SOIL INFERTILITY MANAGEMENT (SST 3603)

LECTURE 1
SAL KHAN
Founder and executive director, Khan Academy

"Don’t talk about stuff. Do it." Khan and son.

One of the powerful things Bill Gates told me is ‘Learn to say no.’ You don’t have to make everyone happy. I’ve also learned by observing how deeply he goes into anything he cares about. How well he knew the nuances of my product was a huge signal that no manager should feel they’re above the pay grade. But one piece of advice that’s driven me the most came from a commencement speech by then-MIT president Charles Vest. He said to keep on moving. Cheesy, but it’s amazing how true it is. Don’t talk about stuff. Do it. When your organization is paused, and when the spirit of just seeing what happens dies, that’s when you should be worried. Before I make a video for Khan Academy, I don’t think, let me go talk to some people and do focus groups. Obviously you have to have some learning, but if it’s ruining the tempo of activity, you have to rethink things. At the end of the day, what matters is whether your product works and whether people like it.” —Interview by Ellen Florian

AGE 35
JOB EXPERIENCE Founder and executive director of the nonprofit Khan Academy, a virtual school providing software and 3,000-plus video tutorials in math, science, and other subjects. Most are taught by Khan, who conceived of the idea in an effort to tutor his cousins remotely. Former hedge fund manager; has three degrees from MIT and an MBA from Harvard.

CLAIM TO FAME In November 2011, Khan Academy had 3.7 million unique visitors and 42 million page views; Bill Gates uses Khan’s videos to help his three children with schoolwork. Khan Academy has received donations from the Gates Foundation. It also won $2 million from Google in 2010.

Photograph by ROBYN TWOMEY

January 16, 2012 FORTUNE/9
SOIL FERTILITY MANAGEMENT

- Soil Fertility Management refers to the efficient use of nutrients sources in the soil system.
  It is primarily concerned with:
  - Essential plant nutrients, their amounts, availability to plants.
  - Chemical reactions with the soil, loss mechanisms, processes making them unavailable to crop plants and ways and means of replenishing them in these soils.

(Prasad and Power, 1997).
Plants require at least 16 essential elements for normal growth and for completion of their life cycle.

1. Non-mineral elements: C, H, O. They are supplied by air and water.
2. Primary nutrients: N, P, K.
3. Secondary elements: Ca, Mg, S.
4. Micronutrients/trace elements: B, Cu, Cl, Fe, Mn, Zn, Mo.
Primary challenges of sustaining soil fertility

- Reduce nutrient losses.
- Maintain or increase nutrient storage capacity.
- Promote recycling of plant nutrients.
- Apply additional nutrients in appropriate amounts.
Principles and Measurement of Soil Fertility

• **Soil fertility** refers to the quality of the soil that enables it to provide essential chemical elements in quantities and proportions for the growth of specified plants (Brady and Weil, 2002).

Agricultural management practices that help to maintain nutrient cycling and soil fertility:

• Crop rotation, reducing tillage, managing and maintaining crop residue, growing cover crops, composting, liming, applying supplemental fertilizers, etc.
Major plant nutrient input and output from agricultural systems

**Inputs**
- Mineral fertilizers
- Organic manures
- Atmospheric deposition
- Biological nitrogen fixation
- Sedimentation

**Outputs**
- Harvested crop parts
- Crop residues
- Leaching
- Gaseous losses
- Water erosion

Soil/plant system
SOIL SAMPLING AND ANALYSIS

• Soil testing program involves analysis of the soil physical and chemical properties and evaluation of the soil nutrient-supplying capacity at the time of sampling.
• The first rule in taking soil samples is to use clean and proper tools.
• Soil auger is the most convenient, but a shovel can also be used.
• Clean and well-labeled containers must be used to store the samples.
Objectives of Soil Testing

- To determine nutrient availability or supply in the soil.
- To predict probability of obtaining a profitable response to fertilizer.
- To provide a basis for fertilizer recommendation.
- To evaluate fertility status of the soil.
Principles of soil testing

• Collection of a representative soil sample.
• Laboratory analyses of the soil sample.
• Interpretation of analytical results.
• Fertilizer recommendations based on interpreted analytical results.
Methods of Soil Sampling

1. Judgment Sampling
2. Simple Random sampling
3. Stratified Random sampling
4. Systematic Sampling
5. Composite sampling
1. Judgment Sampling

- The researcher judges the color differences: e.g. shade of color to be typical for a sample at certain sites. The accuracy of these samples depends totally on the judgment of the researcher - which may or may not be good.

2. Simple Random sampling

It is a more precise method of taking soil samples and is less biased by the sampler than judgment sampling. Random sampling is needed where the soil differences are not immediately noticeable by color, texture, etc.
3. **Stratified Random sampling**
   - The population, i.e. a field or plot, is divided into sub-populations (strata). For example, the strata may be a ridge, a slope, a low area or a level area. A simple random sample is taken from each stratum.

4. **Systematic Sampling**
   - Systematic samples are taken from sites that are equidistant from each other, either in one or two dimensions, forming a grid.
• **Grid sampling** is done when there is variation in the field. With data provided by grid sampling maps of soil test values can be constructed from the results. This information can be entered into a geographical information system (GIS) and combined with additional geospatial data.

5. **Composite sampling**

To obtain composite samples, first take a number of field samples of equal amount sufficient to represent the population. Then mix them to form one composite. Laboratory analyses are done on this composite or a subsample of it.
• Generally, a larger field or a less uniform field should be more intensively sampled than one that is small and uniform.
• The depth of the sampling is important because the mobility of the nutrients varies with the nutrient content in the different soil zones.
• The recommended depth for sampling is the following:

<table>
<thead>
<tr>
<th>Depth</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-15 cm</td>
<td>To measure pH, P, K, Cl, S, Ca, Mg, Zn, NH₄⁺ -N, Fe, Mn, Cu, soluble salts</td>
</tr>
<tr>
<td>15-60 cm</td>
<td>To measure soluble salts, NO₃-N, S, Cl (in addition to 0-15 cm depth)</td>
</tr>
<tr>
<td>60-120 cm</td>
<td>To measure NO₃-N (in addition to 0-15 cm and 15-60 cm depth)</td>
</tr>
</tbody>
</table>
1. SAMPLE EACH FIELD SEPARATELY

Divide the field according to soil heterogeneity

2. TAKE A COMPOSITE SAMPLE

Take a composite sample from each area after scraping away surface litter.

3. SAMPLE BETWEEN LINES IN PLANTED CROPS

4. USE PROPER SAMPLING TOOLS

Tube auger
Screw auger
Spade
Khiprf

5. MIX SAMPLE THOROUGHLY

Mound of soil
Quartered
Remove A & C
Quartered mound
Repeat process

6. PACKING AND MARKING

Mix A & C
Remove E & G
PLANT SAMPLING AND TISSUE ANALYSIS

• Plant tissue analysis is a laboratory determination of the total elemental content of plants or of certain plant parts.
• It is used for a variety of purposes including monitoring the nutrient status of crops and troubleshooting problem areas.
• It also serves as the basis for nutrient recommendations for perennial fruit crops.
• When using plant tissue analysis information from a laboratory, you need to use interpretive guidance in order to determine the nutrient status categories.

• Plant tissue analysis can confirm the adequacy of all nutrients or identify an inadequacy of one or more nutrients.

• Plant tissue samples should be collected from the correct plant part at the appropriate stage of development.
• Just like in soil sampling, it is important to collect a representative plant tissue sample.
• This involves taking samples from many plants (25–50, depending upon size of plant part) throughout the entire area of interest.
• Careful sampling ensures the effectiveness of plant analysis as a diagnostic tool.
• For young seedlings, the entire plant is sampled 2.5 cm above the soil level.
• For larger plants, the most recent fully expanded or mature leaf is the best indicator of nutritional status.
Graphical depiction of interpretive guidance for a generic crop
The concentration of the essential elements in plants is expressed on a dry-matter basis as either percent or grams per kilogram (g/kg) for the major elements, and either parts per million (ppm) or milligrams per kilogram (mg/kg) for the micronutrients, the units selected depending on the system of use.
Interpretation Methods Used in Plant Analysis

There are three major methods of interpreting plant analysis results (Campbell, 2000):

1. **Critical Values**
   - Critical values have been defined as the concentration at which there is a 5–10% yield reduction. It is best suited to diagnose severe deficiencies and has little application in identifying hidden hunger.

2. **Sufficiency Ranges**
   - Sufficiency range interpretation offers significant advantages over the use of critical values.

3. **Ratios**
   - In simplest form, the use of ratios in the interpretation of plant analysis results involves the evaluation of two essential elements together recognizing the effect of one element on the other.
References