
Improved Soil Structure
Improved Nutrient Cycling
Organic Matter Turnover
Biological Activity
Invisible and dynamic process
graphic 3.1

Efficient and Effective Soil Biology Needs

Food

Water

Air

Shelter

Create a stable home for the soil biology

Which table would you rather eat at?

What if your home was constantly exposed to environmental damage?

Stable Microclimate

85-90 F

120-130 F

Temperature profiles in the soil

Extremes in temperature limit the biological activity in the soil, induced by a dry soil

Current State of Our Soils

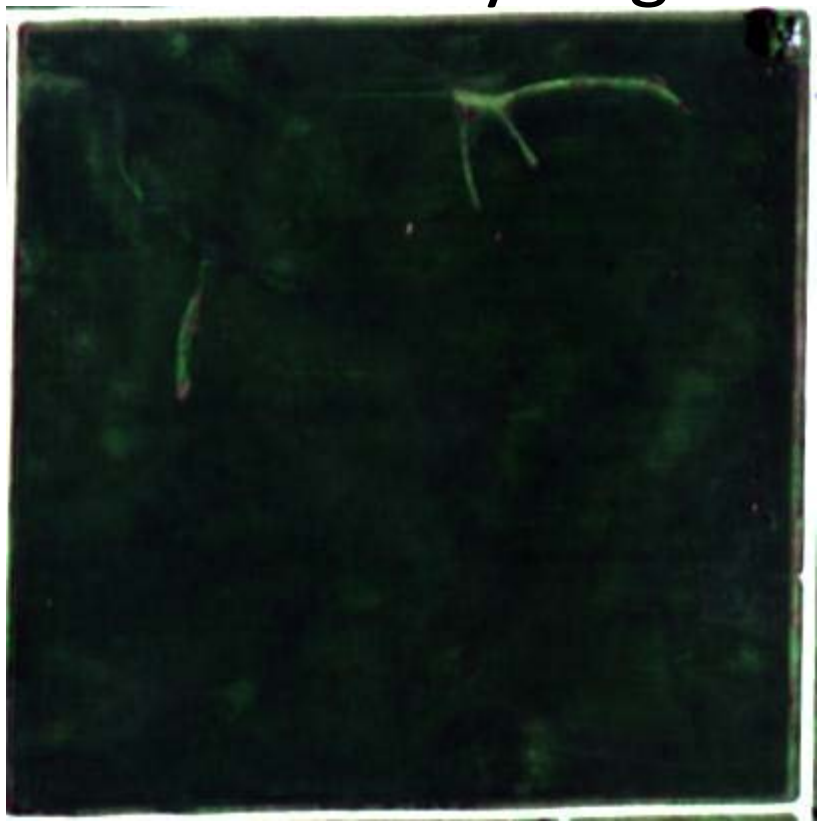
Made them vulnerable to variable weather

Made them dependent upon external nutrient supply

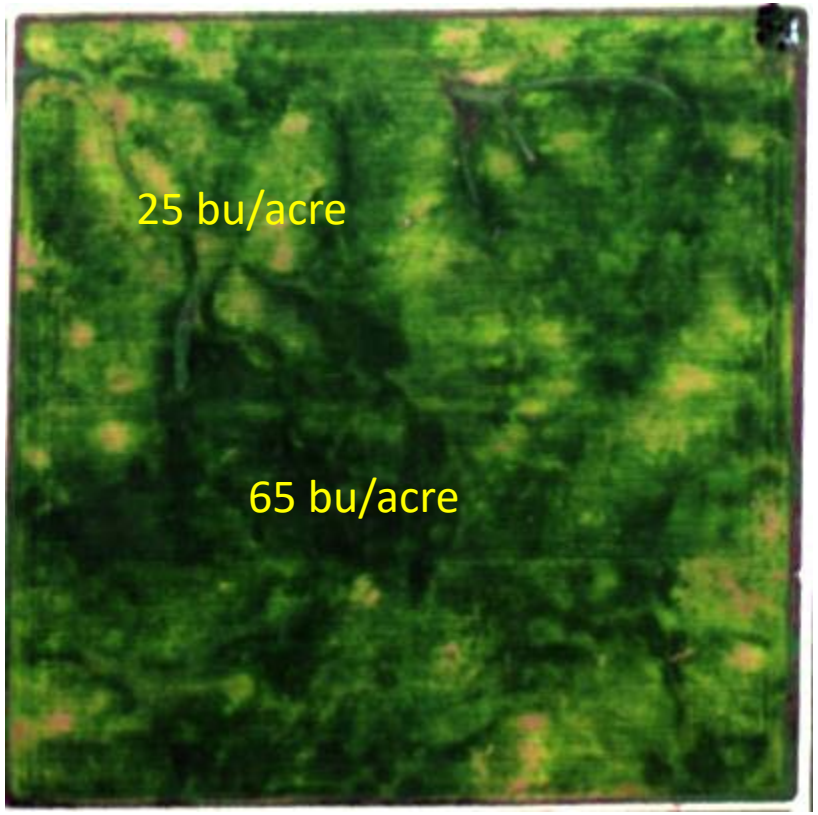
Basically made them a medium for holding up plants with little capacity for resilience to any variation in environmental conditions

Soybean Production Field

Early August



Late August



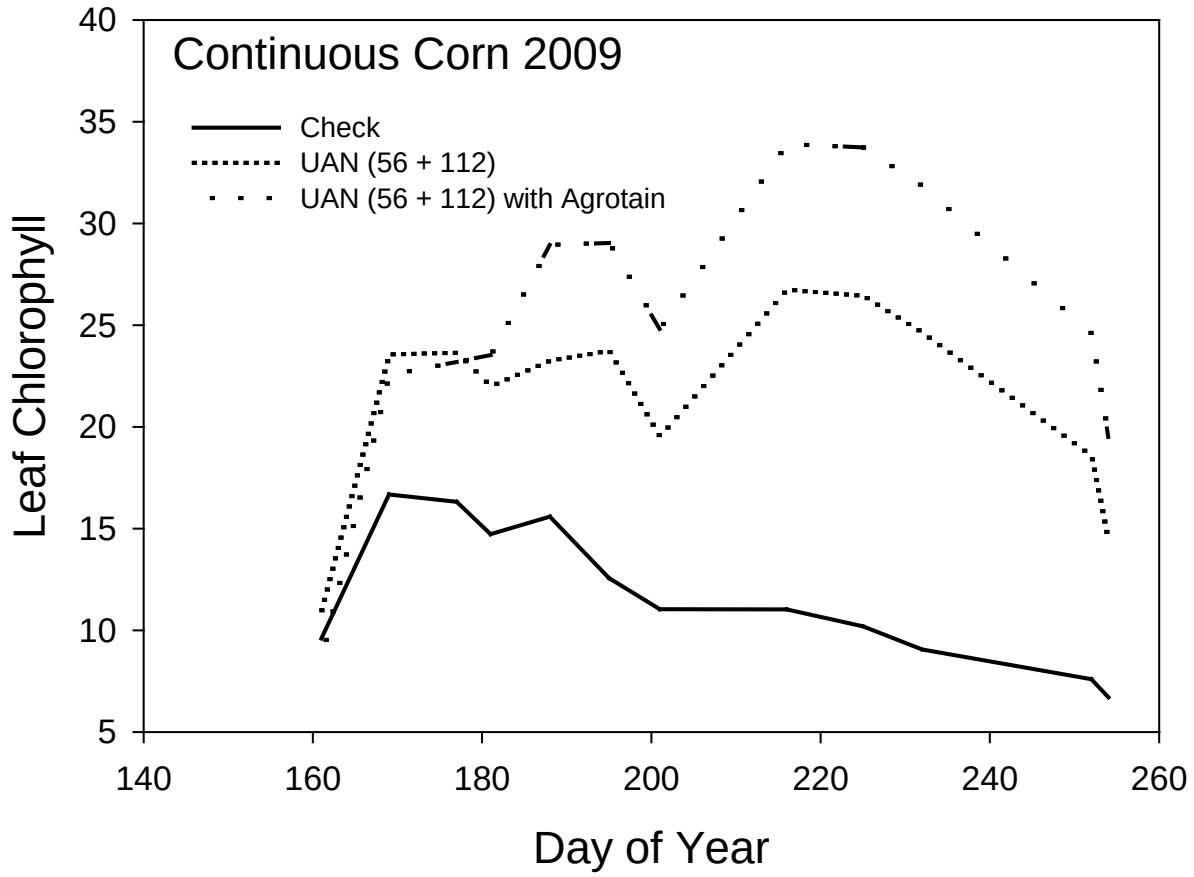
Yield variability in a field comes from soils inability to supply water during grain-filling

Background

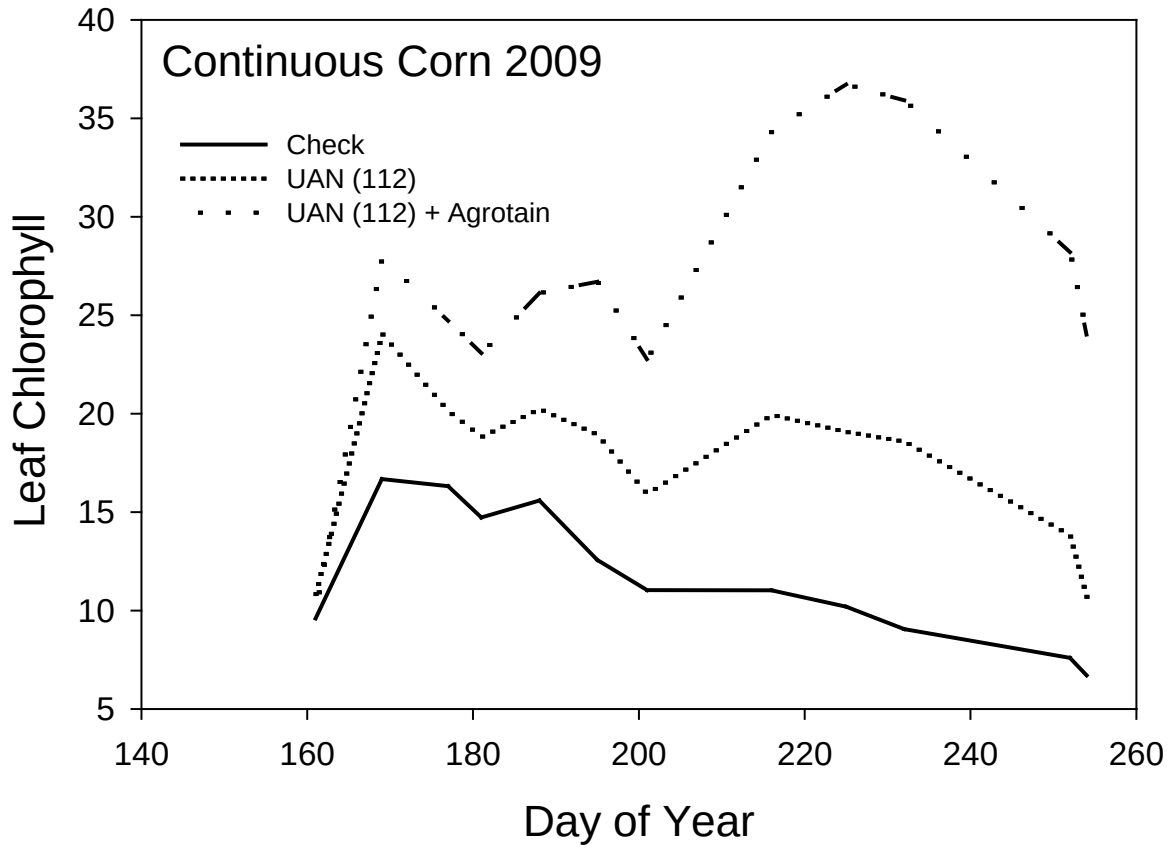
Studies will controlled release fertilizers showed we could maintain green leaf area longer in the grain-filling period and increase grain yield

Observed the same result when we increased the biological activity in the soil with more chlorophyll and longer duration of green leaf area in the grain-filling period.

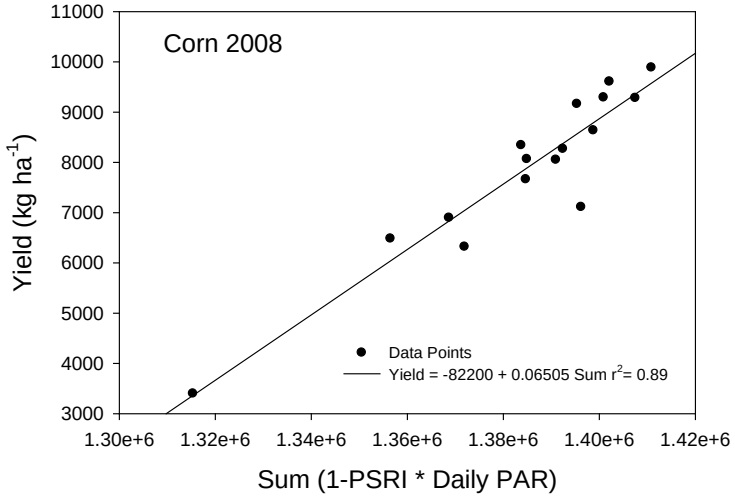
Leaf Chlorophyll Trajectories

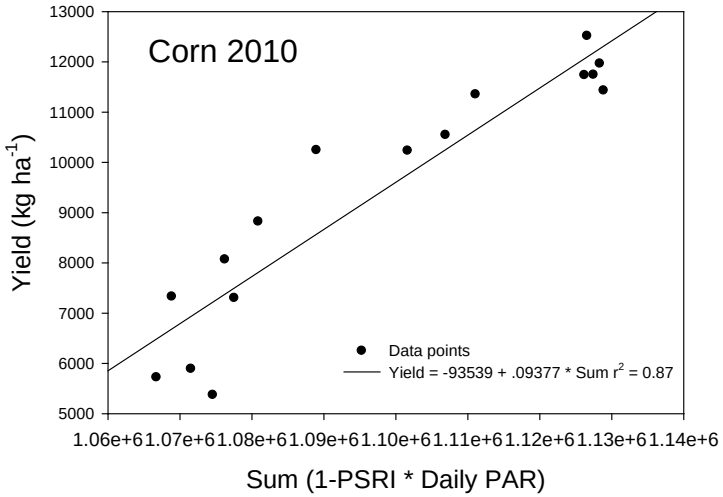


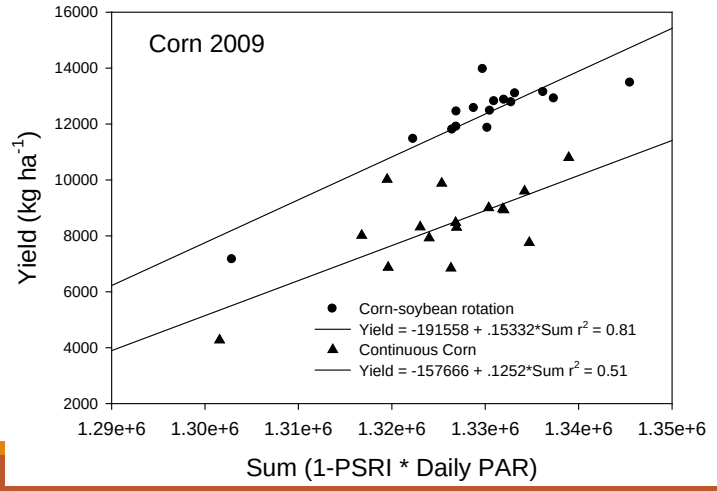
Leaf Chlorophyll Trajectories



Duration of Photosynthetic Capacity





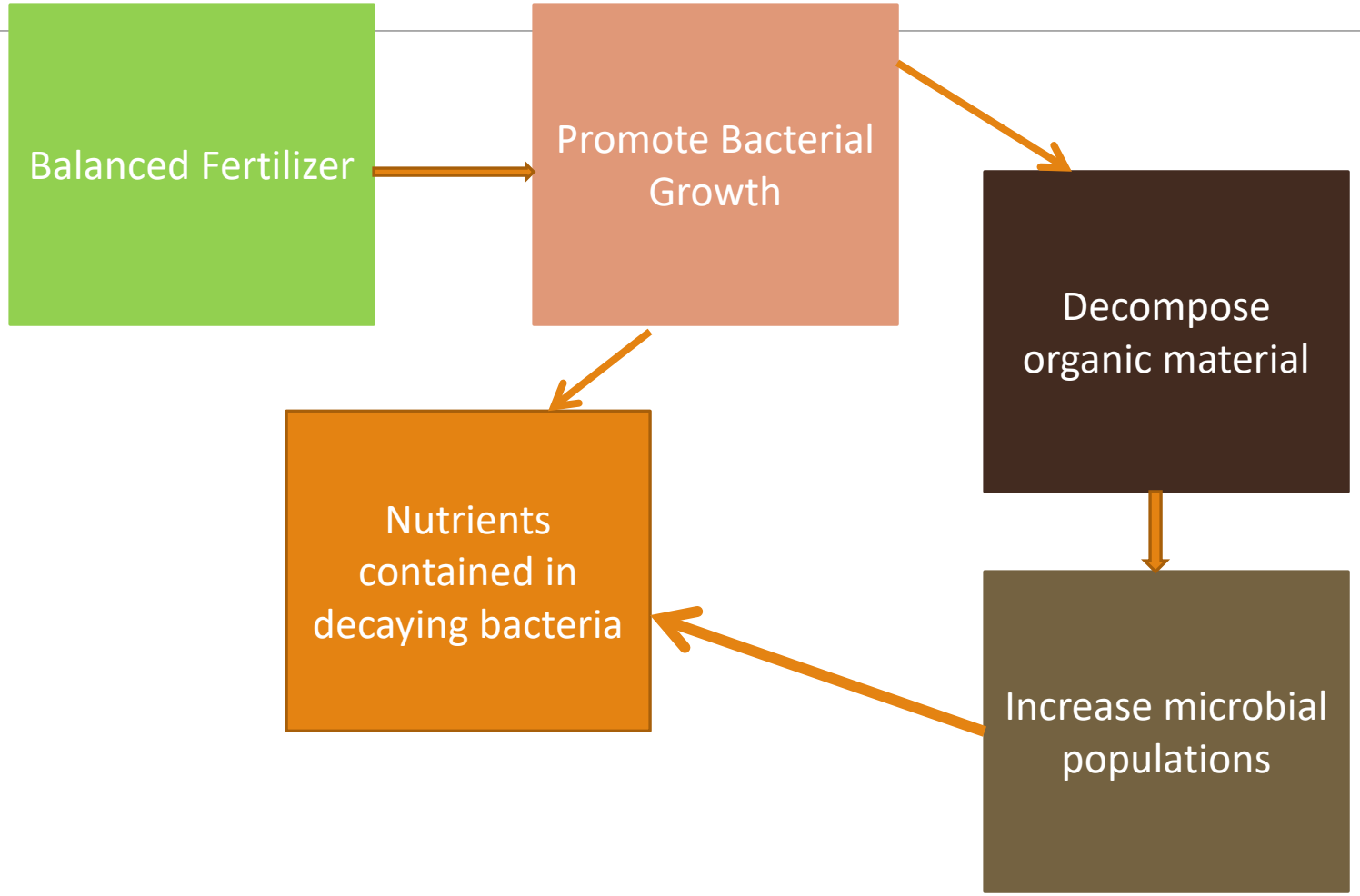


2011-2012 Results

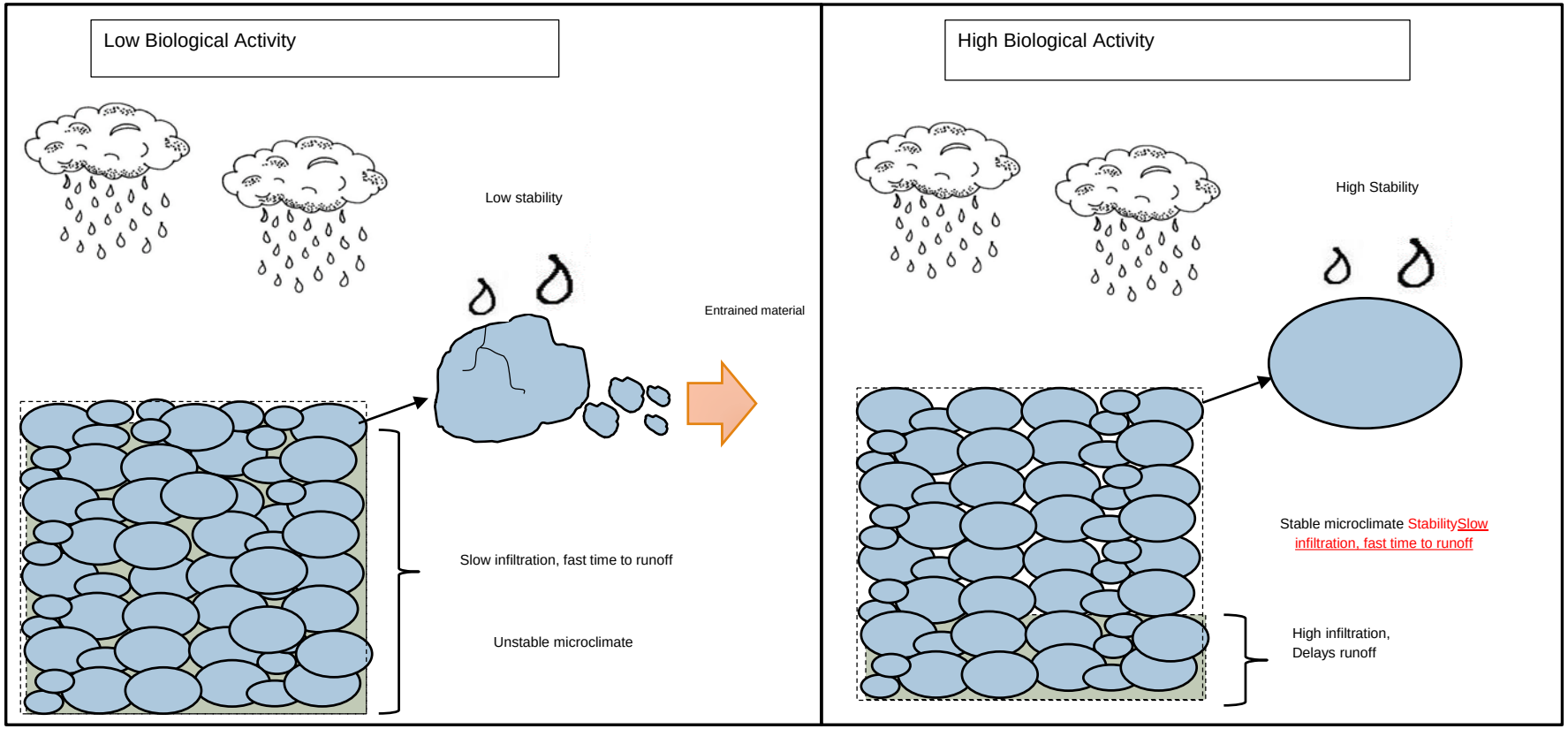
Crop	Treatment	Yield (bu/A)	
Corn	SuperU 1 PB 0 (150)	232	169
Corn	SuperU 0 PB 1 (150)	216	179
Corn	SuperU 1 PB 0 (150)	198	188
Corn	SuperU .67 PB .33 (150)	196	188
Corn	SuperU .33 PB .67 (150)	191	184
Soybean	PB 0	59	56
Soybean	PB .33	57	52
Soybean	PB .67	56	54

No significant differences among treatments within a crop

Process of Biotic Fertilizers



Stable Soil Systems



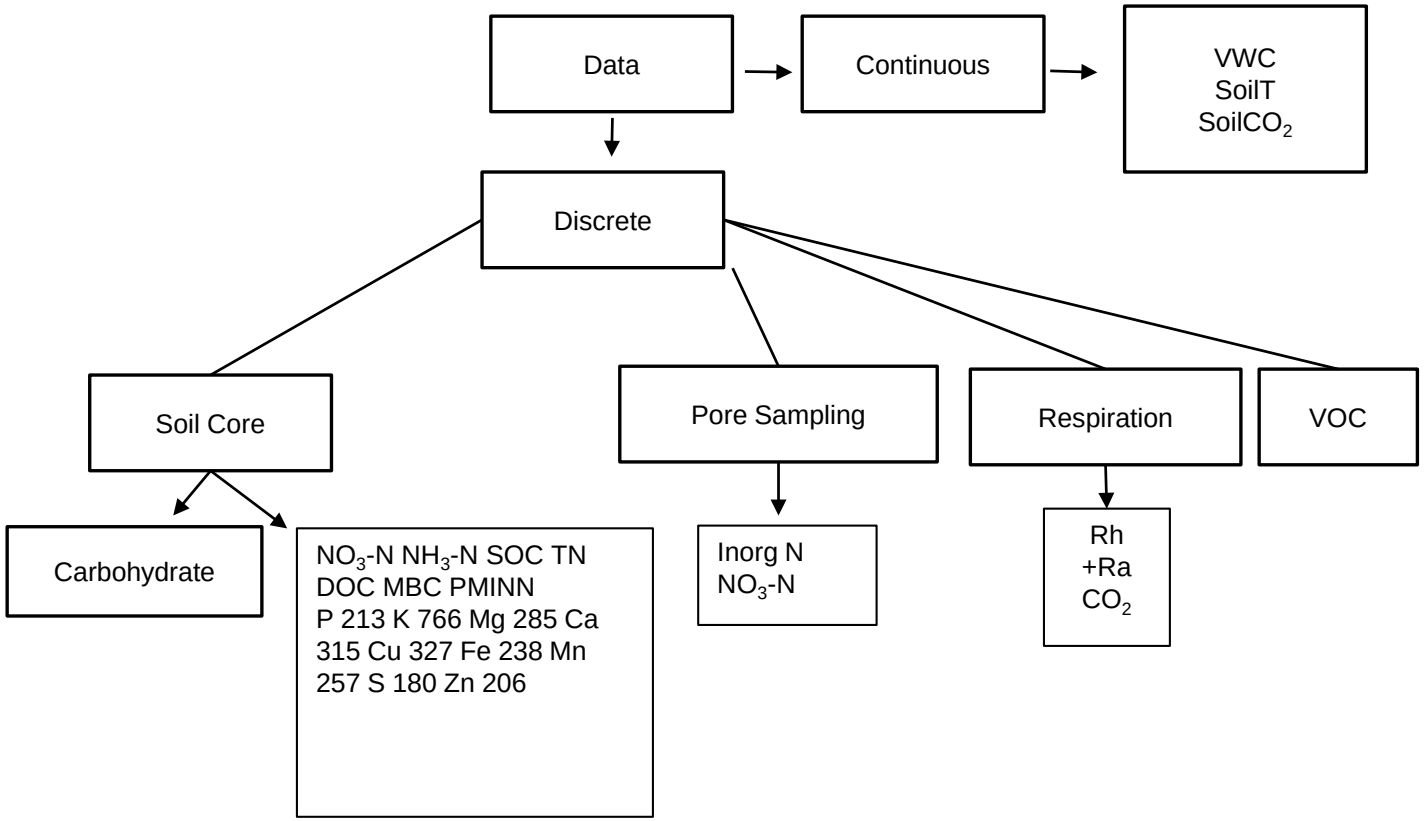
Plant Growth

Difference is due to the prior management of organic vs conventional

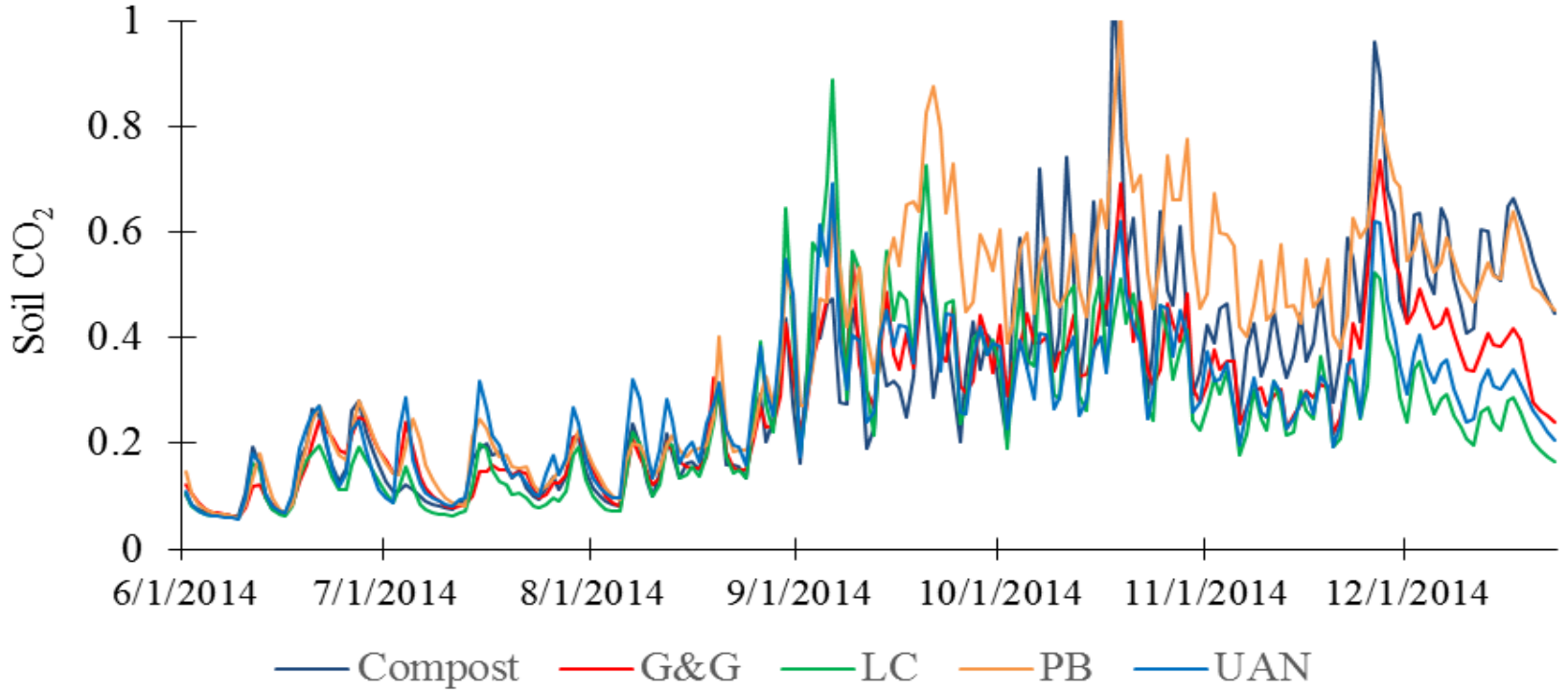
Soil Experiment – Laboratory

Evaluation of cover crop mixtures on changes in soil properties and gas exchange (CO_2 and O_2)

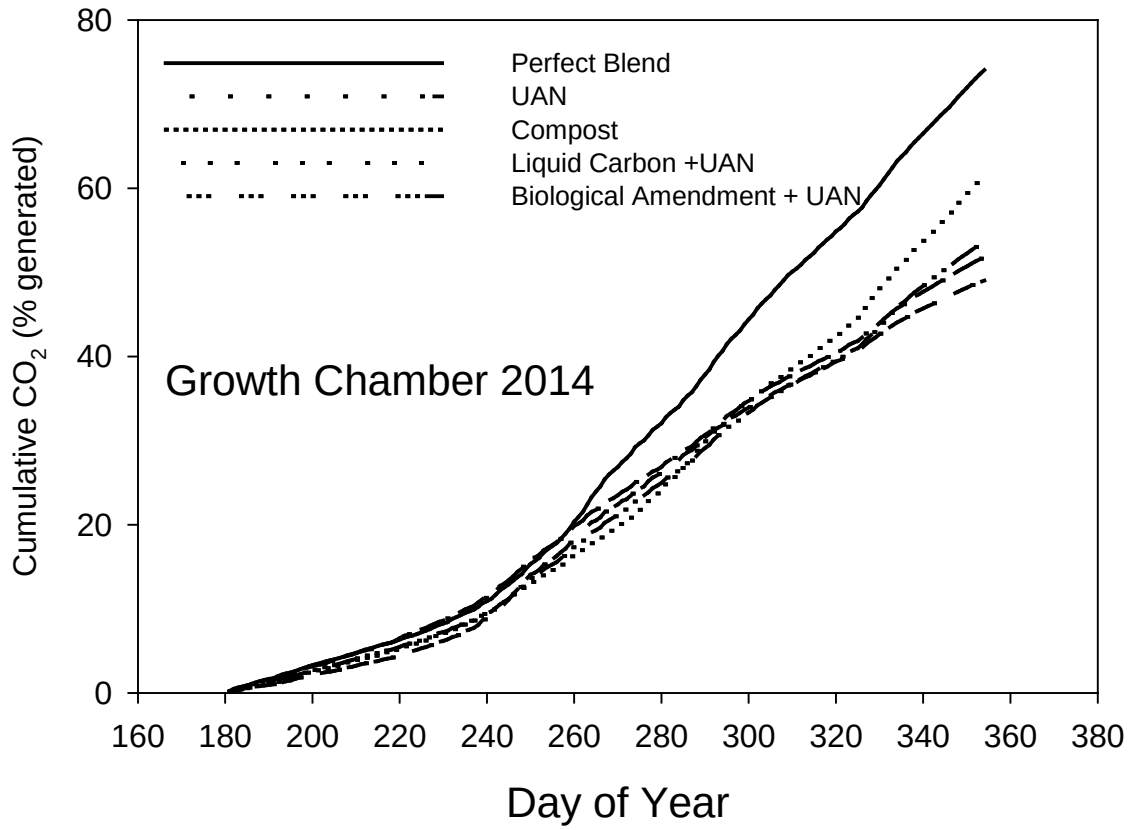
Soil Column Measurements



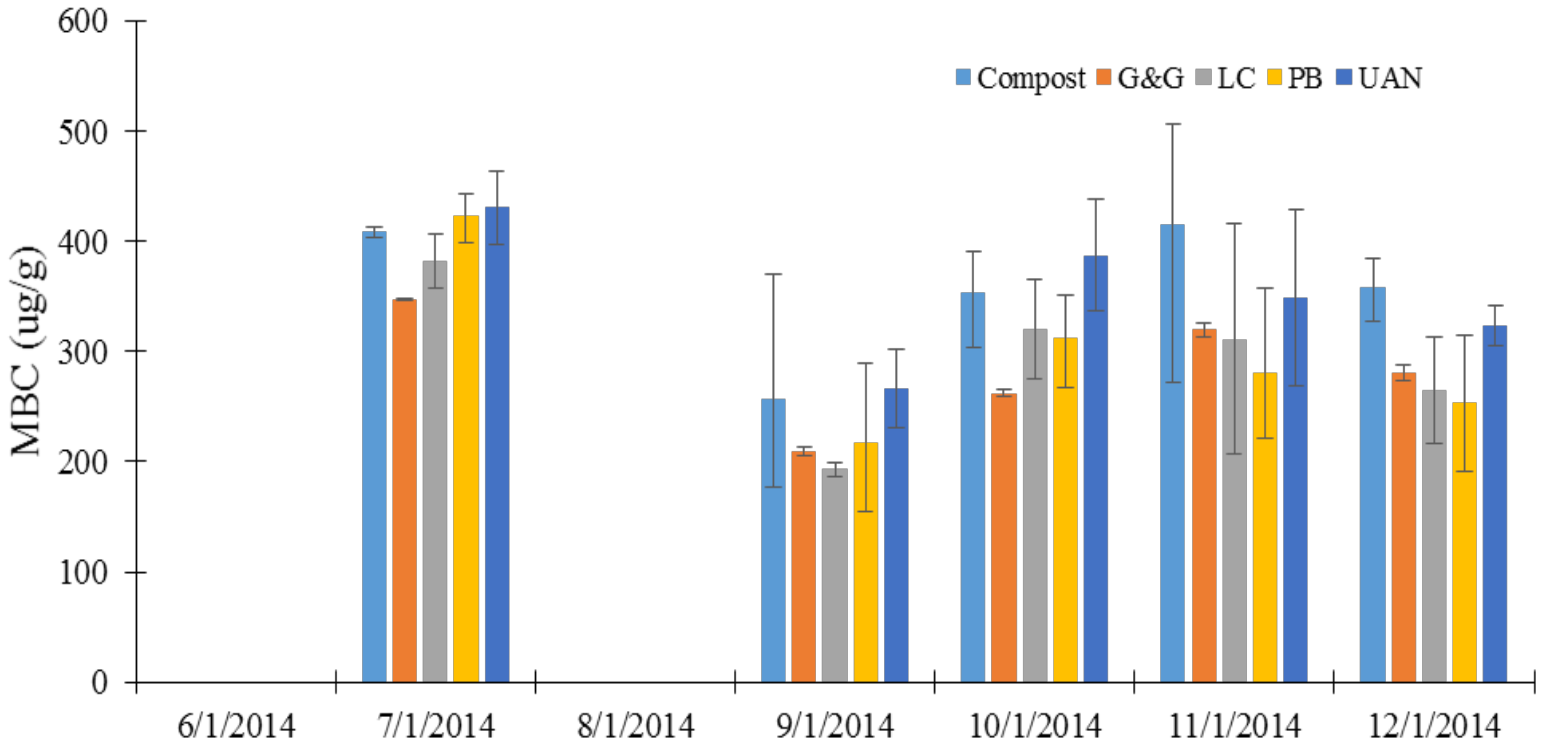
Continuous CO_2 Evolution

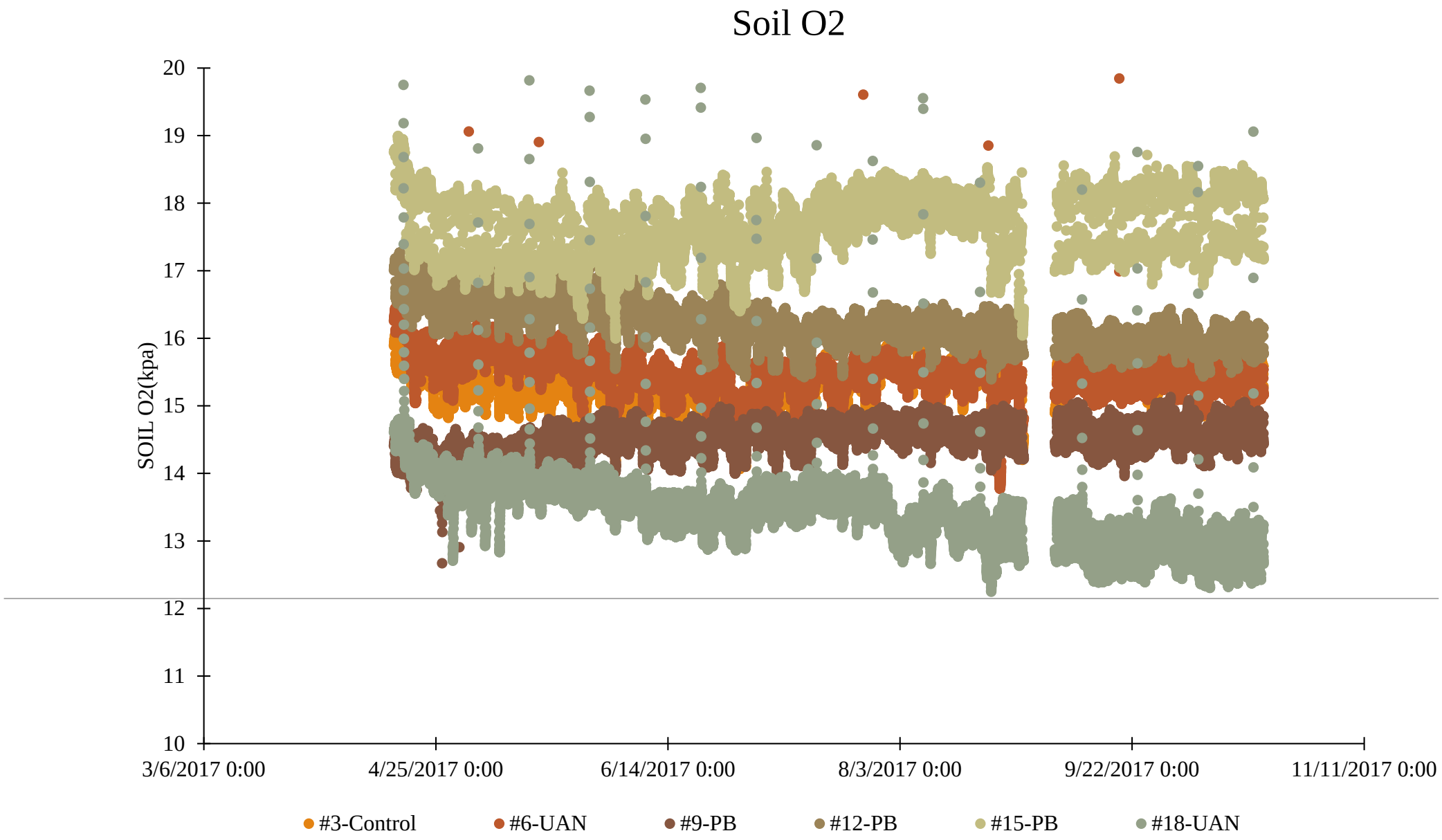


CO_2 Evolution



Microbial Biomass




Soil O2
SOIL O2(kpa)
20
19
18
17
16
15
14
13
12
11
10
3/6/2017 0:00
4/25/2017 0:00
6/14/2017 0:00
8/3/2017 0:00
9/22/2017 0:00
11/11/2017 0:00
#3-Control
#6-UAN
#9-PB
#12-PB
#15-PB
#18-UAN

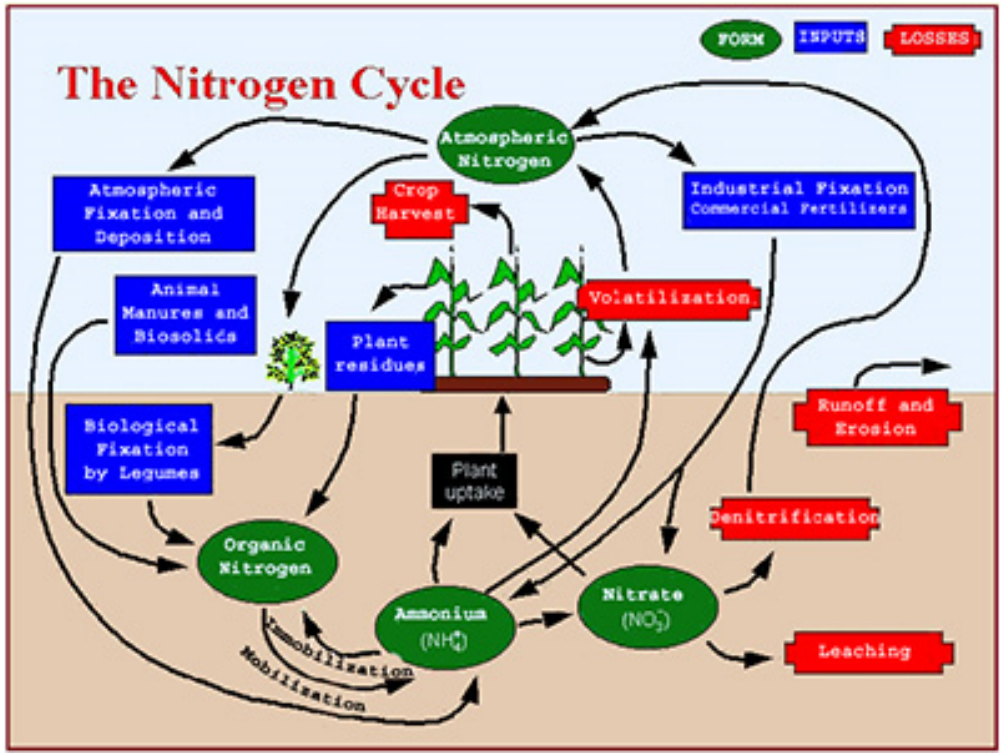
General Observations

Increase leaf chlorophyll with more biological activity

Increase in the CO_2 and O_2 concentration in the soil volume with more diverse cover crop mixtures

Observe an increase in nitrate concentrations in soil profile when we enhance diversity in the crops

Nitrogen Dynamics in Soil



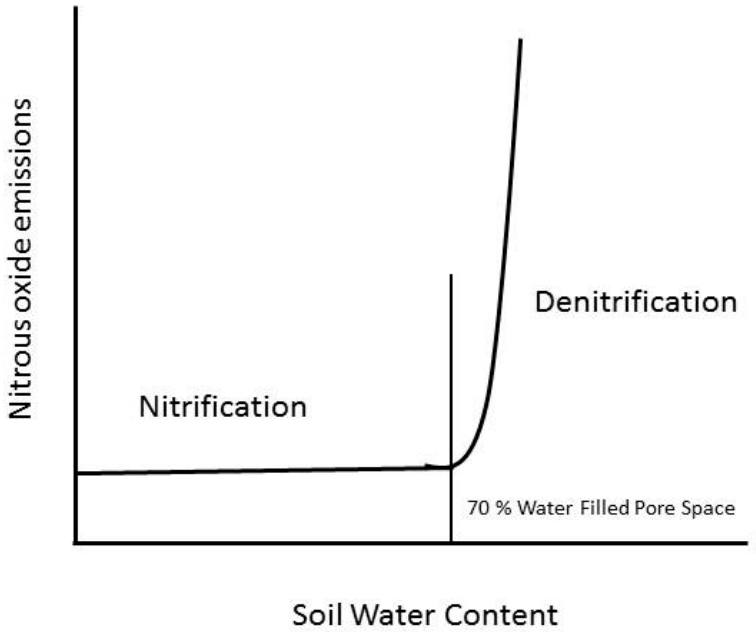
Inputs

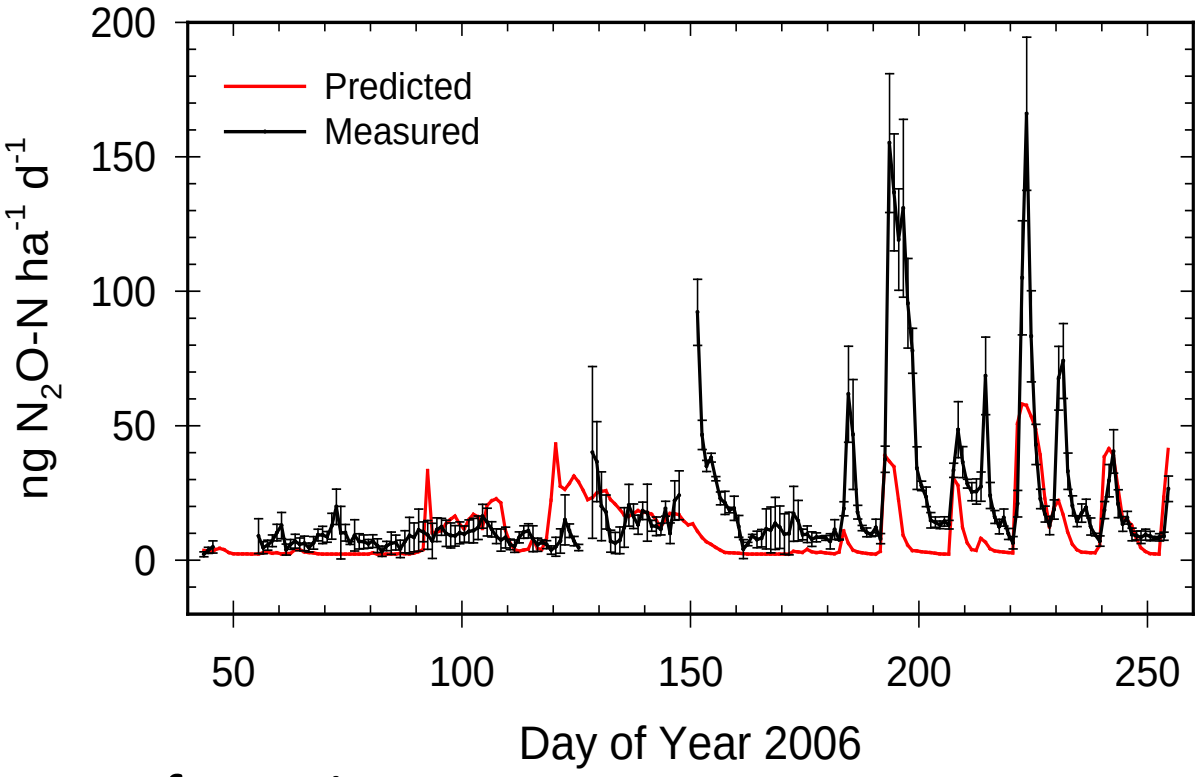
- Atmosphere
- Commercial fertilizer
- Soil organic matter
- Crop residues
- Animal manures

Losses

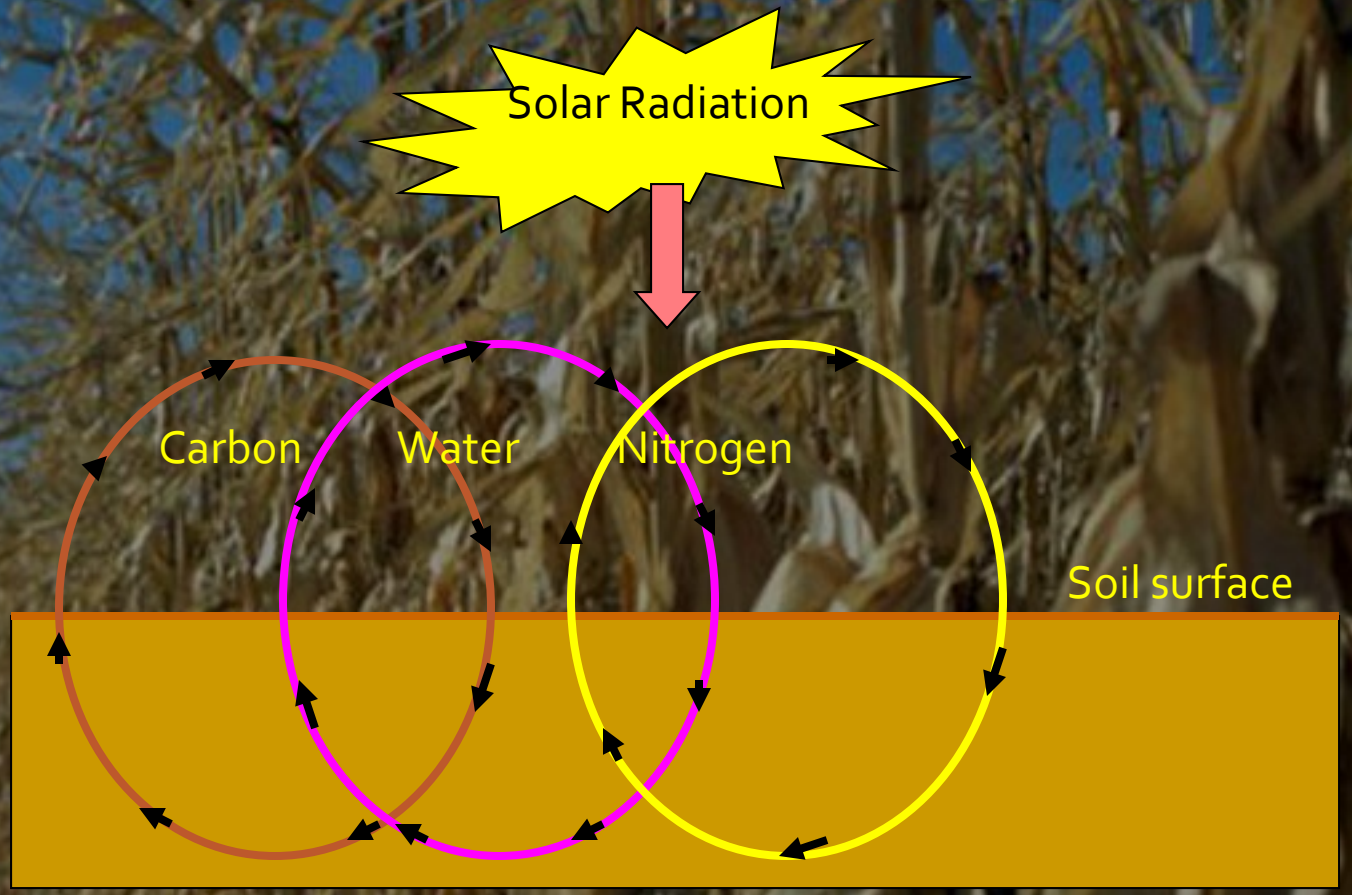
- Leaching
- Denitrification
- Volatilization
- Crop removal
- Soil erosion and runoff

Soil water dynamics





Soil water content changes the rate of reaction



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Cycles interact over time and space with different rates

Knowns

Changes occur within the soil as a result of management changes and can be positive or negative

Enhanced biological activity increases the rate of organic matter decomposition

Increases in organic matter are derived from root material rather than above ground biomass

As organic matter decomposes then more nutrients are available

Soil gases (CO_2 and O_2) are critical to proper functioning of biological systems