Fluid Fertilizer's Role in Sustaining Soils Used for Bio-fuels Production

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National Soil Tilth Laboratory
Creating Agricultural Success

Project Objectives

- **To evaluate several S sources for corn grown on low organic matter soils**
- **To investigate nutrient dynamics in a comprehensive tillage, nutrient management, and residue removal study**


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Sulfur Response: Site Characteristics

- Eroded side slopes
- Loam/silt loam (Typic Haplaquolls)
- Corn after soybean
- N fertilizer applied at planting + spoke-wheel UAN (155 lb N/A)
- Corn (Fontanelle 4693) planted 5/6/08, 32K plants/A

S Fertilizer Treatments

Control

30 lb S/A; 13-33-0-15S; 2x3

30 lb S/A; 21-0-0-24S; 2x3

30 lb S/A; 12-0-0-26S; 2x0

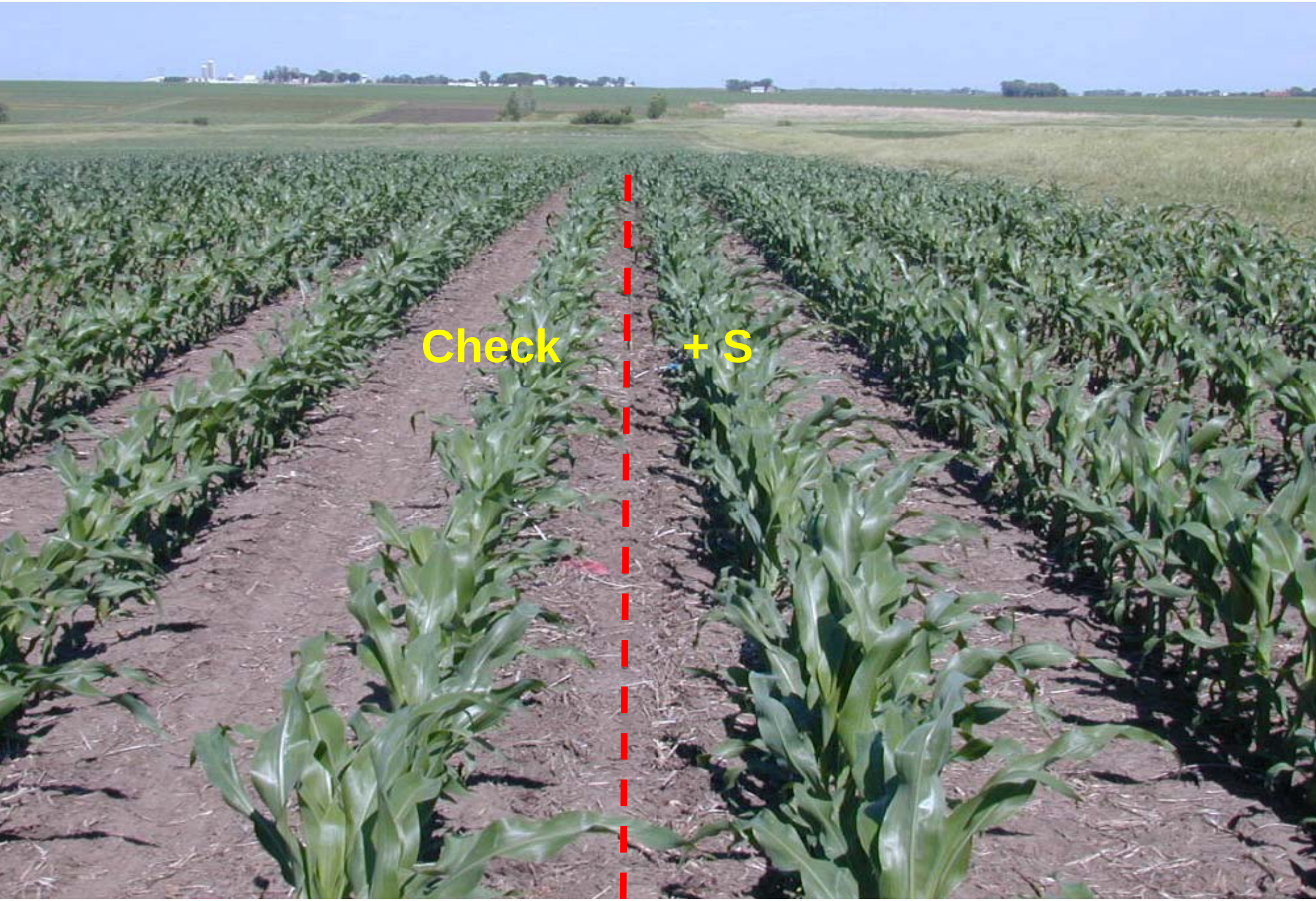
2008 Initial Soil Test Levels

Soil Test	Composite	Range
Bray-1 P, ppm	21 (H)	9 (L) – 36 (VH)
Exch. K, ppm	116 (L)	91 (L) – 177 (H)
Exch. Ca, ppm	2017	1379 – 2308
Exch. Mg, ppm	204	163 – 243
Extractable S, ppm	5.8	4 – 9
pH	6.9	5.6 – 7.6
Organic Matter*, %	2.3	2.0 – 2.6

* Ignition Method

Sulfur Response: Measurements

- Stand counts
- Whole-plant samples at V5
- Ear-leaf samples at mid-silk
- Grain yield and moisture
- Stover yield (whole-plant hand harvest)
- Grain and stover nutrient content


Check
+ S

Effect of 30 lb S/A on Whole-Plant Dry Weight, and S, N, P, and K Tissue Concentrations at V5 in 2008

Treatment	Dry Weight	Nutrient			
		S	N	P	K
	g plant $^{-1}$	---------- % ----------			
Control	5.4b†	0.15b	2.40b	0.36a	3.73a
13-33-0-15S (SEF)	7.9a	0.17ab	2.64ab	0.39a	3.23a
21-0-0-24S (AMS)	6.6ab	0.19a	2.96a	0.33a	3.22a
12-0-0-26S (ATS)	7.0ab	0.18ab	2.50ab	0.32a	3.41a

†Values followed by the same letter are not significantly different at the 0.05 level.

Effect of 30 lb S/A on Corn Grain Yield, Grain Moisture, and Stover Yield in 2008

Treatment	Grain Yield†	Grain Moisture	Stover Yield
	bu/A	%	tons/A
Control	192	17.2	3.36
13-33-0-15S (SEF)	204	16.6	3.97
21-0-0-24S (AMS)	192	17.0	3.65
12-0-0-26S (ATS)	194	16.7	4.51
$LSD_{(0.05)}$	7	0.7	0.69
$LSD_{(0.10)}$	5	0.6	0.56

†Yields adjusted to 15.5% moisture.

Removals of Sulfur (S) with Harvested Corn Grain and Stover in 2008

Treatment	S Removals		Replacement
	Grain	Residue	Cost
	---------- lb S/A ----------		$/A ‡
Control	7.7b†	1.9b	10.40
13-33-0-15S (SEF)	10.7a	2.6a	14.41
21-0-0-24S (AMS)	9.3a	2.2b	12.46
12-0-0-26S (ATS)	9.9a	2.6a	13.54

†Values followed by the same letter are not significantly different at the 0.05 level.

‡Based on $1.08 per lb S (January ’09) as ammonium sulfate ($520/ton).

S Fertility Management (3-yr)

- Greatest benefit on eroded hill slopes
- 30 lb S/A increased plant dry weight and S at V5
- At mid-silk, S concentrations often < sufficiency range
- Corn grain and stover yield increased, grain moisture decreased
- S fertilizers comparable
- Average response 6 bu/A at a cost of $32/A for S

Upscaling


MEYER

Bio-fuels Project Treatments

- ✓ **Residue removal: 0, 50%, 90%**
- ✓ **Tillage: chisel plow, no-till**
- ✓ **Nutrient management: standard (30K plants/A), high input (44K plants/A)**
- **Bio-char: 0, 4.32 tons/A, 8.25 tons/A**
- **Cover crops: annual, perennial**


Cob & Top 50% Removal
Whole Plant Removal
NOV 19 2008

Soil Test Levels

Soil Test	Fall 2005 †	Fall 2008 ‡	
	Surface (0-6”)	Surface (0-2”)	Subsurface (2-4”)
Available P, ppm	33 (VH)	39	24
Exch. K, ppm	128 (L)	199	142
Exch. Ca, ppm	3498	2112	2276
Exch. Mg, ppm	-	301	310
Extractable S, ppm	-	1.0	0.9
pH	6.2	6.5	6.5
Organic Matter*, %	3.6	3.8	3.7

†Mehlich 3 * Ignition Method

‡Bray-1 / NH_4OAc

Nutrient Management

System	Timing	Source
Conventional	Fall 2007	11-52-0 + 0-0-60
190+140+290+20S	Pre-Plant	10-10-10
		12-0-0-26S
	Sidedress	32-0-0 (UAN)
Twin- Row	Fall 2007	11-52-0 + 0-0-60
250+152+294+20S	Pre-Plant	10-10-10
		12-0-0-26S
	Starter	10-10-10 + UAN
	Sidedress	UAN

Field Measurements

- Stand counts
- Whole-plant samples at V5
- Ear-leaf samples at mid-silk
- Grain yield and moisture
- Stover yield and moisture
- Grain and stover nutrient content

Effect of Management System on Whole-Plant N, P, K, and S Tissue Concentrations in 2008

System	Growth Stage	Nutrient			
		N	P	K	S
		---------- % ----------			
Conventional	V6	3.09	0.40	3.86	0.18
Twin Row		2.81	0.36	3.72	0.16
Conventional	Anthesis	2.53	0.33	1.86	0.17
Twin Row		2.44	0.32	1.92	0.16

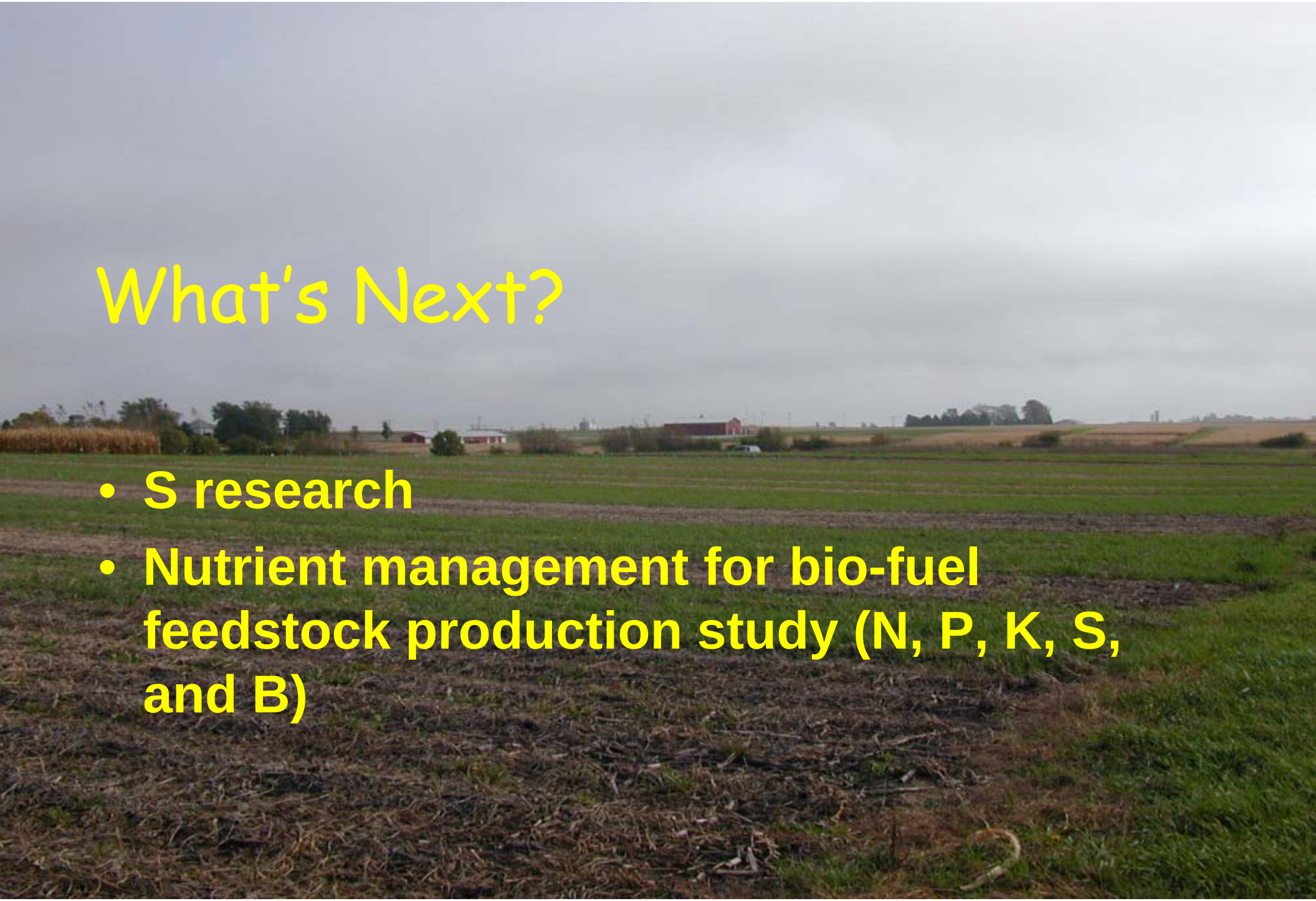
Effect of Management System on Corn Grain Yield, Grain Moisture, and Stover Yield in 2008

Treatment	Grain Yield†	Grain Moisture	Stover Yield	
			50% Cut	90% Cut
	bu/A	%	------ tons/A ------	
Conventional	171	19.3	2.5	2.8
Twin Row	183	19.4	2.9	3.1

†Yields adjusted to 15.5% moisture.

Main Points:

- **At V5, N concentrations below sufficiency range in whole plants, due to wet growing conditions**
- **At mid-silk, N and S concentrations below sufficiency range, K low**
- **Corn grain and stover yields numerically increased in twin-row system**
- **Nutrient removals within each system will guide 2009 fertilizer applications**



What's Next?

- **S research**
- **Nutrient management for bio-fuel feedstock production study (N, P, K, S, and B)**

Some Challenges:

- **Complicated nutrient management for bio-energy feedstock production?**
- **Amount of crop residue to sustain both the farming and ethanol production enterprises?**
- **Tillage, cover crops, other management questions?**
- **New soil test calibration/correlation?**