Interpreting Soil Test Reports and Fertilizer Source Options

Western Extension Agent Training, September 28, 2006

by Clain Jones, Extension Soil Fertility Specialist
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MONTANA STATE UNIVERSITY EXTENSION

Your Questions

- How do I interpret a Soil Test Report?
- What are fertilizer options for forages/Western soil fertility issues?
- What info exists on ESN (Environmentally Sound Nitrogen) and is it worthwhile?
- How are urea applications managed differently than ammonium nitrate applications?
- What are small acreage fertilizer strategies/sustainable nutrient cycling for small acreages?

What should you first look for on a soil test report?

- Depth – should have at least a 0-6 in. section
- Nitrate-N – Is it in lb/ac or ppm? If in ppm, you need to convert to lb/ac: 2 x ppm x depth/6 in. and add up separate depths.
- Is phosphorus measured as Olsen P or Bray P? (MSU guidelines are for Olsen P and there are not good conversions between the 2).

AGVISE LABORATORIES

Soil Analysis by Agvise Laboratories
Northwood: (701) 587-6010
Benson: (320) 843-4109

SOIL TEST REPORT

FIELD [redacted] SAMPLE
CNTY
TWP SECTION
QTR ACRES
PREV. CROP

From: Toole Co.

SUBMITTED FOR: [redacted]

SUBMITTED BY: CE2971
CENEX HARVEST STATES
PO BOX 1272
29 NORTH CENTRAL
CUT BANK MT
59427

REF# 6796906
LAB# 2582
BOX# 0

Date Sampled:		Date Received:	2/28/2002	Date Reported:	2/10/2005

NUTRIENT IN THE SOIL		INTERPRETATION Vlow	Low	Med	High
Nitrate	0-6" 37 lb/ac 6-24" 36 lb/ac 0-24" 73 lb/ac	****	****		
Olsen Phosphorus	14 ppm	****	****	****	***
Potassium	289 ppm	****	****	****	****
Chloride					
Sulfur	0-6" 8 lb/ac 6-24" 360 +lb/ac	**** ****	** ****	****	****
Boron					
Zinc	0.57 ppm	****	****		
Iron					
Manganese					
Copper					
Magnesium					
Calcium					
Sodium					
Org.Matter	2.5 %	****	***		
Carbonate(CCE)					
Sol. Salts	0-6" 0.44 mmho/cm 6-24" 0.67 mmho/cm	**** ****	*** ****	***	

1ST CROP CHOICE		
Barley-Malting		
YIELD GOAL		
50	BU	
SUGGESTED GUIDELINES		
Band		
LB/ACRE		APPLICATION
N	10	
P_2O_5	15	Band(Starter)*
K_2O	10	Band(Starter)*
Cl		
S	5	Band (Trial)
B		
Zn	2	Band
Fe		
Mn		
Cu		
Mg		
Lime		

2ND CROP CHOICE		
YIELD GOAL		
SUGGESTED GUIDELINES		
LB/ACRE		APPLICATION
N		
P_2O_5		
K_2O		
Cl		
S		
B		
Zn		
Fe		
Mn		
Cu		
Mg		
Lime		

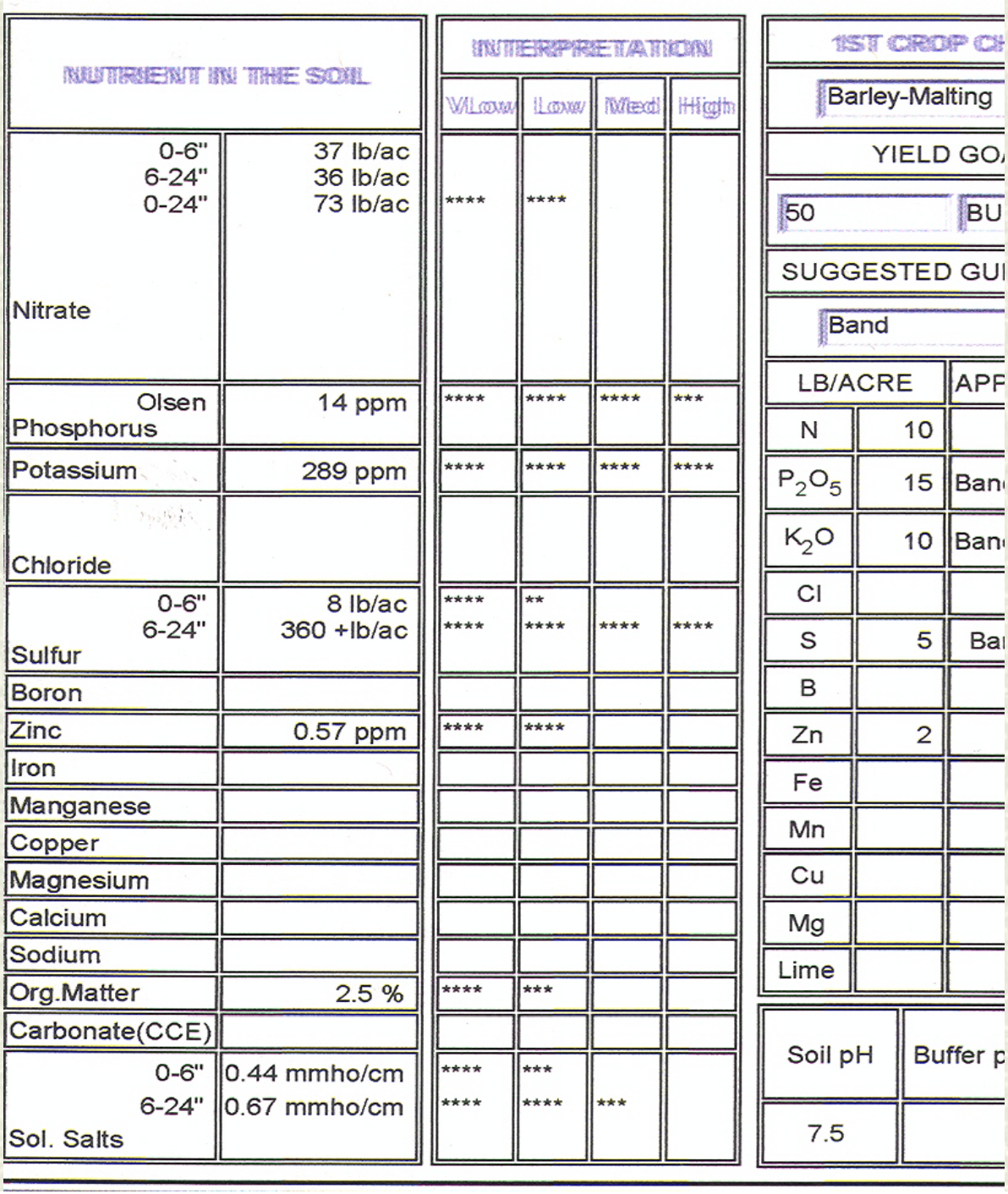
3RD CROP CHOICE		
YIELD GOAL		
SUGGESTED GUIDELINES		
LB/ACRE		APPLICATION
N		
P_2O_5		
K_2O		
Cl		
S		
B		
Zn		
Fe		
Mn		
Cu		
Mg		
Lime		

Soil pH	Buffer pH	Cation Exchange Capacity	% Base Saturation (Typical Range)				
			% Ca	% Mg	% K	% Na	% H
7.5							

What else should I look for?

Test	"Good" range	Possible problem
Soil pH	6-8	Low-poor nodulation; High-can indicate high Na. Either high or low-can tie up P
Organic Matter (O.M.)	2-8%	Low-poor water holding capacity, low nutrient release; High-Cu deficiency, salts if from manure
"EC" or salts	< 4 mmho/cm	Poor water uptake, decreased yields
Nitrate-N	10-200 lb/ac	Low-chlorosis; High-'burn' if hot, dry
Olsen Phosphorus (P)	16-60 ppm	Low-poor energy storage, root growth High-possible Zn deficiency or P losses
Potassium (K)	250-700 ppm	Low-chlorosis, short internodes High-possible Ca deficiency
Zinc (Zn)	> 0.5 ppm	Low-stunted growth, interveinal chlorosis

Any red flags here?



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P_2O_5	15	Ban
K_2O	10	Ban
Cl		
S	5	Ba
B		
Zn	2	
Fe		
Mn		
Cu		
Mg		
Lime		

Soil pH	Buffer p
7.5	

How about here?

Soil Analysis Report

WESTERN TESTING LABORATORY, INC.

1920 9TH AVENUE NORTH, P.O. BOX 3165
GREAT FALLS, MONTANA 59403
(406) 761-1724

Grower: [redacted]
Submitted by: AGRI BASICS FERTILIZER
DATE: 2-8-2005

Lab Number	Field Description	SAMPLE DEPTH	pH	ORGANIC MATTER%	NITRATE NITROGEN PPM	NITRATE LBS/AC	PHOSPHORUS OLSEN PPM	POTASSIUM K PPM
5948	GARDEN	0-6	7.8	2.0	8	16	27	237
	M EAST							

SULPHATE SULFUR PPM	SODIUM Na MEQ/100g	SALT HAZARD MMHOS/Cm	SOIL TEXTURE	LIME	MOISTURE INCHES	ZINC Zn PPM	MANGANESE Mn PPM
55 H	.20	1.12	CL	V		1.2	

COPPER CU PPM	IRON Fe PPM	CEC BASED ON TEXTURE	Apply three pounds of nitrogen, one pound of phosphorus, and one pound of potassium per 1000 sq. ft.	
		21.8		

What else do you see on soil test reports?

Fertilizer Recommendations

- Use EB 161. Point out 'Guidelines'
- Nitrogen: Need yield potential.
  Grass – 25 lb N/ton
  Spring wheat – 3.3 lb N/bu
  Winter wheat – 2.6 lb N/bu
  Malt barley – 1.2 lb N/bu

Table 8. Grass N guidelines based on soil analysis.

GRASS	
Yield Potential (t/a) *	Available N (lbs/a) **
1	25
2	50
3	75
4	100
5	125

* Attainable yield with ***all*** growth factors optimized.
** Fertilizer N = Available N - soil analysis NO_3-N.

Special Conditions

- Fall N application on sandy soils is not recommended. On all other soils,

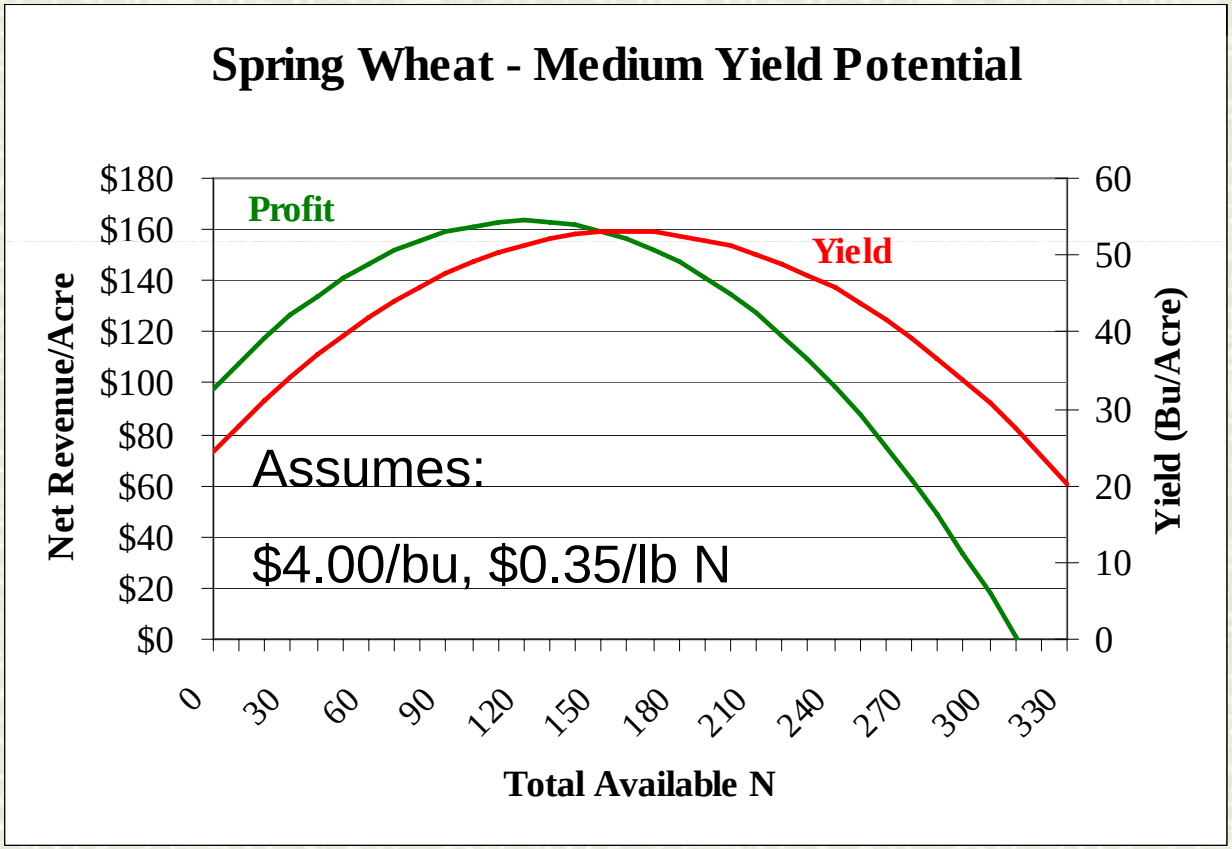
- Fertilizer N =
  Available N (from table)
  - soil N (lb N/ac) (assumes Spring sampled); -25 lb N/ac more if Fall sampled
  - 10 lb N/ac if previous crop is an annual legume, 40 lb N/ac if previous crop is alfalfa
  - 20 lb N/ac if > 3% O.M.

- Orchardgrass N uptake ~ 1.3 x fescue, brome, timothy N uptake

Questions for you:

- Why might more N be needed this coming year in forage crops that received good rainfall in ’06?
- Why might less N than normal be needed this coming year in forage crops with average yields?
- What does this tell you??

What else should you and the grower consider in selecting N rate?



http://www.montana.edu/extensionecon/software/FertilizerCostBenefit.xls

N rates on forages

- Don’t exceed 60 lb N/acre during seeding year, or within 9 months from fall seeding.
- Don’t exceed 15 lb N/acre if placed with seed.

Phosphorus and Potassium Fertilization Strategies

1. Sufficiency Approach – Do you want to apply minimum necessary to maximize yield in most years? *If so*, use Table 18 (P) and Table 19 (K).
2. Maintenance Approach – Do you want to replace the nutrients removed at harvest? *If so*, use Table 21.
3. Build Approach – Do you want to build your soil P and K, to minimize yield losses and save on fertilizer in future years? *If so*, add amounts from 1 and 2.

What might grower's answer depend upon?

Table 18. Phosphorus fertilizer guidelines based on soil analysis.

Crop	Olsen P Soil Test Level (ppm)				
	0	4	8	12	16*
	P Fertilizer Rate (lbs P_2O_5/a)				
Alfalfa-Grass	55	50	40	25	10
Grass	45	35	30	20	5

Table 21. Estimated nutrient uptake in harvested portions of crops.*

Crop	Unit	Test Weight lbs/bu	N	P_2O_5	K_2O	Ca	Mg	S	Fe	Zn	Mn	Cu	B
			lbs										
Alfalfa	ton		48	11	53	28	5	5.50	0.38	0.11	0.11	0.02	0.02
Grass	ton	13-45	25	10	38	7	2.50	2		0.08	0.13	0.01	

Costs to maintain P and K for 5 t/ac alfalfa hay

- 5 t/ac x 11 lb P_2O_5/t = 55 lb P_2O_5/ac
- 5 t/ac x 53 lb K_2O/t = 265 lb K_2O/ac

Cost = $0.28 x 55 = $15.40

+ $0.21 x 265 = $55.70

Total = $71/ac

How much is hay selling for this year?

What P and K fertilization strategy would you recommend for small acreages?

N Source Options

- Urea (46-0-0)
- UAN liquid (28-0-0)
- Anhydrous ammonia (82-0-0)
- Ammonium nitrate (limited supplies)
- Ammonium sulfate (21-0-0-24). Expensive per lb of N, but can increase protein, esp. in dry years.
- CRNs - Controlled release nitrogen, such as ESN.
- Urease inhibitors –Applied to urea to decrease volatilization, such as Agrotain.

Controlled Release N

- Made with polymer coatings to:
  - –Decrease leaching
  - –Decrease volatilization

  Ex: In 124 studies, ESN increased corn yield an average of 7 bu/ac over urea (Blaylock and Tindall, 2006). Increase likely due to decreased volatilization.

  ESN Cost? $50 -$70 more per ton. Net economic gain on corn (mainly Midwest)

  Worth of CRNs and Agrotain on forages and small grains in Montana? Not enough research yet to say, but benefits are likely less due to smaller revenues here and less potential for volatilization.

Differences between urea and ammonium nitrate

- Urea is more damaging to seed germination

  Implications:
  1. MSU recommends < 30 lb N/ac of AN with seed, but < 15 lb N/ac of UR (crop dependent).
  2. Recommend a spreader (or wider spreader) so that more UR can be placed near seed.

- Urea has higher potential to volatilize

  Implications:
  1. Urea application should be done during period with cool temperatures, especially when on moist, sandy soils with residue.
  2. Urea should be irrigated (>0.5 inches) or tilled in if possible.

- Urea is not immediately available for plant uptake

  Implication: For same effect, urea needs to be applied earlier in season, especially if Fall soil test N levels are low (<20-30 lb N/ac).

P Source options

- Monoammonium P (MAP)
- Diammonium P (DAP)
- Liquids (generally more expensive than MAP and DAP)

Generally no yield differences between sources.
Exception: Liquids produce higher yields on highly calcareous soils (> 20% $CaCO_3$)

Placement: Need roughly 3 times more P if broadcast than if placed near the seed at Olsen P levels < 8 ppm, and 2 times more P when Olsen P = 8-12 ppm. MSU guidelines assume P will be banded with the seed.

Fertilizer Application Timing

- Nitrogen:

  Avoid Fall N application on sandy soils.

  How favor warm season grasses in native pasture?

  Are split applications worth it?
- Phosphorus

  Apply in fall or late winter for better response.

Organic fertilizer options for small landowners

Common Organic Fertilizers				
	N (%)	P_2O_5 (%)	K_2O (%)	S (%)
Rock Phosphate[1]	0	3-16	0	0
Blood Meal[2]	12	1-2	0-1	
Bone Meal[2]	1-6	11-30	0	
Gypsum[3]	0	0	0	17
Greensand[3]	0	1	6	0
Manures[4]**: Dairy**	0.6 - 2.1	0.7 - 1.1	2.4 - 3.6	
Beef Cattle	1 - 2.5	0.9 - 1.6	2.4 - 3.6	
Horse	1.7 - 3	0.7 - 1.2	1.2 - 2.4	
Swine	3 - 4	0.4 - 0.6	0.5 - 1	
Poultry	2 - 4.5	4.5 - 5.5	1.2 - 2.4	
Sheep	3 - 4	1.2 - 1.6	3 - 4	

[1]Range of P_2O_5 from Havlin et al. 2005. Soil Fertility and Fertilizers. Prentice Hall.

[2]Blood and bone meal data from Koenig and Johnson, 1999. http://extension.usu.edu/files/gardpubs/hg510.pdf

[3]Gypsum and greensand data from Gardener's Supply Co. http://www.gardeners.com

[4]Manure nutrient content based on dry wt. data from Knott's Handbook for Vegetable Growers. 1997. John Wiley & Sons, Inc.

Conclusions

- Given some criteria, soil test reports can be quickly evaluated for potential problems.
- N, P, and K recommendations can be made by knowing how to use EB 161 AND giving the grower some options (e.g. sufficiency vs. build)
- Different N and P sources generally don't produce large yield differences. However, good management of volatile N sources can reduce yield losses in some situations.
- Fertilizing small acreages is similar to large acreages, but *may* be less constrained by economics.

QUESTIONS?

For more information on N cycling, fertilizer sources, placement and timing see:
http://landresources.montana.edu/nm

For more information on urea volatilization and management, see:
http://www.oznet.ksu.edu/library/crpsl2/NCR326.pdf

MSU Soil Fertility webpage:
http://landresources.montana.edu/soilfertility