Title: Soil Fertility Evaluation
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Unit 2, lesson 1

In preparation for Stage 2 Team Project

Soil Fertility Evaluation

Sampling and analytical methods

Soil Fertility Evaluation Objectives

- Assess nutrient status of soil-crop system
- Diagnose suspected nutrient imbalances
- Monitor effects of management on crop nutrient status, soil fertility

More Objectives

- Provide basis for making fertilizer recommendations for
  - Improving yield and quality
  - Improving fertilizer use efficiency
  - Decreasing impacts on water and air quality, climate change
  - Assess availability of toxic elements
  - Improve soil quality

Tools of Soil Fertility Evaluation

- Visual analysis for deficiency symptoms
- Plant testing
- Soil testing
- Plant response experiments

Steps in Plant Testing

- Plant sampling
- Plant analysis
- Correlation: research defined relationships between nutrient conc. and relative yields or quality.

Sampling Criteria

- Time of sampling (plant developmental stage)
- Plant part to sample
- Number of plants or plant parts

Sample handling

- Wash
- Minimize exposure to contaminants during storage, processing.
- Preservation: dry if plant analysis; keep cold if tissue testing.

Types of Plant Testing

1 . Total analysis: chemical analysis of whole plant or plant parts. Total nutrient concentration is determined on *dried tissue* by volatilizing everything but the mineral components by chemical or high temperature oxidation.

Types of Plant Testing

2 . Tissue testing: Analysis of a specific soluble pool (fraction) of a nutrient in the tissue **sap**, often performed on *fresh tissue (leaves, stems or petioles)*.

*****Rapid analysis for in-season monitoring and fertilizer management adjustments***

Types of Plant Testing

- 3. Leaf reflectance: non-destructive evaluation of leaf color: quantitative relationships between reflectance and nutrient conc.

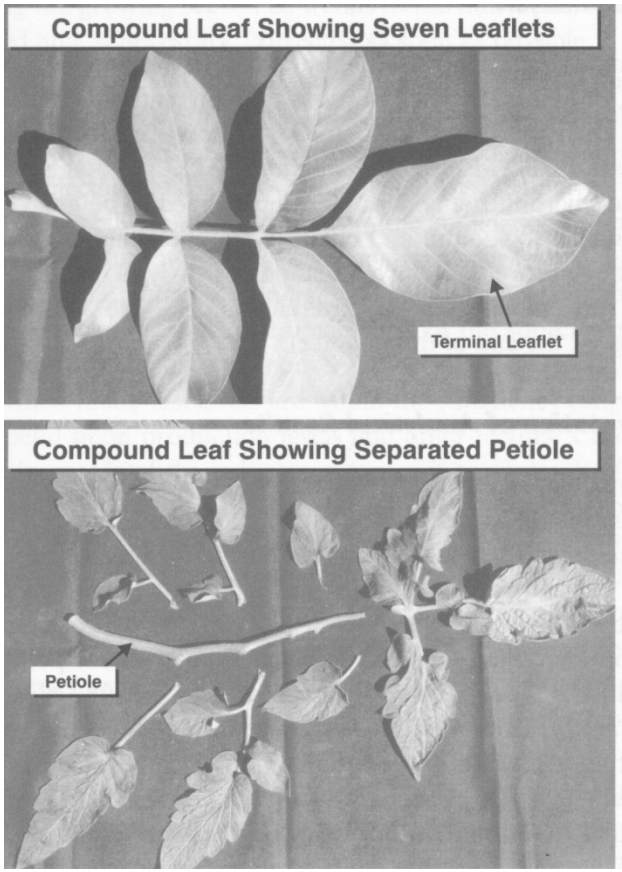
“chlorophyll meter”

Critical Nutrient Concentrations or Range

- Elemental concentrations identify toxicity, sufficiency and deficiency ranges.

Plant Sampling

- Sample plant parts specified in the comparative database.



From Ludwick, A. et al. 2002. Western Fertilizer Handbook. Interstate Publishers, Inc. Danville, IL

Plant Nutrient Diagnosis

- Note the specifications for plant parts.
- Petioles subjected to tissue testing
- 4th leaf analyzed for total concentrations
- What is the trend with plant maturation?

Tomato—Determinate Processing or Fresh Market Early flowering	Petiole of fourth leaf from growing tip	NO_3-N PO_4-P K	9,000–12,000 ppm 3,000–4,000 ppm 6.0–8.0%
	Fourth leaf from growing tip	N P K Ca	4.6–5.2% 0.32–0.49% 2.2–3.5% 1.9–4.1%
Early green fruit (1-inch diameter)	Petiole of fourth leaf from growing tip	NO_3-N PO_4-P K	6,000–8,000 ppm 2,500–3,500 ppm 4.0–6.0%
	Fourth leaf from growing tip	N P K Ca	3.5–4.5% 0.25–0.41% 2.0–3.1% 1.8–3.6%
Early ripe fruit	Petiole of fourth leaf from growing tip	NO_3-N PO_4-P K	3,000–6,000 ppm 2,000–3,000 ppm 3.0–4.0%
	Fourth leaf from growing tip	N P K Ca	2.7–3.8% 0.23–0.37% 0.8–2.0% 2.4–4.1%

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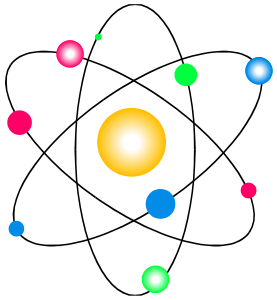
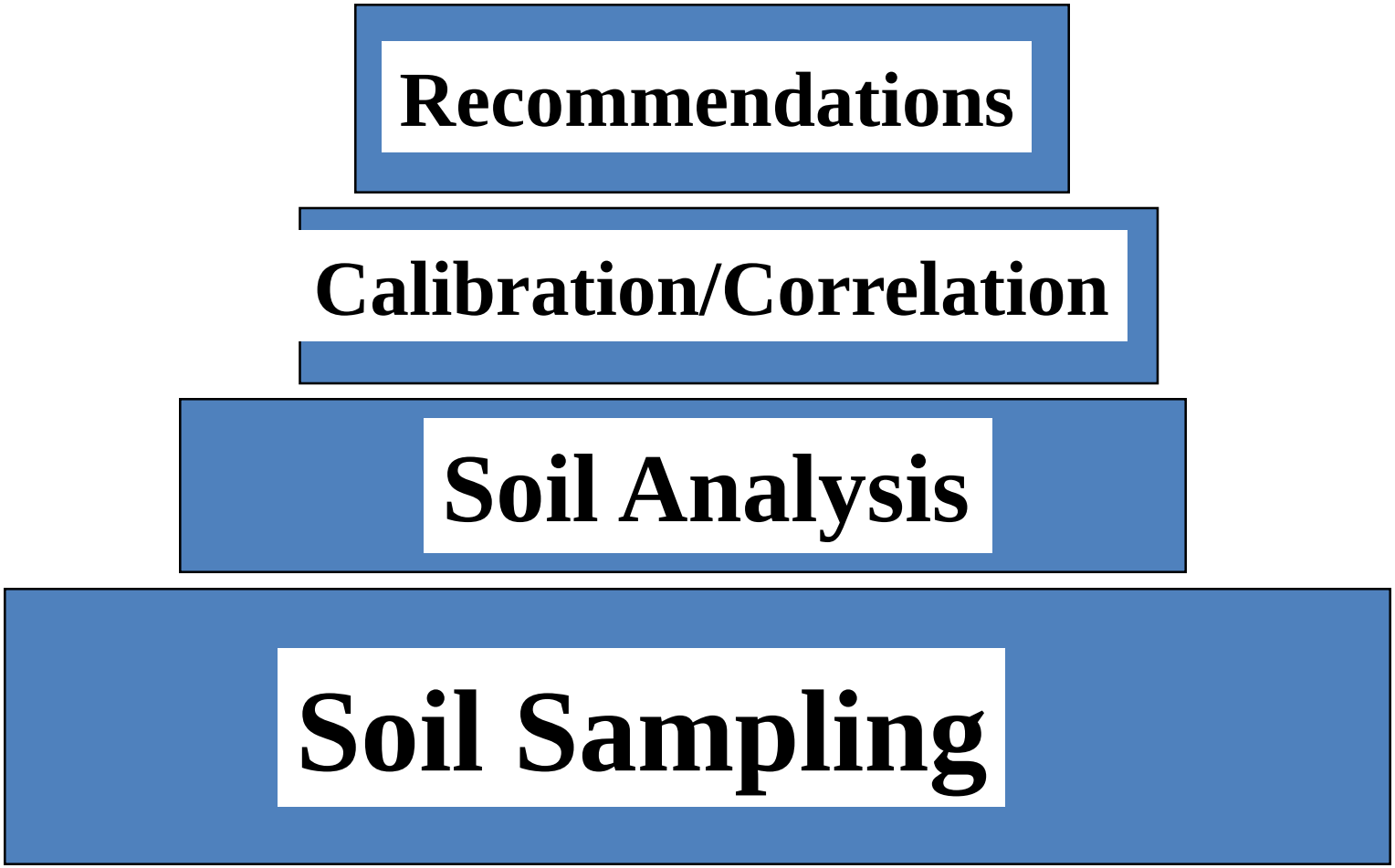
Modern Soil Testing Methods Have Been Developed Over The Last 50 Years



- Chemical methods for estimating nutrient-supplying power of soils.
- Provide basis for predicting the probability of obtaining an economic crop response to nutrient and other soil amendments.
- Provide indicators of soil quality.

Steps in Soil Testing

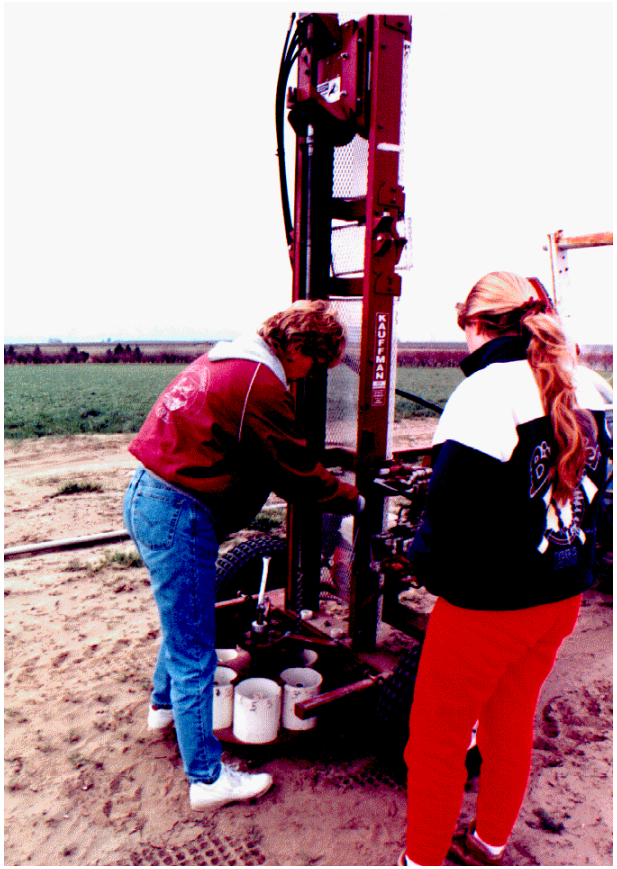


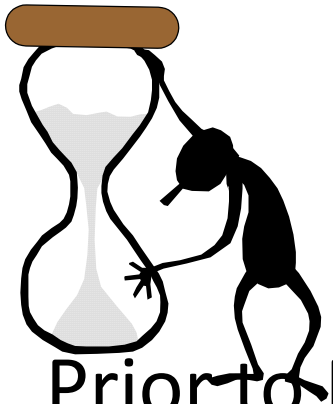
Soil Sampling

- The most critical step (and the most subject to large errors).
- 1 lb of soil is often used to represent 2-10 million lbs.

Important Questions to Ask Before Soil Sampling

- How to sample a large field with a small subsample?
- Depth of sampling?
- Time of sampling?
- Sample handling before analysis?





Time of Sampling

- Prior to Fertilization or Seeding for Predicting Fertilizer Requirements.
- In-season to monitor movement or mineralization/immobilization.

Sample Handling

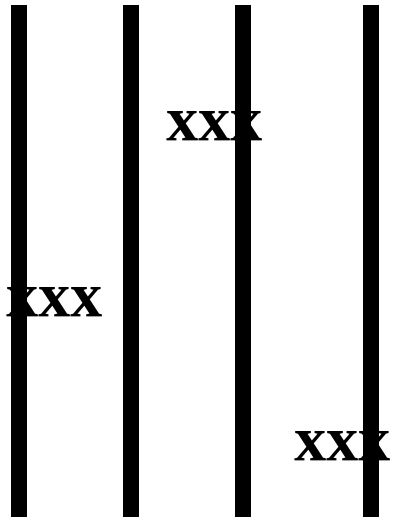
- Avoid contamination, e.g. don’t use a metal bucket when sampling for micronutrients; some wax lined bags have N residues.
- Keep samples cool for elements that undergo microbial transformations, such as N and S.

Depth of Sampling

- Tillage layer (0 to 6”) for most nutrients other than N and S.
- To depth of effective rooting for mobile nutrients N and S.
  - 6 ft winter cereals; 4 ft spring cereals
  - 1 to 2 ft for irrigated potatoes.
- Sample subsoil to examines limits on soil productivity.

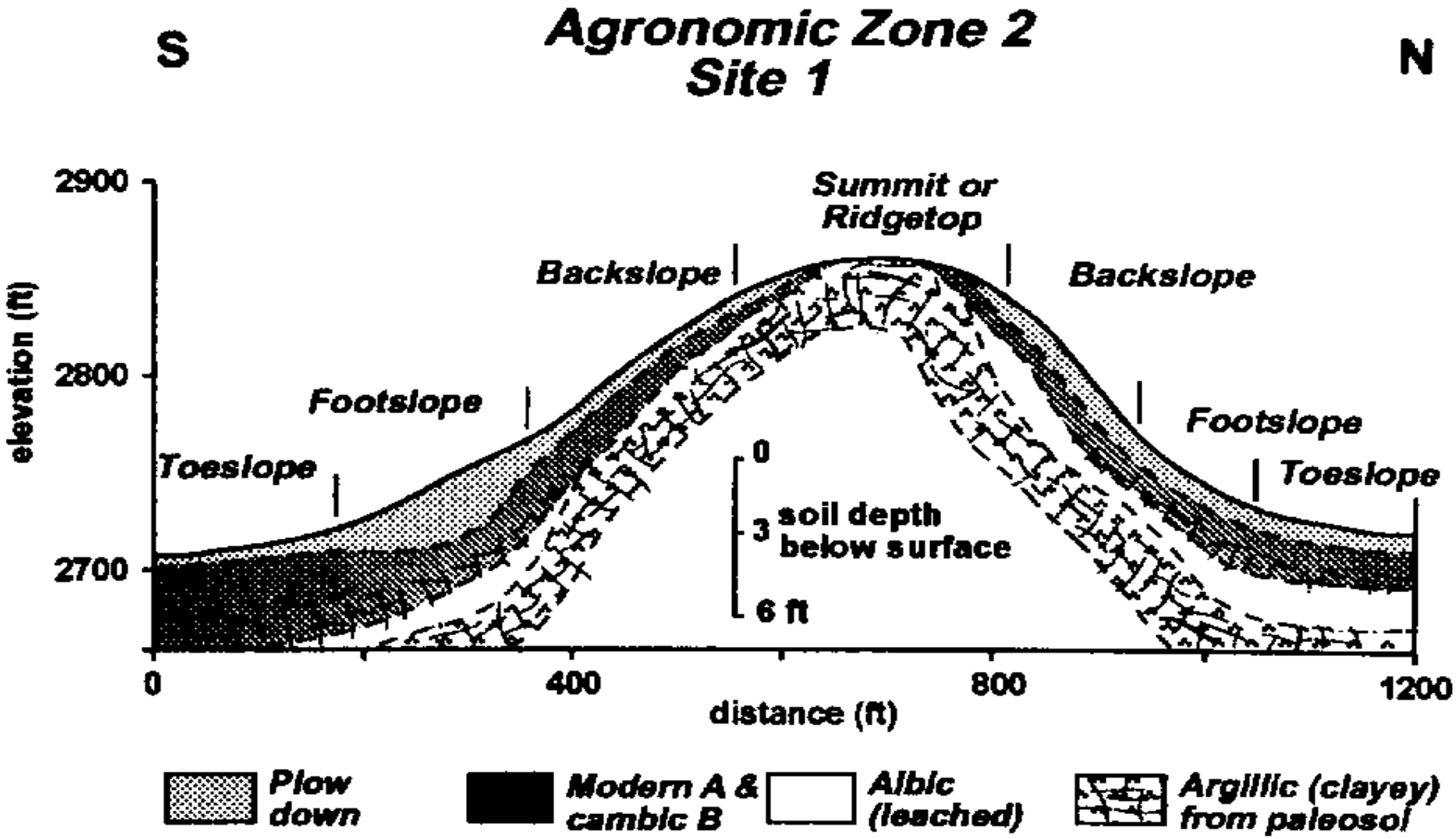
Account for fertilizer banding resulting from:

- Shank applications
- Topdressed bands in perennial crops
- Fertigation in furrow irrigation
- Fertigation in drip irrigation



Take samples perpendicular to row direction

Typical Soil Profiles of eastern Palouse



Early Recognition of Variable P Fertility in the Palouse

Sampling Sections of a Field

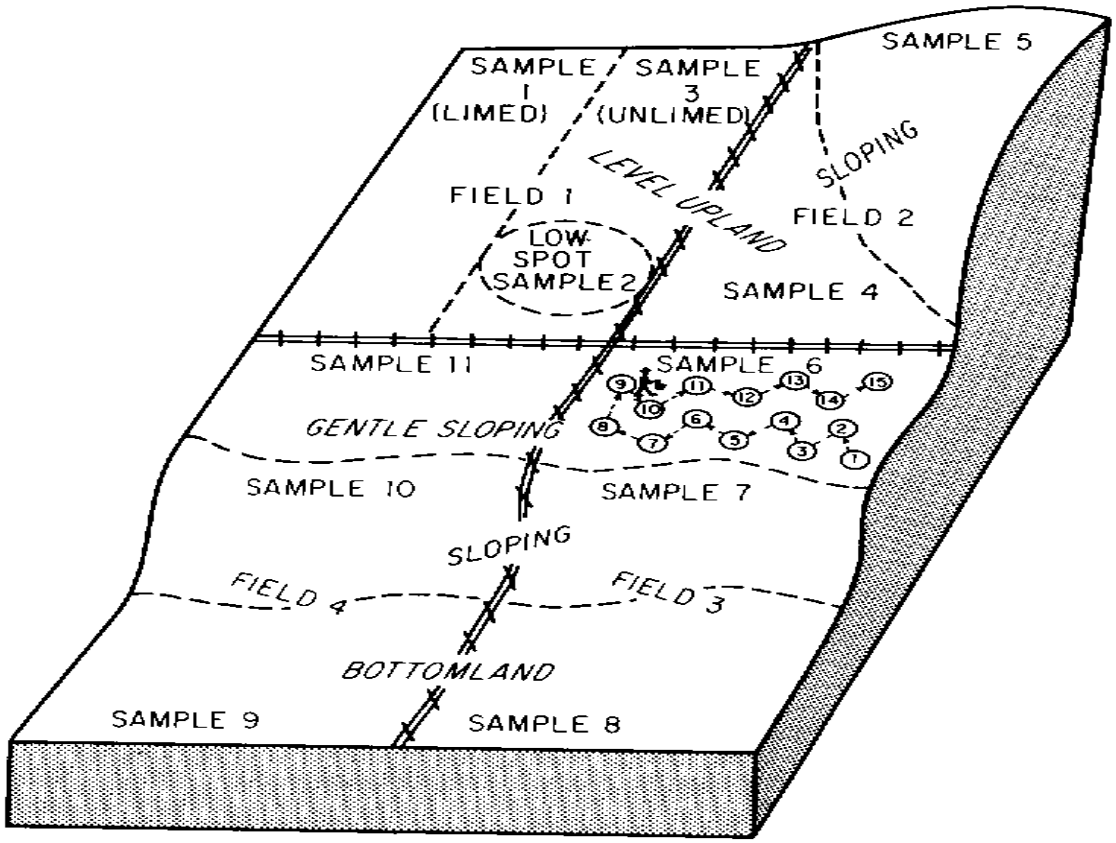
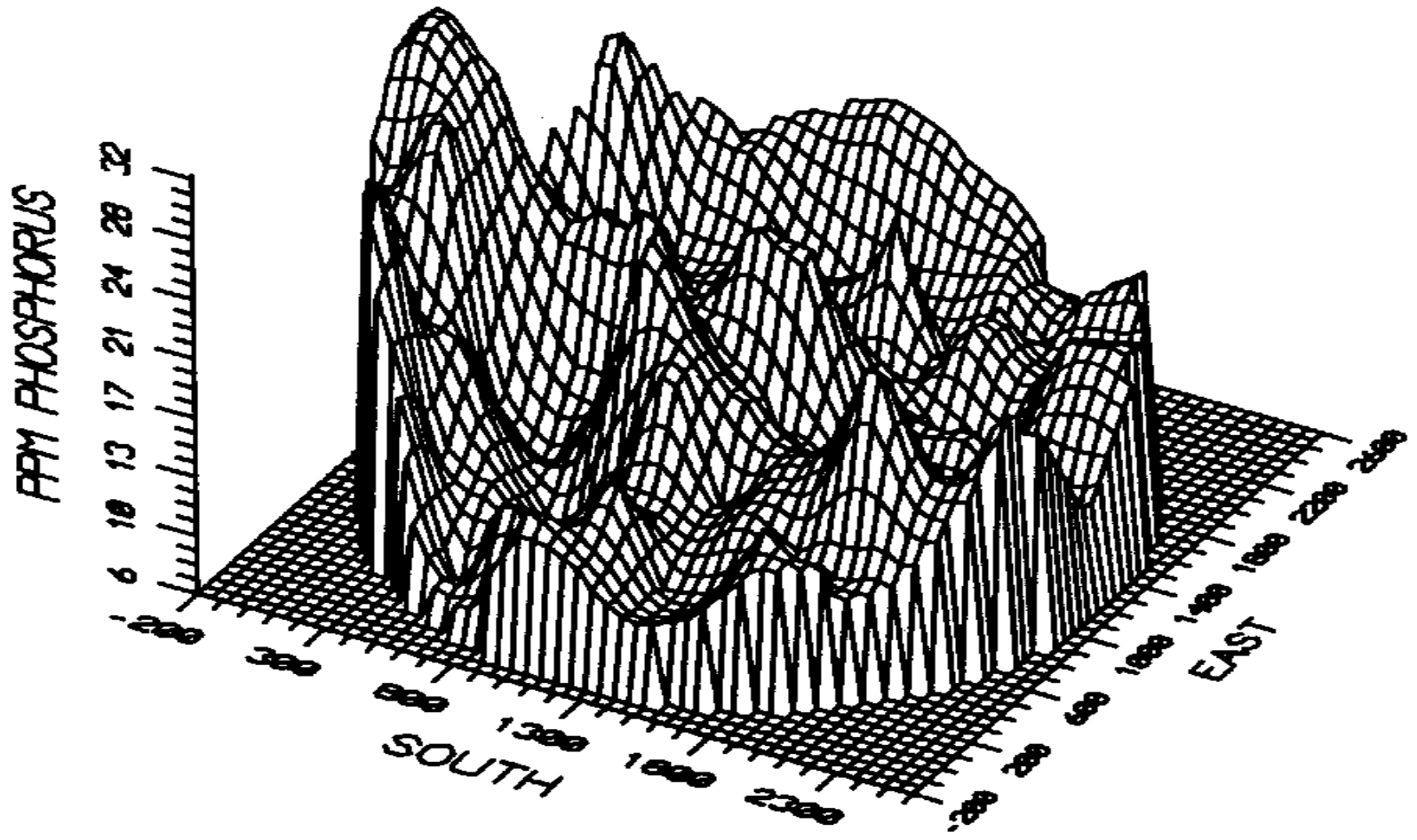


FIGURE 11.19 Samples that are representative of the field to be fertilized are important. The sampling pattern recommended by the various agricultural agencies should be followed. *Courtesy of the Nebraska Agricultural Extension Service.*

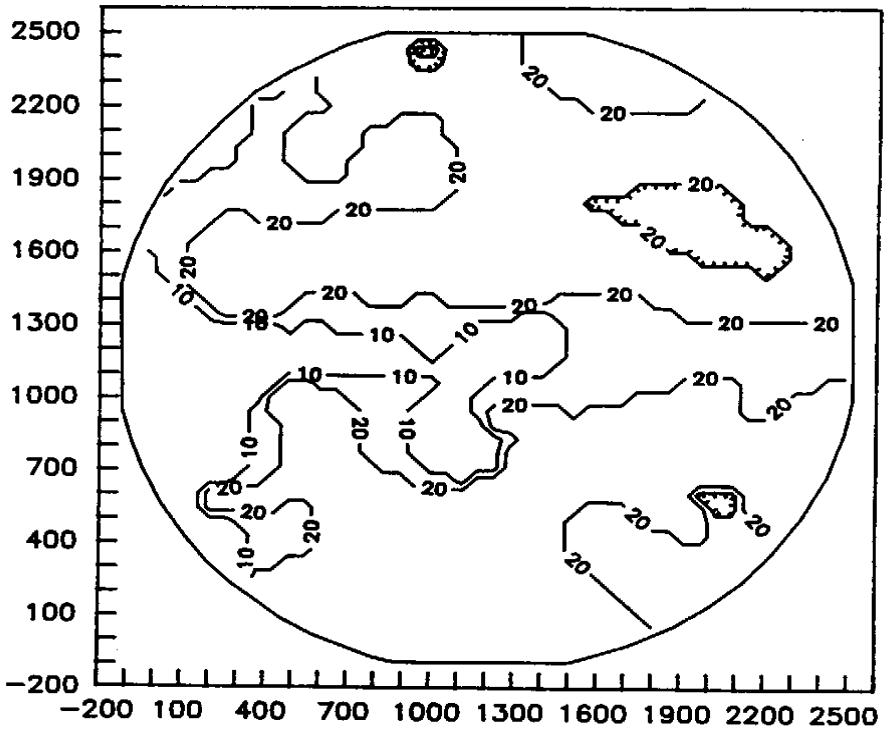
Composite Soil Samples Should Represent the Area to Be Fertilized

- ***If a field is to be fertilized uniformly, then composite sample areas of 5 to 20 may be sufficient.***
- ***If a variable field warrants variable fertility management, then grid sampling on 200' intervals may be warranted.***
- ***Sample each management zone separately.***

Variable Fertility in an Irrigated Circle of the Columbia Basin



Mapping P Management Zones in an Irrigated Circle



ZONE A: LESS THAN 10
ZONE B: 10 – 20
ZONE C: GREATER THAN 20

Soil Sampling References

Soil Analysis

- Biological assays: plant, microbial growth in response to soil additives.
- Chemical extraction methods
- Resin extraction methods

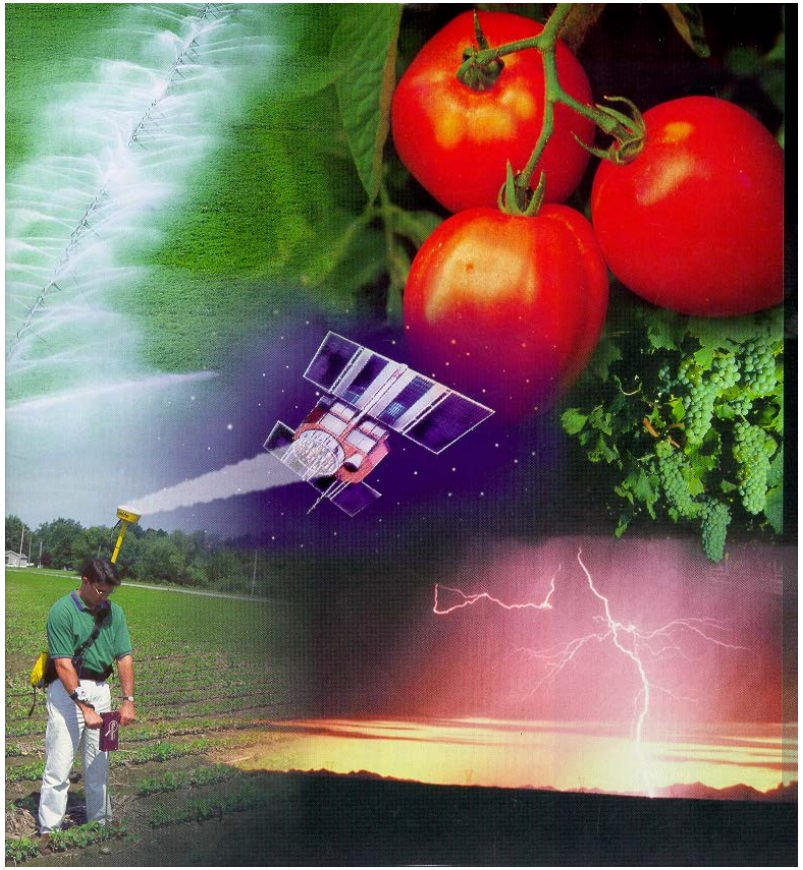
Soil Fertility Analyses

- pH (active acidity)
- lime requirement-estimates neutralizable (reserve + active) acidity
- cation exchange cap. & exch. cations
- available P
- inorganic N (NO_3, NH_4) & S (SO_4)
- organic matter or organic carbon
- available micronutrients
- salinity: Exchangeable Na percentage (ESP) or sodium adsorption ratio (SAR)

Since there are different soil tests that are used in different regions, it is essential that you know what procedure is used in order to make an accurate assessment.

Precision Farming Objectives

- Maximize efficiency of resources.
- Improve yield and quality.
- Improve soil and environmental quality.



Precision Farming: Advanced Applications of Soil Fertility Evaluation and Recommendation

- Substitute information for resources.
- Manage fields on site-specific basis, according to variable crop, soil and environmental conditions- often relies on intensive crop and soil testing.

Steps in Precision Farming of Soil Fertility

- Assess crop, soil and environmental variability.
- Process data and generate maps in GIS.
- Define management maps.
- Variably manage nutrients spatially (in zones or on-the-go), and temporally (fertilizer timing).

Variable Rate Applicator

Tractor mounted computers and GPS units are becoming standard equipment!

Take Home Message on Soil Fertility Evaluation

- Use plant and soil testing in combination with visual diagnosis, field history, and your extensive knowledge of soil biological and chemical processes to generate fertility recommendations for your plant-soil system.