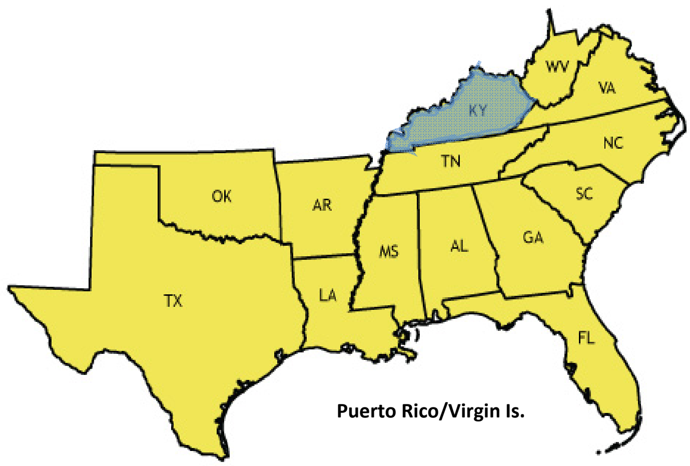
SERA-IEG-6 2014 ANNUAL MEETING
University of Kentucky, Division of Regulatory Services
Lexington, KY

June 22-24, 2014



LabFit

TSP TEXAS SCIENTIFIC PRODUCTS

SPECTRO

ThermoFisher SCIENTIFIC

elementar EXCELLENCE IN ELEMENTS

ALP Agricultural Laboratory Proficiency Program

AGENDA

Sunday, June 22

5:00-6:00PM	**Registration at Good Barn** The Good Barn is walking distance from University Inn
6:00-9:00PM	Evening meeting (dinner, social, and meet) at the Good Barn
6:00-6:10PM	*WELCOME AND INTRODUCTIONS
6:10-6:45PM	Dinner
6:45-7:30PM	*SPONSOR PRESENTATIONS LabFit – Dennis Warrenfeltz Texas Scientific Products – Sergei Leikin & Doug Keene Spectro – Bob Dussich
7:30-9:00PM	**SERA6 ADMINISTRATOR REPORTS** Steve Workman, Assistant Dean for Research & Associate Director, College of Agriculture, Food and Environment Joe Zublena , Associate Dean, CALS and Director, North Carolina Cooperative Extension Service, North Carolina State University *STATE REPORTS (~ 5 to 10 min each)
	ADJOURN

Monday, June 23

8:00-8:15AM	**UK Administrator Welcomes** Jimmy Henning, Associate Dean for Extension, College of Agriculture, Food and Environment Darrell Johnson, Director, Division of Regulatory Services
8:15-8:45AM	*A Long Term N x Tillage Trial: The 45-Year Outcomes* John Grove Plant and Soil Sciences, UK
8:45-9:15AM	*Nutrient Management for Kentucky Farmers* Amanda Gumbert Plant and Soil Sciences, UK
9:15-9:45AM	*Soil Testing: Correlation, Calibration, and Interpretation* Hugh Savoy University of Tennessee
9:45-10:15AM	**BREAK**
10:15-10:45AM	*Automated Soil Sampling Technology* Allan Baucom North Carolina Grower
10:45-11:15AM	*Corn Potassium Dynamics* Bob Miller Colorado State University
11:15-11:45AM	*Modifying the Kentucky P Index using Published P Loss Data* Carl Bolster Animal Waste Management Unit, USDA/ARS

11:45-1:00 PM	**LUNCH – SPONSOR PRESENTATIONS** Thermo Fisher Scientific – Thomas Murphy & Gwyneth Trojan Elementar – Mark Larson
1:00-3:00 PM	Tour Labs at Division of Regulatory Services (Soils and Feed/Fert)
3:00-5:00 PM	Tour Town Branch distillery and brewery
5:00-6:30 PM	Break back to University Inn
6:30-9:00 PM	**DINNER AT HILARY BOONE CENTER**

Tuesday, June 24

8:00-8:30 AM	*Soil Quality/Soil Health Testing for Alabama* Charles Mitchell and Gobena Huluka Auburn University
8:30-9:00 AM	*Evaluation of Methods for Rapid Analysis of Soil Organic Carbon* Ling Ou and Gobena Huluka Auburn University
9:00-9:15 AM	**BREAK – SPONSOR PRESENTATION** ALP/CTS – Bob Miller
9:15-12:00 PM	Regional project proposals to evaluate soil test methods white paper discussion on NRCS and soil test adoption NAPT update, Tony Provin ALP update, Bob Miller NCERA13 update, Manjula Nathan Publications update Next year's meeting Voting for secretary Passing the gavel to Larry Oldham

ADJOURN & HAVE A SAFE TRIP BACK HOME

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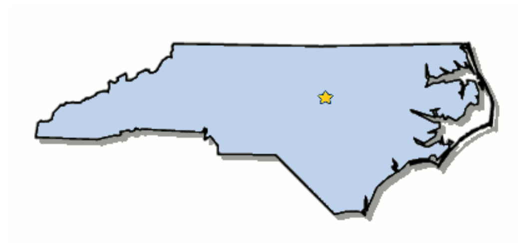
TECHNICAL PRESENTATIONS



Acknowledgements

- Dr. R.L. Blevins, Professor of soil management (emeritus), University of Kentucky
- Dr. Paul Cornelius, Professor of statistics, (deceased) University of Kentucky
- Colleen Steele and Tami Smith, research technical staff, University of Kentucky

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Long-Term Trial Design

- Initiated in spring 1970 into a bluegrass (Poa pratensis L.) pasture
- No-till (NT) and moldboard plow (MP) tillage, with 0, 84, 168 and 336 kg N/ha (0, 75, 150 and 300 lb N/A) as 34-0-0
- Laid out as split strips in each of 4 randomized blocks
- Statistically evaluated using PROC MIXED in SAS

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Long-Term Cropping System/Site

- Continuous corn, with a winter cereal cover crop, for 45 yr (1970 to 2014)
  - temperate climate with udic rainfall and mesic temperature regimes
    - 1140 mm average annual rainfall – 40% falls from May through September
    - 13 C mean annual temperature; 175 day growing season
  - deep, well-drained Maury silt loam (fine, mixed semi-active, mesic Typic Paleudalfs)

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Long-Term Trial Execution

- Tillage and burn-down herbicide treatments imposed middle April
- Crop planted late April to early May
- N applied within 1 week of planting
- Hand harvested late September to early October

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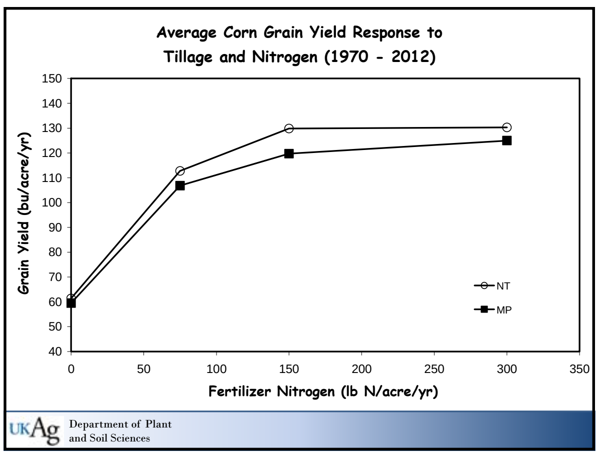
Agronomic Results


Average Corn Grain Yield Response to
Tillage and Nitrogen (1970 - 2012)
Grain Yield (bu/acre/yr)
Fertilizer Nitrogen (lb N/acre/yr)
NT
MP
150
140
130
120
110
100
90
80
70
60
50
40
0
50
100
150
200
250
300
350
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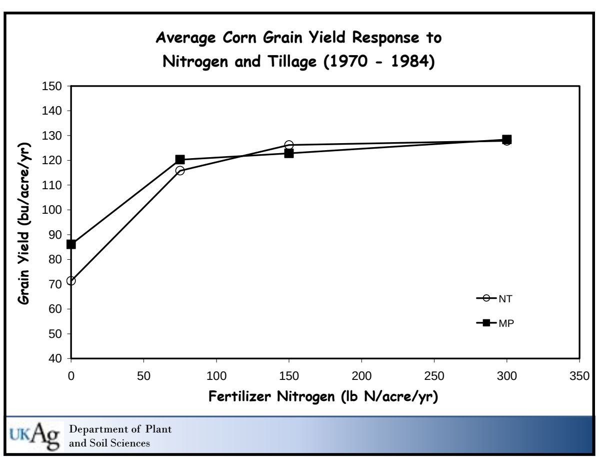
Average Corn Grain Yield Response to
Nitrogen and Tillage (1970 - 1984)
Grain Yield (bu/acre/yr)
Fertilizer Nitrogen (lb N/acre/yr)
NT
MP
150
140
130
120
110
100
90
80
70
60
50
40
0
50
100
150
200
250
300
350
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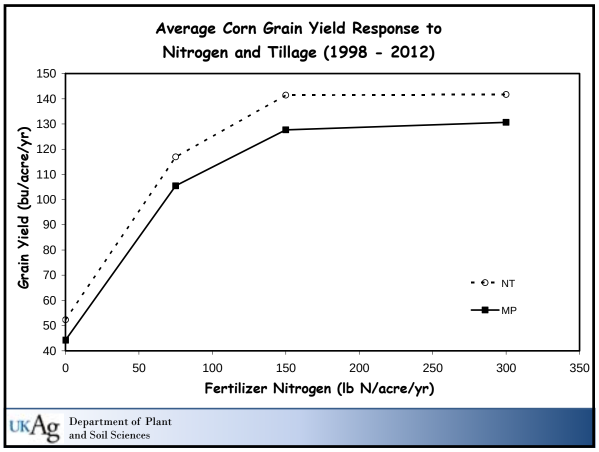

Partitioning Yield Variance

Source of variance	Proportion of total variance %	Probability of a greater F value
year	47.4	< 0.0001
tillage	0.2	0.1370
year*tillage	2.2	< 0.0001
N rate	30.0	< 0.0001
year*N rate	9.1	< 0.0001
tillage*N rate	0.1	0.0397
year*tillage*N rate	1.3	< 0.0001
residual error	9.7	

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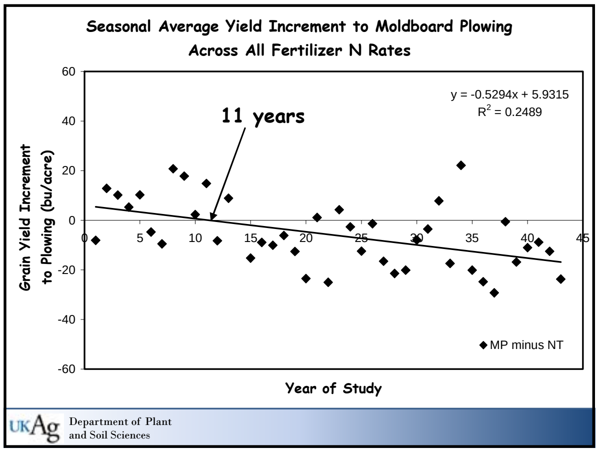
Seasonal Average Yield Increment to Moldboard Plowing
Across All Fertilizer N Rates
y = -0.5294x + 5.9315
R2 = 0.2489
11 years
Grain Yield Increment to Plowing (bu/acre)
MP minus NT
Year of Study
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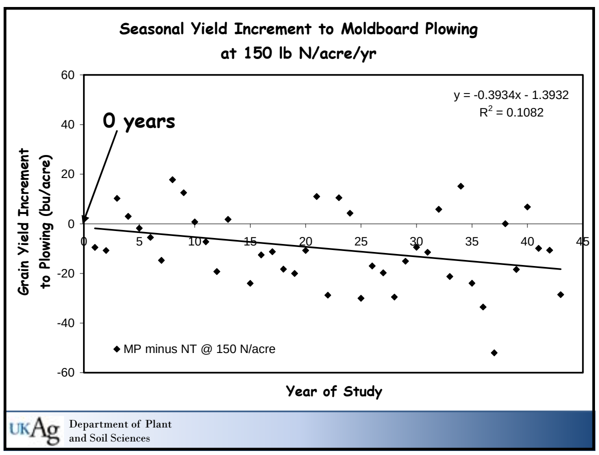
Seasonal Yield Increment to Moldboard Plowing
at 150 lb N/acre/yr
y = -0.3934x - 1.3932
R2 = 0.1082
0 years
Grain Yield Increment to Plowing (bu/acre)
MP minus NT @ 150 N/acre
Year of Study
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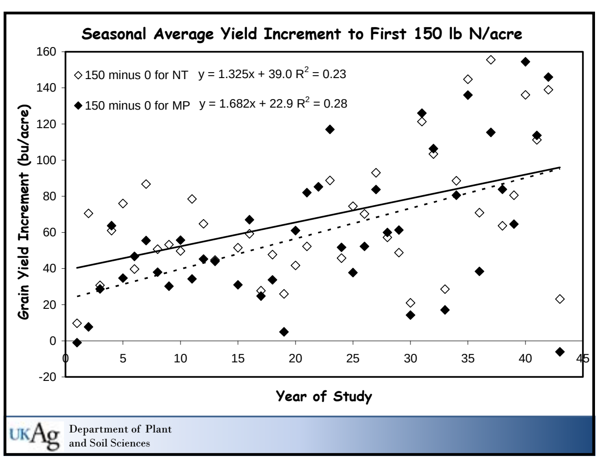
Seasonal Average Yield Increment to First 150 lb N/acre
150 minus 0 for NT y = 1.325x + 39.0 R2 = 0.23
150 minus 0 for MP y = 1.682x + 22.9 R2 = 0.28
Grain Yield Increment (bu/acre)
Year of Study
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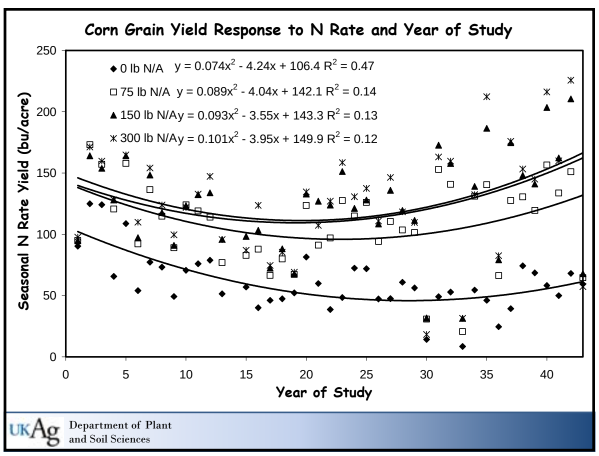
Separating Non-Random
Annual Trend From
Random Seasonal Outcomes


Corn Grain Yield Response to N Rate and Year of Study
0 lb N/A y = 0.074x2 - 4.24x + 106.4 R2 = 0.47
75 lb N/A y = 0.089x2 - 4.04x + 142.1 R2 = 0.14
150 lb N/Ay = 0.093x2 - 3.55x + 143.3 R2 = 0.13
300 lb N/Ay = 0.101x2 - 3.95x + 149.9 R2 = 0.12
Seasonal N Rate Yield (bu/acre)
Year of Study
0
50
100
150
200
250
5
10
15
20
25
30
35
40
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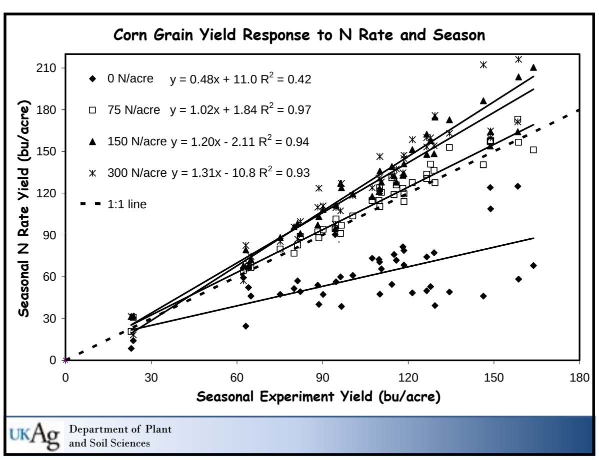
Corn Grain Yield Response to N Rate and Season
0 N/acre y = 0.48x + 11.0 R2 = 0.42
75 N/acre y = 1.02x + 1.84 R2 = 0.97
150 N/acre y = 1.20x - 2.11 R2 = 0.94
300 N/acre y = 1.31x - 10.8 R2 = 0.93
1:1 line
Seasonal N Rate Yield (bu/acre)
Seasonal Experiment Yield (bu/acre)
0
30
60
90
120
150
180
210
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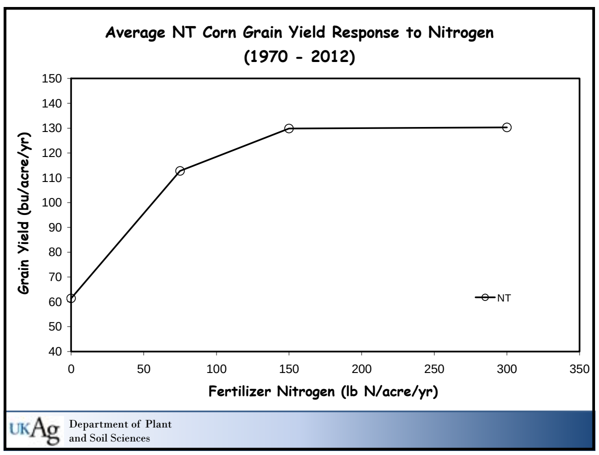
N Rate Recommendations?


Average NT Corn Grain Yield Response to Nitrogen
(1970 - 2012)
Grain Yield (bu/acre/yr)
150
140
130
120
110
100
90
80
70
60
50
40
0
50
100
150
200
250
300
350
Fertilizer Nitrogen (lb N/acre/yr)
NT
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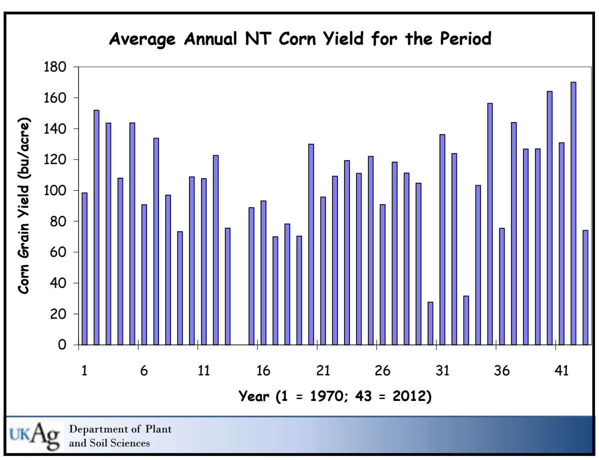
Average Annual NT Corn Yield for the Period
Corn Grain Yield (bu/acre)
180
160
140
120
100
80
60
40
20
0
1
6
11
16
21
26
31
36
41
Year (1 = 1970; 43 = 2012)
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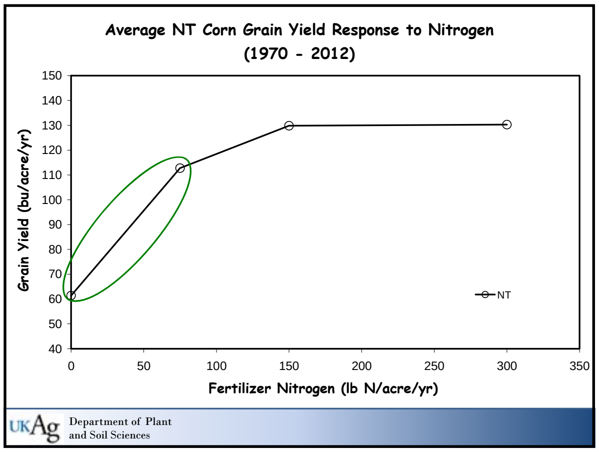
Average NT Corn Grain Yield Response to Nitrogen
(1970 - 2012)
Grain Yield (bu/acre/yr)
Fertilizer Nitrogen (lb N/acre/yr)
NT
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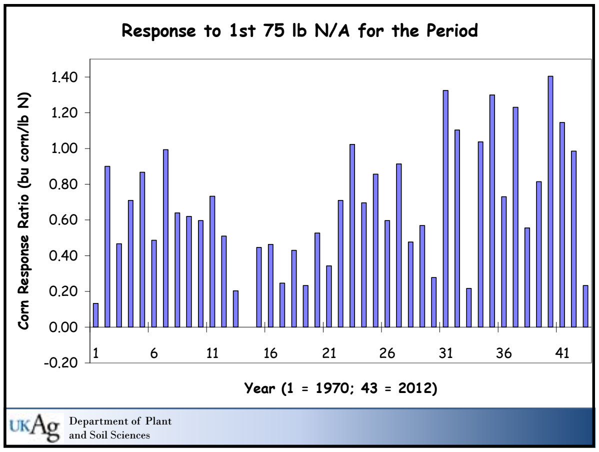
Response to 1st 75 lb N/A for the Period
Corn Response Ratio (bu corn/lb N)
Year (1 = 1970; 43 = 2012)
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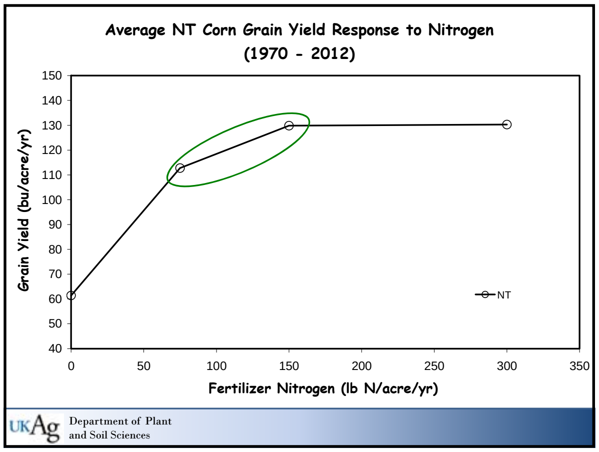
Average NT Corn Grain Yield Response to Nitrogen
(1970 - 2012)
Grain Yield (bu/acre/yr)
Fertilizer Nitrogen (lb N/acre/yr)
NT
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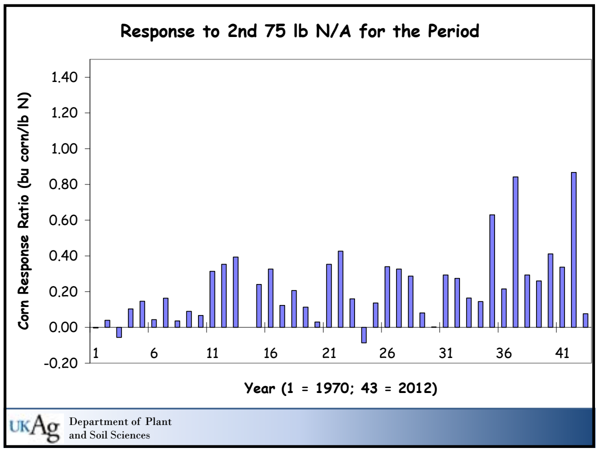
Response to 2nd 75 lb N/A for the Period
Corn Response Ratio (bu corn/lb N)
Year (1 = 1970; 43 = 2012)
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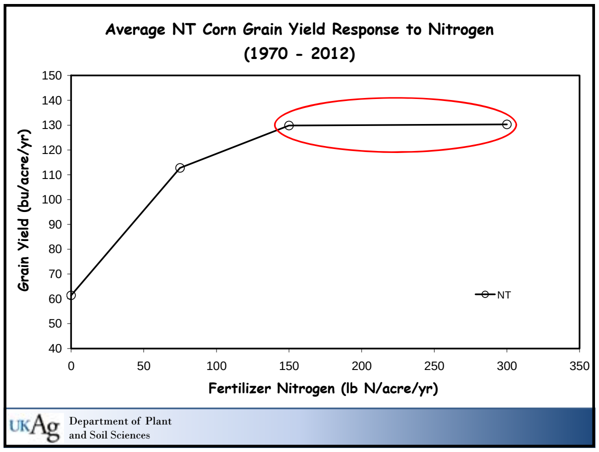
Average NT Corn Grain Yield Response to Nitrogen
(1970 - 2012)
Grain Yield (bu/acre/yr)
Fertilizer Nitrogen (lb N/acre/yr)
NT
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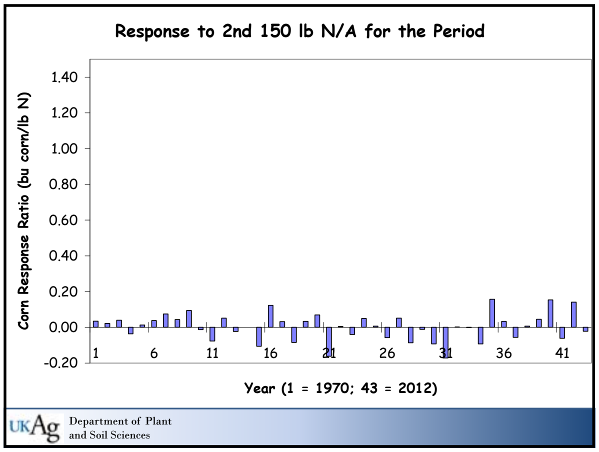
Response to 2nd 150 lb N/A for the Period
Corn Response Ratio (bu corn/lb N)
Year (1 = 1970; 43 = 2012)
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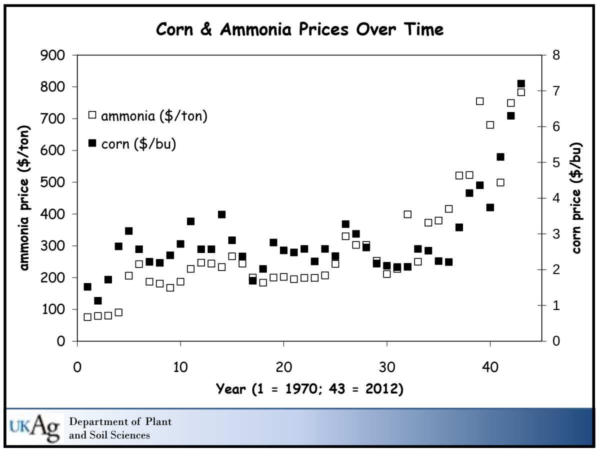
Corn & Ammonia Prices Over Time
ammonia ($/ton)
corn ($/bu)
ammonia price ($/ton)
corn price ($/bu)
Year (1 = 1970; 43 = 2012)
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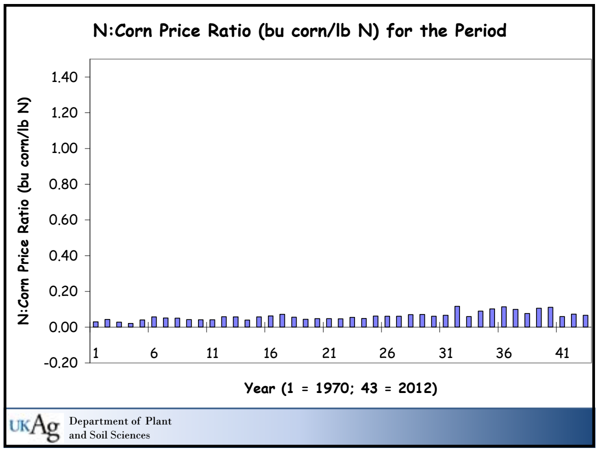
N:Corn Price Ratio (bu corn/lb N) for the Period
N:Corn Price Ratio (bu corn/lb N)
Year (1 = 1970; 43 = 2012)
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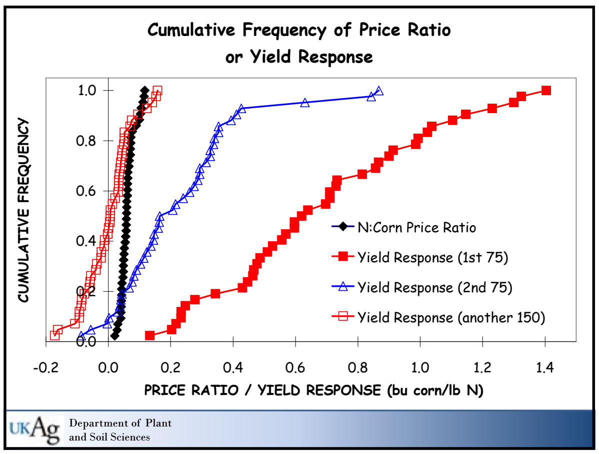
Cumulative Frequency of Price Ratio or Yield Response
CUMULATIVE FREQUENCY
N:Corn Price Ratio
Yield Response (1st 75)
Yield Response (2nd 75)
Yield Response (another 150)
PRICE RATIO / YIELD RESPONSE (bu corn/lb N)
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Soil Profile Sampling

- Soil sampled 0, 168 and 336 (not 84) kg N/ha rate treatments, in both no-till (NT) and moldboard plow (MP) tillage treatments, and the nearby sod
- Took 3 cores per plot, to a depth of 1 m, in 10 cm increments
- Determined bulk density (BD), C and N by dry combustion

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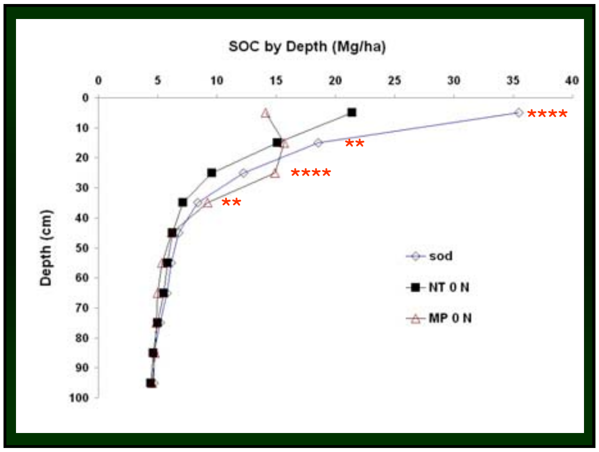
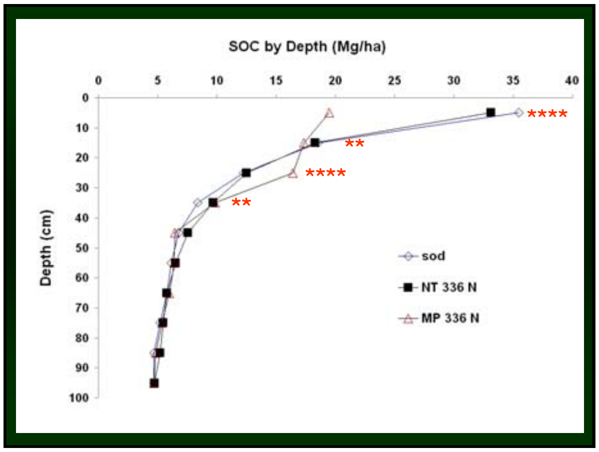
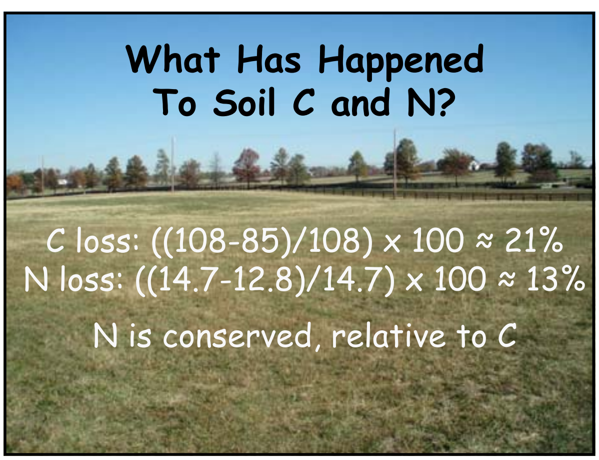
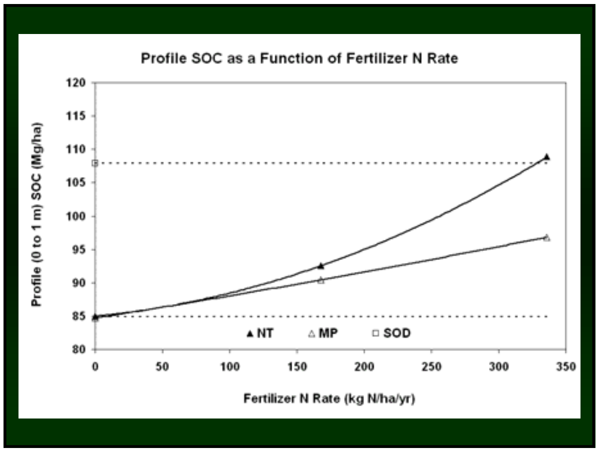


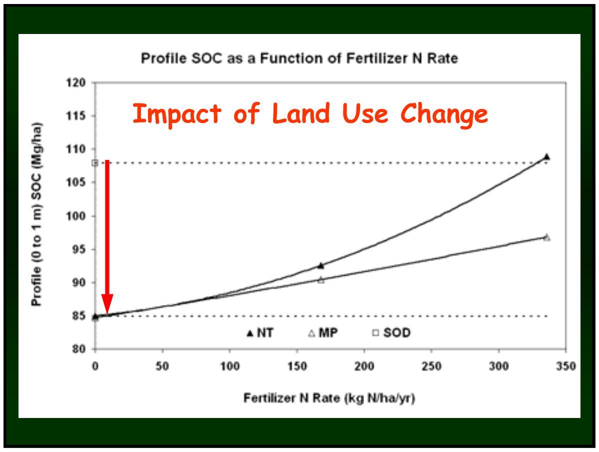


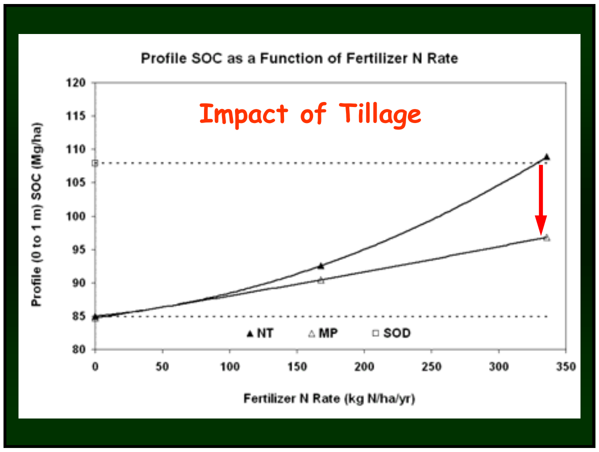
Profile C and N

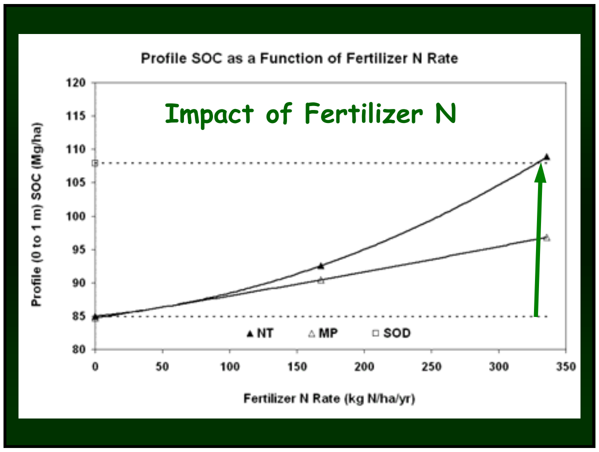
Tillage System	N Rate (kg/ha)	Profile C (Mg/ha)	Profile N (Mg/ha)
NT	0	85 ± 4	12.8 ± 0.5
	168	93 ± 4	13.8 ± 1.9
	336	109 ± 7	14.9 ± 1.2
sod	**---**	**108 ± 13**	**14.7 ± 1.5**
MP	0	85 ± 7	12.8 ± 0.5
	168	90 ± 8	13.6 ± 0.7
	336	97 ± 10	13.9 ± 0.8




Profile SOC as a Function of Fertilizer N Rate
Profile (0 to 1 m) SOC (Mg/ha)
Fertilizer N Rate (kg N/ha/yr)
NT
MP
SOD
120
115
110
105
100
95
90
85
80
0
50
100
150
200
250
300
350


Profile SOC as a Function of Fertilizer N Rate
Impact of Land Use Change
Profile (0 to 1 m) SOC (Mg/ha)
Fertilizer N Rate (kg N/ha/yr)
NT
MP
SOD


Profile SOC as a Function of Fertilizer N Rate
Impact of Tillage
Profile (0 to 1 m) SOC (Mg/ha)
Fertilizer N Rate (kg N/ha/yr)
NT
MP
SOD



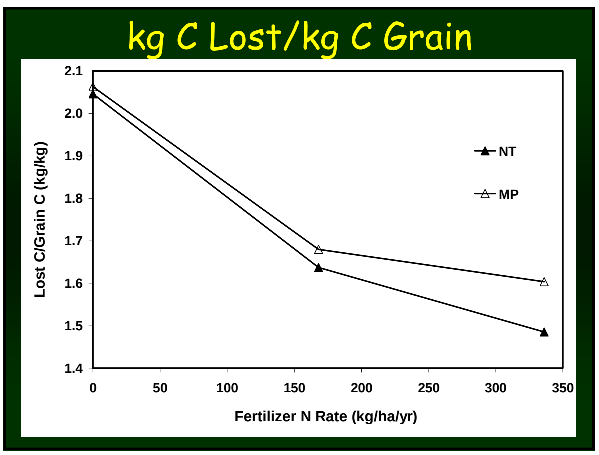
The C Budget

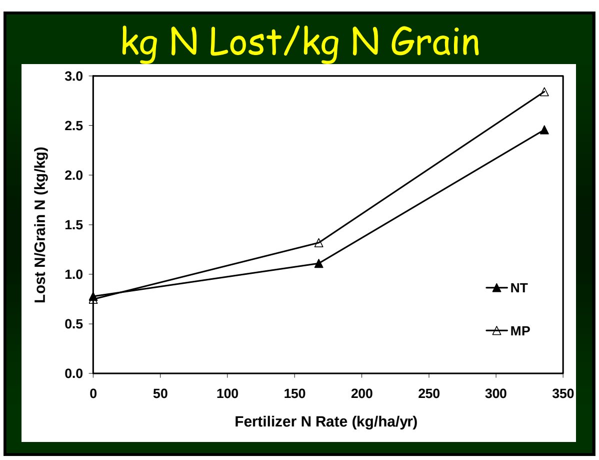
Tillage System	Annual N Rate (kg/ha)	Grain Yield (Mg/ha)	Residue C (Mg/ha)	Profile C (Mg/ha)	Lost C (Mg/ha)
NT	0	141	83	85	106
	168	291	160	93	175
	336	290	159	109	158
Sod	0	0	0	108	0
MP	0	139	82	85	105
	168	268	148	90	166
	336	282	155	97	166

The N Budget

Tillage System	Annual N Rate (kg/ha)	Total N Applied (Mg/ha)	Grain N Removal (Mg/ha)	Profile N (Mg/ha)	Lost N (Mg/ha)
NT	0	0.0	1.1	12.8	0.8
	168	6.4	3.5	13.8	3.8
	336	12.8	3.6	14.9	8.9
Sod	0	0	0	14.7	0
MP	0	0.0	1.1	12.8	0.8
	168	6.4	3.2	13.6	4.2
	336	12.8	3.5	13.9	10.1


Using The
Budget
Numbers


kg C Lost/kg C Grain
Lost C/Grain C (kg/kg)
Fertilizer N Rate (kg/ha/yr)
NT
MP
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
0
50
100
150
200
250
300
350


kg N Lost/kg N Grain
Lost N/Grain N (kg/kg)
Fertilizer N Rate (kg/ha/yr)
NT
MP
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
50
100
150
200
250
300
350

Conclusions

- Strong tillage by N rate interaction on corn yield, but character of interaction profoundly changed with time
- NT corn environment more favorable for improved yield potential with improved genetics and management
- MP corn yield will continue to decline on this soil if N economics/policies cause low fertilizer N use rates

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Conclusions

- At 168 kg N/ha, 46 and 53% of each kg of fertilizer N were recovered in maize grain and soil N on MP and NT soils, respectively
- Fertilizer N sustained greater long-term soil C and N levels
- Inadequate, or excessive, fertilizer N rates result in suboptimal coupling of C and N

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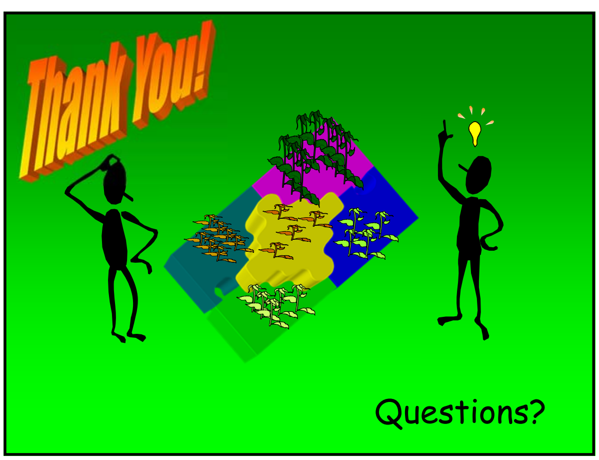
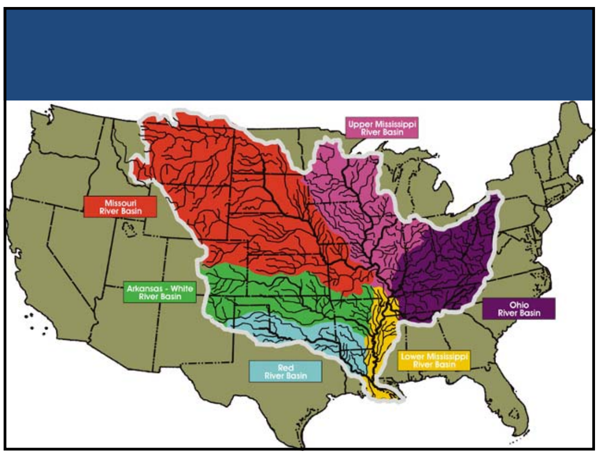
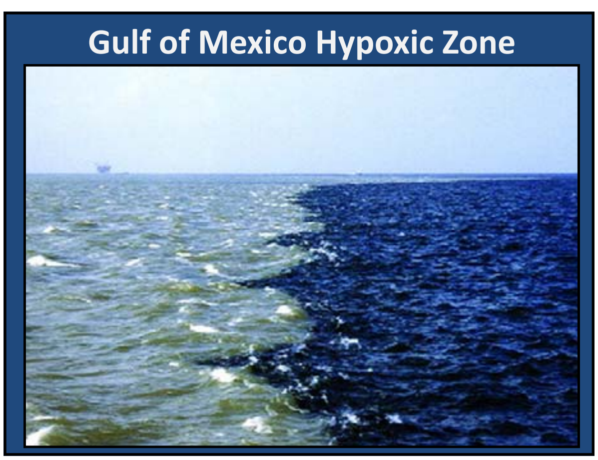
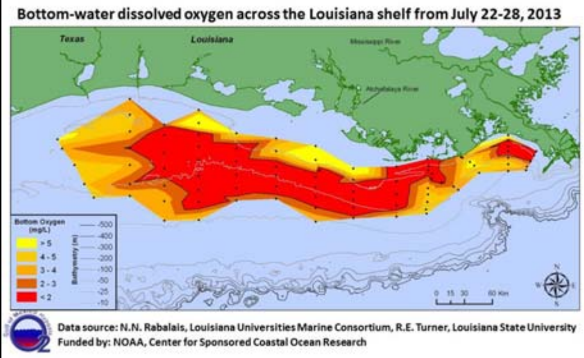


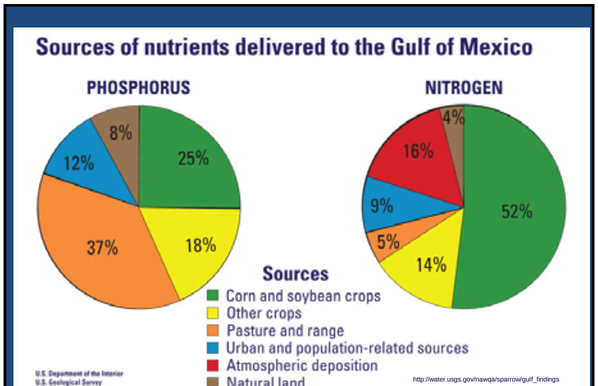

Nutrient Management for KY Farmers
Amanda Gumbert
Water Quality Liaison
UK College of Agriculture/KY Division of Conservation


Upper Mississippi River Basin
Missouri River Basin
Arkansas - White River Basin
Ohio River Basin
Red River Basin
Lower Mississippi River Basin


Gulf of Mexico Hypoxic Zone

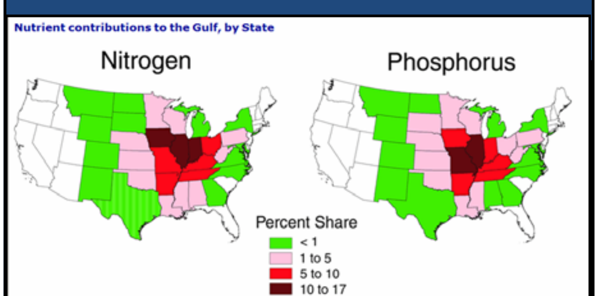


- This year: 5,840 sq. miles (3.7m acres/size of Connecticut)
- Average over last 5 years: 5,176 sq. miles (3.3m acres)



80% P and 71% N coming from agriculture

Where Does the N and P Originate?



Differences in Phosphorus and Nitrogen Delivery to the Gulf of Mexico from the Mississippi River Basin. Alexander, et al. *Environ. Sci. Technol.*, 2008, 42 (3), pp 822–830

230,000 tons Total N and 38,000 tons Total P annually enter the Gulf of Mexico from the Mississippi River

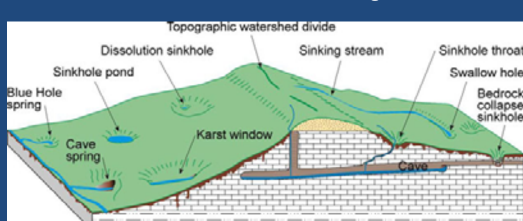
What's Going On In Kentucky?

Current Situation

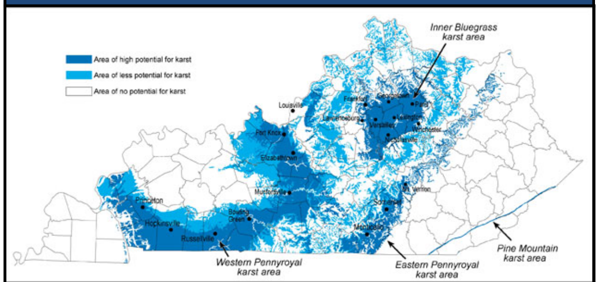
- 90,000+ miles streams and rivers in KY
- Agriculture is the leading source of stream impairments in KY (KEEC, 2010)
  - Affecting 55% of impaired streams

Sensitive Areas

- Where ground water is near the surface or easily accessed (wells, sinkholes, porous soil, etc.)
- In karst regions, there may be little infiltration into the soil before contaminants reach ground water



Karst Regions of Kentucky



How Does Kentucky Agriculture Respond?

Agriculture Water Quality Plans

KY Agriculture Water Quality Act

- 10+ acres in agriculture or forestry must develop a water quality plan
- Plan includes Best Management Practices (BMPs) to protect water quality

Who needs a plan?

- Anyone farming or raising trees on 10+ acres
- Anyone applying for cost share
  - Kentucky Soil Erosion and Water Quality Cost Share Program (State cost share)
  - NRCS Environmental Quality Incentives Program (EQIP)
  - GOAP County Ag Investment Program (CAIP)

What is a plan?

- A plan is the list of BMPs to be implemented on the farm to protect water quality
  - Livestock
  - Crops
  - Pesticides and Fertilizers
  - Farmstead
  - Forestry
  - Streams and Other Waters
- Plans should be up-to-date and reflect current farm activities

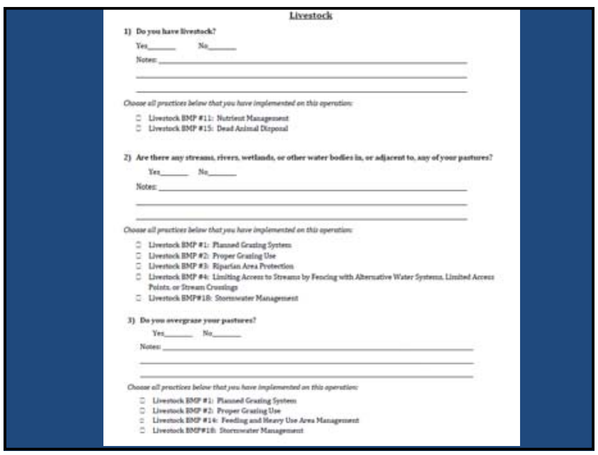
How Do Farmers Develop a Plan?

1. Use a web-based tool: www.ca.uky.edu/awqa
2. Use a printed document
3. Get assistance from local Conservation District

Kentucky Agriculture Water Quality Plan
Producer Workbook

PLAN YOUR FARM

FARM YOUR PLAN



Livestock

1) **Do you have livestock?**

Yes_______ No_______

Notes: ______________________________

Choose all practices below that you have implemented on this operation:

- ☐ Livestock BMP #11: Nutrient Management
- ☐ Livestock BMP #15: Dead Animal Disposal

2) **Are there any streams, rivers, wetlands, or other water bodies in, or adjacent to, any of your pastures?**

Yes_______ No_______

Notes: ______________________________

Choose all practices below that you have implemented on this operation:

- ☐ Livestock BMP #1: Planned Grazing System
- ☐ Livestock BMP #2: Proper Grazing Use
- ☐ Livestock BMP #3: Riparian Area Protection
- ☐ Livestock BMP #4: Limiting Access to Streams by Fencing with Alternative Water Systems, Limited Access Points, or Stream Crossings
- ☐ Livestock BMP#18: Stormwater Management

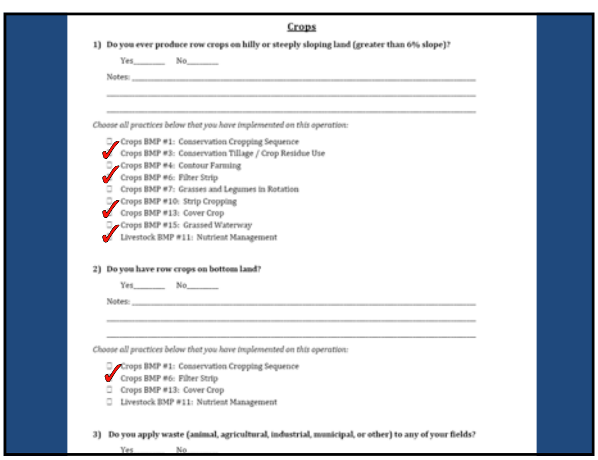
3) **Do you overgraze your pastures?**

Yes_______ No_______

Notes: ______________________________

Choose all practices below that you have implemented on this operation:

- ☐ Livestock BMP #1: Planned Grazing System
- ☐ Livestock BMP #2: Proper Grazing Use
- ☐ Livestock BMP #14: Feeding and Heavy Use Area Management
- ☐ Livestock BMP#18: Stormwater Management



Crops

1) **Do you ever produce row crops on hilly or steeply sloping land (greater than 6% slope)?**

Yes_______ No_______

Notes: ______________________________

Choose all practices below that you have implemented on this operation:

- ☐ Crops BMP #1: Conservation Cropping Sequence
- ✓ Crops BMP #3: Conservation Tillage / Crop Residue Use
- ☐ Crops BMP #4: Contour Farming
- ✓ Crops BMP #6: Filter Strip
- ☐ Crops BMP #7: Grasses and Legumes in Rotation
- ☐ Crops BMP #10: Strip Cropping
- ✓ Crops BMP #13: Cover Crop
- ☐ Crops BMP #15: Grassed Waterway
- ✓ Livestock BMP #11: Nutrient Management

2) **Do you have row crops on bottom land?**

Yes_______ No_______

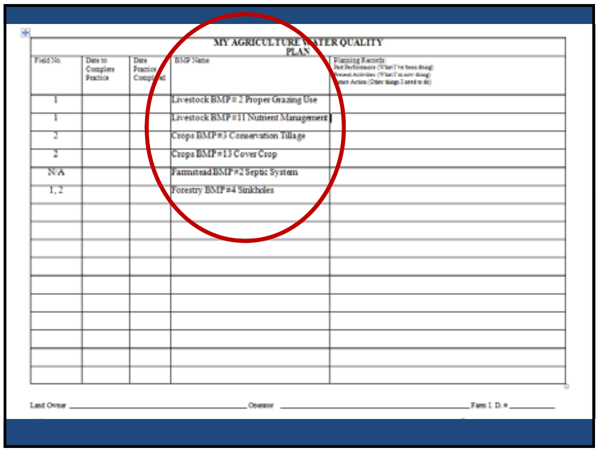
Notes: ______________________________

Choose all practices below that you have implemented on this operation:

- ☐ Crops BMP #1: Conservation Cropping Sequence
- ✓ Crops BMP #6: Filter Strip
- ☐ Crops BMP #13: Cover Crop
- ☐ Livestock BMP #11: Nutrient Management

3) **Do you apply waste (animal, agricultural, industrial, municipal, or other) to any of your fields?**

Yes_______ No_______



MY AGRICULTURE WATER QUALITY PLAN

Field No.	Date to Complete Practice	Date Practice Completed	BMP Name	Planning Records: Past Performance (What I've been doing) Present Activities (What I'm now doing) Future Action (Other things I need to do)
1			Livestock BMP # 2 Proper Grazing Use	
1			Livestock BMP #11 Nutrient Management	
2			Crops BMP #3 Conservation Tillage	
2			Crops BMP #13 Cover Crop	
N/A			Farmstead BMP #2 Septic System	
1, 2			Forestry BMP #4 Sinkholes	

Land Owner ____________ Operator ____________ Farm I. D. # ________

How is Nutrient Management Related to the KY Ag Water Quality Plan?

- Livestock BMP #11 – Nutrient Management
- Crops BMP #14 – Nutrient Management

This is NOT new!

AWQA Minimum Requirements - Old

- Comply with NRCS Code 590 (2001)
- Manage manure in a manner that prevents degradation of water, soil, air, and that protects public health and safety.
- Sufficient land must be available for a disposal area without overloading soils or exceeding crop requirements.
- Minimize edge-of-field delivery of nutrients where no setbacks are required.

What Changed?

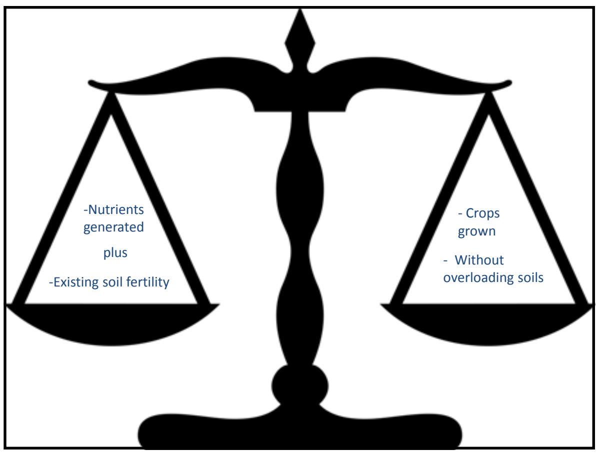
- Updates to KY NRCS 590
- N and P Risk Assessments must be used on every field
  - A new N and P Index have been developed
  - Producers no longer have the choice to choose a P threshold vs. a P index approach for planning nutrient applications (2001)
- Every application field must have a RUSLE2 soil loss assessment
  - Soil loss tolerance levels must not be exceeded

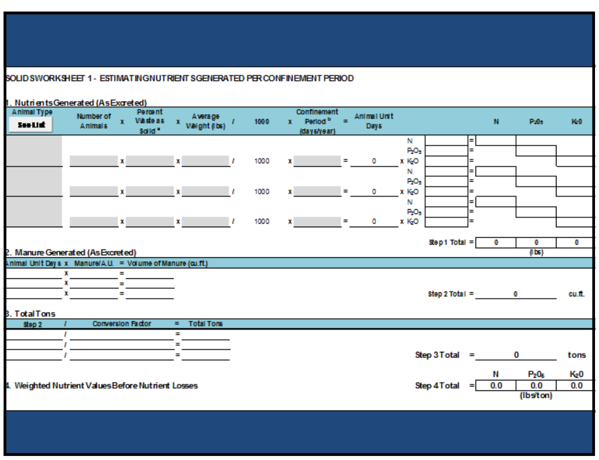
What Changed?

- The KY NRCS 590-based CNMP is complex, requires TSPs, and a waiting period
- The AWQA has added another option for developing NMPs

AWQA Minimum Requirements - New

- Comply with NRCS Code 590 (2013) or KyNMP (UK Pub – ID-211 *Kentucky Nutrient Management Planning Guidelines*).
- Manage manure in a manner that prevents degradation of water, soil, air, and that protects public health and safety.
- Sufficient land must be available for a disposal area without overloading soils or exceeding crop requirements.
- Minimize edge-of-field delivery of nutrients where no setbacks are required.




SOLIDS WORKSHEET 1 - ESTIMATING NUTRIENTS GENERATED PER CONFINEMENT PERIOD

1. Nutrients Generated (As Excreted)

Animal Type (See List)	Number of Animals	x	Percent Waste as Solid [a]	x	Average Weight (lbs)	/	1000	x	Confinement Period [b] (days/year)	=	Animal Unit Days				N	P_2O_5	K_2O
		x		x		/	1000	x		=	0	x	N, P_2O_5, K_2O	=			
		x		x		/	1000	x		=	0	x	N, P_2O_5, K_2O	=			
		x		x		/	1000	x		=	0	x	N, P_2O_5, K_2O	=			
													Step 1 Total	=	0	0	0
																(lbs)	

2. Manure Generated (As Excreted)

Animal Unit Days	x	Manure/A.U.	=	Volume of Manure (cu.ft.)
	x		=	
	x		=	
	x		=	

Step 2 Total = 0 cu.ft.

3. Total Tons

Step 2	/	Conversion Factor	=	Total Tons
	/		=	
	/		=	
	/		=	

Step 3 Total = 0 tons

4. Weighted Nutrient Values Before Nutrient Losses

		N	P_2O_5	K_2O
Step 4 Total	=	0.0	0.0	0.0
			(lbs/ton)	

SOLIDS WORKSHEET 2 - NUTRIENT BALANCE

Tract	Field No.	Acres

Soil Test P Value (Mehlich 3) ____

	N	P_2O_5	K_2O
1 . Crop or Crop Sequence/Rotation			
2 . Realistic Yield (Average from 5-10 Years)			
3 . Plant Nutrients Needed or Allowed (lbs/ac)			
4 . Adjusted P_2O_5 Application Rate According to Threshold			
5 . Fertilizer Credits (lbs/ac)			
6 . Plant Nutrients Needed Minus Credits (lbs/ac)	#VALUE!	#VALUE!	#VALUE!
7 . Nutrients in Manure (lbs/ton) Enter lab results in box on right to override Worksheet 1 values	0.0	0.0	0.0
8 . Percent Nutrients Retained in System [Table 1] Enter Table 1 values or Enter zero if lab results are used in Step 7			
9 . Net Retained Nutrients in Manure (lbs/ton)	0.0	0.0	0.0
10 . Percent of Available Nutrients Enter Table 2 value for N [Table 2]		80%	100%
11 . Net Available Nutrients (lbs/ton)	0.0	0.0	0.0
12 . Application Rate (tons/ac) Application limitations may apply. Enter Chosen Application Rate in box on right	#VALUE!	#VALUE!	#VALUE!
13 . Net Application Amount for All Nutrients (lbs/ac)	0	0	0
14 . Nutrient Needs (-) or Surpluses (+) (lbs/ac)	#VALUE!	#VALUE!	#VALUE!

Tons Available ________ - Tons Applied in Field ________ = Balance #VALUE!

Uniform Application Rate = #VALUE! ton/ac

Worksheet 3

SOLIDS WORKSHEET 3 - APPLICATION RATES AND LAND REQUIREMENTS [1]

Tract No. ____

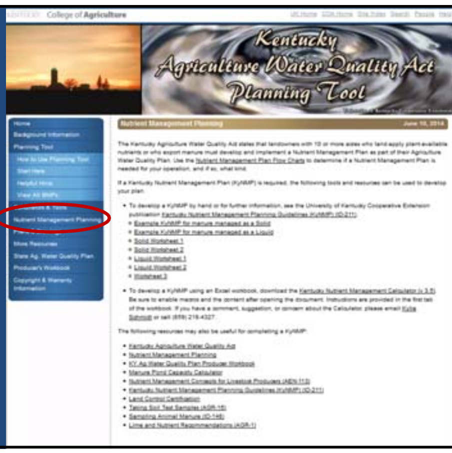
Field No.	Acres	Soil Test Phosphorus (STP)	Crop Rotation / Sequence	Planned Application Date or Timing	Planned Application Rate[2] (tons/ac)	Actual Application Date	Actual Application Rate[2] (tons/ac)	Solid or Commercial Fertilizer (S or C)	Implemented BMPs[2]	
									BMP	Date

KyNMP Summary

- Similar concept as in NRCS 590 (2001/2013)
  - Inventory nutrients available (manures)
  - Determine crop needs
  - Distribute nutrients so that crop needs are met without overloading soils
- Producer can write his/her own plan
- Benefit = better understanding of their operation and nutrient management concepts
- Adaptive management can improve efficiency, production, and economic returns

How is the KY Ag Water Quality Act enforced?

- Complaints reported to the KY Division of Water
- Inspectors visiting operations for routine inspection (permit holders)
- Inspectors drive by a questionable operation



Questions?

Soil Testing: Correlation, Calibration, and Interpretation

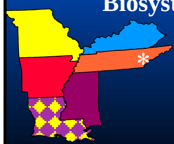
by

Hugh Savoy, Ph.D.

Associate Professor

University of Tennessee

Biosystems Engineering and Soil Science



Soil Testing: Sampling, Correlation, Calibration, and Interpretation

(SSSA special pub. 21, 1987)
Editor J. R. Brown

https://dl.sciencesocieties.org/publications/books/pdfs/sssaspecialpubl/soiltestingsamp/frontmatter

Steps in the Soil Test Recommendation System

- **Determine a Suitable Extractant (Correlation)**
- **Determine probability of response and critical values that define such (Calibration)**
- **Make Recommendations for each range of nutrient values defined (Interpretation)**

Soil Test Correlation

Involves correlating the amount of nutrient extracted by the particular extractant (soil test value) with the amount taken up by the plant or some other biological assessment such as yield

Factors Affecting Soil Test Correlation

Does the Extractant measure nutrient amounts (available) to the plant during critical growing periods

Best assessed across a range of soil test values including highly deficient situations

- Example of Soil Test Correlation

Table 9. Simple correlation between biological measures+ and the amounts of P extracted by various chemical soil test methods.

Soil Test Methods	A Value	P Uptake	% Yield++
		r**	
Bray 1	.864	.909	.898
Bray 2	.883	.911	.868
Bray 1-modified	.873	.906	.893
Olsen	.901	.879	.858
Mehlich 1	.559	.686	.868
Mehlich 1-modifed	.652	.752	.864
Mehlich 2	.856	.898	.860
Triple Acid	.936	.926	.894
MSW	.900	.878	.850
MST	.907	.905	.892
Resin	.904	.854	.841
H_2O	.897	.925	.831

\+ 82 samples.
++ Logarithmic values of P extracted by the chemical soil test methods were used for the correlation with % yield.
** All r values are significant at 0.01 level.

Jittanoonta, D. 1980
M.S. Ms State

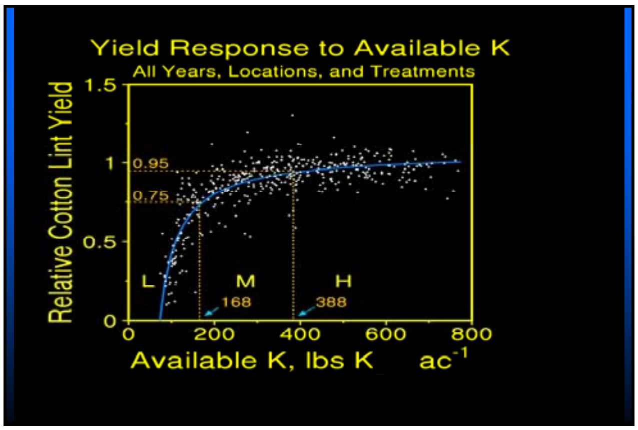
Soil Test Calibration

That process of determining the meaning of soil test values in terms of potential for crop yield or quality response

Soil Test Calibration

- **PHOSPHORUS**
  - **0-18 LOW**
  - **19-130 MEDIUM**
  - **31-120 HIGH**
  - **120 + V HIGH**
- **POTASSIUM**
  - **0-90 LOW**
  - **91-160 MEDIUM**
  - **161-320 HIGH**
  - **320 + V HIGH**

■ Example of Soil Test Calibration



Soil Test Calibration
Results

	Low	Medium	High	V. High
		lbs K_2O ac^{-1}		
Current	< 90	90 - 160	160 - 320	> 320
Proposed	< 140	140 - 320	> 320	–

Soil Test Interpretation

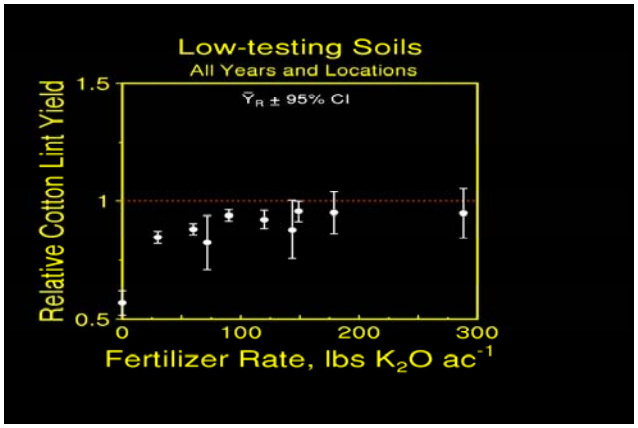
- That process of developing fertilizer recommendations based on soil test values
  - Crop Sufficiency or some modification of that used by most Land Grant labs

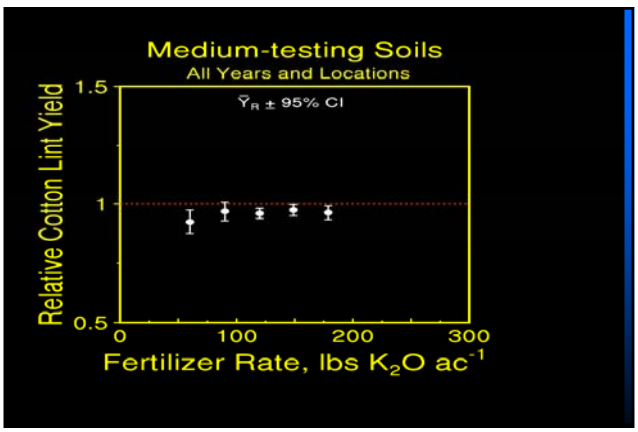
Methodology

Fertilizer Rate Recommendation

- Soils are grouped by soil test category
- A mean relative yield ($\hat{Y}_R$) and 95% CI is determined for each fertilizer rate
- The minimum fertilizer rate that corresponds to ($\hat{Y}_R$ + 95% CI) $\geq$ 1 is the recommendation for the soil test category

- Example of Soil Test Interpretation





Fertilizer Rate Recommendation Results

	Low	Medium
	lbs K_2O ac^{-1}	
Current	120	90
Proposed	150	90

TN P/K Verification Studies (2009 to present)

Average Soil Test Levels of P (Mehlich 1), Corn PK Verification, Milan 2009-13

4 Replication Average, Pounds per Acre

Trt	P and B				
	2009	2010	2011	2012	2013
0P 80K	73	46	50	31	28
0K 80P	.	60	74	40	56
4040PK	.	65	67	39	45
8080PK	.	51 .35B	68 .48B	39 .23B	48 0.45
8080 PK+1B	.	51 .65B	61 .80B	43 .45B	47 0.73

Average Soil Test Levels of K (Mehlich 1), Corn PK Verification, Milan 2009-13

4 Replication Average, Pounds per Acre

Trt	K				
	2009	2010	2011	2012	2013
0P 80K	201	250	195	134	149
0K 80P	.	269	239	150	104
4040PK	.	272	208	140	132
8080PK	.	250	195	129	126
8080 PK+1B	.	228	273	178	163

Yield Response to P and K on High Testing Soils at Two Locations in TN

Year	Crop	Milan	Spring-field	Milan	Spring-field
		P Response (Yes or No)		K Response (Yes or No)	
2009	corn	No	No	No	No
2010	corn	No	No	No	No
2010-11	wheat	No	No	No	No
2011	soybeans	No	No	No	No
2012	corn	drought	drought	drought	drought
2012-13	wheat	No	No	No	No
2013	soybeans	No	No	No	No

Average Soil Test Levels of P (Mehlich 1), Corn P rates Verification, Milan 2009-13

5 Replication Average, Pounds per Acre					
P_2O_5 Lbs/acre	P				
	2009	2010	2011	2012	2013
0	26	22	21	13	15
60	.	30	28	23	30
120	.	35	34	25	37
180	.	36	43	30	46
240	.	42	63	36	76

Average Soil Test Levels of K (Mehlich 1), Corn K rates Verification, Milan 2009-10

5 Replication Average, Pounds per Acre					
K_2O Lbs/acre	K				
	2009	2010	2011	2012	2013
0	82	108	96	58	60
50	.	125	119	63	80
100	.	148	150	79	93
150	.	142	159	95	97
200	.	157	198	98	133

Yield Response to P and K on Medium to Low Testing Soils at Two Locations in TN

Year	Crop	P Response (Yes or No)		K Response (Yes or No)	
		Milan	Springfield	Milan	Springfield
2009	corn	No	No	No	Cattle
2010	corn	No	No	No	drought
2010-11	wheat	No	Yes	No	No
2011	soybeans	No	No	No	No
2012	corn	drought	drought	drought	drought
2012-13	wheat	Yes	Yes	Yes	Yes
2013	soybeans	No	No	No	Yes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FALCON SERIES AUTOMATED SOIL SAMPLING SYSTEM
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PRECISION
of Falcon Technologies
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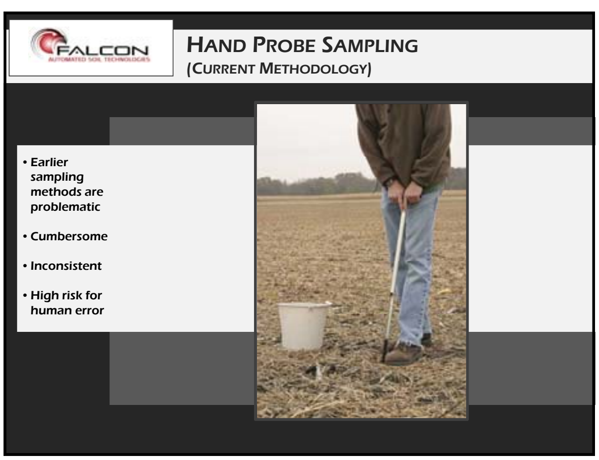
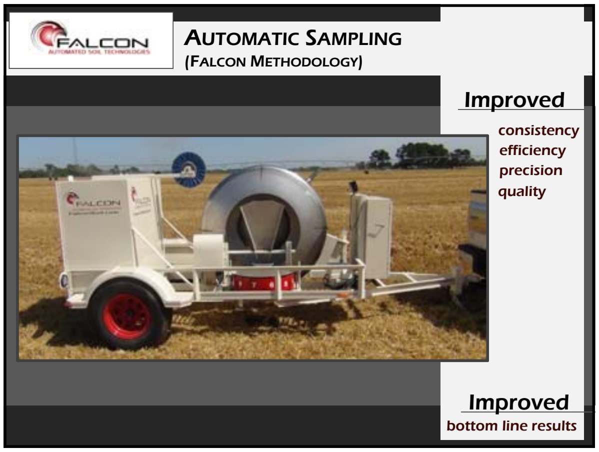
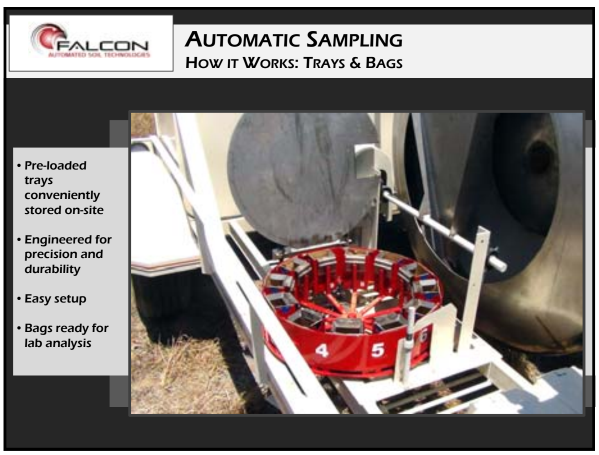
HAND PROBE SAMPLING
(CURRENT METHODOLOGY)
Then…
• Time consuming
• Labor intensive
• Cumbersome
• Inconsistent
• Tedious
Now…
…not much has changed…


HAND PROBE SAMPLING
(CURRENT METHODOLOGY)
• Earlier sampling methods are problematic
• Cumbersome
• Inconsistent
• High risk for human error


FALCON
AUTOMATIC SAMPLING
(FALCON METHODOLOGY)
Improved
consistency
efficiency
precision
quality
Improved
bottom line results


FALCON
AUTOMATIC SAMPLING
HOW IT WORKS: TRAYS & BAGS
• Pre-loaded trays conveniently stored on-site
• Engineered for precision and durability
• Easy setup
• Bags ready for lab analysis


FALCON
AUTOMATIC SAMPLING
HOW IT WORKS: BAGS
• Easy to manipulate
• Foldable bottom portion for fast, no-mess closure

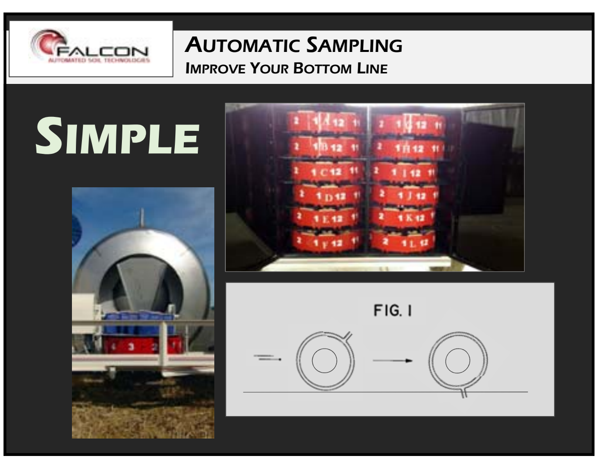

FALCON
AUTOMATED SOIL TECHNOLOGIES
AUTOMATIC SAMPLING
HOW IT WORKS: MIXING & FUNNELING
• Electric motor rotates to mix soil
• Soil is funneled into bags in carousel
4 3 2 1


FALCON
AUTOMATED SOIL TECHNOLOGIES
AUTOMATIC SAMPLING
HOW IT WORKS: OPERATIONS
• Onboard circuitry controls all operations
• All functions are 12-volt
• Onboard deep cycle battery
• Recharges with standard 7-pin connector on tow vehicle
FALCON


FALCON
AUTOMATED SOIL TECHNOLOGIES
AUTOMATIC SAMPLING
HOW IT WORKS: OPERATIONS
• Operates with your sampling software
• Wireless remote control from laptop or keypad
• Camera for remote monitoring of operation
• Light for nighttime operation


FALCON
AUTOMATED SOIL TECHNOLOGIES
AUTOMATIC SAMPLING
HOW IT WORKS
• Tow behind any vehicle with 2200 lbs. towing capacity
• High quality materials


FALCON
AUTOMATED SOIL TECHNOLOGIES
AUTOMATIC SAMPLING
IMPROVE YOUR BOTTOM LINE
ACCURATE


FALCON
AUTOMATED SOIL TECHNOLOGIES
AUTOMATIC SAMPLING
IMPROVE YOUR BOTTOM LINE
SIMPLE
FIG. I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AUTOMATIC SAMPLING
IMPROVE YOUR BOTTOM LINE
SIMPLE


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FALCON SERIES AUTOMATED SOIL SAMPLING SYSTEM
Experience
CONSISTENCY
EFFICIENCY
PRECISION
QUALITY
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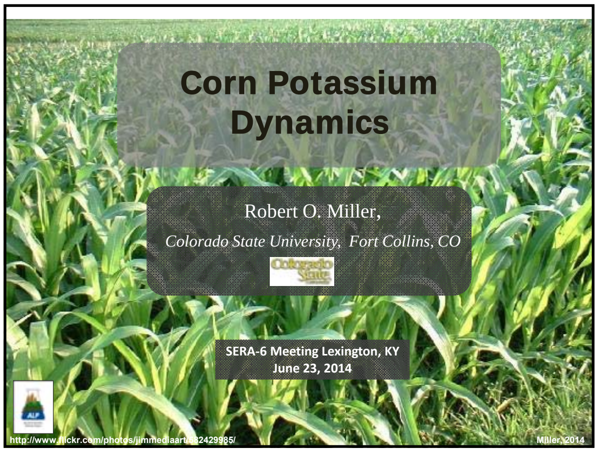
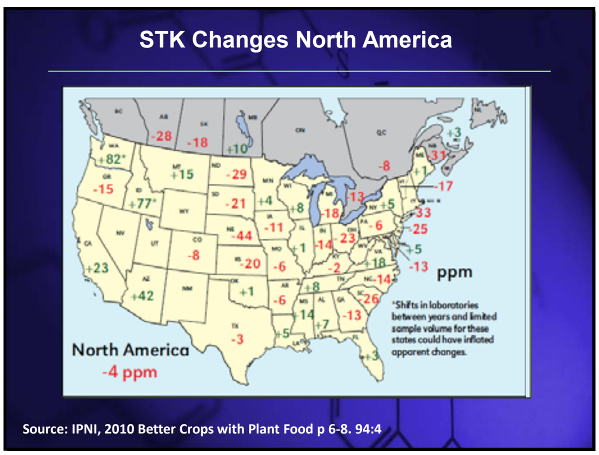
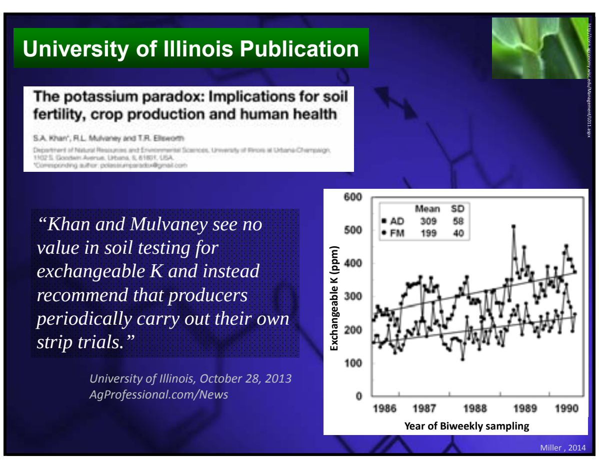

Corn Potassium Dynamics
Robert O. Miller,
Colorado State University, Fort Collins, CO
SERA-6 Meeting Lexington, KY
June 23, 2014
Miller, 2014


STK Changes North America
ppm
*Shifts in laboratories between years and limited sample volume for these states could have inflated apparent changes.
North America
-4 ppm
Source: IPNI, 2010 Better Crops with Plant Food p 6-8. 94:4


University of Illinois Publication
The potassium paradox: Implications for soil fertility, crop production and human health
S.A. Khan*, R.L. Mulvaney and T.R. Ellsworth
"Khan and Mulvaney see no value in soil testing for exchangeable K and instead recommend that producers periodically carry out their own strip trials."
University of Illinois, October 28, 2013
AgProfessional.com/News
Mean SD
AD 309 58
FM 199 40
Exchangeable K (ppm)
Year of Biweekly sampling
Miller, 2014

Corn Leaf Nutrients Indiana

Ear Leaf VT-R1 1623 samples

Nutrient	Deficiency Threshold [1]	Percent of Samples Deficient		
	< Less Than	2011	2012	2013
N (%)	< 2.76	5.0	33.1	10.5
P (%)	< 0.25	1.1	20.4	2.7
K (%)	< 1.75	15.3	57.3	17.9
Mg (%)	< 0.16	6.2	1.7	13.2
Ca (%)	< 0.30	0.0	0.8	0.6
S (%)	< 0.16	0.2	8.1	2.4
Zn (ppm)	< 19	7.2	0.6	6.6
B (ppm)	< 5	7.1	2.8	11.1

[1] http://www.extension.purdue.edu/extmedia/nch/nch-46.html

Data: Betsy Bower, Ceres Solutions

Miller and Bower, 2014

Corn Ear Leaf Nutrition

Midwest Laboratories

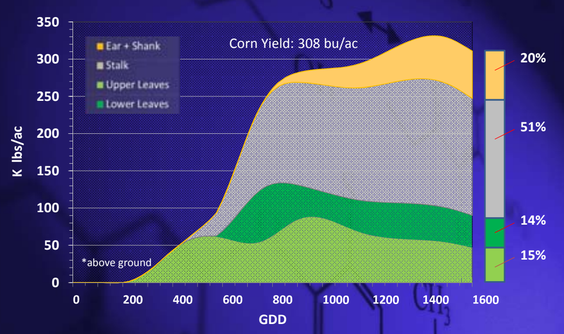
Midwest Laboratories[1]

Nutrient	Deficiency Threshold	Percent of Samples Deficient (%)		
	%	2011	2012	2013
N %	< 2.76	24.2	15.3	24.2
P %	< 0.25	7.2	5.3	4.2
K %	< 1.75	17.3	29.3	20.4
S%	< 0.16	7.3	5.4	10.5
Mg %	< 0.16	12.0	7.5	12.7
Ca %	< 0.37	9.0	8.4	11.6

[1] Source: February 3, 2014, Samples: 4246, 4909 and 6485

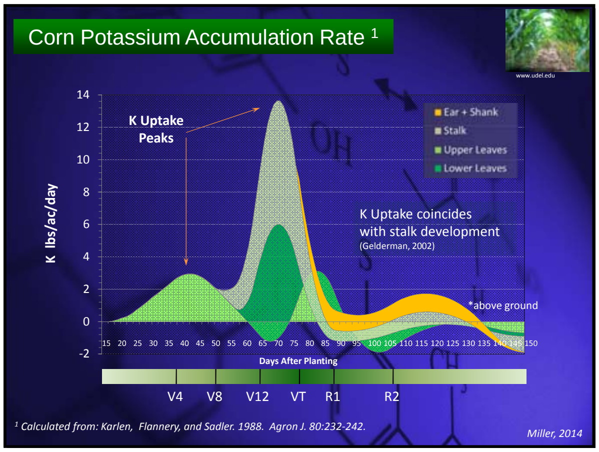
Miller, 2014

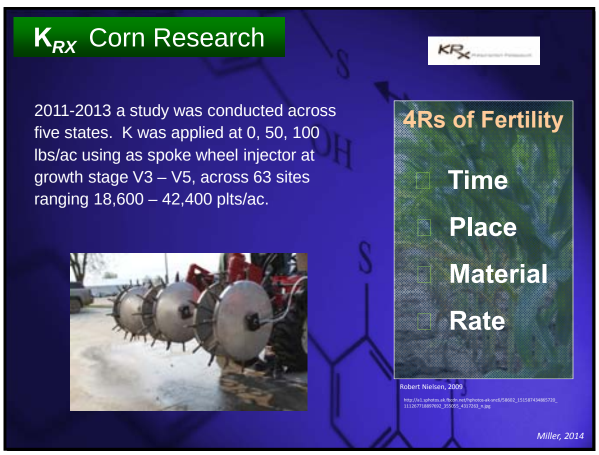
Potassium Accumulation: Karlen et. al. 1988 [1]

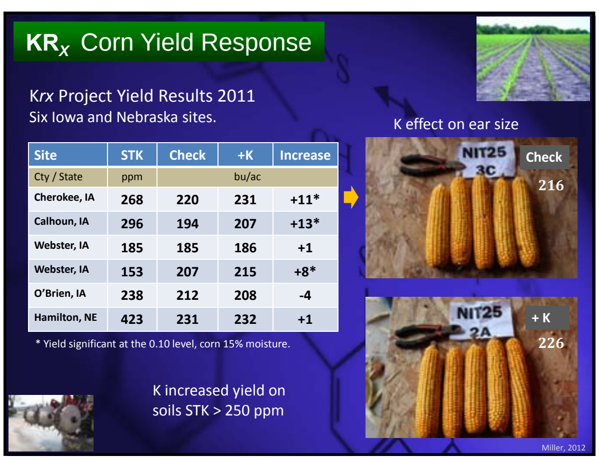


[1] Calculated from: Karlen, Flannery, and Sadler. 1988. Agron J. 80:232-242.

Miller, 2014


Corn Potassium Accumulation Rate 1
K Uptake Peaks
K lbs/ac/day
Ear + Shank
Stalk
Upper Leaves
Lower Leaves
K Uptake coincides with stalk development
(Gelderman, 2002)
*above ground
Days After Planting
V4 V8 V12 VT R1 R2
1 Calculated from: Karlen, Flannery, and Sadler. 1988. Agron J. 80:232-242.
Miller, 2014


KRX Corn Research
2011-2013 a study was conducted across five states. K was applied at 0, 50, 100 lbs/ac using as spoke wheel injector at growth stage V3 – V5, across 63 sites ranging 18,600 – 42,400 plts/ac.
4Rs of Fertility
Time
Place
Material
Rate
Robert Nielsen, 2009
Miller, 2014


KRX Corn Yield Response
Krx Project Yield Results 2011
Six Iowa and Nebraska sites.
Site | STK | Check | +K | Increase
Cty / State | ppm | bu/ac
Cherokee, IA | 268 | 220 | 231 | +11*
Calhoun, IA | 296 | 194 | 207 | +13*
Webster, IA | 185 | 185 | 186 | +1
Webster, IA | 153 | 207 | 215 | +8*
O'Brien, IA | 238 | 212 | 208 | -4
Hamilton, NE | 423 | 231 | 232 | +1
* Yield significant at the 0.10 level, corn 15% moisture.
K effect on ear size
NIT25 3C
Check
216
NIT25 2A
+ K
226
K increased yield on soils STK > 250 ppm
Miller, 2012

KR_x Corn Yield Response

Krx Project Yield Results 2012
Six Iowa sites

Site	STK	Check	+K	Increase
Cty / State	ppm	bu/ac		
Pocahontas, IA	163	172	165	- 7
Palo Alto, IA	196	152	185	+ 31*
Calhoun, IA	126	166	171	+ 5
Wright, IA	135	155	175	+ 21*
Cherokee, IA	290	211	227	+ 9 *
Hardin, IA	147	204	216	+ 12*

* Yield significant at the 0.10 level, corn 15.5% moisture. STK 0-6" Depth

K effect on ear size

K increased yield on soils STK > 250 ppm

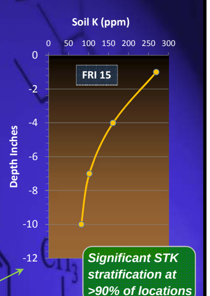
Miller, 2013

KR_x Corn Yield vs STK by Depth

Yield vs STK by depth, IA sites, 2012

Treatment/ Site	NEL 18	NIE 9	FRI 15	CAL 23
0 K bu/ac	149	155	205	226
+ 50 K[1] bu/ac	150	176	216	230
Delta Yield	+1.3	+21.4	+11.6	+4.4

Depth (in)	STK (ppm)			
0 – 2	186	160	269	450
2 – 6	130	123	161	208
6 – 8	98	96	102	136
8 – 12	102	102	82	124



[1] Yield increase to application of 50 lbs/ac K at V4-V6.
* Grain responsive sites

Miller, 2014

KR_x STK: Dry vs Wet by Depth

ISU has re-introduced the STK wet method IOWA STATE UNIVERSITY

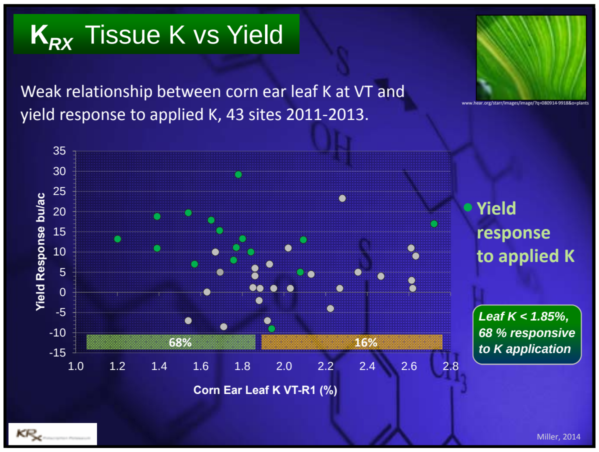
Site	HAL 24		BON 22		STO 15	
Yield / Delta bu/ac	212	- 4.1	202	+11.6 *	214	+ 1.0
Depth (in)	Soil Test K (ppm)					
	Dry	Wet	Dry	Wet	Dry	Wet
0 – 2	300	261	249	145	259	239
2 – 6	155	65	194	90	127	79
6 – 8	124	33	137	46	86	30
8 – 12	100	21	100	24	91	21

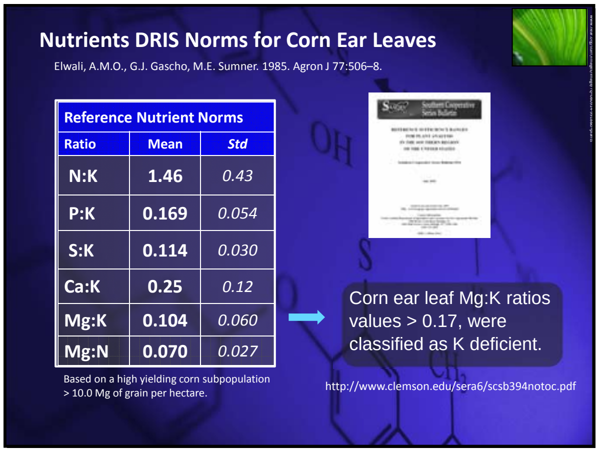
Significant STK stratification

Dry and Wet STK decrease with depth, but equal probability of yield response

[1] Treatment application of 50 lbs/ac K at V4-V6.
* Grain responsive sites

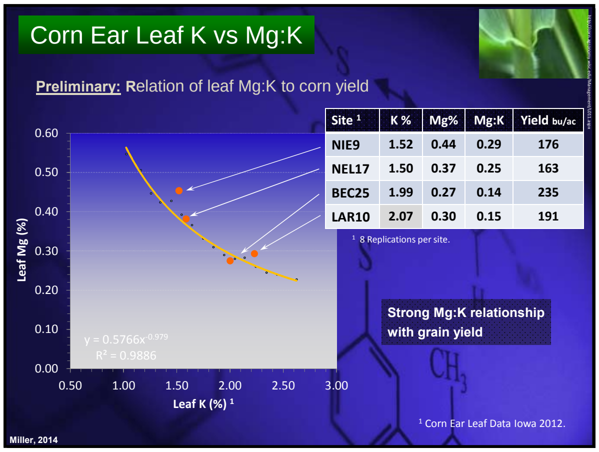
Miller, 2014


K_RX Tissue K vs Yield
Weak relationship between corn ear leaf K at VT and yield response to applied K, 43 sites 2011-2013.
Yield Response bu/ac
35
30
25
20
15
10
5
0
-5
-10
-15
1.0
1.2
1.4
1.6
1.8
2.0
2.2
2.4
2.6
2.8
68%
16%
Corn Ear Leaf K VT-R1 (%)
Yield response to applied K
Leaf K < 1.85%, 68 % responsive to K application
Miller, 2014


Nutrients DRIS Norms for Corn Ear Leaves
Elwali, A.M.O., G.J. Gascho, M.E. Sumner. 1985. Agron J 77:506–8.
Reference Nutrient Norms

Ratio	Mean	Std
N:K	1.46	0.43
P:K	0.169	0.054
S:K	0.114	0.030
Ca:K	0.25	0.12
Mg:K	0.104	0.060
Mg:N	0.070	0.027

Based on a high yielding corn subpopulation > 10.0 Mg of grain per hectare.
Corn ear leaf Mg:K ratios values > 0.17, were classified as K deficient.
http://www.clemson.edu/sera6/scsb394notoc.pdf


Corn Ear Leaf K vs Mg:K
Preliminary: Relation of leaf Mg:K to corn yield

Site [1]	K %	Mg%	Mg:K	Yield bu/ac
NIE9	1.52	0.44	0.29	176
NEL17	1.50	0.37	0.25	163
BEC25	1.99	0.27	0.14	235
LAR10	2.07	0.30	0.15	191

[1] 8 Replications per site.
Leaf Mg (%)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Leaf K (%) [1]
y = 0.5766x^-0.979
R² = 0.9886
Strong Mg:K relationship with grain yield
[1] Corn Ear Leaf Data Iowa 2012.
Miller, 2014

Corn Ear Leaf N:K vs Yield

Contrast five KRx 2012 sites with highest and lowest Mg:K ratios, show substantial yield differences.

16 Sites Limited: Leaf N > 3.0 % (Range 3.09 -3.75)

High Mg:K Ratio

Site	STK	Mg:K [1]	Yield [2]
	ppm	Ratio [3]	bu/ac
GIB 12	188	0.23	110
NEL 17	158	0.25	172
NIE 9	149	0.30	155
BLA 11	151	0.33	142
NEL 18	149	0.44	149
Average	159	0.31	146
stdev	*17*	*0.08*	*22*

Low Mg:K Ratio

Site	STK	Mg:K	Yield
	ppm	Ratio	bu/ac
BEC 27	325	0.11	240
BEC 25	180	0.14	169
LAR 10	194	0.15	192
CAL 22	280	0.16	212
CAL 23	289	0.18	226
Average	254	0.15	212
stdev	*67*	*0.02*	*21*

← Low Population 20,800/ac

Difference 59 bu/ac

60% of high Mg:K ratios show yield response

[1] Mg:K ratios based on corn ear leaf at VT-R1 growth stage, 4 reps.
[2] Yield based on average of 8 replications, 0 lb/ac K rate plots, Krx.
[3] Elwali et al 1985, critical earl leaf VT Mg:K value is 0.10± 0.06.

Miller, 2014

Leaf Mg:K vs Yield 2013

Contrast KRx 2013 sites by Mg:K ratios.

9 Sites Limited: Leaf N > 2.3 % (Range 2.32 – 3.01)

High Mg:K Ratio

Site	Mg:K [1]	N:K [2]	Yield [3]
	Ratio	Ratio	bu/ac
West-S	0.26	1.88	251
GMS	0.20	1.74	123
BLA 1	0.32	2.17	126
NEI 2	0.52	2.32	164
Average	0.33	1.93	166
stdev	*0.13*	*0.17*	*59*

Low Mg:K Ratio

Site	Mg:K	N:K	Yield
	Ratio	Ratio	bu/ac
D7	0.10	1.57	219
D18	0.11	1.54	249
West-N	0.16	1.46	118
SMI-S	0.17	1.41	216
Average	0.13	1.50	200
stdev	*0.03*	*0.07*	*57*

← Greens Snap 30%

Difference 34 bu/ac

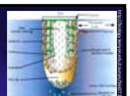
Adj 62 bu/ac

75% of high Mg:K ratios show yield response

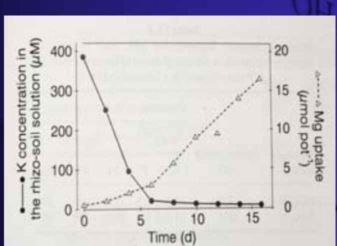
[1] Mg:K ratios based on corn ear leaf at VT-R1 growth stage.
[2] Elwali et al 1985, critical earl leaf VT N: value is 0.45 ± 0.44.
[3] Yield based on average of 8 replications, 0 lb/ac K rate plots, KRx.

Miller, 2014

Magnesium Uptake vs K Content in Rhizo-Solution



Time course of Mg and K uptake by ryegrass



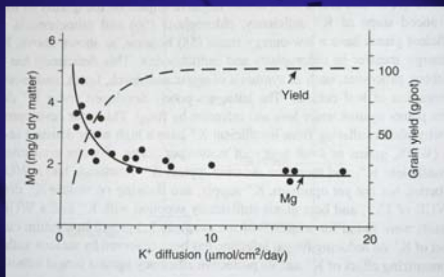
Mg uptake suppressed by K > 50 uM in soil-grown systems. As K is depleted, < 10 uM Mg uptake increases.

In the field as soil moisture declines, K rhizosphere diffusion increases, and Mg uptake increases, and leaf Mg levels climb.

[1] *Seggeweiss and Jungk, 1988. Z. Pflanzenernaehr. Bodenk*

Miller, 2014

Impact of K Diffusion on Oat Mg Uptake and yield



[1] Grimme, L.C., von Braunschweig, K. Nemeth. 1974/75. K, Mg and Ca interactions as related to cation uptake and yield. Buntehof Abs. 4:7-8. From Handbook of Plant Nutrition, *Barker and Pilbeam*.

Miller, 2014

KRx What we've Learned

Nutrient Stratification is substantial, reduced tillage has stratified K and P at 0-2", sub soils show strong depletion > 80% of KRx sites. Sub soils show very low wet K levels.

Side dress K 42% of sites were responsive, with an resposne 7 - 31 bu/ac, and had minimal impact on leaf K content.

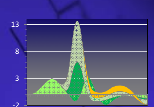
Corn Leaf: Mg:K, N:K and Ca:K, are indicative of lower corn yield potential, and greater likely hood of K response. When soil K release/diffusion is limited greater potential of Mg and Ca uptake.

Miller, 2014

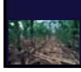
Why Corn K Issues

- STK is estimate of K supply, based on probability of response
- Plant growth, therefore uptake, is demand driven
- Demand is growth stage specific and soil depth definitive 2-12"
- Limits on soil K diffusion/supply V5-V12, result in Mg substitution

Impact Yield



STK does not estimate soil K supply rate lbs/ac/day



Miller, 2014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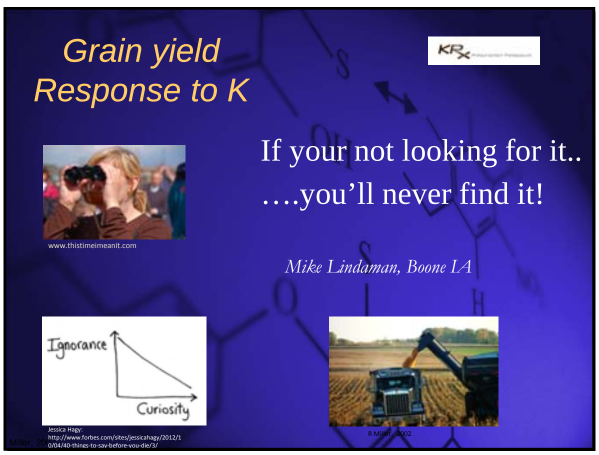
Ed Hopkins, Sure-Tech Laboratories, IN
Jodi Jaynes, Sure-Tech Laboratories, IN
Mike Lindaman, Ag Source – LGI Lab, IA
Tim Eyrich, Winfield Solutions, NE
Larry May, Lincoln, NE
WINFIELD


Grain yield
Response to K
If your not looking for it..
….you'll never find it!
Mike Lindaman, Boone IA
www.thistimeimeanit.com
Ignorance
Curiosity

Modifying the Kentucky Phosphorus Index using published P loss data

Carl H. Bolster
USDA-ARS
Food Animal Environmental Systems Research Unit
Bowling Green, KY

KY 590 Revision Committee

- NRCS – Leslie Hammond, Tibor Horvath, Jeff Sanders, Randy Smallwood, Karen Woodrich
- UK – Richard Coffey, Steve Higgins, Brad Lee, Stephanie Mehlhope, Edwin Ritchey
- DOW – Peter Goodman
- DOC – Steve Coleman, Crystal Renfro
- ARS – Carl Bolster, Jorge Delgado

What is a P index?

- Intended Purpose of Initial PI Approach (Lemunyon and Gilbert, 1993):
  - Assess risk of P transport from field to waterway
  - Identify critical parameters affecting risk
  - Identify land management practices to reduce risk

Concerns with P indices

- Lack of demonstrable declines in STP and P in water bodies since adoption of PI approach (not necessarily fault of P index)
  - Legacy effects
  - P index applied only to small fraction of watershed (CAFOs)
  - Results from P index not followed/enforced
  - Unrepresentative data used for index
  - Human error
  - Unrealistic expectations – does not deal with P balance at farm or regional scales

Concerns with P indices

- Many P indices have been developed based on professional judgment rather than scientific data
- There exists a significant amount of diversity in P indices among the states
  - What factors are included
  - How those factors are weighted
  - How the final index is calculated
  - How the final index value is interpreted
  - Major differences can exist in P indices from neighboring states
- Push from many to reevaluate the entire P index approach with some calling for P-based planning to be based on STP levels
- Perceived by some as being too farmer friendly
- Criticism of P index approach has led NRCS to revise its 590 Standard
  - Each state must demonstrate the accuracy of their P index

Original KY P Index

KY P Index

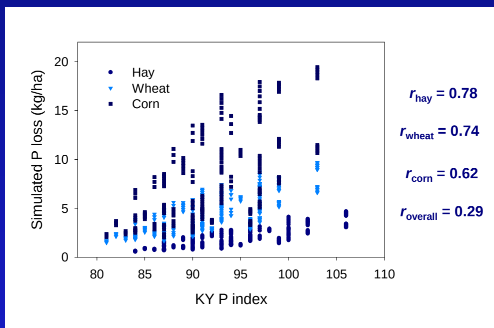
Field Feature	Weight	Low (1 point)	Medium (2 points)	High (4 points)	Very High (8 points)	
Hydrologic soil group	1	A	B	C	D	4
STP level (lb/acre)	3	400-500	501-800	801-1066	> 1066	6
Field slope (%)	1	< 2	2 – 5	6 – 12	> 12	4
Land cover (%)	3	60 – 90	30 – 60	15 – 30	0 – 15	12
Vegetative buffer width (ft)	3	> 29	20 – 29	10 – 19	< 10	24
Impaired watershed?	1	NO			YES	8
Application timing	3	June – Sept.	A, M, O; Mar, N w/winter cover	Mar, Nov	Dec., Jan., Feb.	12
Application method	3	Injected	Incorporated within 48 hr.	Incorporated within 1 mo.	Unincorporated for > 1 mo	6
Distance	2	Over 150 ft	50 – 100	0 – 50	Adjacent	4
Location	1	BG region	All other			2
Index value						82

Limitations with original KY P Index

- **Does not include erosion directly**
  - **Uses % land cover and field slope as surrogates**
- **Does not account for P application rates**
- **Uses an additive formulation**
  - **Ignores critical source areas**
- **Weights are not scientifically based**
- **P leaching is ignored**
  - **In tile-drained or shallow soils in well-developed karst areas P leaching may be an important P loss pathway**

Evaluating original KY P index against modeled P loss data

Correlations between APLE P loss and KY PI



Bolster, C.H. 2011. A critical evaluation of the Kentucky Phosphorus Index. Journal of the KY Academy of Sciences. 72:46-58.

Revisions made to the KY PI

- Includes erosion and P application rates
- Uses a component formulation

Component index formulation

PI =P loss from soil + P loss from erosion + P loss from manure + P loss from fertilizer

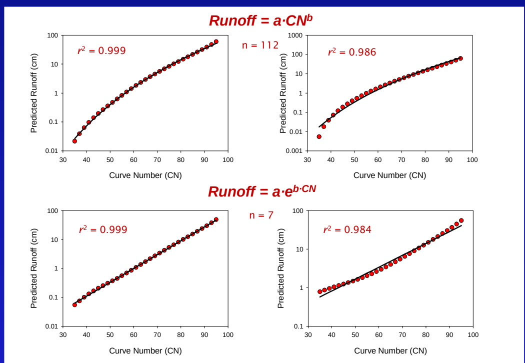
- Each component is a function of source and transport term(s)
- Best represents physical processes governing P loss in the field
- Approach used by process-based P loss models

Bolster, C.H., P.A. Vadas, A.N. Sharpley, and J.A. Lory. 2012. Using a phosphorus loss model to evaluate and improve phosphorus indices. Journal of Environmental Quality 41:1758-1766.

Revisions made to the KY PI

- Uses estimates of annual runoff depth rather than hydrologic soil group
  - Runoff data generated from 30-yr precip records for each county using SCS Curve Number Method for a range in CN values (35-95)
  - Empirical relationship between runoff and CN was established for each county

Example correlations between CN and runoff



a and b are county-specific parameters

Revisions made to the KY PI

- Uses a component formulation
- Includes erosion and P application rates
- Uses estimates of annual runoff depth rather than hydrologic soil group
- Using continuous rather than categorical values for input variables
- Weights are based on published data relating P loss to source and transport factors
- Scaled by a factor of 18
  - Correlate PI value of 100 to P loss of ~ 5 lbs/acre (High Risk)
  - Value of 40 correlates to P loss of 2 lbs/acre (Low Risk)

Revised KY PI

$$KY\ PI = DF \cdot [(DP_{soil} + DP_{fert} + DP_{man}) \cdot BMP_{DP} + P_{sed} \cdot BMP_{Psed}] \cdot 18$$

$$DP_{soil} = C_1 \cdot STP \cdot RO$$

$$P_{sed} = C_2 \cdot TP \cdot ER \cdot PER$$

$$DP_{man} = C_3 \cdot WEP \cdot (RO/PT) \cdot AF_{man}$$

$$DP_{fert} = C_4 \cdot FertP \cdot (RO/PT) \cdot AF_{fert}$$

- RO – runoff
- STP – Soil test P

- TP – total soil P
- ER – erosion rate
- PER – enrichment ratio

- WEP – water extractable P
- AF_F – Application factor

- FertP – fertilizer P
- AF_F – Application factor

Evaluation of new KY PI

- No data available for KY
- Evaluated new KY PI against national P loss data set (n = 255) compiled by Vadas et al. (2009).

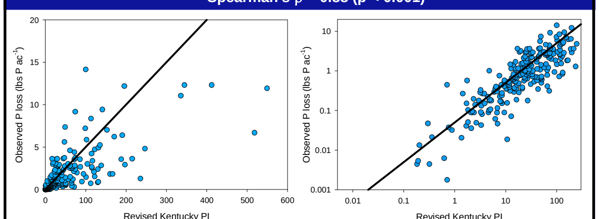
Source	Location	Plot Size	Crop	Duration	P Source
		ha		Months	
Angle et al. (1984)	MD	0.26-0.37	Corn	36	Dairy manure
Berg et al. (1988)	OK	2.7-5.6	Grassed, wheat	120	None
Burwell et al. (1975)	MN	0.009	Corn, oats, hay	72	Fertilizer
Chinkuyu et al. (2002)	IA	0.4	Corn, soybean	36	Hen manure
Edwards et al. (1996)	AR	0.57-1.46	Grassed	30	Poultry litter, grazing manure
Gessel et al. (2004)	MN	0.007	Corn, soybean	36	Swine manure
Ginting et al. (1998)	MN	0.007	Corn	24	Beef manure
Harmel et al. (2004)	TX	1.2-8.4	Corn, pasture	36	Poultry litter, grazing manure
Jones et al. (1985)	TX	2.1-3.3	Grassed	72	None
Kurz et al. (2005)	Ireland	0.46-1.54	Grassed	15	Fertilizer, grazing manure
Langdale et al. (1985)	GA	1.3-2.7	Corn, rye	12	Fertilizer
McDowell and McGregor (1980)	MS	0.01	Corn, soybean	18	Fertilizer
Moore and Edwards (2007)	AR	0.41	Pasture	120	Poultry Litter
Owens et al. (2006)	OH	2.2-4.2	Pasture	132	Fertilizer, grazing cow manure
Panuska et al. (2008)	WI	0.0146	Corn	12	Liquid Dairy Manure
Pierson et al. (2001)	GA	0.75	Pasture	36	Poultry litter, grazing manure
Soileau et al. (1994)	AL	3.8	Cotton, rye	72	Fertilizer
Thoma et al. (2005)	MN	0.016	Corn	38	Swine manure, fertilizer
Vervoort et al. (1998)	GA	0.45	Grassed	30	Poultry litter
Vories et al. (2001)	AR	0.6	Cotton	36	Poultry litter
Wood et al. (1999)	AL	0.001	Corn, rye	24	Fertilizer, poultry litter
Wortmann et al. (2006)	NE	0.004	Corn, soybean	36	Composted beef manure
Young and Holt (1977)	MN	0.001	Alfalfa, corn	36	Fertilizer, dairy manure

Evaluation of new KY PI

- No data available for KY
- Evaluated new KY PI against national P loss data set (n = 255) compiled by Vadas et al. (2009).
- PI values for original and new KY PIs evaluated against subset of P loss data collected in southern US (n=26).
  - Data set used to evaluate Southern PIs by Osmond et al. (2013).
- PI values for original and new KY PIs evaluated against a random collection of data from CNMPs written in KY for 2013 (n=46).

Correlation between revised KY PI and observed P loss (National data set)

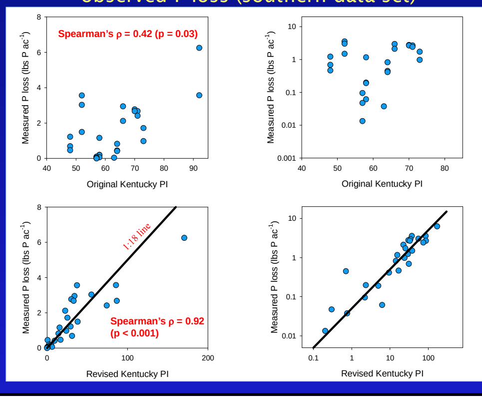
Spearman's $\rho = 0.88$ ($p < 0.001$)



Risk ratings: National data set

Measured P Loss	n	Low Risk	Medium Risk	High Risk
< 2 lbs/acre (Low)	181	**151 (83%)**	22 (12%)	8 (4%)
2 – 5 lbs/acre (Med)	53	16 (30%)	**23 (43%)**	14 (26%)
> 5 lbs/acre (High)	18	0	5 (28%)	**13 (72%)**

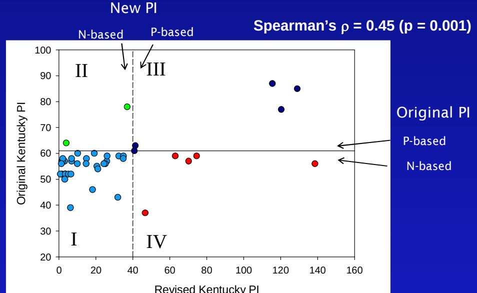
Correlation between original and revised KY PIs and observed P loss (southern data set)



Risk ratings: Southern data set

Measured P Loss	n	Low Risk	Medium Risk	High Risk
< 2 lbs/acre (Low)	17	17	0	0
2 – 5 lbs/acre (Med)	9	5	4	0
> 5 lbs/acre (High)	1	0	0	1

Correlation between original and revised KY PIs for data collected for 46 CNMPs



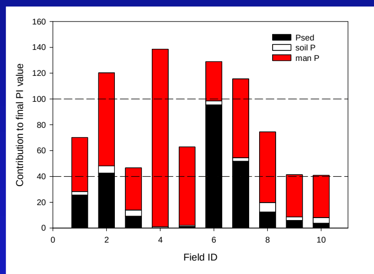
I – N-based both PIs (34)

II – N-based new PI,
P-based original PI (2)

III – P-based both PIs (5)

IV – P-based new PI,
N-based original PI (5)

Relative contributions of P loss for 10 fields (CNMP data set) labeled as Moderate or High risk with new KY PI



Conclusions

- Original KY PI had several limitations and required modifications to be consistent with new 590 Standard
- Revised KY PI addresses several of these limitations and meets requirements of new 590 Standard
- Revised PI will likely result in somewhat more restrictive P applications throughout Commonwealth
- New PI provides visual tool to aid planners on identifying dominant P loss pathways
- New PI has been incorporated into GUI developed for N Index

Where do we go from here?

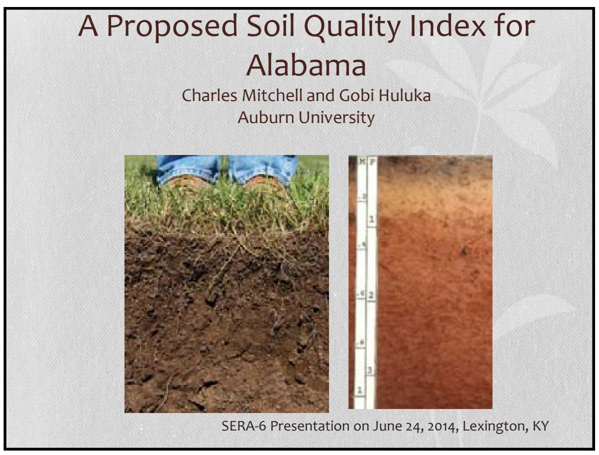
- Field evaluation of PI
  - Need to locate field sites
- Develop relationships specific to KY
  - Relating total soil P to Mehlich-3 P
  - Collecting and analyzing manures for water-extractable P
  - Evaluating impacts of BMPs on P loss
- Accounting for leaching losses in tile-drained fields
- Develop PI for karst regions

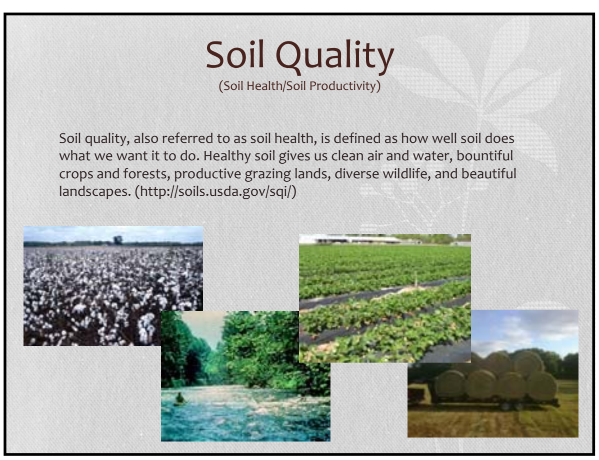
Questions?

For more information

- Bolster, C.H., T. Horvath, B.D. Lee, S. Mehlhope, S. Higgins, and J.A. Delgado. In Press. Development and testing of a new phosphorus index for Kentucky. Journal of Soil and Water Conservation.
- Bolster, C.H. 2011. A Critical Evaluation of the Kentucky Phosphorus Index. Journal of the Kentucky Academy of Sciences 72(1): 46-58.
- Bolster, C.H., P.A. Vadas, A.N. Sharpley, and J.A. Lory. 2012. Using a phosphorus loss model to evaluate and improve phosphorus indices. Journal of Environmental Quality 41:1758-1766.
- Sharpley et al. 2012. Phosphorus Indices: Why we need to take stock of how we are doing. Journal of Environmental Quality 41:1711-1719.


Plot 7
Winter legume only
2013 yield = 2060 lb. lint/acre
Plot 6
No N/no cover crop
2013 yield = 470 lb. lint/acre
"The Old Rotation"
circa 1896
Auburn University, AL
July 28, 2013


A Proposed Soil Quality Index for Alabama
Charles Mitchell and Gobi Huluka
Auburn University
SERA-6 Presentation on June 24, 2014, Lexington, KY


Soil Quality
(Soil Health/Soil Productivity)
Soil quality, also referred to as soil health, is defined as how well soil does what we want it to do. Healthy soil gives us clean air and water, bountiful crops and forests, productive grazing lands, diverse wildlife, and beautiful landscapes. (http://soils.usda.gov/sqi/)

Soil Quality

(Soil Health/Soil Productivity)

- Regulates water
Soil helps control where rain, snowmelt, and irrigation water goes. Water and dissolved solutes flow over the land or into and through the soil.
- Sustains plant and animal life
The diversity and productivity of living things depends on soil.
- Filters potential pollutants
Minerals and microbes found in soil filter, buffer, degrade, immobilize, and detoxify organic and inorganic materials.
- Cycles nutrients
Carbon, nitrogen, phosphorus, and many other nutrients are stored, transformed, and cycled in the soil.
- Supports structures
Buildings need stable soil for support, and archeological treasures associated with human habitation are well protected in soils.

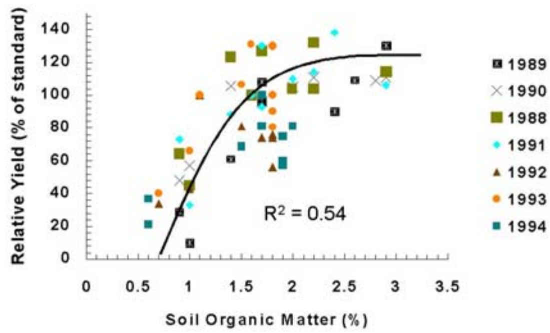
Most Alabama soils would be considered "poor quality" because. . .

- A history of severe erosion
- Low soil organic matter
- Excessive runoff
- Traffic pans or surface crusting/soil compaction
- Steep slopes
- Shallow rooting of crops
- Lack of cover crops
- Soil borne diseases e.g. nematodes
- Low water holding capacity
- Low productivity

A 2001 survey of Central Alabama cotton fields showed. . .

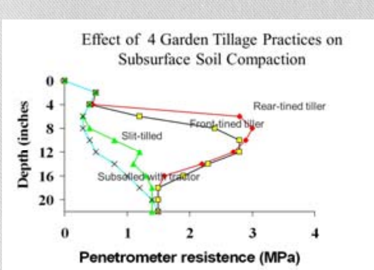
- 63% had traffic pans within 12 inches of surface **in spite of in-row subsoiling**
- 55% had less than 0.4% soil organic matter in soil surface
- 85% WERE NOT using a cover crop
- 80-95% were doing a great job of fertilizing and liming according to soil test; soil pH and plant nutrients were in ideal range.

As soil organic matter in the plow layer increases, yield potential goes up!
(data from Alabama's Old Rotation Experiment (circa 1896))



Traffic pans created by rototillers, disk harrows, field cultivators, and turning plows can greatly restrict root growth.

Even garden tillers can create severe soil compaction and destroy soil structure!



Conservation tillage practices can:

- Prevent erosion
- Increase soil organic matter
- Reduce or eliminate traffic pans
- Improve water infiltration and soil moisture holding capacity
- Increase yields
- **IMPROVE SOIL QUALITY!!**

Can we measure soil quality?

In the lab?

In the field?

Perhaps

USDA-ARS Soil Quality Test Kit
Soil Quality Institute
August, 1999

In the lab?

- Routine soil test
- Soil cation exchange capacity
- Soil texture
- Base saturation
- Soil organic matter
- Aggregate stability/slaking
- Electrical conductivity
- Soil respiration
- Mineralizable nitrogen
- Heavy metals/soil contamination

In the field?

- Soil series/mapping unit
- History of site
- Slope
- Infiltration
- Traffic pans
- Soil compaction/bulk density
- Aggregate stability
- Slaking

Soil Indices

Table 1
Indicators used by different authors in soil quality indexes in agro-ecosystems

Authors	Objective	Indicators used
Karlen et al. (1994a)	Soil Quality Index: Evaluation of effects of crop residue management on soil quality under corn culture	Aggregate stability, porosity, worms, microbial biomass, respiration, ergosterol, total C, total N, bulk density, available water, pH, electrical conductivity
Wang and Gong (1998)	Relative Soil Quality Index: Evaluation of changes in soil quality in natural and agriculture systems	Soil depth, texture, slope, organic matter, total and bioavailable N, P and K, cation exchange capacity and pH.
Hussain et al. (1999)	Adaptation of indices to evaluate effect of three cultivation systems on soil quality	Aggregate stability, organic C crop residues, porosity, exchangeable K, pH.
Glover et al. (2000)	Soil Quality Index: Evaluation of effects of different apple production systems: conventional, organic and integrated	Aggregate stability, porosity, worms, porosity, organic C, microbial biomass C and N, cationic exchange capacity, pH and N.
Liebig et al. (2001)	Land Quality Index: Agroecosystem performance: effects of conventional and alternative agricultural systems	Seed yield, N content of seed, pH, organic C, nitrates.
Andrews et al. (2002b)	Soil Quality Index: Evaluation of tomato and cotton crop quality in conventional and organic cultivation.	Organic matter, electrical conductivity, pH, water water-stable aggregates, real density and Zn

(Bastida, F., Zsolnay, A., Hernández, T., García, C., 2008. Past, present and future of soil quality indices: a biological perspective. Geoderma 147, 159–171.)

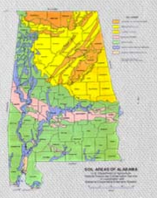
Soil Quality Indicators

- Measurable attributes influencing crop production or environmental functions
- Best indicators are the most sensitive to management decisions
- Some indicators may be affected or correlated with others
- Soil quality indicators must include physical, chemical and biological parameters.
- **While there may be universal indices listed the weight of the indices will have to be determined on a regional level due to the differences in cropping systems and geography.**

Arshad, M.A., and S. Martin.2002. Identifying critical limits for soil quality indicators in agro-ecosystems. Agriculture, Ecosystems and Environment. 88: 153–160.

Smith, J.L., Halvaorson, J.J., Papendick, R.I., 1993. Using multiple-variable indicator kriging forevaluating soil quality. Soil Sci. Soc. Am. J. 57, 743–749.

A Proposed Soil Quality Index for Alabama



- Should make farmers and gardeners aware of soil quality/soil health.
- Should suggest ways of improving soil quality/soil health.
- Must be adaptable to existing soil test methodologies.
- Must be relatively inexpensive to run on traditional soil samples.
- Must provide information in a simple, easy to understand manner.

Proposed calculations for input into Soil Quality Index Value

Factor	Values					Max. value	Score
Soil CEC/soil group	<4.6 (Grp 1)	4.7-9.0 (Grp 2)	9.0- 15.0 (Grp.3)	>15,0 (Grp 4)			
	4	8	10	10		10	
Soil pH_w	<5.0	5.1-5.8	5.9-7.0	7.0-8.0	>8.0		
	0	10	15	10	5	15	
P RATING	VL/LOW	MEDIUM	HIGH	VERY HIGH	EXTREMELY HIGH		
	0	5	10	5	0	10	
K RATING	VL/LOW	MEDIUM	HIGH	VERY HIGH	EXTREMELY HIGH		
	0	3	5	3	2	5	
Base saturation	<10%	11-25%	26-50%	50-75%	>75%		
	0	3	6	10	8	10	
Soil O.M.(%)	<0.5	0.6-1.0	1.1-2.0	2.1-3.0	>3.0		
	0	5	15	20	25	25	
N mineralized (lb/a)	<10	11-20	21-30	31-50	>50		
	0	4	6	8	10	10	
EC (1:2) Mmho/cm	<0.40	0.40-0.80	0.81-1.60	1.61-3.20	>3.20		
	3	5	3	2	0	5	
Metals	Two or more metals "very high"		One metal is "very high"		All metals low or high		
	-10		-5		10	10	
TOTAL SOIL QUALITY INDEX						100	

An Example: A productive soil from a Tenn. Valley cotton field.

Proposed calculations for input into Soil Quality Index Value

Factor	Values					Max. value	Score
Soil CEC/soil group	<4.6 (Grp 1)	4.7-9.0 (Grp 2)	9.0- 15.0 (Grp.3)	>15,0 (Grp 4)			
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	0	4	6	8	10	10	8
EC (1:2) Mmho/cm	<0.40	0.40-0.80	0.81-1.60	1.61-3.20	>3.20		
	3	5	3	2	0	5	5
Metals	Two or more metals "very high"		One metal is "very high"		All metals low or high		
	-10		-5		10	10	10
TOTAL SOIL QUALITY INDEX						100	88

CEC=10.0; Soil group= 3

Soil pH = 6.3

P = 90 lb/a (HIGH)

K = 300 lb/a (HIGH)

B.S. = 70%

SOM = 1.5%

N = 45 lb/a

E.C. = 0.60 Mmho/cm

Metals= low and micronutrients= high

An Example: A typical, plowed Coastal Plain cotton field.

Proposed calculations for input into Soil Quality Index Value

Factor	Values					Max. value	Score
Soil CEC/soil group	<4.6 (Grp 1)	4.7-9.0 (Grp 2)	9.0- 15.0 (Grp.3)	>15,0 (Grp 4)			
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	0	5	15	20	25	25	
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TOTAL SOIL QUALITY INDEX						100	

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	0	5	10	5	0	10	10
K RATING	VL/LOW	MEDIUM	HIGH	VERY HIGH	EXTREMELY HIGH		
	0	3	5	3	2	5	5
Base saturation	<10%	11-25%	26-50%	50-75%	>75%		
	0	3	6	10	8	10	6
Soil O.M.(%)	<0.5	0.6-1.0	1.1-2.0	2.1-3.0	>3.0		
	0	5	15	20	25	25	5
N mineralized (lb/a)	<10	11-20	21-30	31-50	>50		
	0	4	6	8	10	10	4
EC (1:2) Mmho/cm	<0.40	0.40-0.80	0.81-1.60	1.61-3.20	>3.20		
	3	5	3	2	0	5	5
Metals	Two or more metals "very high"		One metal is "very high"		All metals low or high		
	-10		-5		10	10	10
TOTAL SOIL QUALITY INDEX						100	49

CEC=4.2; Soil group= 1

Soil pH = 5.8

P = 90 lb/a (HIGH)

K = 130 lb/a (HIGH)

B.S. = 45%

SOM = 0.8%

N = 12 lb/a

E.C. = 0.45 Mmho/cm

Metals= low and micronutrients= high

To determine soil quality index parameters. . .

- Extension agents are taking paired soil samples from fields throughout Alabama.
- Samples come from similar soils or landscape positions in a field with different yield potentials (e.g. 100% yield versus 70% yield)
- These samples are being evaluated using both field and laboratory measurements.
- Growers will receive extensive test results including SOM, EC, BS, micronutrients, metals, soil respiration, mineralization N, etc.
- All samples will be run free during the evaluation.

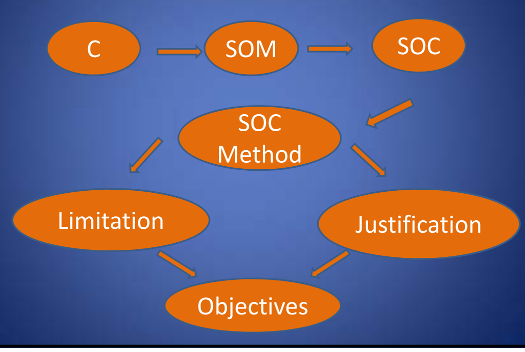
"Soil tests won't help you create good soil. At best, they help you scrape by with really poor soil."

--Bill Finch
former Garden Editor,
Mobile Press Register, and
Director, Mobile Botanical
Gardens
Blog on Jan. 23, 2013

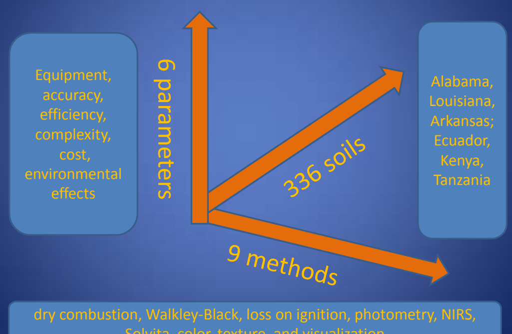
Soil Organic Carbon Methods Comparison

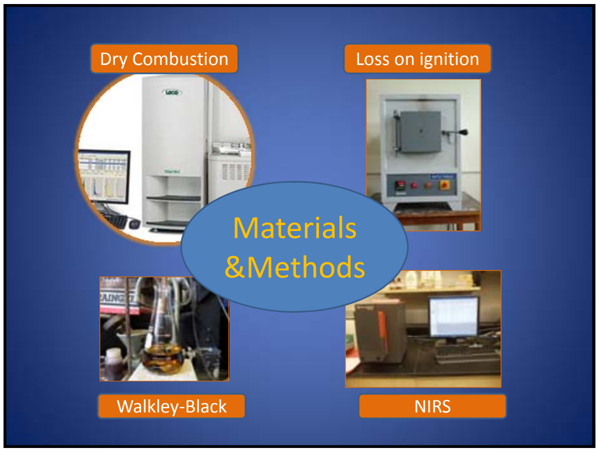
Ling Ou (Lottie)

Introduction



Objective




Dry Combustion
Loss on ignition
Materials
&Methods
Walkley-Black
NIRS


Materials and Methods
Photometry
Solvita method
Color method
Texture method


Visualization

Analyses

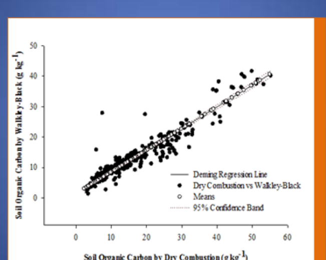
- Equipment → Listed
- Accuracy → Deming regression
- Efficiency → samples/day
- Complexity → training time it takes
- Cost → initial set-up cost, cost/sample
- Environmental effects → listed the hazardous

Accuracy comparison

Method	n	r	r2	Equation
Walkley-Black	336	0.9447	0.8925	y=0.7147x + 1.3379
Loss on Ignition	336	0.9258	0.8571	y = 2.3846x - 1.6149
Photometry	336	0.5597	0.3133	y = 0.0101x - 0.0056
Near-Infrared Spectroscopy	336	0.3564	0.1270	y = 0.3306x + 7.8805
Solvita CO2-C	274	0.7975	0.6360	y = 4.3092 x -20.5939
Chroma Meter, Hue	336	0.1561	0.0244	y = 0.0243x + 2.7746
Chroma Meter, Value	336	-0.4147	0.1720	y = -0.0258x + 4.8333
Chroma Meter, Chroma	336	-0.2978	0.0887	y = -0.0228x + 2.6715
Particle Size, Clay	336	0.2043	0.0417	y = 6.8706x - 83.5777
particle Size, Silt	336	-0.06	0.0036	y = -18.4539x + 329.2429
Particle Size, Sand	336	-0.1162	0.0135	y = -17.8010x + 326.0532
Visualization	30	0.4111	0.1690	y = 0.4407x + 7.1649

Results and Discussion

Dry combustion vs Walkley-Black



Summary of comparison

Method	Main Apparatus	Accuracy (r^2)	Efficiency (samples/day)	Complexity	Initial Set-Up Cost	Cost/Sample (Without Labor)	Cost/Sample (With Labor)	Environmental Effect
Dry Combustion	C Analyzer	Standard	65-100	5 days	$50,000	$1.88	$4.22	Magnesium Perchlorate
Walkley-Black	Burette	0.89	60-80	<1 day	$300	$1.10	$2.01	Potassium Dichromate
Loss on Ignition	Muffle Furnace	0.86	150	< 1 hour	$10,000	$0.00	$0.43	Minimum
Photometry	Colorimeter	0.31	200-400	< 4 hour	$25,000	$0.02	$0.24	Minimum
NIRS method	NIRS	0.13	> 200	2 days	$30,000	$0.00	$0.32	None
Solvita Method	Solvita Kit	0.64	300	< 30 min	$5,000	$8.25	$8.46	Minimum
Color Method	Chroma Meter	0.17 Value	> 250	< 1 hour	$9,900	$0.00	$0.26	None
Texture Method	Hydrometer, Cylinder	0.04 Clay	30	< 2 hour	$2,600	$0.00	$1.07	Minimum
Visualization	None	0.17	400	2-4 hour	$0	$0.00	$0.16	None

Recommendations

- The lab is eligible → dry combustion
- Basic equipment is available → loss on ignition
- Cheap set-up → Walkley-Black
- Commercial method → Solvita
- Semi-quantitative → Photometry
- not strongly recommend now → Other methods
- Routine analyses → loss on ignition

Conclusion

Dry combustion, Walkley-Black, loss on ignition, Solvita, and photometry recommended in different situations

NIRS, color method, texture method, visualization need more research

Future research: improve the methods above, and develop new methods.

SPONSOR PRESENTATIONS

LabFit

Home Combustion Analyser Soil Testing Loss On Ignition

Soil Lime Buffer Capacity Automated pH Measurement

AS3010 Robotic pH determines Soil Lime Buffering Capacity

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  - Sergei Leikin Ph.D.
  - Bruce Moulton


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Reliable and Robust
Friendly and Forgiving in Operation
Affordable
Fits Cyclonic Spray Chamber
TSP

Sample Introduction for Soil Analysis

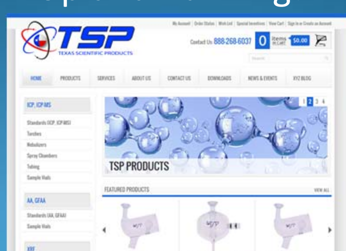
OptiMist™ Nebulizer

Cyclonic Spray Chamber

SOME USERS - SOIL LABS

- University of AR, Marianna
- OSU
- Texas A&M University
- LSU
- University of AR, Fayetteville
- University of MA, Amherst

NEW USER FRIENDLY WEBSITE Up and Running!



Instralytical, LLC

- Sister company to Texas Scientific Products
- Focus on Representing Instrumentation
- Spectro / Ametek
  - ICP

Automated Digestion and Work-up System

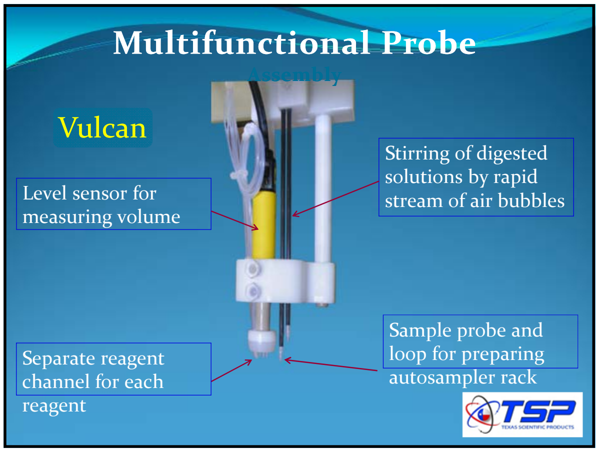
Vulcan

- Automates precise addition of reagents
- Monitors temperature and sequence of various steps in the process
- Automatically homogenizes the solution
- Performs levelling and sample rack preparation after digestion
- Provides a contamination free environment

Heating the Samples

Vulcan

- Accommodates both standard and large size Qblocks
- Multistep sample heating
- Pneumatically driven tray lift mechanism to move samples in and out of QBlock
- Laminar flow exhaust to remove acid fumes



THANK YOU FOR YOUR TIME

SPECTRO AMETEK MATERIALS ANALYSIS DIVISION

SERA-6 Meeting
JUNE 22-24, 2014
Lexington, Kentucky
SPECTRO ICP
PRESENTATION

Bob Dussich-6-22-2014
Meeting hosted by Frank Sikora

www.spectro.com

SPECTRO

Spectro offers 7 different models/ configurations of ICP's.

- A) ARCOS
  - EOP-Axial
  - SOP-Radial
- B) BLUE
  - EOP-Axial
  - SOP-Radial
  - Twin Interface (NEW!)
- C) GENESIS
  - EOP-Axial
  - SOP-Radial

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SPECTRO

SPECTRO's ARCOS…Dedicated SOP(Radial) or Dedicated EOP (Axial) models

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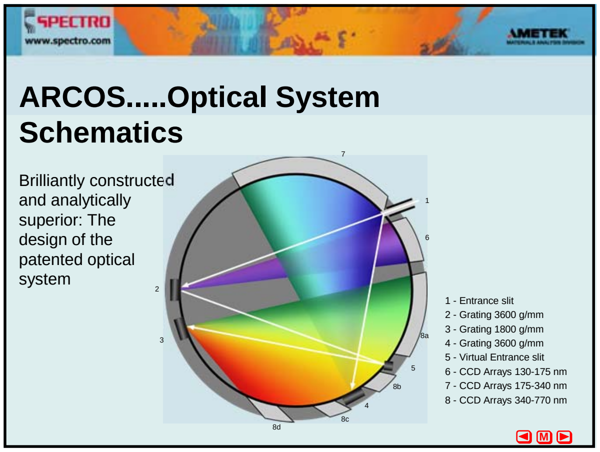
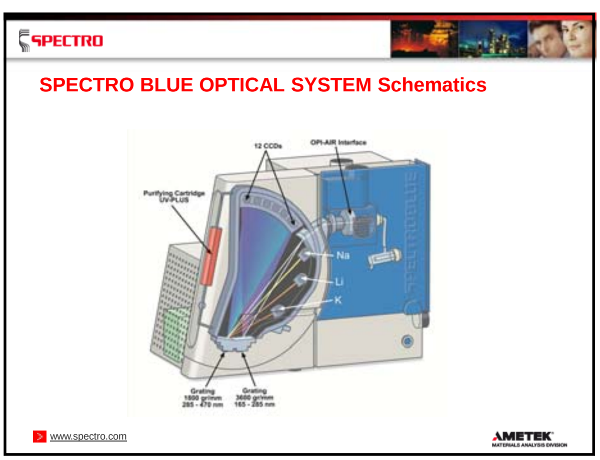
SPECTRO ANALYTICAL INSTRUMENTS
spectro.info@ametek.com
www.spectro.com





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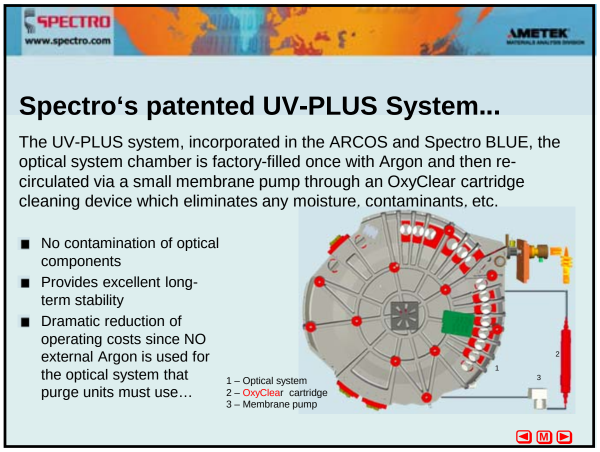
SPECTRO
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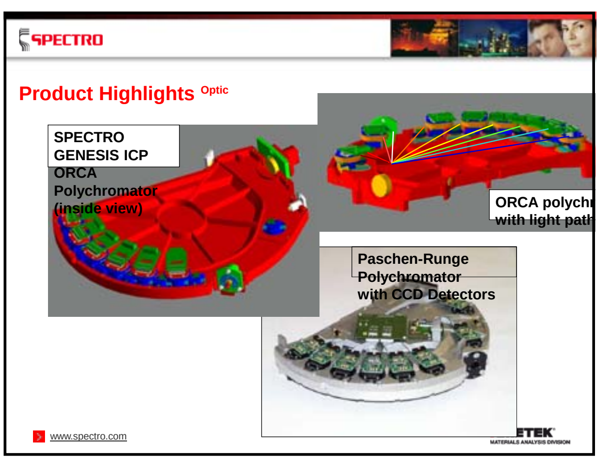
AMETEK
Spectro's patented UV-PLUS System...
The UV-PLUS system, incorporated in the ARCOS and Spectro BLUE, the optical system chamber is factory-filled once with Argon and then re-circulated via a small membrane pump through an OxyClear cartridge cleaning device which eliminates any moisture, contaminants, etc.
No contamination of optical components
Provides excellent long-term stability
Dramatic reduction of operating costs since NO external Argon is used for the optical system that purge units must use…
1 – Optical system
2 – OxyClear cartridge
3 – Membrane pump


SPECTRO
Spectro GENESIS-Lower cost-Purged Optical design-not a sealed optical system like ARCOS or BLUE
SPECTRO GENESIS
www.spectro.com
8
AMETEK


SPECTRO
Product Highlights Optic
SPECTRO GENESIS ICP ORCA Polychromator (inside view)
ORCA polychr with light path
Paschen-Runge Polychromator with CCD Detectors
www.spectro.com

SPECTRO

AND NOW-The New SPECTRO BLUE patented Twin Interface (TI) design offers Axial and Radial viewing in one instrument!

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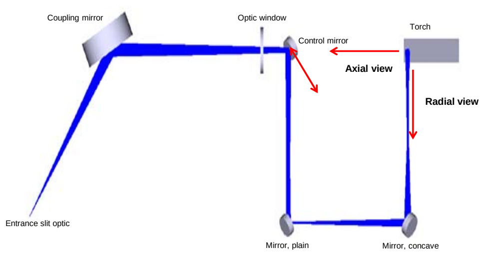
SPECTRO

SPECTROBLUE Twin Interface - Principle



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SPECTROBLUE Twin Interface - Design

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SPECTROBLUE Twin Interface - Properties

- Switchable 3-Mirror Periscope
- Optimized for smallest size and maximum light throughput using “Reverse Ray Tracing”
- Self adjusting, pneumatic control mirror
- Robust construction. Rigidly coupled to the optical system and the plasma torch
- 45°- viewing angle to reduce contamination
- Plasma sided protection windows to avoid contamination of optical components
- All components easy to maintain
- Separate, computer controlled light path with purge flows.

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SPECTRO

TI Analytical Performance: LODs TI axial mode

- Integration time 60s per replicate
- TI-Torch with slit
  - No visible wear after 200h of operation

	Line	LOD	Appl. Report EOP	TVO-LOD Limit
	nm	ppb	ppb	ppb
As	189.042	0.79	0.81	1
Sn	189.991	0.26	0.28	
Tl	190.864	0.58	0.55	
Se	196.09	0.96	0.98	1
Sb	206.833	0.88	0.87	1
Zn	213.856	0.04	0.05	
Cd	214.438	0.04	0.04	0.5
Pb	220.351	0.63	0.68	1
Ni	231.604	0.17	0.19	2
Cr	267.716	0.14	0.15	5
Cu	324.778	0.28	0.31	
Na	589.592	0.29	0.4	
Li	670.784	0.04	0.04	
K	766.491	1.50	1.7	
K	769.896	2.10		

- The SPECTROBLUE TI in axial mode achieves the exact same sensitivity as a SPECTROBLUE EOP

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SPECTRO

TI Analytical Performance: LODs TI radial mode

	Line	LOD	Appl. Report SOP
	nm	ppb	ppb
P	177.495	4.3	1.7
As	189.042	4.8	1.9
Sn	189.991	2.6	1.1
Tl	190.864	5.5	2.8
Se	196.09	5.9	4.3
Sb	206.833	4.5	2.6
Zn	213.856	0.26	0.13
Cd	214.438	0.26	0.13
Pb	220.351	4.8	2.4
Ni	231.604	1.3	0.8
Cr	267.716	0.85	0.51
Be	313.042	0.07	0.07
Ca	315.887	3.2	2.8
Cu	324.778	1.3	1.2
Ca	396.847	0.09	0.08
Sr	407.771	0.04	0.05
Ba	455.404	0.17	0.15
Na	589.592	6.8	8.2
Li	670.784	1.3	1.3
K	766.491	65	70
K	769.896	135	

- Integration time 60s per replicate
- TI-Torch with slit
  - No visible wear after 200h of operation
- In the relevant spectral range > 285 nm the TI in radial mode achieves the exact same sensitivity as a SPECTROBLUE SOP
- LODs in the UV spectral range < 285nm are merely a factor 2 lower than with a SPECTROBLUE SOP
- Even Al 167.078 and Pb 168.215 in the VUV spectral range are measurable

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SPECTRO

Which do I choose????

ALL THREE torch configurations (Axial, Radial or T- I) have distinct advantages..

- The ARCOS SOP (Radial) ICP is the fastest ICP overall, due to its simple (optics stationary-multiple detectors) optical design…
- The ARCOS EOP (Axial) ICP is the fastest Axial ICP, again, due to its patented OPI design-No need for DV switching…
- The Spectro BLUE SOP offers the performance of the ARCOS but does not have the capability of low wavelength coverage for Chlorine, Bromine, etc. (Wavelength coverage is from 165-770 nm)
- The Spectro BLUE EOP offers the best detection limits of any ICP.
- The Spectro BLUE T-I offers the best performance of the Axial EOP model (lowest detection limits) and the best matrix tolerable performance of the Radial SOP model-(No need to worry about matrix effects issues) Therefore..NO COMPROMISES IN ANALYTICAL PERFORMANCE.. NOTE-Any "dual viewing" ICP optical design sacrifices speed for analytical performance

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SPECTRO

SouthEast Region
ICP REFERENCE LIST

- (In order of geography North to South and the colors of the rainbow…ROYGBV.)
  - Virginia- **Dr. Steve Heckendorn**-1-ARCOS SOP and 1-Spectro BLUE TI system
  - North Carolina- **Dr. Dave Hardy**-3-ARCOS SOP's and 1-EOP
  - South Carolina- **Dr. Kathy Moore**-2- ARCOS SOP's & 1 Spectro Vision (SOP)
  - Georgia- **Dr. Leticia Sonon**-2 ARCOS's--1-SOP..1 EOP (Oohh..1-Thermo Model 7300 unit-Radial)
  - Arkansas- **Dr. Morteza Mozaffari** & **Cindy Herron**-3-ARCOS SOP's & 1- Vision (SOP)
  - Florida-**Dr. M. Rau**-1-ARCOS SOP & 1 Vision (SOP)

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SPECTRO

Thank You all for your continued support and attention!

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www.spectro.com

ThermoFisher SCIENTIFIC

iCAP 7000 Series ICP-OES and new advances in sample introduction

Tom Murphy

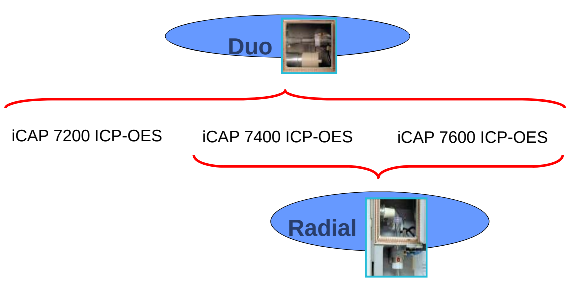
The world leader in serving science

Thermo Scientific™ iCAP™ 7000 Series ICP-OES

- Lowest cost ICP-OES analysis, the highest quality data
  - *iCAP 7200 ICP-OES* - Entry level, cost-effective analysis for low sample thru-put requirements.
  - *iCAP 7400 ICP-OES* - For routine analysis requirements and mid-range sample thru-put.
  - *iCAP 7600 ICP-OES* - Highest productivity and maximum sample thru-put with advanced, flexible accessory support, such as laser ablation.

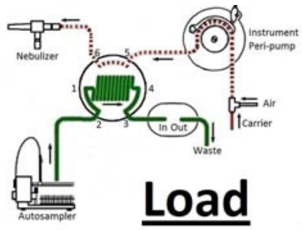
2 ThermoFisher SCIENTIFIC

iCAP 7000 Series ICP-OES – Plasma View Configurations



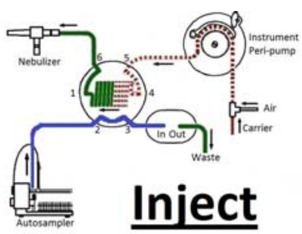
3 ThermoFisher SCIENTIFIC

Sprint valve system – How does it work?



4

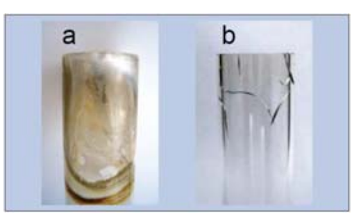
Sprint valve system – How does it work?



5

New Torches

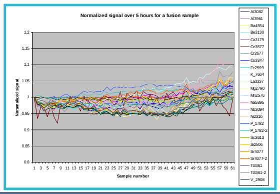
- The challenge of torch lifetime with complex soil samples



6

Torches

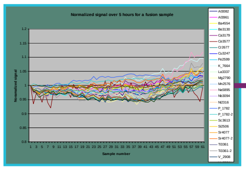
- High matrix samples can damage a torch
  - A process known as devitrification
  - The quartz will change from crystal free to crystalline
  - Shorten the life time of the torch
  - High concentration of group I and II elements
- Ceramic torches
  - Longer life time
  - Equal performance

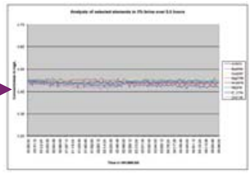


7

Ceramic torch for tough matrices

- Ceramic torch enhances matrix tolerance and long term stability





8

Ceramic *D-Torch* Accessories – Key Features

- Fully demountable design for cost effective replacement of parts
- Identical geometry to EMT (parallel tube design for optimized gas flows and sample channel stability)
- Interchangeable with EMT design in any iCAP 7000 Series ICP
- Silicon nitride (Sialon) ceramic outer tube – highly durable material
- Alumina intermediate (auxiliary) tube – excellent chemical and temperature resistance
- Compatible with EMT centre tubes to enable maximum application flexibility

9

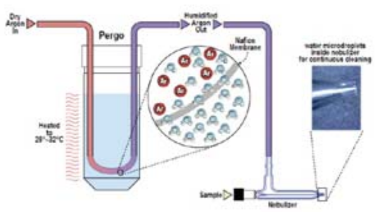
The NEW Argon Humidifier

- Why humidify the argon?
- What type of samples benefit?
- How does it work?

10 Thermo Fisher SCIENTIFIC

The NEW Argon Humidifier

- The Pergo uses Nafion® tubing the selectively permeates water vapor thought the membrane. This evenly humidifies the passing argon

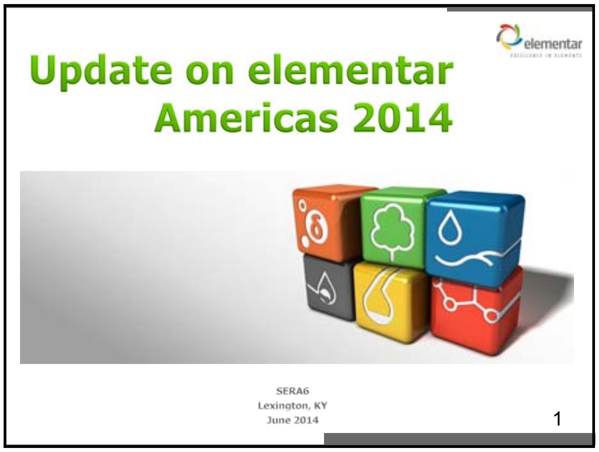


11 Thermo Fisher SCIENTIFIC

Thank you!

- Questions?

12 Thermo Fisher SCIENTIFIC


elementar
Update on elementar Americas 2014
SERA6
Lexington, KY
June 2014
1


elementar
Scott Hughes
Sandy Hughes
Elementar Analysensysteme GmbH purchases elementar Americas.
2


elementar
Georg Schick
President, EAI
Elementar Analysensysteme GmbH purchases elementar.
Americas.
3

Albrecht Sieper,
Managing Director
Elementar Analysensysteme GmbH

Dr. Hans-Peter Sieper,
Chairman
Elementar Analysensysteme GmbH

- IsoSpark now covering Canada
- Dedicated Applications Chemist
- Additional Service locations
- New office in Houston

VisION
Isotope Ratio Mass Spectrometer

Simplicity	Good for Go	Completely intelligent instrument pre-analy confidence in your results
	Data Handling	The most advanced IRMS software created v instant familiarization
	IonOS	Handle the most complex data sets effortles
Power	Dedicated	Specifically geared for your applications, Visi in mind
	Performance	Market leading EA & GC IRMS performance
	CentrION	Integrated monitoring gas system with capa switching and digital flow control
Efficiency	Money Saving	Intrinsic stand-by functionality to reduce consumption of precious resources
	Space Saving	Almost 50% smaller footprint than all other IRMS systems
	Time Saving	Significantly reduced instrument contact time gives you more time to do what you need to do

Iso TOC cube

IRMS peripheral for:

δ13C TIC measurements
δ13C TOC measurements
δ15N TNb measurements

Unique Low Concentration Module eliminates use of cryoliquids

Concentration range:
3 ppb to 60,000 ppm

Stable isotope TNb measurements > 1 ppm
Stable isotope TOC/TIC measurements > 200 ppb

Elementar vario MAX CNS cube

N < 5 mins; CN appx. 7 mins; CNS appx 10 mins

350 mg organic carbon, 350 mg nitrogen and 15 mg sulfur

LOD < 100 ppm (e.g. soil) in N/CN and S modes

	$/analysis	
Cost Element	N mode	CN mode
Helium Cost	$0.242	$0.333
Oxygen Cost	$0.008	$0.008
Chemical Reagents	$0.418	$0.418
Hardware	$0.293	$0.293
Total Cost per analysis	**$0.961**	**$1.052**

3 g soil sample

AOAC 990.03,AOAC 968.06, AOAC 993.13, AOAC 992.15, AOAC 992.23, ASBC, AACC, FGIS, AOCS, CGC (for fertilizer, meat, meat produce, cereals, oil seed, brewing grain, flour, animal feed), DIN/EN/ISO 14891 (milk and milk products), DIN/ISO 13878 (soil), LUFA, MEBAK (brewing), ICC 167

rapid N exceed: exceed your expectations

- ***Regain*** **catalyst ensures binding of excess oxygen without reduction metals.**
- **The** ***Reductor*** **tube life time increased by approx. a factor of 10.**
- **3 step gas drying utilizing condenser, gas membrane drying and chemical fine drying**
- **N: 0 - 500 mg absolute or 0 -100 %**
- **Detection limit < 20 ppm (TCD)**
- **standard deviation: < 0.05 % absolute (250 mg glutamic acid)**

rapid N exceed: metal free oxygen binding; regaining reducing agent

- Regainer© (inexpensive, metal free, non-toxic, non haz mat reagent) in post-combustion tube reacts with excess oxygen and releases reducing gases as by-product. Check filling level when changing ash finger.
- Reductor© (metal) reduces NO and NO_2 to N_2 and turns into metal oxide
- reducing gases from Regainer © reduce metal oxide back to metal
- **life time of Reductor© at least 2000 samples!**

rapid N exceed: exceed your expectations

Elementar vario MACRO cube

CHNS 10 min
CHN 8 min
CN 6 min
N 3 min

up to 200 mg plant material
up to 1 g soil sample

Helium	$0.212
Oxygen	$0.008
Consumables	$1.375
Containers	$0.100
Total Cost	$1.695

In accordance with: AOAC 990.03, AOAC 968.06, AOAC 993.13, AOAC 992.15, AOAC 992.23, ASBC, AACC, (for fertilizer, (excerpt) meat, meat products, cereal, oil seed, brewery cereal, flour, feed), DIN 10467 (milk anddairy products), DIN/ISO 13878 (soil), LUFA, MEBAK (breweries), DIN 51724-3 (Testing of solid fuels - Determination of the sulfur content, ASTM D5373-93, (CHN in coal and coke), ASTM 5291-91 (CHN in oil products and lubricants), ISO 15178:2000(E) Soil quality - determination of total sulfur in dry combustion

Combustion Methods to Analyze Total Sulfur

Determination of Total Sulfur in Fertilizers by High Temperature Combustion: Single-Laboratory Validation

Bernius et al.
Journal of AOAC International
Vol. 97, No. 3, 2014

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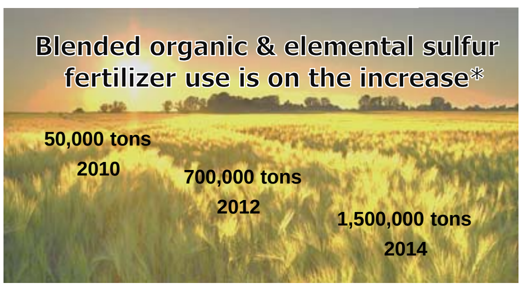
Combustion Methods to Analyze Total Sulfur



*per personal communication Bill Hall, Mosaic, 08/2012

14

Combustion Methods to Analyze Total Sulfur

a) detection on competition Sulfur Analyzer is matrix dependent, peak shapes vary with type of sulfur

b) calibration needed for each sulfur species

c) blended organic & elemental sulfur fertilizers are problematic

d) Gravimetric method cumbersome

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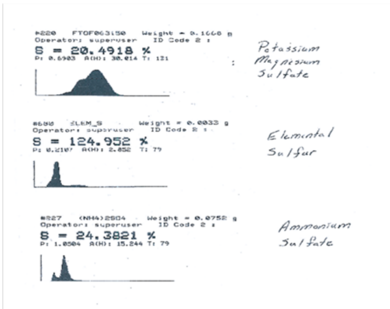
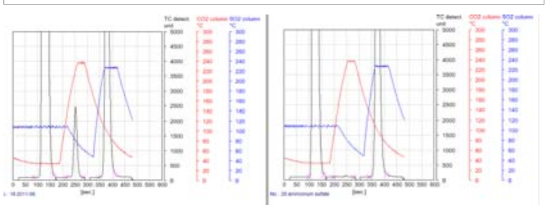
Combustion Methods to Analyze Total Sulfur



16

Combustion Methods to Analyze Total Sulfur

Uniform Peak Shape & Compete Resolution of the Sulfur Peak



Graphics of CNS or NS Fertilizer Samples

17

Combustion Methods to Analyze Total Sulfur

Absorption/ Desorption Column

Not GC column

18

Combustion Methods to Analyze Total Sulfur

- Gas Separation
  - Helium carrier gas pushes combustion gases through analyzer. Argon is alternate gas.
  - C, H and S combustion gases are trapped in separate columns, then sequentially released (aka "purge and trap").
  - N_2 gas is not trapped. It flows straight thru columns.

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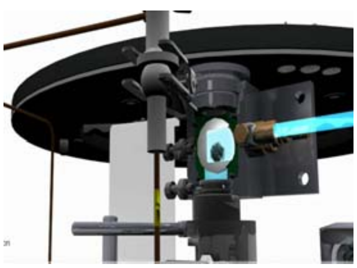
- **Jet injection of oxygen via lance right over / at sample**
  - Creates turbulent flow around sample
  - like blowing on a fire



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Thanks!!

Mark Larson
Regional Sales Manager
Mark.Larson@elementarAmericas.com
856.787.0022 x256
609.760.6137 mobile
www.elementaramericas.com

SERA6
Lexington, KY
June 2014

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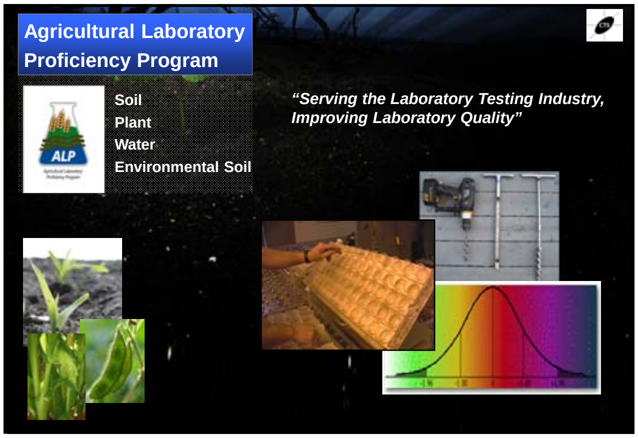
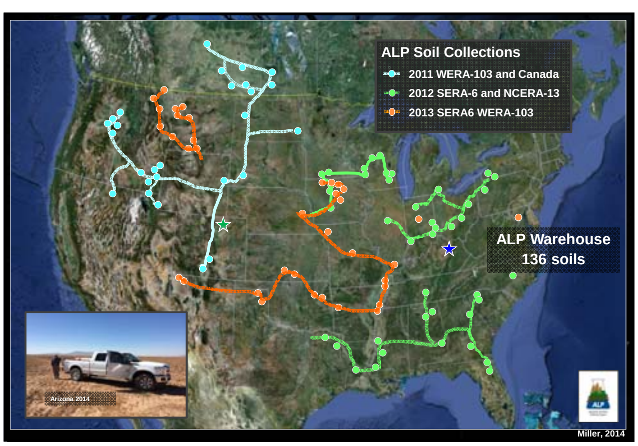

Agricultural Laboratory
Proficiency Program
Soil
Plant
Water
Environmental Soil
"Serving the Laboratory Testing Industry,
Improving Laboratory Quality"
ALP


The ALP Program
Experience
Core
Competency
Analysis
Experience. CTS: 4 decades, nine PT programs. Technical Director: 20 years, prepared 295 soil PT materials[1] since 1997.
Professional Competence. Compliant with ILAC G13 guidelines; 51 presentations and six papers published on analytical performance.
Service. Participants receive technical support. Program sponsors: workshops; symposiums; lab tours; and conduct > 30 lab visits annually.
[1] Preparation and analysis of PT soils 1997-2014.
Miller, 2014

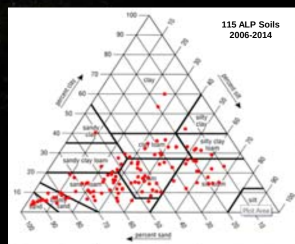

ALP Soil Collections
2011 WERA-103 and Canada
2012 SERA-6 and NCERA-13
2013 SERA6 WERA-103
ALP Warehouse
136 soils
Arizona 2014
Miller, 2014

Proficiency Soils

ALP is the only PT Program that has collected soil from 48 states and 4 Canadian Provinces since 2006[1].

Each proficiency cycle one soil from each workgroup region (SERA-6, NCERA-13, WERA-103 and NEC-1007) is utilized.

Soils utilized in the PT program since 2006 represent 11 of 12 USDA soil textures.



[1] ALP has utilized soils from 51 states and provinces since 2006.

Miller, 2014

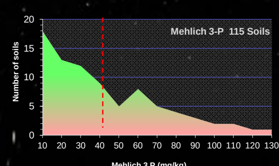
Competence

Homogeneity testing. All PT soils are pretested for uniformity, 7 tests.

Representative PT samples. 50% of soils utilized have Mehlich 3 P < 42 ppm; 52% soils would have a Mehlich 3 K fertilizer recommendation[1].

Lab Proficiency. Each cycle lab performance is evaluated based on analysis bias and precision. Each cycle a report is provide on overall method bias.

Sample	pH (1:1)		NO_3-N (ppm)	
	mean	std	mean	std
SRS-1311	7.61	0.02	55.2	1.7
SRS-1312	4.85	0.03	40.9	0.9
SRS-1313	4.94	0.05	5.6	0.2
SRS-1314	7.27	0.02	18.4	0.8



[1] Based on Purdue University Recommendations for corn.

Miller, 2014

ALP Reports

Special points of interest summary

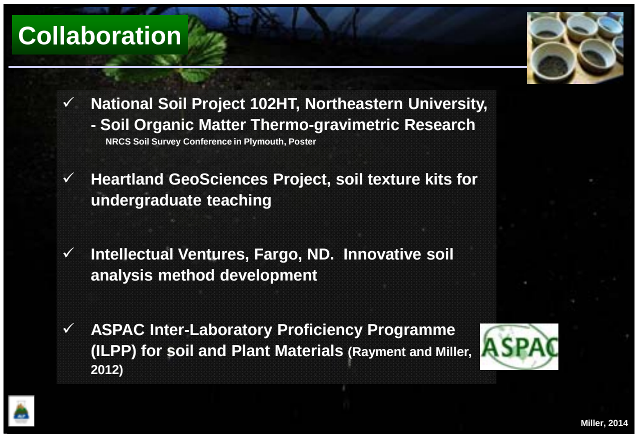
Report Table of Contents

Number of participants and countries

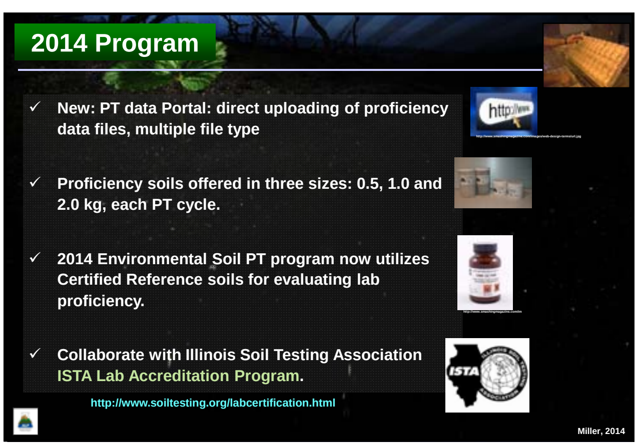
Statistical Protocol used and source document info

Source Information of proficiency materials

Miller, 2014


Collaboration
National Soil Project 102HT, Northeastern University, - Soil Organic Matter Thermo-gravimetric Research
NRCS Soil Survey Conference in Plymouth, Poster
Heartland GeoSciences Project, soil texture kits for undergraduate teaching
Intellectual Ventures, Fargo, ND. Innovative soil analysis method development
ASPAC Inter-Laboratory Proficiency Programme (ILPP) for soil and Plant Materials (Rayment and Miller, 2012)
ASPAC
Miller, 2014


Service
Sponsor Workshop and Meetings
6 workshops since 2012
Organized Tours
Regional, small groups (California tour Mar 2014)
Lab Visits and Technical Assitance
Regional and International, 32 visits 2013
WARD
A & L WESTERN AGRICULTURAL LABORATORIES
Miller, 2014


2014 Program
New: PT data Portal: direct uploading of proficiency data files, multiple file type
http://www
Proficiency soils offered in three sizes: 0.5, 1.0 and 2.0 kg, each PT cycle.
2014 Environmental Soil PT program now utilizes Certified Reference soils for evaluating lab proficiency.
Collaborate with Illinois Soil Testing Association ISTA Lab Accreditation Program.
http://www.soiltesting.org/labcertification.html
ISTA
Miller, 2014


Special thanks to the labs of the SERA-6 Region for their participation and support in ALP