CERTIFIED PROFESSIONAL AGRONOMIST

American Society of Agronomy

CERTIFIED CROP ADVISER

Managing Nutrients After the Drought

September 26, 2012

Key Topics for Today's Discussion:

- Assessment of Current Nutrient Situation
  - Crop yields vs. removal, movement of nutrients, nutrient forms
- Nitrogen-Related Topics
  - Crop uptake vs. carryover nitrogen
  - Considerations for whole crop harvest
  - Fate of carryover nitrogen through the next crop
  - Nitrogen testing options
  - Residual nitrogen following soybeans
- Lime, Phosphorus, and Potassium Considerations
  - Crop removal considerations
  - Nutrient cycling and soil test differences in drought conditions
- Managing Cover Crops

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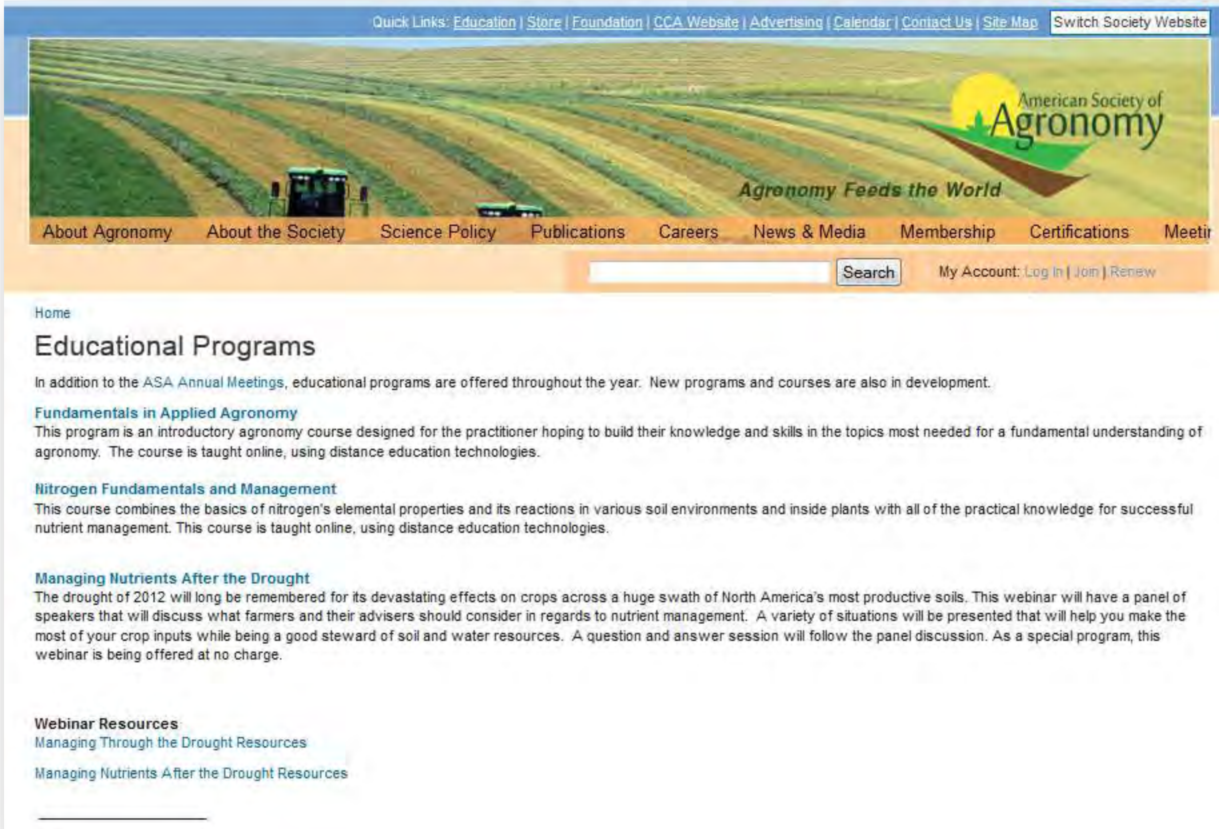
We appreciate the support of the sponsor for today's webinar:

ANPC
Agricultural Nutrient Policy Council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Educational Programs

In addition to the ASA Annual Meetings, educational programs are offered throughout the year. New programs and courses are also in development.

Fundamentals in Applied Agronomy
This program is an introductory agronomy course designed for the practitioner hoping to build their knowledge and skills in the topics most needed for a fundamental understanding of agronomy. The course is taught online, using distance education technologies.

Nitrogen Fundamentals and Management
This course combines the basics of nitrogen's elemental properties and its reactions in various soil environments and inside plants with all of the practical knowledge for successful nutrient management. This course is taught online, using distance education technologies.

Managing Nutrients After the Drought
The drought of 2012 will long be remembered for its devastating effects on crops across a huge swath of North America's most productive soils. This webinar will have a panel of speakers that will discuss what farmers and their advisers should consider in regards to nutrient management. A variety of situations will be presented that will help you make the most of your crop inputs while being a good steward of soil and water resources. A question and answer session will follow the panel discussion. As a special program, this webinar is being offered at no charge.

Webinar Resources
Managing Through the Drought Resources
Managing Nutrients After the Drought Resources

Today's slides, links to additional resources at:

https://www.agronomy.org/education/

managing-nutrients-drought-resources

Today's Panel Members

Jim Camberato, PhD
Purdue University

John Grove, PhD
University of Kentucky

Antonio Mallarino, PhD
Iowa State University

Scott Murrell, PhD
International Plant Nutrition Institute

American Society of Agronomy

Mike Plumer, MS

University of Illinois Extension (retired)

Coordinator, Illinois Council on Best Management Practices

Bruce Erickson, PhD

Agronomic Education Manager

American Society of Agronomy

Adjunct Asst. Professor, Purdue University

Managing Nutrients After the Drought

We Welcome Your Questions and Comments:

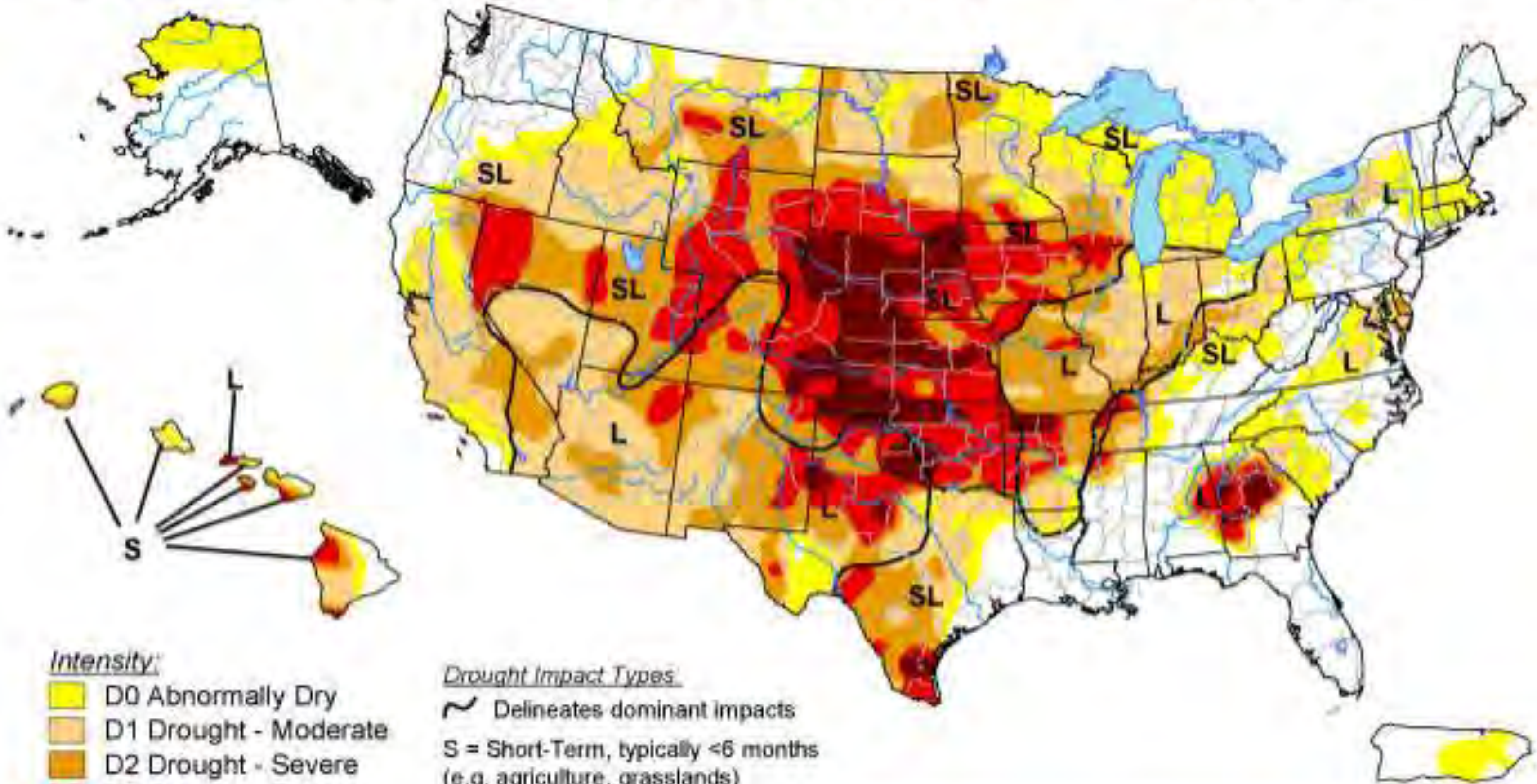
- Type in the question queue
- Please be as brief as possible
- Indicate which panel member to ask if you have a preference
- Indicate your location, if relevant to question

Overview of the 2012 Drought

T. Scott Murrell
U.S. Northcentral Director

U.S. Drought Monitor

September 18, 2012
Valid 7 a.m. EDT



Intensity:
- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

Drought Impact Types:
- ~ Delineates dominant impacts
- S = Short-Term, typically <6 months (e.g. agriculture, grasslands)
- L = Long-Term, typically >6 months (e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu/

Released Thursday, September 20, 2012
Author: David Simeral, Western Regional Climate Center

Percent of U.S. area (contiguous 48 states) in various drought intensity classifications

		Drought intensity classification		
Period	Date	None	Dry to moderate	Severe to exceptional
One year ago	9/13/2011	55.36	20.54	24.10
3 months ago	6/19/2012	31.22	44.51	24.27
Current	9/18/2012	21.85	37.08	41.07

National Drought Mitigation Center, USDA, NOAA. 2012. U.S. Drought Monitor. Available at http://droughtmonitor.unl.edu.

Impacts of 2012 drought on agriculture

Crop	Average U.S. yield to date	Comparison to 2011 average
	-------------- (bu/acre)	------------
Corn	122.8	-24.4
Soybean	35.3	-6.2

Other impacts:

- Increased hay thefts
- Increased selling of cattle
- Many counties designated as Primary Natural Disaster Areas
- Increased competition for water use

USDA-NASS. 2012. Crop Production. Available at http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1046;
National Drought Mitigation Center. 2012. Drought impact reporter. Available at http://droughtreporter.unl.edu;
National Drought Mitigation Center, USDA, NOAA. 2012. U.S. Drought Monitor. Available at http://droughtmonitor.unl.edu.

IPNI

Reduced yield results in reduced nutrient removal for a given harvested portion

Crop	State	Grain yield: Normal year (1987)	Grain yield: Drought year (1988)	Yield and nutrient removal reduction
		------------ (bu/acre)	-------------	(%)
Corn	Illinois	132	73	45
	Indiana	135	83	39
	Iowa	130	84	35
Soybean	Illinois	38.0	27.0	29.0
	Indiana	40.0	27.5	31.3
	Iowa	43.5	31.0	28.7

A change in harvested portion changes nutrient removal

Scenario	Harvested portion	Yield	Nutrient removal** N	P_2O_5	K_2O
			---------- (lb/acre) --------		
Planned	Corn grain	150 bu/acre	100	53	38
Actual	Corn silage with barren ears*	10.8 tons/acre	70	18	67
Difference			-30	-35	+29

*Assumes corn stover corresponding to 150 bu/acre grain crop, no grain formed, a harvest index of 0.5, and a moisture content of 67% (wet basis).

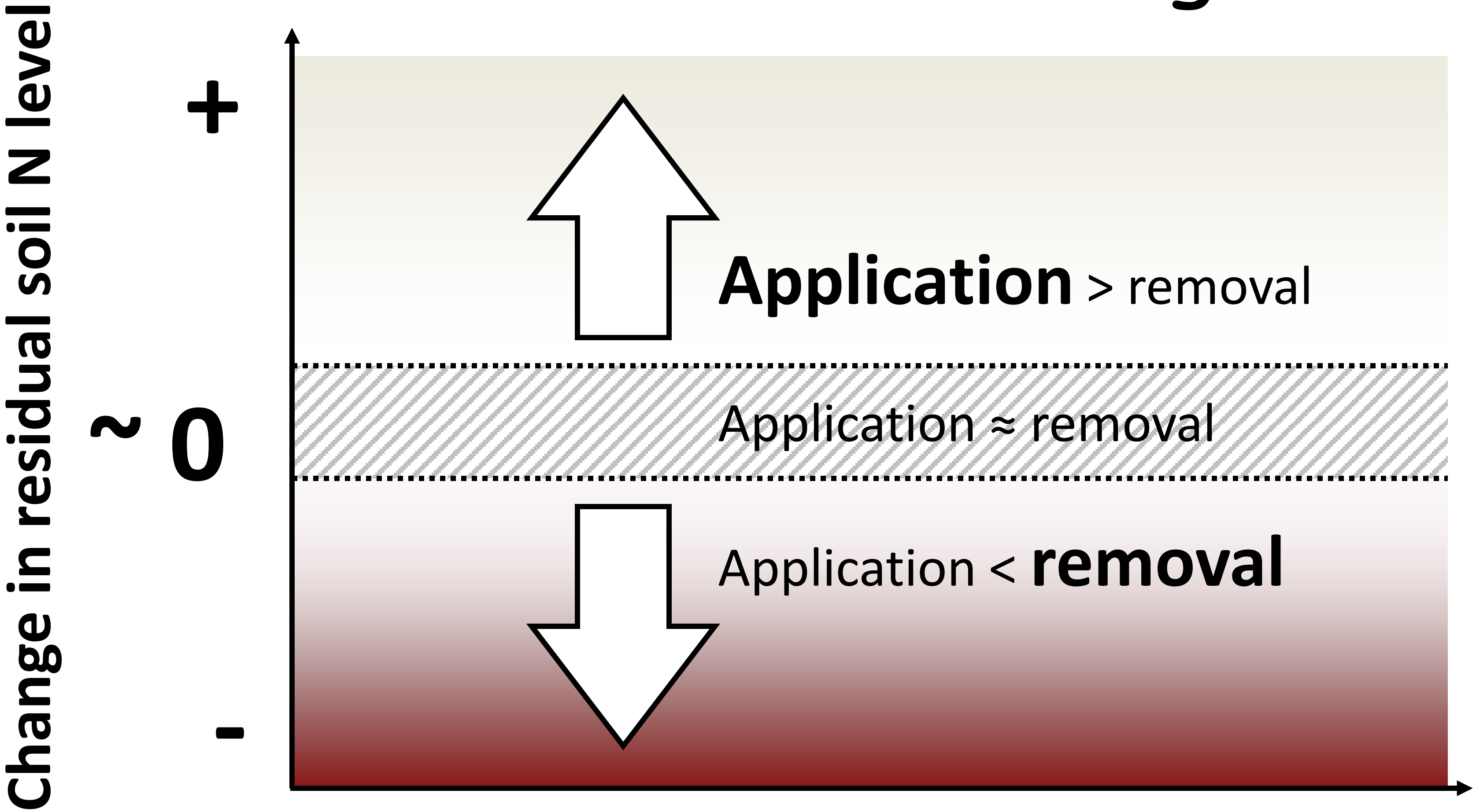
**Based on nutrient removal rates of published in:
Phillips, S. and K. Majumdar. 2012. Scientific principles supporting – right rate. p. 4-1 to 4-11. *In* Bruulsema, T., P.E. Fixen, and G.D. Sulewski (eds.) 4R plant nutrition: A manual for improving the management of plant nutrition. North American version. International Plant Nutrition Institute, Norcross, Georgia. Nitrogen, P_2O_5, and K_2O removal rates for corn silage were 67, 55, and 85% of published values to account for lack of grain.

IPNI

Managing Soil Nitrogen After The Drought

John H. Grove
University of Kentucky

Potential N carryover – With different N budgets



Adapted from Murrell, 2012

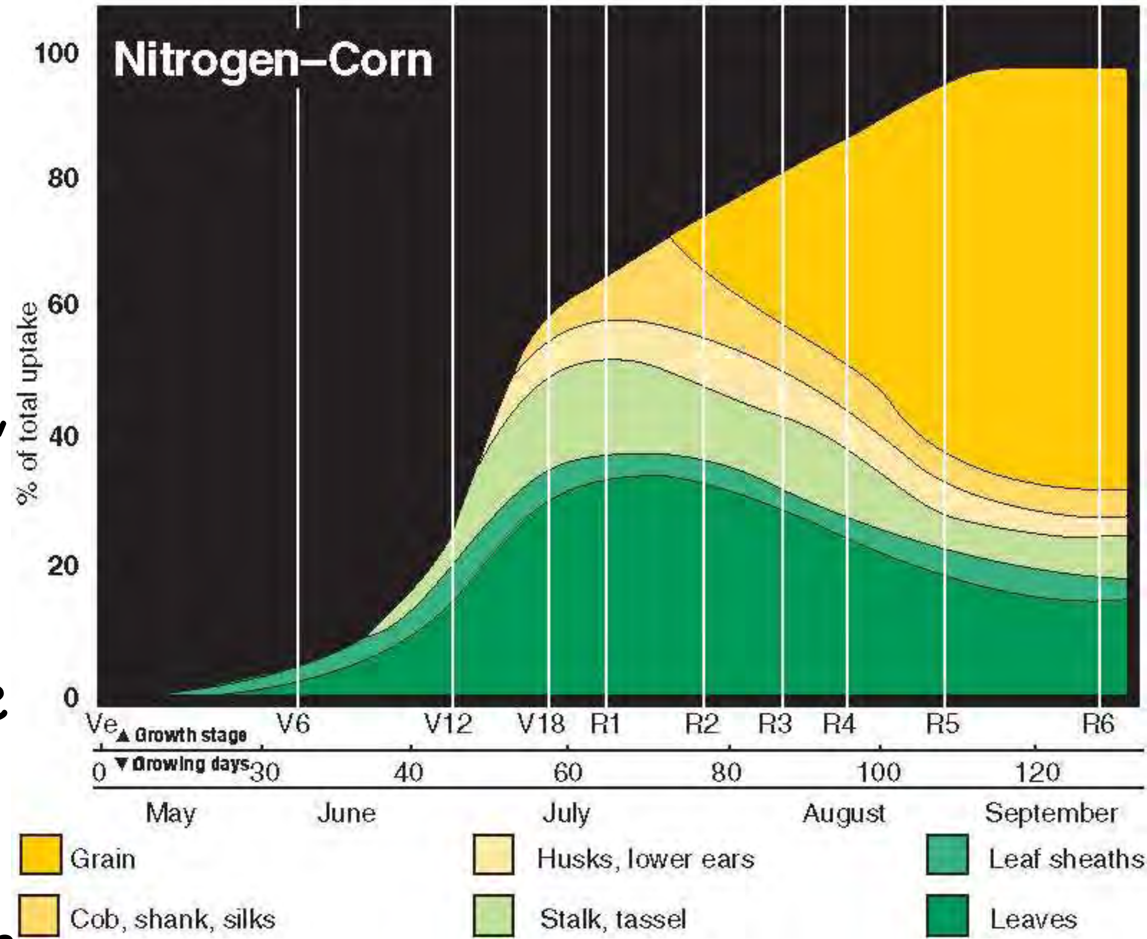
How Large Is The Problem?

- Karlen et al. (1988) reported that a corn crop yielding about 310 bu/A took up about 345 lb N/A.
- So, a good 225 bu/A corn crop will need at least 250 lb N/A from soil and fertilizer.
- Producer provides 180 lb N/A, assuming the soil (organic matter) provides 70 lb N/A.
- Understanding the problem:
  - Worst case – all vegetative material returned (destroyed the crop without grain/silage harvest).

How Much?

If corn stopped growing around R1-R2, then about 2/3 of N uptake has occurred.

Assuming total uptake = 250 lb N/A, that means 167 lb/A is in the standing crop with 83 lb/A remaining in the soil in the fall.



Iowa State Extension Service

Fall soil N could be less (early N losses); could be more (more organic N mineralization).

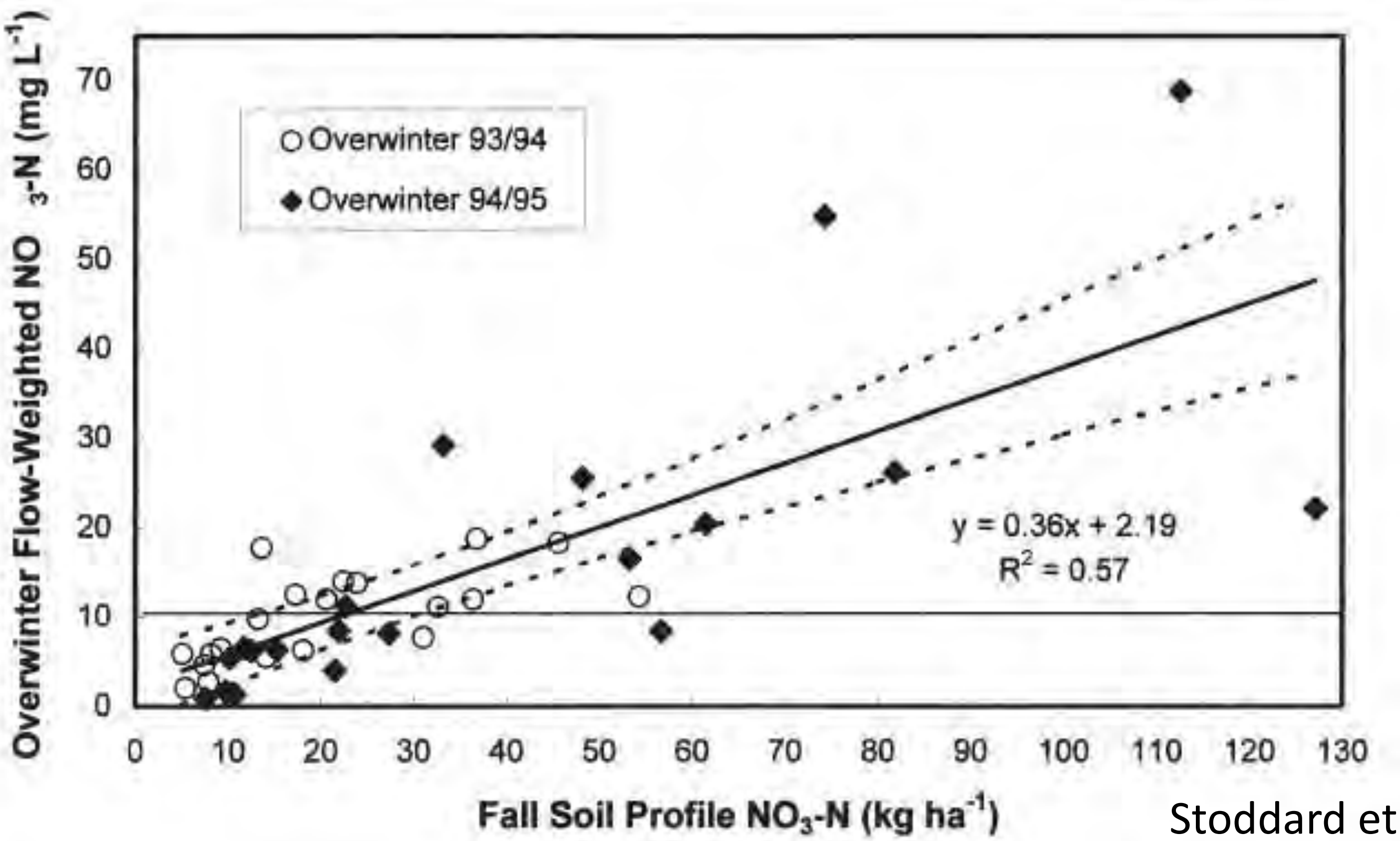
Where Is That Carryover N?

- Worst Case:
  - Stover/root N (167 lb N/A) lies on/near surface.
  - Unused soil N (83 lb N/A) left in soil, near surface.
- Not Worst Case (some grain harvested):
  - Grain removes 0.8 to 0.9 lb N/bushel (reduce carryover N pools, both soil and stover, equally).
- In What Form Is That Carryover N?
  - Carryover stover/root N found as 'labile' organic N and nitrate-N.
  - Carryover soil N largely nitrate-N.

What 'Happens' To Carryover N?

- Stover/root 'labile' organic N
  - Microbial immobilization (good)
  - Microbial mineralization (not good)
  - Outcome depends upon C:N ratio, available C and O_2, environmental conditions (T, H_2O).
- Stover/root nitrate N
- Soil nitrate N
  - Immobilization (good)
  - Denitrification (not great)
  - Leaching (not good)

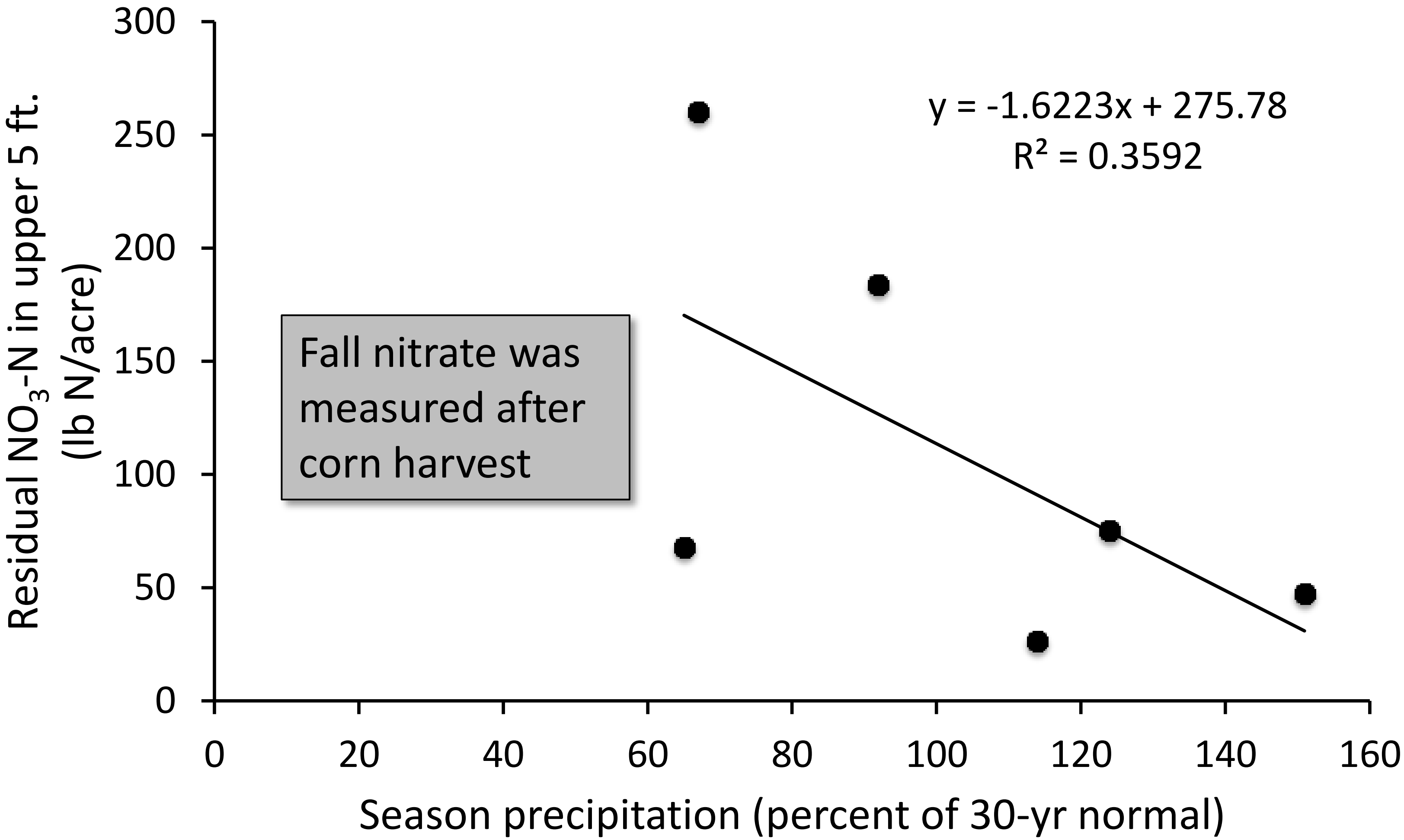
What Do You Mean 'Not Good'?



Stoddard et al. 2005

November to April nitrate-N in leachate water collected below corn rooting depth, as related to the amount of fall soil nitrate -N. N rate and manure treatments. No-tillage/no cover crop.

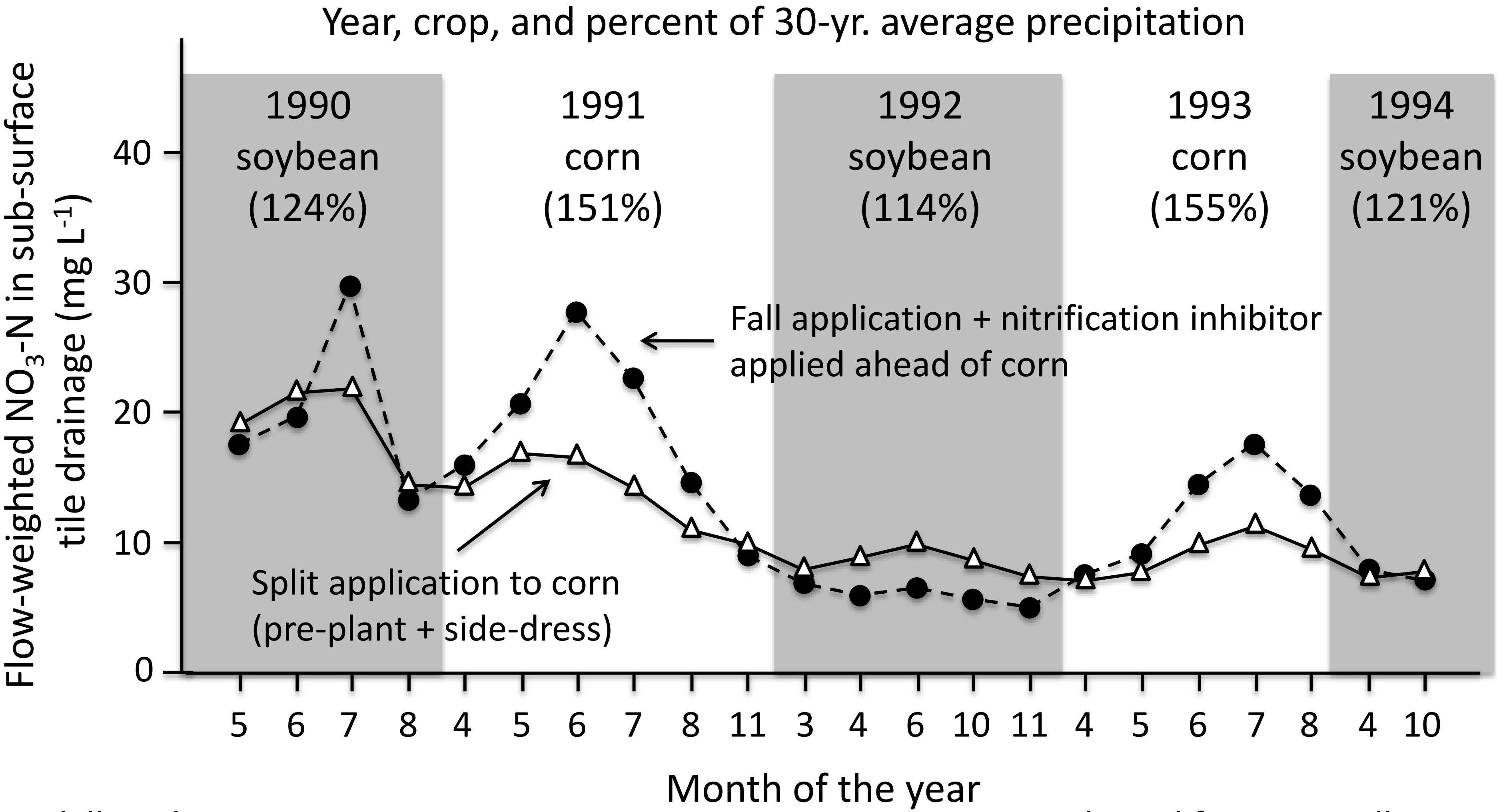
Residual nitrate in the fall soil profile tends to be higher after a droughty year



Randall et al. 2003

Adapted from Murrell, 2012

Nitrate leaching is related to the amount of early season rainfall – and also to fertilizer N management



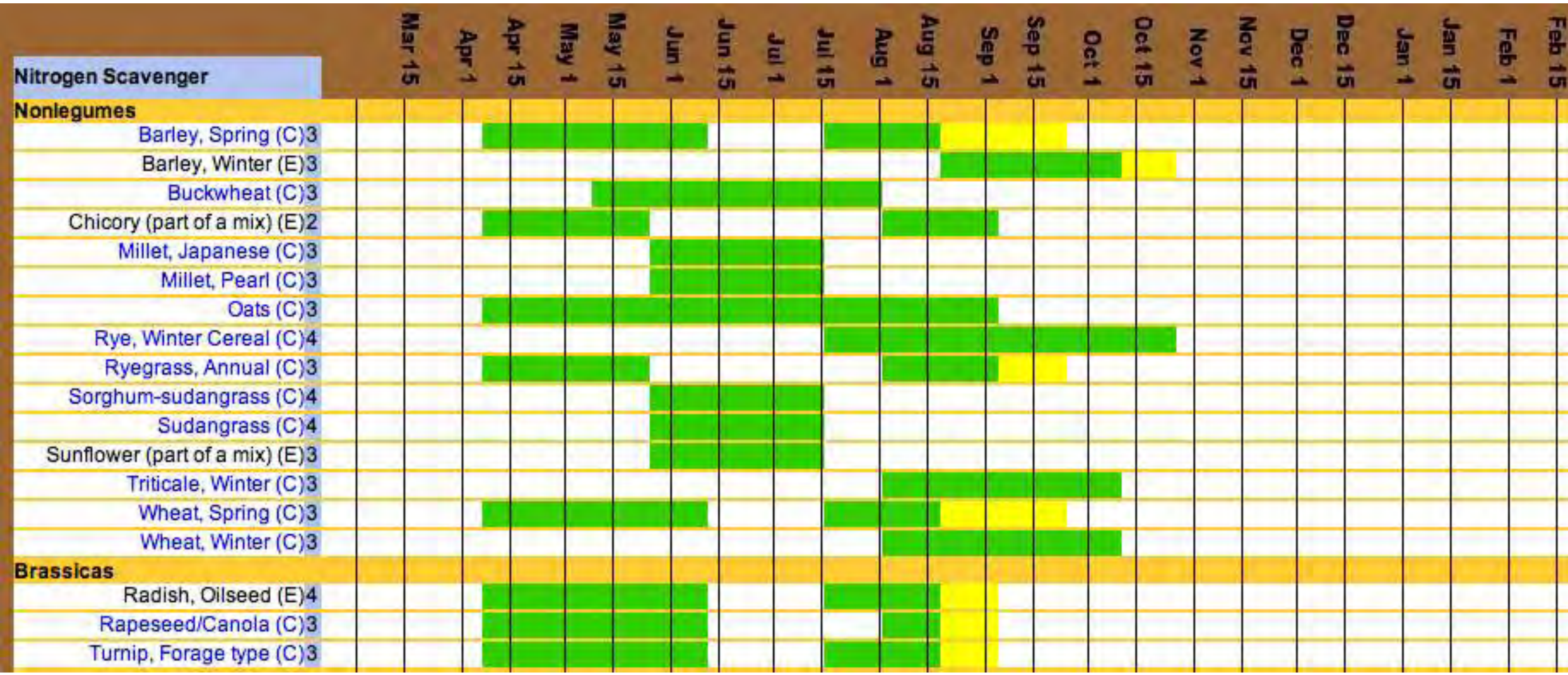
Randall et al. 2003

Adapted from Murrell, 2012

Dealing With Carryover N

- Next spring – Dr. Camberato
- This fall
  - Principles and options:
    - Biologically immobilize as much labile or nitrate N as possible – reconnect C and N
    - Minimize/slow oxidation of labile C
    - Use cover crops (biological immobilization)
    - More on cover crops – Mr. Plumer

Midwest Cover Crop Council
http://www.mccc.msu.edu



Adapted from Murrell, 2012

Dealing With Carryover N

- Next spring – Dr. Camberato
- This fall
  - Principles and options:
    - Biologically immobilize as much labile or nitrate N as possible – reconnect C and N
    - Minimize/slow oxidation of labile C
    - Use cover crops (biological immobilization)
    - Minimize tillage (avoid accelerated oxidation)
      - Only the wettest, untiled, soils/fields – nitrate N more likely lost to denitrification than to leaching

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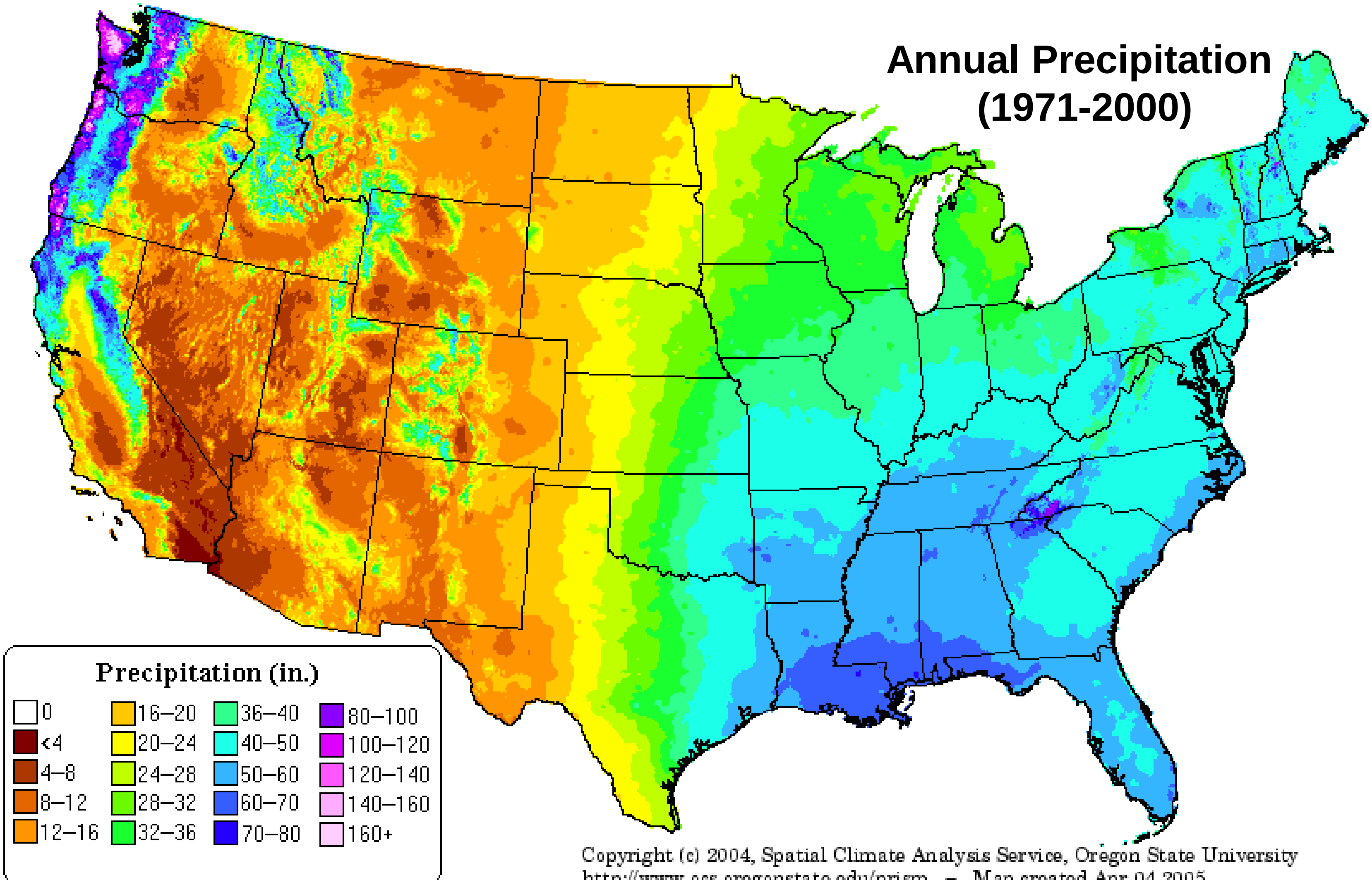
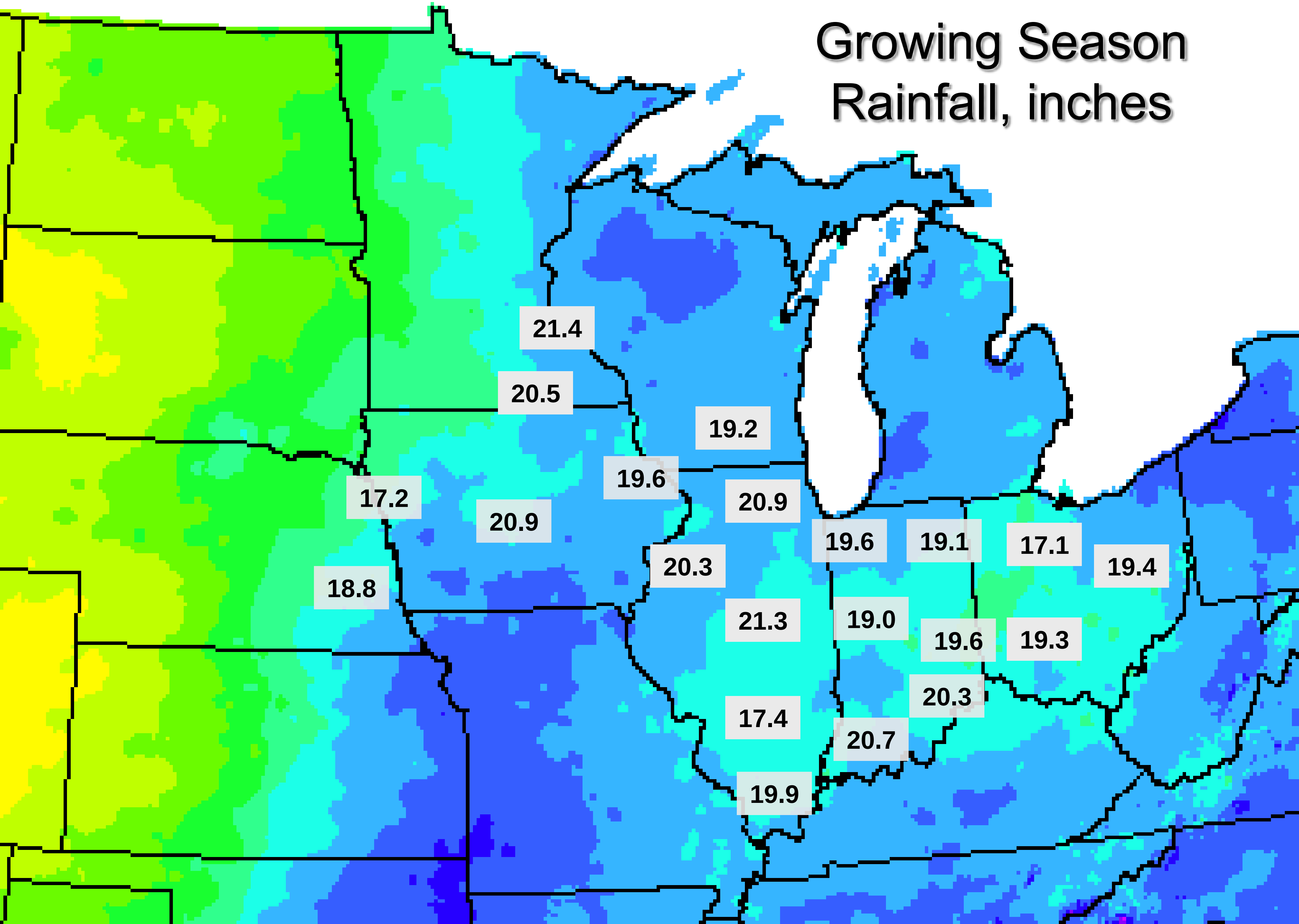
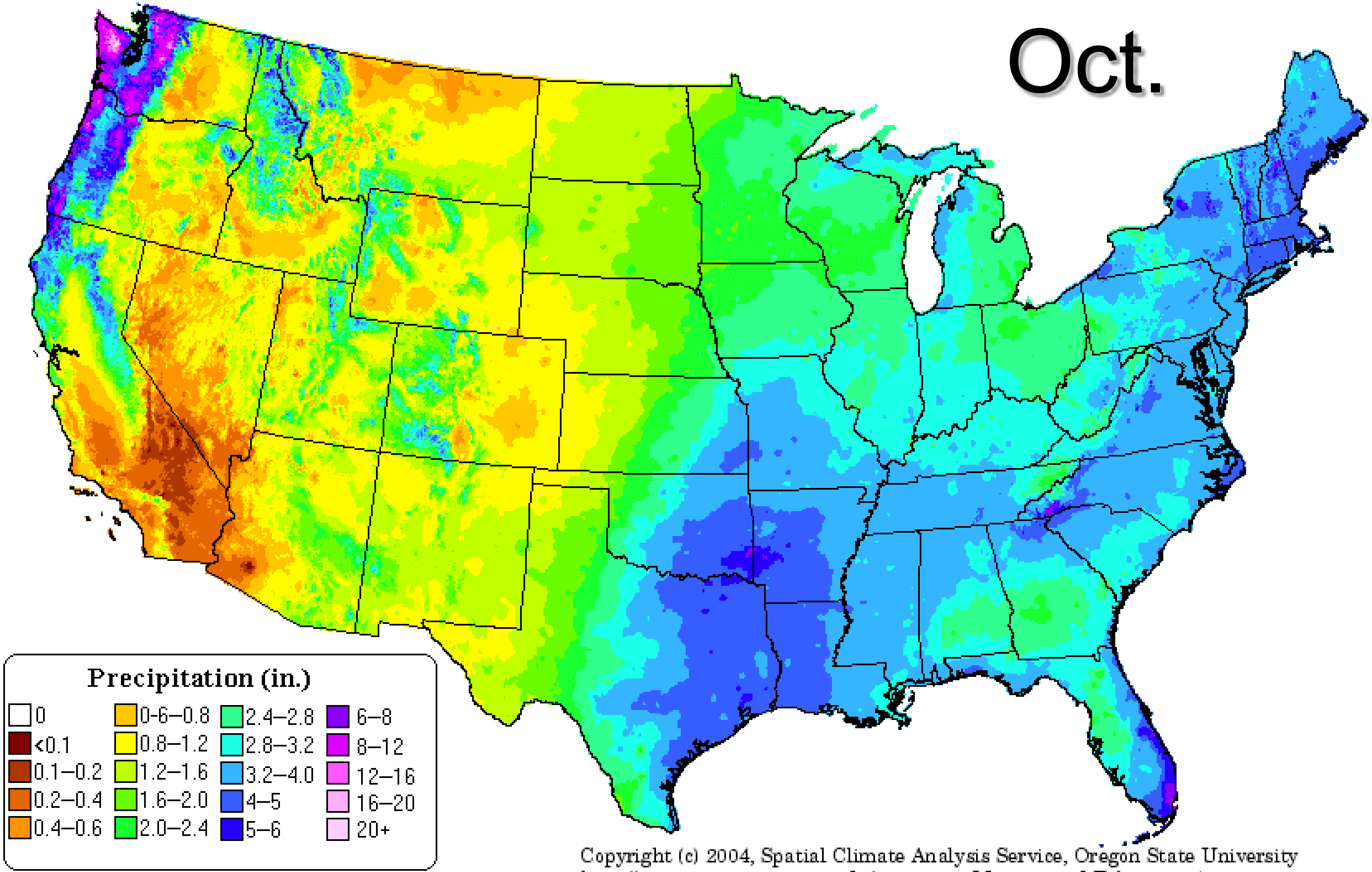
Precipitation Across the Corn Belt





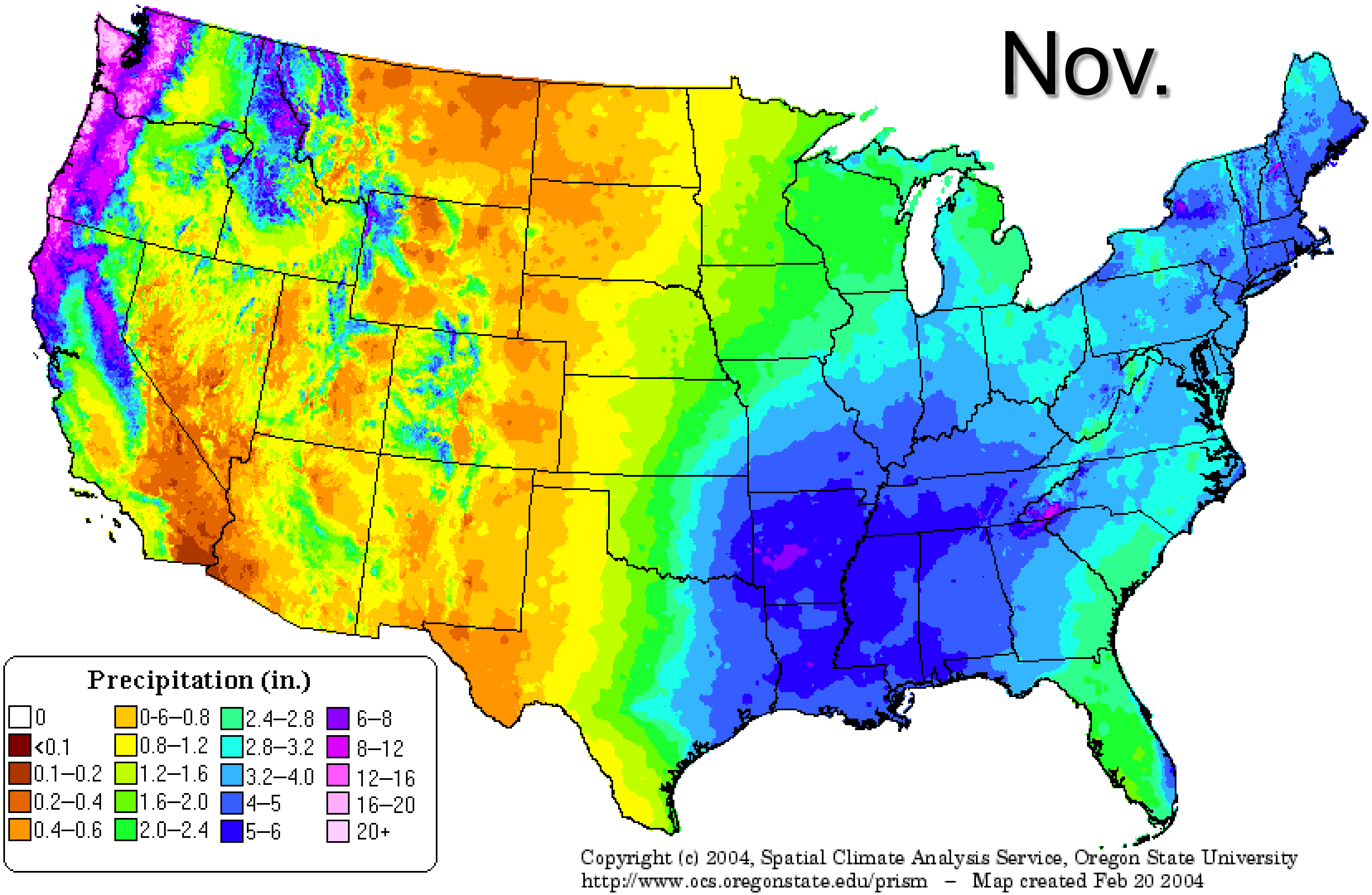
Growing Season Rainfall, inches
21.4
20.5
19.2
19.6
17.2
20.9
20.9
19.6
19.1
17.1
19.4
18.8
20.3
21.3
19.0
19.6
19.3
20.3
17.4
20.7
19.9

Oct.

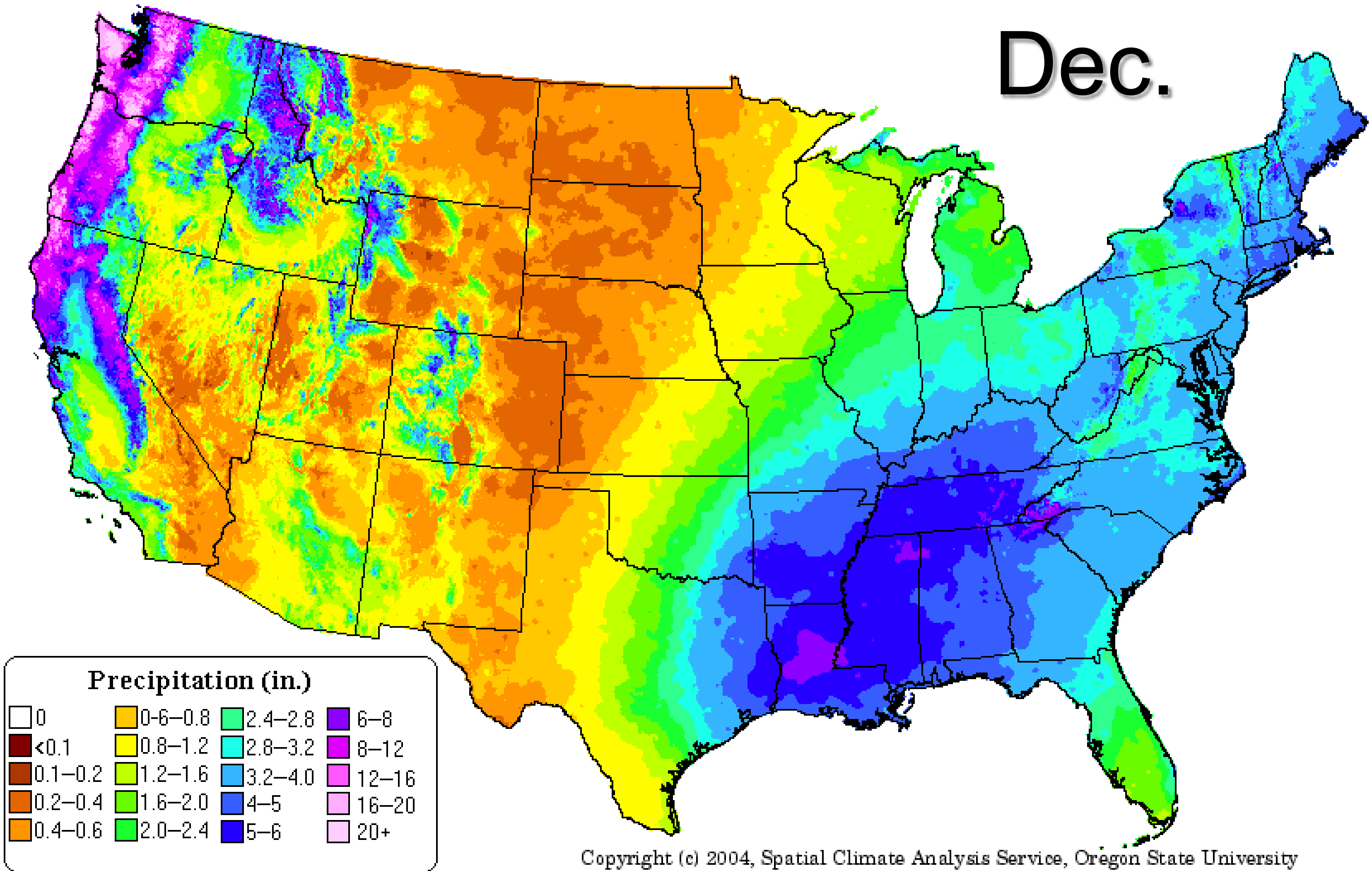


Precipitation (in.)
0
<0.1
0.1–0.2
0.2–0.4
0.4–0.6
0-6–0.8
0.8–1.2
1.2–1.6
1.6–2.0
2.0–2.4
2.4–2.8
2.8–3.2
3.2–4.0
4–5
5–6
6–8
8–12
12–16
16–20
20+

Nov.


Precipitation (in.)
0
<0.1
0.1–0.2
0.2–0.4
0.4–0.6
0-6–0.8
0.8–1.2
1.2–1.6
1.6–2.0
2.0–2.4
2.4–2.8
2.8–3.2
3.2–4.0
4–5
5–6
6–8
8–12
12–16
16–20
20+
Copyright (c) 2004, Spatial Climate Analysis Service, Oregon State University
http://www.ocs.oregonstate.edu/prism – Map created Feb 20 2004

Dec.


Precipitation (in.)
0
<0.1
0.1–0.2
0.2–0.4
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0.8–1.2
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3.2–4.0
4–5
5–6
6–8
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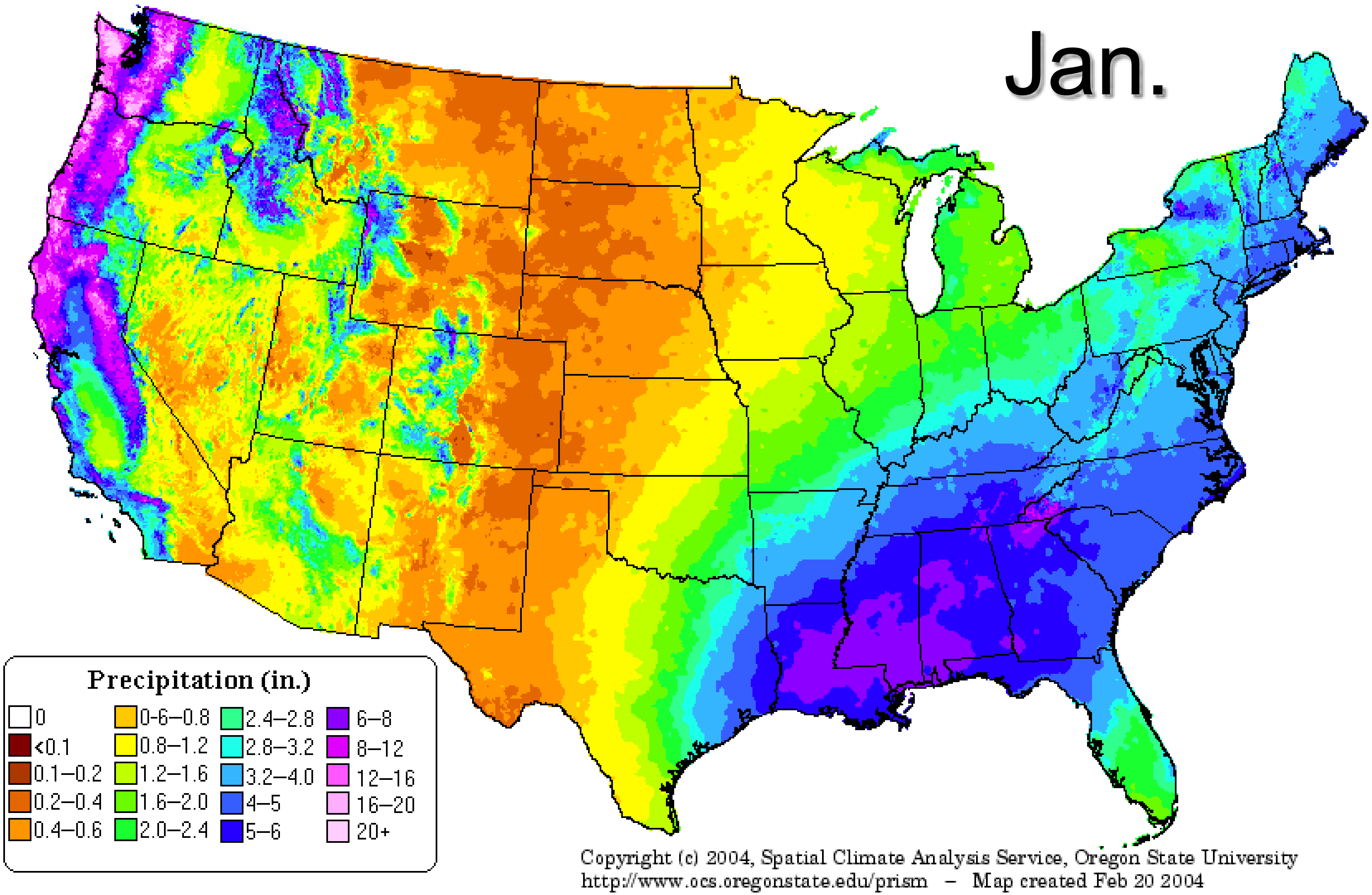

Jan.
Precipitation (in.)
0
<0.1
0.1–0.2
0.2–0.4
0.4–0.6
0-6–0.8
0.8–1.2
1.2–1.6
1.6–2.0
2.0–2.4
2.4–2.8
2.8–3.2
3.2–4.0
4–5
5–6
6–8
8–12
12–16
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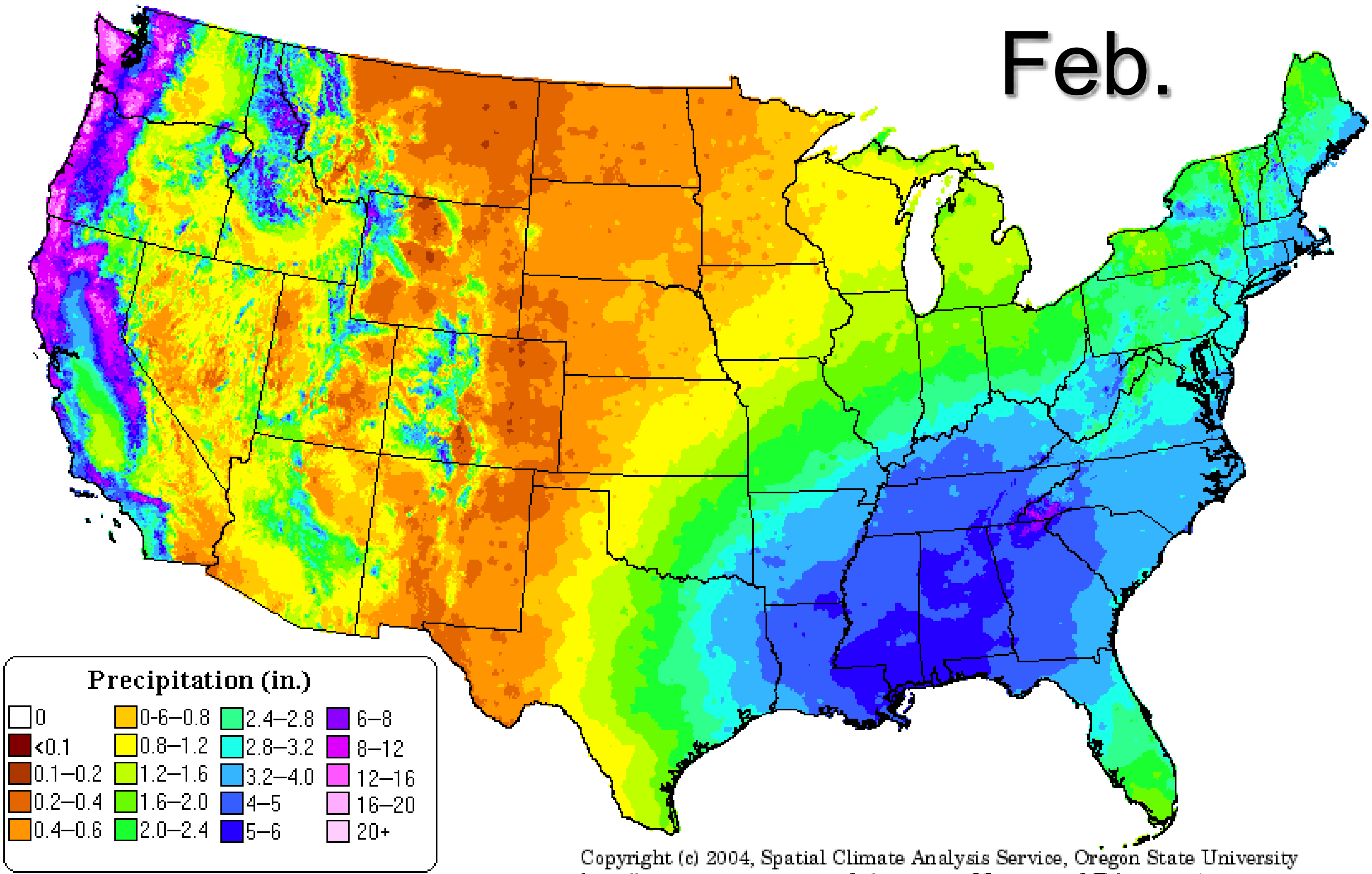
20+
Copyright (c) 2004, Spatial Climate Analysis Service, Oregon State University
http://www.ocs.oregonstate.edu/prism – Map created Feb 20 2004

Feb.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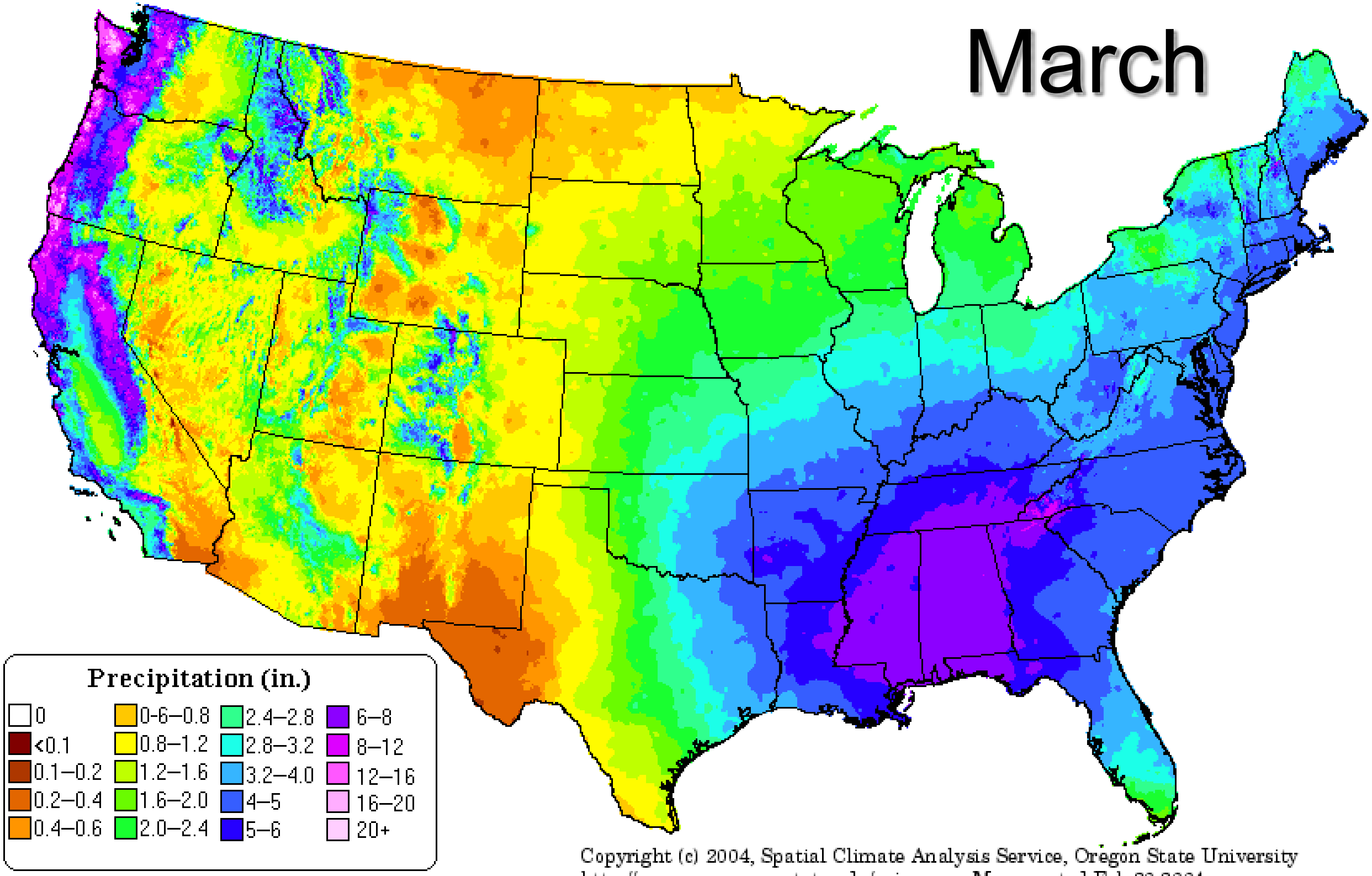
2.4–2.8
2.8–3.2
3.2–4.0
4–5
5–6
6–8
8–12
12–16
16–20
20+

March


Precipitation (in.)
0
<0.1
0.1–0.2
0.2–0.4
0.4–0.6
0-6–0.8
0.8–1.2
1.2–1.6
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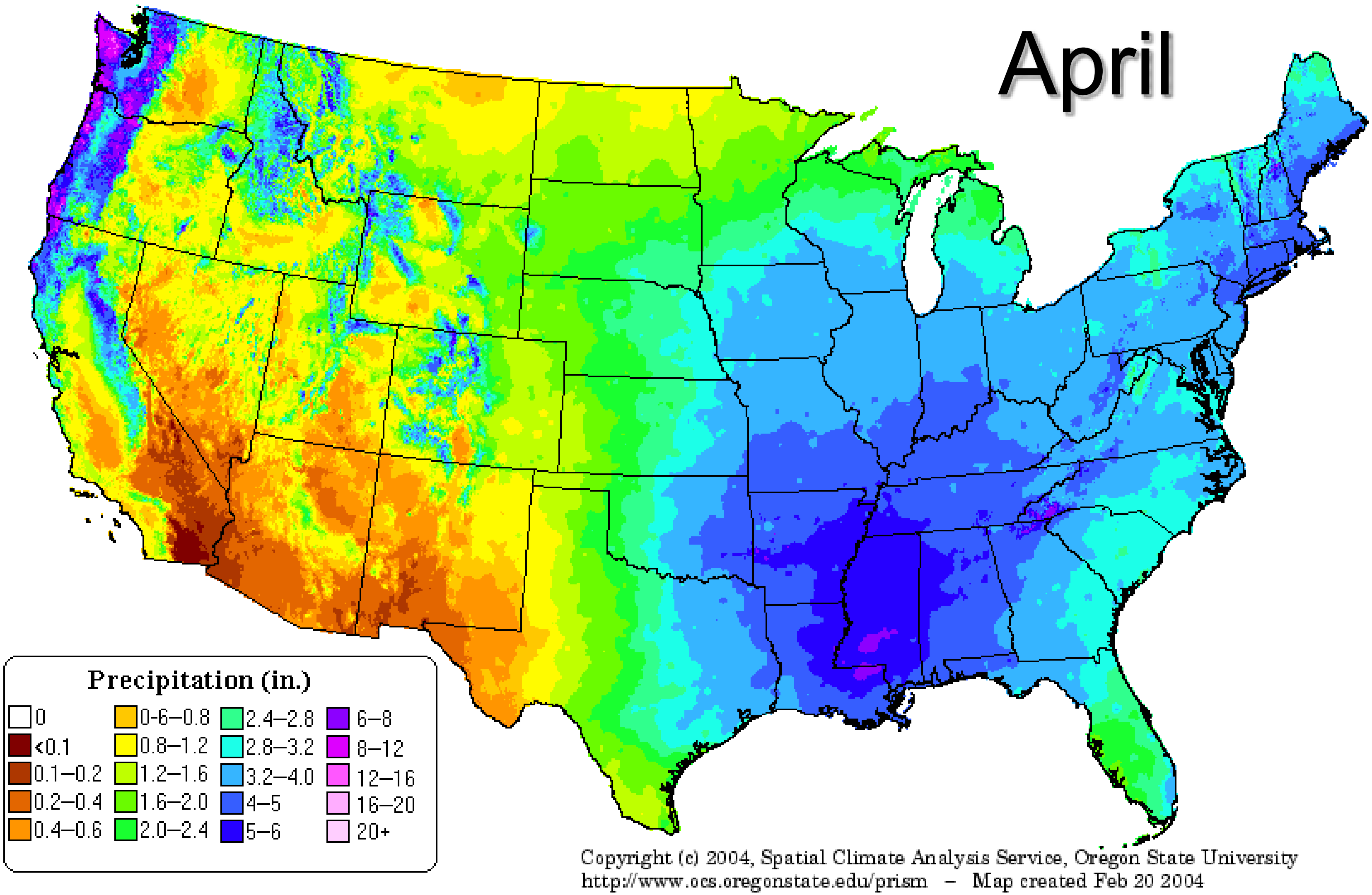
2.4–2.8
2.8–3.2
3.2–4.0
4–5
5–6
6–8
8–12
12–16
16–20
20+

April


Precipitation (in.)
0
<0.1
0.1–0.2
0.2–0.4
0.4–0.6
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0.8–1.2
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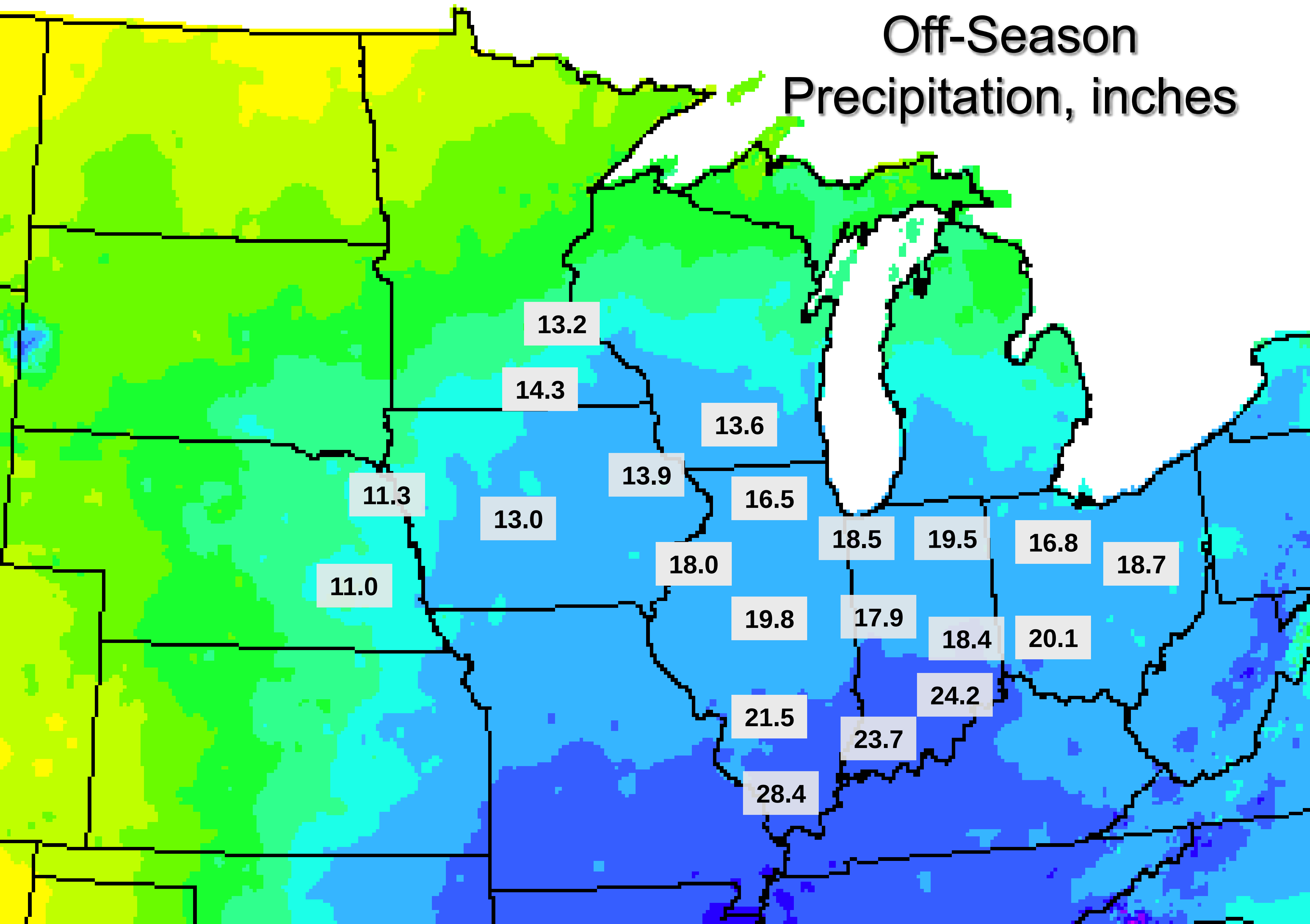
3.2–4.0
4–5
5–6
6–8
8–12
12–16
16–20
20+
Copyright (c) 2004, Spatial Climate Analysis Service, Oregon State University
http://www.ocs.oregonstate.edu/prism – Map created Feb 20 2004

Off-Season Precipitation, inches



Taking Stock of Nitrate Carryover

- Fall soil sampling – Western Corn Belt
- PrePlantNitrateTest (PPNT) – Central and Northern Corn Belt
- PreSidedressNitrateTest (PSNT) – Eastern Corn Belt

Western Corn Belt

Ex. - Nebraska

- 4' soil sample in fall
- About 50% of the NO_3-N in a 4' depth subtracted from the yield goal based N recommendation (if only 0-2' sampled then 2-4' estimated)

Table IV. An example calculation of mean depth-weighted soil nitrate-nitrogen concentration across several soil depths.

Soil layer, inches	*Thickness, inches*	*Nitrate-N, ppm*	*Calculations for soil layer*
0-8	8	15	8 x 15 =120
8-24	16	10	16 x 10 =160
24-48	24	3	24 x 3 = 72
Total	48		352
Weighted average ppm			352/48 = 7.3 ppm

Note: to convert from lb N/ac to ppm, the default soil density can be assumed to be 3.6 M lb soil/ac-ft.

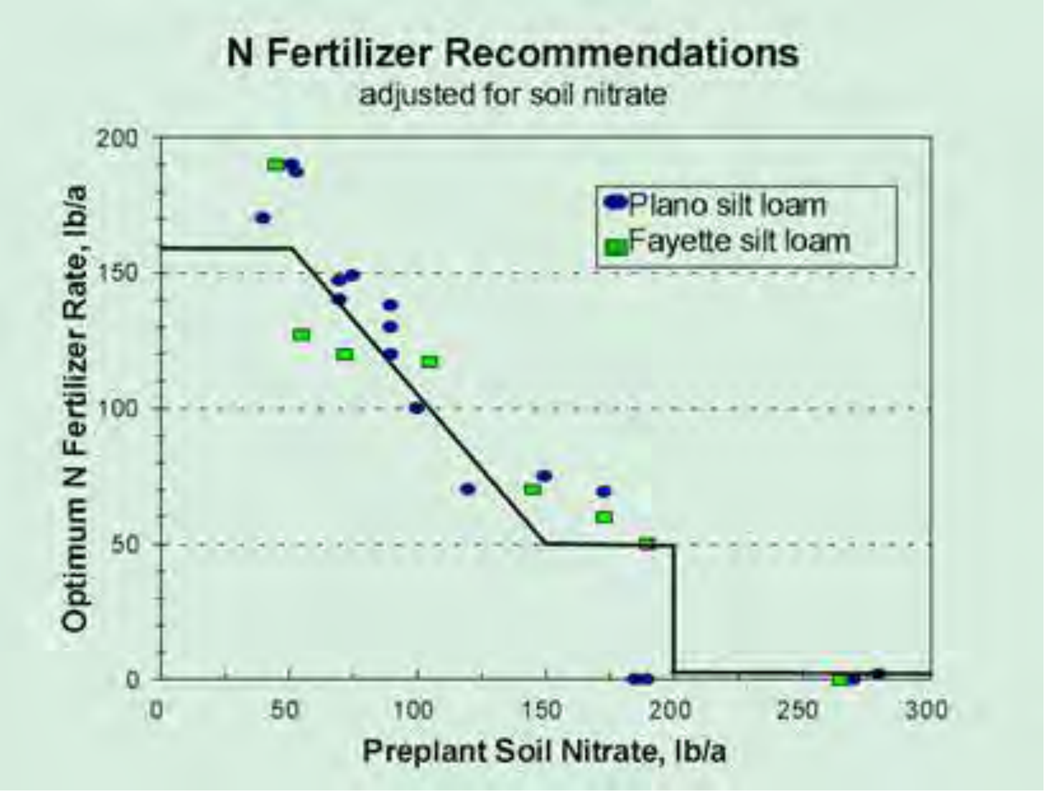
8 x NO_3-N ppm = lb/acre subtracted from rec.

Fertilizer Suggestions for Corn. Univ. of Nebraska, EC117, Shapiro et al., 2010.

Central and Northern Corn Belt

Ex. – Wisconsin

- 2’ soil sample in 1’ increments as soon as frost is out of ground
- NO_3-N greater than 50 lb/acre is subtracted from recommendation



Wisconsin's Preplant Soil Nitrate Test, A3512, Bundy et al., 1995.

Eastern Corn Belt

Ex. - Indiana

- 1′ soil sample after corn is planted (V4-V6, 6-12 inches tall)
- NO3-N determined is an index of the N to be released from organic N sources – soil OM, manure, legumes

Soil NO_3-N	Subtraction from standard N rec.
ppm	lb/acre
0-10	**No subtraction**
11-15	**-25**
16-20	**-45**
21-25	**-90**
>25	**No N rec.**

The Pre-Sidedress Nitrate Test for Improving N Management in Corn, Purdue Univ. AY-314-W, Brouder and Mengel, 2000.

Soil Nitrate Testing

- Significant leftover NO_3-N may be available due to poor corn yield this past season
  - Routine sampling in West
  - Be prepared elsewhere to obtain soil samples if winter is normal to dry
  - Follow recommendations for sampling and sample interpretation in your states
- Keep samples cold for overnight delivery, spread thin on clean paper or plastic to air dry, or freeze

Will soybean N credits be affected for next year?

T. Scott Murrell
U.S. Northcentral Director

Crop effects on organic nitrogen content of soils

Soil	Change in organic nitrogen content from May to Sept.	
	Corn 1997	Soybean 1998
	--------------------------- (%) ---------------------------	
Zenor	-9.17	27.1
Clarion 1	-9.86	22.4
Clarion 2	-16.5	17.5
Webster 1	-26.0	2.6
Webster 2	-10.3	17.0
Webster 3	-12.4	15.1
Webster 4	-13.9	10.3
Okoboji	-1.3	0.24

Martens, D.A., D.B. Jaynes, T.S. Colvin, T.C. Kaspar, and D.L. Karlen. 2006. Agron. J. 70:382-392.

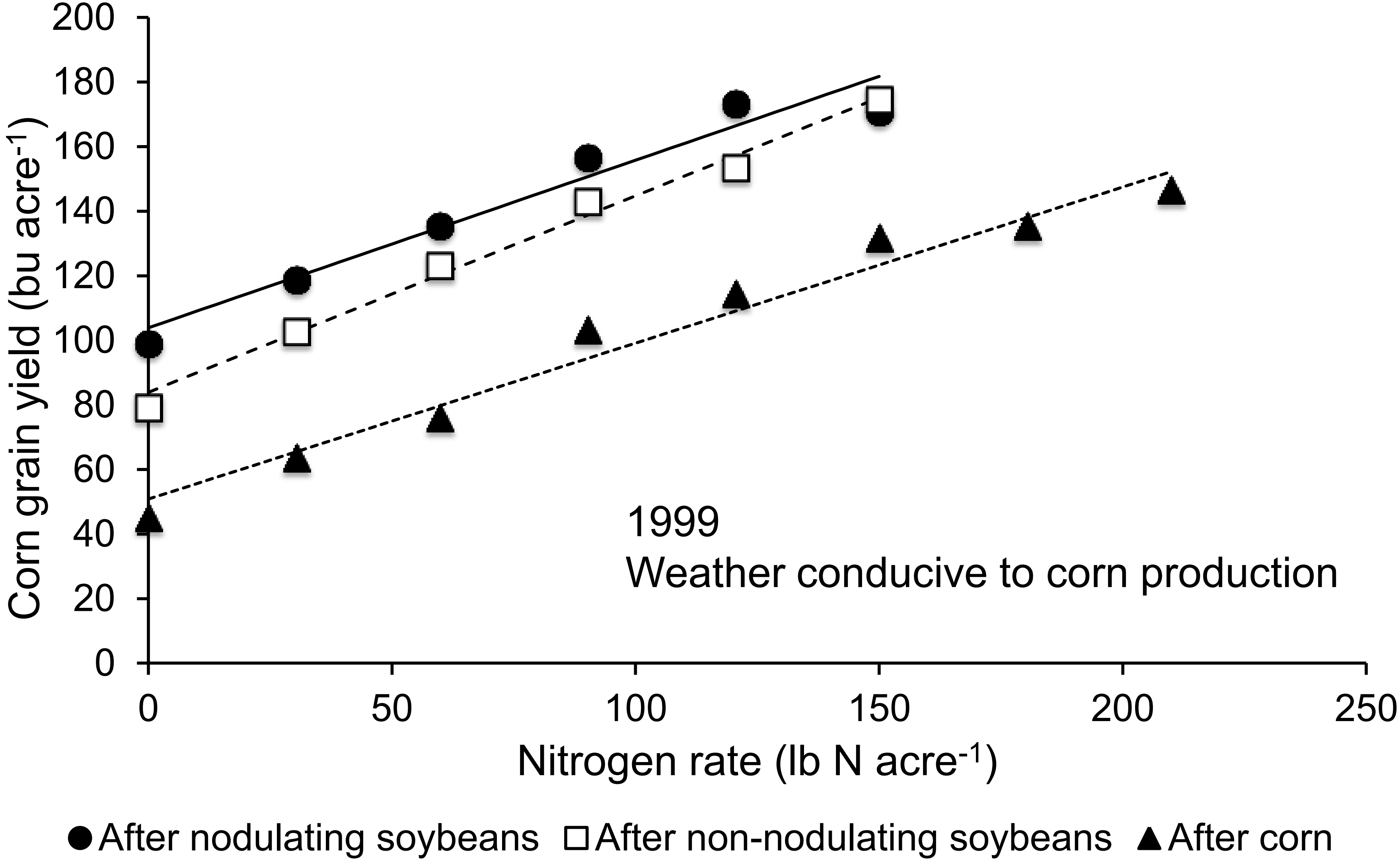
Comparing C/N ratios of corn residue to soybean residue

Crop	Fertility treatment	C/N ratio
	(lb N/acre)	
Corn	100	90/1
	200	57/1
	300	45/1
Soybean	0	41/1

Green, C.J. and A.M. Blackmer. 1995. Soil Sci. Soc. Am. J. 59:1065-1070.

IPNI

Contribution of soybean nodules to the N response of the following maize crop



Bergerou et al. 2004. Plant Soil 262:383-394.

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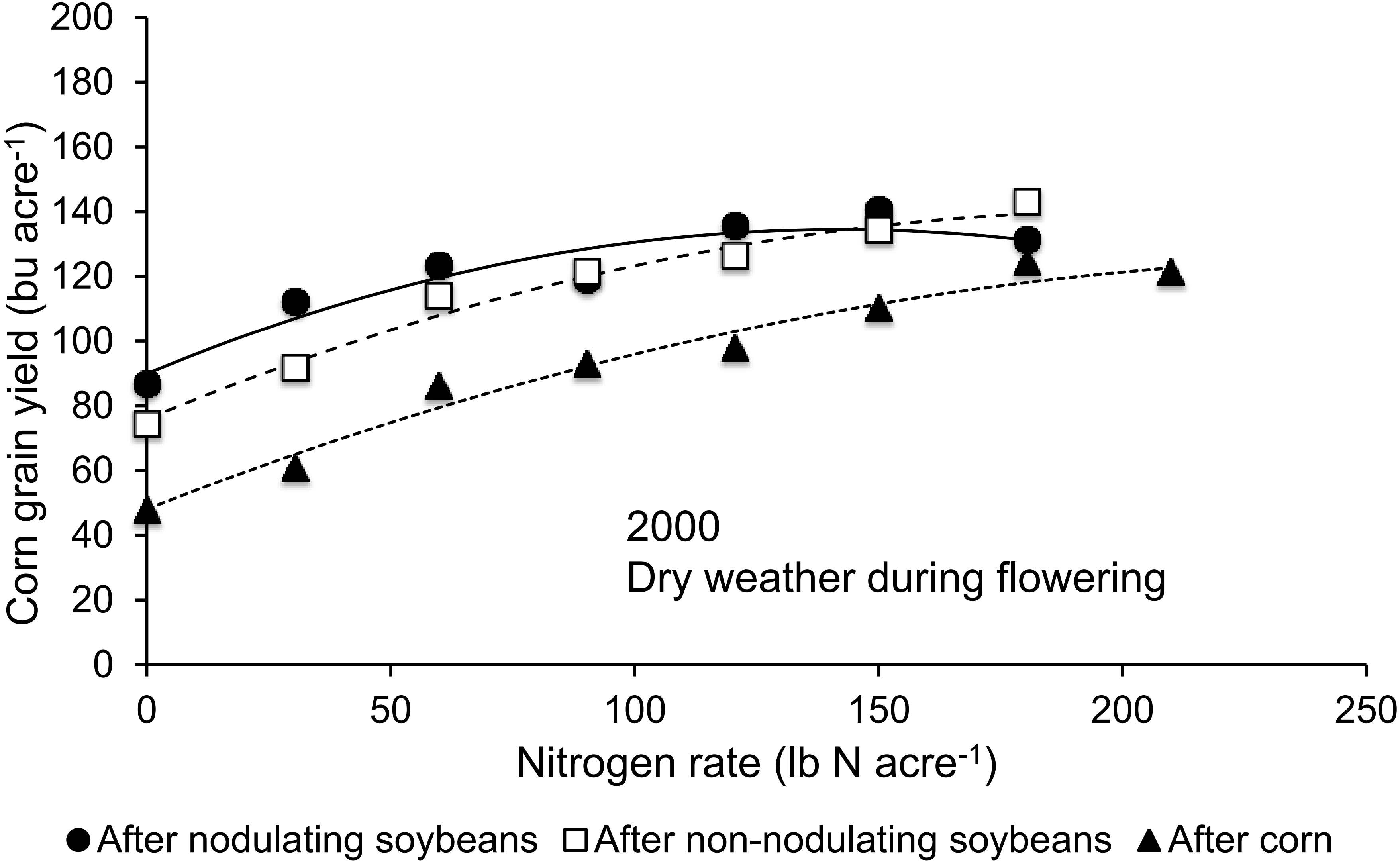

Bergerou et al. 2004. Plant Soil 262:383-394.

Taking the soybean N credit next year

- The N "credit" likely arises from:
  - Increase in a readily mineralizable organic N pool
  - Less immobilization of N due to lower C/N ratios of soybean residue compared to corn residue
- 2012 drought year:
  - For corn, yields were lower than planned for
    - N rates ended up being beyond those needed to maximize the low yields
    - C/N ratios are likely lower in corn residue this year
    - Corn residue will look more like soybean residue, so baseline for comparison shifts, making the soybean credit appear lower
  - For soybean, poorer nodulation could result in slightly lower N credits
  - Overall, N credit will likely be less, but overall N rates needed next year could also be less, due to higher residual nitrate and lower C/N ratios of corn stover

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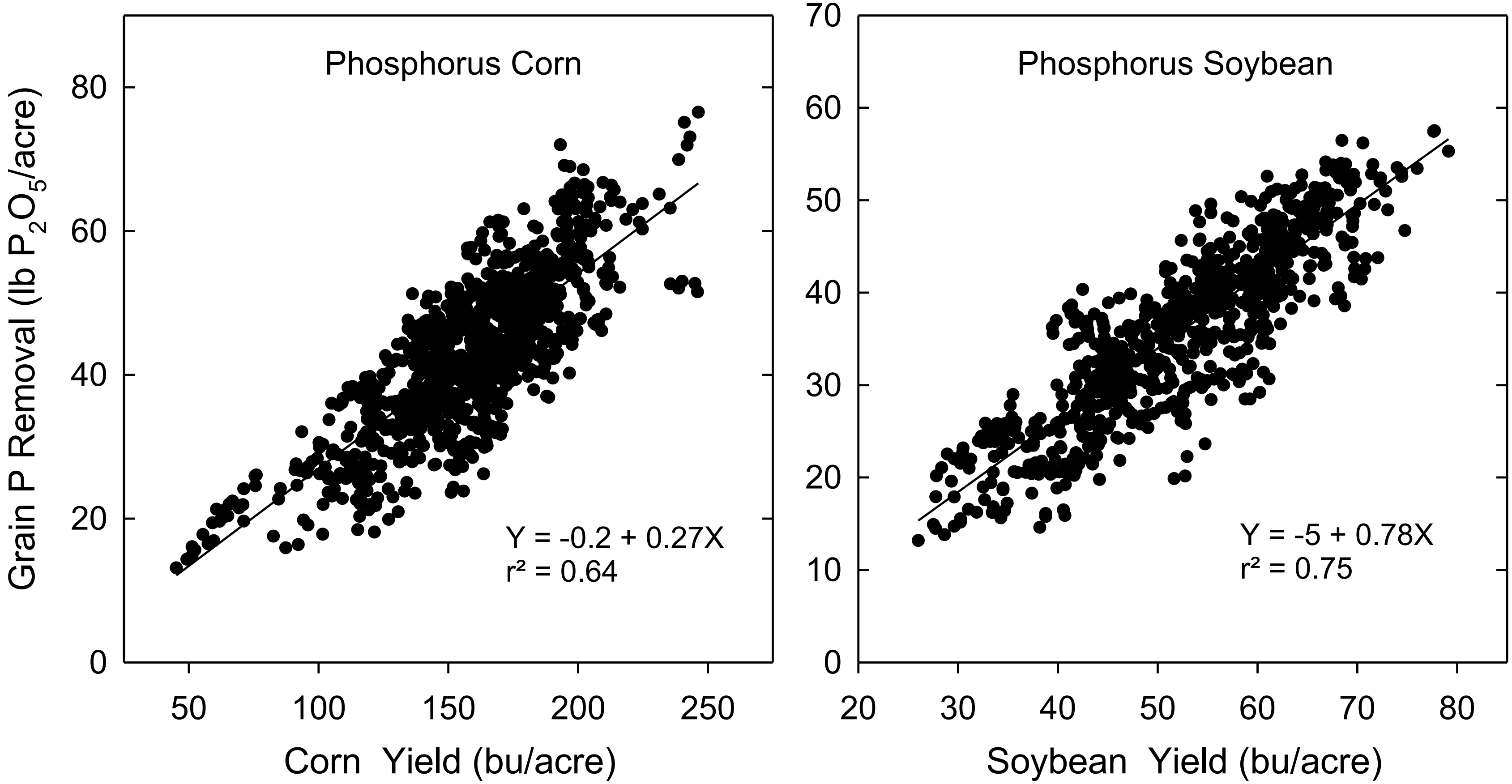
Major P and K issues due to drought

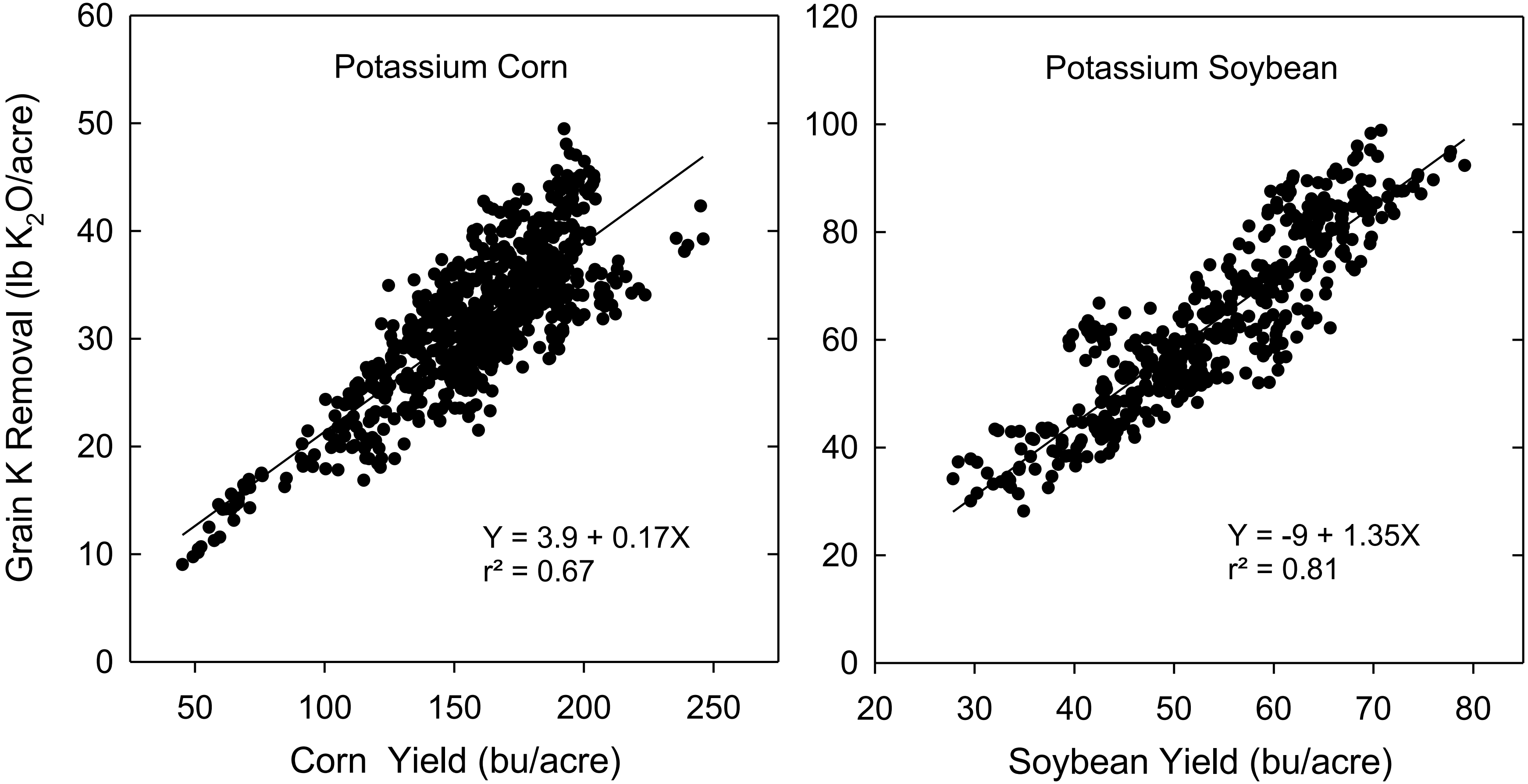
- **Crop issues**
  - Less than normal uptake and yield
  - Less removal with harvest
  - Very large yield and removal variability within and across fields
- **Soil issues**
  - Dry weather effect on recycling to soil
  - Dry soil effects on soil-test results

Yield level and P Removal



Mallarino, Oltmans, et al., 2011

Yield level and K Removal



Mallarino, Oltmans, et al., 2011

Use suggested concentrations and yield estimates

Crop	Unit of Yield	Pounds per Unit of Yield	
		P_2O_5	K_2O
Corn	bu	0.375	0.30
Corn silage	bu grain equiv.	0.55	1.25
Corn silage	ton, 65% H_2O	3.50	8.0
Soybean	bu	0.80	1.5
Oat and straw	bu	0.40	1.0
Oat straw	ton	5.0	33.0
Wheat	bu	0.60	0.30
Alfalfa	ton	12.5	40.0
Red clover	ton	12.0	35.0

Adapted from PM 1688 publ.

Use yield monitors to estimate yield and removal variation within fields

Nutrient removal of drought-damaged corn harvested for silage
(assuming no or little grain produced)

Corn growth stage	Percent of normal full removal	
	P_2O_5	K_2O
R1 (silking)	50	75
R2 (blister)	55	85
R3 (milk)	55	85
R4 (dough)	55	85

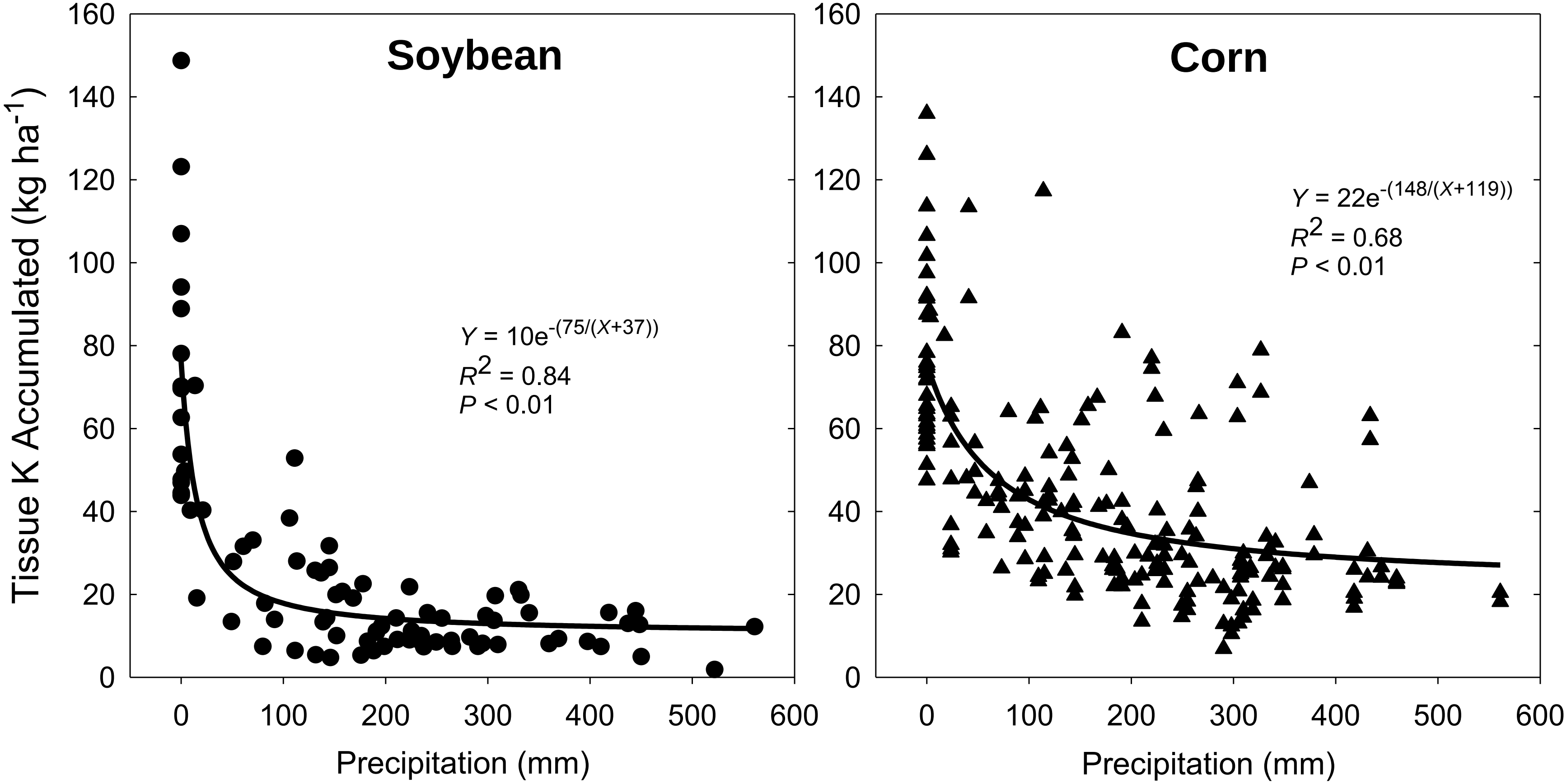
Calculations from Iowa State University publ. PMR 1009, Corn growth and development

Summary:

- Uncertain drought effects on crop P and K concentrations, and expected high variation
- Yield level drives amounts of P and K removed

- **Use locally suggested average nutrient concentrations**
- **Measure yield level the best you can, use of yield monitors to estimate within-field yield and removal variation**

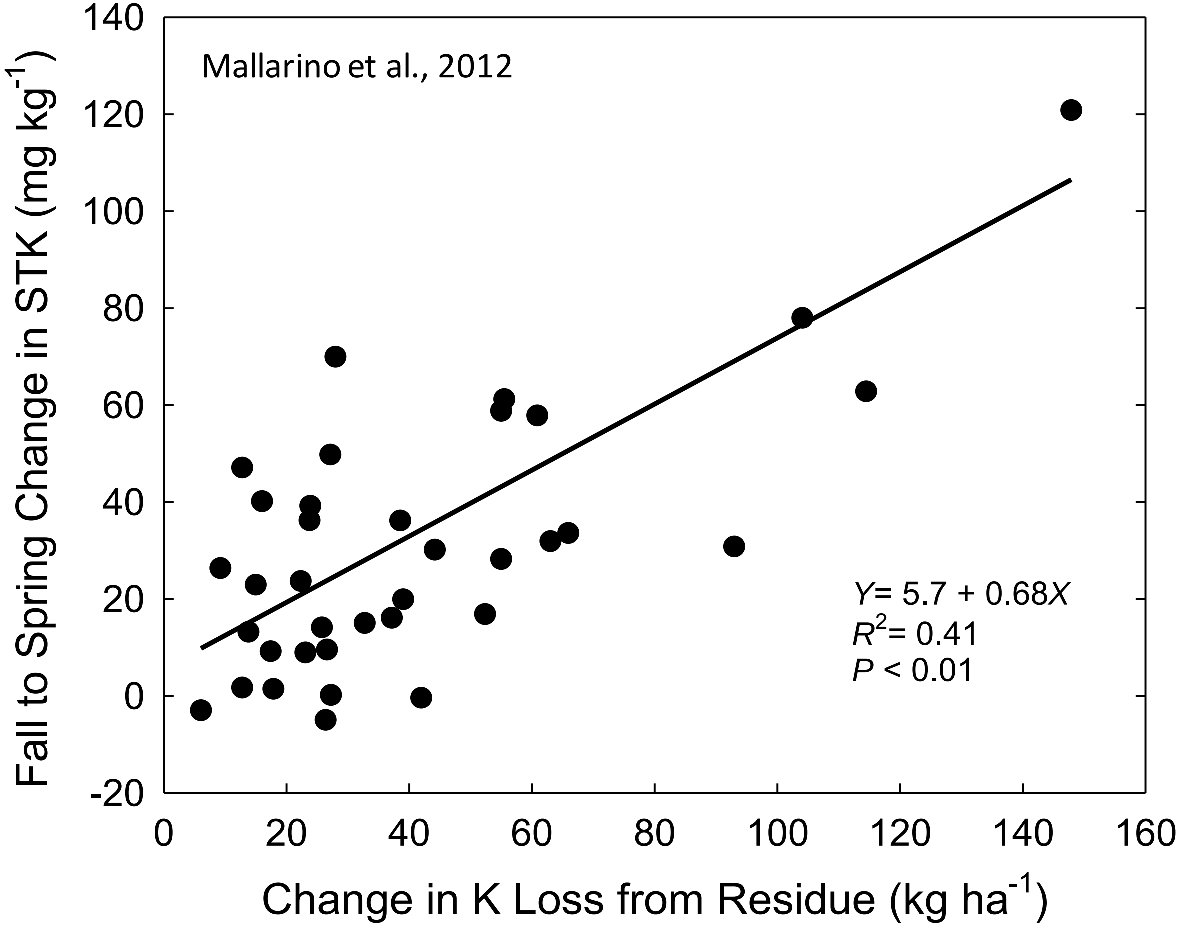
K recycling and rainfall



Mallarino et al., 2012

Measurements from physiological maturity until early spring of the following year

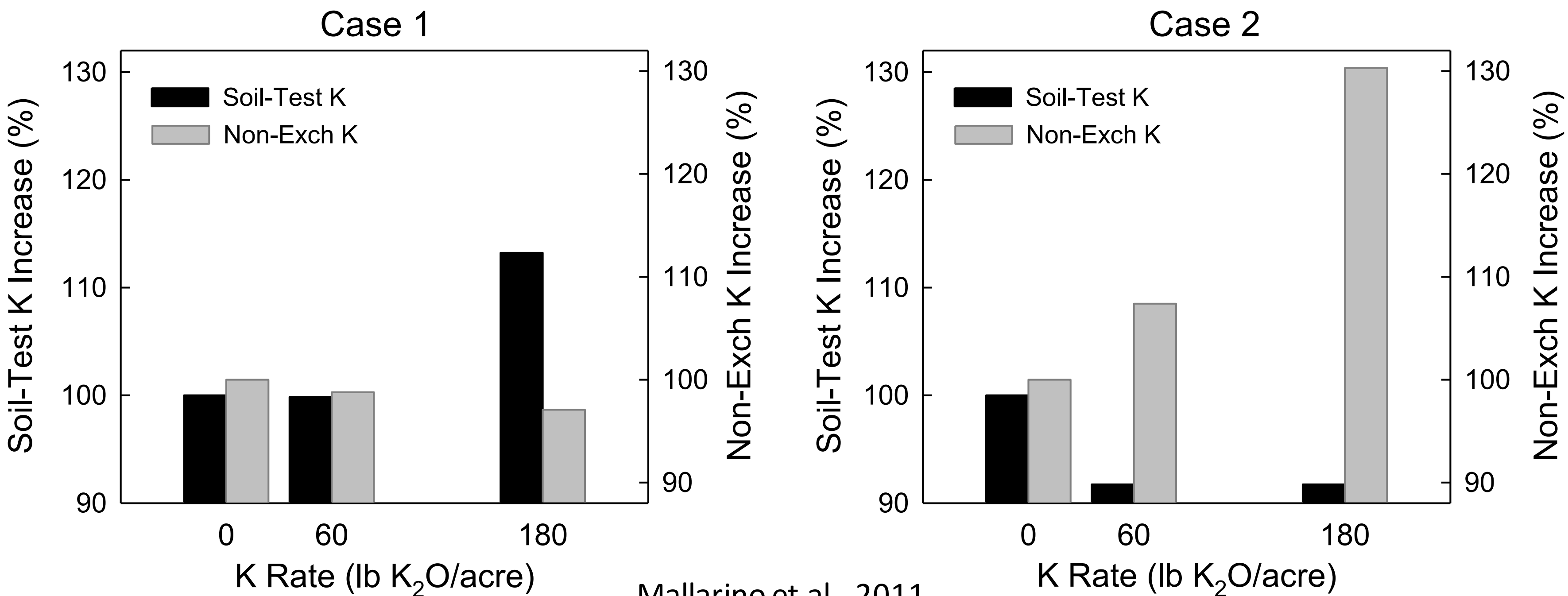
K recycling and soil-test K change from fall to spring



Exchangeable/Non-Exchangeable K Reactions

Uncertain but possible effect of drought due to limited equilibrium between pools:

- Likely less exchangeable K increase after harvest crops
- More K remains exchangeable when fertilizing dry soil



Mallarino et al., 2011

Effect of pre-plant K fertilization on soil-test K and non-exchangeable K after corn harvest

Summary

- Less P and K recycling and slower equilibrium between soil P and K pools equilibrium
- Unclear effects on P: Values may be perhaps 0 to 15% lower, but I would use the normal interpretations
- Much lower soil-test K results
  - Less K recycled from standing plant and residue
  - Slower replenishment of exchangeable K
- Late fall (after some rain) or spring soil sampling will provide more reliable results

Fall Drought and Soil pH

- Issue: Less leaching of soluble salts from topsoil
- pH values may be 0.1 to 0.3 units lower
  - Example: 5.7 to 5.9 instead of 6.0
- Little or no effects on Buffer pH used to calculate amounts of lime to apply
- A couple of inches of rain will be enough to restore normal conditions and pH test results
- If little rain continues, little movement of lime into soil in no-till or pastures

Cover Crop Considerations

Mike Plumer

University of Illinois Extension (retired)

Coordinator, Illinois Council on Best Management Practices

Illinois KIC -Soil nitrate study 2012

- 10-25ppm in top 12” of soil
  - Max found 75ppm side dress track with UAN
  - Very little found below 12”
- Cover crops only way to stop nitrogen loss

Cover Crop
Picking up excess nitrogen from
Anhydrous tracks after corn

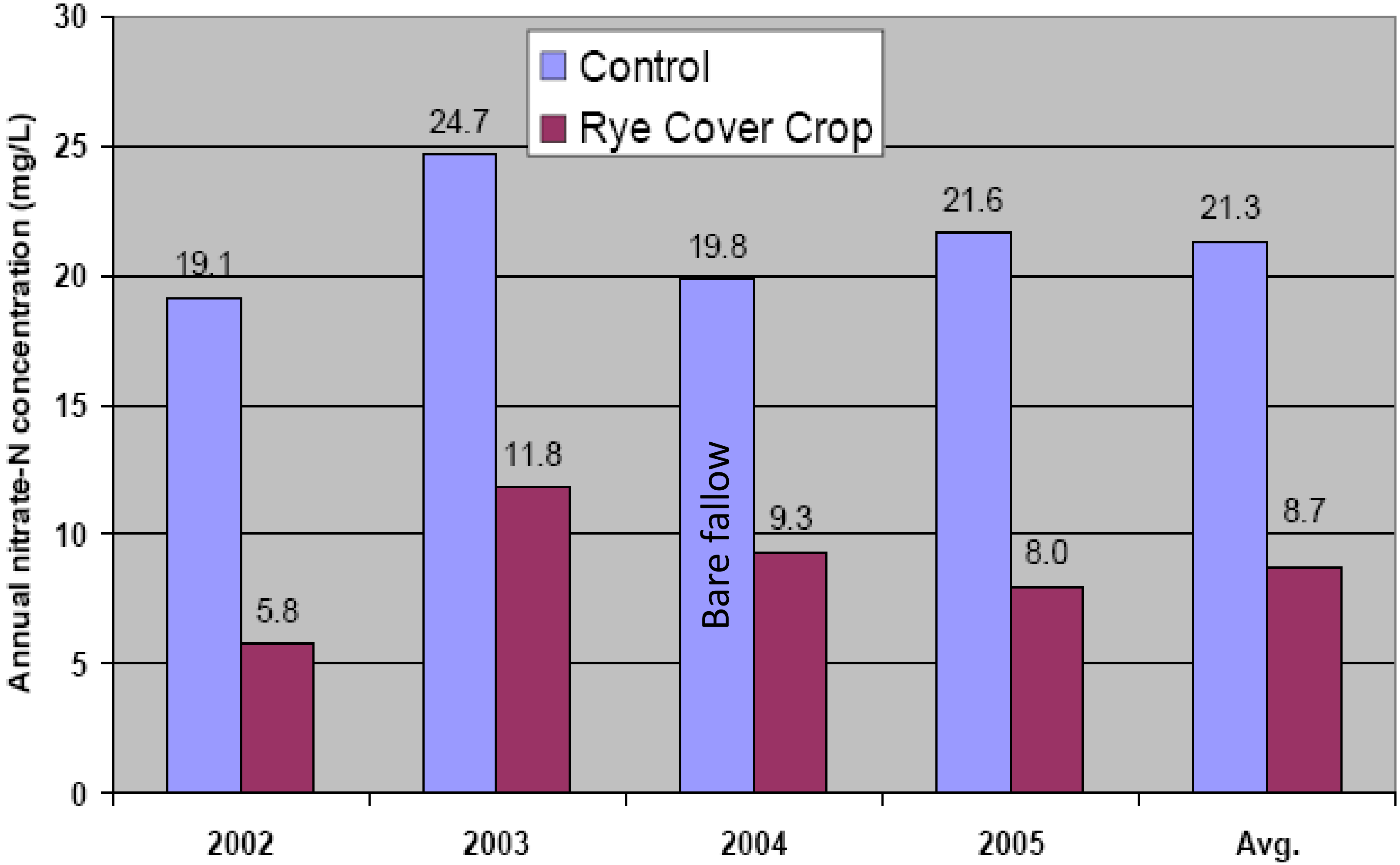
Frost damage on lush growth

Protecting ground water by holding left over nitrogen till spring

Nitrogen Uptake

- Continuous no-till
- Corn after Corn
- 200#N/a = 215 bu/A
- 3642 #/A. annual ryegrass Jan. 6
- 84 #/a of Nitrogen from ryegrass water leachable
- Leached out of ryegrass with 2” of water applied

Average annual flow-weighted nitrate-N concentration of drainage water for 2002-2005



U of Ill.

Recovering the nutrients

- Killing plants in vegetative stage of growth will recover nitrogen quickly:
  - Lack of lignin
  - Fragile cellulose
  - Good carbon:nitrogen ratio
    - Cereal rye 20:1
    - Ryegrass 15:1
    - Legumes 10:1
  - No-till system grass leaches out nitrogen with rainfall and surface decomposition
  - Tillage systems require microbial breakdown of plant which is quick at this stage of growth

American Society of Agronomy

Managing Nutrients After the Drought

We Welcome Your Questions and Comments:

– Type in the question queue

– Please be as brief as possible

– Indicate which panel member to ask if you have a preference

– Indicate your location, if relevant to question

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- Annual Meetings October 21-24, Cincinnati, OH
- Watch for announcement of 4R Nutrient Management Online Class—Nov, Dec, Jan

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Managing Nutrients After the Drought

Today's slides, links to additional resources at:

https://www.agronomy.org/education/managing-nutrients-drought-resources