KSU Soil Fertility Management Meetings

24 January 2023

- *Lincoln*
- *Hays*

25 January 2023

- *Colby*
- *Norton*

K·STATE
Research and Extension

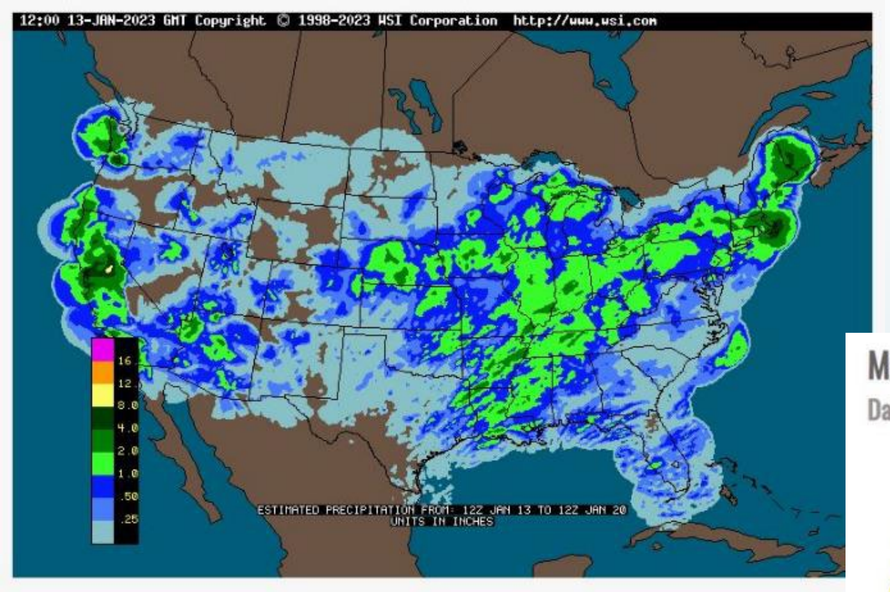
Fred Vocasek

Senior Lab Agronomist

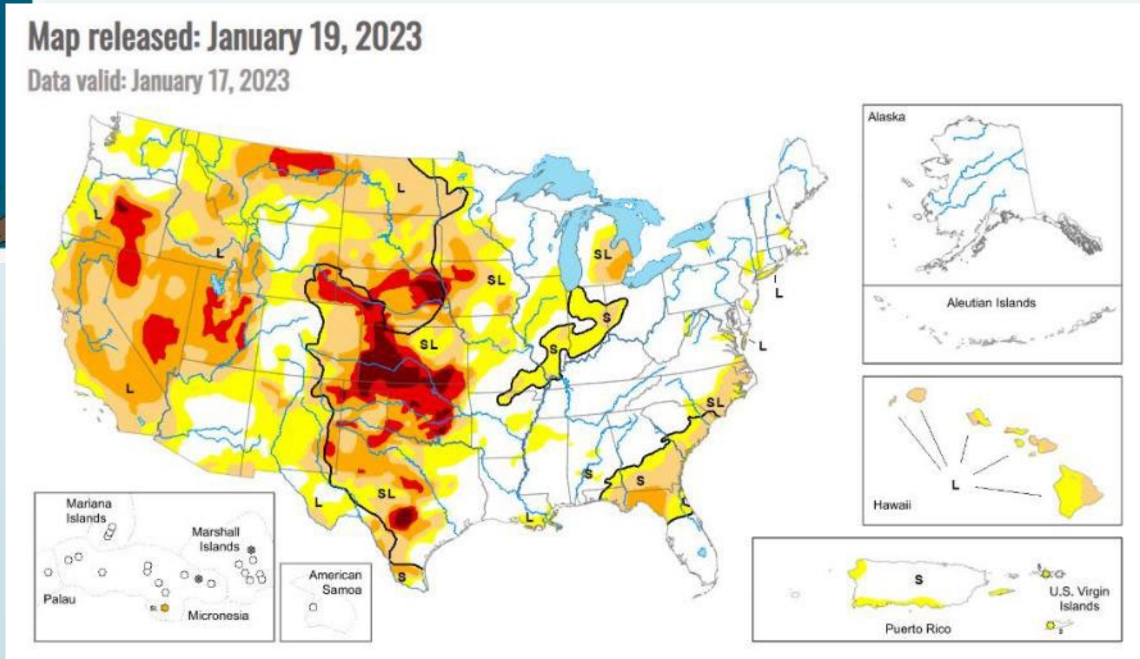
CCA #01803

ServiTech Laboratories, Dodge City, Kansas

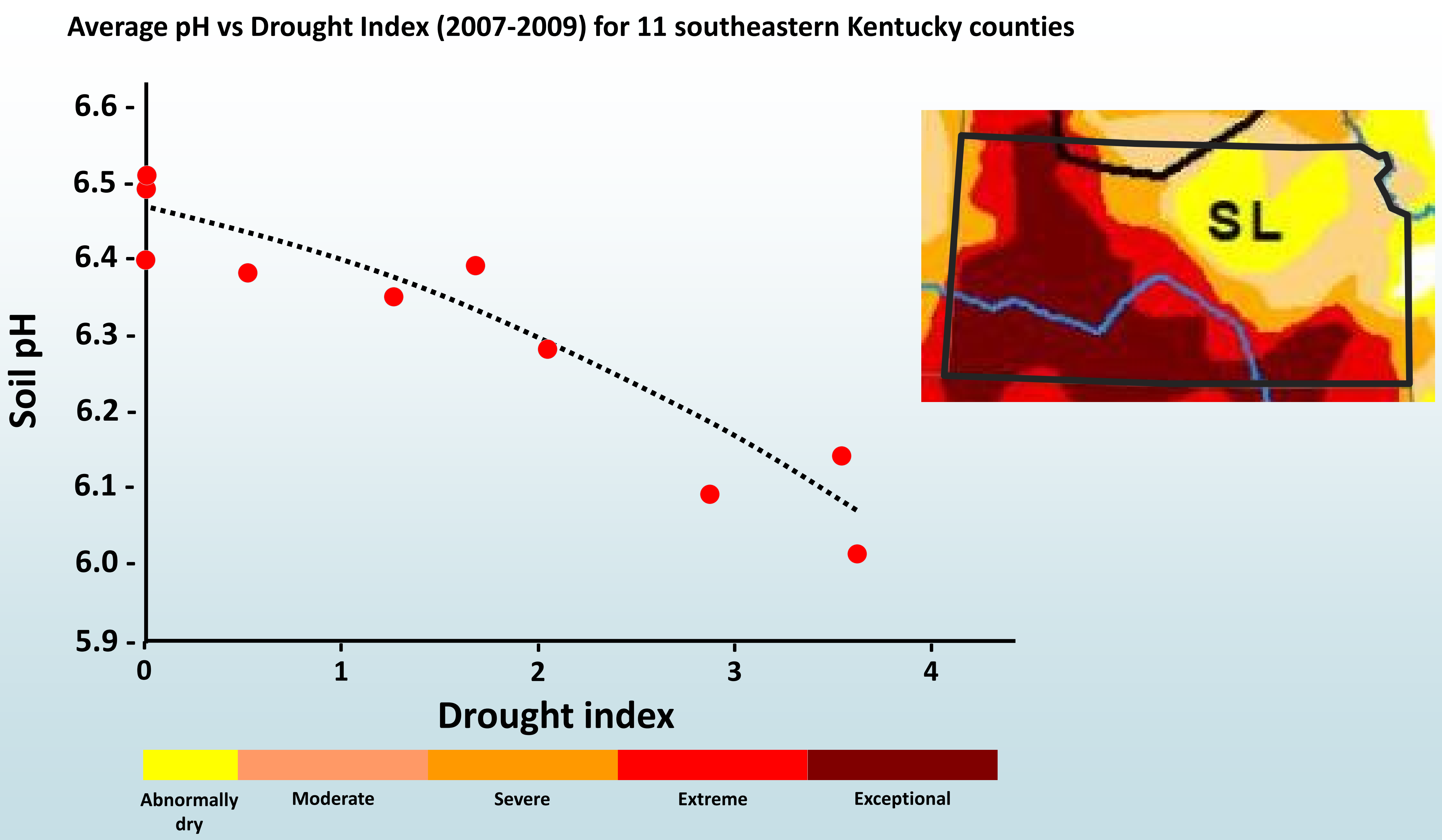
Weather events can impact soil test results



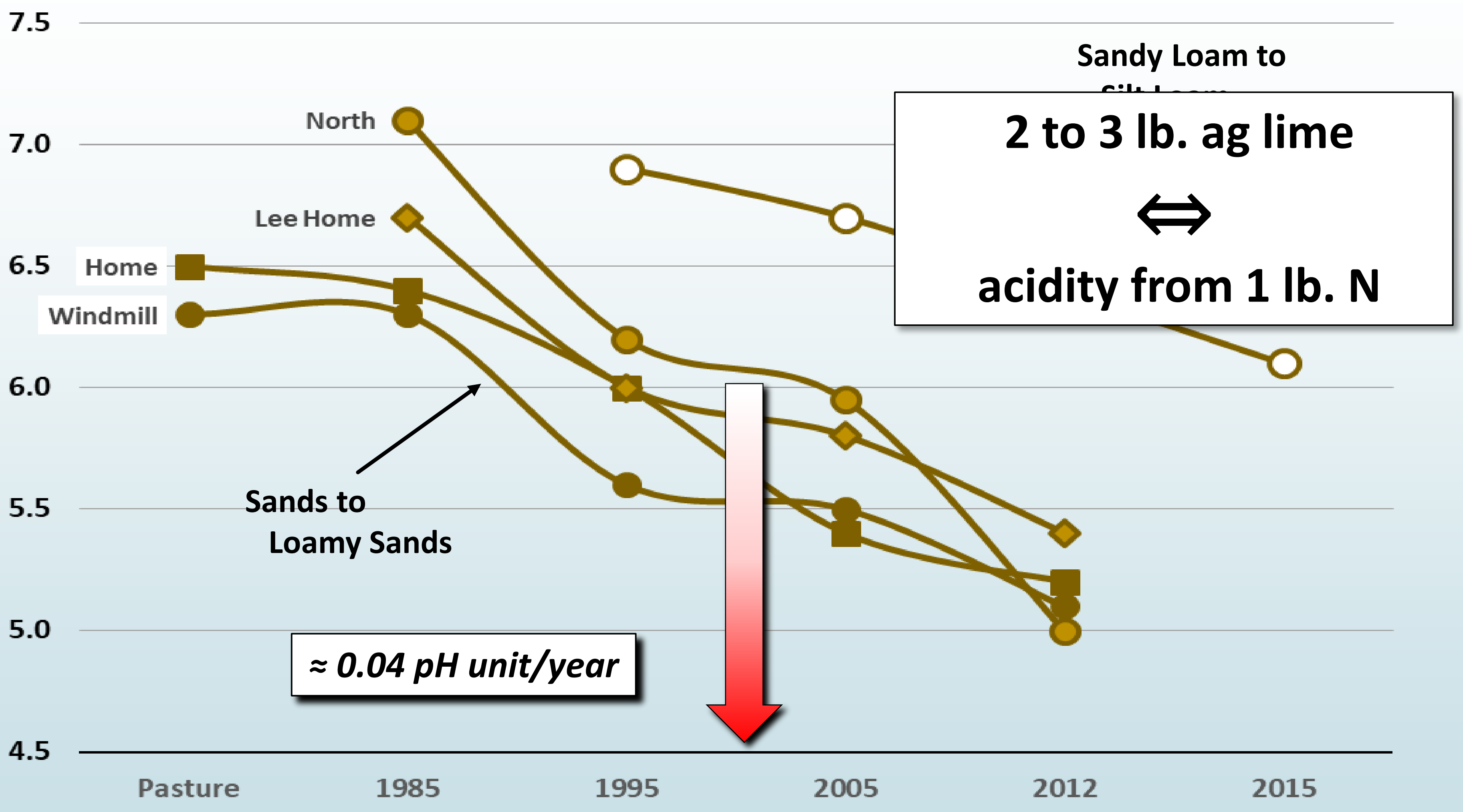
https://www.wunderground.com/maps/precipitation/weekly



https://droughtmonitor.unl.edu/


Average pH vs Drought Index (2007-2009) for 11 southeastern Kentucky counties
6.6
6.5
6.4
6.3
6.2
6.1
6.0
5.9
Soil pH
0
1
2
3
4
Drought index
SL
Abnormally dry
Moderate
Severe
Extreme
Exceptional

Monitoring soil pH changes over time *(northeast Colorado)*



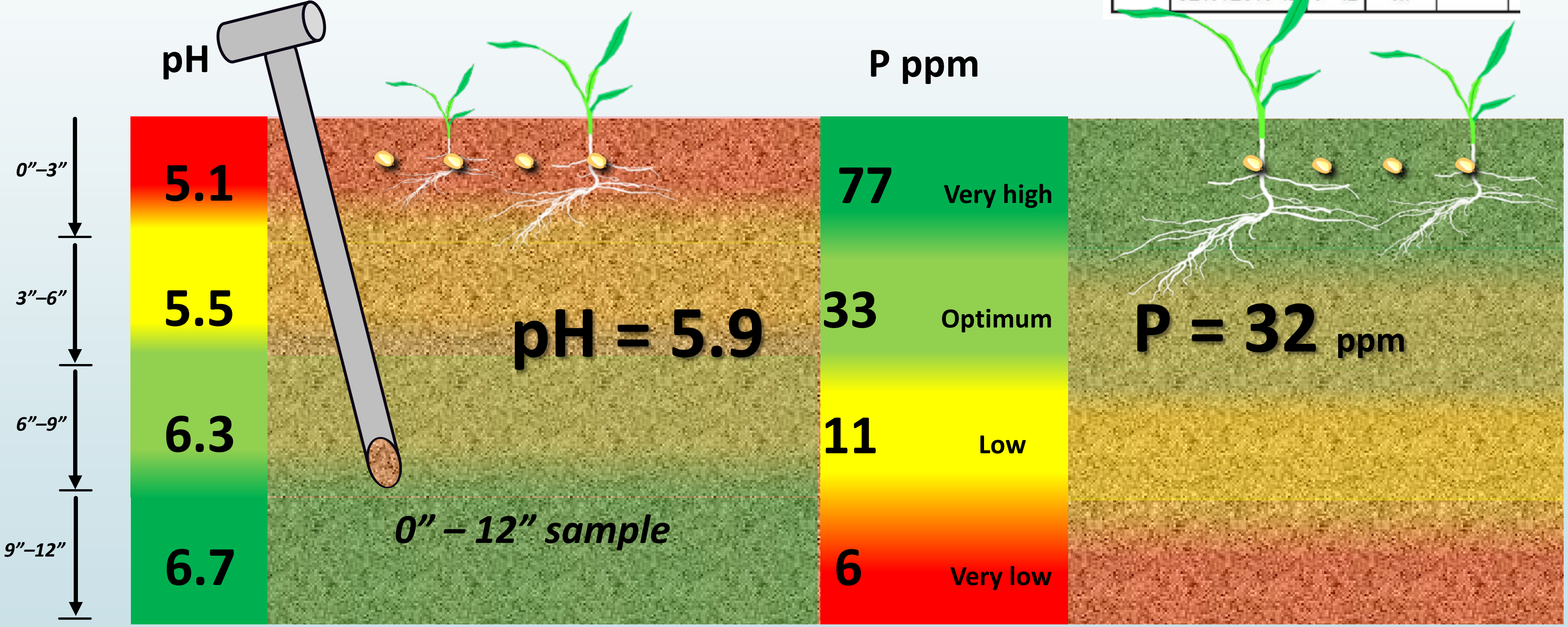
- *Northeast Colorado area*
- *15” to 18” rainfall*
- *4000’ elevation*

- *wheat/corn/fallow & continuous corn*
- *farmed since 1890 to 1920*
- *data courtesy of Dave Green, ServiTech*

"Stratification"

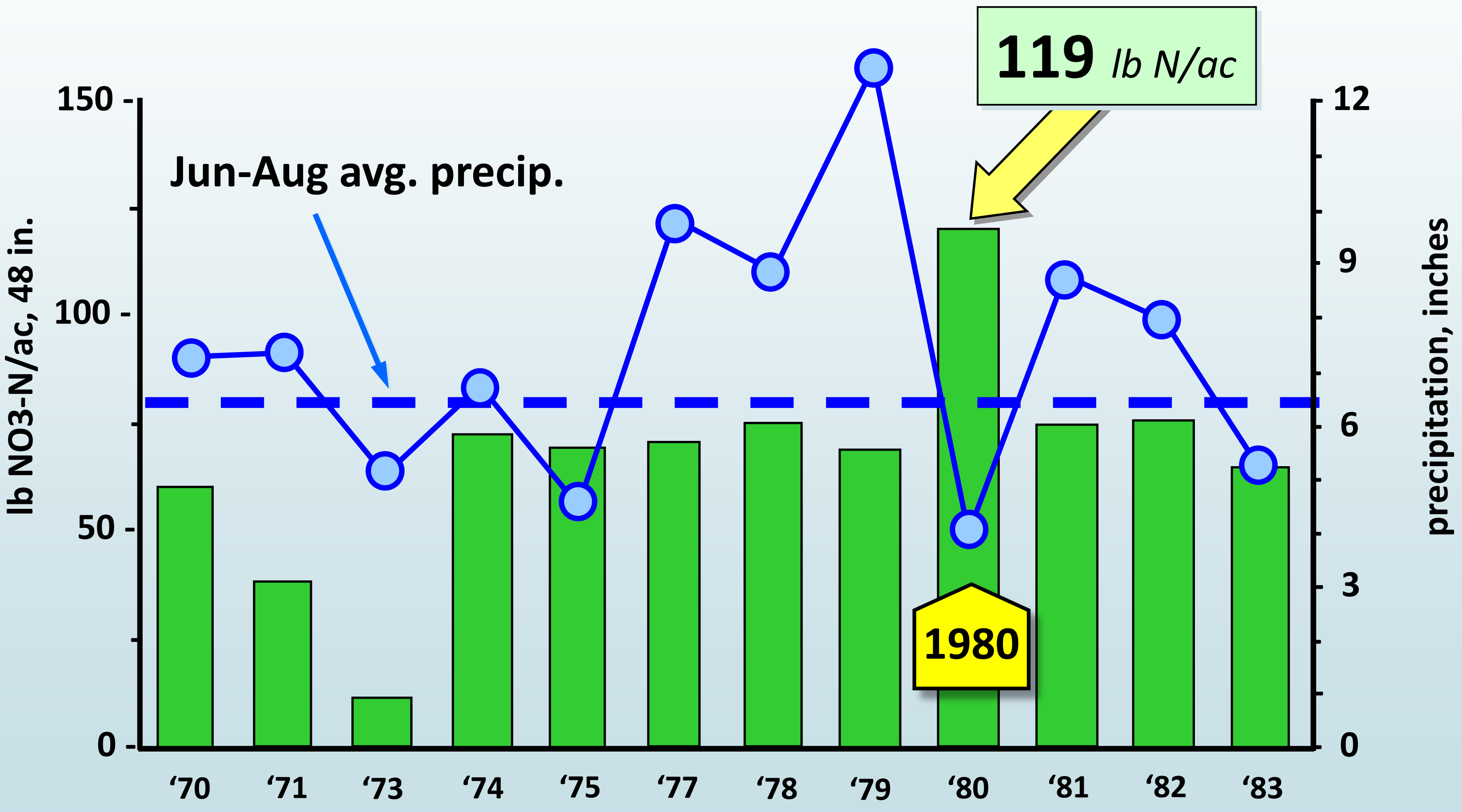
SOIL ANALYSIS RESULTS FOR:

METHOD USED:			1:1 (c) Water-Soil	Sikora 2
Lab Number	Sample ID	Sample Depth	Soil pH	Buffer pH
	SE15TEST 0-3	0 - 3	5.1	6.5
	SE15TEST 3-6	3 - 6	5.5	6.7
	SE15TEST 6-9	6 - 9	6.3	
	SE15TEST9-12	9 - 12	6.7	



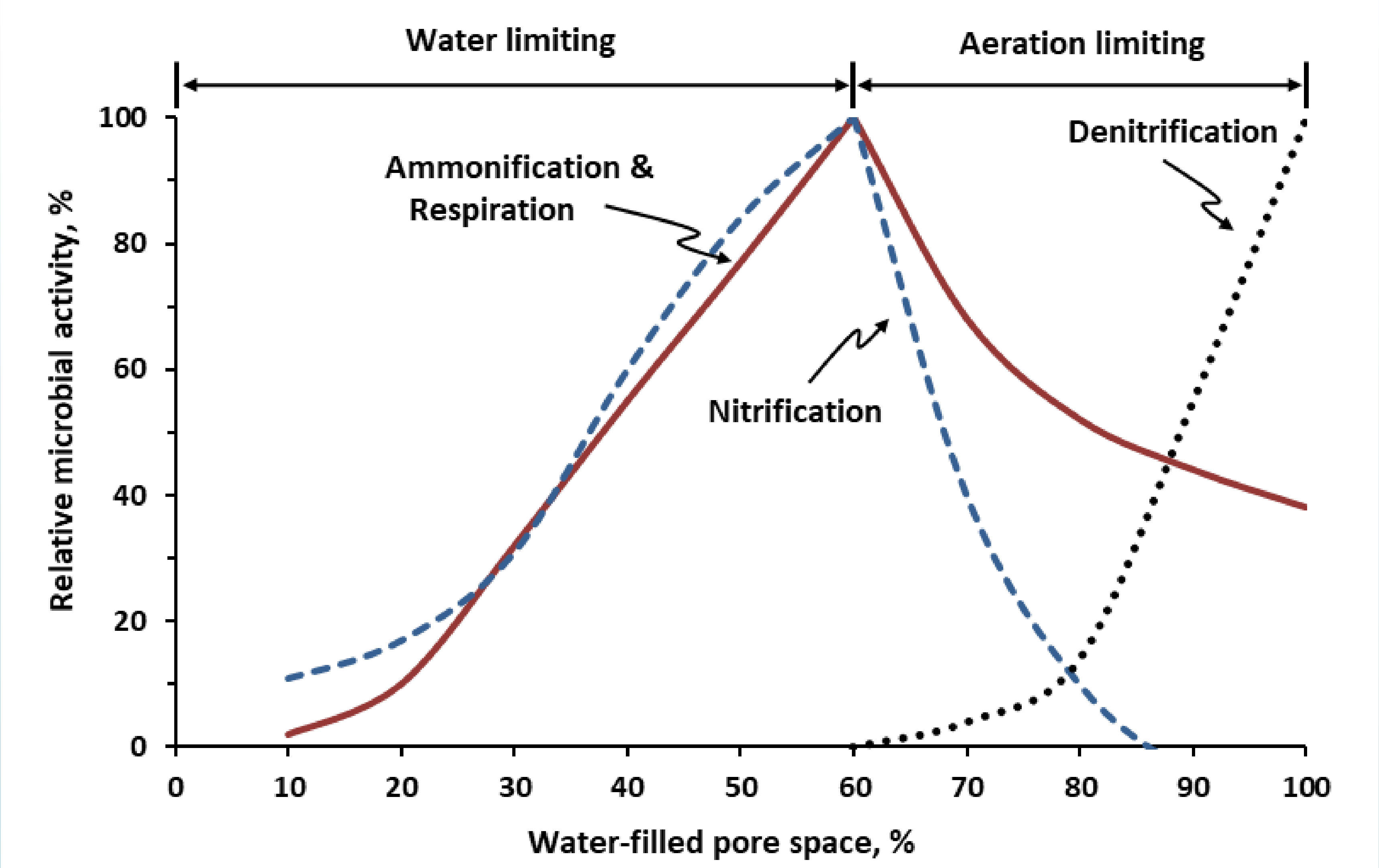
Drought and soil nitrates

Alliance, Nebraska: avg = 15.5 in/yr
fallow wheat, no nitrogen applied

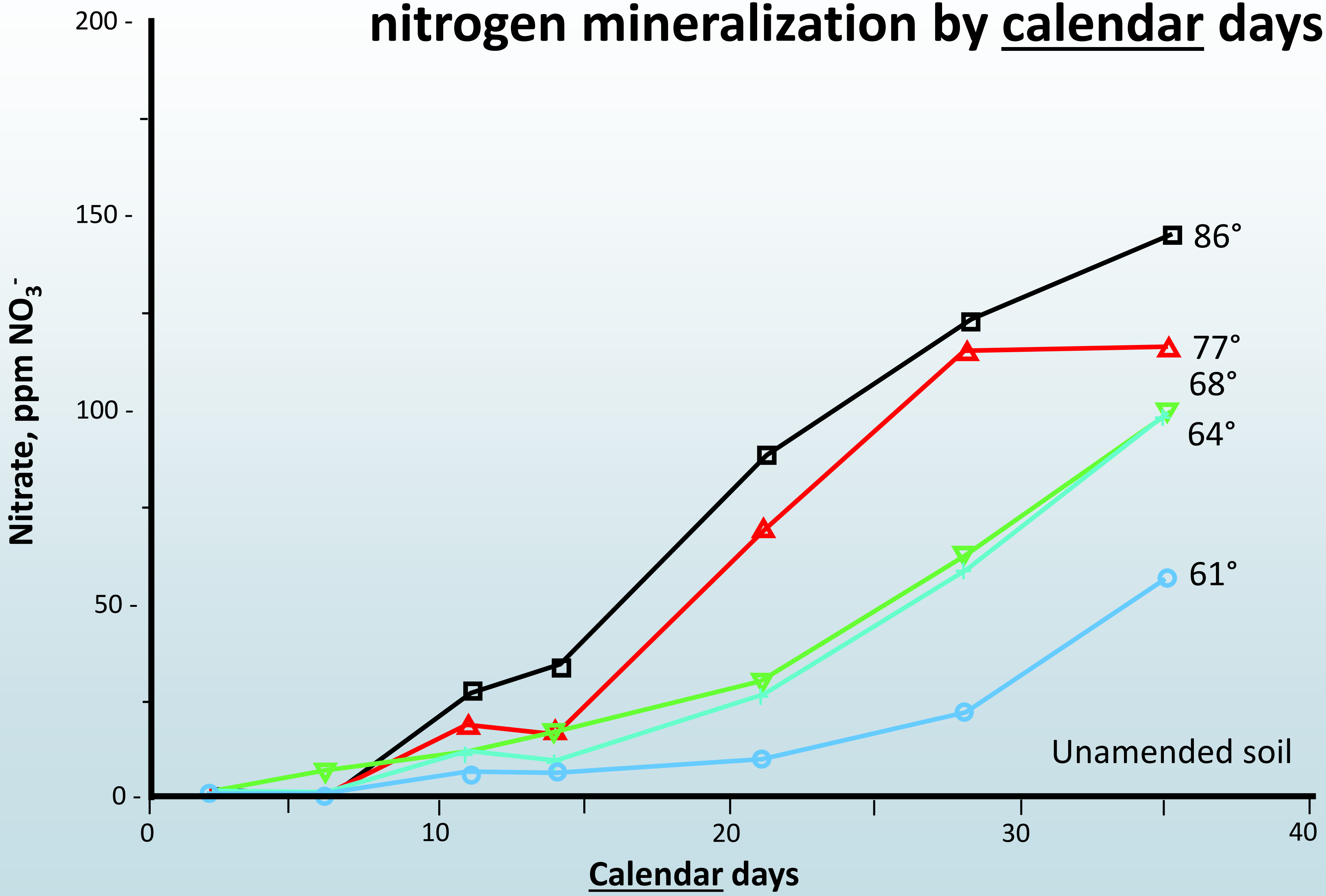


Lamb, Peterson, Fenster. 1985 Agron. Journ.

Soil moisture affects microbial processes

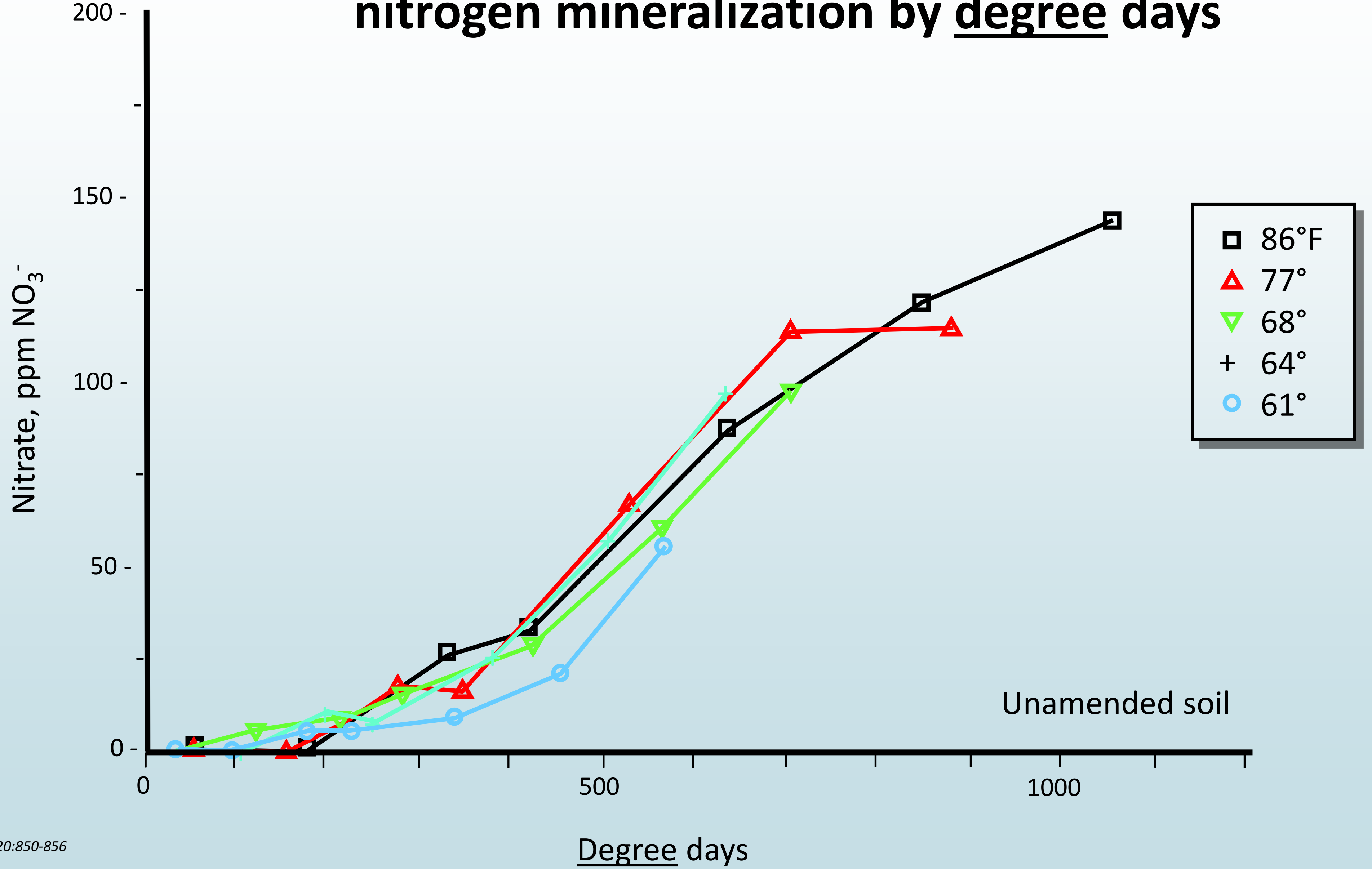


Soil temperature affects rate of nitrogen mineralization by calendar days



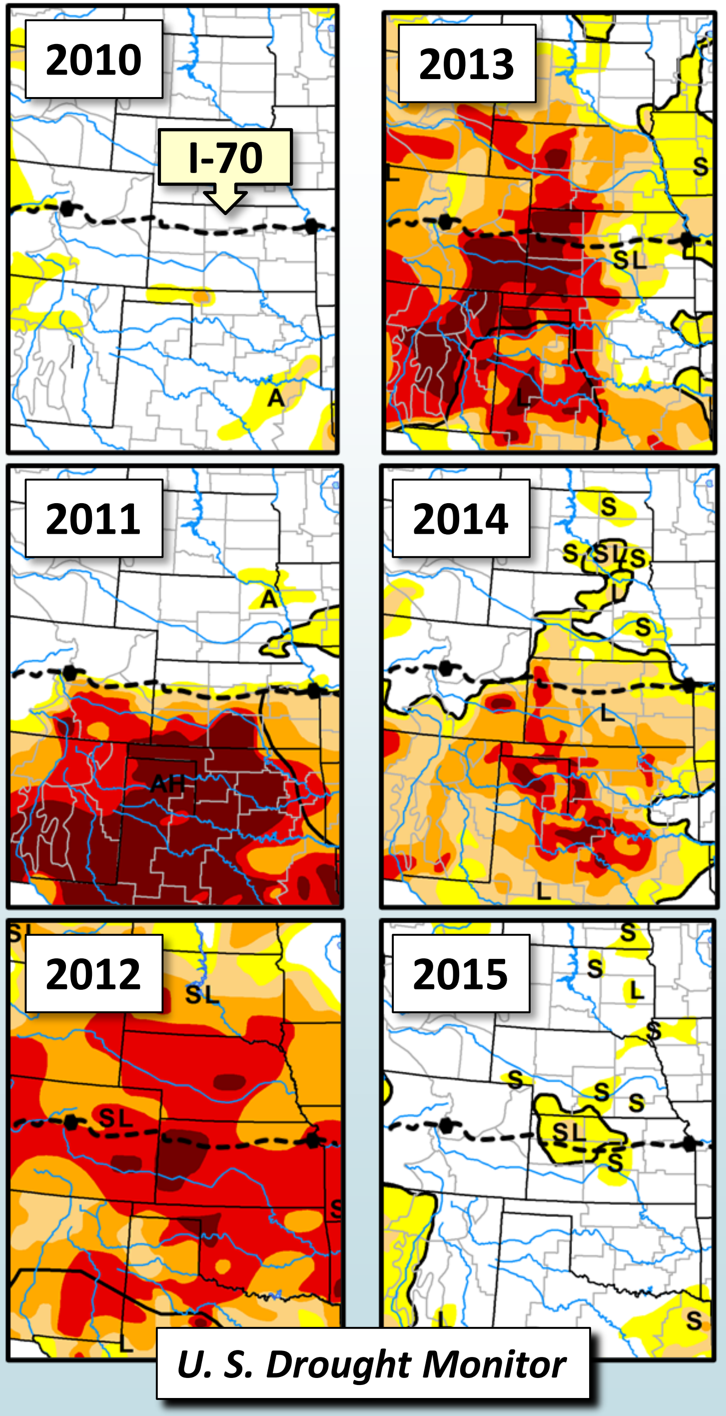
Honeycutt, et. al. 1991. JEQ 20:850-856

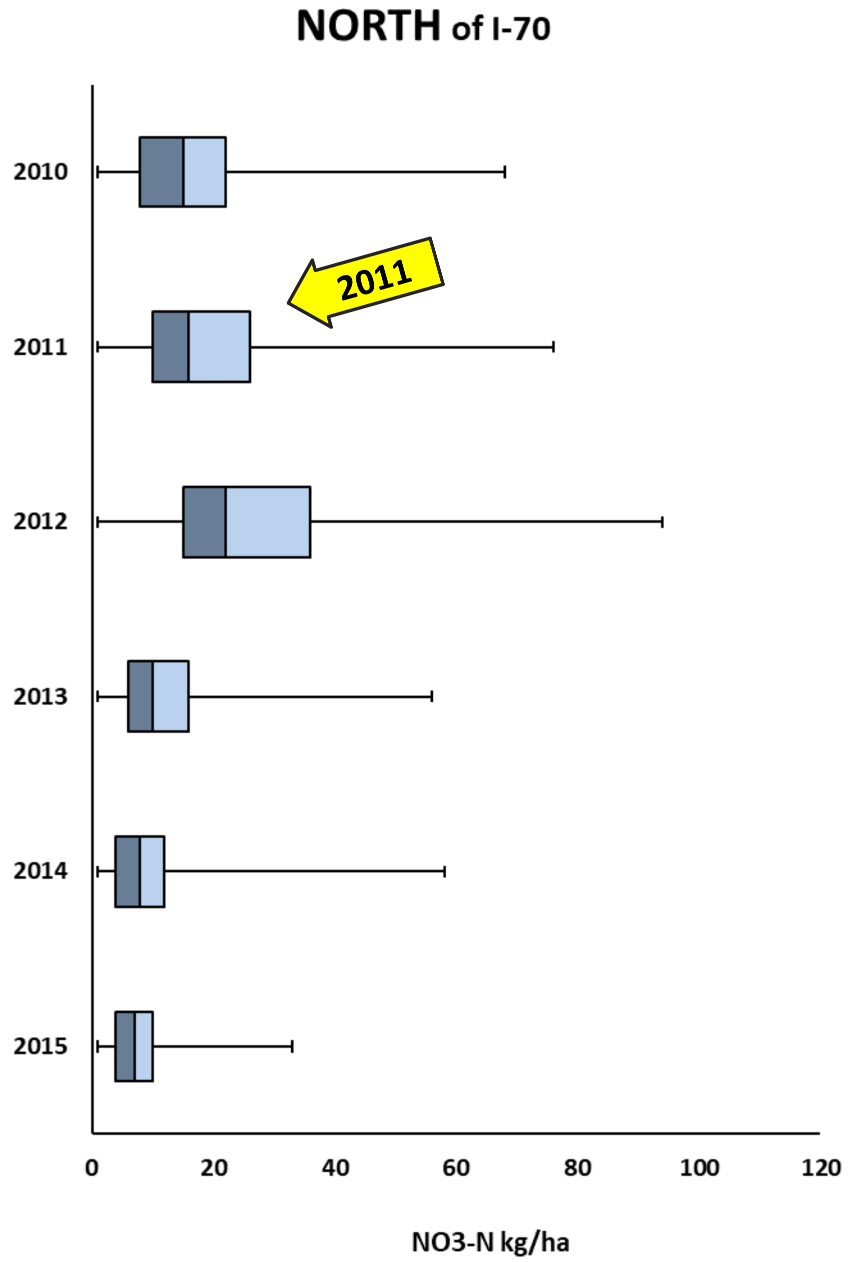
Soil temperature affects rate of nitrogen mineralization by degree days



Honeycutt, et. al. 1991. JEQ 20:850-856

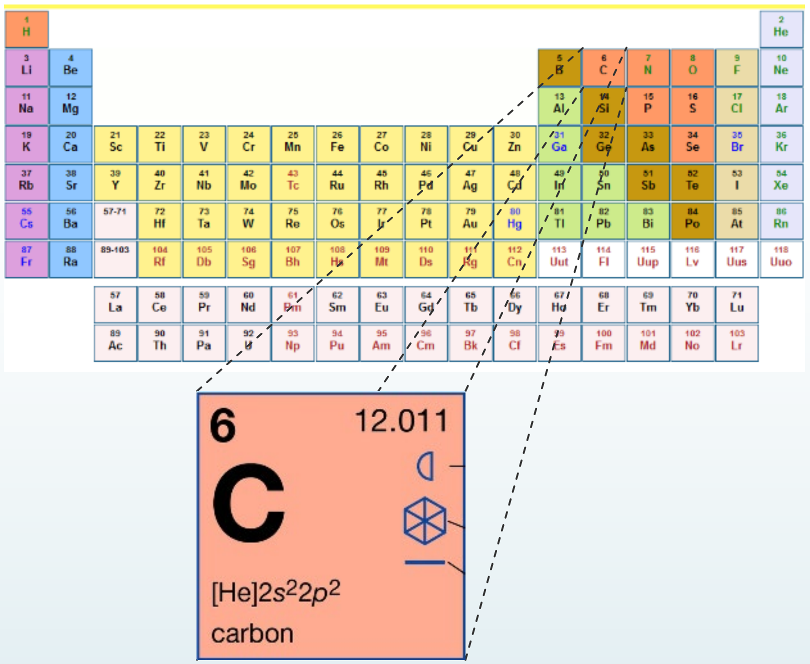

SOUTH of I-70
2011
2010
2011
2012
2013
2014
2015
0
20
40
60
80
100
120
NO3-N kg/ha


2010
I-70
A
2013
S
SL
L
2011
A
AH
2014
S
S SLS
S
L
L
2012
SL
SL
S
L
2015
S
S
L
S
S
S
S
SL
S
S
U. S. Drought Monitor

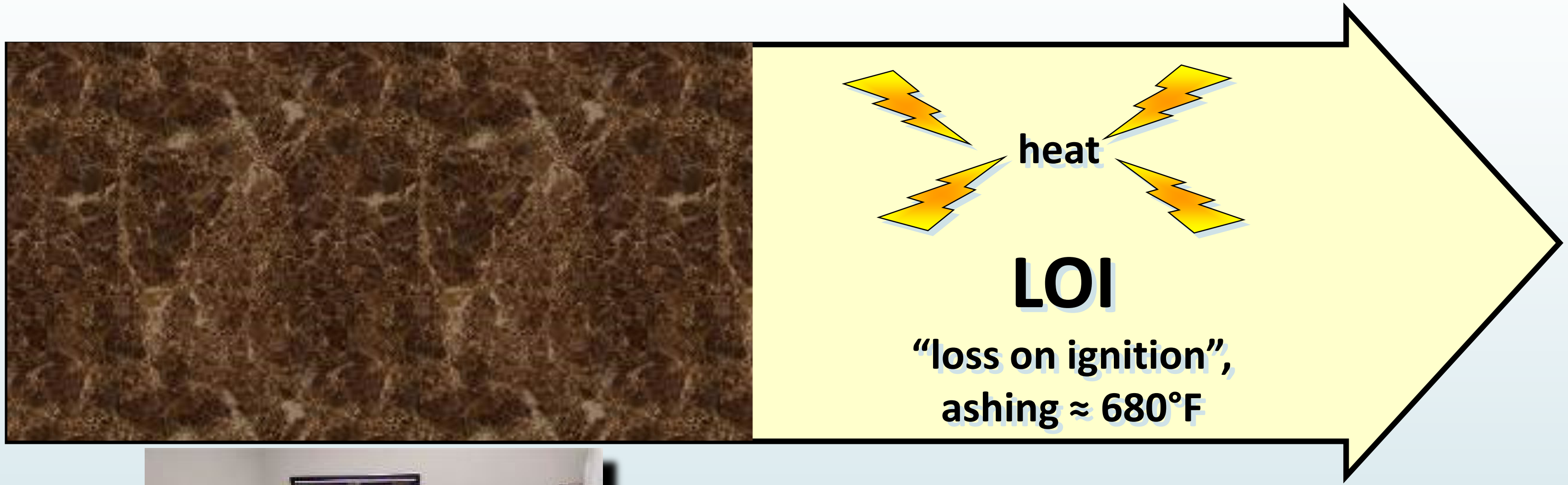

NORTH of I-70
2011
2010
2011
2012
2013
2014
2015
0
20
40
60
80
100
120
NO3-N kg/ha

What is soil carbon??

- soil organic matter ≈ 56% carbon
- feedlot manure ≈ 8% to 15% C
- cellulose ≈ 49% C
- glyphosate ≈ 21% C
- diesel fuel ≈ 86% C
- human body ≈ 10% C



Measuring soil organic matter

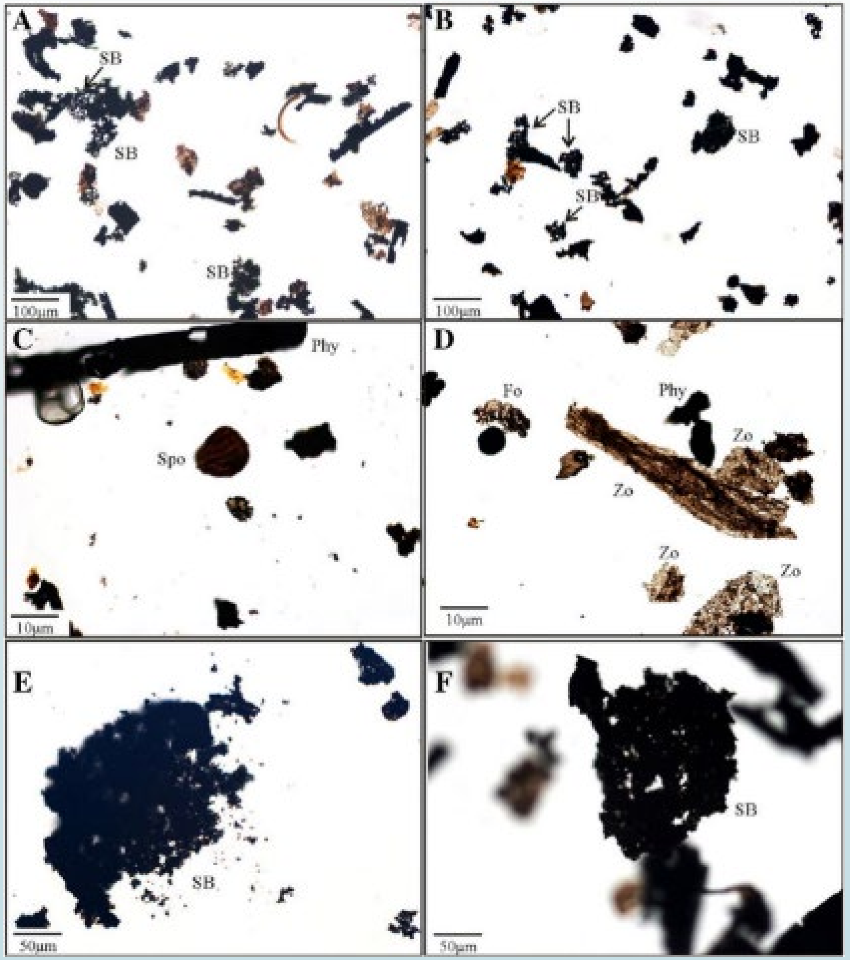


LOI
% Organic matter
2.8
0.8
1.5

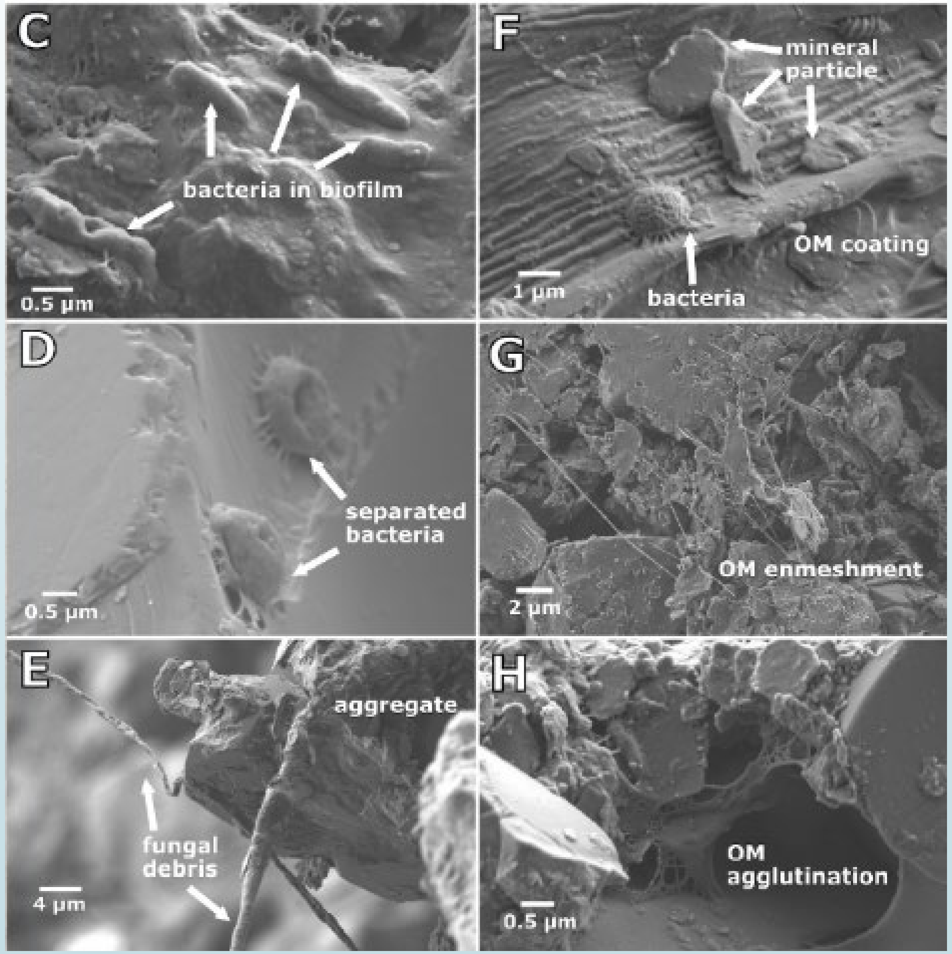
Organic matter is not just one thing.
CO_2
Function
Persistence
1% OM ≈ 36,000 lb OM/ac-ft
Plant biomass
living & active
Accumulation
Days – weeks
Microbial biomass
living & active
Decomposition
Hours – days
400 – 700 lb/ac-ft
Active OM
dead & active
Mineralization
Months – few years
2,000 - 3,500 lb/ac-ft
Slowly degradable OM
dead & inactive
Stabilization
Years – decades
4,000 - 10,000 lb/ac-ft
Passive OM
(humic materials)
very dead & very inactive
Structural preservation
Decades – centuries
20,0000 – 30,000 lb/ac-ft

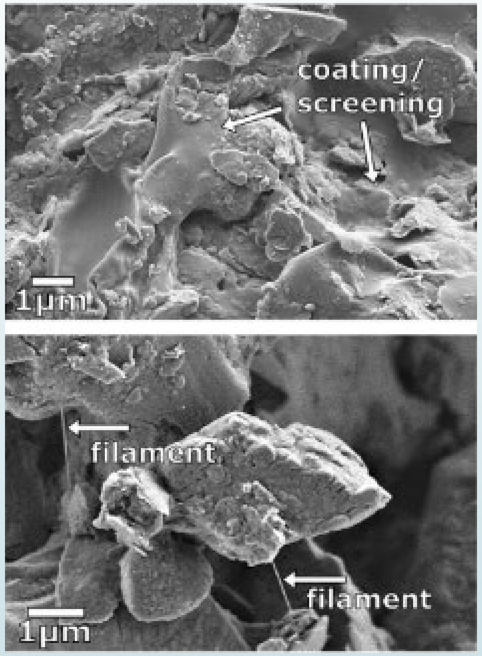
Organic matter is not just one thing.

Particulate organic matter
(10% to 20% of soil OM)



Mineral-associated & biogenically excreted organic matter
(80% to 90% of soil OM)

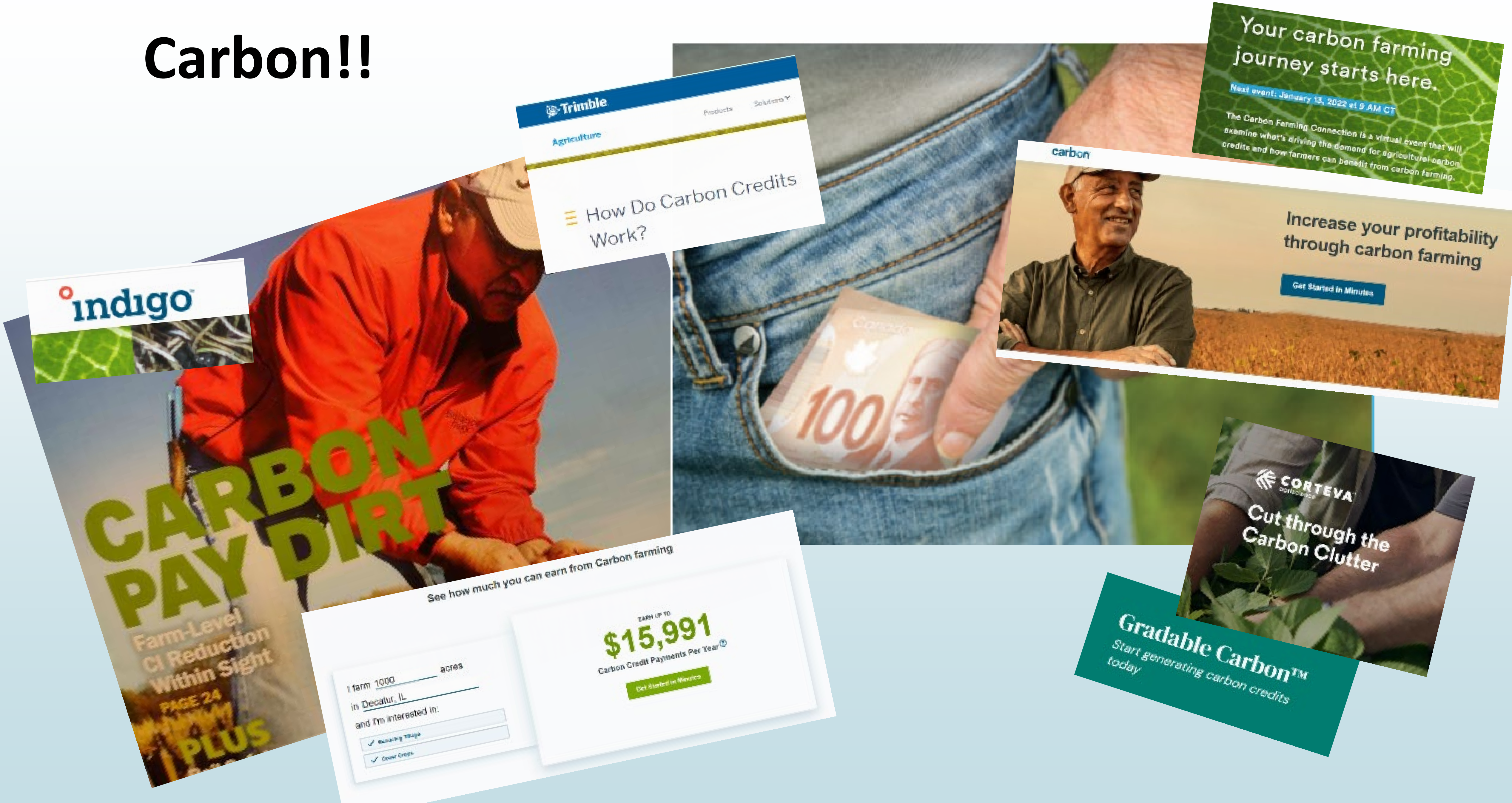




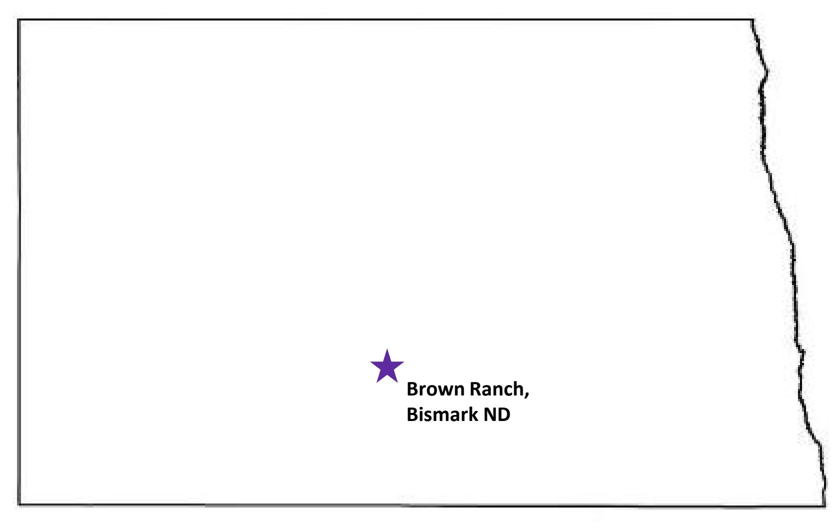
agglutination = clumping of particles

1 μm = 1 micron
1 μm ≈ 1/25,000th inch

Carbon!!


indigo
Trimble
Agriculture
How Do Carbon Credits Work?
Your carbon farming journey starts here.
Next event: January 13, 2022 at 9 AM CT
The Carbon Farming Connection is a virtual event that will examine what's driving the demand for agricultural carbon credits and how farmers can benefit from carbon farming.
carbon
Increase your profitability through carbon farming
Get Started in Minutes
CARBON PAY DIRT
Farm-Level CI Reduction Within Sight
PAGE 24
PLUS
100
See how much you can earn from Carbon farming
I farm 1000 acres
in Decatur, IL
and I'm interested in:
$15,991
Carbon Credit Payments Per Year
CORTEVA
Cut through the Carbon Clutter
Gradable Carbon™
Start generating carbon credits today

Building organic matter



… in the past **20 years** has seen his soil organic matter increase from **1.9%** to **6.1%** …

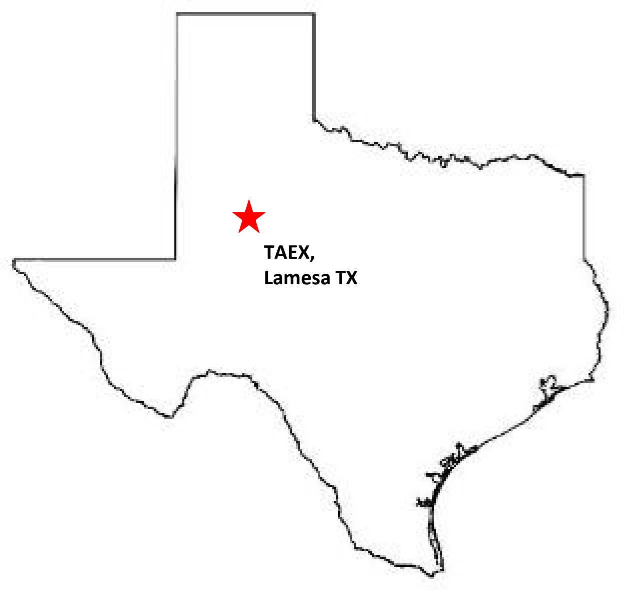
SARE National Conference on Cover Crops & Soil Health, Nov. 2017

https://www.covercropstrategies.com/articles/344-video-gabe-brownsare-national-conference-on-cover-crops-soil-health

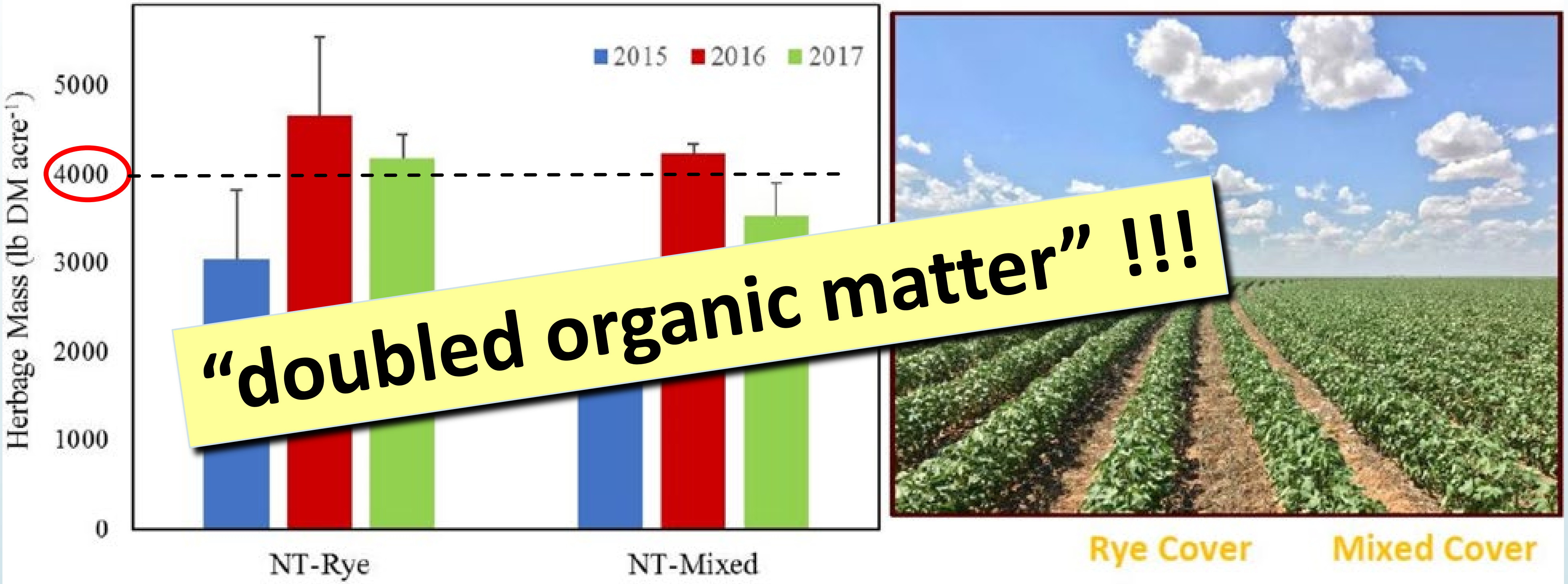
Building organic matter: research, Texas

Location	Annual precip, in.	Soil texture	Initial OM %
Lamesa, TX	19	fSaL	0.30 – 0.35

- 19 years, 1998 – 2017
- Continuous cotton
- Deficit irrigation, LEPA
- Tillage systems:
  - conventional till
  - no-till, rye cover-crop
  - no-till, mixed cover-crop



Cover Crop Biomass



2014 - 2015
Seeded: 2 Dec 2014
Terminated: 26 March 2015

2015 - 2016
Seeded: 4 Nov 2015
Terminated: 10 March 2016

2016 - 2017
Seeded: 12 Dec 2016
Terminated: 28 March 2017

Adapted from https://www.plantmanagementnetwork.org/edcenter/seminars/2017AgChemicalsConference/CoverCropSemiAridRegions/CoverCropSemiAridRegions.pdf

Building organic matter

Cereal rye, silage:

- 63 % moisture (27% DM)
- 10.1 % ash *(dry matter basis)*

C. **4,000** lb/ac residue dry matter
x 10.1 % ash
= 404 lb/ac ash in residue

D. 4,000 lb residue/ac
\- 404 lb ash/ac
= 3,596 lb residue-OM/ac

E. 3,596 lb OM/ac
x 47.5 % *(typical C content of plant OM)*
= 1,708 lb residue-C/ac

I. 1,708 lb C/ac
x 10 % *(10% residue C remains as measurable soil C)*
= 171 lb soil organic carbon/ac

J. 171 lb SOC/ac
x 1.72 *(to convert soil C to soil OM)*
= 294 lb SOM/ac

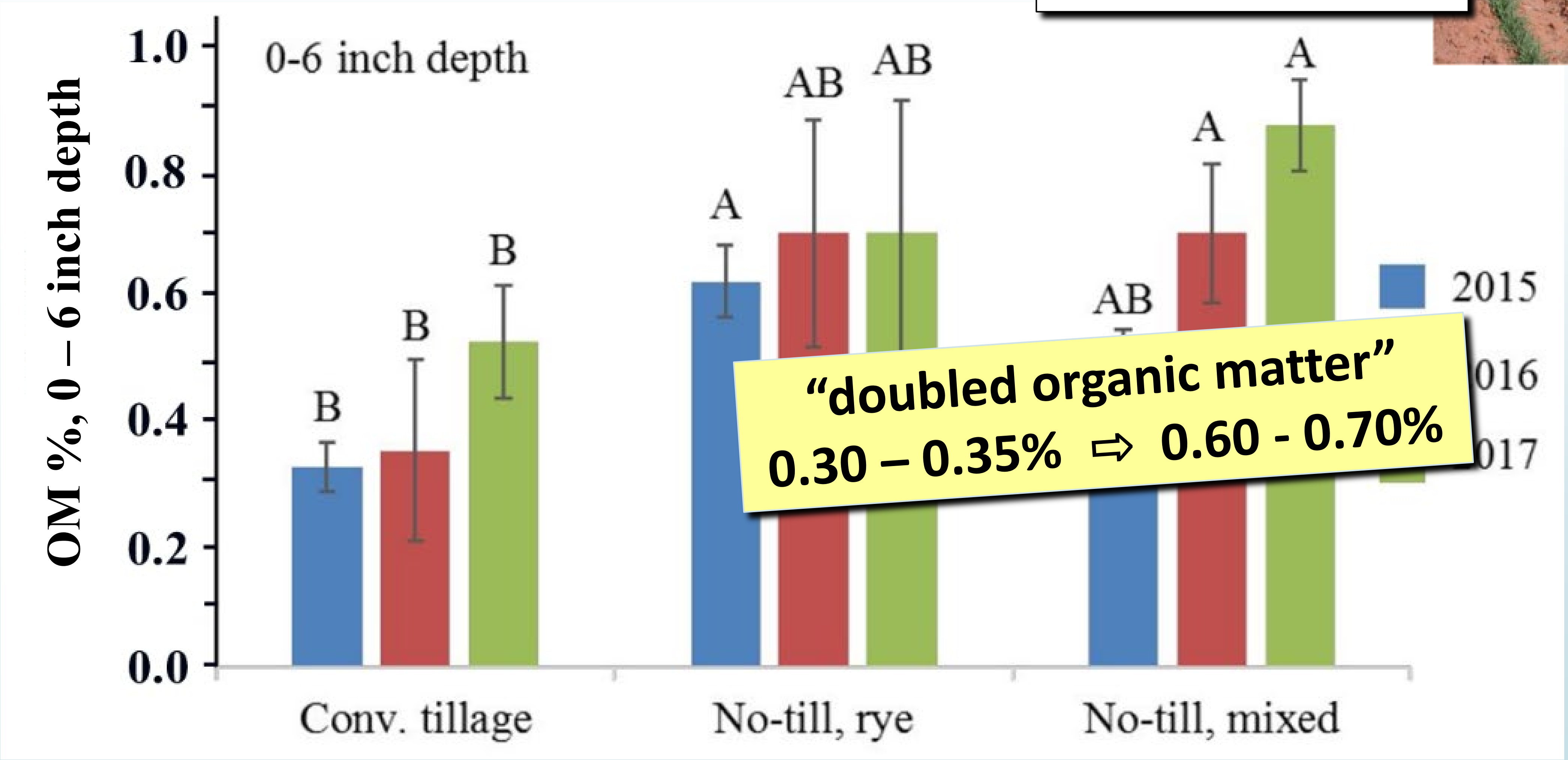
K. 6 inch, soil sample depth
x 300,000 lb soil/ac-in of depth
= 1,800,000 lb soil/ac

L. 294 lb SOM/ac
÷ 1,800,000 lb soil/ac
= 0.00016 = soil SOM fraction

M. 0.00016 SOM fraction
÷ 100 *(to convert to percentage)*
= **0.016** % expected annual SOM increase

Building organic matter

	0.016	% OM per year
x	19	years
	0.30	% OM increase



Adapted from https://www.plantmanagementnetwork.org/edcenter/seminars/2017AgChemicalsConference/CoverCropSemiAridRegions/CoverCropSemiAridRegions.pdf

Building organic matter

6.1% SOM *(now)*
\- 1.9% SOM *(20 years ago)*
= 4.2% SOM increase

4.2% SOM
÷ 20 years
= **0.21%** SOM increase/year required

1,800,000 lb soil in 6_ac-in (assumed)
x 0.21% SOM
= 3,780 lb SOM/ac/yr required

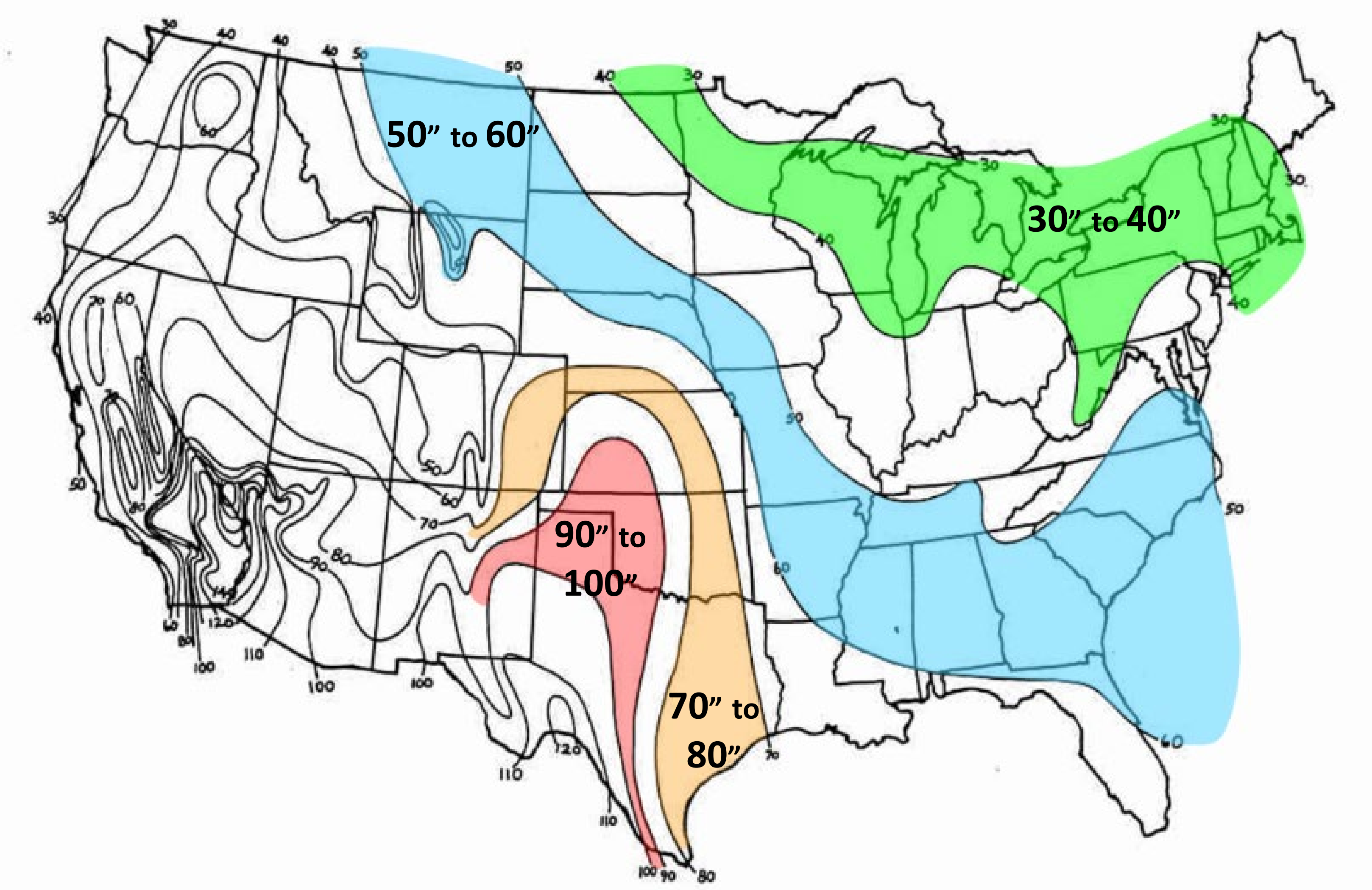
3,780 lb SOM/ac/yr
x 58% carbon
= 2,192 lb SOC/ac/yr required to increase 0.21% OM

852 lb residue-C/ton of rye silage dry matter
x 10% *(of residue C remains as measurable soil C)*
= 85 lb residual-C/ton of rye silage DM

2,192 lb SOC/ac/yr required
÷ 85 lb residual-C/ton
= 25.8 tons of rye silage dry matter/ac/yr required

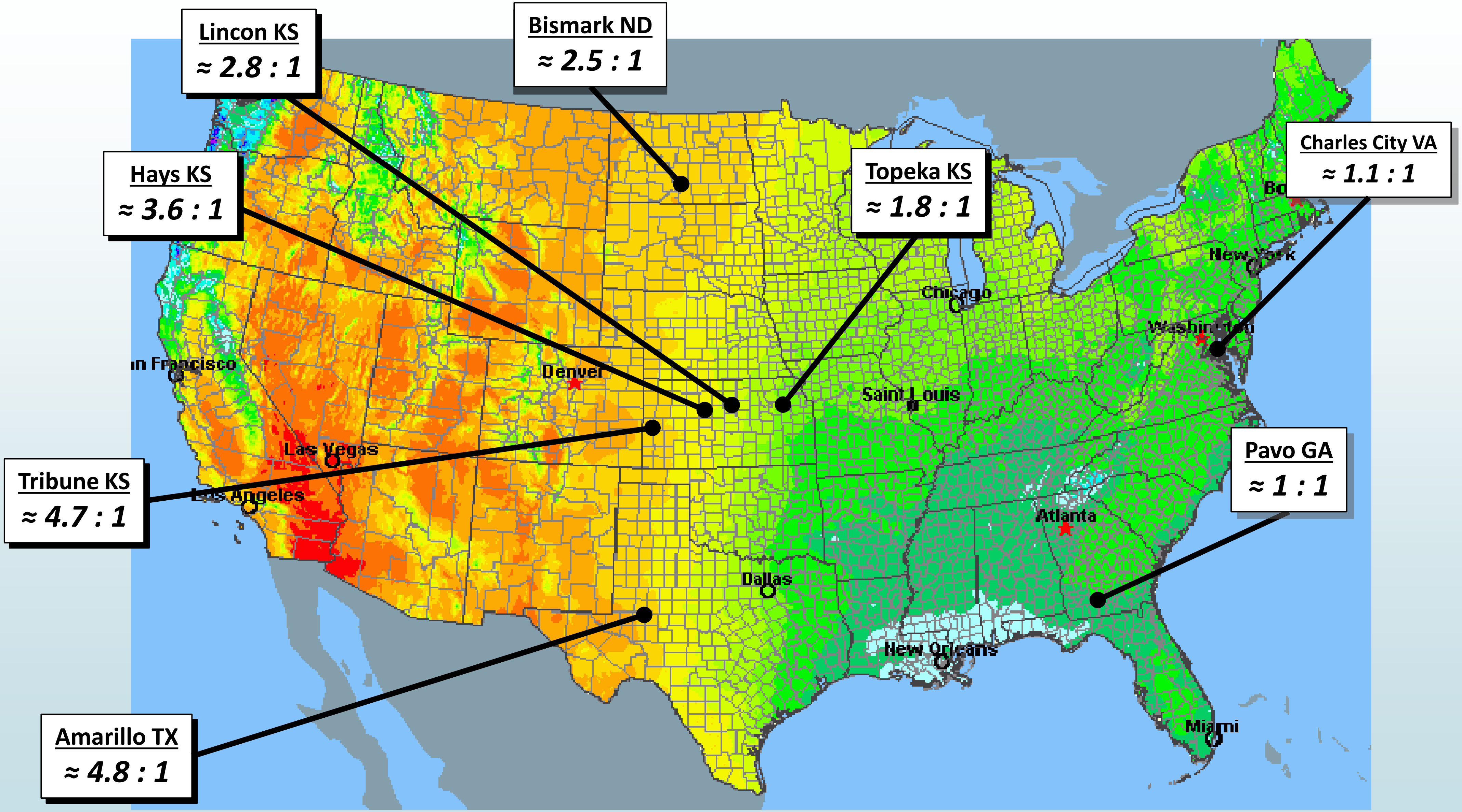
25.8 tons rye silage DM
÷ 37% rye silage DM
= **70** tons of "wet" rye silage/acre/year required

Climate affects soil organic matter



Open-pan evaporation, inches per year

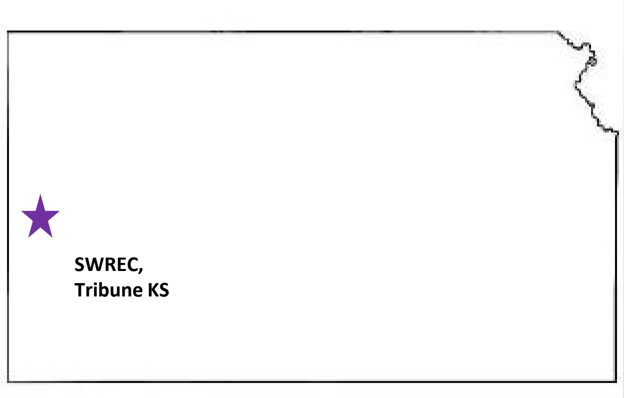
Climate affects soil organic matter



Evaporation-to-precipitation ratio

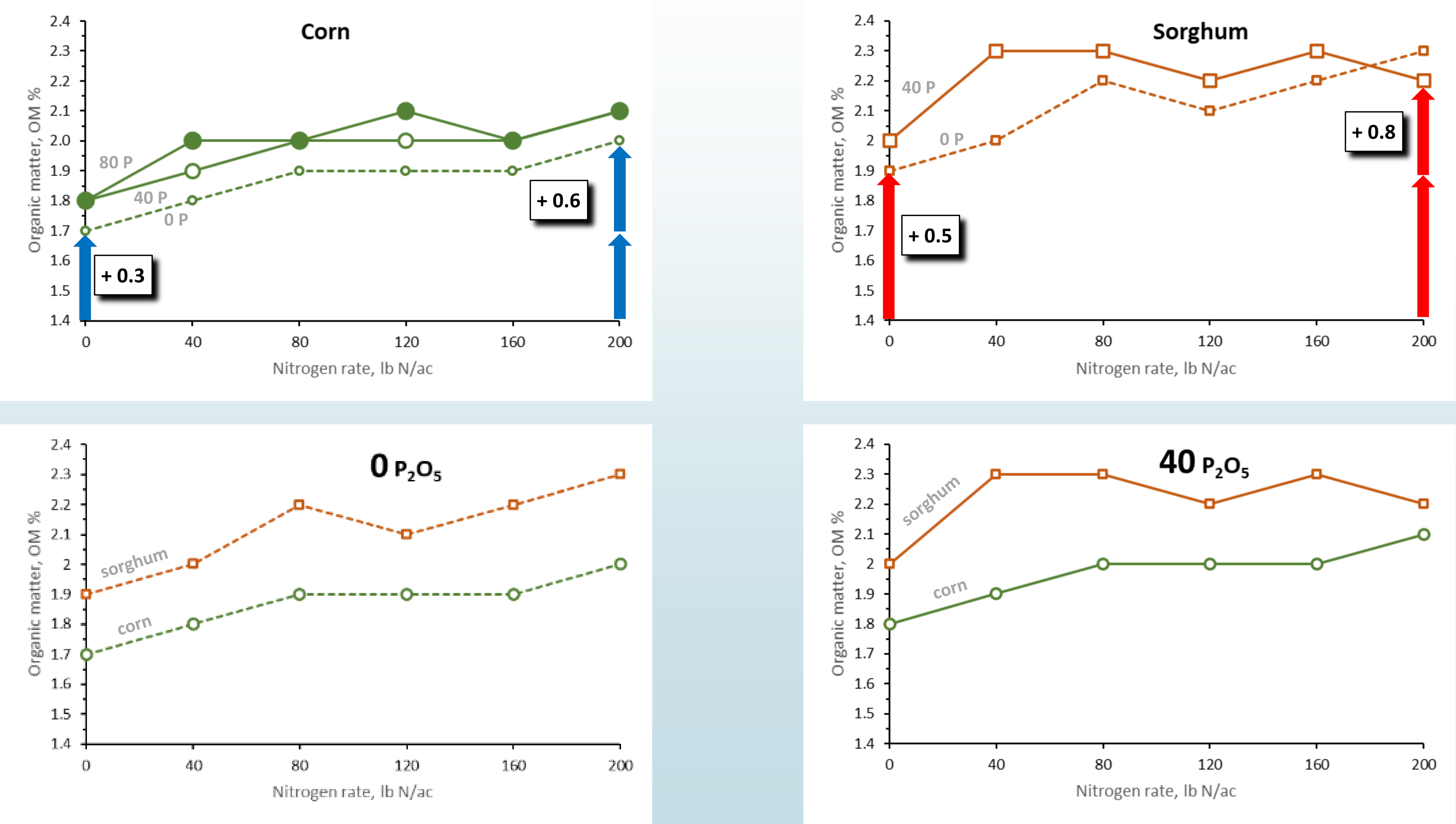
Building organic matter: research, Kansas

Location	Annual precip, in.	Soil texture	Initial OM %
Lamesa, TX	19	fSaL	0.30 – 0.35
Tribune, KS	18	SiL - CL	1.4



- 60 years, 1961 – 2020
- Continuous corn and grain sorghum
- N rate: 0 – 200; P2O5 rate: 0, 40, 80; applied annually
- Irrigated, conventional tillage
- Kanas State Univ., Southwest Res. & Ext. Center
- Dryland production prior to 1960; time unknown

SOM changes after 60 years of N and P applications with conventional tillage



Carbon-to-nitrogen ratio (C:N)

?

Carbon-to-nitrogen ratio

Material	C:N
Soil organic matter	10:1
Young alfalfa hay	13:1
Rye cover crop (veg.)	26:1
Corn/sorghum stalks	60:1
Grain straw	80:1
Sawdust	400:1

Carbon-to-nitrogen ratio

Material	C:N	% N
Soil organic matter	10:1	**5.5 – 6.0**
Young alfalfa hay	13:1	**3.5 - 4.0**
Rye cover crop (veg.)	26:1	**1.8 – 2.0**
Corn/sorghum stalks	60:1	**0.8 – 0.9**
Grain straw	80:1	**0.6 – 0.7**
Sawdust	400:1	**0.1**

Carbon-to-nitrogen ratio

"soil microbial ration"

	C:N	% N	% Crude Protein
Soil organic matter	[illegible]	[illegible] – 6.0	**35 – 38**
Young alfalfa hay	[illegible]	[illegible] – 4.0	**22 – 25**
Rye cover crop (veg.)	[illegible]	[illegible]	**11 – 13**
Corn/sorghum stalks	[illegible]	[illegible] – 0.9	**4.5 – 5.5**
Grain straw	[illegible]	[illegible] – 0.7	**3.5 – 4.0**
Sawdust	400:1	0.1	**0.7 – 0.9**

MINERALIZATION
(more rapidly decomposed)

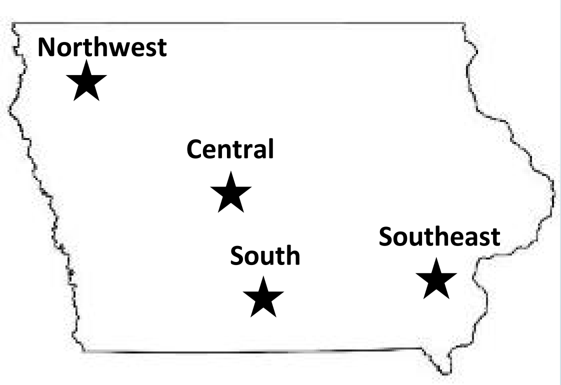
EQUILIBRIUM DIET:
C:N = 20:1 to 30:1
10% to 15% Crude protein

IMMOBILIZATION
(more slowly decomposed)

Building organic matter: research, Iowa

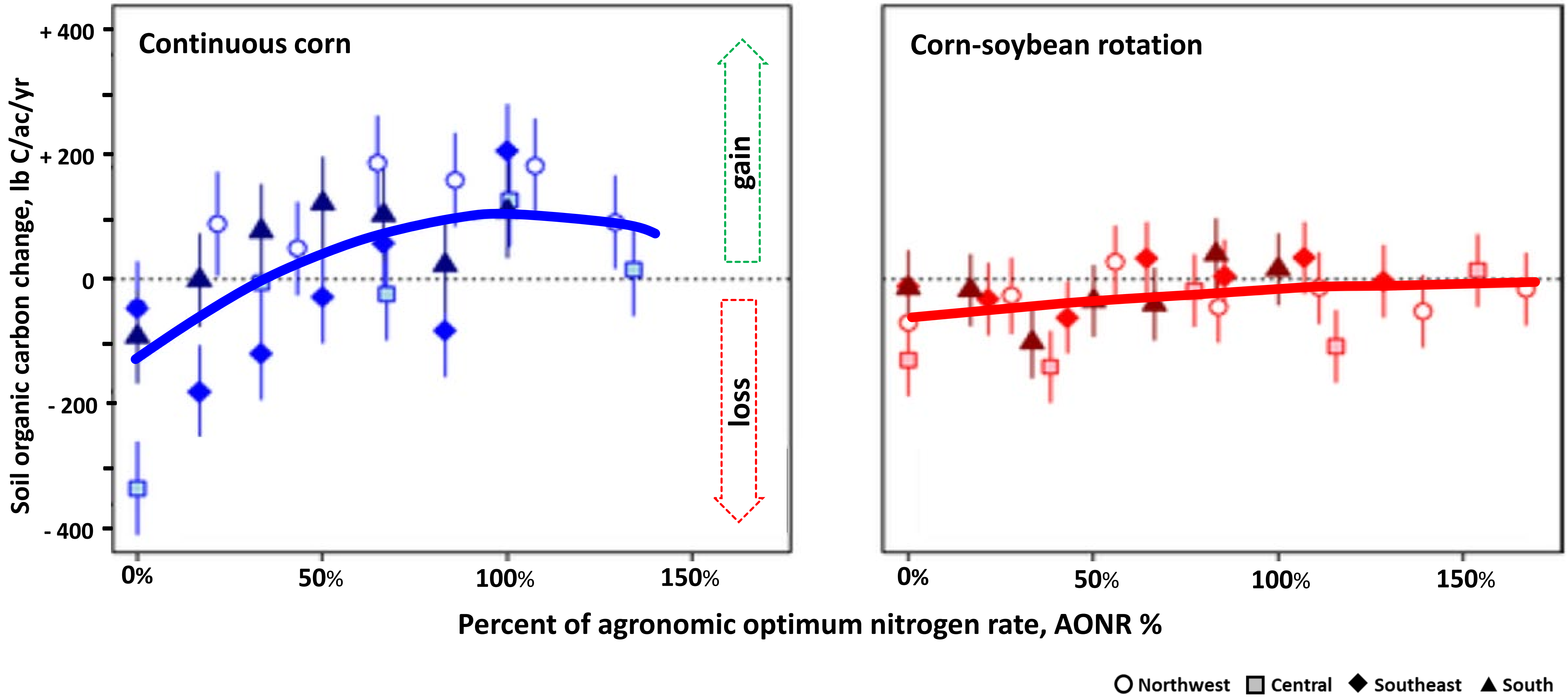
Location	Annual precip, in.	Soil texture	Initial OM %
Lamesa, TX	19	fSaL	0.30 – 0.35
Tribune, KS	18	SiL - CL	1.4
Northeast, IA	31	SiCl	4.8
Central, IA	38	L	3.6
South, IA	39	SiCL	4.8
Southeast, IA	39	SiL	3.9

- Four Iowa State Univ. Research Farms; 2000 - 2015
- Corn-corn or corn-soybean rotation
- N rate: 0 – 240 lb N/ac; applied only to corn
- Non-irrigated
- Fall chisel plowed; spring secondary tillage

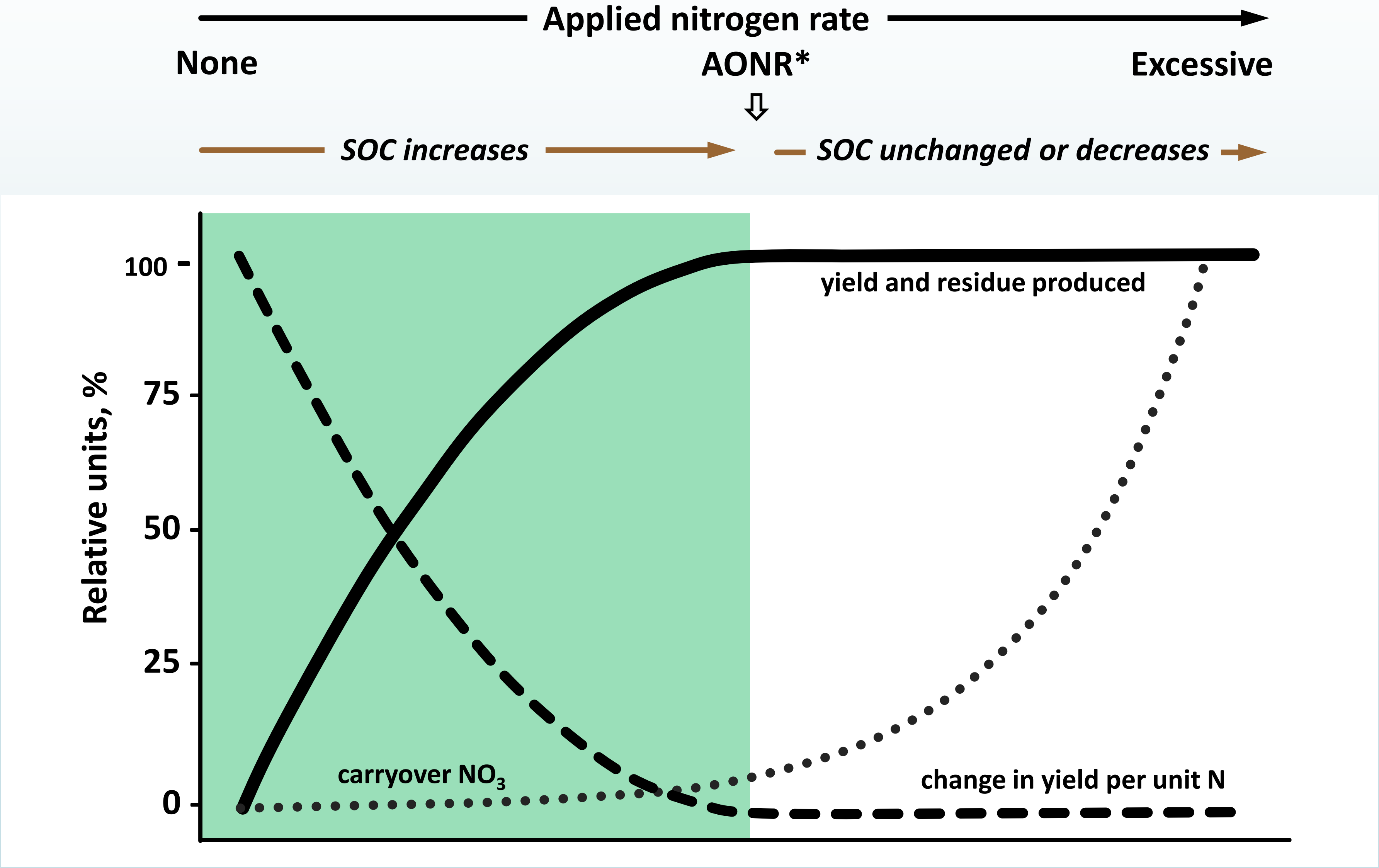


Poffenbarger, et. al. 2017. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0172293

SOC storage x N rate x crop rotation



Conceptual relationship between applied nitrogen, yield & residue, carryover nitrogen, and soil organic carbon storage



Building organic matter

Long term fertilizer N rate and soil C storage effects		
Crop rotation:	Cont. corn	Corn/soybean
AONR for corn crop:	180 – 240 *lb N/ac* *each year*	145 – 240 *lb N/ac* *every other year*
Percent of AONR:	------------- *change in SOC, lb C/ac/yr*	-------------
0%	⇩135 *lb C*	⇩ 62 *lb C*
36%*	⇔	⇔
104%	⇧ 98 *lb C*	⇔

* *68 – 85 lb N/ac*

- **Impact?**
  - **98** *lb SOC/ac/yr* ⇨⇨ *169 lb OM/ac/yr*
  - *169 lb OM/ac* ⇨ *1,800,000 lb soil @ 6-inches* ⇨ **+0.009%** *SOM/yr*

Lamesa TX
cotton w/ c.c.
0.016*% SOM/yr*

Take-home points

- Soil pH may be lower during drought conditions
  - Don’t panic, check for “bounce-back” next year
  - Watch for long-term changes
- Soil nitrates typically higher during drought cycle
  - Increased microbial activity, reduced precipitation
- Be aware of potential “stratification”
  - Soil pH, phosphorus, organic matter
- Nitrogen, residue can build soil organic matter s-l-o-w-l-y
  - Excess nitrogen may not build

Is your soil healthy?

Probably healthy	Question	Probably not healthy
NO	Does the soil blow or flow away?	YES
YES	Does the soil allow water to soak in quickly?	NO
YES	Does the soil drain?	NO
NO	Does the soil crust or seal off?	YES
YES	Does the crop recover the nutrients that I applied?	NO
NO	Are there areas where plants die or grow poorly?	YES

Probably healthy

Probably not healthy

http://csanr.wsu.edu/whats-the-problem-with-my-soil/

Really cheap soil health test?

We appreciate your attention and your business!