Review of Recent NDSU Fertilizer Recommendation Changes

The 25th Soil and Soil Water Workshop

2020

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Soil Fertility Emphasis

Yield and N rate are independent between fields.

First published from work with active-optical sensors at Oklahoma State University

Implied in the 'RETURN TO N' economic production functions used by NDSU and other mid-west states beginning in 2005

Sawyer and Nafziger, 2005-

RETURN TO N model-

Integrates yield response to N with economics of the application. Recommendations are not necessarily linked to a 'yield goal'. Assumes the grower is going for as much yield as economically practical. Categories known to affect yield are treated separately.

(EONR, MRTN)

Rates and Charts

Options

CHART SIZE

- Small
- Medium
- Large

DISPLAY CHARTS

- [x] Return to N
- [ ] % of Max Yield
- [ ] EONR Frequency
- [ ] EONR vs. Yield

HELP

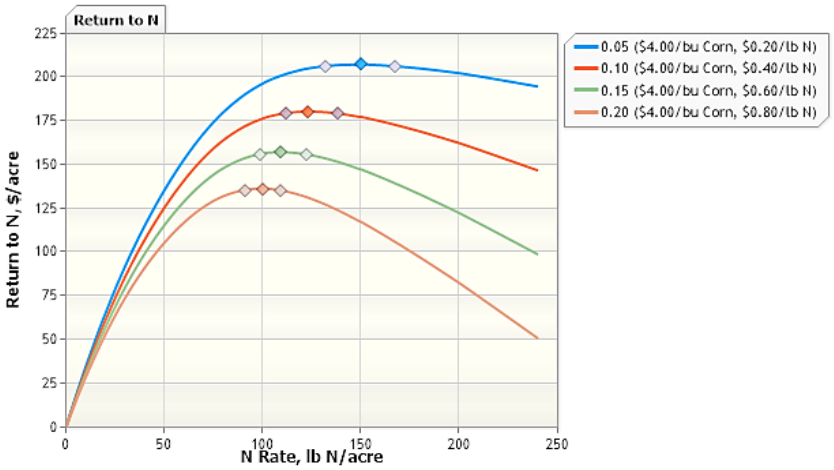
Definitions
Calculated Values

RECALCULATE

RETURN TO INPUT

State: Minnesota
Number of sites: 98
Rotation: Corn Following Soybean

N Price ($/lb N):	$0.20	$0.40	$0.60	$0.80
Corn Price ($/bu):	$4.00	$4.00	$4.00	$4.00
Price Ratio:	0.05	0.10	0.15	0.20
MRTN Rate (lb N/acre):	150	123	109	100
Profitable N Rate Range (lb N/acre):	131 - 166	111 - 137	98 - 121	90 - 108
Net Return to N at MRTN Rate ($/acre):	$207.46	$180.51	$157.26	$136.49
Percent of Maximum Yield at MRTN Rate:	99%	98%	97%	97%
Anhydrous Ammonia (82% N) at MRTN Rate (lb product/acre):	183	150	133	122
Anhydrous Ammonia (82% N) Cost at MRTN Rate ($/acre):	$30.00	$49.20	$65.40	$80.00



Welcome to the

North Dakota Wheat Nitrogen Calculator

You will need to know the location of the farm, the general productivity of the soils, the price you contract for wheat, the cost per pound of N, the soil test nitrate-N to a depth of 2-feet, and the previous crop.

Please select the location of the farm. The map of North Dakota on this site will help you determine the region of the farm. ***Click on the map for a detailed view.***

- (•) Eastern North Dakota
- ( ) Western North Dakota
- ( ) Langdon Region

1

Low productivity is defined in Eastern ND as historical yields below 40 bushels per acre

Medium productivity is defined in Eastern ND as historical yields from 41 to 60 bushels per acre

High productivity is defined in Eastern ND as historical yields over 60 bushels per acre

Please select the historical productivity of the farm from the options below.

- (•) Low Productivity
- ( ) Medium Productivity
- ( ) High Productivity

2

Select Nearest Wheat Price ($/bushel) $5.00

Please indicate the crop previously planted in the field.

- (•) No Nitrogen-supplying crop
- ( ) Soybean, Field Pea, Dry Bean, Lentil, Chickpea, or harvested Sweet Pea
- ( ) Sugarbeet with yellow-green leaves
- ( ) Sugarbeet with green leaves
- ( ) Harvested Alfalfa or unharvested Sweet Clover (&#062 5 plants/sq-ft)
- ( ) Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
- ( ) Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
- ( ) Harvested Alfalfa or unharvested Sweet Clover (&#060 1 plants/sq-ft)

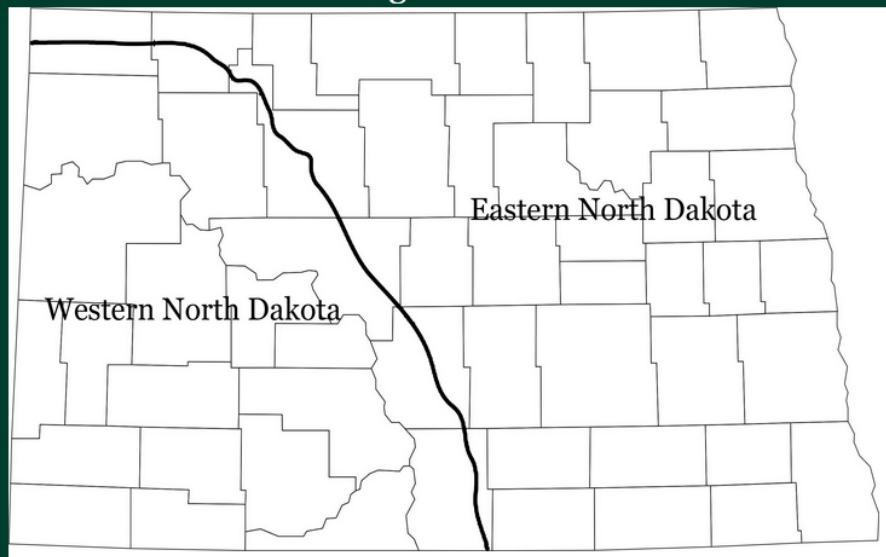
Nitrogen provided by previous crops: 0

Please indicate the previous tilling method used in the field.

Conservation Tillage Conf | NDSU Corn Nitrogen Calc

www.ndsu.edu/pubweb/soils/corn/

North Dakota Corn Nitrogen Calculator



Region:
West River:
Eastern ND:

Field Information (If in Eastern ND):
- No-Till for 6+ Years
- Irrigated Corn
- Conventional Till/Minimal No-Till
  - Conventionally-Tilled
  - No-Till for 1-5 years
    - High-Clay Soils
      - Historic Yield > 160 bu/a
      - Historic Yield less than 160 bu/a
    - Medium-Texture Soils
      - Historic Yield > 160 bu/a
      - Historic Yield less than 160 bu/a

Input Nearest Corn Price ($/Bushel):	2.00
Input Nearest Nitrogen Cost ($/Pound):	0.20
Soil Test for Nitrogen Analysis (lbs/acre 2-ft depth):	0.0
Percent Organic Matter In Soil:	0.0

Nitrogen Recommendation: 0
plus/minus 30 lbs.

Previous Crops Planted

- (•) No nitrogen-supplying crop
- ( ) Soybean, Field Pea, Dry Bean, Lentil, Chickpea or harvested Sweet Pea
- ( ) Sugarbeet with yellow-green leaves
- ( ) Sugarbeet with green leaves
- ( ) Harvested Alfalfa or unharvested Sweet Clover (>5 plants/sq-ft)
- ( ) Harvested Alfalfa or unharvested Sweet Clover (3-4 plants/sq-ft)
- ( ) Harvested Alfalfa or unharvested Sweet Clover (1-2 plants/sq-ft)
- ( ) Harvested Alfalfa or unharvested Sweet Clover (less than 1 plant/sq-ft)

The data used in development of the North Dakota Corn Nitrogen Calculator was gathered with funding from the North Dakota Corn Council, the International Plant Nutrition Institute, and Pioneer Hi-Bred, Int. Data was gathered by Dr. Dave Franzen, lead investigator, with collaboration from Roger Ashley, Greg Endres, Jasper Teboh, Lakesh Sharma, Honggang Bu, Brad Schmidt and Eric C. Schultz. Dr. John Lamb,

12:38 PM
12/14/2014

2017-roundup-schedule | ND Sunflower Nitrogen | How to Take Screenshots

https://www.ndsu.edu/pubweb/soils/sunflower/

Apps | Stuffed Bell Peppers | United Airlines – Airlines

North Dakota Sunflower Nitrogen Calculator

Select A Region From The List Below:

- Eastern North Dakota
- Western North Dakota
- Langdon Area

Select Tillage From The List Below:

Conventional Till (Tillage greater than 2 inch depth, thin ammonia shank or striptill shank, does not contribute to conventional till)
- Oil-Seed
- Confection

Long-Term No-Till (6 years or more continuous no-till)
- Oil-Seed
- Confection

Short-Term No-Till (1-5 years of continuous no-till)
- Oil-Seed
- Confection

Select Previous Crop Credits From The List Below:

- No previous crop credits
- Soybean, Dry Bean, Field Pea, Lentils, Chickpea, Sweet Clover
- Alfalfa stand greater than 5 plants per square foot
- Alfalfa stand from 3 to 4.9 plants per square foot
- Alfalfa stand from 1 to 2.9 plants per square foot
- Alfalfa stand less than 1 plant per square foot
- Sugar beet with yellow leaves at harvest
- Sugar beet with yellow-green leaves at harvest
- Sugar beet with dark green leaves at harvest

Sunflower Price:

Price Range From: ($0.09/lb to $0.30/lb)
Price Increments: ($0.03)

0.09

Nitrogen Cost:

Price Range From: ($0.20/lb to $1.00/lb):
Price Increments: ($0.10)

0.20

Percent Organic Matter In The Soil:

If organic matter is greater than 5.9% additional credits are considered.

Organic Matter Percentage:

0.0

Soil Test Nitrate-N (0-2 foot depth):

Whole Numbers: Zero to No-Limit, (No Decimal Values):

0

Nitrogen Recommendation:

Nitrogen Recommendation Preview:

0 plus or minus 20 pound N per acre.

Nitrogen Recommendation After Credits:

0 **plus or minus 20 pound N per acre.**

The final N recommendation is an average optimal rate. Your final N rate decision may be plus or minus 20 pounds N per acre from that value depending on individual field situations. The value assumes an optimal N application and timing strategy. If these strategies are not optimal, a greater N rate maybe needed. Suboptimal N application strategies include to early N application the fall prior to seeding, surface urea/UAN application or lightly incorporated urea/UAN, or shallow ammonia application. Fields that are first year sunflower, or sunflower more then 4 years after a deep rooted crop including sunflower may have have deep N, and a minimal N preplant application followed by side-dress application at V5-V8 is recommended.

Site developed by: Max McGrath, Date: Spring 2016
For: Dr. Dave Franzen, NDSU: Department of Soil Science

Ask me anything

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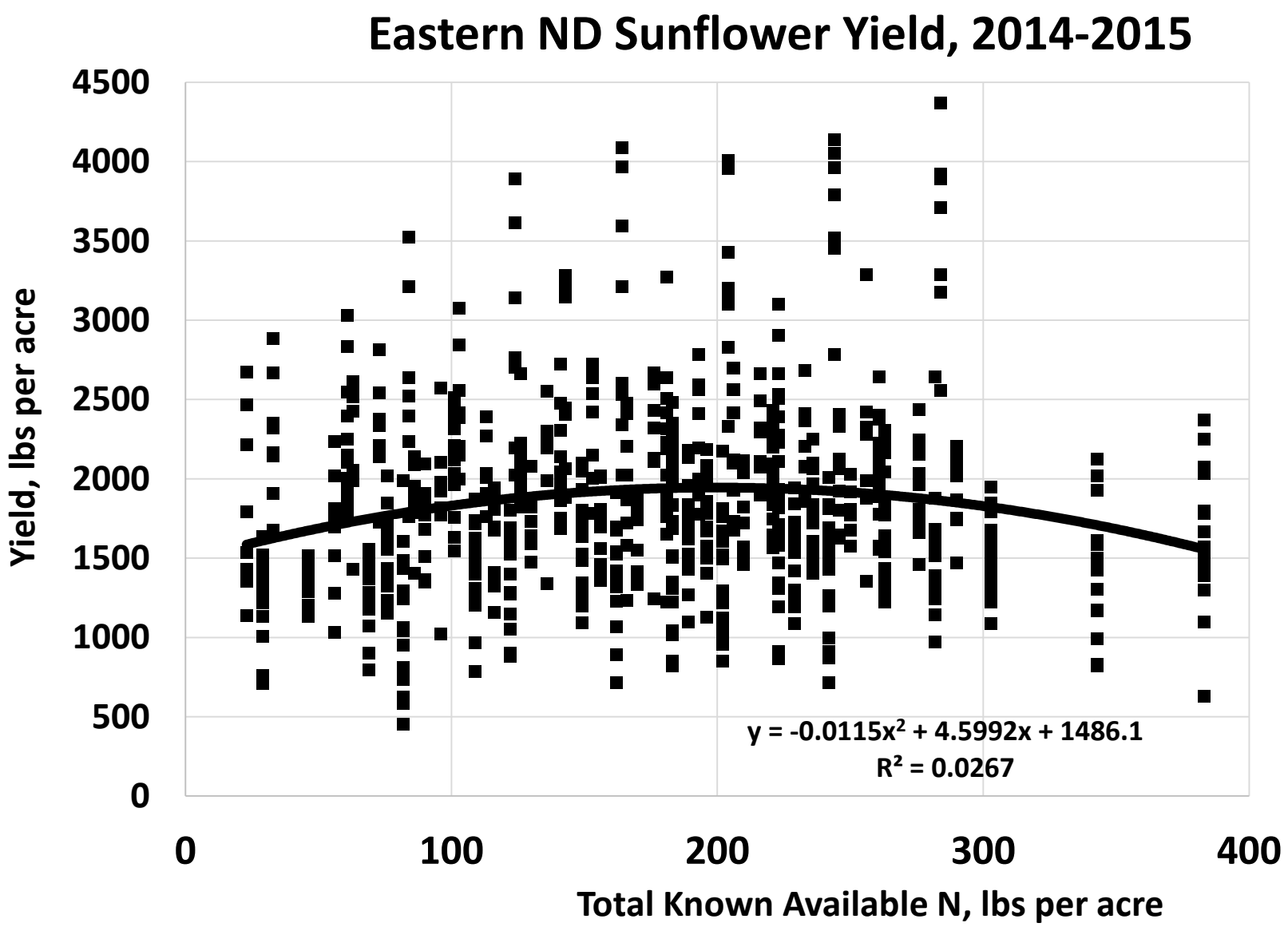
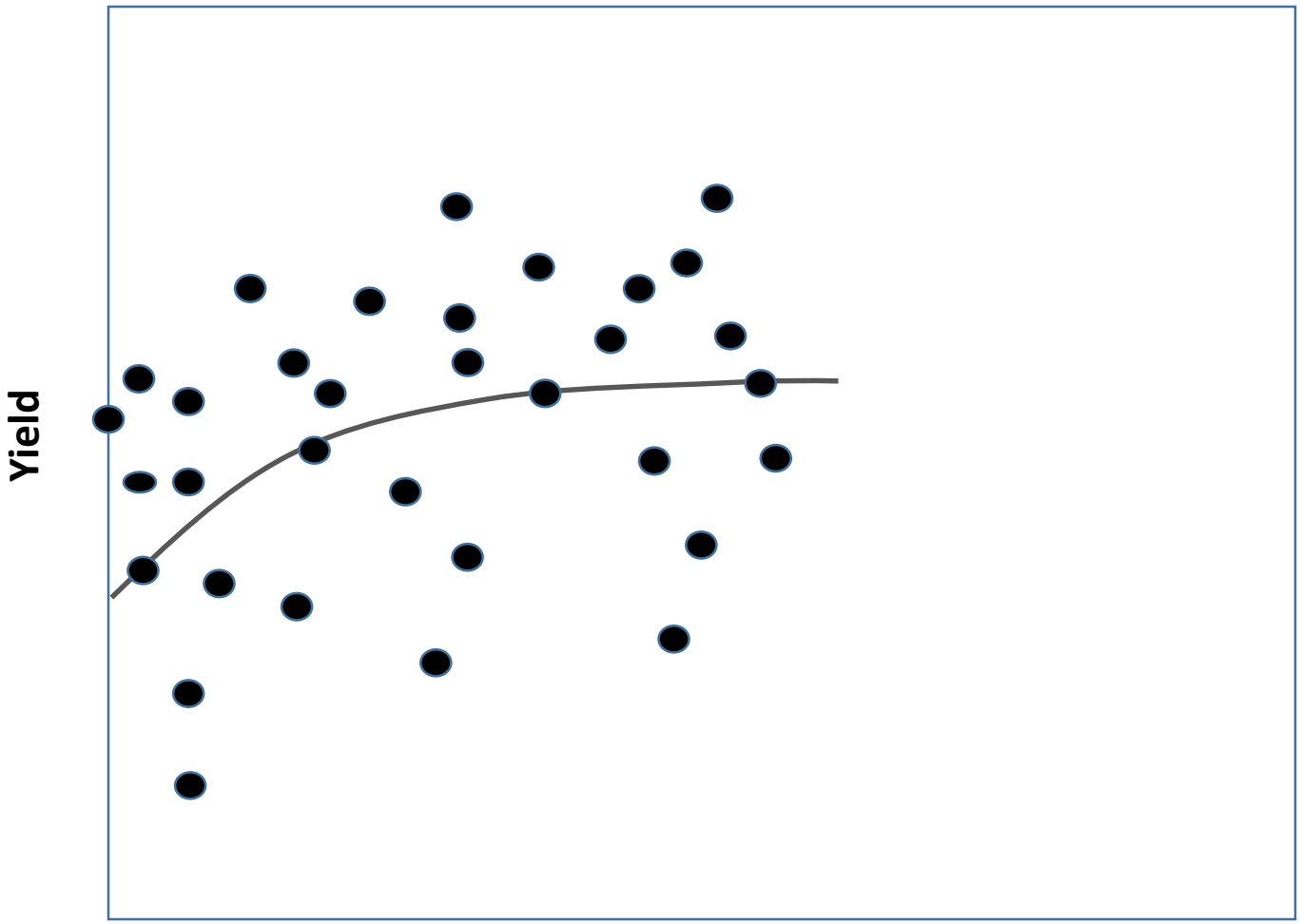
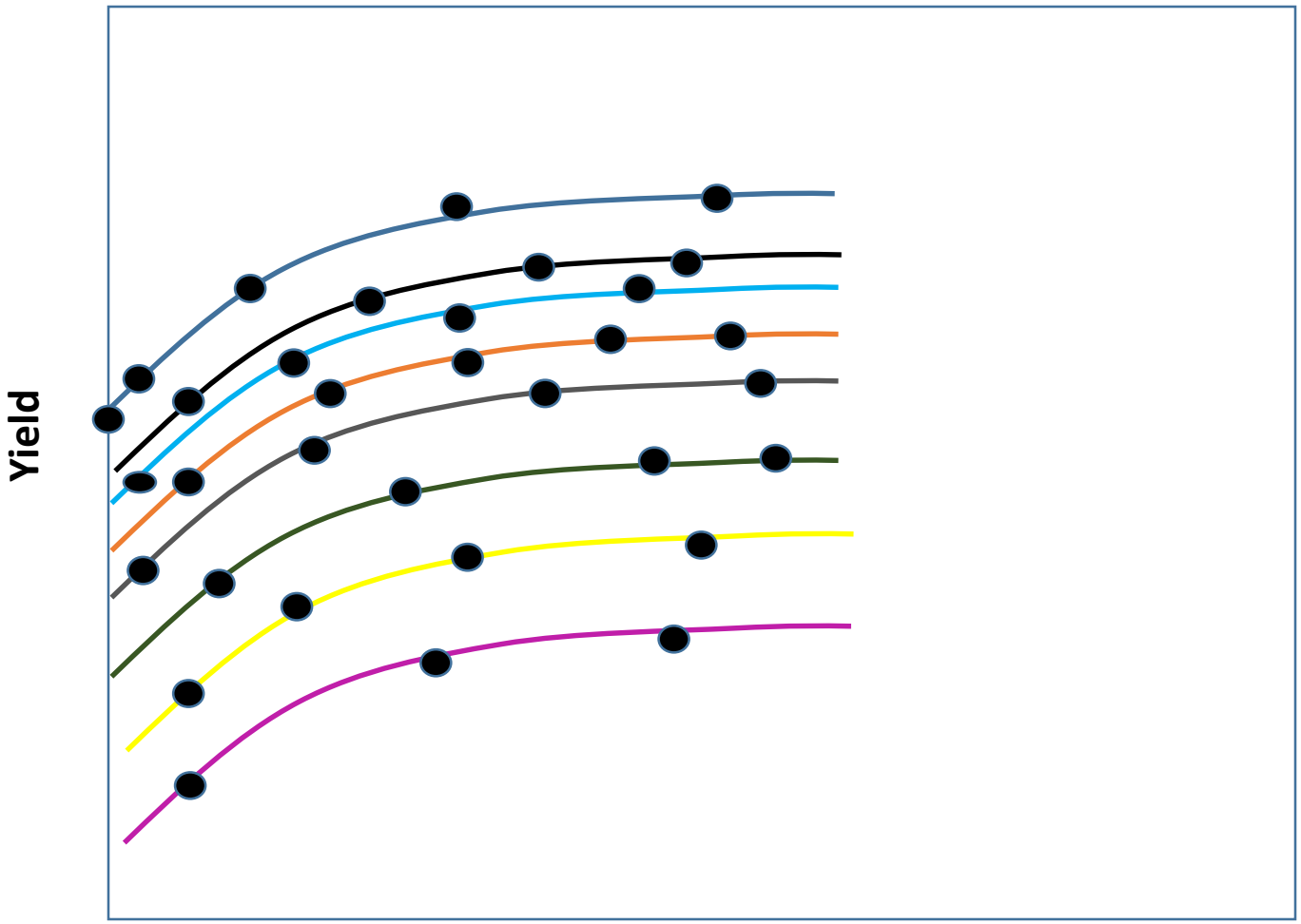
12/27/2016


Eastern ND Sunflower Yield, 2014-2015
Yield, lbs per acre
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
100
200
300
400
Total Known Available N, lbs per acre
y = -0.0115x² + 4.5992x + 1486.1
R² = 0.0267

Example-Combining all sites with actual yield at N rate looks like this



When it really looks like this-



To get a better idea of what the data look like without showing all the curves is to '*Standardize*' the data- putting it all in the same scale

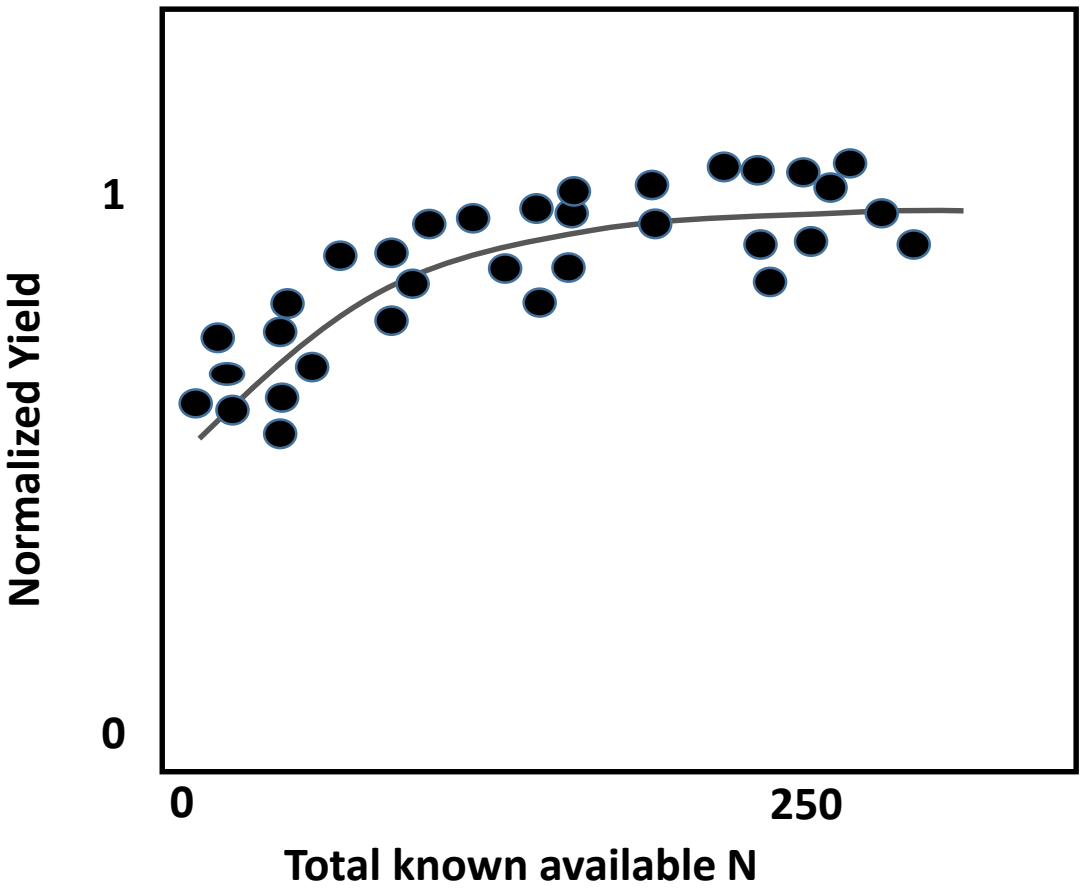
For example-

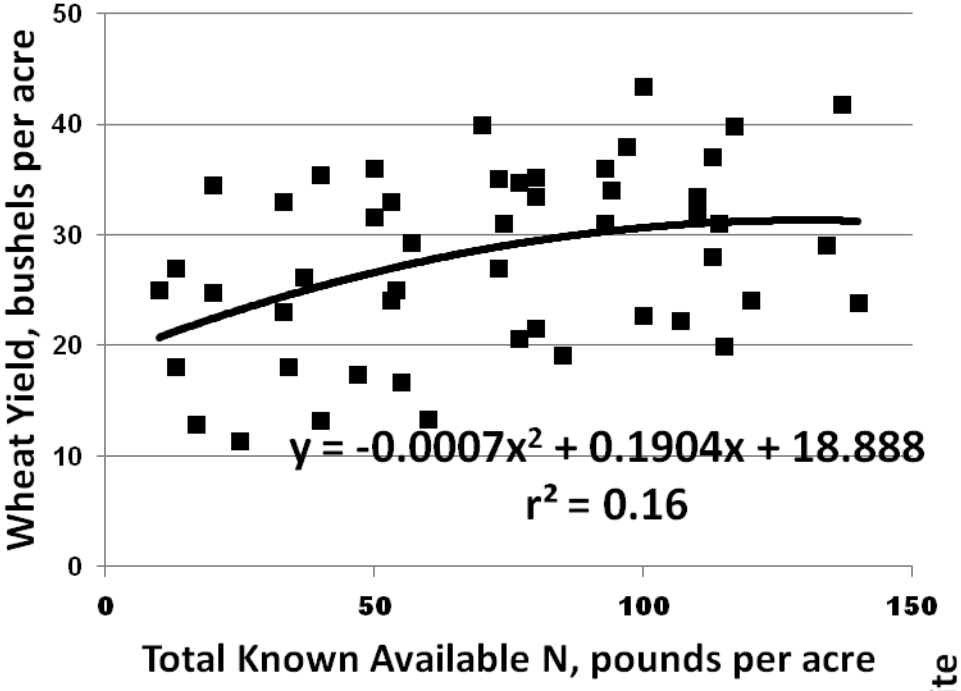
A sunflower site with high yield 4,000 lb/acre, divide all yields by 4,000, and we end up with values from 0 to 1

A sunflower site with high yield 1,800 lb/acre, divide all yields by 1,800, and we end up with values from 0 to 1

A sunflower site with high yield 2,500 lb/acre, divide all yields by 2,500, and we end up with values from 0 to 1

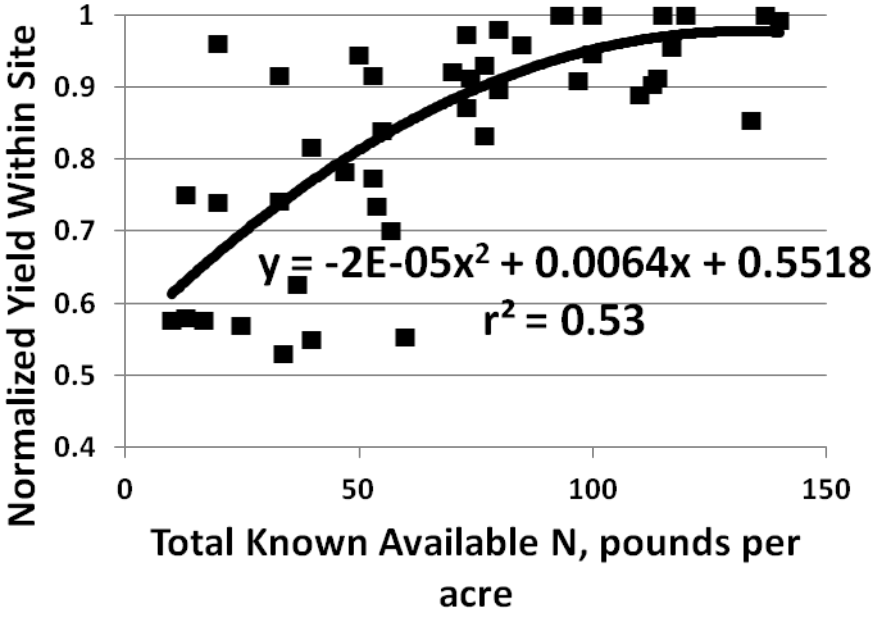
Standarding yields at all sites ends up looking like this-



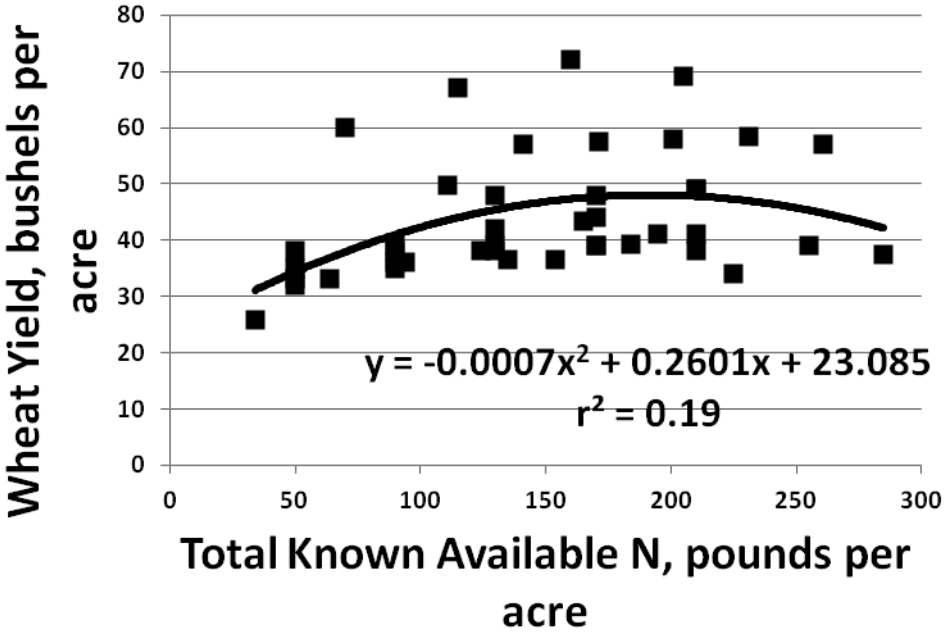


Western ND Conventional Till wheat sites raw yields

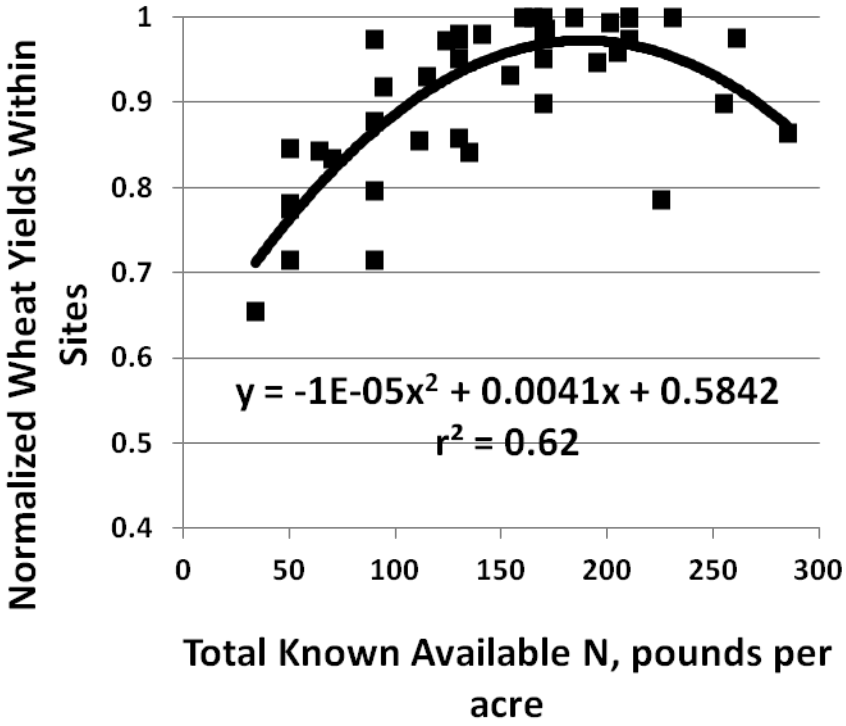
Western ND Conventional Till wheat sites, normalized yields

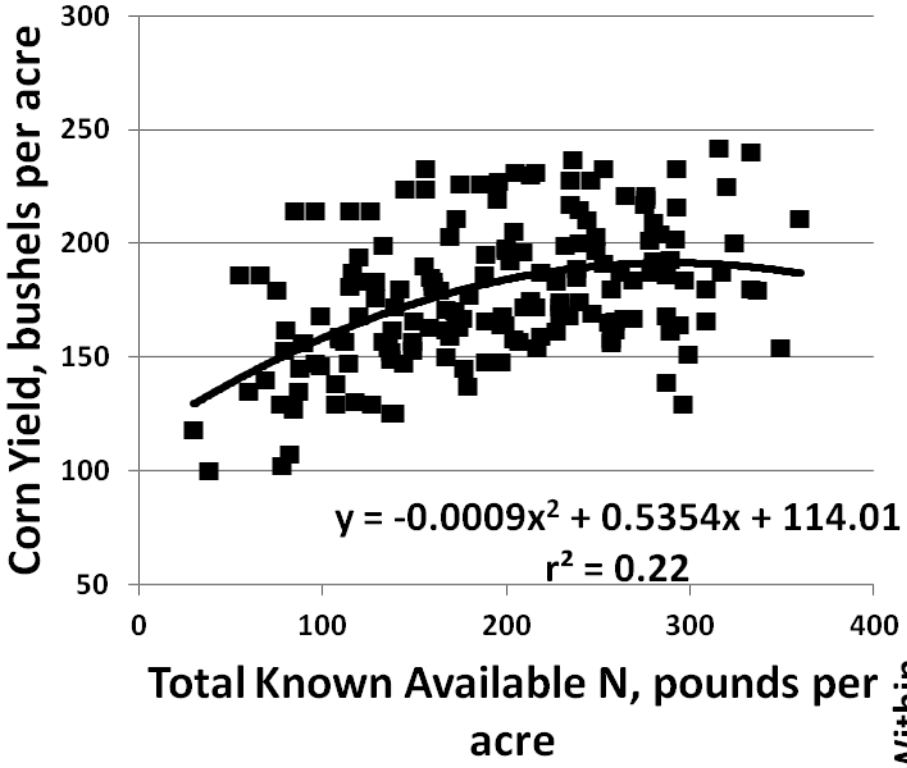


Western ND No-Till wheat sites raw yields



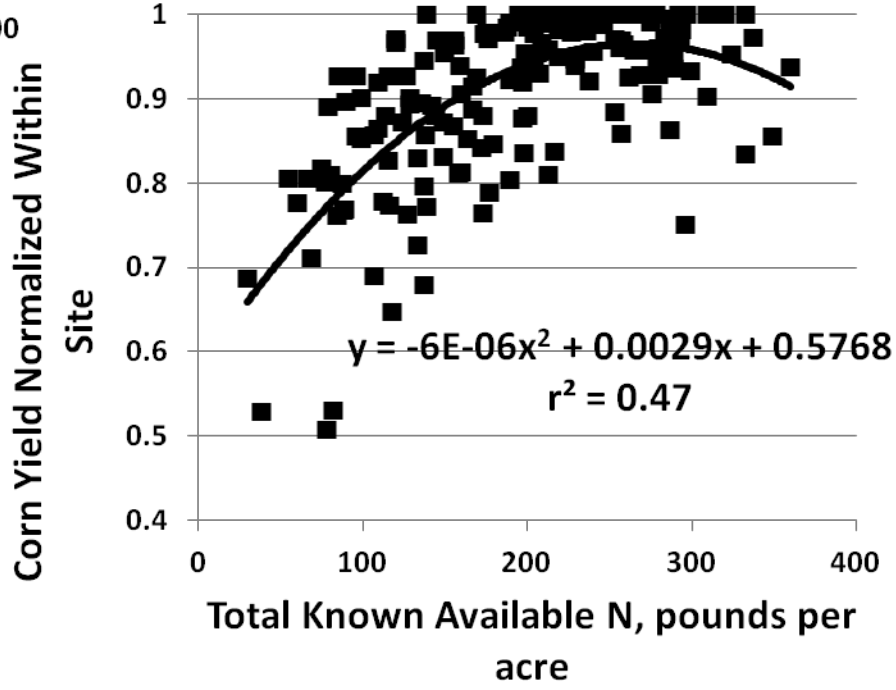
Western ND No-Till wheat sites normalized yields

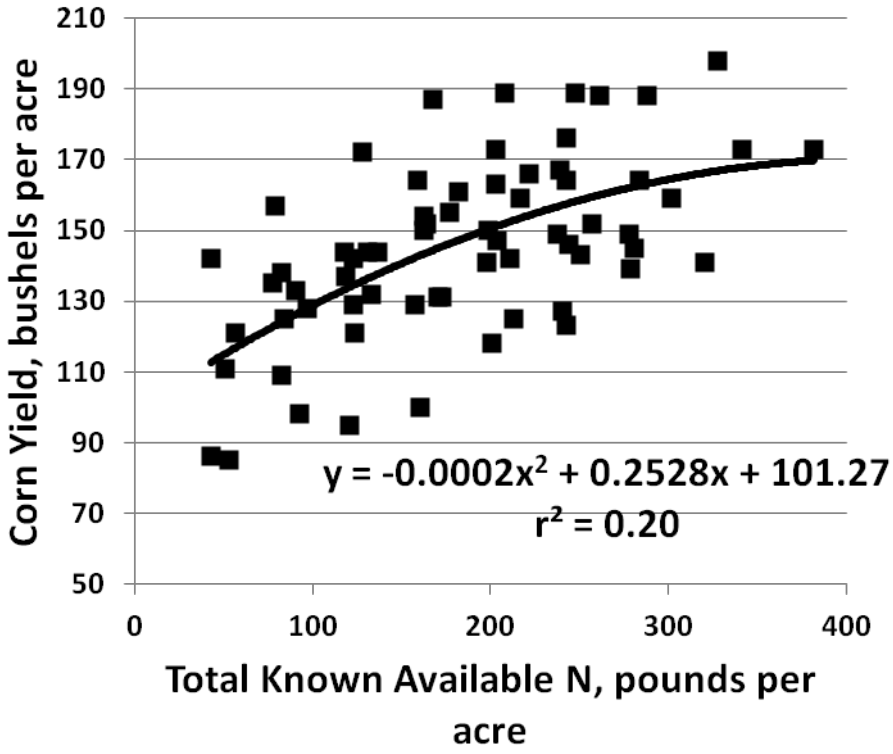




Eastern ND high-clay, Conventional Till, corn sites raw yields

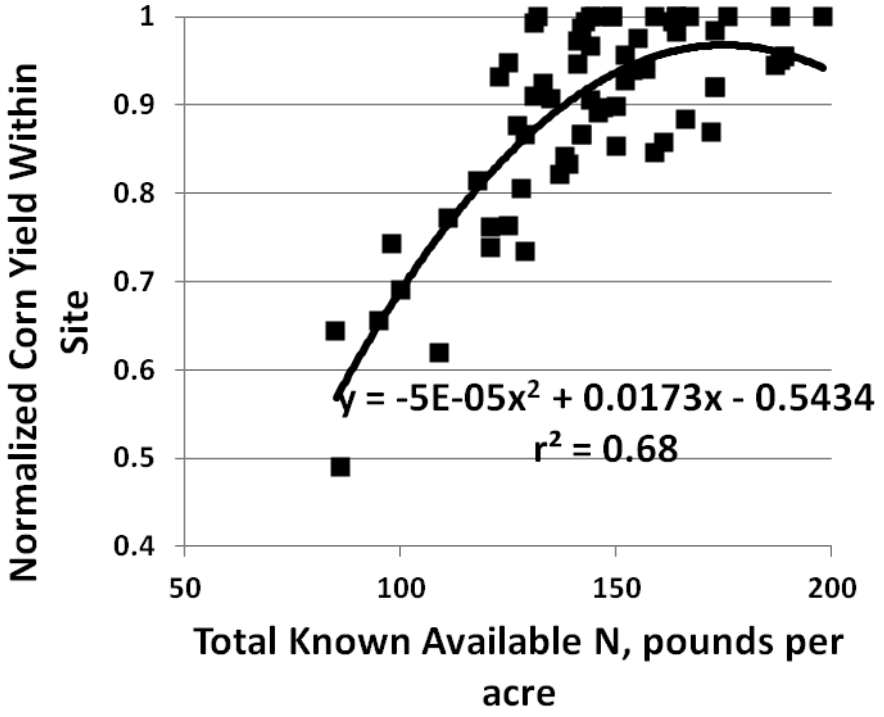
Eastern ND high-clay, Conventional Till, corn sites normalized yields



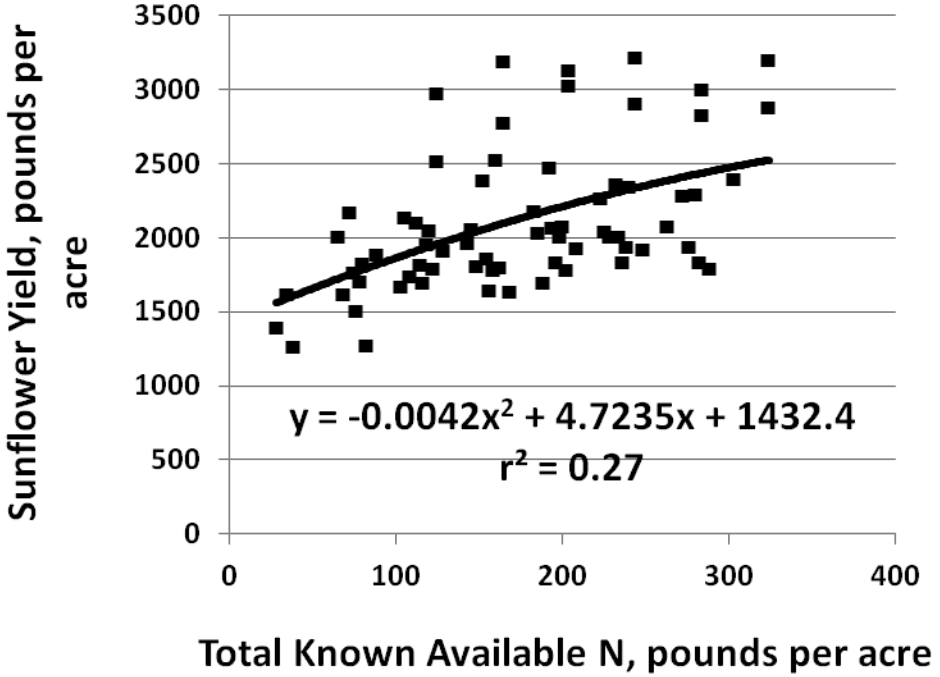


Eastern ND no-till, corn sites raw yields

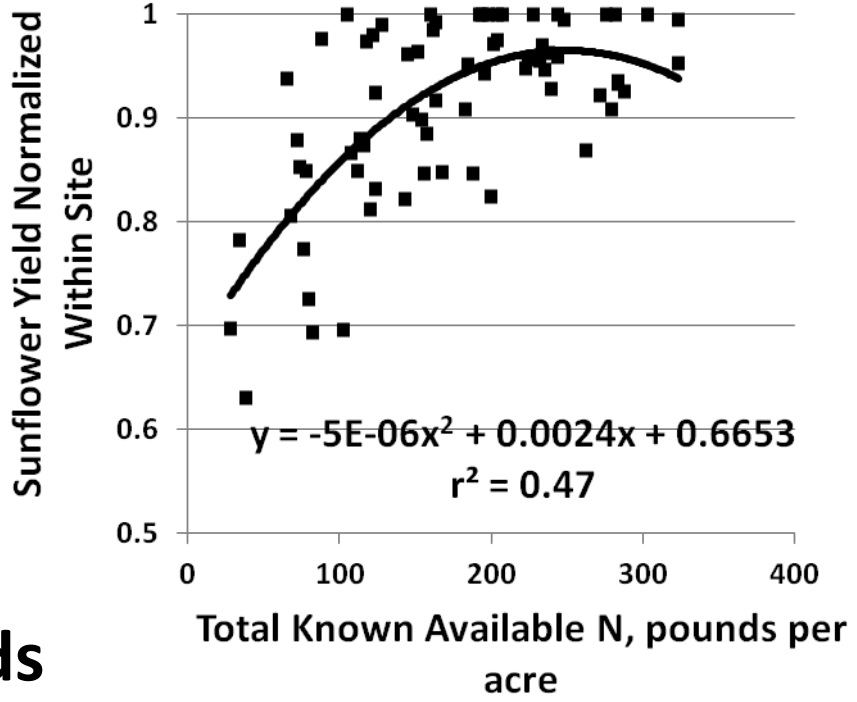
Eastern ND no-till, corn sites normalized yields



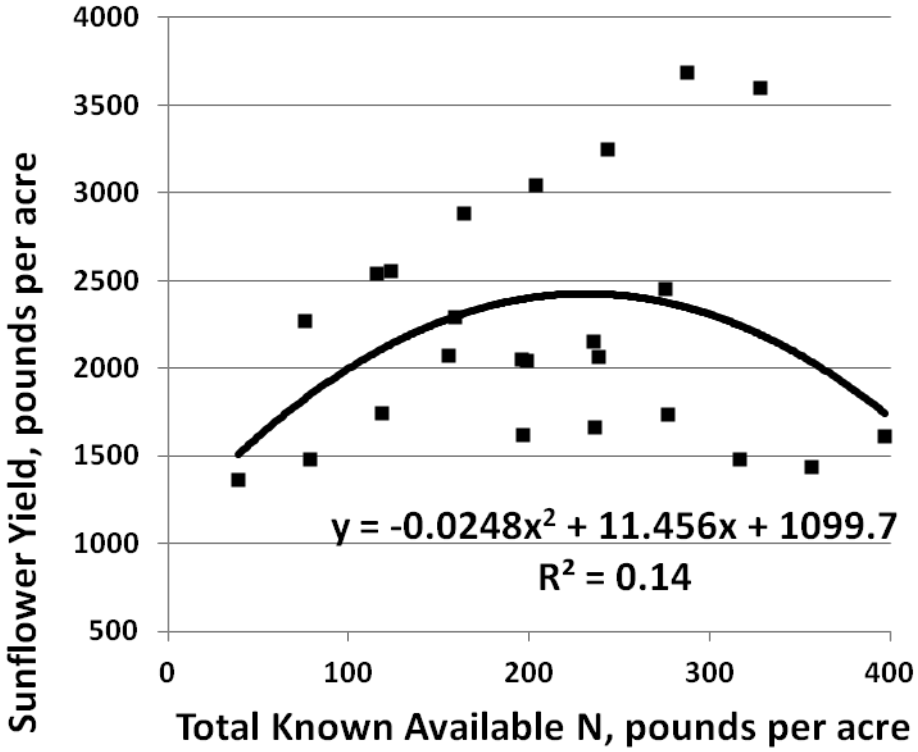
Western ND no-till, sunflower sites raw yields



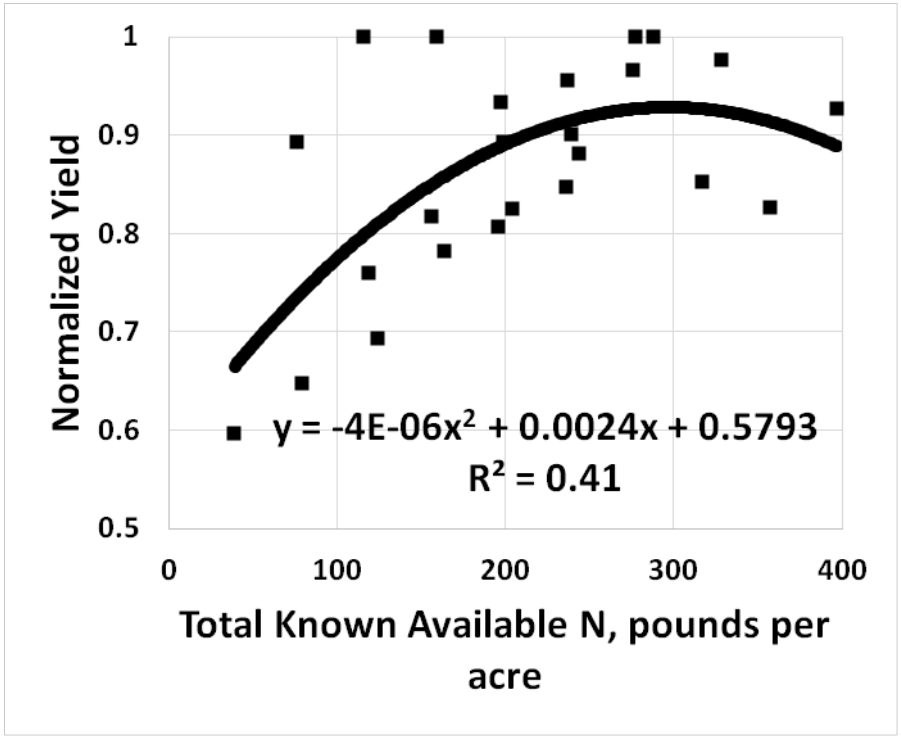
Western ND no-till, sunflower sites normalized yields



Eastern ND Conventional Till, sunflower sites raw yields



Eastern ND Conventional Till sunflower sites normalized yields



Low yield environment-

usually drier (sometimes excessive wetness)

Lower N use efficiency and crop uptake

Less N mineralization

High yield environment-

Moisture near ideal- not too wet or too dry

Higher N use efficiency and crop uptake

Greater N mineralization

Net result is that rate to produce economic max yield is similar in both environments.

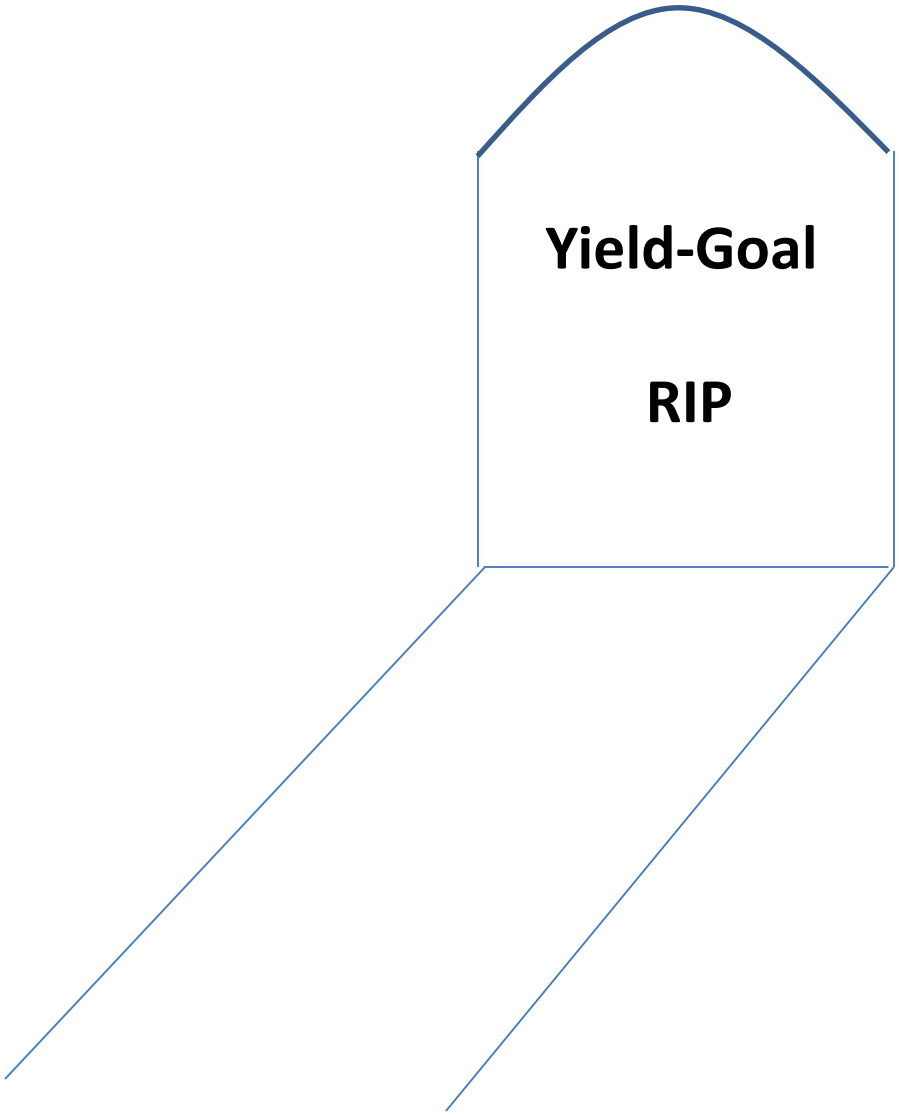
There is a new phone app for Android phones for the 3 N calculators.

Go to app store and search for North Dakota Crop Nitrogen Calculator and follow the instructions.

It's free to download.

We also have an app for IPhones-

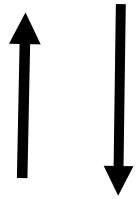
Go to the Iphone app store and look up
North Dakota Crop Nitrogen Calculator,
then follow instructions.


Yield-Goal
RIP

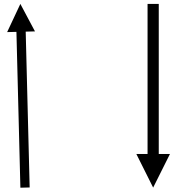
Modern K Recommendations for ND

What the textbooks state:

Available pool
(K on CEC) **(Plant available K)**



Slowly Available Pool
(K in clay interlayers) **(Maybe available over years)**



Unavailable Pool
(feldspars) **(Your Grandkids might benefit a little)**

K soil test method used in North Dakota-

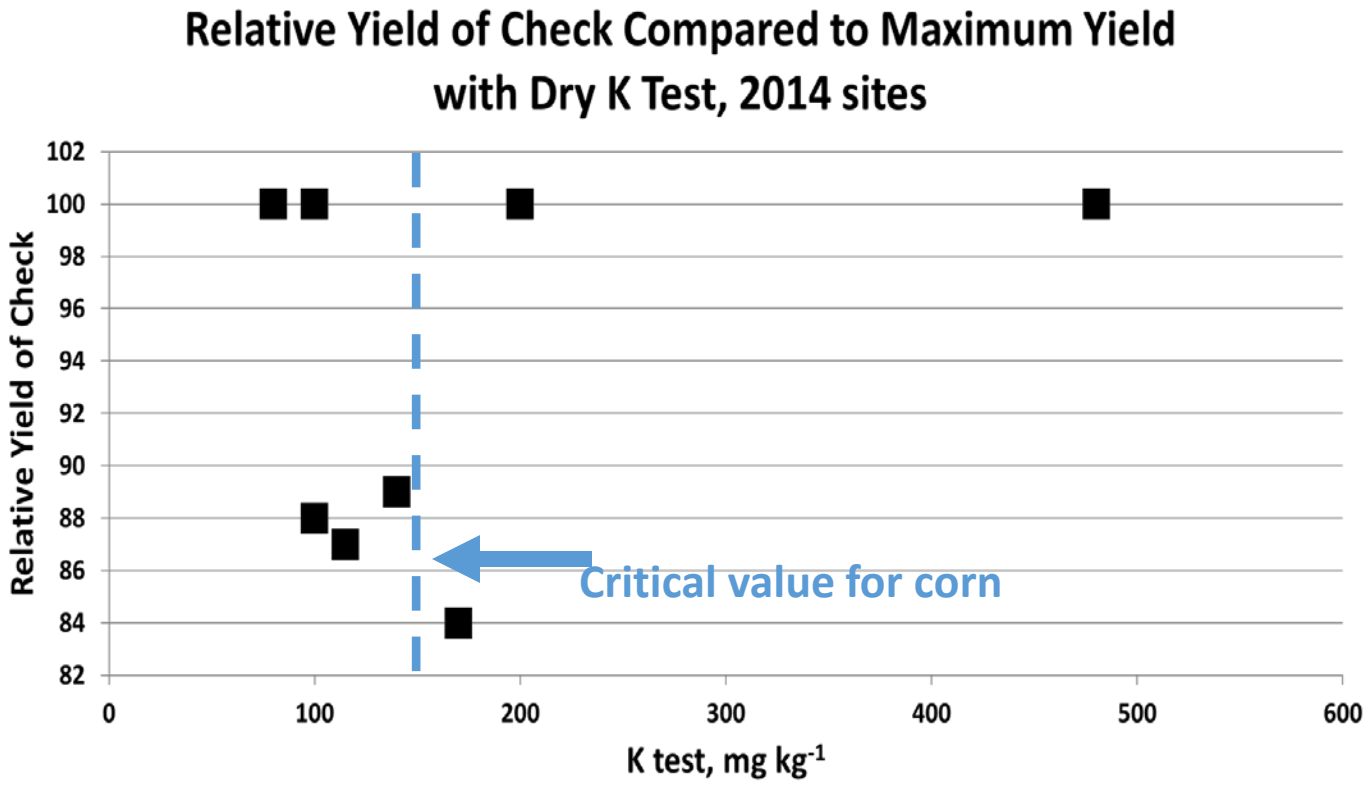
Dry soil K test- (Warncke & Brown, 2015)

http://extension.missouri.edu/explorepdf/specialb/sb1001.pdf

Air-dry soil, 1M Ammonium acetate, fixed shaking time, filter, analyze for K in flame-photometer or AA set up for emission.

2014- 10 sites in SE North Dakota.

Only half behaved the way the recommendation indicated. (response if K < 150 ppm, no response if K > 150 ppm.)

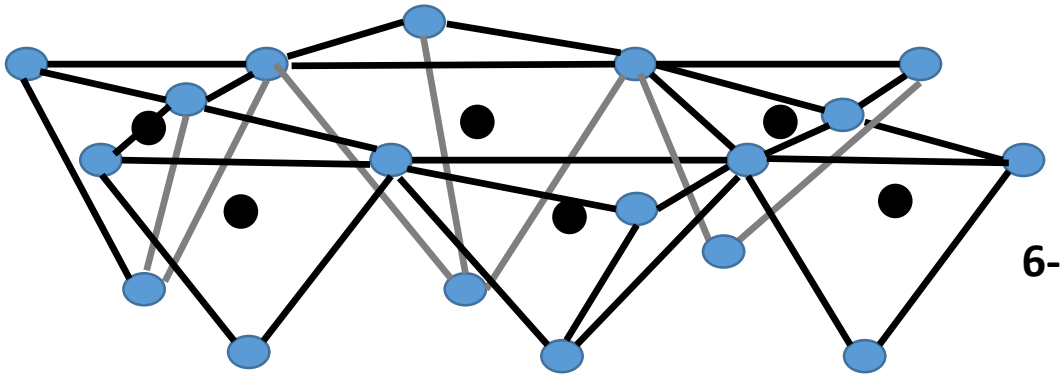


2014 results were very distressing.

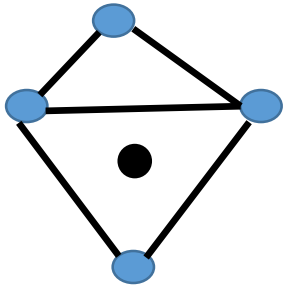
After attending an American Society of Agronomy Symposium (Dr. Don Sparks, U. Del.) we started investigating clay chemistry and soil mineralogy.

Clay chemistry short version:

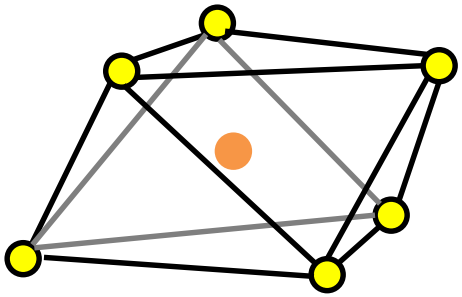
The silicon oxide sheet layer-



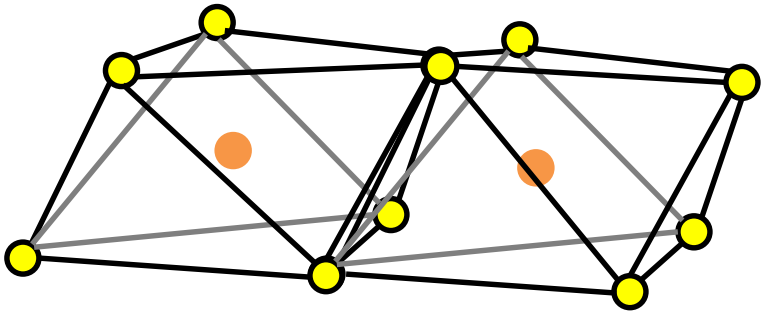
6- SiO_4 in a sheet



The SiO_4 building block

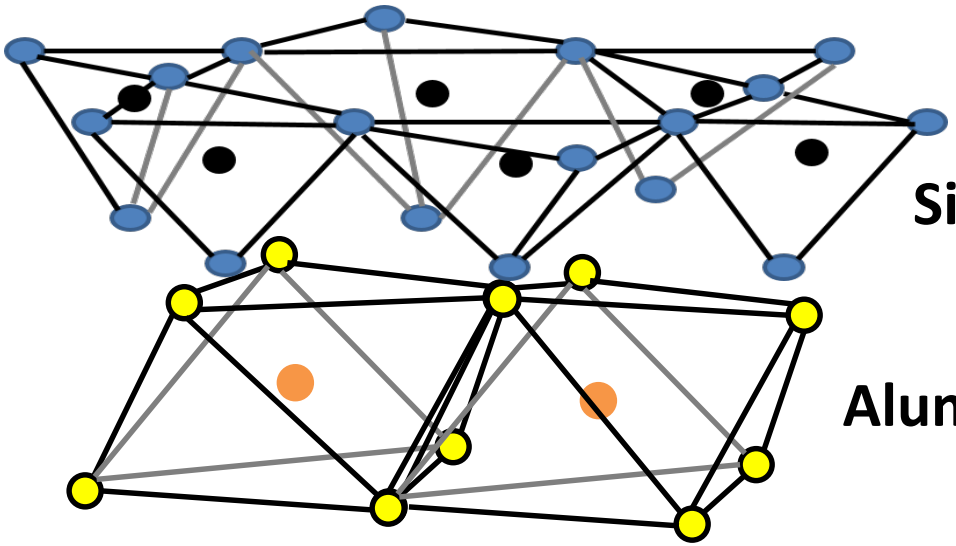


Aluminum hydroxide building block



Aluminum hydroxide sheet

A 1:1 silicon oxide sheet bound to an aluminum hydroxide sheet.



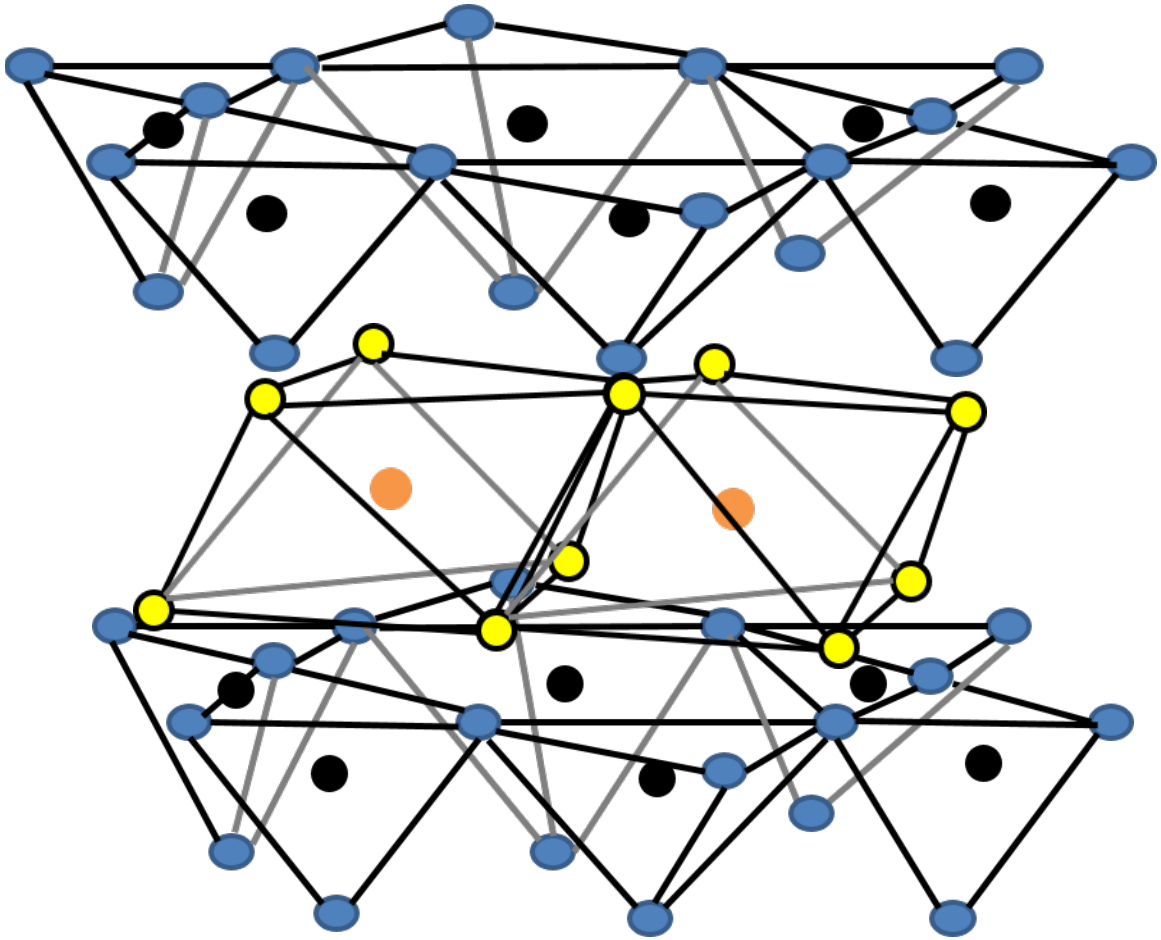
Silicon oxide sheet

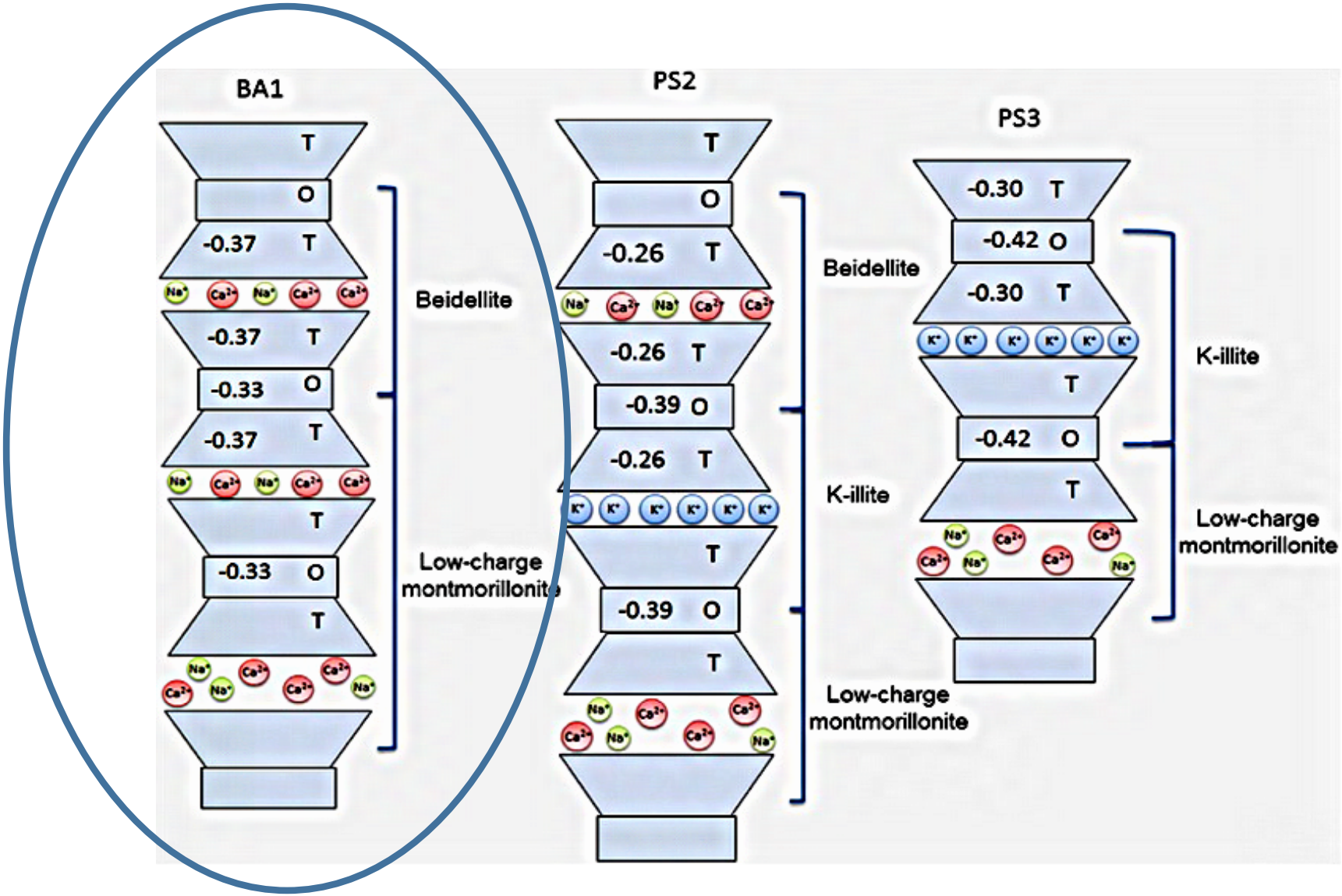
Aluminum hydroxide sheet

Bound by partial charge from $O^{-\rho}$ and $OH^{+\rho}$

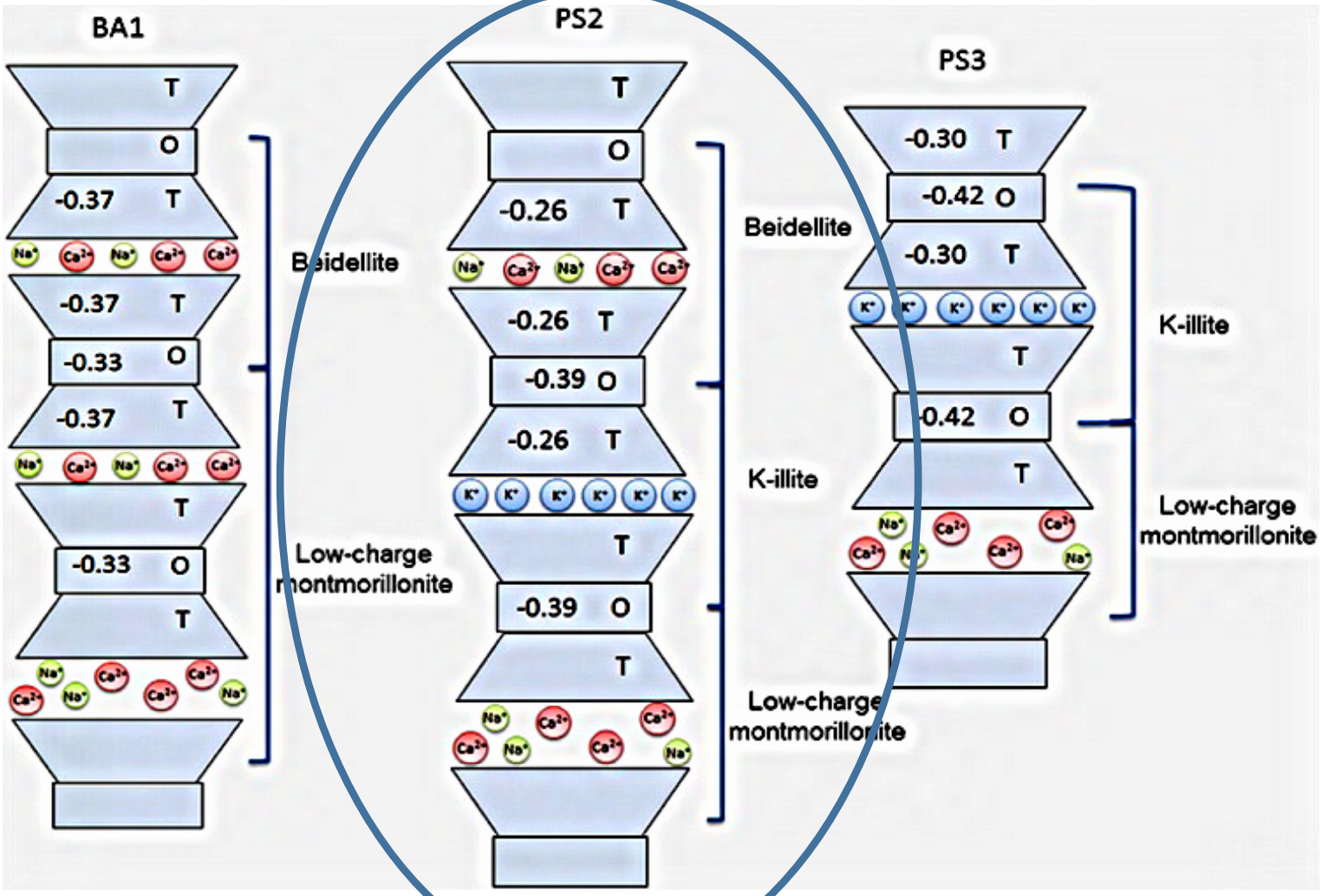
A 2:1 clay-

Sheet of Aluminum hydroxide with 2 sheets of Silicon oxide- one above, one beneath.

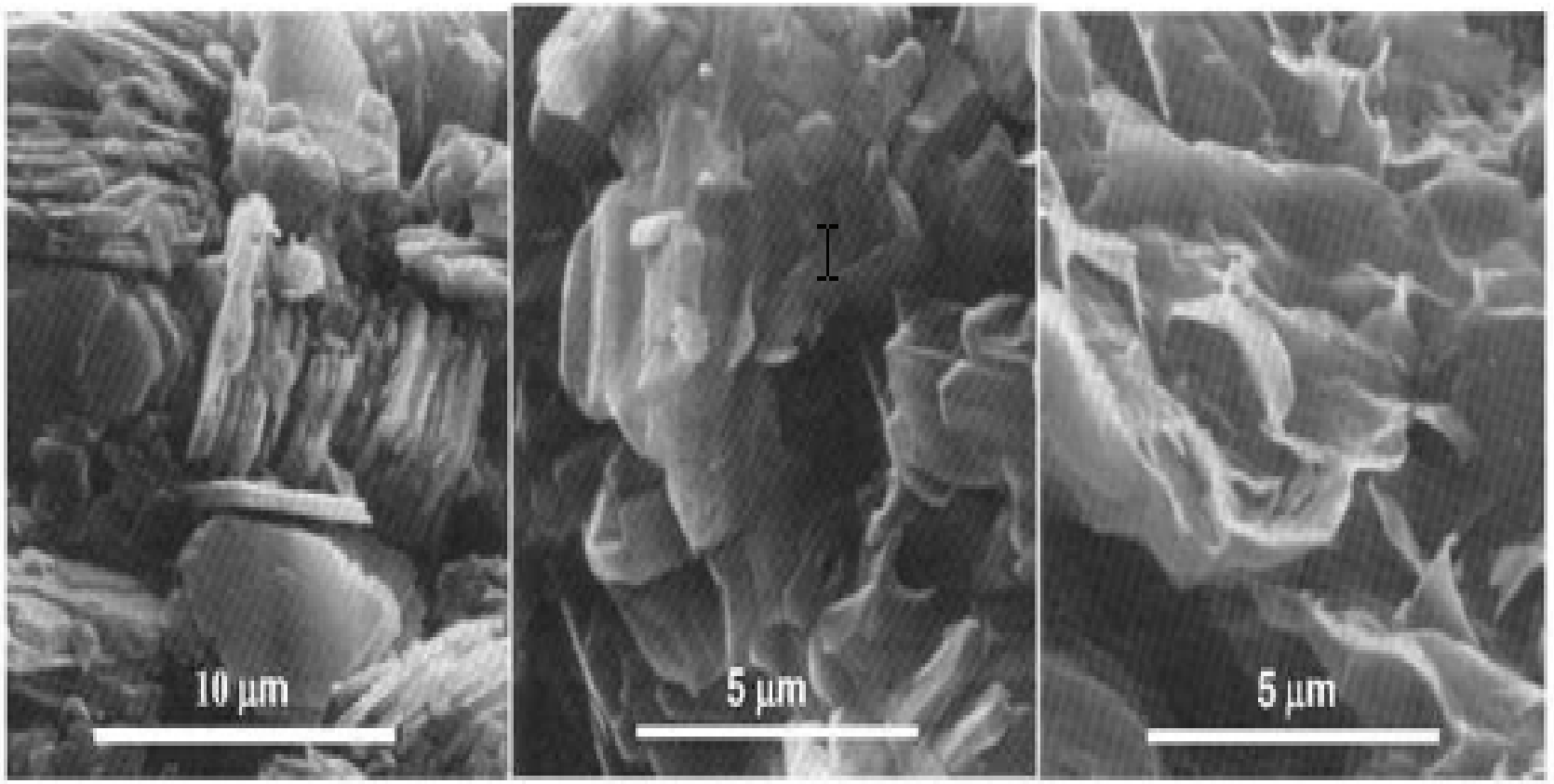




Smectite (beidellite and montmorillonite) and illites diagrams



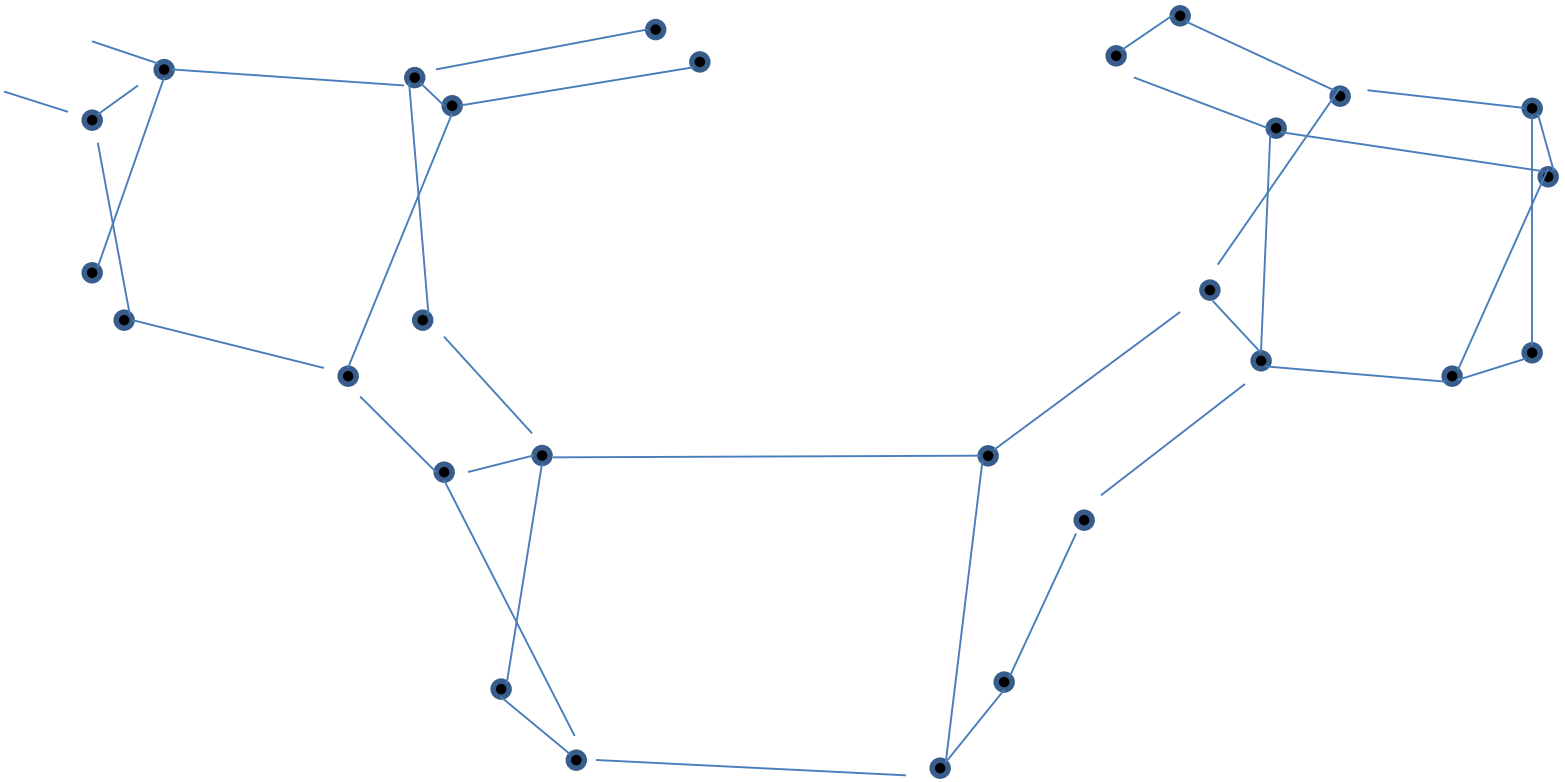
Smectite (beidellite and montmorillonite) and illite diagrams



Micrographs of kaolinite (1:1 clay) left Illite (limited shrinking 2:1 clay) center and Smectite (high shrink/swell 2:1 clay) right

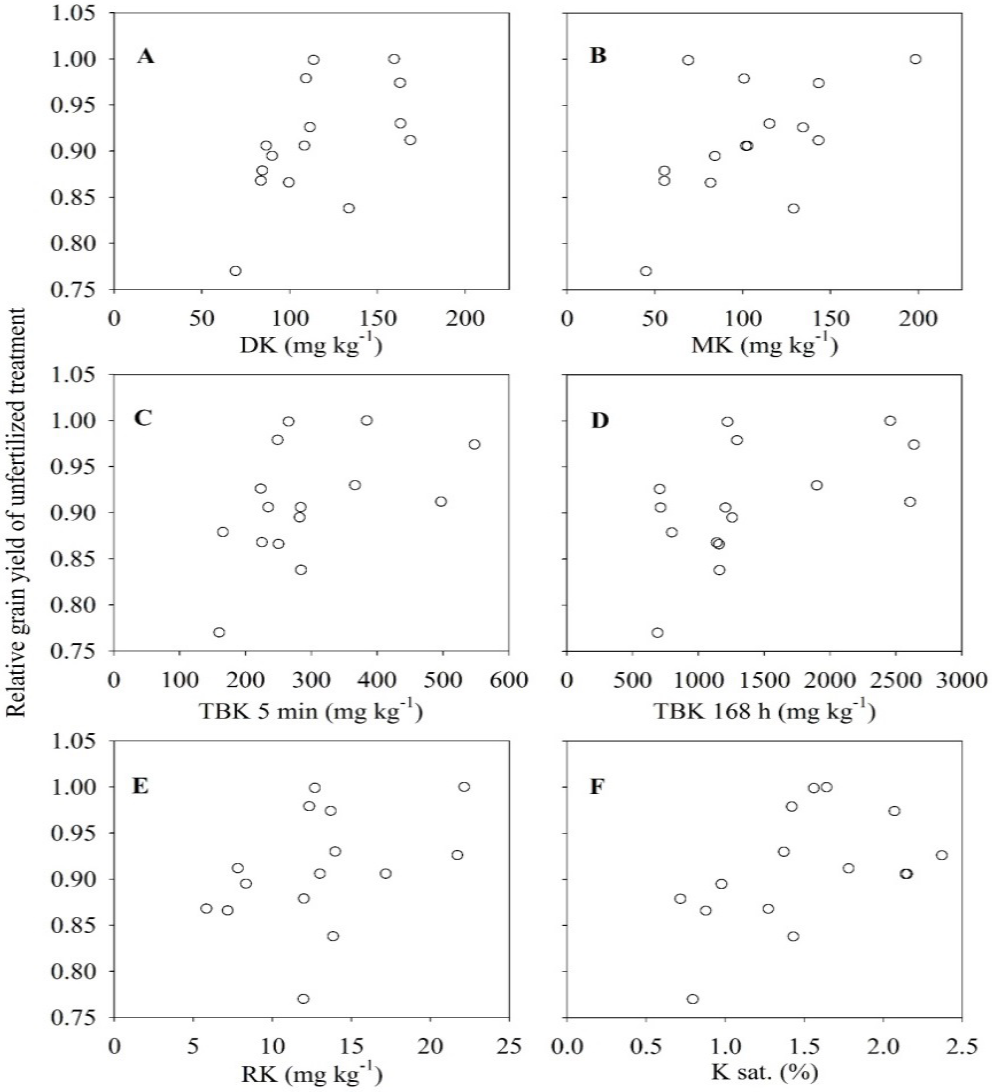
Smectite clays, particularly those with high interlayer charge (beidellite) 'fix' K during dry soil periods and prevent K release upon shrinking/collapse. This is a reversible process when the soil re-wets.

Potassium feldspar-

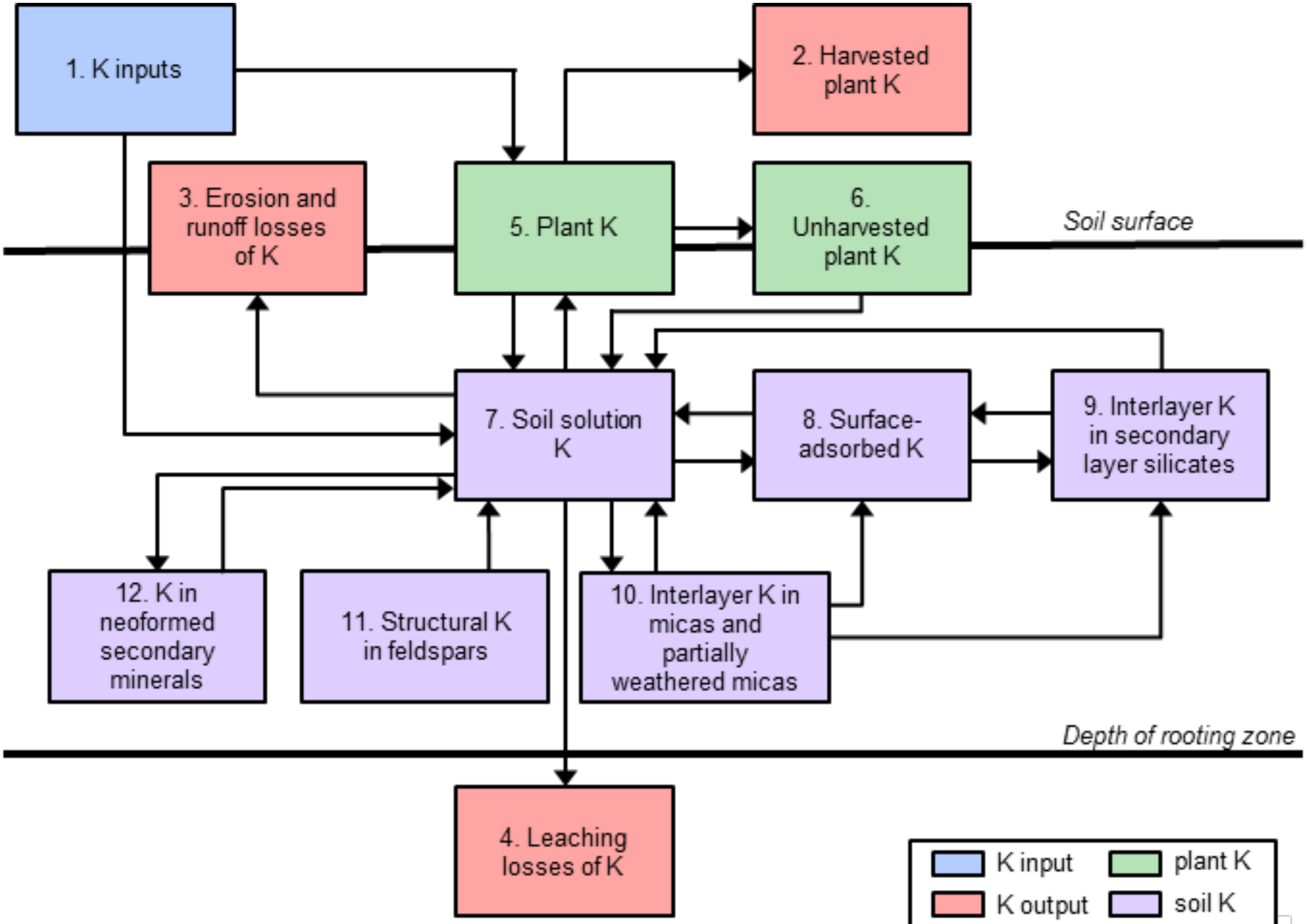


3-D framework of SiO_4 and Al_2O_3 tetrahedrals isomorphous substitution of Al for Si ~ ¼ of the time results in significant negative (-) charge. Potassium within the open spaces helps balance charge.

Examination of different K soil testing methods:



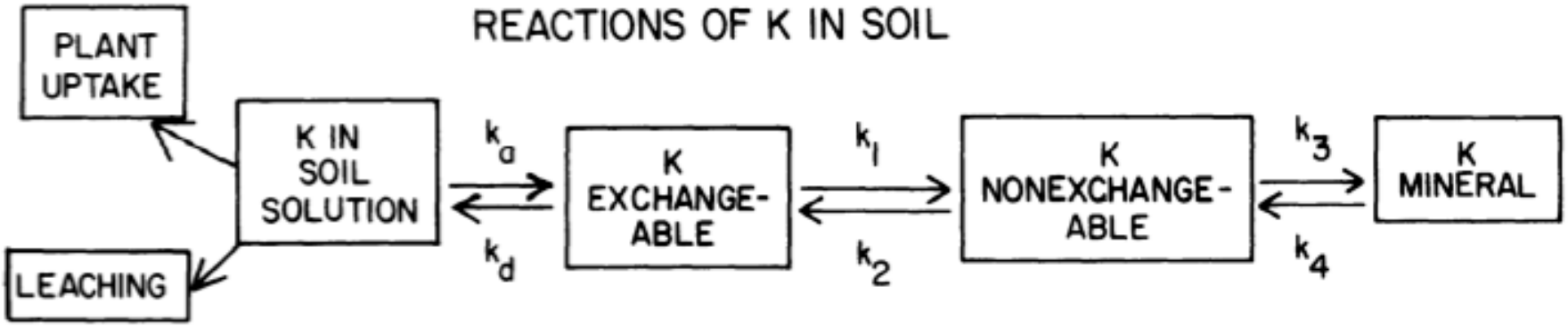
Test	R^2
Dry K	0.49
Moist K	0.47
TBK 5min	0.33
TBK 1 wk	0.30
Resin	0.16
CEC	0.42


1. K inputs
2. Harvested plant K
3. Erosion and runoff losses of K
5. Plant K
6. Unharvested plant K
Soil surface
7. Soil solution K
8. Surface-adsorbed K
9. Interlayer K in secondary layer silicates
12. K in neoformed secondary minerals
11. Structural K in feldspars
10. Interlayer K in micas and partially weathered micas
Depth of rooting zone
4. Leaching losses of K
K input
plant K
K output
soil K
process
Time scale: a cropping season
Spatial scale: cumulative rhizosphere volume for a crop

Forms of K in soils explored by Sparks et al., AJ. 1980 (meq/100 g)

Site	Exchangeable	Non-Exch	Feldspar	Mica	Total K
Greensville	0.11	0.17	5.4	0.8	6.5
Nottoway	0.10	0.22	11.3	0.4	12.0

No yield responses to K recorded at these and other sites of similar mineralogy over a series of years, despite low K soil test values.



where

k_a = adsorption rate coefficient in h^{-1},

k_d = desorption rate coefficient in h^{-1},

From Sparks and Huang 1985

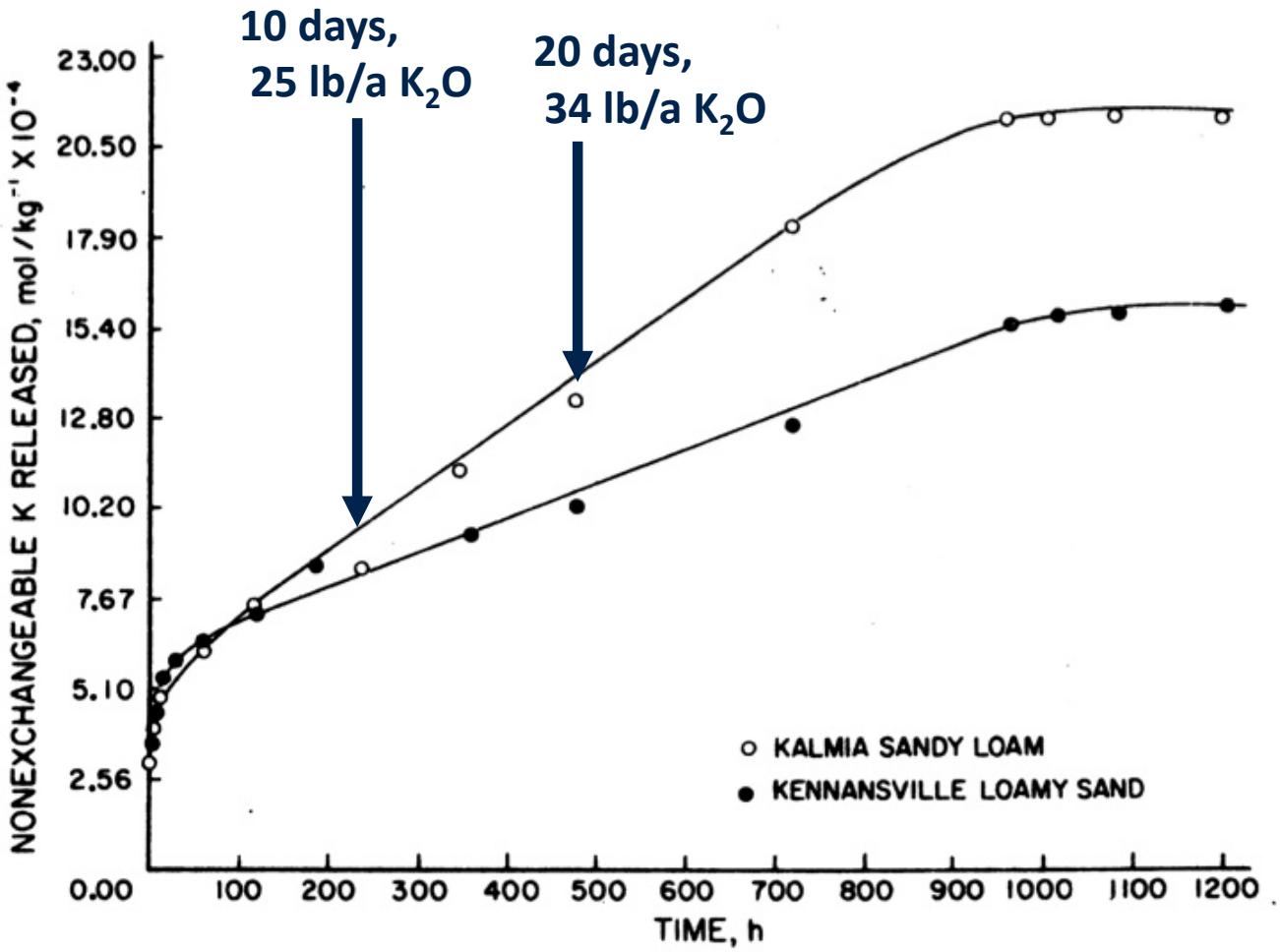


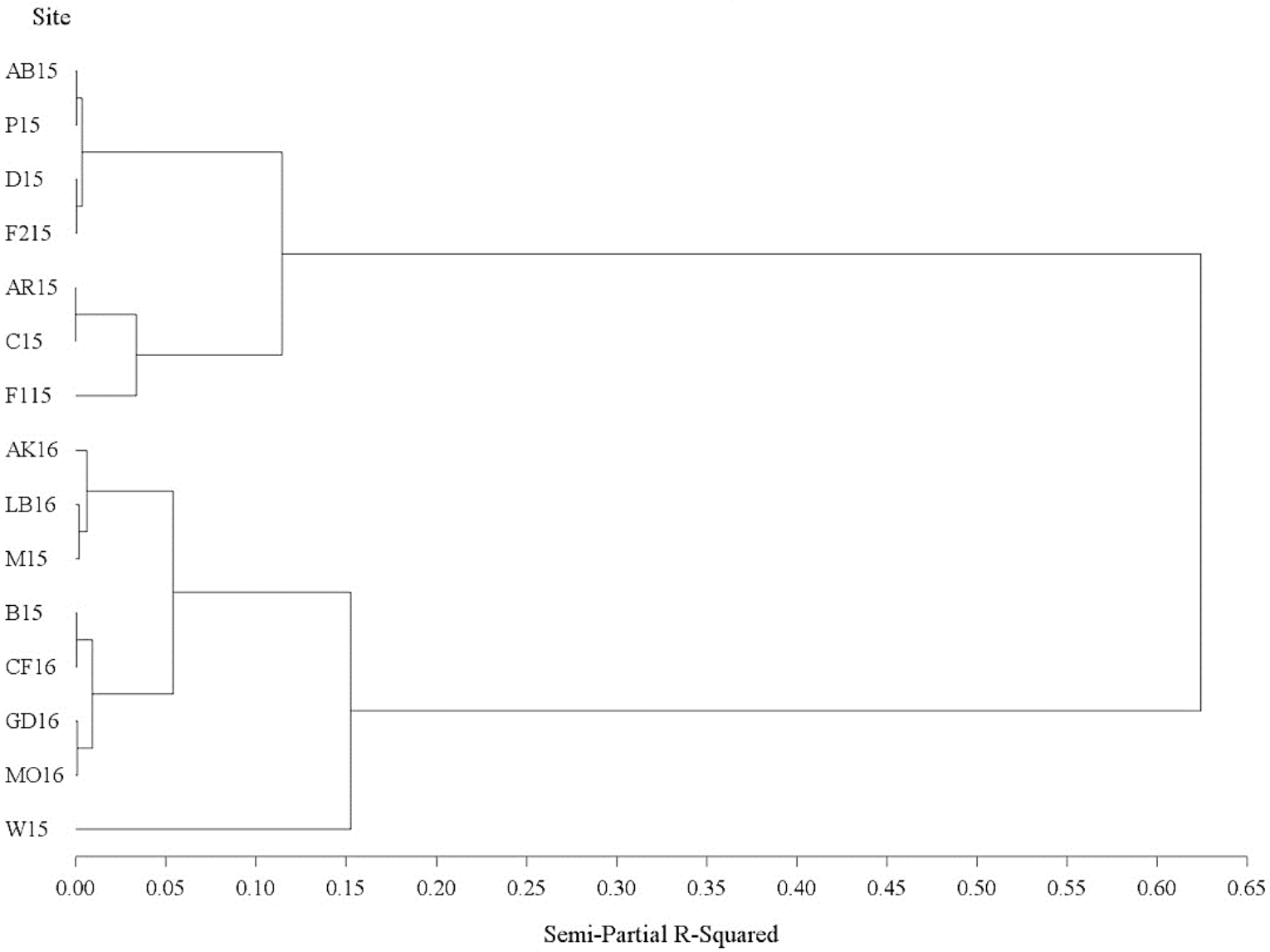
Fig. 1—Amount of nonexchangeable K released vs. time in the 0.45- to 0.60-m depth of Kalmia and Kennansville soils.

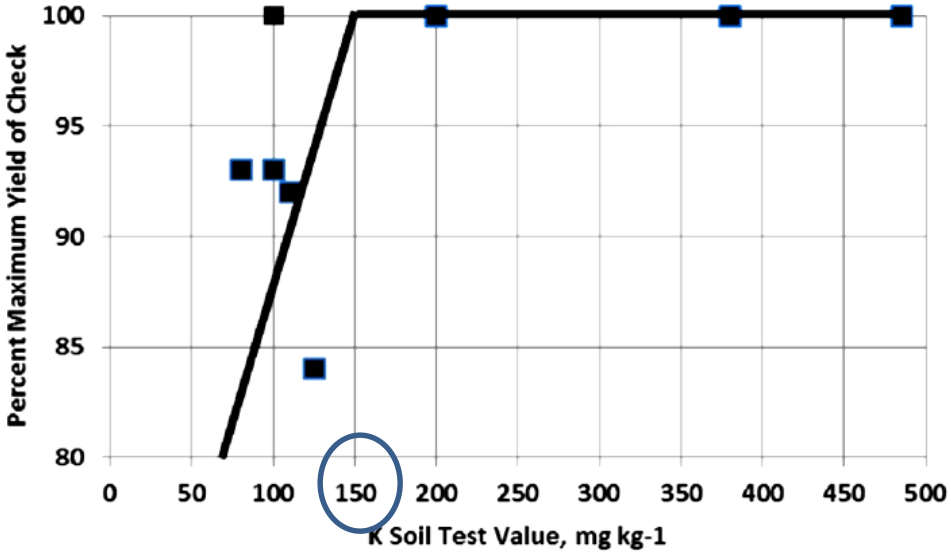
From Martin and Sparks, SSSAJ 1983

The sand fractions of soil from M.C. Sandusky et al., 1987 released 300 lb K_2O into a H^+ saturated resin over a 30-day period. (a Sparks study)

Most of this release was from potassium feldspar-K

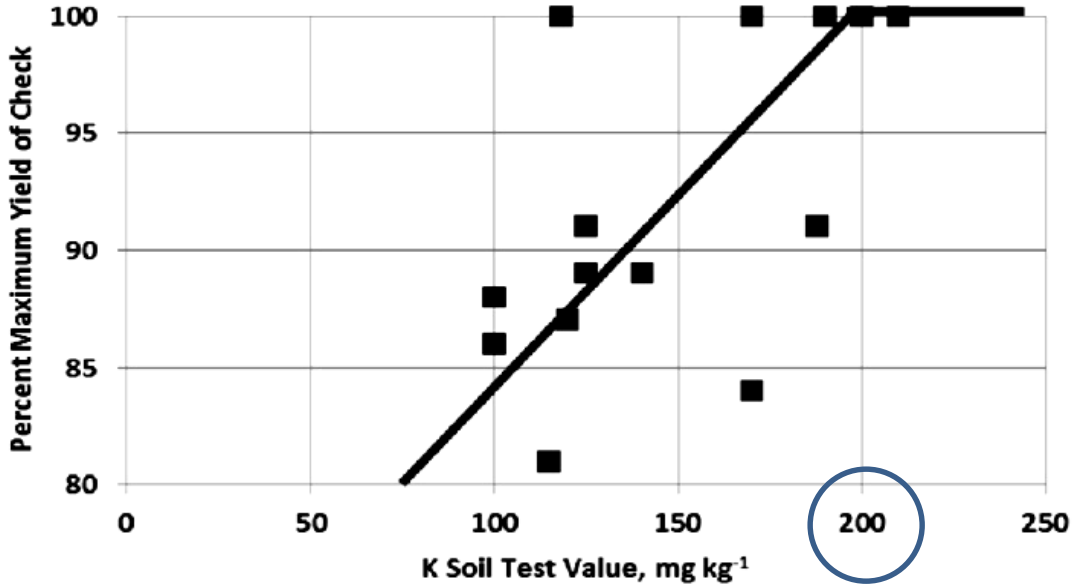
Used statistics to cluster the sites into two groups. The ratio of smectite to illite that was best for dividing our data-set was 3.5





Smectite/illite ratio < 3.5

Smectite/illite ratio > 3.5



Minerals & Clays measured in survey-

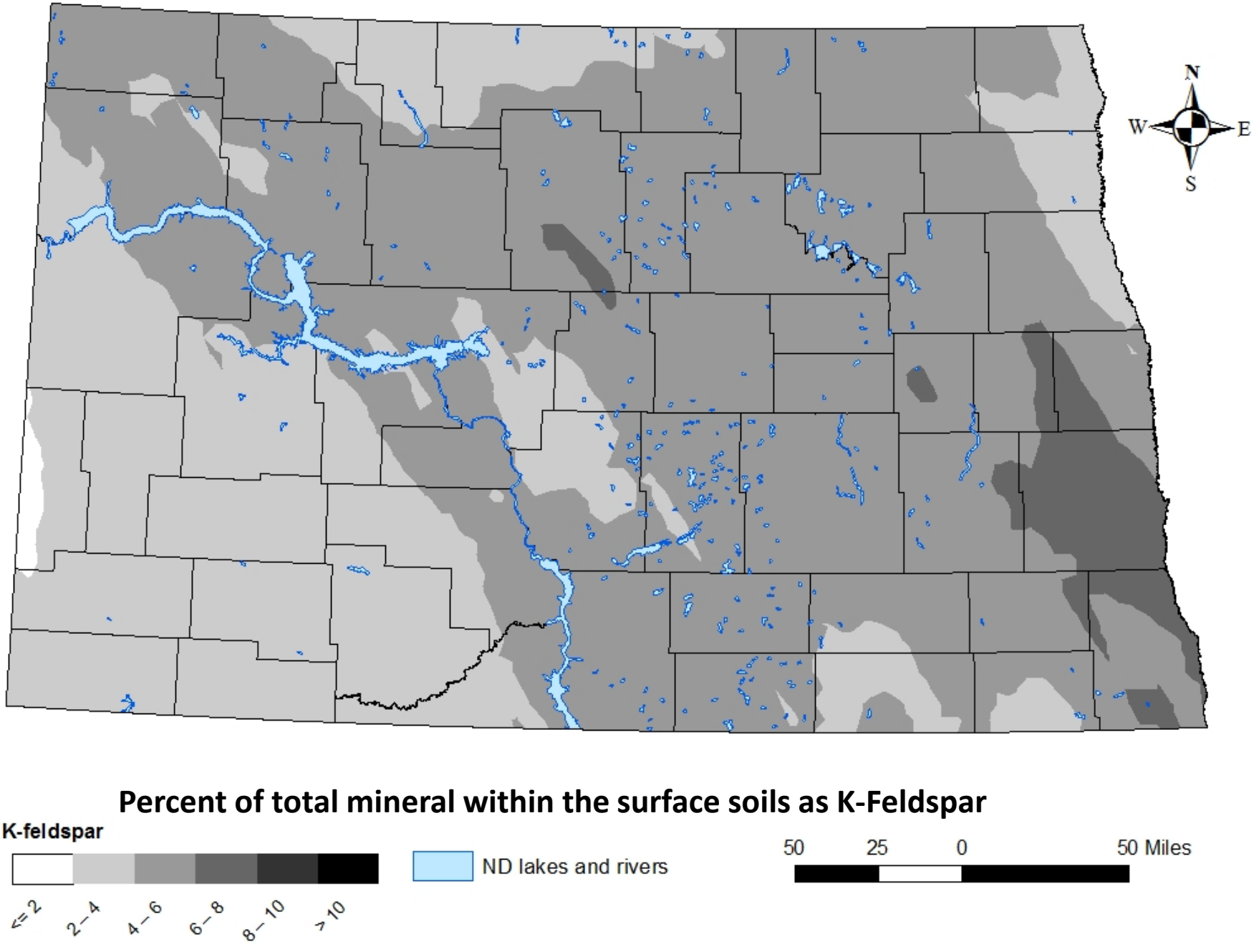
Smectite 2-1 (includes montmorillonite/beidelite)

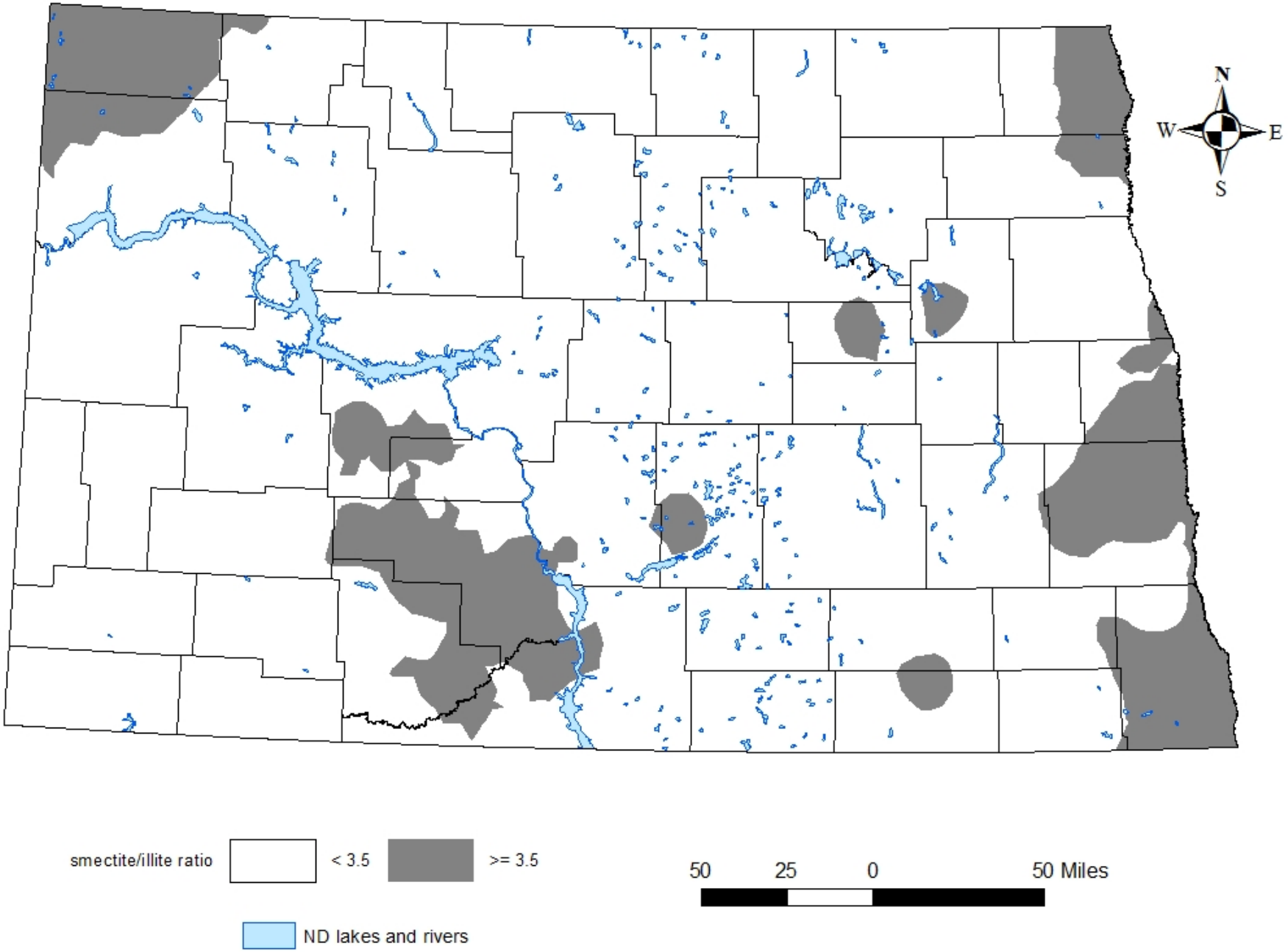
Illite- 2-1 limited expanding clay

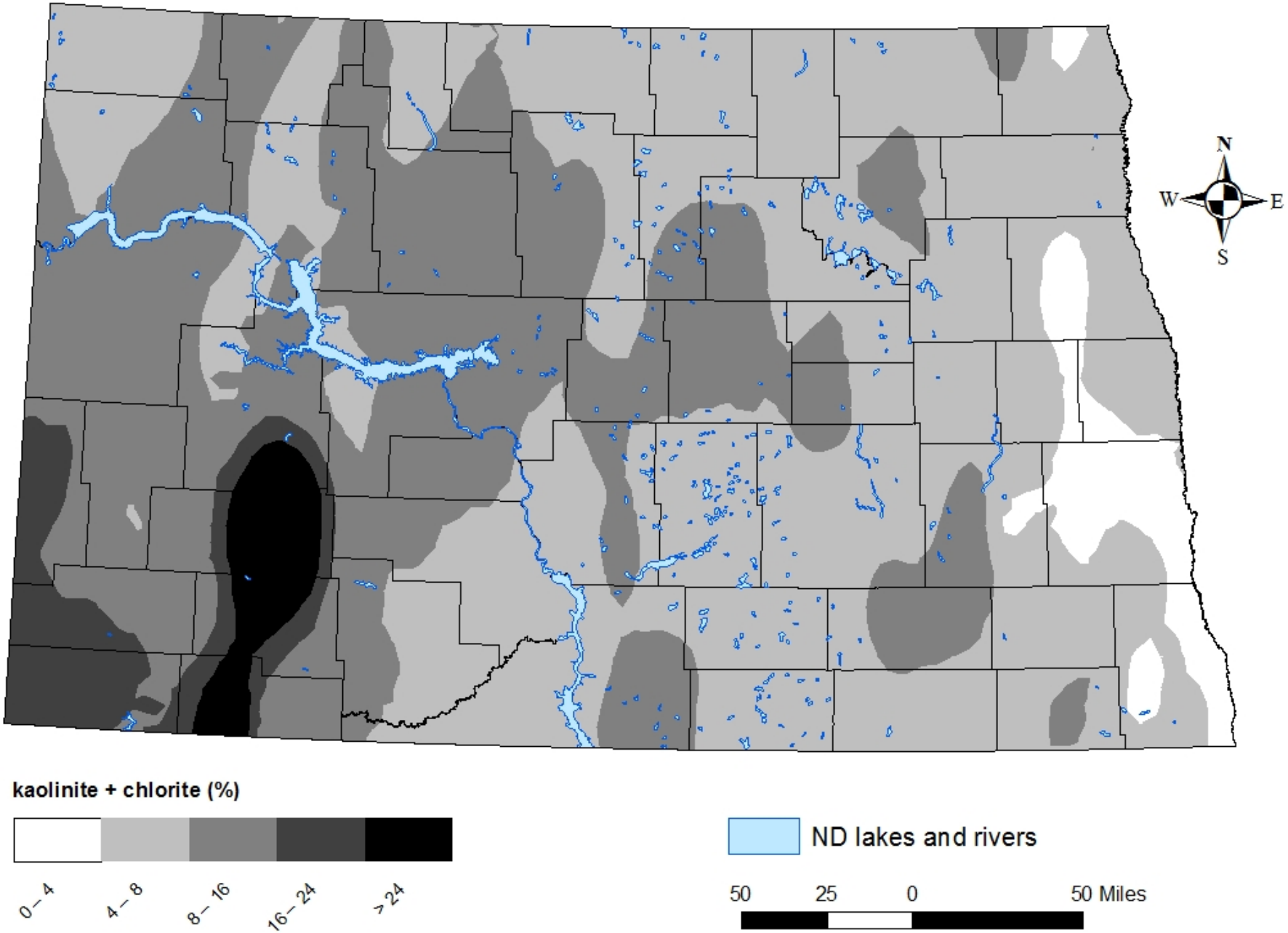
Kaolinite (1-1 non-expanding clays)

Chlorite (3-1 non-expanding clays)

Potassium feldspar


N
W
E
S
Percent of total mineral within the surface soils as K-Feldspar
K-feldspar
<=2
2–4
4–6
6–8
8–10
>10
ND lakes and rivers
50
25
0
50 Miles


N
W
E
S
smectite/illite ratio
< 3.5
>= 3.5
ND lakes and rivers
50
25
0
50 Miles


N
W
E
S
kaolinite + chlorite (%)
0 – 4
4 – 8
8 – 16
16 – 24
> 24
ND lakes and rivers
50
25
0
50 Miles

New North Dakota critical K levels-

For corn, alfalfa-

Smectite/illite > 3.5 200 ppm

Smectite/illite < 3.5 150 ppm

For sugar beet-

>3.5 150 ppm

< 3.5 120 ppm

For spring wheat/durum/winter wheat

> 3.5 150 ppm

< 3.5 100 ppm

Zone Soil Sampling
Should Be the Default
ND Site-specific Sampling Strategy

Site specific nutrient management requires gathering information that helps tell a grower whether a fertilizer is needed or not, and the rate.

This information can be obtained using

-Grid soil sampling
-Zone soil sampling
-Sensor information, usually a growing crop (N, mostly)

Grid Sampling-

It takes about 1 sample per acre grid to characterize a field. This represents about 50% of the nutrient variability in a field.

A 1 sample per 2.5 acre grid only captures about 20% of the field variability.

A 5 acre grid only captures about 10% of field nutrient variability.

The Corn-Belt standard 2 ½ acre grid-

Originally used in Illinois for whole field P, K, and soil pH determination

Especially in the 'I' states, P and K soil test values are almost all in the 'high' range, requiring only maintenance fertilizer rates. Fields have experienced buildup P and K rates for years.
Rates of 300 lb/a DAP and 250-300 lb/a 0-0-60 every other year in a corn/soybean rotation have not been uncommon for 30 years.

In central ND, P rates have been 100 lb/a MAP as a rule at most. A much higher percentage of fields are fertilized using a starter P band to maximize efficiency, but it does nothing to build a soil test P value.

Most soils have medium P values or lower. P values of 2-5 ppm (very low) are more the rule than the exception.

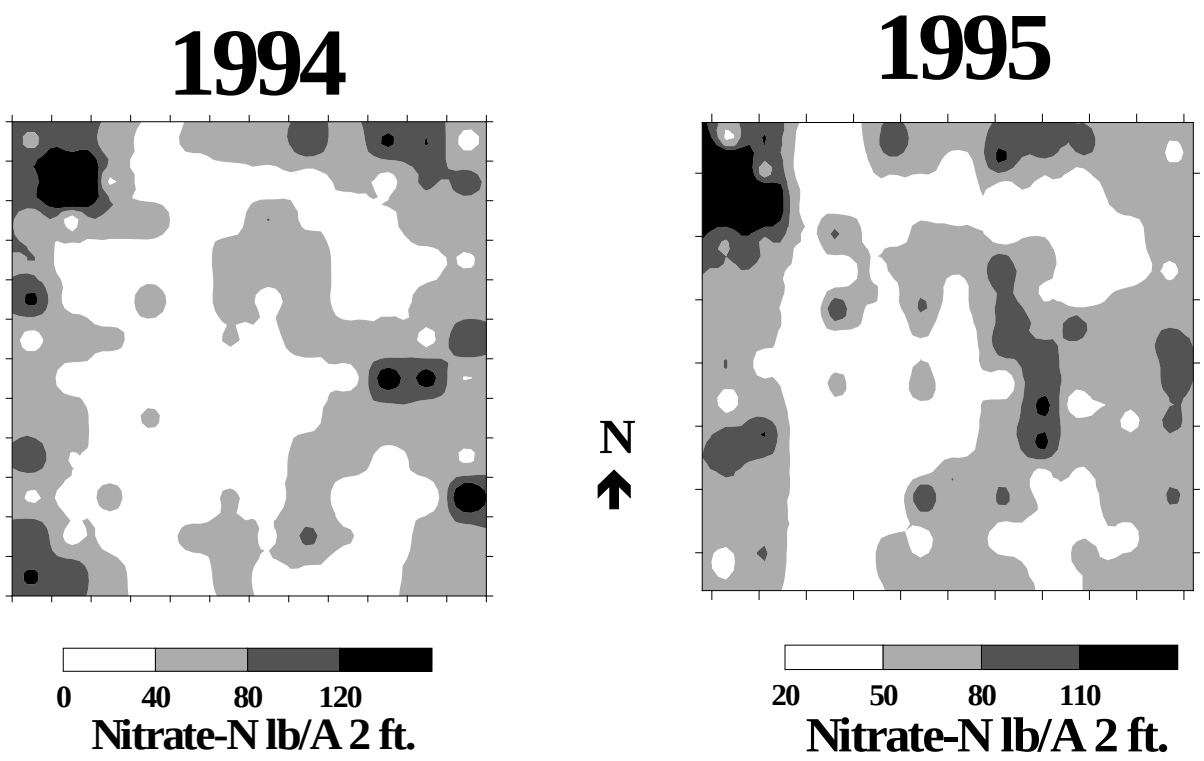
Variation in all soil nutrients are related to soil and landscape position unless parts of the field have a historic manure history.

Zone sampling

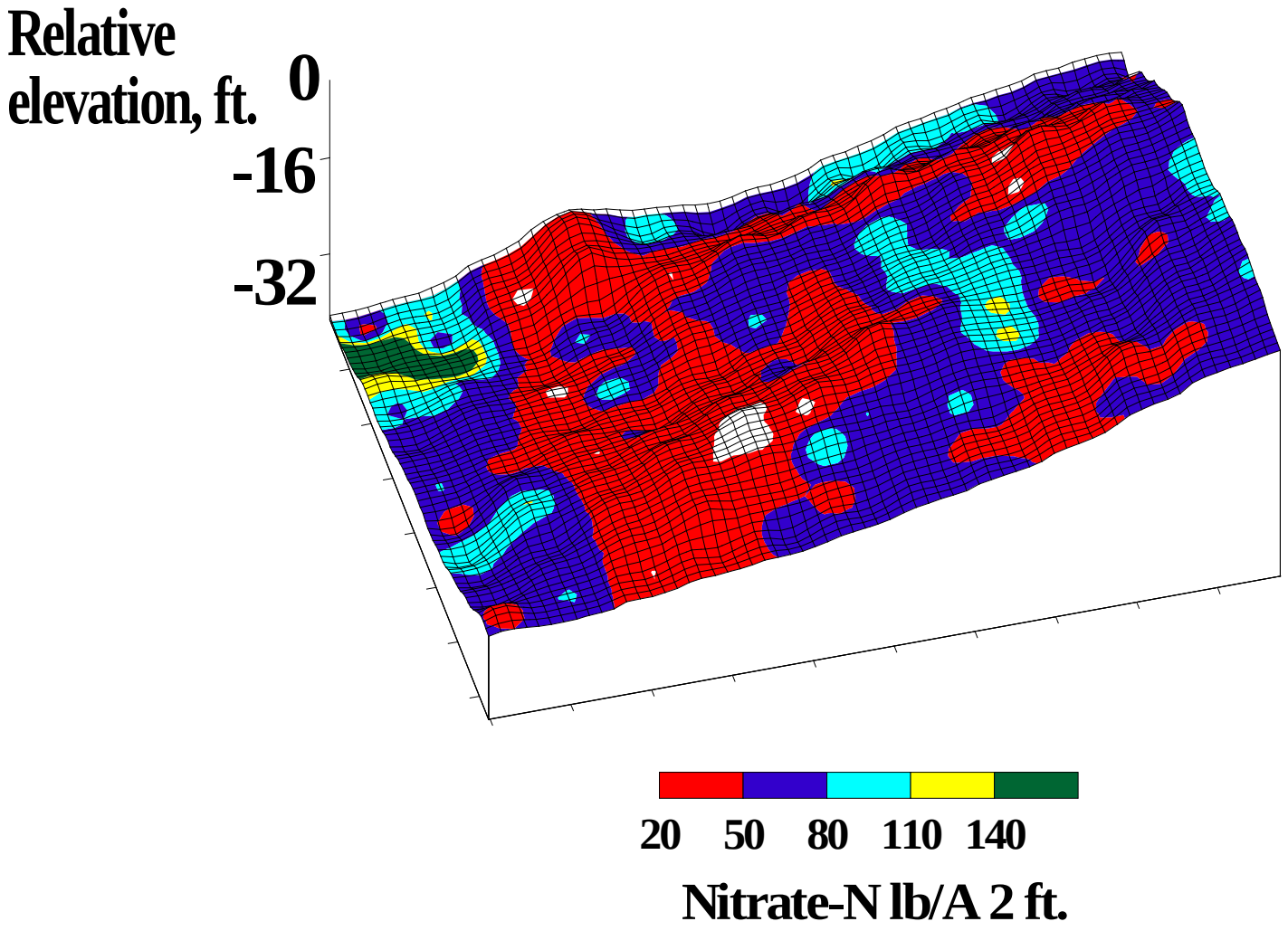
Zone sampling assumes that fertility patterns exist because of some logical, predicable reason.

Zone sampling captures about 50% of nutrient variability, similar to 1 acre grid.

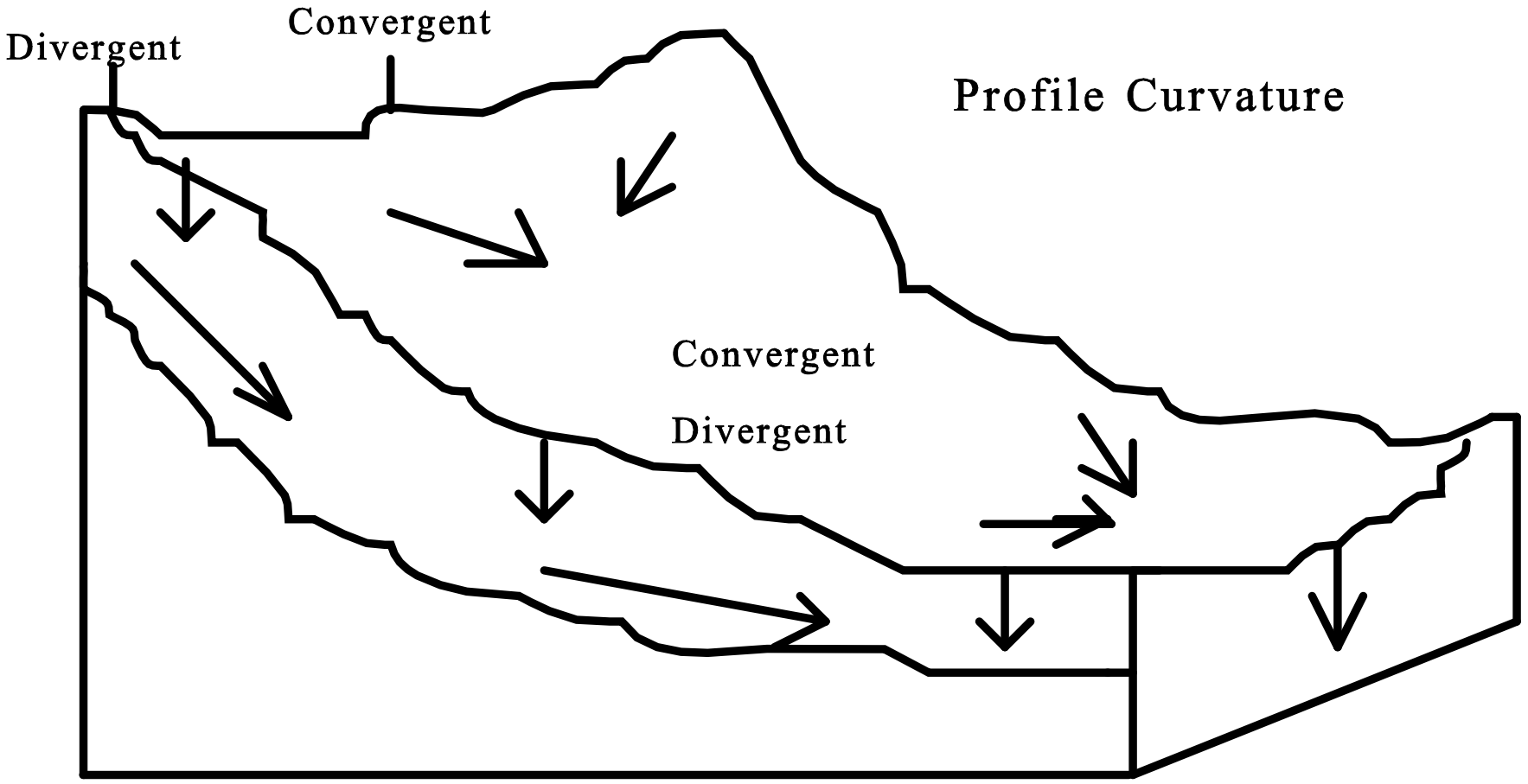
Patterns of mobile nutrients tend to be stable between years.



Valley City N over topography



Mobile Nutrients Move, But They Tend To Move To The Same Places.

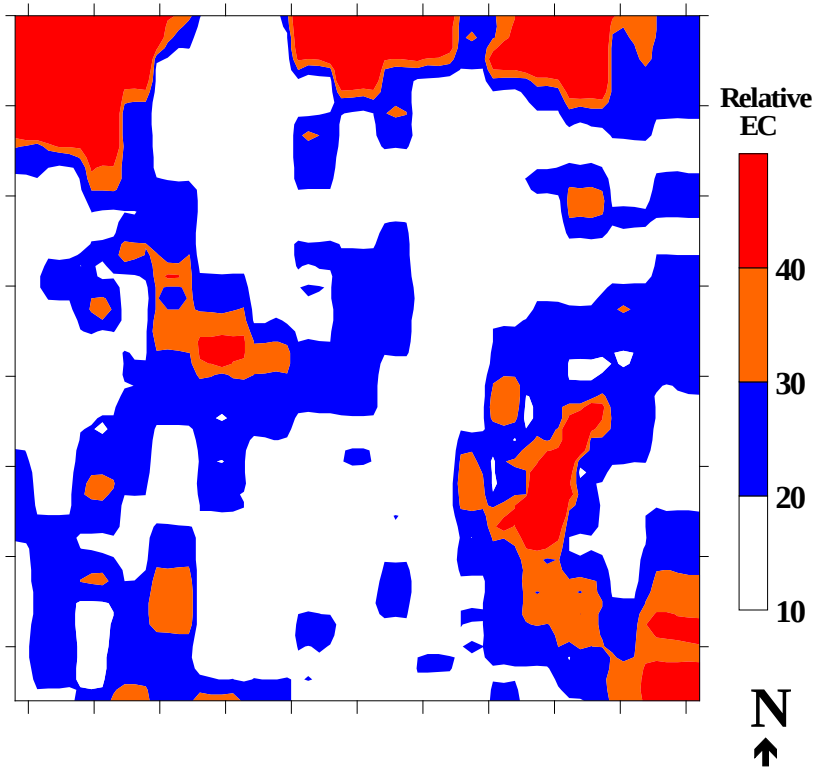


Veris EC sensor
VerisTech, Salina, KS

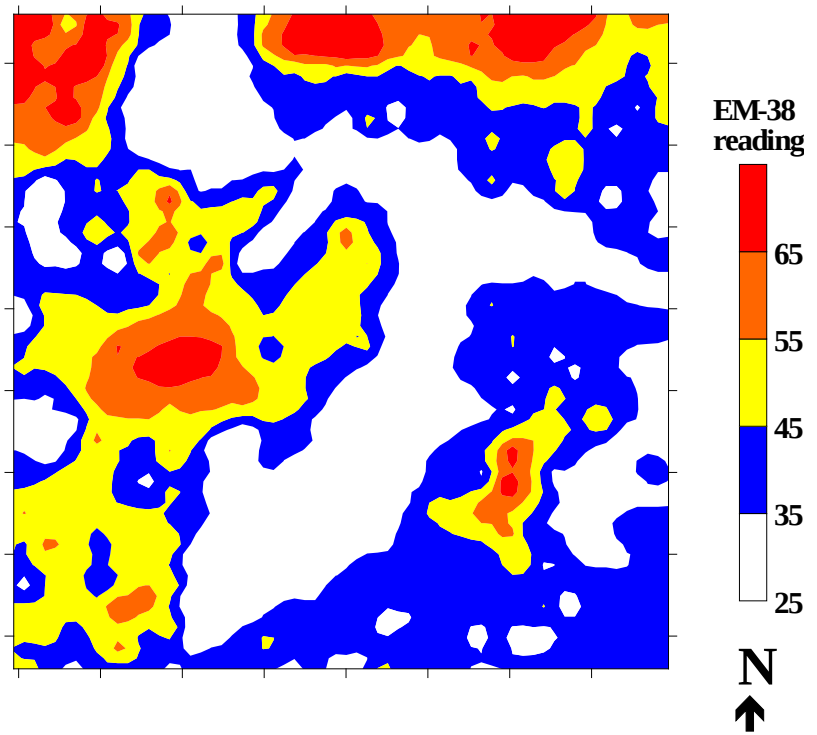
EM-38 and others
Geonics, Ltd
Missassauga, ON

Electrical conductivity

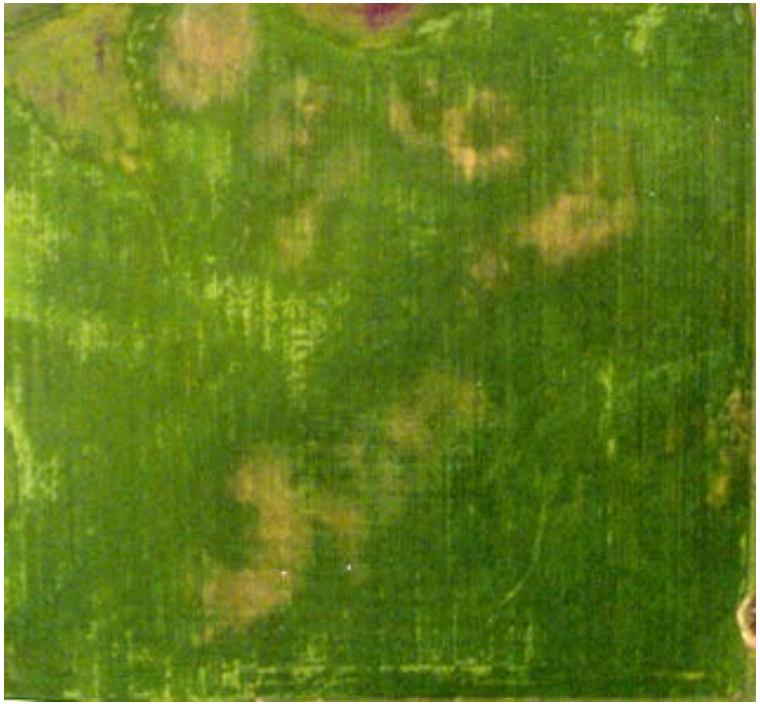
VERIS

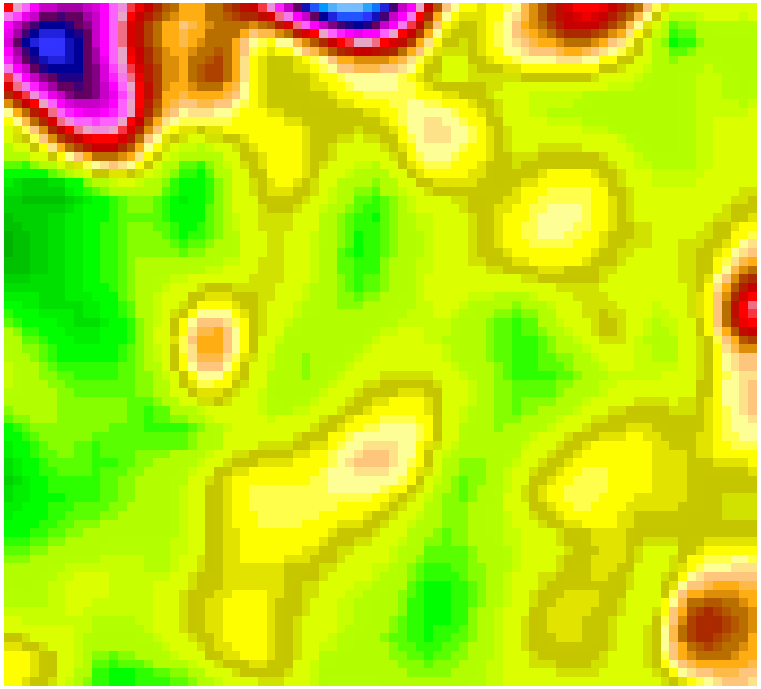


EM-38

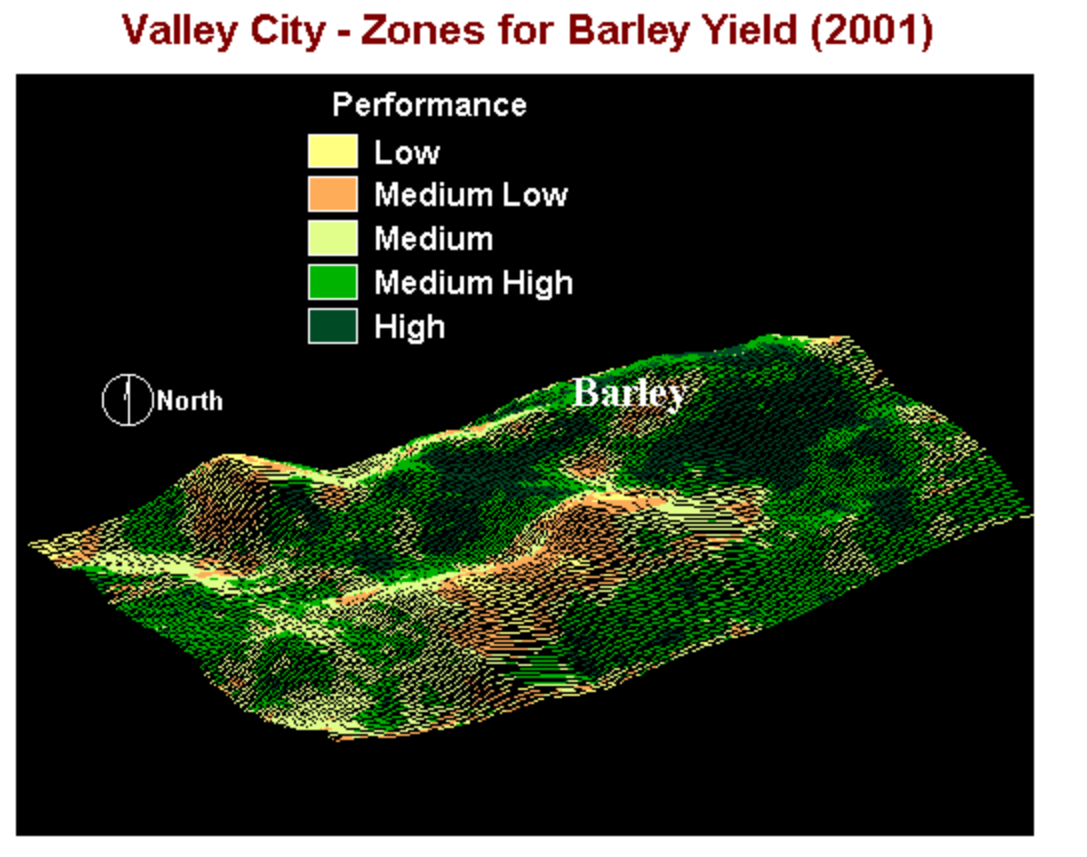


Remote imagery-
Aerial photo, Satellite imagery, Drones

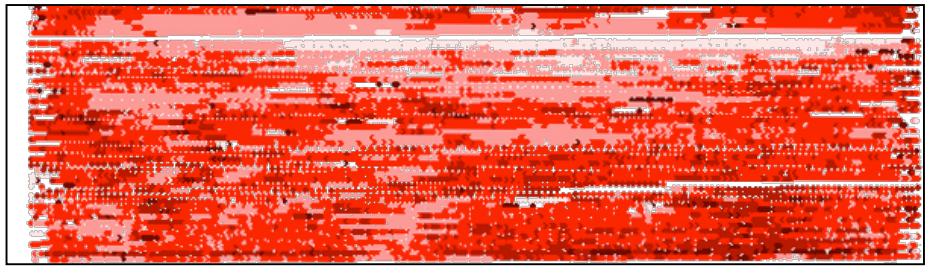




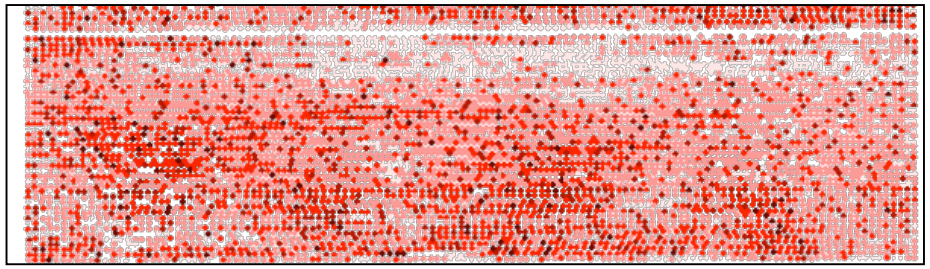
Yield


Valley City - Zones for Barley Yield (2001)
Performance
Low
Medium Low
Medium
Medium High
High
North
Barley

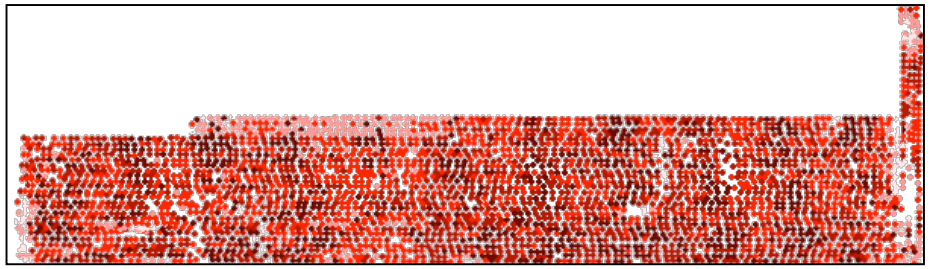
How do you manage multiple years of yield data?



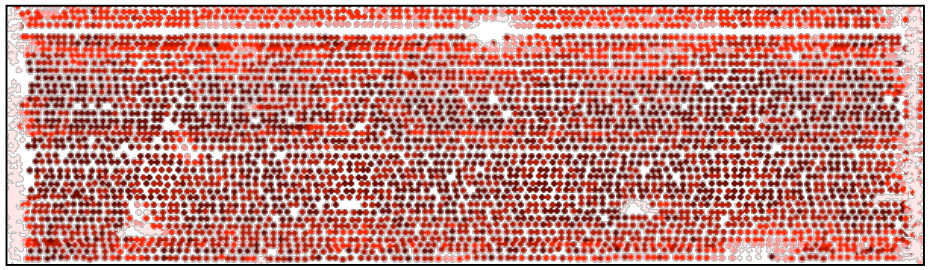
1994 Yield



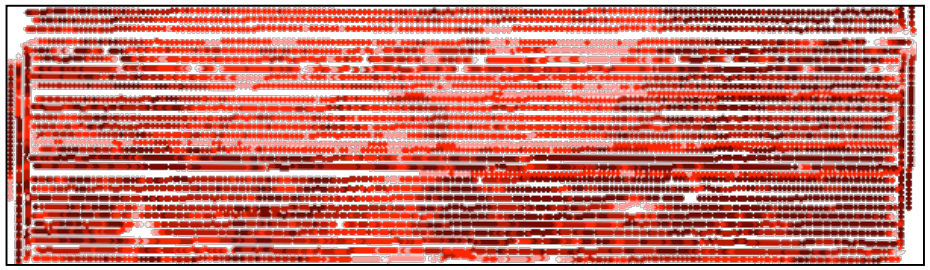
1995 Yield



1997 Yield



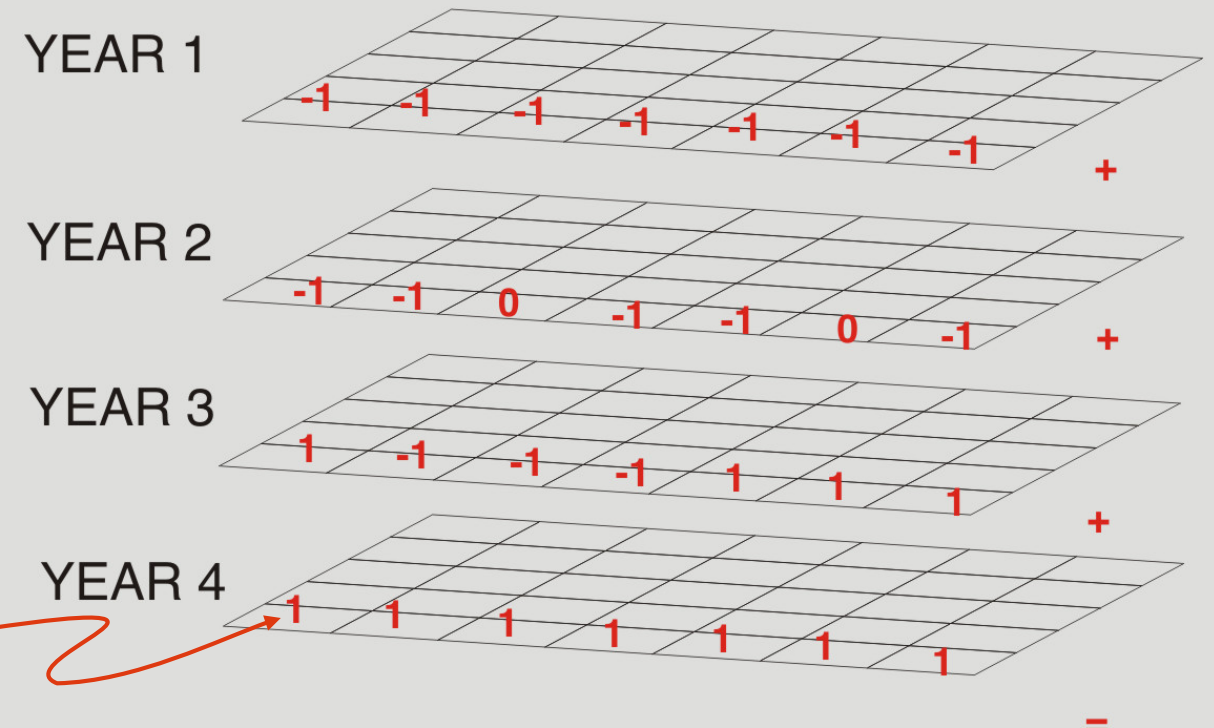
1998 Yield



2000 Yield

Managing multiple yield data using rank & frequency

Assign rank for each year



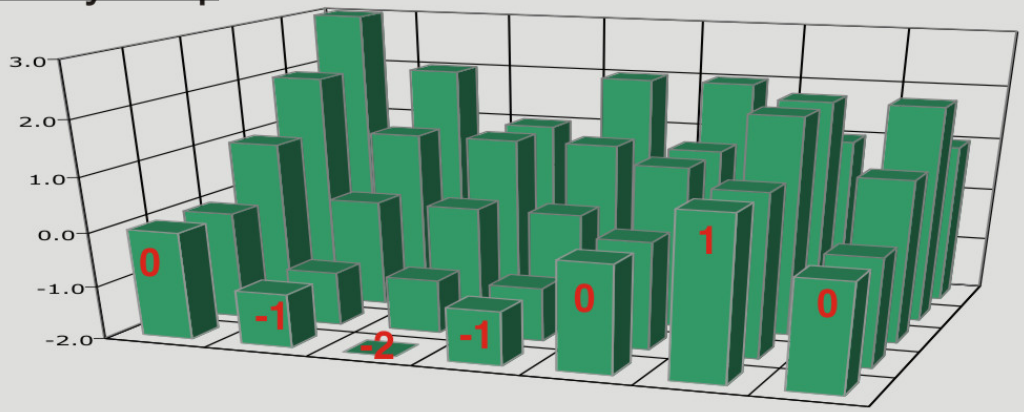
Assign rank:

1 if > average yield

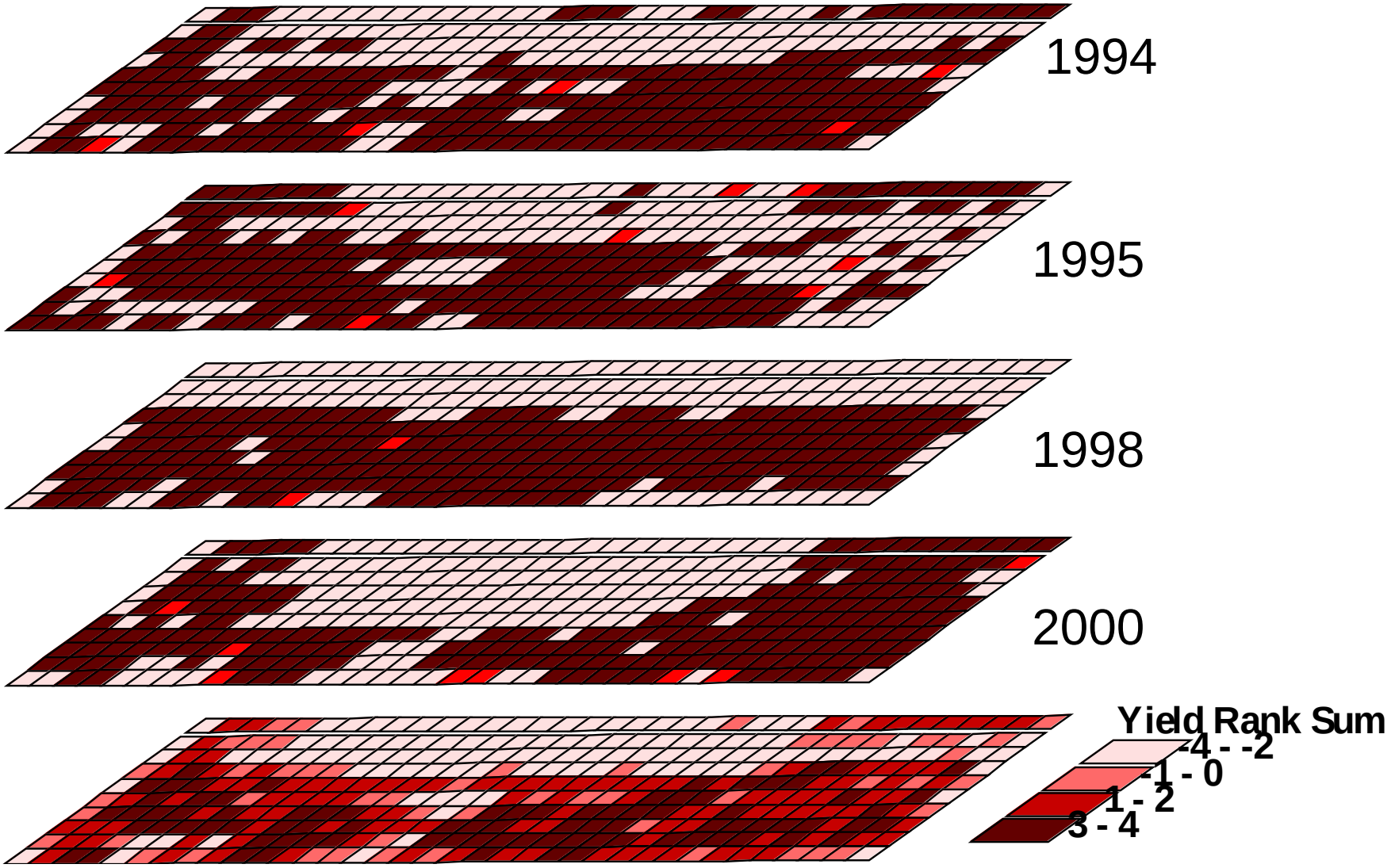
0 if = average yield

-1 if < average yield

Frequency map



Developing Frequency Map



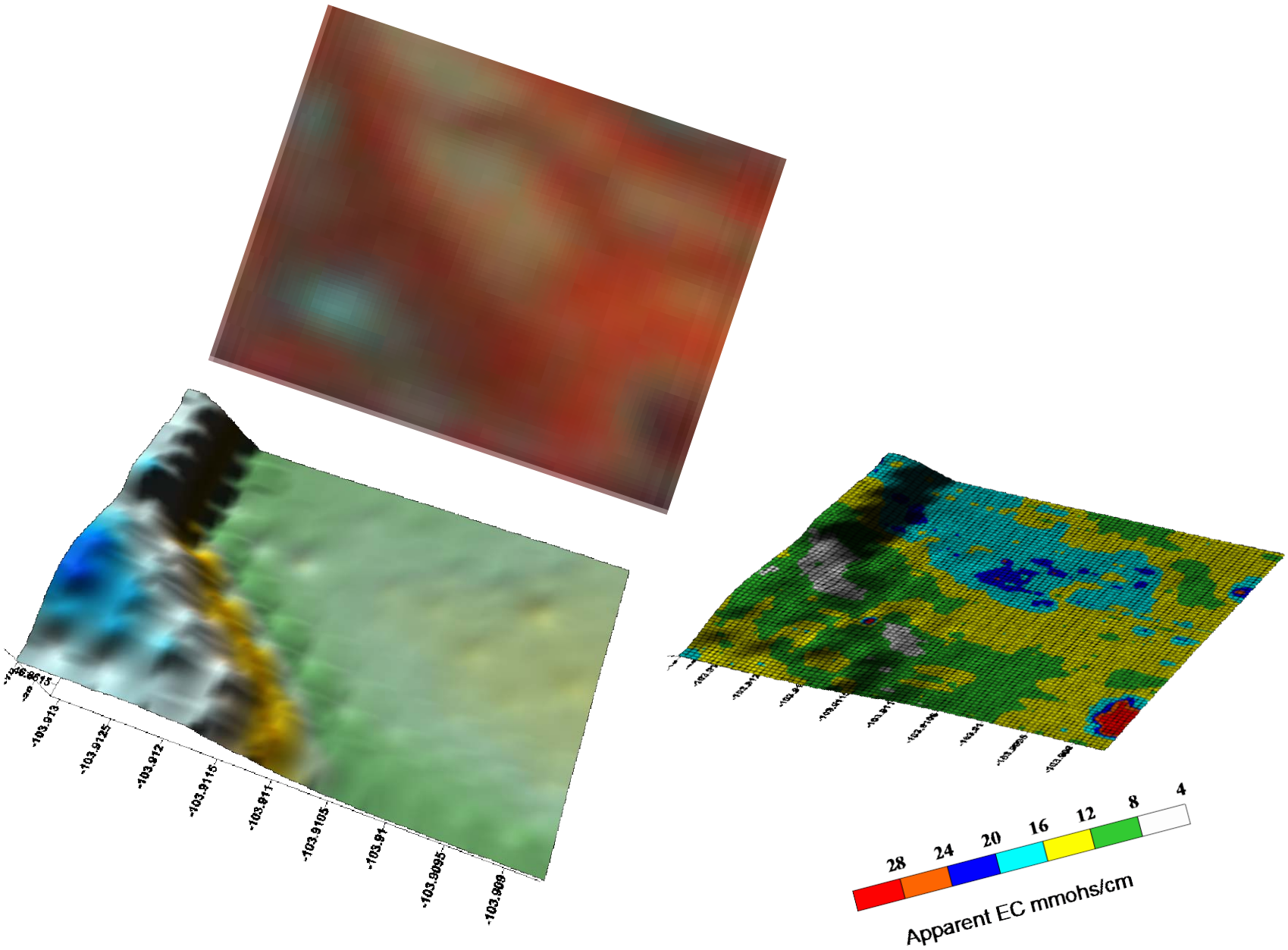
It is wise to use more than 1 zone development tool.

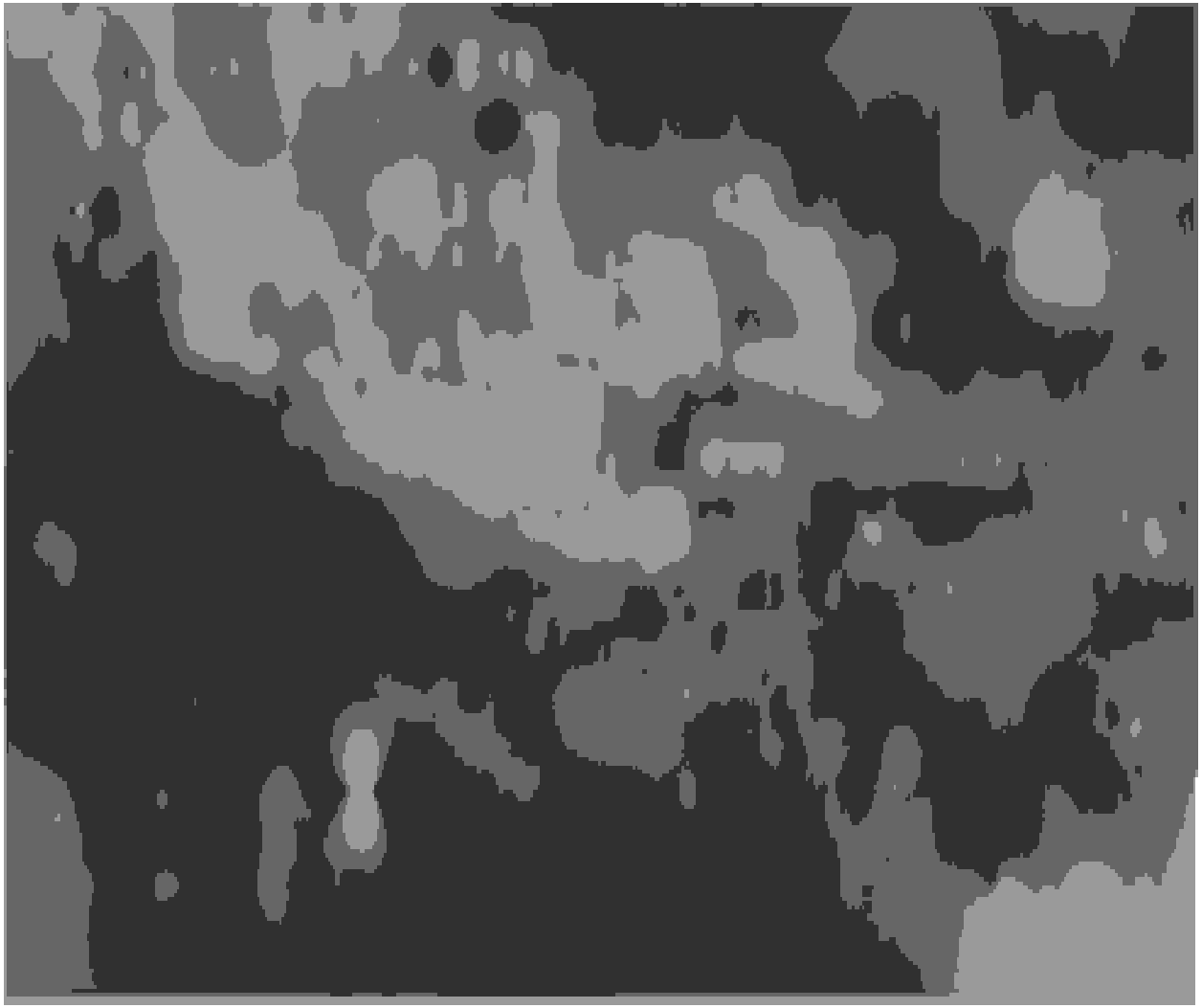
You might pick a poor year for imagery for example.

At least 2 tools improves zone delineation greatly.

3 tools even more

(Do not use NRCS soil maps unless they agree with zones delineated using other tools)


-103.913
-103.9125
-103.912
-103.9115
-103.911
-103.9105
-103.91
-103.9095
-103.909
28
24
20
16
12
8
4
Apparent EC mmohs/cm



Beach, EC, elevation as watershed modeling and satellite imagery, clustered into zones using unsupervised classification in Erdas Imagine

Once the management zones are developed, they are used to direct soil sampling.

From 3-5 zones per field and about 10 cores per zone.

Yield potential does not factor into the zone recommendation.

Zone management is the site-specific system that will describe areas requiring separate soil sampling in 98% of our fields.

The 2 ½ acre grid results in a poor map that will result in less than positive economic return for your trouble.

Zone management will improve the efficiency of fertilizer application, distributing fertilizer to areas that need it, and greatly reducing wasteful application.

More information can be found on my website-
'The source of all soil fertility information important to North Dakota farmers'

https://www.ndsu.edu/soils/personnel/faculty/dr_david_franzen/

https://www.ndsu.edu/fileadmin/soils/pdfs/SF-1176-2.pdf

https://www.ndsu.edu/fileadmin/soils/pdfs/SF-1176-3.pdf

No N Credit Should be Given for a Cover Crop with Cereal Grain, Radish, even if Legumes are added

Nutrient cycling in cover crops??

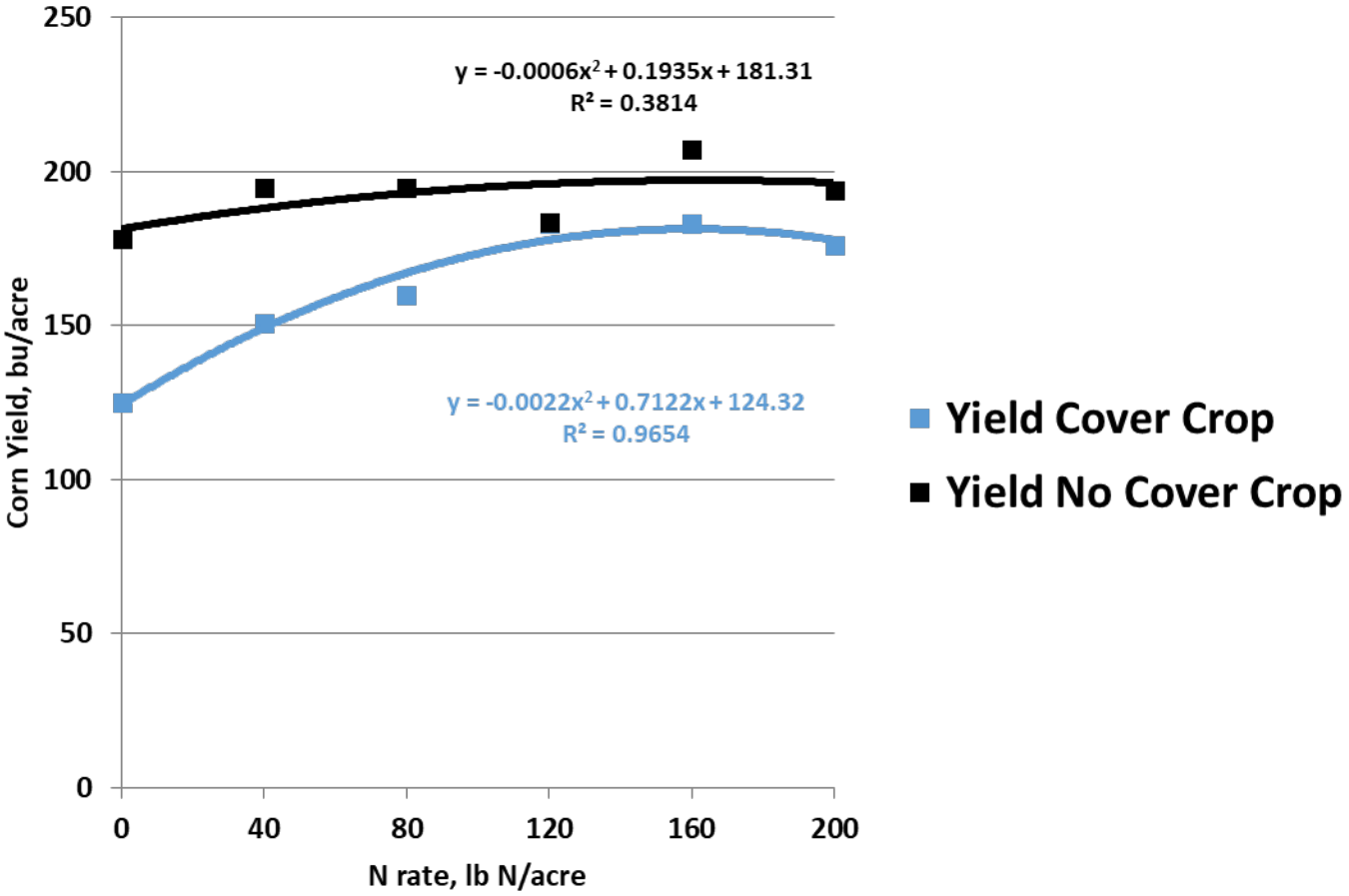
Rutland 2016-17 story-

Fall 2016- cover crop
5,097 lb/acre dry matter- 142 lb N/acre

Residual nitrate in cover crop following winter wheat.

Treatment	8/12	9/28	10/24
	Nitrate-N, lb/acre		
Cover crop	57	18	15
No Cover Crop	50	130	114

Recommended N from calculator for soil and tillage would be 52 lb/acre



Active optical sensor algorithms are been published

Greenseeker (Trimble)

Holland Crop Circle Sensor (Holland Scientific)

The C/N ratio of the cover crop at death/termination is important. BUT

Nitrogen that can be credited to the next crop is iffy.

If decomposition does not go to completion within the period of crop uptake, full equation-value of benefit will not be realized.

An N-rich standard, consisting of the N credit rate, will help the grower have confidence that the N credit is deserved, or will direct them to provide supplemental N to make up deficit.

Conventional Till

Most N lingers in the soil and is Susceptible to

leaching/denitrification

No-Till

N is taken up by microorganisms. Microorganism life cycle is measured in days and weeks. Nutrient cycling is continuous and rapid.

N credit likely comes from increased efficiency of N use compared to conventional till

Conventional Till

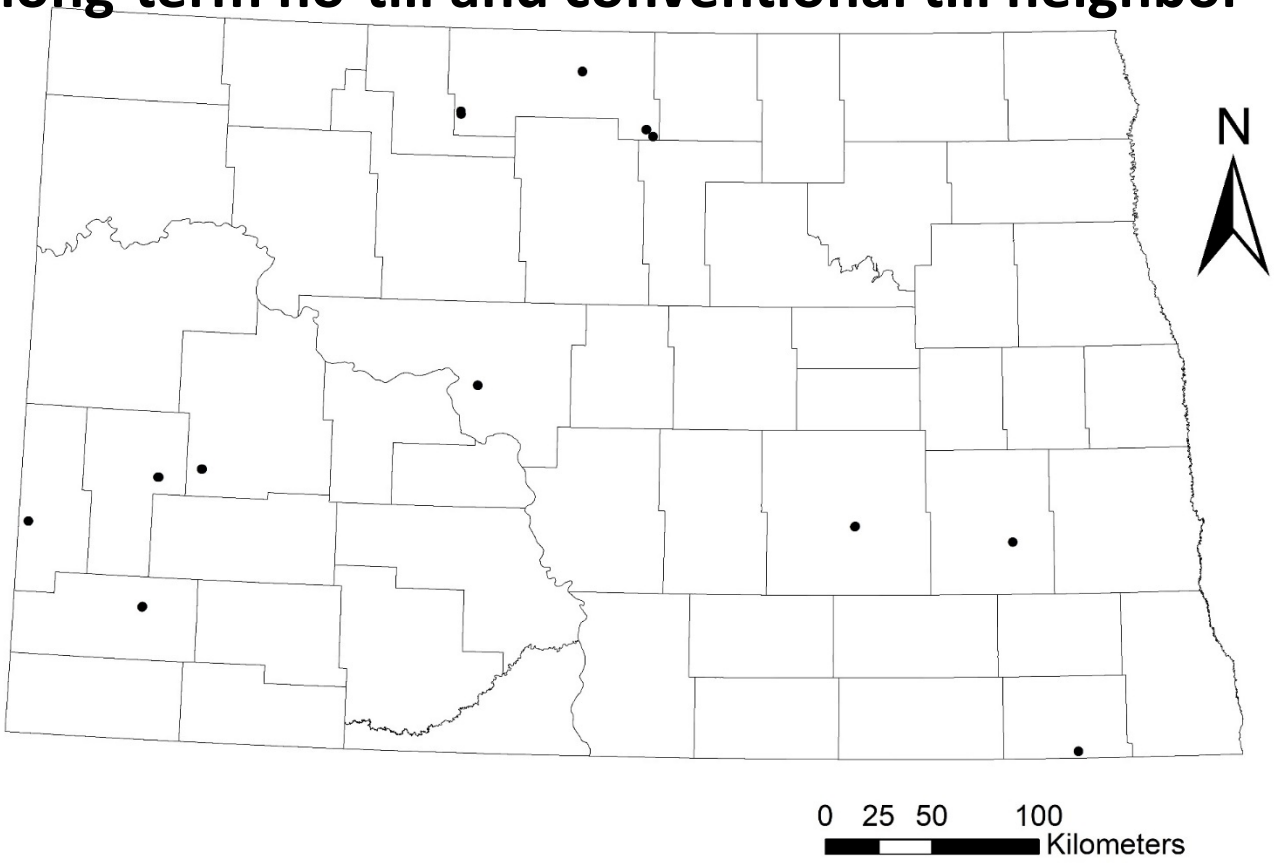
Most N lingers in the soil and is Susceptible to

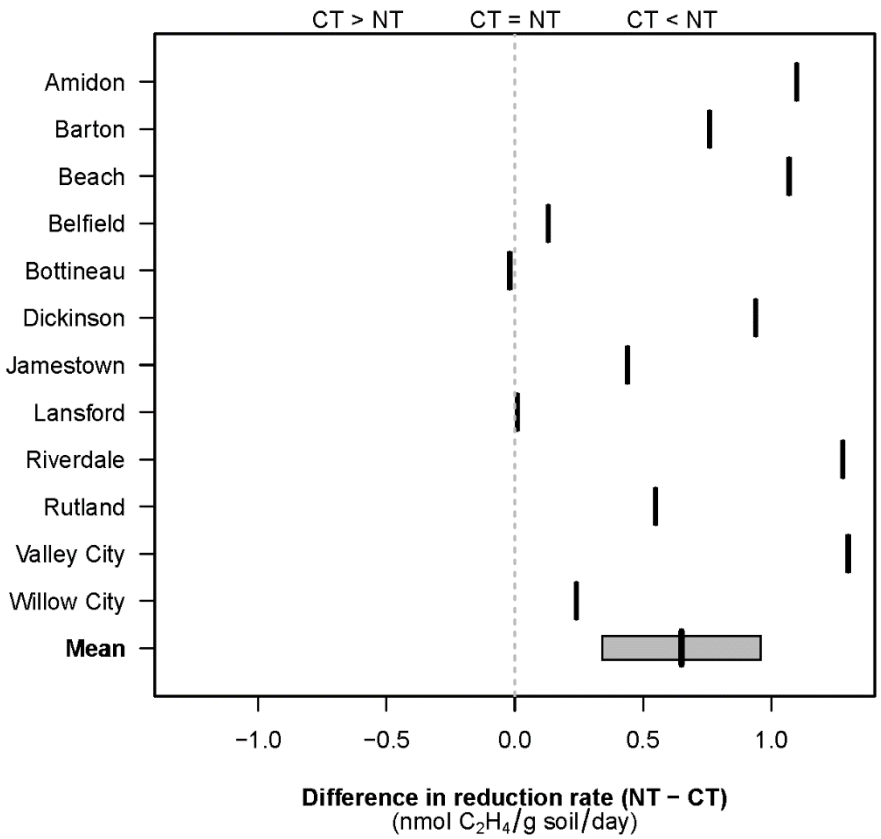
leaching/denitrification

No-Till

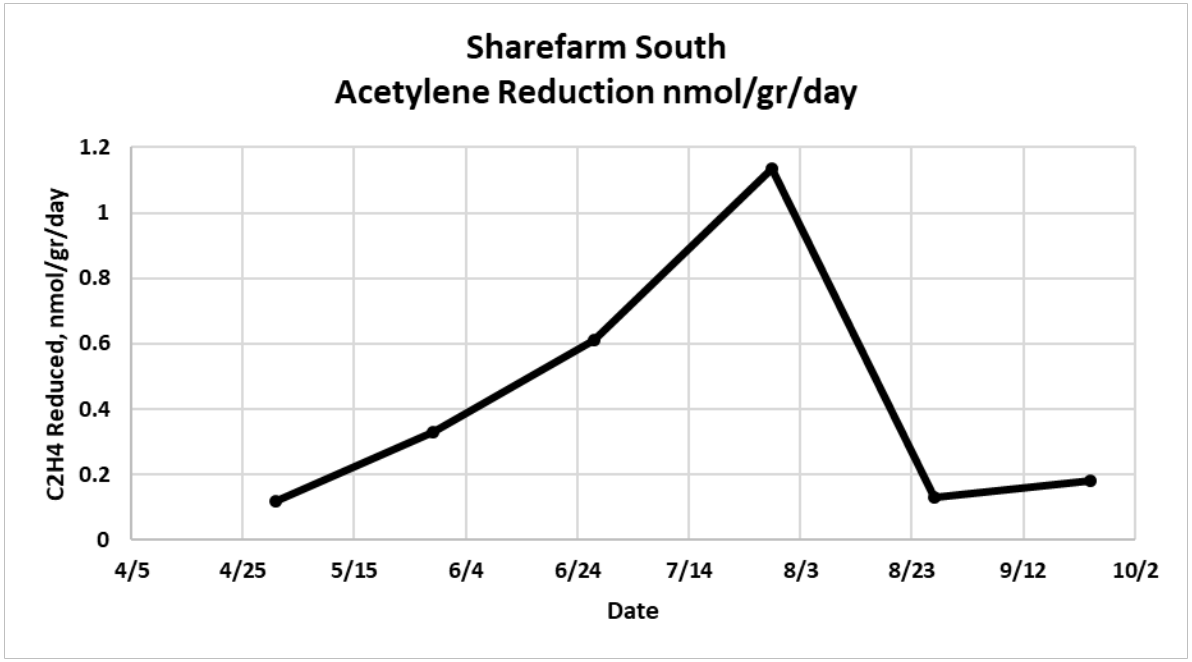
Also, 2018 spring paired soil sampling and incubation analysis by colleague at University of Florida showed much greater asymbiotic N-fixing activity in long-term no-till.

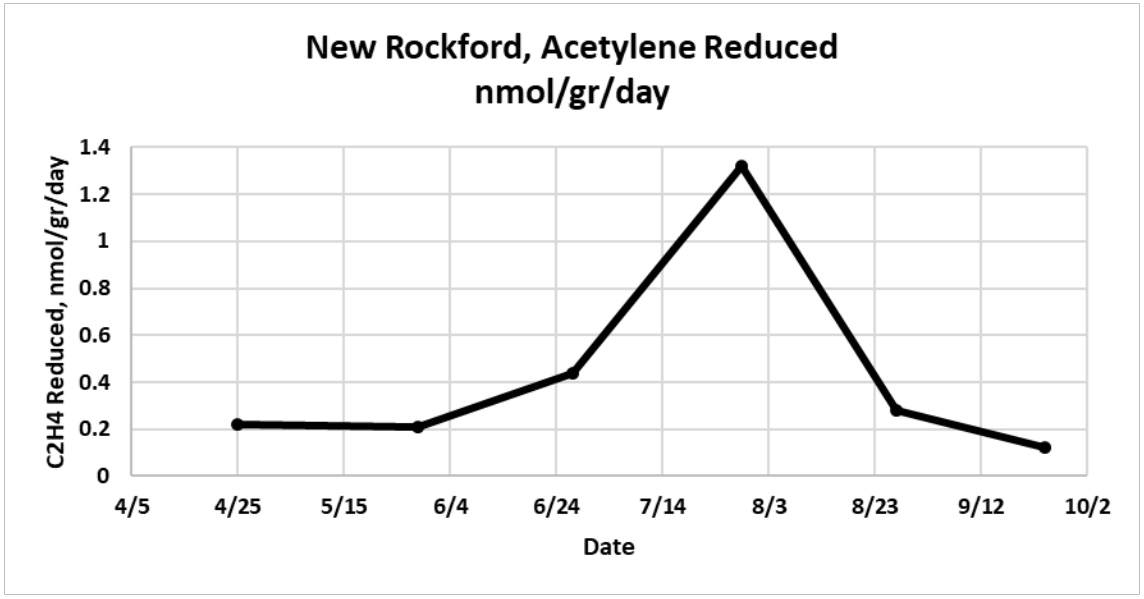
The paired-sampling
long-term no-till and conventional till neighbor




CT > NT
CT = NT
CT < NT
Amidon
Barton
Beach
Belfield
Bottineau
Dickinson
Jamestown
Lansford
Riverdale
Rutland
Valley City
Willow City
Mean
−1.0
−0.5
0.0
0.5
1.0
Difference in reduction rate (NT − CT)
(nmol C2H4/g soil/day)

Considering the different in N-fixing activity of asymbiotic organisms in long-term no-till vs conventional till neighbors, from 15-25 lb/a N come from these organisms, which is a third to one half of the long-term no-till N credit.


Sharefarm South
Acetylene Reduction nmol/gr/day
C2H4 Reduced, nmol/gr/day
1.2
1
0.8
0.6
0.4
0.2
0
4/5
4/25
5/15
6/4
6/24
7/14
8/3
8/23
9/12
10/2
Date


New Rockford, Acetylene Reduced
nmol/gr/day
C2H4 Reduced, nmol/gr/day
1.4
1.2
1
0.8
0.6
0.4
0.2
0
4/5
4/25
5/15
6/4
6/24
7/14
8/3
8/23
9/12
10/2
Date

New Managing Saline Soils circular available
Also, new managing sodic soils circular

All crop fertility circulars were updated late 2017 through late 2019 that include overhauls.

These are downloadable from the web when needed and printed out at end-user location.