Soil Sampling and Nutrient Recommendations

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SW Agronomy Agent Update

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Research and Extension

Outline

- How to take a soil sample
  - What is the appropriate depth for soil tests
  - How many should you take
  - How often should we sample
  - Preparing samples for lab analysis
  - Good or not-so-good soil tests
- Nutrient Recommendations
  - N recommendation Model
  - P and K (Sufficiency and Build-Maintain)

Why Should We Soil Test?

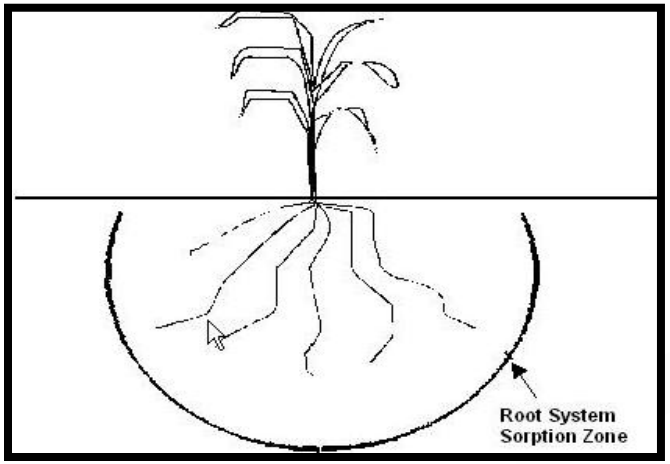
- Determine plant available nutrients in soil
- Estimate crop responses to nutrient additions
- Record long-term soil fertility trends
- Problem solving
- Generate nutrient recommendations
- Make financial decisions

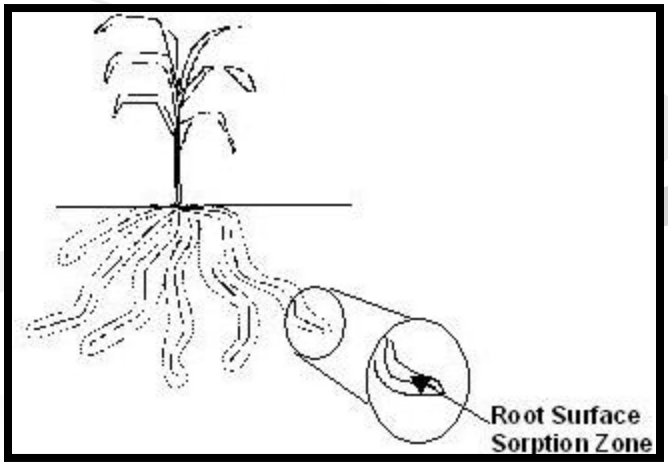
Appropriate Soil Sample Depth

- Consistently take samples from the same depth
  - 6 inch sample – P, K, pH, Organic Matter

    Approximate depth of historical tillage
  - 24 inches – Nitrate, Chloride, Sulfate

    Mobile nutrients can be taken up from deeper in the soil





Number of Soil Samples

Number of soil samples for specific accuracy

pH		P		K		OM	
+/-	#	+/-	#	+/-	#	+/-	#
0.1	337	1	337	10	164	0.1	89
0.2	85	5	14	25	27	0.2	23
0.3	38	10	4	50	7	0.3	10
0.4	21	15	2	100	2		

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Number of Soil Samples

- Number of composite samples submitted to the lab depends on management areas
- 15-20 subsamples for each composite sample

Number of Soil Samples

- Number of composite samples may depend on field variability
  - Identify management zones

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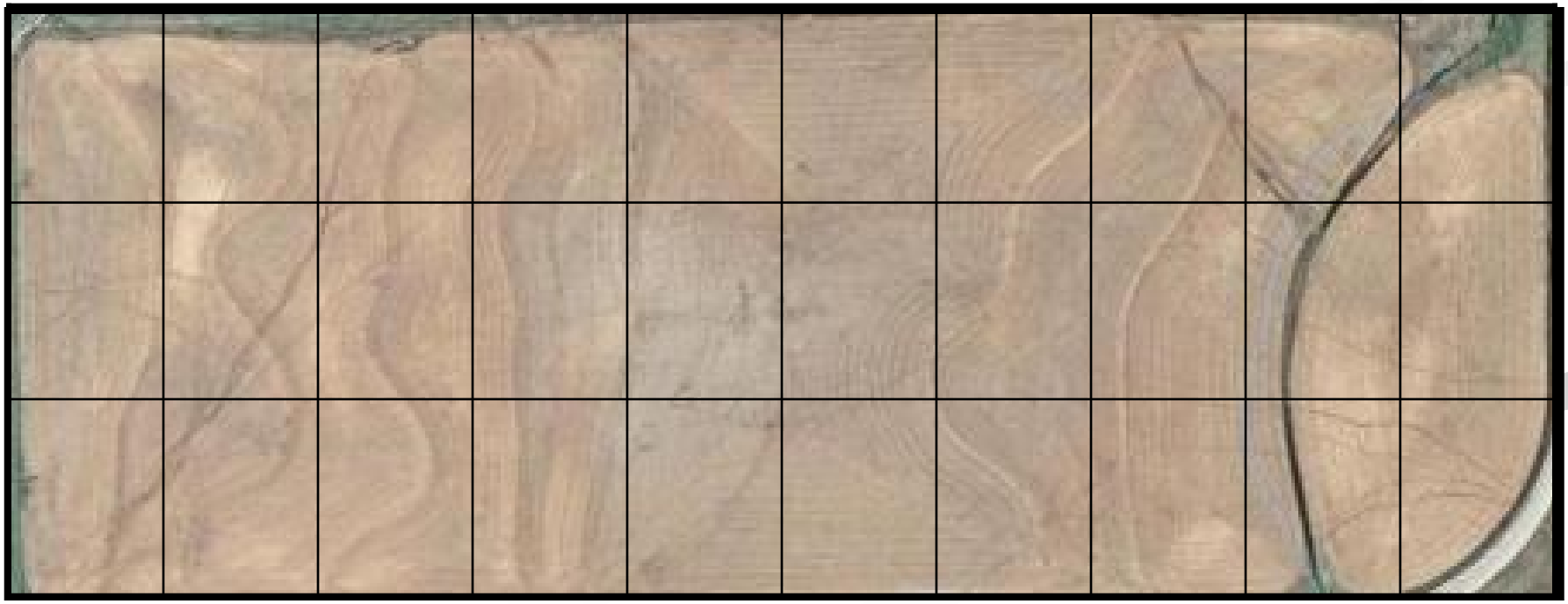
Number of Soil Samples

- Grid soil sampling
  - Requires more samples and ultimately more cost
  - 60 ac field divided into ~2 ac grids

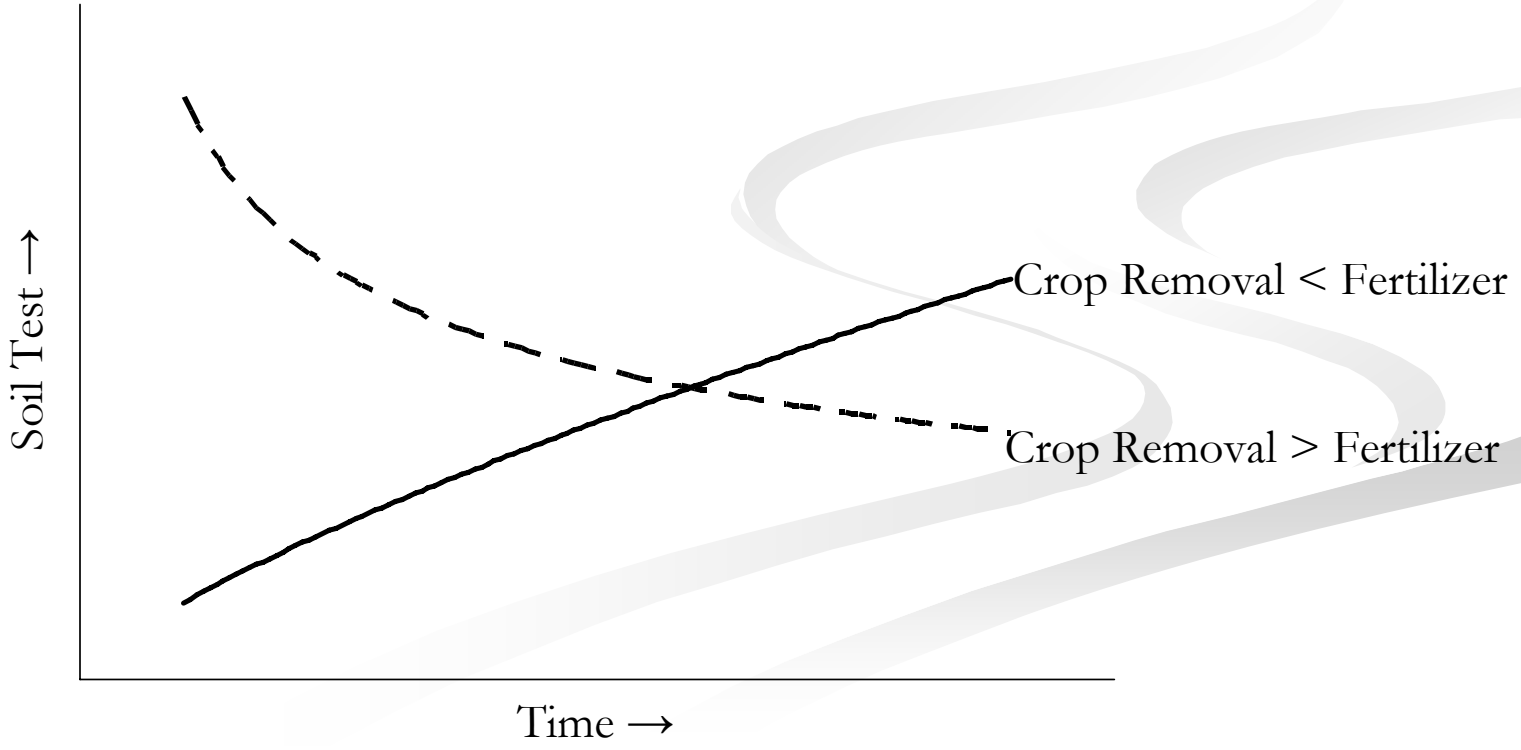


Grid Soil Sampling

- May be beneficial in highly variable fields
  - GPS and precision application equipment make this possible

How Often Should We Sample

- Every year until a history is established
  - Historical trends is a strong point of soil testing
- Generally recommended every 3-4 years



Preparing Samples for Lab

- Know your objectives
  - Laboratory data is only as good as the sample submitted – regardless of the lab
- Combine subsamples into composite samples
  - Keep uniform depth and mix thoroughly
  - Avoid contamination – buckets used for mixing
  - Know how much sample to submit – a sandwich bag is usually enough

Lubricants for Soil Sampling?

Table 2. Eftects of soil probe lubricants on soil chemical Analysis (Blaylock et al., 1995. Wyoming).

Lubricant	Organic Matter	NO3-N	P	K	Fe	Mn	Zn	Cu
				ppm				
No lubricant	1.67	1.4	14	249	11.4	1.5	0.8	1.7
WD-40	1.59	1.3	16	248	13.2	1.8	1.0	2.0
PAM	1.66	2.1	16	263	13.5	3.8	1.1	2.3
Dove Soap	1.67	2.6	14	280	10.1	1.3	0.7	1.2
Motoroil	1.63	1.6	16	265	12.5	1.4	0.9	2.0
Silicone	1.62	1.3	16	246	9.9	1.3	0.6	1.0
LSD_{005}	NS	NS	NS	NS	0.7	0.8	0.2	0.3

Preparing Samples for Lab

- Drying samples
  - Not necessary except nitrate samples that are not submitted immediately
  - Nitrate – lay out on paper, turn on fan
    - Don't – put it in the oven or microwave it
  - Freezing is an option for nitrate samples
- Fill out paperwork including relevant historical information

Sample Information Sheet

K-State Research and Extension
Soil Testing Laboratory
2308 Throckmorton Plant Sciences Center
Manhattan, KS 66506-5503
Tel: 785-532-7897 Fax:785-532-7412
www.agronomy.ksu.edu/soiltesting/

Soil Sample Information Sheet

Date Sent: ________

Submitted by:

Grower: ____________________

Address: ____________________

____

Phone: __________ County: __________

Email: __________

Package No./Name	Analysis Included	Cost
#1	pH, Buffer pH, P, K	$6
#2	Package #1 + O.M. + NO3	$10.50
#3	Package #1 + Zn	$8
Irrigation	Package #1 + O.M., Zn, S, NO3, CEC	$15.50
Environmental	Package #1 + Zn, Cu, NO3, Cl	$14
Profile	NO3, S, Cl (0-24")	$7

*Individual test can be selected. For full listing of analysis offered please refer to the back of this sheet.

For Lab Use	Sample ID	Sample Depth		First Crop Choice		Second Crop Choice		Tillage	Irrigated	Previous Crop	Soil Test Requested
		Top	Sub	Intended Crop	Yield Goal	Intended Crop	Yield Goal				
				☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______		☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______		☐ Conv. ☐ No-Till	☐ Yes ☐ No	☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______	
				☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______		☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______		☐ Conv. ☐ No-Till	☐ Yes ☐ No	☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______	
				☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______		☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______		☐ Conv. ☐ No-Till	☐ Yes ☐ No	☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______	
				☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______		☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______		☐ Conv. ☐ No-Till	☐ Yes ☐ No	☐ Corn ☐ Milo ☐ Soybeans ☐ Wheat ☐ ______	

Type of Fertilizer Recommendation for P and K (Refer to back of sheet for explanation):

☐ **Sufficiency** – Sufficiency recommendations are based upon meeting the intended crops nutrient requirements.

☐ **Build** – Build-maintenance recommendations can be used to build soil test P and K within a certain number of years.

Number of years to build P and K: ______

Comments: ____

____

Where To Send Your Samples

- Your objectives! What is important?
  - Tests appropriate for your area
  - Accurate results
  - Turn around time
  - Cost
  - Service
- Part of a government program?
  - Ask your local extension agent what tests are required – Don't assume all labs provide the same required tests!

Choosing Soil Tests

- pH (1:1 soil:water)
  - Very accurate and reliable
  - Substantial research conducted on pH
  - Determines if lime is needed
  - pH > 7.3 – calcium carbonate present (free lime)
  - pH < 5.8 – crop response to lime
- Buffer pH (Buffer Index)
  - Very accurate and reliable
  - Tells how much lime to add
  - SMP is most common

Choosing Soil Tests

- Phosphorus
  - Variety of tests
  - Bray P-1
    - Most correlation/calibration data
    - Inaccurate on calcareous soil (reads low)
  - Olsen P
    - Specific to high pH soil (abundant data on high pH)
  - Mehlich 3
    - Works on a wide range of soil pH (acid → calcareous)
    - Limited correlation/calibration data
    - Most common

Choosing Soil Tests

- Potassium
  - Exchangeable ammonium acetate
  - Fairly good test
  - Most useful for watching trends over time
- Nitrate
  - KCl extractable
  - Abundant data
  - Based on expected yield
  - Adjusted based on organic matter, previous crop, fallow

Choosing Soil Tests

- Organic Matter (%)
  - Modified Walkley-Black or loss on ignition
  - Reliable, consistent data
  - May be inflated if crop residue is in sample
  - Warm season crop N adjustment = %OM×20
  - Cool season crop N adjustment = %OM×10
- Zinc
  - DTPA extract – diethylenetriaminepentacetic acid
  - Good predictor of crop response
  - Reliable on high pH soil, less on acid soils

Choosing Soil Tests

- Sulfate
  - Calcium phosphate extract
  - Little calibration data
  - Variable crop response
  - Credit from organic matter (2.5 × % OM)
- CEC (Cation Exchange Capacity)
  - Measured by summation (K^+, Ca^{++}, Na^+, H^+)
  - Soil's potential to 'hold' nutrients
  - Overestimates on calcareous soils

Choosing Soil Tests

- Iron
  - DTPA extractable
  - Poor calibration data
  - Inadequate for acid soils
  - Limited use for calcareous soil
- Calcium, Magnesium, Manganese, Molybdenum
  - Poorly calibrated
  - Deficiency is rare

Choosing Soil Tests

- Boron
  - Poor calibration
  - Poor soil test
  - Used for alfalfa grown on sandy soil
- Copper
  - Poor Calibration
  - Deficiency is rare
  - Occasional deficiency in wheat on organic soil

Choosing Soil Tests

- Exchangeable Sodium Percentage
  - Fairly reliable
  - Diagnoses alkali/sodic soils
- Soluble Salts (Electrical Conductivity)
  - 1:1 soil to water paste
  - Diagnoses saline soil

Soil Tests Summary

Good	Questionable
pH	Calcium
Buffer pH	Magnesium
Phosphorus	Copper
Potassium	Manganese
Nitrate	Molybdenum
Organic Matter	
Zinc	
Chloride	
ESP	
Soluble Salts	

Sample Results

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Soil Test Report

Grower:
Date Received:
Date Reported:
County:

K-State Research and Extension
Soil Testing Laboratory
2308 Throckmorton Plant Sciences
Center Manhattan, KS 66506-5503
Tel: (785)532-7897 Fax:(785)532-7412
www.oznet.ksu.edu/agronomy/SoilTesting/

Soil Test Results

METHODS USED:		1:1	SMP	Mod. W.B.	Cd Reduction		Mehlich	Ammonium Acetate				DTPA				Ca-P	$CaNO_3$
Lab Number	Sample ID	Soil pH	Buffer pH	Organic Matter %	Nitrate Nitrogen ppm Surface	Profile	Phosphorus ppm P	Potassium ppm K	Calcium ppm Ca	Magnesium ppm Mg	Sodium ppm Na	Zinc ppm Zn	Iron ppm Fe	Manganese ppm Mn	Copper ppm Cu	Sulfate ppm S	Chloride ppm Cl

Fertilizer Recommendations — Pounds Actual Nutrient Per Acre

Sample ID	Previous Crop	Intended Crop	Yield Goal	Lime, ECC lbs/acre	Nitrogen N	Phosphorus P_2O_5	Potassium K_2O	Zinc Zn	Sulfur S	Chloride Cl	Boron B

Special Tests

Sol.Salts mmho/cm	Cation Exchange Capacity meq/100g	Aluminum ppm Al	DTPA Boron ppm B	Texture % Sand	% Silt	% Clay

Approved by:

Comments:

Submitted By:

Nutrient Recommendations

K-STATE Kansas State University

Soil Test Interpretations and Fertilizer Recommendations

Department of Agronomy MF-2586 Nutrient Management

Development of sound nutrient management programs involves knowledge of a wide range of information. Soil test records are an important piece of required information, but other factors such as soil moisture conditions, land ownership/tenure, crop and cropping sequence, pest management, cultural practices, environmental issues, and other management items are vital for developing sound nutrient management programs. It is beyond the scope of this publication to detail the ramifications of all these factors, but they should not be overlooked when finalizing nutrient application programs.

The following tables, equations and accompanying information are the most recent soil test interpretations for major crops for the most commonly deficient plant nutrients in Kansas. These interpretations are valid for interpreting soil test values from the KSU Soil Testing Laboratory and other laboratories utilizing the same soil testing procedures.

Yield Goals

Suggested recommended application rates are tied to yield goals for several nutrients. Yield records should be used to set individual realistic, but progressive, yield goals for each field. Appropriate yield goals for a specific field should be high enough to take advantage of high production years when they occur, but not so high as to jeopardize environmental stewardship and/or profitability when environmental conditions are not as favorable. Appropriate yield goals fall between the average yield obtained in a field over the past 3 to 5 years and the highest yield ever obtained in a particular field.

Soil Sampling Depth.

Interpretations for the nitrate-N, sulfate-S and chloride-Cl soil tests are based on a 0-24 inch soil profile sampling depth. All other nutrient interpretations are based on surface soil samples collected to a depth of six inches. We suggest collecting a sample from the 0 to 24 inch depth for N, S and Cl recommendations and a separate 0- to 6-inch sample for pH, P, K, Zn, Fe and B soil test determinations.

For lime, the recommended lime rate should be adjusted to reflect the depth of lime incorporation, while no-till and perennial crops should assume a depth of 2 inches.

Appropriate Soil Test Procedures

The KSU soil test interpretations are based on the following soil test procedures:

Soil pH – 1:1 Water pH

Buffer pH – SMP Buffer (determines lime requirement)

Nitrogen – Available Nitrate-N

Phosphorus:

Bray P1 Extractable P

Mehlich III Extractable P (ICP) – interpreted the same as Bray P1

Olsen P – multiply by 1.6 and interpret similarly to Bray P1

Potassium – Ammonium Acetate Extractable

Zinc, Iron and Boron – DTPA Extractable

Sulfur – Calcium Phosphate Extractable Sulfate

Chloride – Mercury (II) Thiocyanate Extractable (Colorimetric)

A downloadable version of these recommendations is available at www.oznet.ksu.edu/agronomy/soiltesting/

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

Available at:
http://www.agronomy.ksu.edu/SoilTesting

Nutrient Recommendations

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SOIL TEST REPORT

GENERAL INFORMATION:

Producer:	
Address:	
City, State:	
County:*	Region:

*Must enter full county name.

Date: 2/23/09

Tillage:	Lime Incorporation Depth (in):
Conventional	6.67
Irrigation:	**Years to build soil test:**
No	4

*If field is no-till, alfalfa or grass lime incorp. should be set at 2 in.

CROP INFORMATION:

Field ID	Total Sample Depth (in)	Intended Crop	Yield Goal (bu/acre or T/acre)	Second Crop	Yield Goal (bu/acre or T/acre)	Third Crop	Yield Goal (bu/acre or T/acre)	Previous Crop

SOIL TEST RESULTS:

Lab Number	Field ID	pH	SMP Buffer pH	Organic Matter %	Nitrate-N ppm (surface or profile)*	Mehlich 3 P ppm	NH_4OAc Ext. K ppm	DTPA		Sulfur ppm	Chloride ppm	Boron ppm
								Zn ppm	Fe ppm			

*Enter profile NO_3-N value if 0-24" sample was submitted, otherwise enter the NO_3-N value for the surface sample.

Nutrient Recommendations

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FERTILIZER RECOMMENDATIONS

					LBS/ACRE							
Lab Number	Field ID	Previous Crop	Intended Crop	Yield Goal	Lime ECC	Nitrogen	Phosphate P_2O_5	Potassium K_2O	Zinc	Sulfur	Chloride	Boron
						#NAME?						
						#NAME?						
						#NAME?						
						#NAME?						
						#NAME?						
						#NAME?						
						#NAME?						
						#NAME?						
						#NAME?						
						#NAME?						
						#NAME?						
						#NAME?						

Comments:

#NAME?

#NAME?

#NAME?

#NAME?

Nutrient Removal

Crop	Unit	P2O5	K2O
Alfalfa	lbs/ton	12.00	60.00
Red clover	lbs/ton	12.00	50.00
Bermudagrass	lbs/ton	12.00	40.00
Bromegrass	lbs/ton	12.00	40.00
Fescue, tall	lbs/ton	12.00	40.00
Corn	lbs/bu	0.33	0.26
Corn silage	lbs/ton	3.20	8.70
Grain sorghum	lbs/bu	0.40	0.26
Sorghum silage	lbs/ton	3.20	8.70
Wheat	lbs/bu	0.50	0.30
Sunflowers	lbs/cwt	1.50	0.60
Oats	lbs/bu	0.25	0.20
Soybeans	lbs/bu	0.80	1.40
Native grass	lbs/ton	5.40	30.00

Nutrient Removal

- Example
  - Assume 50 bu/ac wheat
  - 50×0.5 = 25 lb P_2O_5/ac removed
  - 50×0.3 = 15 lb K_2O/ac removed

  - 5 years of production without fertilization
    - 125 lb P_2O_5/ac removed
    - 75 lb K_2O/ac removed

Questions?