NITROGEN: A Challenge for Modern Agriculture

Nitrogen provides robust growth in crops

Nitrogen has serious environmental issues

MN agriculture has a “leaky” nutrient system

“Troubled Waters” Larkin McFee

N transfer to surface and ground water: a matter of how we manage our soil


ST. OLAF

Taking Care of the Land?

- “Nobody cares about good soil and clean water more than farmers”
- “Farmers are the original environmentalists”
- “Farmers produce more by using less”
- “Minnesota farmers are the best”
- “Farmers have a moral obligation to feed the world”

John Deere 3710 moldboard new plow sales, 8-10 bottom

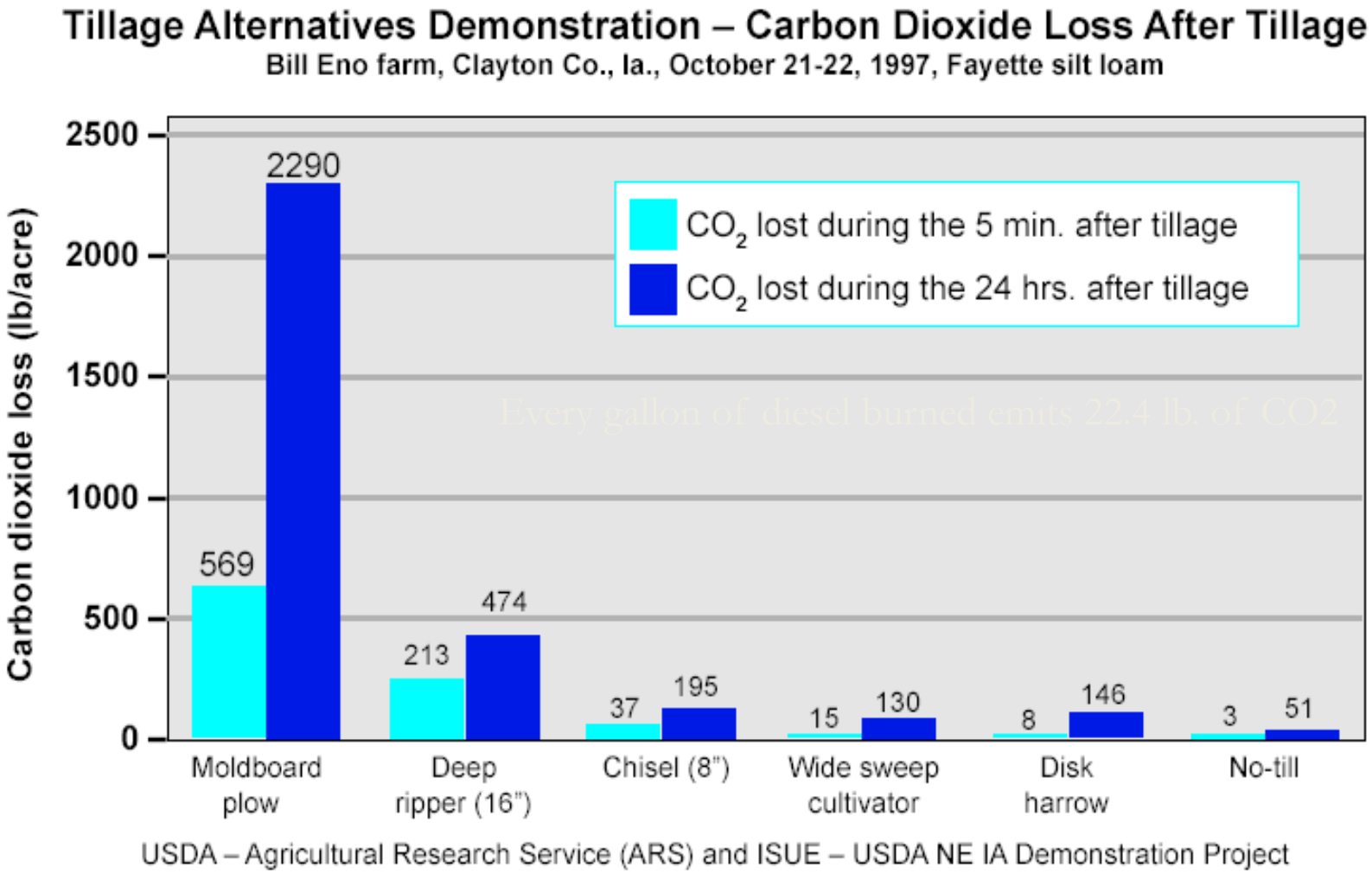
- 2006 2
- 2007 6
- 2008 7
- 2009 3
- 2010 11
- 2011 15
- 2012 15 plows on order

(8 SEMA dealers, sales data, new plows)

Salford 12 and 14 bottom plows

	» 12 bottom	14 botttom
– 2010	0	2
– 2011	3	7
– 2012	1	4, 2 on order

– (SEMA equipment data)


Tillage Alternatives Demonstration – Carbon Dioxide Loss After Tillage
Bill Eno farm, Clayton Co., Ia., October 21-22, 1997, Fayette silt loam
Carbon dioxide loss (lb/acre)
2500
2000
1500
1000
500
0
CO_2 lost during the 5 min. after tillage
CO_2 lost during the 24 hrs. after tillage
Every gallon of diesel burned emits 22.4 lb. of CO2
569
2290
213
474
37
195
15
130
8
146
3
51
Moldboard plow
Deep ripper (16")
Chisel (8")
Wide sweep cultivator
Disk harrow
No-till
USDA – Agricultural Research Service (ARS) and ISUE – USDA NE IA Demonstration Project


ENVIRONMENTAL TILLAGE
ENVIRONMENTAL TILLAGE
SYSTEMS INC.
FARIBAULT, MN 55021


Soil Warrior with dry fertilizer system $84,354
Trimble Auto Steer with cellular correction $20,322

WHAT IS SOIL QUALITY?

AIR

ORGANIC MATERIAL (HUMUS) 1% TO 11%

BIOTA: BUGS, WORMS, BACTERIA,

WATER HOLDING CAPACITY

AGGREGATE STABILITY

Soil scientists agree that less tillage builds soil quality.

St. Olaf Nitrogen Rate Trials 2011

Ryan Lemickson
And
Rachel Weime ’ 12 St. Olaf College

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Premilinary

Corn/Soybean Site

Corn Price: $6.01/bushel **N Price (UAN): $448/ton *($0.80/lb)***

(.13 ratio)

Iowa N Rate Calculator MRTN: **103 lbs N** (96 – 110 lbs N/acre)

Corn Nitrogen Rate Calculator

Finding the Maximum Return To N and Most Profitable N Rate

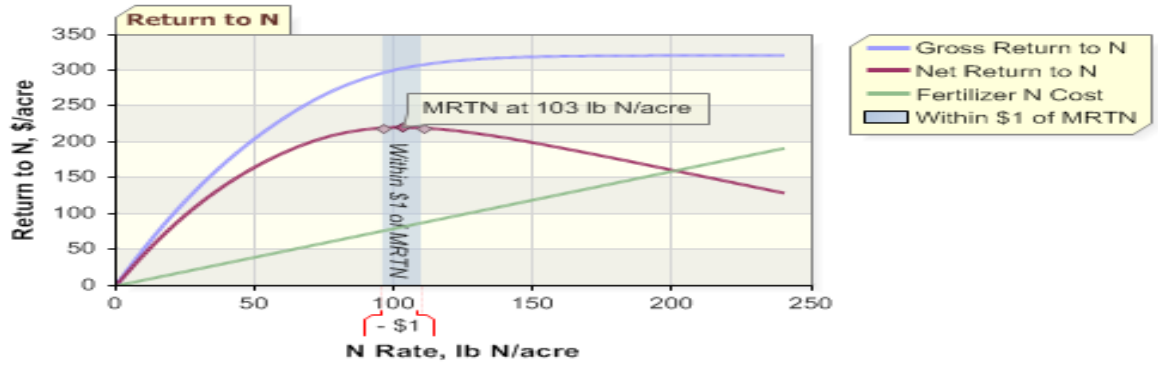
A Regional (Corn Belt) Approach to Nitrogen Rate Guidelines

State: Minnesota
Number of sites: 60
Rotation: Corn Following Soybean
Non-Responsive Sites Not Included

Nitrogen Price ($/lb): 0.80
Corn Price ($/bu): 6.01
Price Ratio: 0.13

MRTN Rate (lb N/acre):	**103**
Profitable N Rate Range (lb N/acre):	96 - 110
Net Return to N at MRTN Rate ($/acre):	$221.51
Percent of Maximum Yield at MRTN Rate:	98%
UAN (28% N) at MRTN Rate (lb product/acre):	368
UAN (28% N) Cost at MRTN Rate ($/acre):	$82.40

Most profitable N rate is at the maximum return to N (MRTN).
Profitable N rate range provides economic return within $1/acre of the MRTN.



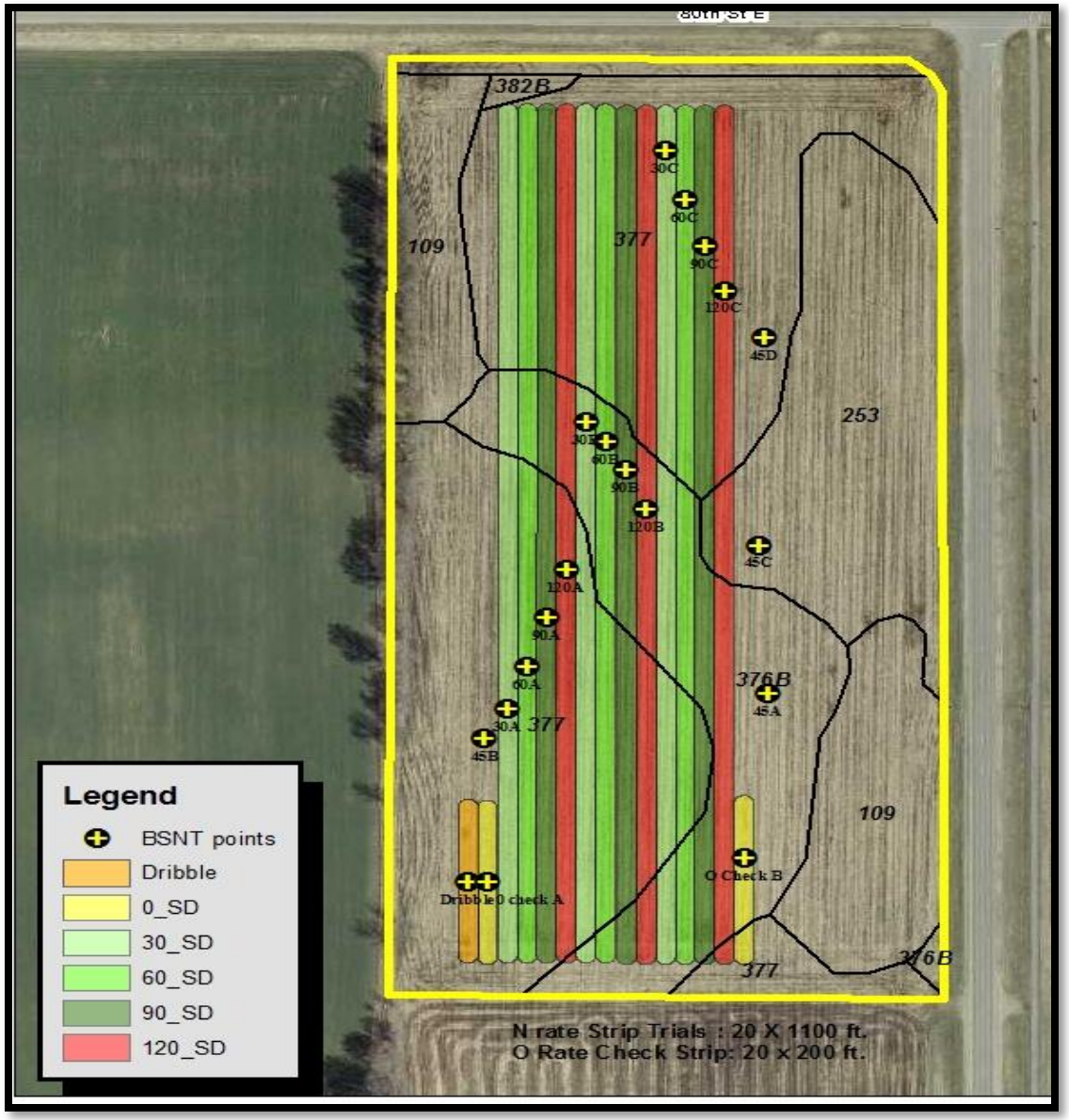
http://extension.agron.iastate.edu/soilfertility/nrate.aspx

Basal Stalk Nitrate Testing

- **Sample points built in ArcGIS**
  - Trimble GPS Unit to navigate to points in the field
- **10 Stalks Per Strip = 1 Sample**
  - 8 inch Section
  - 6” off the ground
- **Ear Samples as Visuals**

Basal Stalk Nitrate Testing

- **After Black Layer (Maturity)**
- **2 Dominant Soil Types**
  - Merton Silt Loam 377 (1-3 % Slope)
  - Moland Silt Loam 376B (1-4% Slope)
- **Each Individual Strip Sampled**
  - Rest of field sampled



Methods: Sampling

- Soil Samples – 2 samples per replicate
  - Test for % Soil Moisture, SOM, NO_3-N,NH_4, PO_4-P
- Stalk Nitrate
  - Mature Corn -> Black layer
  - 6-14” above ground
- Soil Respiration & Corn Moisture
- C:N and Stable Isotope
- Yield Data

Corn/Soybean

Results (Averages)

Strip ID (sidedress)	Total N (lbs)	Moisture (%)	Test Weight	Yield (Bu/ac)	BSNT (ppm)
30	75	14.2	57.0	159	79
60	105	14.3	57.1	175	167
90	135	14.3	57.1	179	900
120	165	14.2	57.3	185	404

Rest of Field

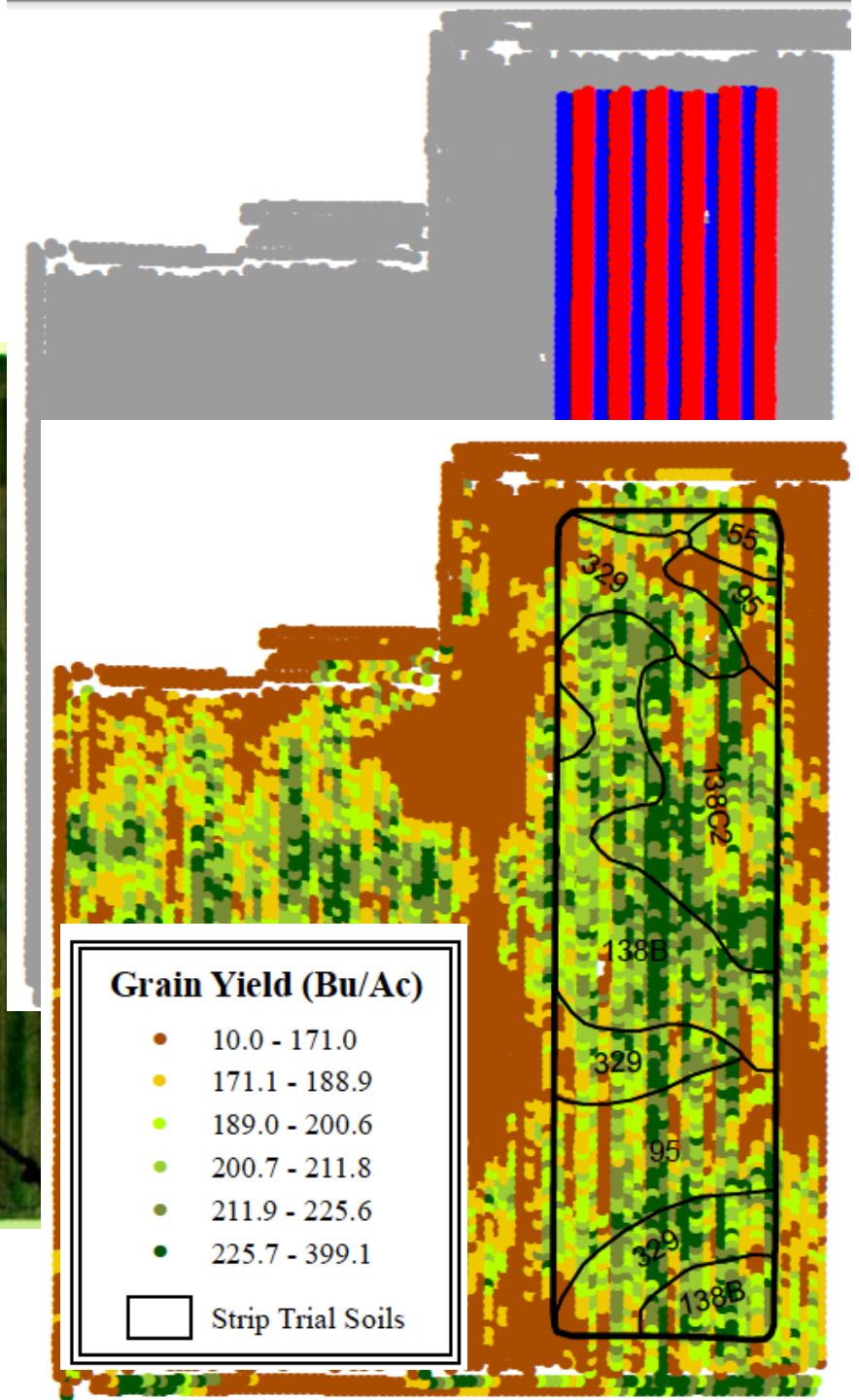
BSNT: 97 ppm

Yield: ??

Results

Total N (lbs)	Sidedress (lbs) *(Increase from 75 lbs)*	Strip Yield (Avg)	*Yield Increase (bushels)	Yield Benefit	N cost	Return to N *(Yield Increase x Corn $) - (SD increase x N cost/lbs)*
75	NA	159	NA	NA	NA	NA
105 (BMP Rate)	30	175	17	$102	$24	$78
135	60	179	20	$120	$48	$72
165	90	185	26	$156	$72	$84

Iowa On-Farm Network Trials



2013 St. Olaf Research

Professor Kathleen Shea

Ellen Squires, Nitrogen research

Megan Exner, Nitrogen research

Alex Bauch, Soil quality/macroinvertebrates

2013 Corn Field Study

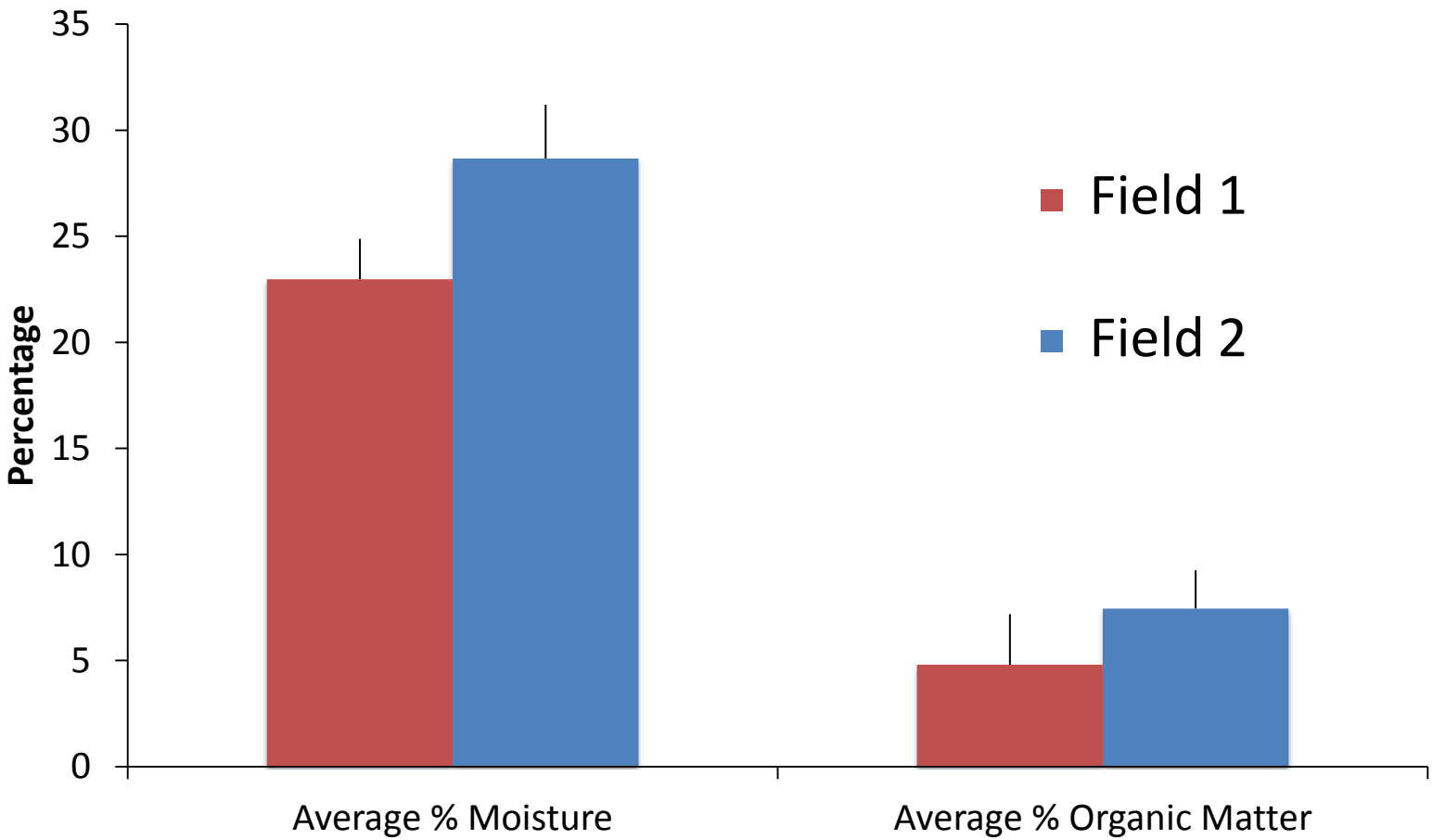
Field 1	Field 2
Conservation/Conventional tillage Most crop residues left on field	Strip tillage Crop residues left on field

Both applied
1 flat rate and 1 variable rate
of nitrogen

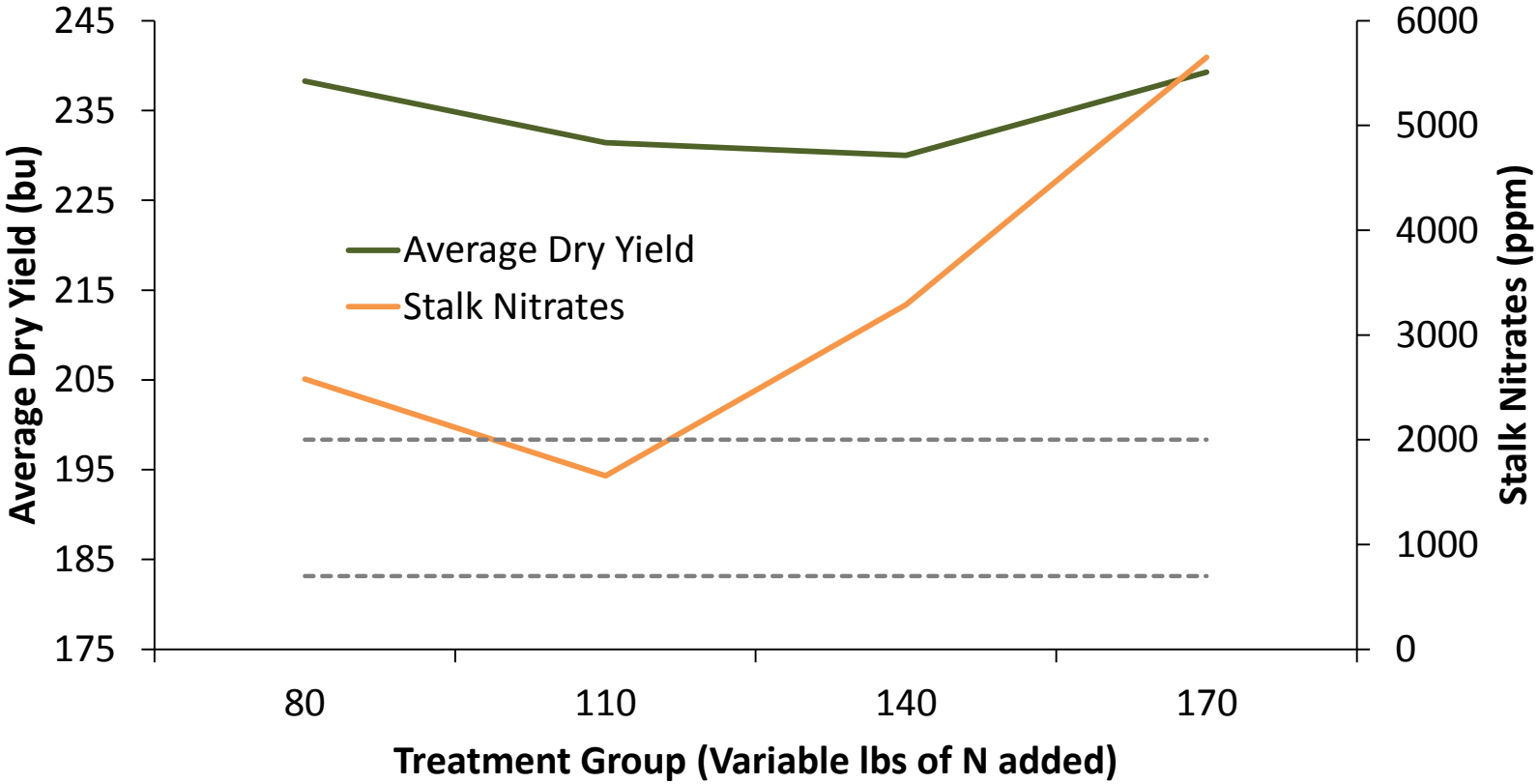
Objectives

1) Compare tillage methods in terms of soil characteristics
2) Compare nitrogen application in terms of yield, soil characteristics, and stalk nitrate levels

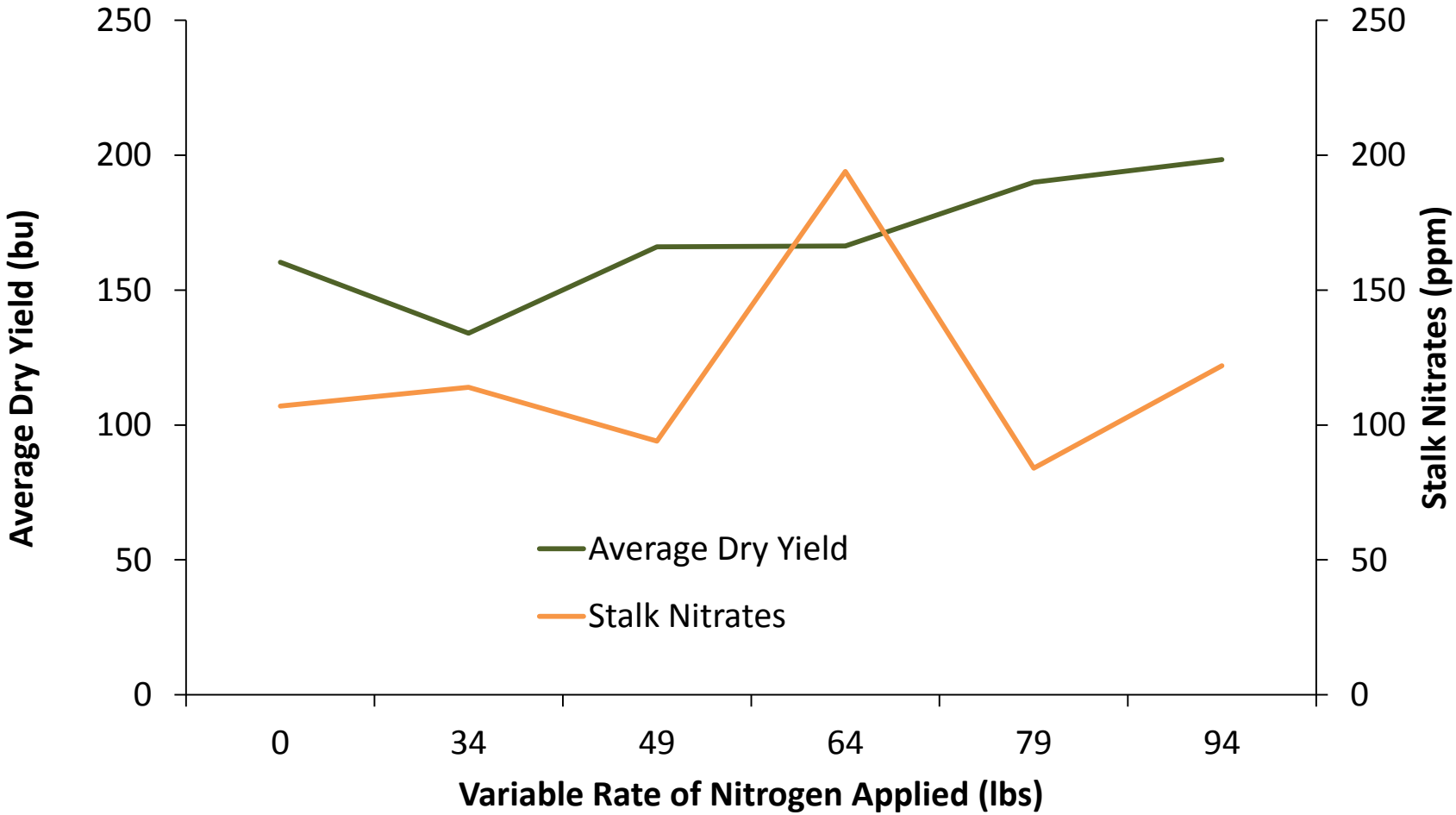
Soil Characteristics



Conservation/Conventional Tillage Yield and Stalk Nitrates



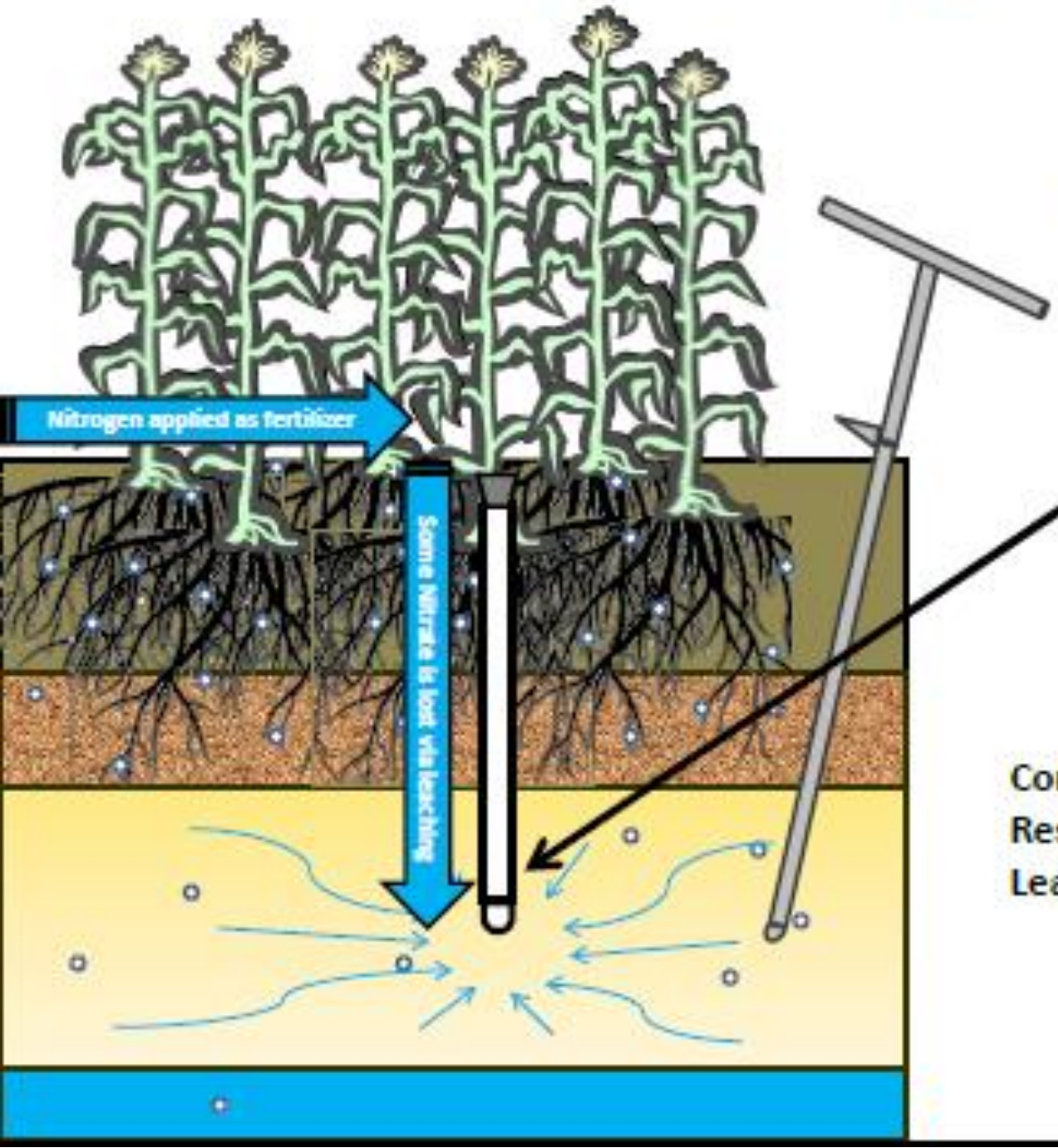
Strip Tillage Yield and Stalk Nitrates



Summary

- Strip tillage had higher % moisture and organic matter
- The conservation/conventional tillage field may have applied more than the necessary amount of nitrogen in all treatment plots
- Possibly, the strip tilled field lost some nitrogen due to heavy rains
- Difficult to set appropriate nitrogen targets

Understanding Potential Impacts to Groundwater



How?

- **Deep Nitrate Soil Testing**
  (In Season & After Harvest)

  (4 ft.)

- **Suction Tube Lysimeters**
  (In Season)

  (Pull water from 4-6 ft.)

Comparing Crop Nitrogen Rates, Responses, and the associated Leaching losses to Groundwater

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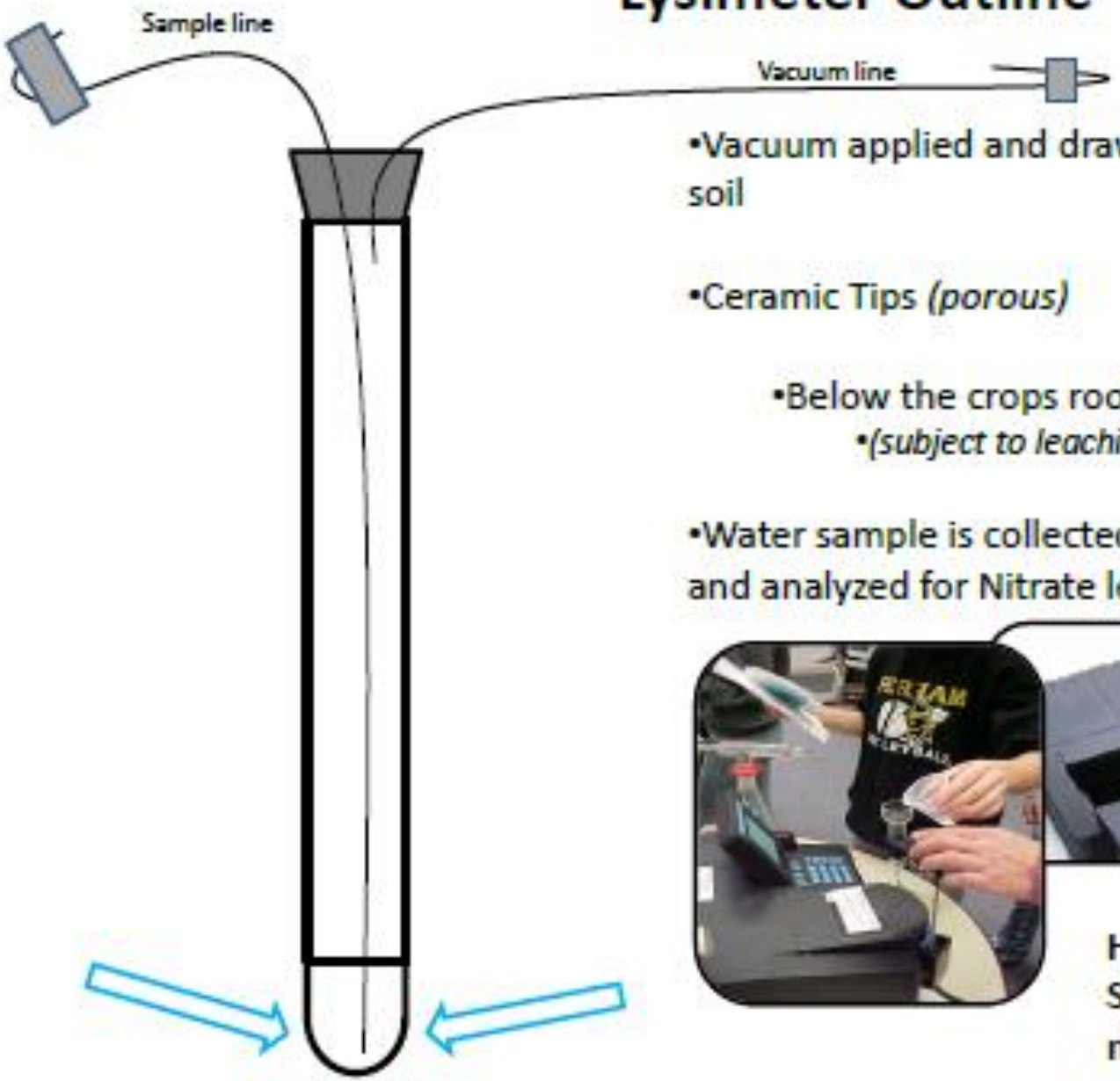
Lysimeter Outline



- Vacuum applied and draws water out of the soil
- Ceramic Tips *(porous)*
  - Below the crops root zone
    - *(subject to leaching)*
- Water sample is collected through sample line and analyzed for Nitrate levels

Hach UltraViolet Spectrophometer for nitrate analysis

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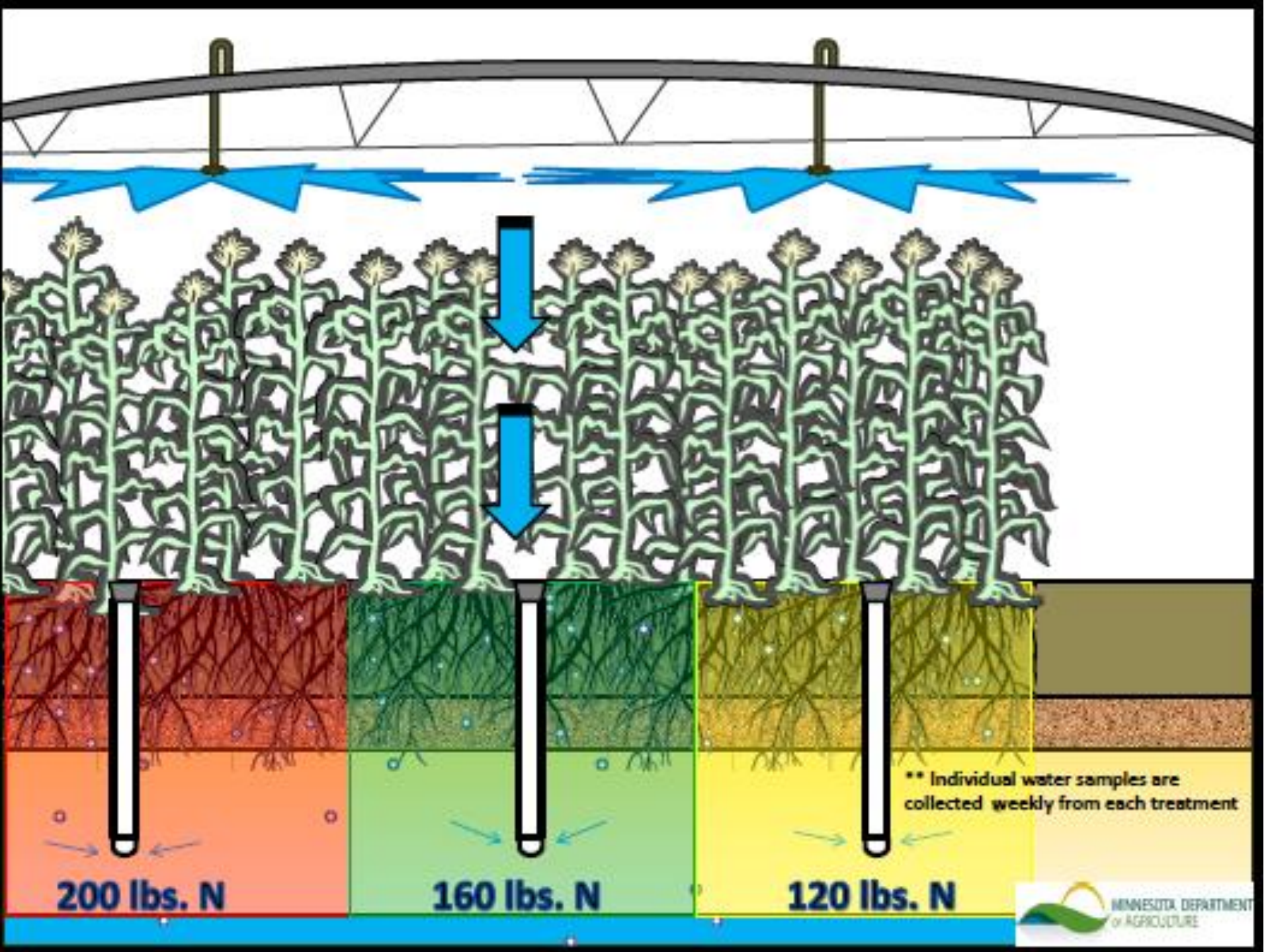
Water Samples Collected Weekly under each N Rate


** Individual water samples are collected weekly from each treatment
200 lbs. N
160 lbs. N
120 lbs. N
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How do we bring about change in agriculture?

Minnesota Discovery Farms:

Centralized research done by

U of M, MN Dept of Agriculture,

Sponsored by commodity groups and agriculture agencies.

Excellent science but remote from individual farmers.

Decentralized research

- Scientific research done on individual farms.
- Resource issues are chosen by each farm operator.
- Economic outcomes may drive decision making.
- Environmental benefits can be proven.
- Each producer “owns” his/her data.
- Data proves the effectiveness of practices.
- Authentic results on “my soil”.
- Who can make this happen?

COLLABORATIVES


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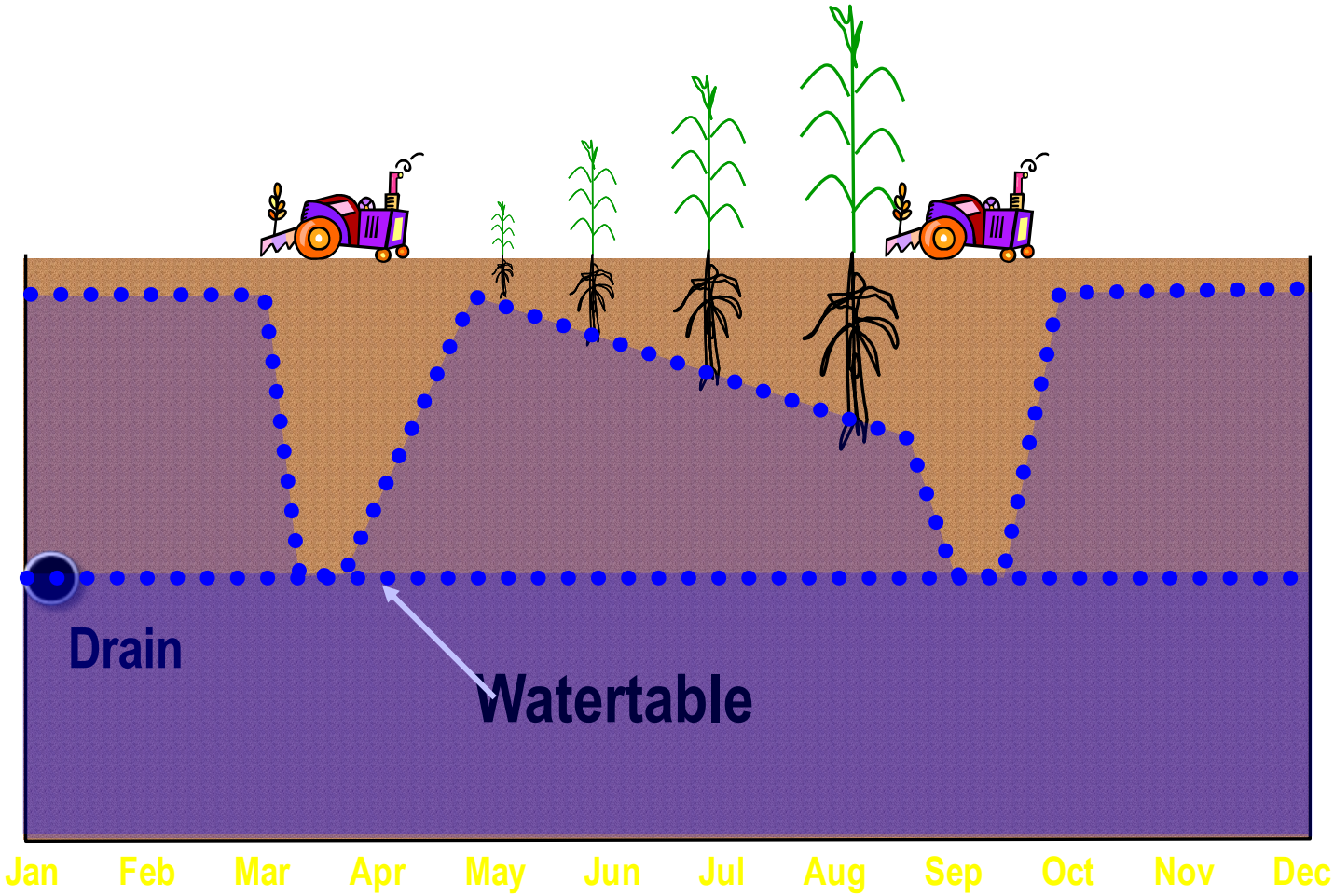
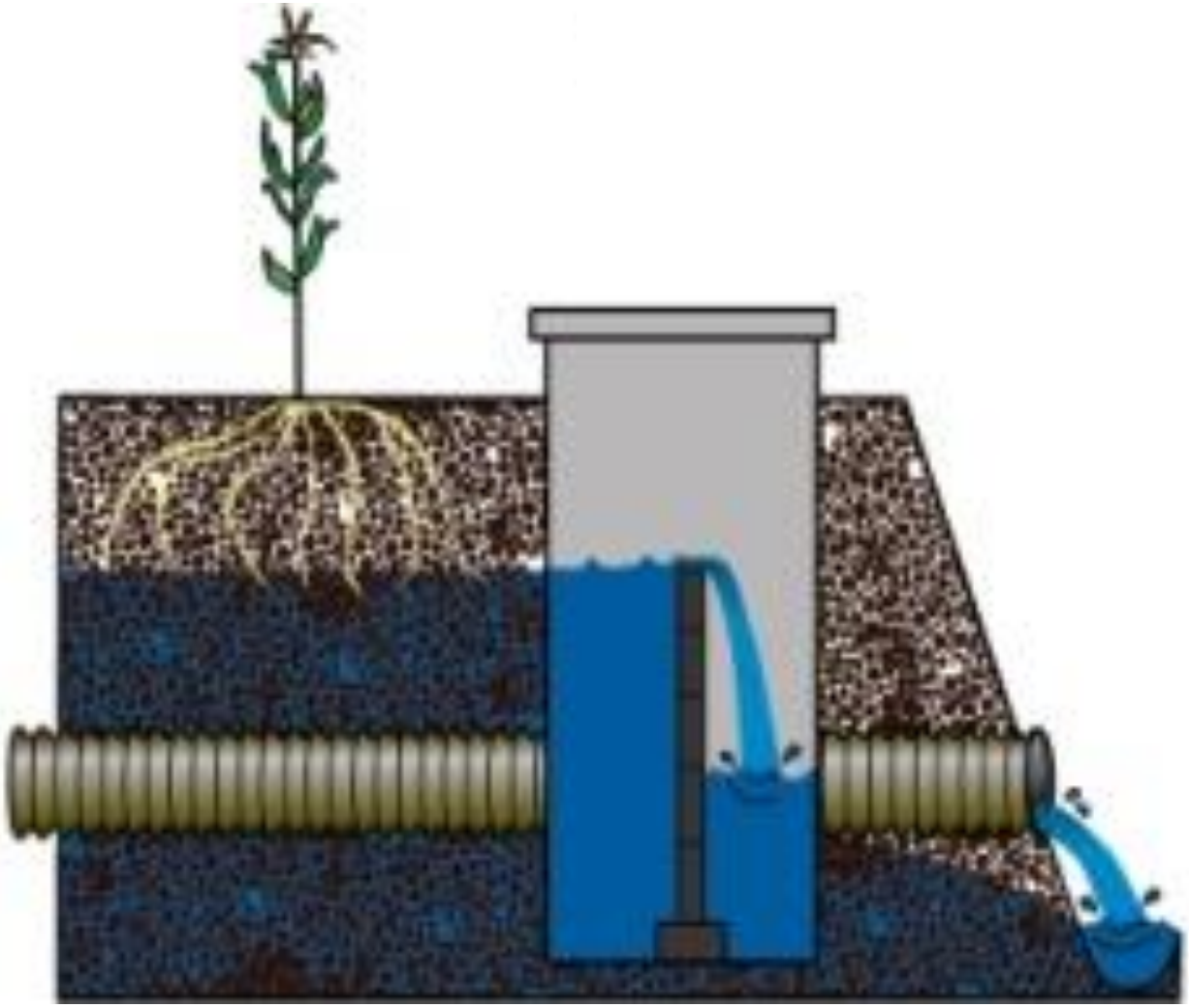
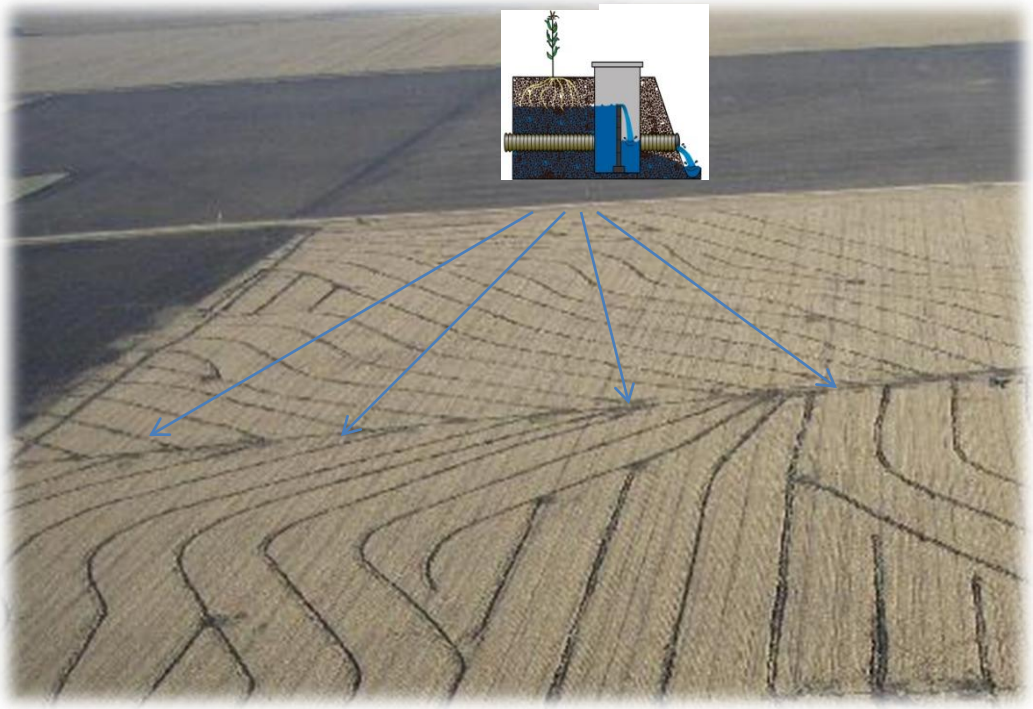
Drainage Water Management





Subsurface Drainage Practices

- Drainage water management
- Better drainage design



Mower County Surge Basin Near Grand Meadow.


Mower County Site Retention Basin Near Ostrander

Tile flow from subsurface drainage divereted into a trench of woodchiops. Routed in and out with one structure.

Site, one month after construction.

Bioreactor receiving 66 acres, 10 by 75 ft excavated area.

How do we value good groundwater in agriculture?

Well water for ag uses.

Fertilizer efficiency relates to less groundwater pollution.

$ Better bottom line $

The Learning Curve

On-farm research promotes producers improving practices.

Look at other state's initiatives and learn from them.

As aid from government programs retracts, build collaboratives, seek support from a wide variety of sources.