Soil Testing & Plant Analysis

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4 Steps in the soil testing-nutrient recommendation system

1. Collect soil samples
2. Determine the nutrient availability of the soil represented by the samples (soil test)
3. Interpret the soil test results (soil test calibration)
4. Estimate the quantity of nutrient required by the crop (nutrient recommendation)

Soil Sampling

Minimum Requirements

- Follow recommendations in UWEX A2100
- How will the data be used?
  - One recommendation per field – whole field
  - Variable rate application – grid

At least 10 cores per sample

Whole Field – Sampling Intensity

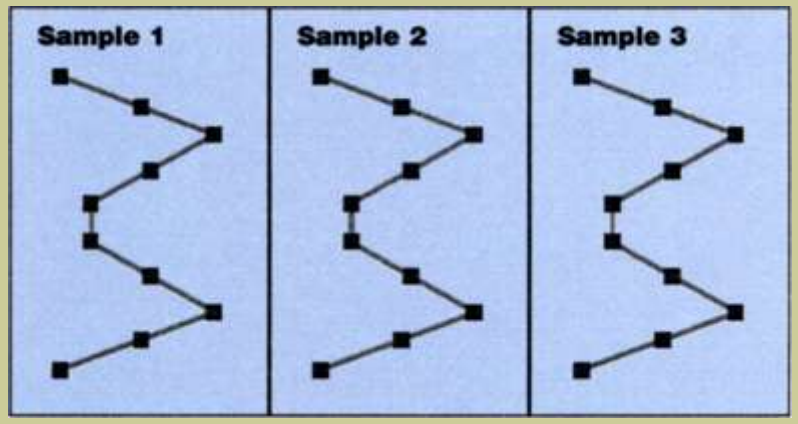
Field characteristics	Field size (acres)	Suggested number of samples
Fields tested > 4 years ago; *or* Fields testing in responsive range	All fields	1 sample/ 5 acres
Non-responsive fields tested ≤ 4 years ago	5 – 10	2 samples/ field
	11 – 25	3 samples/ field
	26 – 40	4 samples/ field
	41 – 60	5 samples/ field
	61 – 80	6 samples/ field
	81 - 100	7 samples/ field

- Responsive range is where either soil test P or K are in the high (H) category or lower
- Non-responsive range is where both soil test P & K are in the very high (VH) or excessively high (EH) category

Whole Field – Specific sampling details in A2100

- Proper tools
- Depth
- Pattern / location
- Frequency
- Special situations
  - Tillage
  - Contour strips

- Sampling pattern for 15 acre field with past soil tests in responsive range

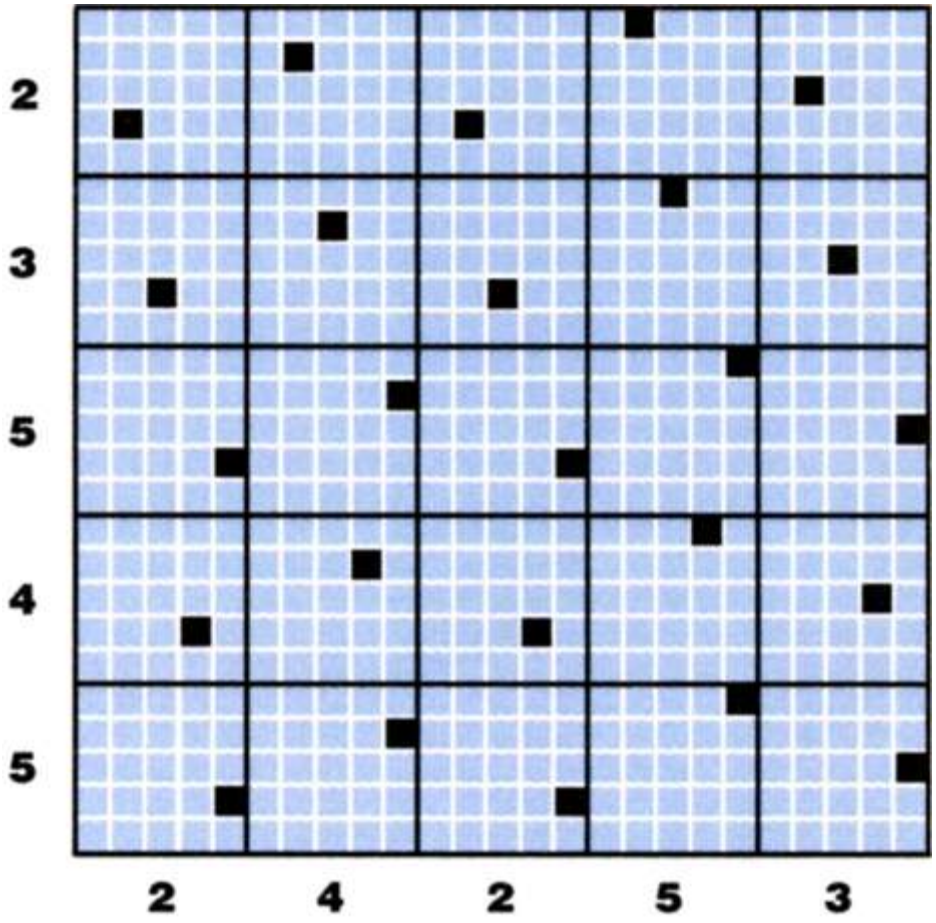


- Each sample should be composed of at least 10 cores

Grid

- Unaligned systematic grid point method
  - 300’ (2.1 acre) grid – if both P & K are in non-responsive categories (VH & EH)
  - 200’ (0.92 acre) grid – if either P or K are in responsive categories (below H)

Grid



- Sample locations have GPS coordinates
- Sample consists of at least 10 cores composited within a 10’ radius of grid point

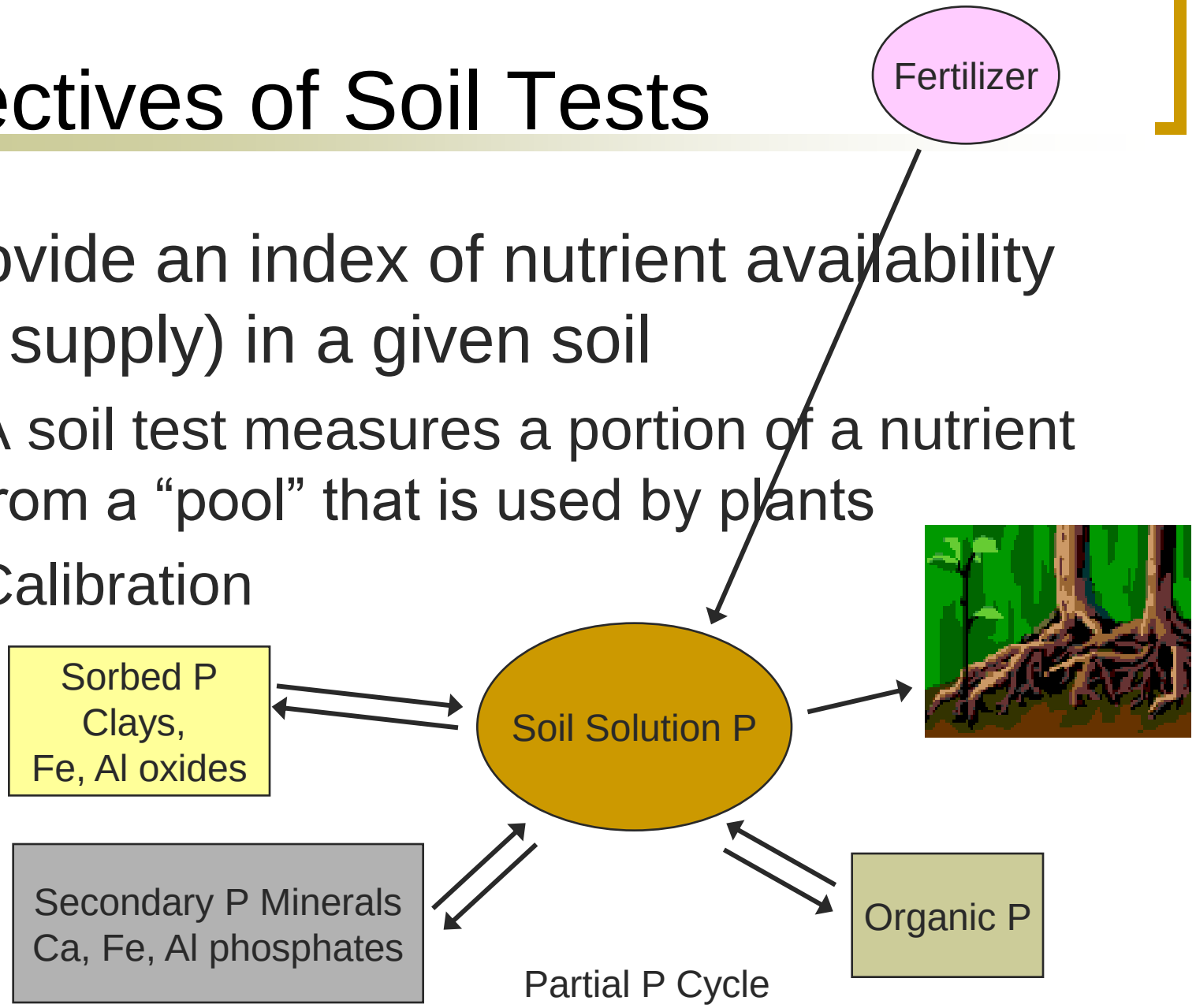
Soil Testing

What is a soil test?

- A chemical method for estimating the nutrient supplying capacity of a soil
  - Measures a portion of a nutrient from a “pool” that is used by plants
    - An index of nutrient availability
  - *Does not measure the total amount of a nutrient in the soil*
  - Needs to be calibrated in field/greenhouse rate studies to then use in nutrient (fertilizer) recommendations
- Can determine soil’s nutrient status before a crop (field, vegetable, ornamental) is planted

Objectives of Soil Tests

1. Provide an index of nutrient availability (or supply) in a given soil
   - A soil test measures a portion of a nutrient from a “pool” that is used by plants
   - Calibration



Objectives of Soil Tests

2. Predict the probability of obtaining a profitable response to lime and fertilizer
   - On low testing soils, a response to applied nutrients may not always be obtained because of other limiting factors (moisture, pH, other nutrients)
   - *BUT* the probability of a response to nutrient additions on low testing soils is greater than high testing soils
   - Correlation

Objectives of Soil Tests

3. Provide a basis for recommendations on the amount of lime and fertilizer to apply
   - Relationships obtained through laboratory, greenhouse, and field studies

Overriding Goal of Soil Testing

- To obtain a value that will help to predict the amount of nutrients (fertilizer) needed to supplement the nutrient supplying capacity of the soil such that maximum economic yield is achieved
  - Now, and more so in the future, we will need to balance environmental degradation with economics

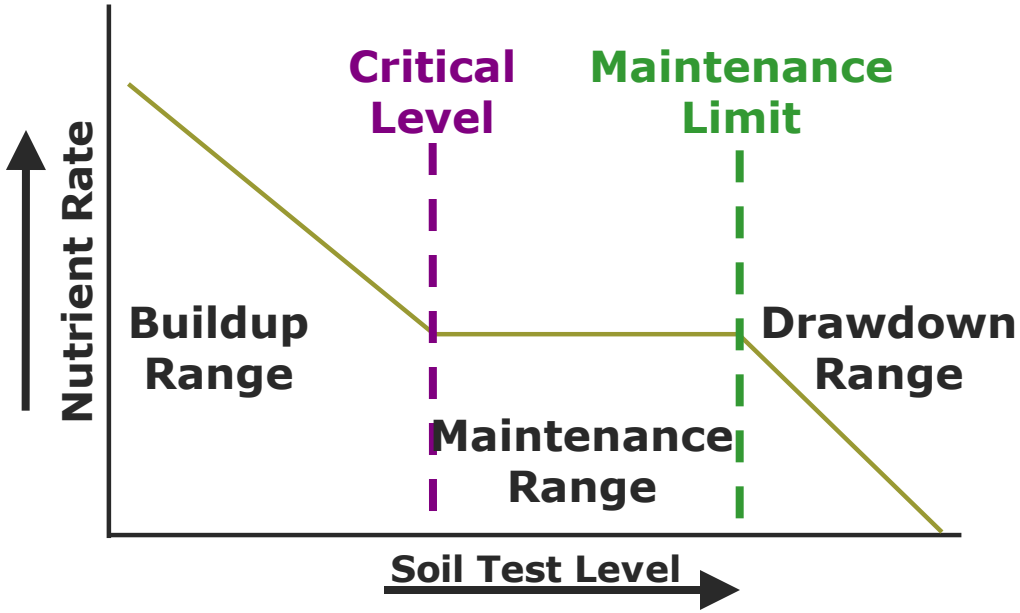
Nutrient Recommendation Philosophies

- Build and Maintain
- Sufficiency Level
- Cation Ratio/Balance

- For immobile nutrients
  - Primarily P & K, not N

Build and Maintain

- Goal: Apply nutrients such that soil tests are built up to a certain level and then maintained within a range

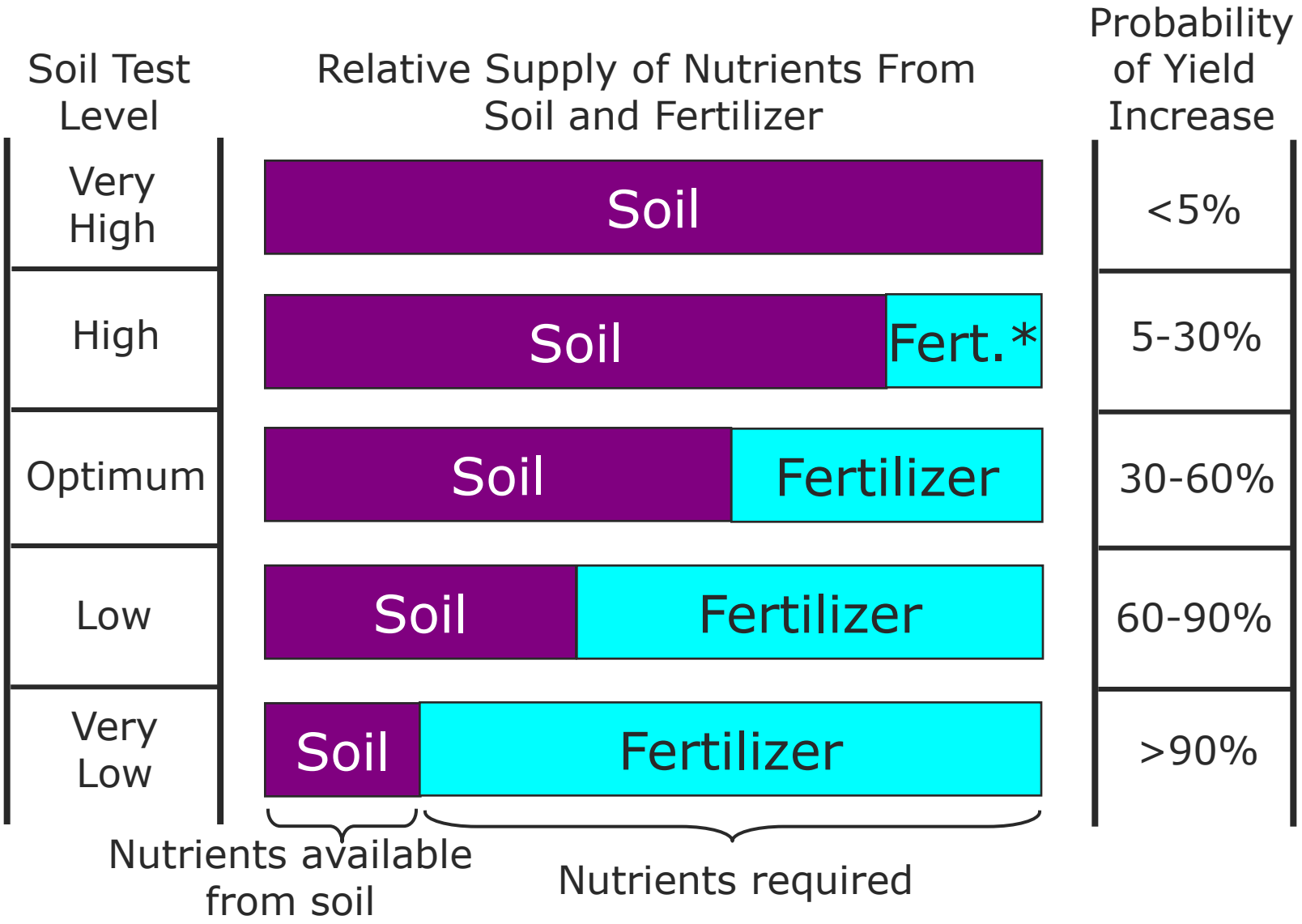


- Feed the soil theory
- Provides a margin of safety to compensate for differential crop response

Sufficiency Level

- Soil test levels established & identified by likelihood of a crop response
  - Low soil test = crop response assured
  - Medium soil test = crop response possible
  - High soil test = crop response marginal
  - Very high soil test = crop response unlikely
- Nutrient recommended only for low through high soil tests
- Fertilize the crop theory

Soil Test Interpretation Categories



* Fertilizers used at high soil test levels are for starter or maintenance purposes

Relationship Between Soil Test and Fertilizer Recommendations in WI

Soil Test Category	Recommendations
Very Low, Low	Crop removal +
Optimum	Crop removal
High	½ Crop removal
Very High	¼ Crop removal
Excessively High	None

Basic Cation Saturation Ratios (BCSR)

- Concept that there is an ideal ratio or range of ratios that maximizes crop production
  - Eg. 65-85% Ca, 6-12% Mg, 2-5% K
- Research in WI does not support this theory
- Relying on cation ratios has several drawbacks:
  - OK ratio, but nutrient supply not sufficient
  - Not OK ratio, but nutrient supply sufficient
  - No economic analysis goes into recommendations that use the cation ratio approach

Quotes from BCSR Researchers

1. "Basic cation ratios per se seem unimportant to the well-being of the crop. Indeed, it appears that instead we should concentrate on sufficiency levels of each basic cation."

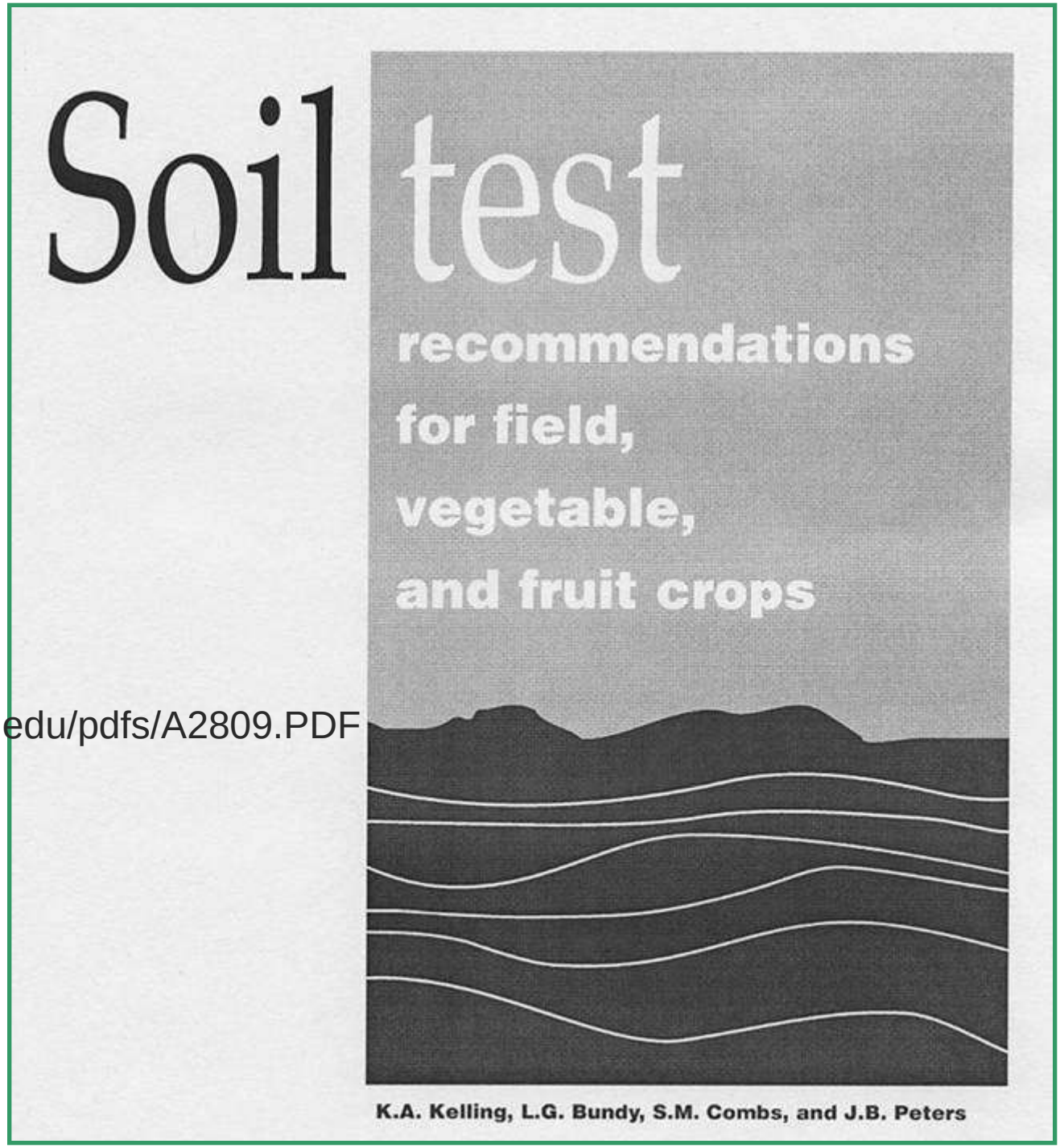
   E.O. McLean, 1982

2. Emphasis should be placed on providing sufficient, but non-excessive levels of each basic cation rather than attempting to adjust to a favorable BCSR which evidently does not exist.

   McLean et al., 1983

A2809

http://cecommerce.uwex.edu/pdfs/A2809.PDF



Field size

Soil & field name

Yield goal

Recommendation

Soil test interpretation categories

Soil test values

Samples Analyzed By:

SOIL TEST REPORT

COOPERATIVE EXTENSION
University of Wisconsin-Extension
University of Wisconsin-Madison
Department of Soil Science

LAB #: 102

County: Winnebago
Account No.: 1
Date Received: 7/21/2005
Date Processed: 7/21/2005
Slope: 5%
Acres: 30
Plow Depth: 7"
Soil Name: Lorenzo
Field Name: White

This Report is for:
Badger Acres

NUTRIENT RECOMMENDATIONS

Cropping Sequence	Yield Goal	Crop Nutrient Need			Fertilizer Credit				Nutrients to Apply		
		N	P2O5	K2O	Legume N	Manure N	P2O5	K2O	N	P2O5	K2O
	per acre	lbs/a			lbs/a	lbs/a			lbs/a		
Red Clover	1.5-2.5 tons	0	0	50	0	0	0	0	0	0	50
Red Clover	2.6-3.5 tons	0	0	75	0	0	0	0	0	0	80
Corn, grain	131-150 bu	120	0	20	90	0	0	0	30	0	20
(no crop)	n/a										

The lime required for this rotation to reach pH 6.3 is 4 T/a of 60-69 lime or 3 T/a of 80-89 lime.

ADDITIONAL INFORMATION

If lime has been applied in the last two years, more lime may not be needed due to incomplete reaction.

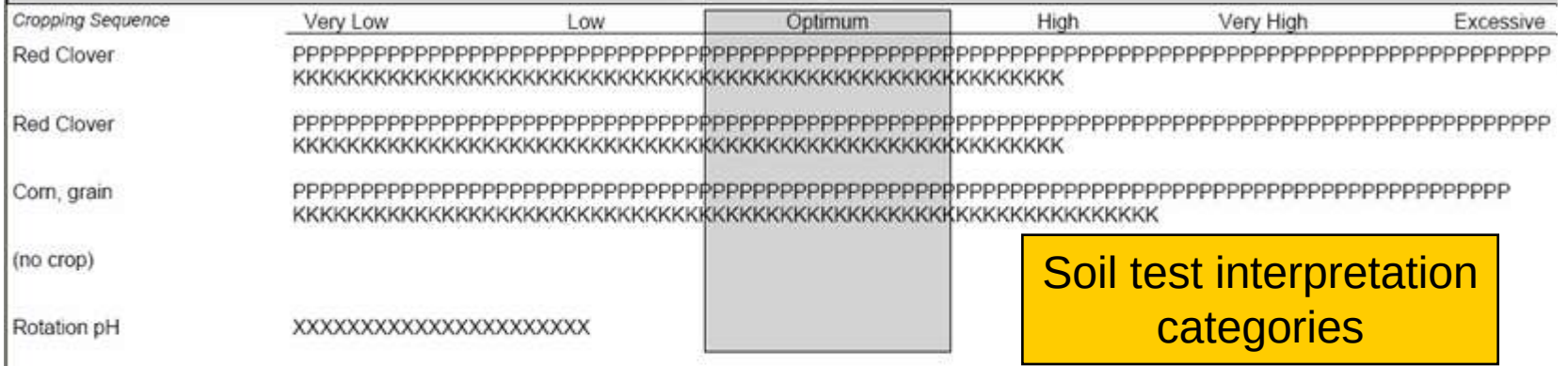
Year 3: If corn harvested for silage instead of grain apply extra 90 lbs K2O per acre to next crop.

Starter fertilizer (e.g. 10+20+20 lbs N+P2O5+K2O/a) is advisable for row crops on soils slow to warm in the spring.

A soil nitrate test may better estimate actual corn needs.

If conservation tillage leaves more than 50% residue cover when corn follows after corn, add an additional 30 N lbs/a.

TEST INTERPRETATION



LABORATORY ANALYSIS

Sample Identification	Soil pH	O.M %	Phosphorus ppm	Potassium ppm	Calcium ppm	Magnesium ppm	Estimated CEC	Boron ppm	Manganese ppm	Zinc ppm	Sulfate-Sulfur ppm	Sulfur Avail. Index	Texture Code	Sample Density	Buffer Code
4	5.8	3.3	35	110									2	0.00	6.2
5	5.7	3.4	39	135									2	0.00	6.1
6	5.9	3.4	45	114									2	0.00	6.3
7	5.8	3.4	48	149									2	0.00	6.1
Adjusted Averages	5.8	3.4	40	120											

Plant Analysis Uses

- Identify deficiency symptoms
  - Determine nutrient shortages before they appear as symptoms
- Aid in determining nutrient supplying capacity of the soil
  - Need soil test and field history
- Aid in determining effect of nutrient addition on the nutrient supply in the plant
- Study the relationship between nutrient status of plant and crop performance

Types of Plant Analysis

- Cell sap tests
  - Usually in-field, quick tests, semiquantitative
- Total analysis
  - Lab tests on whole plant or specific part
    - Sampled part may be dependent on growth stage
  - Provides an indicator of plant nutritional status
  - Assumes nutritional status is related to soil nutrient availability

Tissue Sampling

- What to sample
- When to sample
- Sample handling
  - Refrigerated (kept cold)
  - Removal of contaminants (soil, dust, fertilizer)
- Interpretation

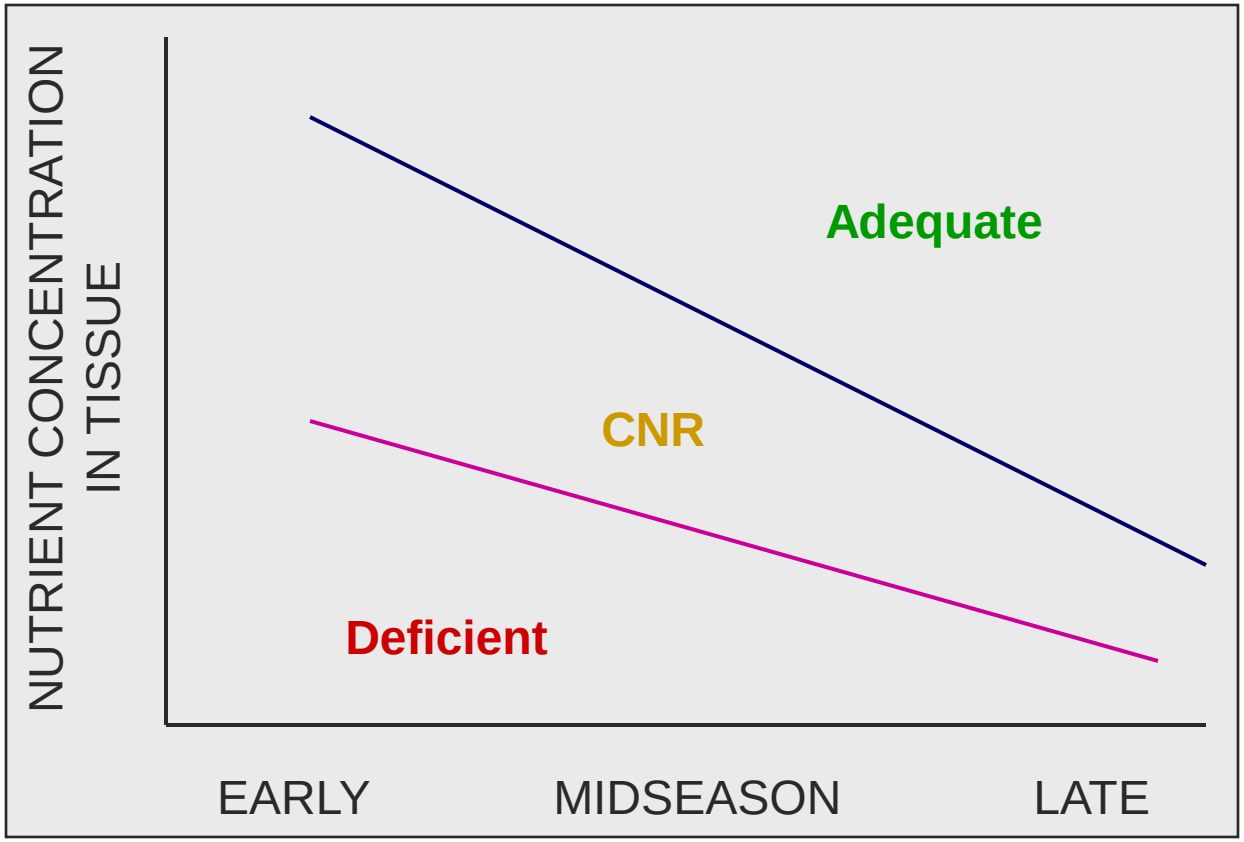
What & When to Sample

Table 12-13. Proper plant sampling for diagnostic plant analysis

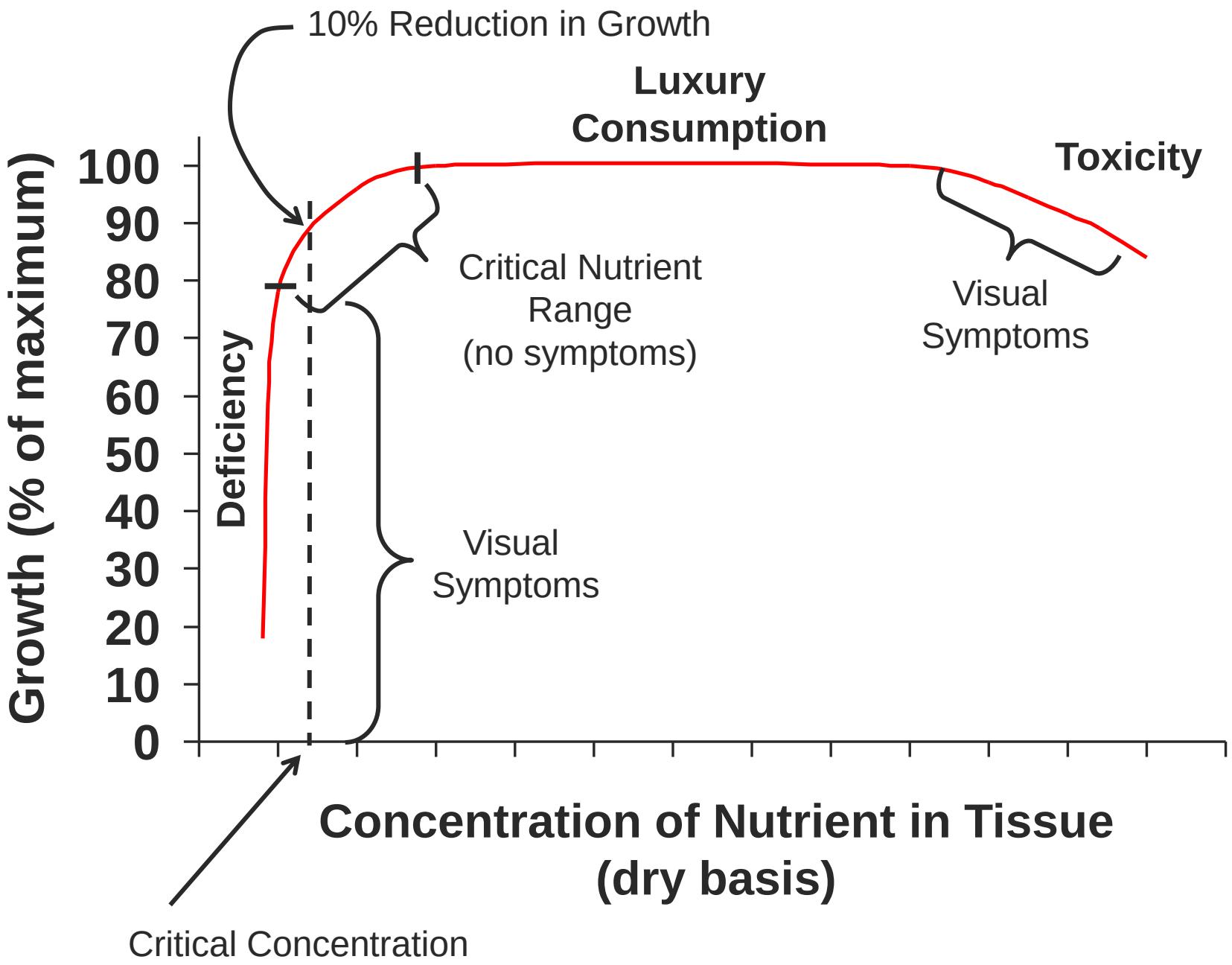
Crop	Stage of growth	Plant part	Number of plants to sample
Alfalfa, birdsfoot trefoil, clover	Prior to flowering	Top 6 inches	35
Asparagus, onion	Boot	Top 6 inches	20
Bean, pea	Prior to or at initial flowering	Newest fully developed leaf	25
Beets, broccoli, brussels sprouts, cabbage, carrot, cauliflower, celery, lettuce, radish, spinach, tobacco	Midseason	Upper mature leaves	20
Corn	a) Seedling to 20 inches high b) 20 inches high to flag leaf c) Tasseling to silking	Whole plant above ground Newest fully developed leaf Earleaf or opposite & below	20 15 15
Cucumber, melon, pumpkin, squash	Prior to or at initial flowering	Newest fully developed leaf	25
Forage (grasses, grains)	Prior to heading	Newest fully developed leaf	50
Mint	Boot	Whole plant	20
Pepper, potato, tomato	Prior to or at initial flowering	Newest petiole and leaflet	40
Sorghum (grain, sudan)	Prior to heading	Second fully developed leaf	20
Apple, cherry, pear, plum	Current season's shoots taken July 1–15	Fully developed leaf at midpoint of new shoots	4 leaves from each of 10 trees
Grape	Bearing primary shoots	Petioles from newest leaves	5 petioles from each of 10 vines
Strawberry	Current season's shoots	New petioles and leaves	5 parts from each of 10 plants

Table 12-13 in Management of WI Soils (A3588)

Relationship between nutrient concentration in leaves over the growing season



Redrawn from Havlin et al., 2005



Redrawn from Havlin et al., 1999

Tissue Test Interpretation

- Critical nutrient concentration ranges (sufficiency ranges)
  - Using Plant Analysis as a Diagnostic Tool

    see New Horizons in Soil Science 2000

    http://www.soils.wisc.edu/extension/publications/horizons/index.htm
- DRIS (Diagnostic & Recommendation Integrated System)
- PASS (Plant Analysis with Standardized Scores)

Correction of deficiencies identified with tissues tests may not be feasible because:

- Deficiency may have already caused yield loss
- Crop may not respond at the growth stage tested
- Crop may be too large for nutrient application
- Weather may be unfavorable for fertilization and/or for crop to benefit

From Havlin et al., 2005

Using plant analysis to help diagnose a field problem

- **Not a clear cut tool**
- Need to collect all the evidence:
  - Nutrient deficiency symptoms
  - Root growth patterns
  - Weather
  - Current field conditions
  - Field history
  - Tissue analysis
  - Soil analysis


Don’t Guess
Soil Test !