SOIL SAMPLING AND HOW TO READ SOIL TESTS
Extension Agent Agronomy College
September 24, 2014

Clain Jones
clainj@montana.edu 994-6076

Objectives

- Learn to plan and implement soil sampling, correctly handle samples and select a laboratory
- Discuss soil quality/health tests
- Unravel the mysteries of soil test reports

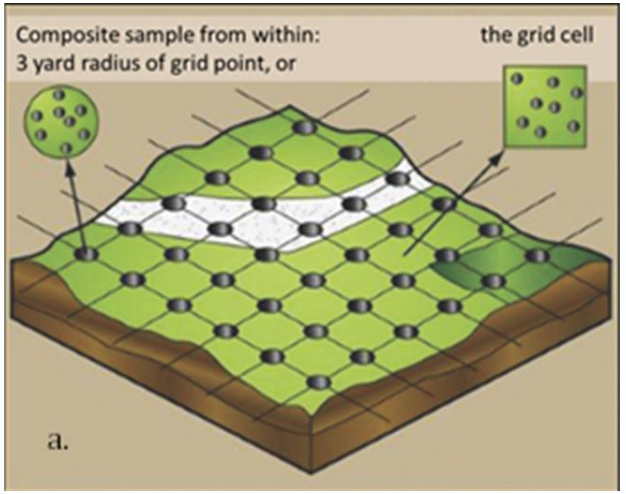
Advantages of soil testing (even if only occasionally)

- To identify nutrient deficiency or imbalance
- To help calculate optimal fertilizer rates
- Especially important in case where soil nutrient availability has been depleted or is in excess
- Can increase yield and/or save on fertilizer costs, and decrease environmental risks

Sampling location: Grid vs. Zone

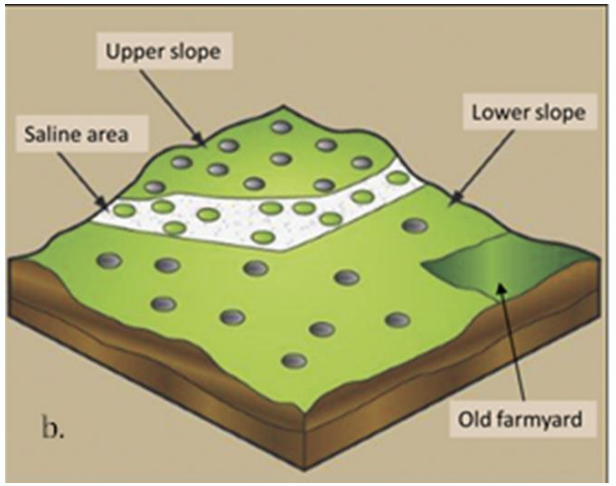
Grid sampling

- For non-mobile nutrients (e.g. P, K, zinc)
- History of manure or high fertilizer levels (esp. P, K)
- Small fields merged to form larger field
- More samples, more cost



Zone based sampling

- For mobile nutrients (esp. N)
- Unknown or long cropping history
- Historically low levels of fertilization, no manure
- High with-in field variability or relationship of yield to landscape
- Fewer samples, more planning time



Images adapted from IPNI 2012, used by permission.

Why are more samples better when it comes to soil sampling?

Variability can be large!

Range and average of test values from 40 individual soil cores from a 80-acre field[1].

Analysis	Range (lb/acre)	Average (lb/acre)
Nitrate-N	12-225	53
Phosphorus	5-250	39
Potassium	156-1164	557

[1] From Swenson et al. (1984)

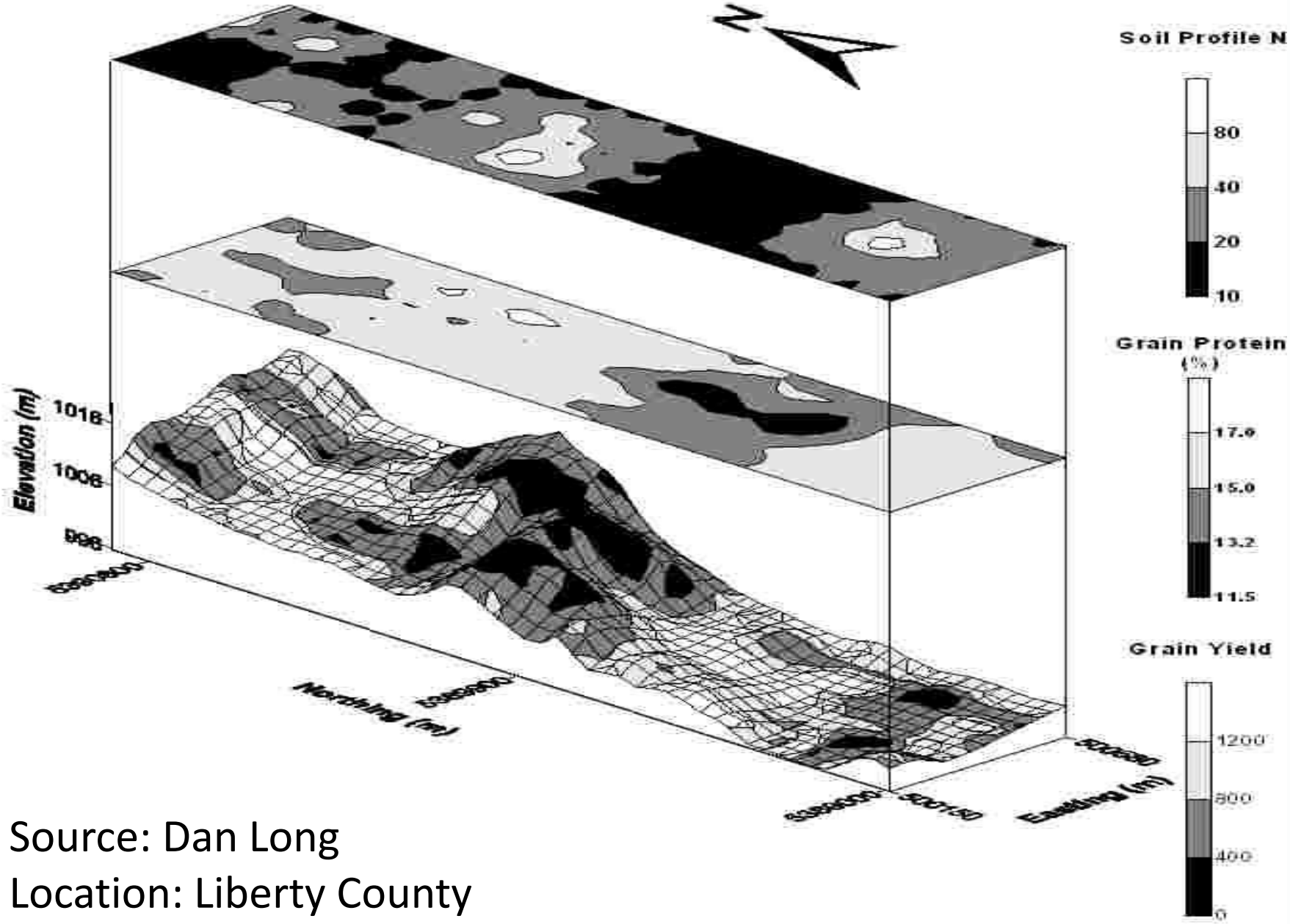
Number of sub-samples

Number of sub-samples required to be 80% confident that test result is close to 'truth', and the range in nutrient level a field could have if sampled at this level with this test result[1].

Accuracy Level					
±15%			±25%		
Nitrate-N	P_2O_5	K_2O	Nitrate-N	P_2O_5	K_2O
Number of sub-samples					
18	21	5	6	8	2
Nutrient range (lb/acre)					
45-61	32-45	463-626	40-66	30-68	408-680

[1] Adapted from Swenson et al., 1984

For a home garden mix 10 samples into 1 composite per 1000 ft ^{2}, more if very different 'zones'



Source: Dan Long
Location: Liberty County

Why is N tested to 2 feet and P and K to only 6 inches?

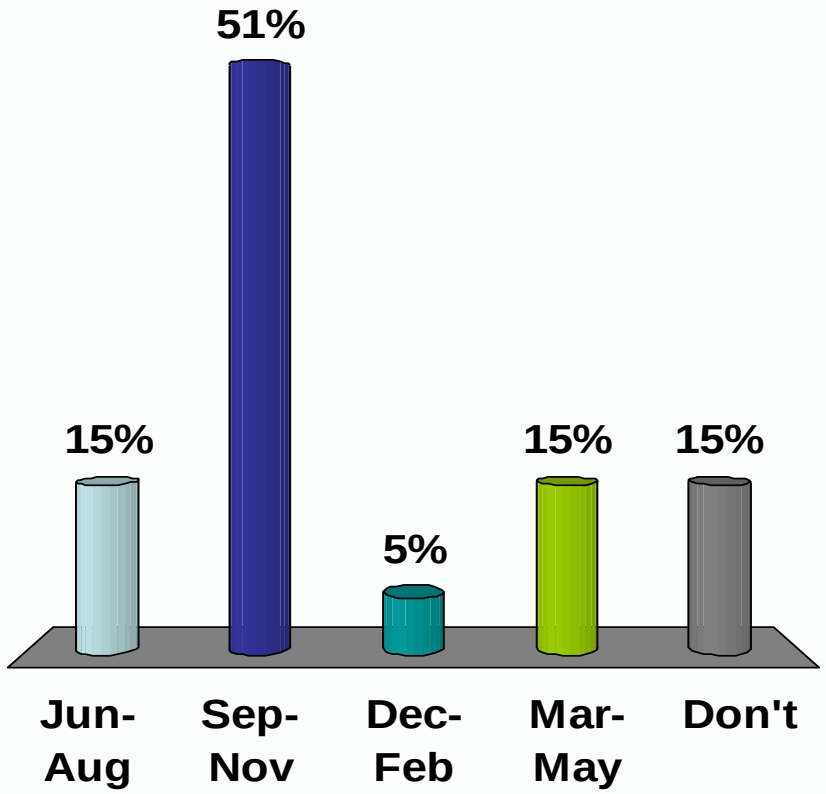
- N can easily move to 2 feet (and beyond) and the lower depths often have substantial amounts of N.
- P and K fertilizer generally stay in upper ½ foot and amounts are often very low below there.

Timing of soil sampling

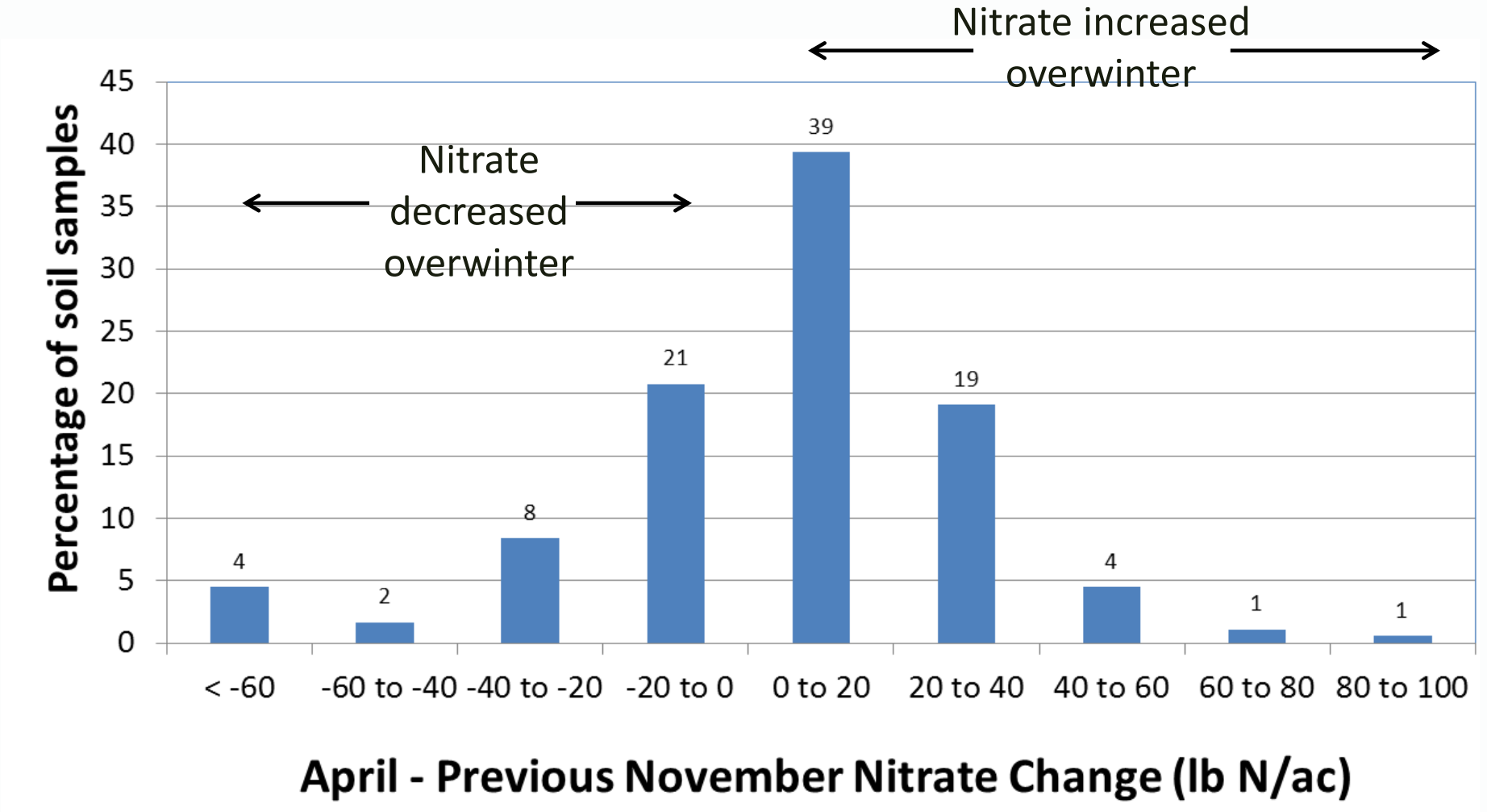
- Nitrogen fertilizer guidelines are based on spring soil samples for nitrate in Montana
- BUT, most sampling in MT occurs from late summer to late fall

Based on 35 ‘clicker’ responses at MABA 2010 Convention, when asked when crop advisers do most of their soil sampling:

Why is this a potential problem?



November to April nitrate changes, Montana data based on 180 samples (Jones et al. 2011)



Soil sampling timing summary

- Changes in nitrate levels from late summer/fall to spring can be large and highly variable
- High nitrate levels on shallow coarse soils can be lost overwinter, resulting in under-fertilization
- Nitrate levels can increase overwinter (from ‘mineralization’), resulting in over-fertilization
- Sampling later will better represent growing season nitrate levels

Sample handling

- Remove surface residue from sample location
- Break up clumps and thoroughly mix subsamples from each depth increment
- Place subsample from this mix into glass jar or plastic lined soil sample bag
- Store below 40°F or dry at 110-120°F to stop microbial activity which changes soil nutrient levels
- Deliver or over-night ship to lab
- Clean and store equipment between sampling and away from dust/dirt/fertilizers

Lab selection

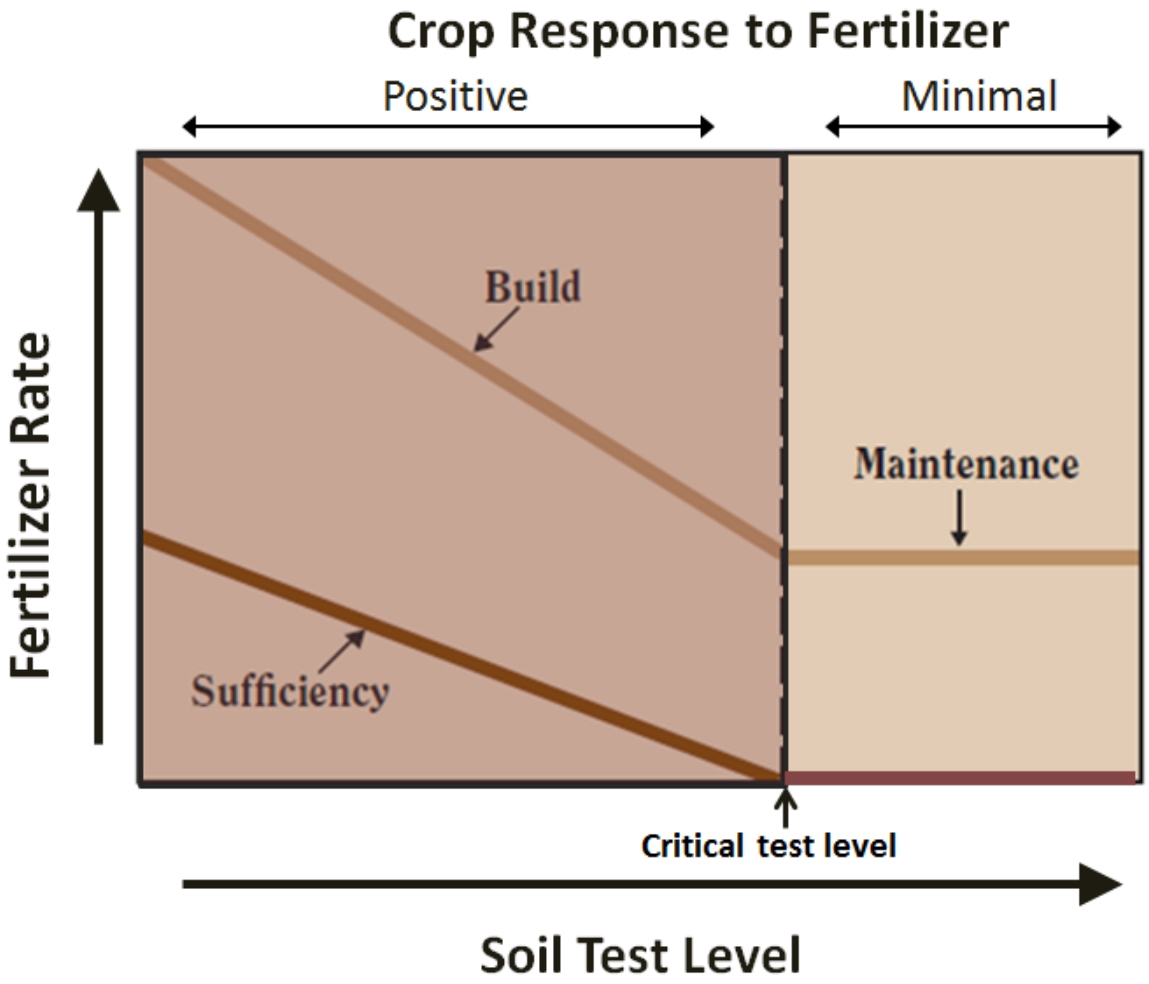
- High degree of variability among labs
- Get the right test for our soils – Olsen P, not Bray P
- Select lab with a proficiency testing program (ALP, NAPT) for accuracy (how close to true value) and precision (how repeatable)
- Use same lab over time

Lab selection (cont)

If you use the lab's recommendations:

- Did you provide realistic yield goals to help lab make accurate recommendations?
- Is recommendation based on:
  - State or region specific guidelines
  - On sufficiency, build, or maintenance approach

Fertilizer recommendation philosophies and crop yield response



Sufficiency - Minimum necessary to maximize yield in most years

Maintenance - Replace nutrients removed at harvest

Build - Build nutrients to minimize yield losses and save on fertilizer in future years

Soil health tests

- Measure and monitor over time or between fields
- Useful to assess effect of management or evaluate problem areas
- Standardized methods may not yet be in place
- Currently no calibration between test values and fertilizer recommendations for N. Great Plains
- See NRCS for info on soil health

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/health/

Soil health test measurements

- Chemical characteristics – e.g. Potentially mineralizable N (PMN) – amount of organic N that can be converted to plant available N
  - Has direct influence on N fertilizer rates, but not calibrated for our region
- Physical indicators, e.g.
  - Available water holding capacity (AWHC)
  - Aggregation
- Biological indicators, e.g.
  - Soil respiration
  - Solvita microbial activity

Improving physical and biological indicators improves soil's potential to supply water and nutrients. See The Soil Scoop next week on SF website for more info.
http://landresources.montana.edu/soilfertility/

Haney test – incorporates several of the above and more

- Haney test: "Solvita C respiration", dissolved ("water extractable") organic and inorganic carbon (C), N and P
- "Standard" test: SOM, pH, nitrate, Olsen P, K, Ca, Mg, sodium, S, Zn, CEC

How much does test explain winter wheat yield variability?

- Haney (15%) - Dissolved organic C most important variable
- "Standard" (25%) - 6 – 24" Nitrate most important variable
- Haney + "Standard" (39%) - 6 – 24" Nitrate most important

For now, Haney soil tests appear no better related to ww grain yield than standard tests, but combination is better than standard tests alone (Jones and Boss, 2014 unpub data, Conrad, MT).

Questions?

Soil test interpretation

What are the first things to look for on a soil test report?

Factors affecting crop production

Factor	Value	Impact/consider
Soil organic matter	≤ 1 (%)	Minimize fallow, add a perennial, increase N
	> 3 (%)	N credit (~15 lb N/ac)
Soil pH	< 6	Poor legume nodulation
	> 8.3	Sodic soil, nutrients tied up
Soluble salts (EC)	> 4 (mmhos/cm)	Too saline, water stress, nutrient imbalance

Figure 3. Sample Soil Test Report and Fertilizer Recommendations

Name: Producer		**Sample Date:** April 1, 2007		
Lab Number: 12345		**Your Sample Number:** 1		
Crop to be Grown: Spring Wheat		**Previous Crop:** Fallow		
Sampling Depth: 0 to 24 inches		**Yield Goal:** 50 bu/acre		
Soil Test Results			**Interpretation**	**Recommendation**
Nitrate-N	0-6 in	37 lb/acre		
	6-24 in	36 lb/acre		
	0-24 in	73 lb/acre	Medium	90 lb N/acre
Olsen Phosphorus	0-6 in	15 ppm	Medium	20 lb P_2O_5/acre
Potassium	0-6 in	192 ppm	Medium	40 lb K_2O/acre
Sulfate-S	0-6 in	6 lb/acre		
	6-24 in	54 lb/acre		
	0-24 in	60 lb/acre	High	———
Boron	0-6 in	0.5 ppm	Medium	1 lb B/acre
Copper	0-6 in	1.7 ppm	Very High	———
Iron	0-6 in	47 ppm	Very High	———
Manganese	0-6 in	10 ppm	Very High	———
Zinc	0-6 in	1.3 ppm	High	———
Soluble Salts	0-6 in	0.3	Low	———
Organic Matter	0-6 in	3.4%	Medium	———
Soil pH	0-6 in	7.7	Medium/High	———
CEC	0-6 in	17.8	Medium	
Soil Texture	0-6 in	Sandy Loam		

Soil Nutrients

Limiting soil nutrient levels

Nutrient	Limiting level in top 6 inches (ppm)
N	Crop and yield goal dependent
P	16
K	250
S	Not available –tissue testing better
B	1.0
Cl	30 lb/ac in top 2 feet
Cu	0.5
Fe	5.0
Mn	1.0
Zn	0.5

Table 1. *Interpretation of Soil Test Reports for Agriculture* (MT200702AG)

REPORT NUMBER
14-153-0179
COMPLETED DATE
Jun 4, 2014
ACCOUNT
20532
RECEIVED DATE
Jun 2, 2014

Midwest Laboratories Inc.®
13611 "B" Street • Omaha, Nebraska 68144-3693 • (402) 334-7770 • FAX (402 334-9121
www.midwestlabs.com

TODAY'S DATE
Jun 04, 2014

MSU EXTENSION- TOOLE COUNTY
JOE PARKS
226 1ST ST SOUTH
SHELBY MT 59474

SOIL ANALYSIS REPORT

LAB NUMBER *267*	SAMPLE IDENTIFICATION	ORGANIC MATTER L.O.I. percent	RATE	PHOSPHORUS P_1 (WEAK BRAY) 1:7 ppm	RATE	PHOSPHORUS P_2 (STRONG BRAY) 1:7 ppm	RATE	OLSEN BICARBONATE P ppm	RATE	NEUTRAL AMMONIUM ACETATE (EXCHANGEABLE) POTASSIUM K ppm	RATE	MAGNESIUM Mg ppm	RATE	CALCIUM Ca ppm	RATE	SODIUM Na ppm	RATE	pH SOIL pH 1:1	BUFFER INDEX	CATION EXCHANGE CAPACITY C.E.C. meq/100g	PERCENT BASE SATURATION (COMPUTED) % K	% Mg	% Ca	% H	% Na
16192	LINDA	4.6	VH					70		186	H	566	VH	2607	H	88	M	8.1		18.6	2.6	25.4	69.9	0.0	2.1

LAB NUMBER *267*	NITRATE-N (FIA) SURFACE ppm	SURFACE lbs/A	SURFACE depth (in)	SUBSOIL 1 ppm	SUBSOIL 1 lbs/A	SUBSOIL 1 depth (in)	SUBSOIL 2 ppm	SUBSOIL 2 lbs/A	SUBSOIL 2 depth (in)	Total lbs/A	SULFUR S ICAP ppm	RATE	ZINC Zn DTPA ppm	RATE	MANGANESE Mn DTPA ppm	RATE	IRON Fe DTPA ppm	RATE	COPPER Cu DTPA ppm	RATE	BORON B SOIL. DTPA ppm	RATE	EXCESS LIME RATE	SOLUBLE SALTS 1:1 mmhos/cm	RATE
16192	4	7	0-6							7													L	0.3	L

What stands out to you?
What might you suggest to gardener?

REV. 12/03

What do ‘Olsen P’ and ‘soil test K’ mean on my lab results?

- They are measures of ‘plant-available’ P and K and are determined by adding extractants to the soil and measuring P and K in solution. The result is the sum of soluble nutrient PLUS weakly bound nutrient.

Why is ‘soluble’ N measured, rather than extracted like P and K?

- Nitrate-N is so soluble, that the concentration in solution is about equal to what is plant available at that point in time.

Nutrient levels and calculations are discussed in ‘rate’ presentation, later.

Summary

- Soil tests can increase yield and/or save on fertilizer costs, and decrease environmental risks
- Zone vs. grid sampling depends on the history and diversity of the field
- Soil tests for N are best done in the spring, can be done in fall for P and K, and not worthwhile for S
- Soil *health* tests are useful to assess management or problem areas, but currently no calibration between tests and fertilizer recommendations

Questions?

For more information: see Extension publications at http://landresources.montana.edu/soilfertility/

Home Garden Soil Testing & Fertilizer Guidelines (MT200705AG)

Soil Sampling Strategies (MT200803AG)

Interpretation of Soil Test Reports for Agriculture (MT200702AG)

Soil Sampling and Laboratory Selection (4449-1) revision on-line soon http://landresources.montana.edu/NM/