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Strategizing for Ecological Management & Implementing a Soil Health Management System

Soil Health Division

USDA United States Department of Agriculture

Objectives

1. Identify key components of practices and activities to develop a Soil Health Management System
2. Describe the interaction, dependency and synergy between practices in a SHMS
3. Recognize barriers to implementation
4. Describe an entry level strategy to develop a SHMS

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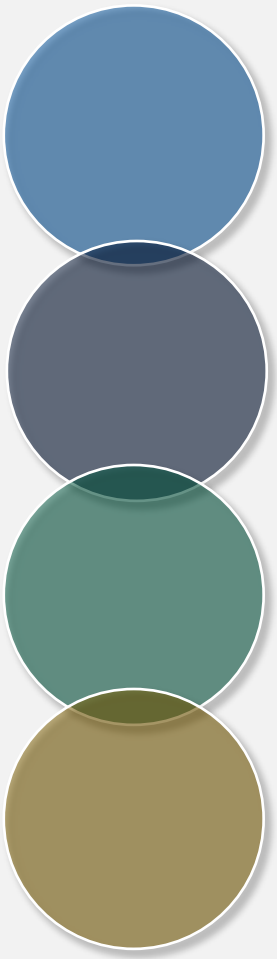
Soil Health Management System



Collection of NRCS and other conservation practices, BMPs, activities, that focus on maintaining or enhancing soil health

Address all the soil health principles

Create a “synergistic” effect

Cropping system and landuse specific

Best Accepted New Technology

Conservation activities that might not be in an NRCS conservation practice standard. Examples:

- Companion cropping
- Traffic management
- Precision application of nutrients and pesticides
- Use of floatation tires or tracks
- Bale Grazing

Soil Health Management System

- Achieving soil health through:
  - A Quality No-till/ Strip-till System
  - Diverse and Strategic Cover Crops
  - Adapted Nutrient Management
  - Integrated Weed & Pest Management
  - Diverse Crop Rotations
  - Precision Farming Technology that results in reductions overall
  - Prescriptive Buffers
  - Livestock integration

Soil Health is not a destination…it's a Journey

Quality no-till/strip-till

Adapted nutrient management

New technology
and
integrated weed &
pest management

Prescribed cover crops

Diverse crop rotation

Quality no-till/strip-till


No-Till / Strip-Till
Planter set-up and maintenance is critical


Goal: Every seed at the exact same depth…


Day1
Day2
Day3
Day5
Day4
Jeff Miller @jeffmillerttu · 22h
Planting emergence study. 8.9 bu loss on plants emerged after the first day. Pay attention to soil conditions, speed, and depth. Free yield

Spread the Weight!

Spread residue

Spread the Residue!

PHOTOS: USDA - SHD

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Knowledge Check: Poll Question

What Issues with No-till have you seen or heard of in your location?

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Poor Structure = Yield Loss

No-Till Planter Attachments


Adapted nutrient management
New technology and integrated
weed & pest management

Compounding extent of soil degradation and effect on other cycles

Only 30-55% of Inorganic Fertilizer is Directly Used by Plants

Denitrification:

- Anaerobic conditions cause Losses of N_2, NO and N_2O

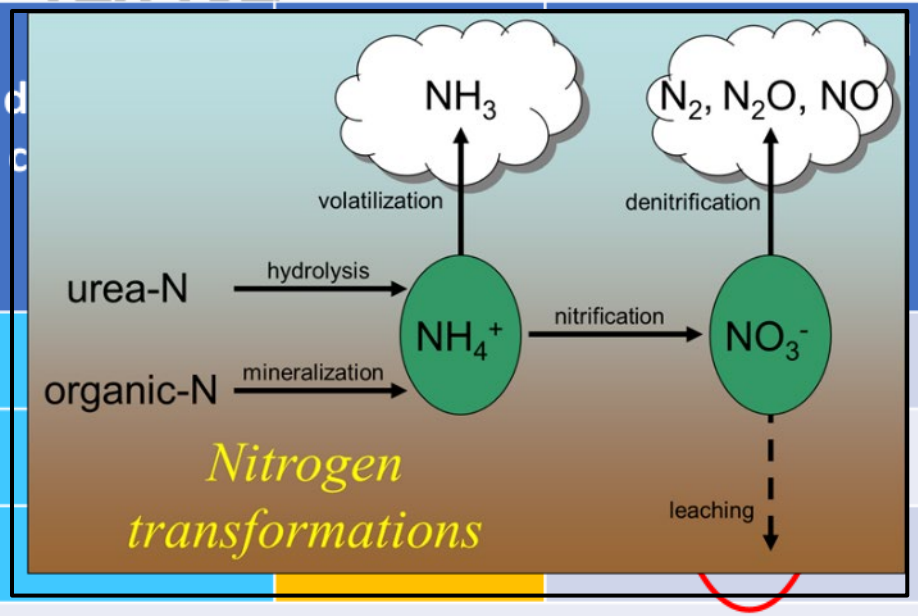
Leaching

- Plenty of heat to convert ammonium to nitrate
- Nitrate leaves with the water

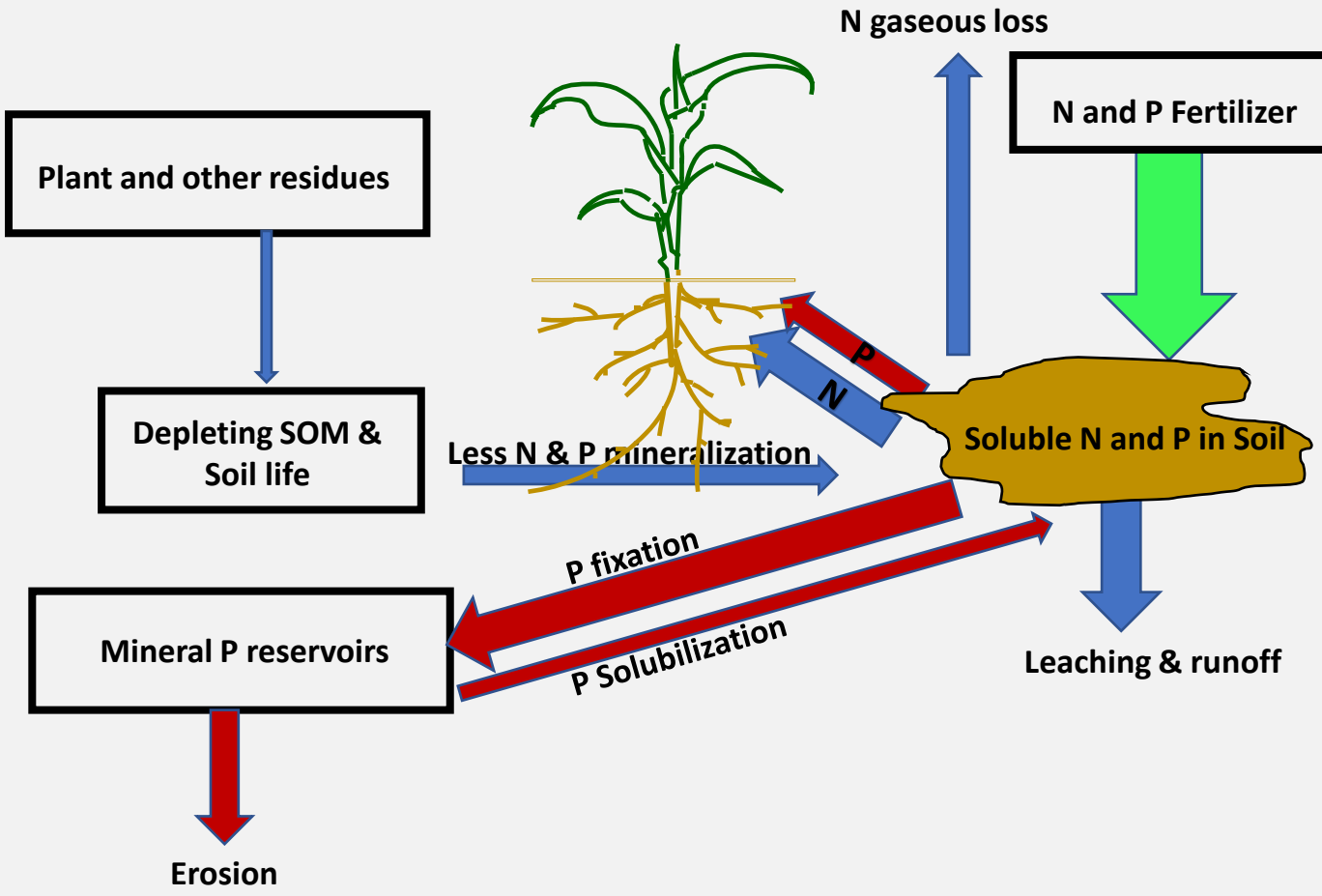
- Both applied and soil available N are at risk of loss

Fertilizer N applied (lb/ac)	Corn grain yield (Bu/ac)	Total N in corn plant (lb/ac)
45	62	76
89	73	130
178	88	140

Calculated from Reddy and Reddy, 1993 and modified from Weil & Brady, The Nature and Properties of Soils, 15th ed.



Dominant Nutrient Management Strategy

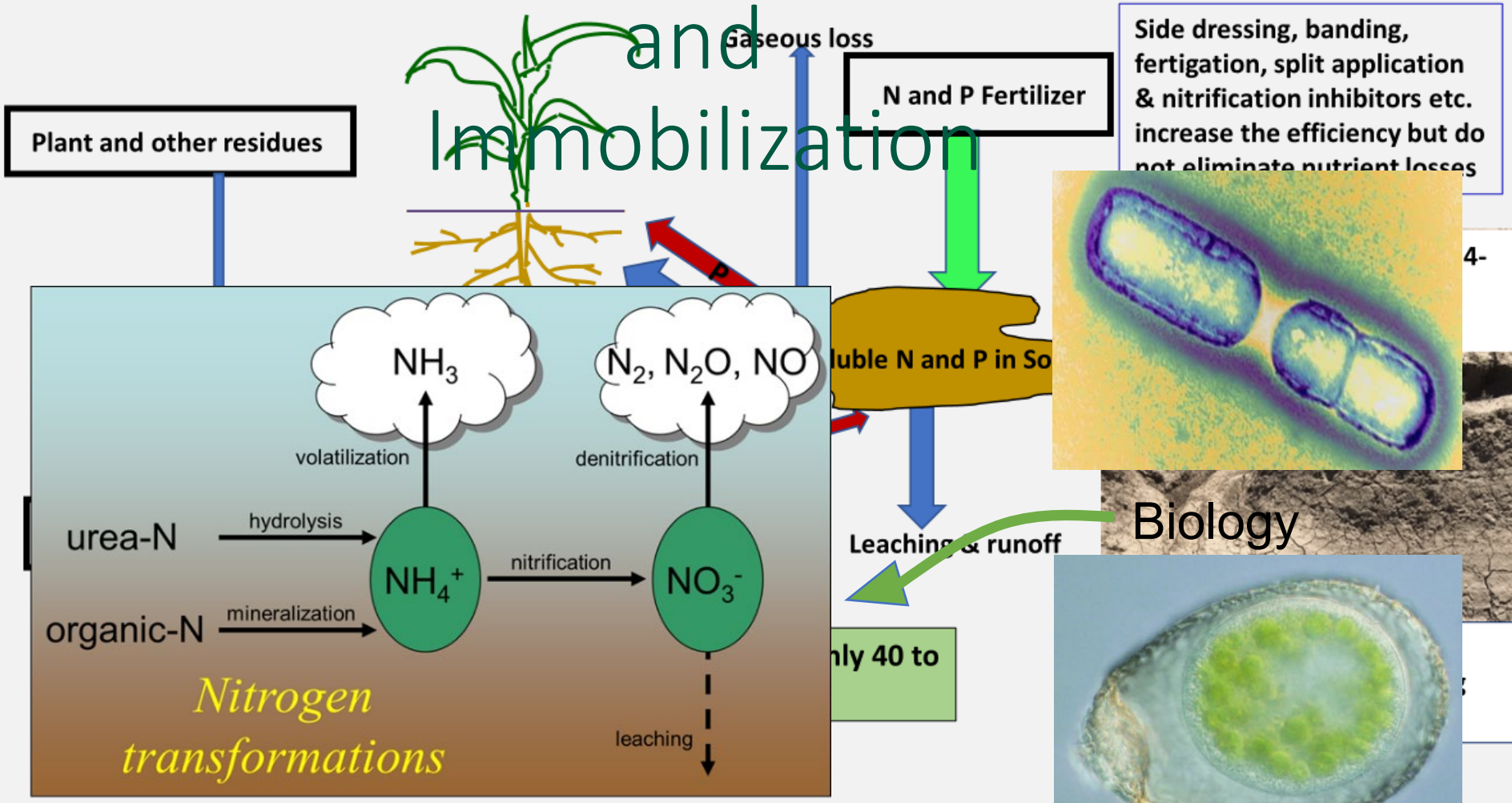


Plenty N & P are added to meet the yield goal. Soil with excess fertilizers is leaky

Adapted from Drinkwater & Snapp, 2007

The 4R Nutrient Management Strategy

Nitrogen Mineralization and Immobilization



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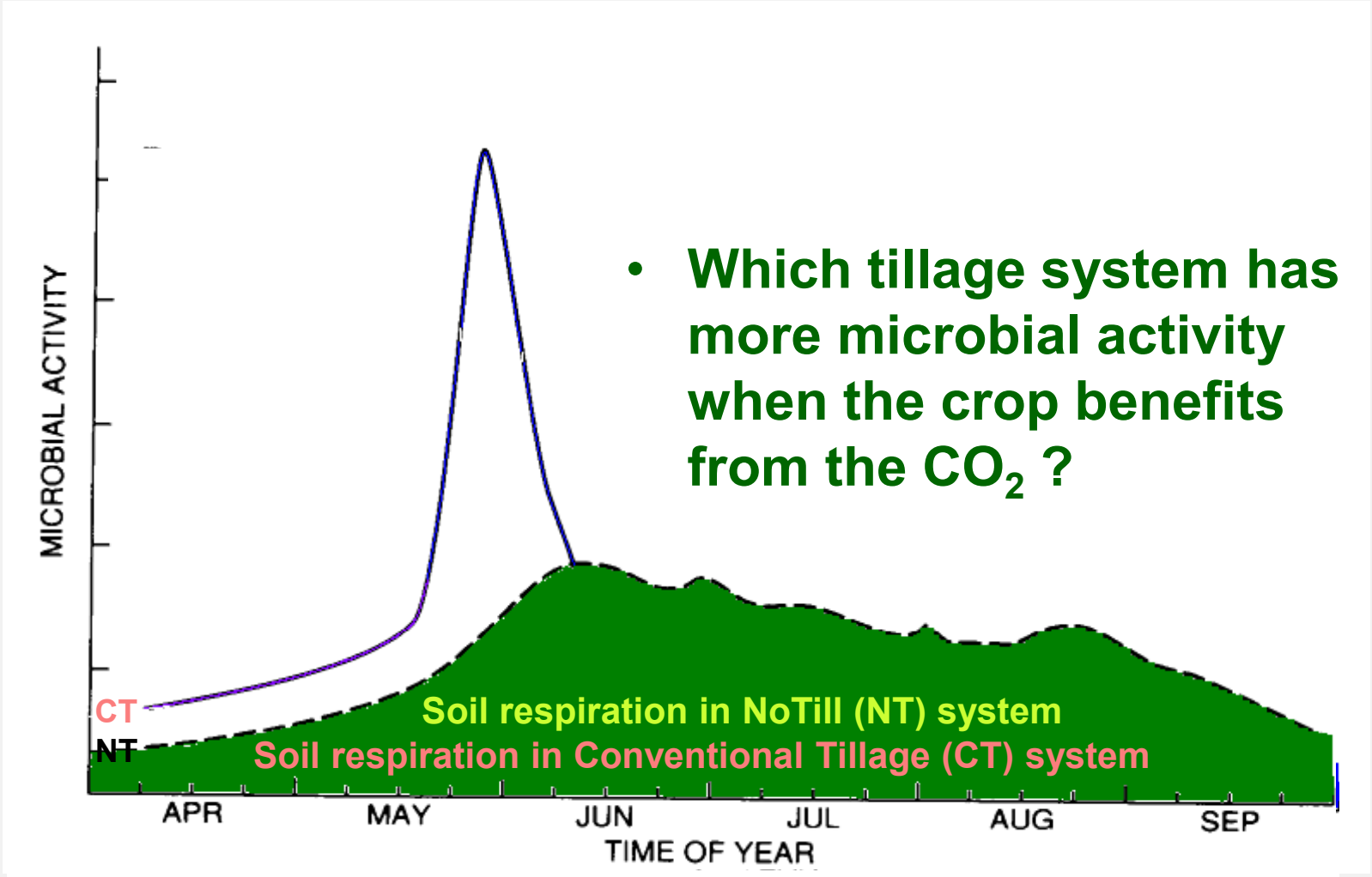
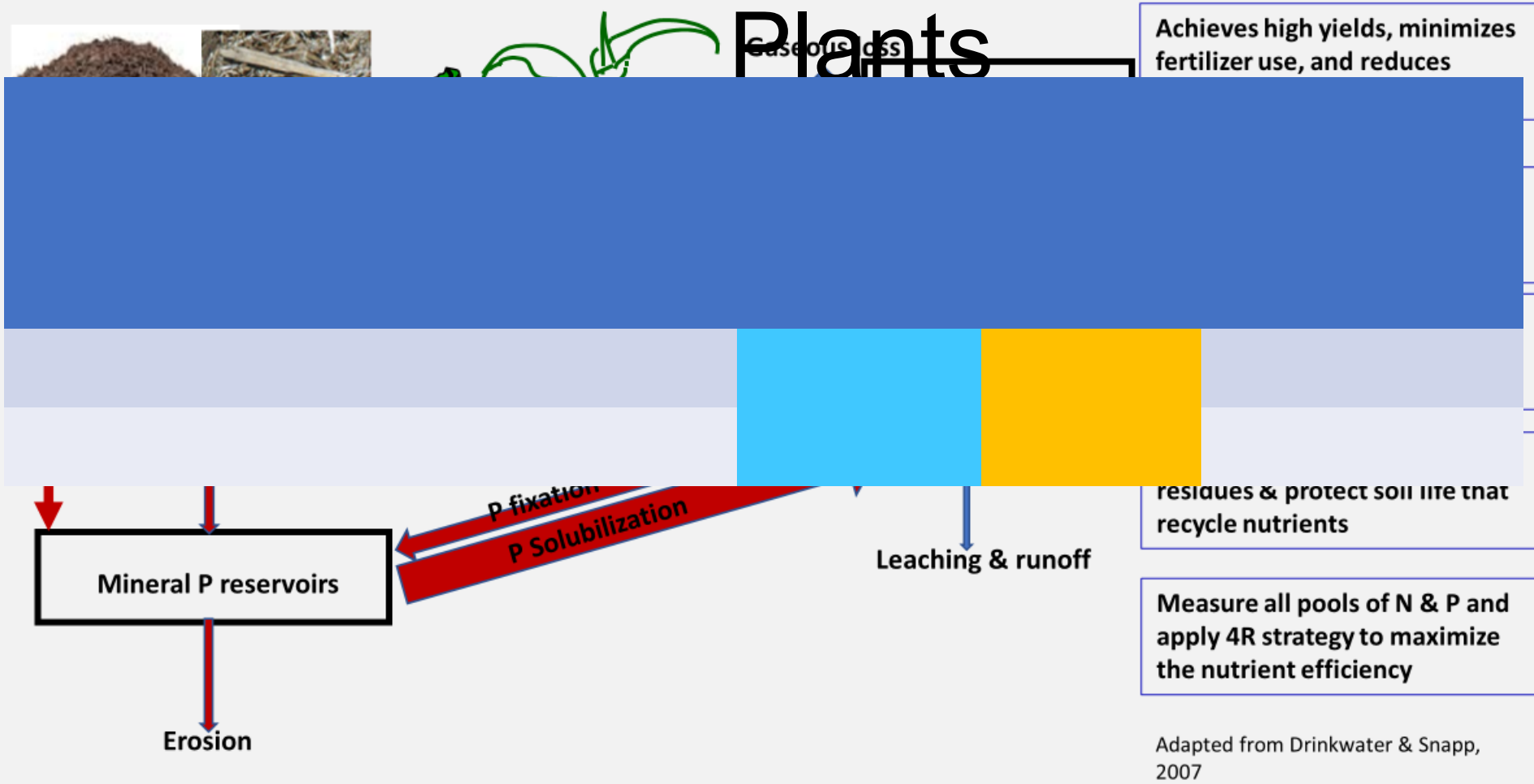
Effect of Tillage on Microbial Activity



- **Which tillage system has more microbial activity when the crop benefits from the CO_2 ?**

Havlin et al. (1999)

Only 30-55% of Inorganic Fertilizer is Directly Used by Plants



Achieves high yields, minimizes fertilizer use, and reduces

residues & protect soil life that recycle nutrients

Measure all pools of N & P and apply 4R strategy to maximize the nutrient efficiency

Adapted from Drinkwater & Snapp, 2007

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New technology and integrated weed & pest management

No-Till Planters

Precision nutrient placement and rate

With Adapted 4R Precision

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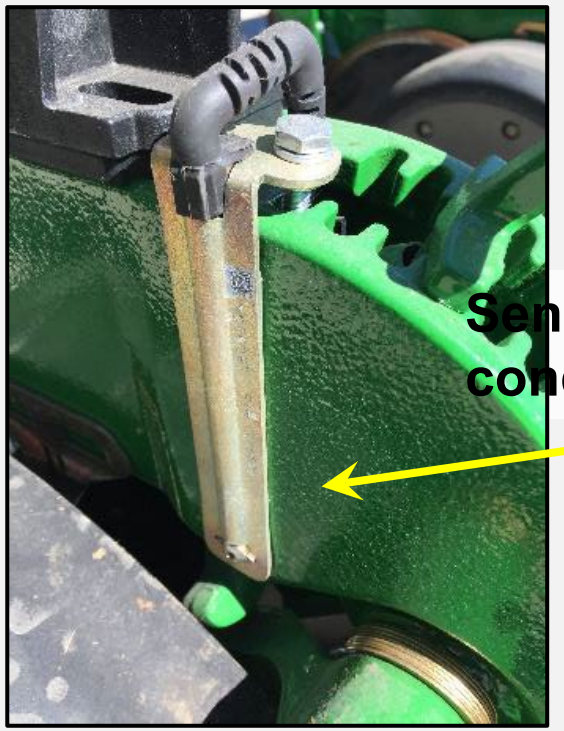
No-Till Planters

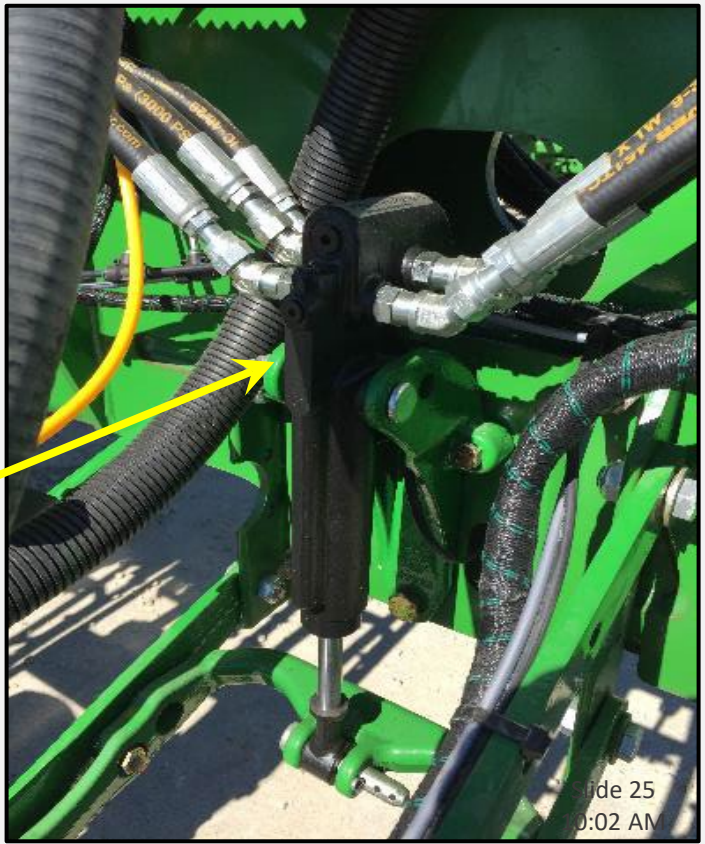


Sense and adapt to field conditions on the go!

With Space Shuttle Tech

Precision downforce

in sub inch increments.



New Technology using Nature for Weed Management

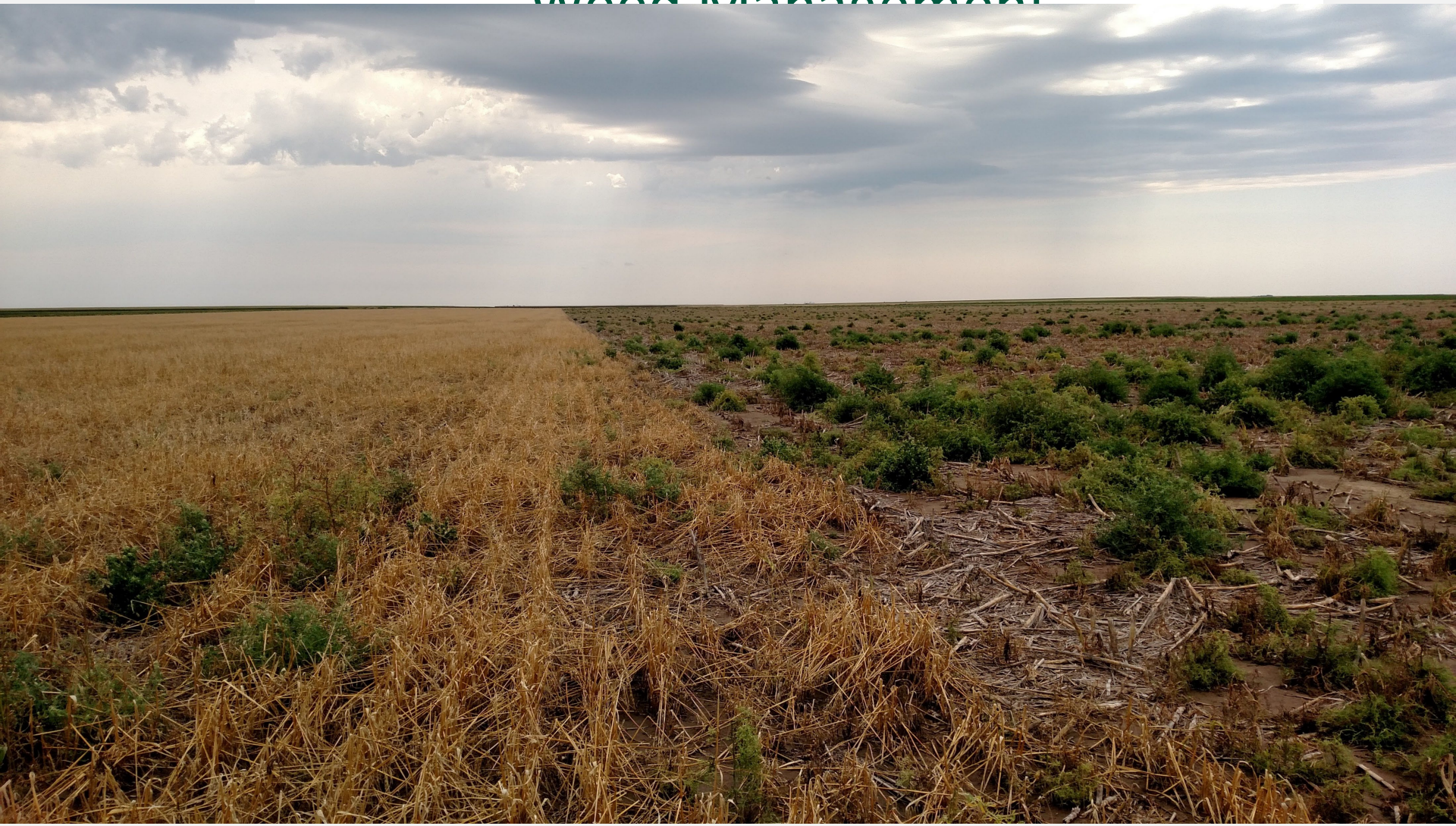


Photo by: Larry Pridley
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7 Strategies to Control Weeds with Cover Crops

1. Determine the time and emergence of target weeds.
2. Plan for robust growth of cover crops
3. Choose cover crop species that produce a significant amount of biomass
4. Choose species that meet your goals
5. Plan a strategy to allow allelopathy to work
6. Consider planting conditions and rates
7. Monitor the effectiveness

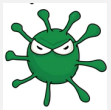
https://www.agriculture.com/crops/cover-crops/7-ways-cover-crops-help-fight-weeds


Prescribed cover crops

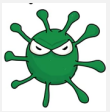
Strategically…CC Should Complement the Following Crop

Mineralization Vs. Immobilization

Mineralization:

Organic N +  → NH_4/NO_3

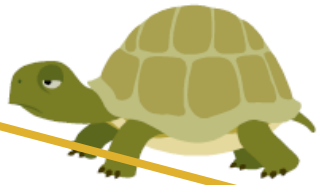
Immobilization is the reverse of mineralization.

NH_4/NO_3 +  → Organic N

Johnson et al. 2005, Cornell University

Strategically…CC should match desired C:N Ratio

Material	C:N Ratio
rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
Ideal Microbial Diet	**24:1**
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1



slower

Relative Decomposition Rate

faster

Good for Soybean

Good for Corn

Strategically…CC should complement the following crop …Which is better?

Nitrogen Dependent Crops into:

- High Carbon (Cereals Rye/Wheat)

…or

- High Nitrogen (Protein)
- Cover Crop (Clover/Peas)

Strategically…CC Should Complement the Following Crop

Corn into:

- High N (Protein)
- Cover Crop (Clover/Peas)
- Contributes high quality N
- Less likely to harbor disease pathogens

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Strategically…
CC should complement the following crop

Corn strategy:

Strip Till

- Easy spring management

Other innovations

Biotill

Strategically…CC Should Complement the Following Crop

Corn into a mix:

High Protein

Can Provide:

- Optimum Nutrient Release
- Extra water During rapid demand

Strategically…CC Should Complement the Following Crop

Corn into a mix:

High Carbon (Rye)

- Provides erosion and weed control

Uses/ immobilizes:

- Nitrogen/ nutrients
- Disease?

Starter N a must!

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Strategically…What about Legume or low N Dependent Crops?

Choices

Do Soybeans need N ?

…Sure, but they capture their own!

Strategically…

- Legumes do well into a high carbon Cover Crop.
  …Why?
- Weed Control, Late Season Water and Nutrient Cycling

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Starting the System

Example of a Corn and Soybean System being strategically planned over 18 months

Strategically…Planning the System Using the Step-by-Step Approach

1. Drill or Aerial Seed Cereal Rye or Annual Ryegrass into Corn Stalks

Strategically…Planning the System

2. Terminate the Cereal Rye at 12”…

Or

Strategically…Planning the system

3. Plant a short season Soybean into the Rye (preferably early in the season)

Strategically…Planning the system

4. Plant a low C:N mix into or after Soybean

Strategically… Planning the system

18 months into the system we have had:

Three no-till plantings (Minimized Disturbance)

Year-round ground cover (Maximized Ground Cover)

Added diversity that was lacking (Maximized Diversity)

Two winters of a living root (Maximized Living Roots)

Strategically…Planning the system

5. NT Corn into a:

Biologically active high functioning soil

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Options for Higher Level Management

Strategically…Planning the system… for a higher level?

6. Add a Small Grain and make it a true rotation

A Small Grain gives endless options…

Strategically…Planning the system… for a higher level?

7. Maximize Diversity by companion cropping…

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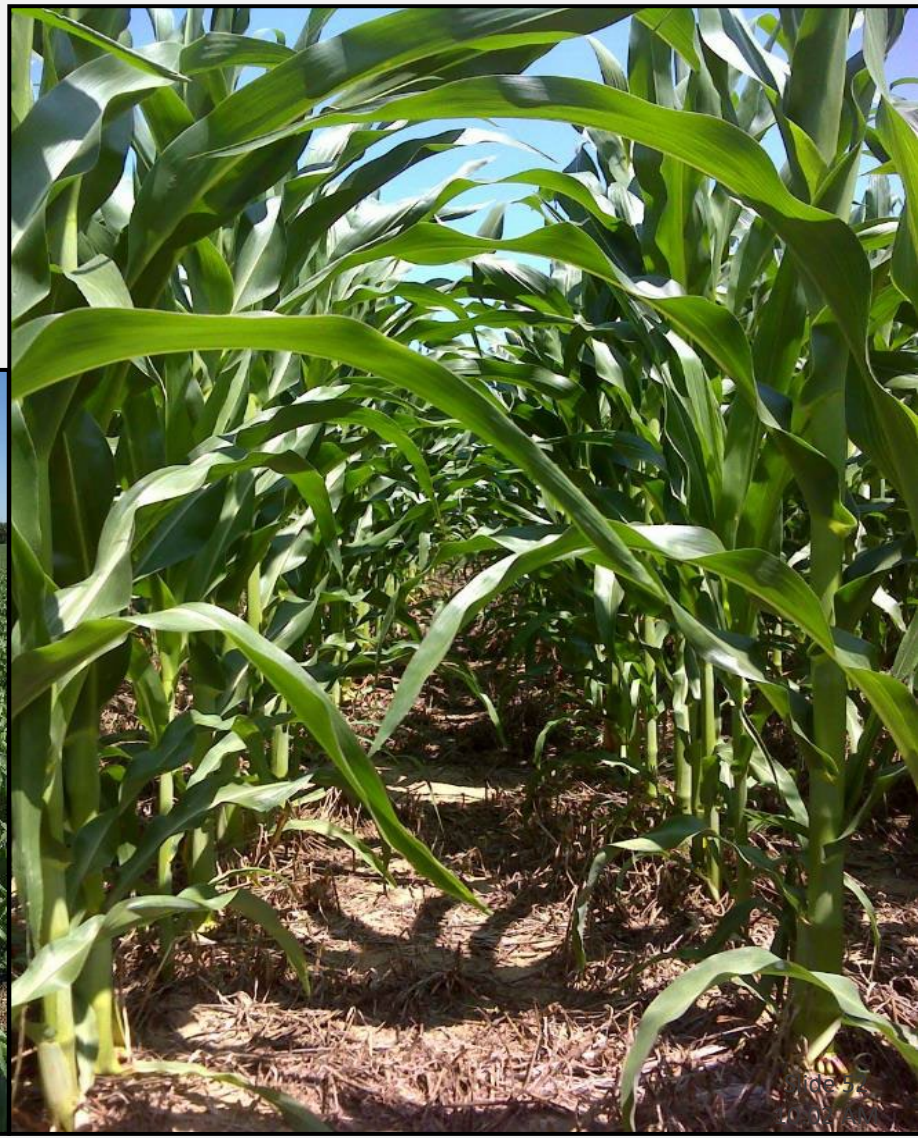
Strategically…Planning the system… for a higher level?

8. Maximize Diversity by adding livestock…with high end grazing systems

Strategically… Planning the system

9. Enjoy The Rewards of Soil Health!



Managing for a Living Ecosystem is Key to Optimum Production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