SOILS AND FERTILIZERS
MODULE 5
NRCS COUNTY SOIL SURVEYS

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1. **<u>Southwest Florida Landscape Positions</u>**
   These landscapes look very similar, and can differ by as little as 6 inches in depth to the wet season water table:
   a. **Flatwoods** occupy upland positions and are rarely under water.
   b. **Sloughs** occupy transitional areas between flatwoods and depressions; they usually have overland sheet flow of slowly-moving water during the wet season.
   c. **Depressions** remain under ponded water for more than 6 months or more of the year.

   In terms of general suitability of soils for agricultural uses, flatwoods are more suitable (drainable) than sloughs, which are more suitable than depressions. A soil survey can identify into which of these categories each soil series falls.

2. **<u>The Soil Profile</u>**
   Soils are characterized by a sequence of developed horizons. A vertical exposure of this sequence is termed a **soil profile**. The layers resulting from soil-forming processes are grouped into five categories termed the O, A, E, B, and C horizons.

   O An organic layer of fresh and decaying plant residue.

   A The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed or disturbed surface layer.

   E The mineral horizon in which the main feature is a loss of silicate clay, iron, aluminum, organic matter, or some combination of these.

   B The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as 1) accumulation of clay, iron and aluminum oxides, humus, or a combination of these; 2) redder or browner colors than those in the A horizon; or 3) a combination of these.

   C The mineral horizon or layer that is little affected by soil-forming processes and does not have the properties typical of the overlying horizons. The material of a C horizon may be either like or unlike that in which the above soil formed.

   R Hard, consolidated bedrock beneath the soil.

Cultivation will destroy the original layering at the surface. Construction of beds for citrus production will bury surface layers and create a new surface layer, sometimes with undesirable characteristics, such as low organic matter and/or alkalinity.

3. **Codes Used in Horizon Designations**

   When describing a soil profile, soil classifiers use coding to designate special physical and/or chemical characteristics that they observe. Some of these include:

   t Accumulation of clay (argillic horizon).
   h Accumulation of humic material, i.e. organic matter (spodic horizon).
   w Weak form of the designated horizon.
   ca Presence of calcium carbonate.
   k Same as ca.
   ir Presence of iron compounds (usually oxides and hydroxides).
   g Gleying (indicates reducing conditions, i.e. lack of oxygen, so this horizon has been under water for a substantial amount of time).
   p Plowing or other disturbance.

4. **Soil Texture Abbreviations**

   S, Sand; **L**, Loam; **Si**, Silt; **C**, Clay; **F**, Fine

5. **County Soil Surveys**

   A soil survey is an acre-by-acre inventory of the upper 80 inches (2 meters) of the earth's surface. It is developed by professional soil scientists who cover the land on foot and examine the soils in detail. The soil scientist locates "boundaries" between different kinds of soils and plots them on an aerial photograph. Soil surveys are normally published on a county-by-county basis.

   a. A soil survey contains:
      i. Aerial photographs with soil boundaries shown.
      ii. Descriptions of the soils surveyed in the county.
      iii. Interpretations for agricultural and non-agricultural uses of the soils.
      iv. Laboratory data describing soil physical and chemical properties.
   b. Purposes of a soil survey
      i. Record the location of soil types.
      ii. Predict performance of defined kinds of soil under specific uses and management.

   Soil surveys are made to collect soil information that is useful in developing land use plans, resource management systems, and to evaluate and predict effects of continuing or changing land uses. They permit knowledge about soils in one area to be transferred to other areas having the same or similar soils. Fundamentally, soil surveys contribute to the knowledge and understanding of the land and related resources.

6. An Example: The Collier County Soil Survey

a. Introduction
   i. General nature of the county.
   ii. How the survey was made.
      1. Observation of drainage patterns.
      2. Observation of native plant communities and crops grown.
      3. Dig holes and observe soil profiles and bedrock.
         a. Note soil color, texture, root depth, acidity/alkalinity, layer thickness.
         b. Take samples for laboratory measurements.
      4. Assign soils to a **taxonomic class** (e.g. soil series name).
      5. Relate observed soils to landscape position.
      6. Development of a model of how soils were formed.
      7. Place boundaries in transition areas between different soils.
      8. Make predictions of how the soils will behave in different uses. under different levels of management.
   iii. Soil map units.
      1. An area on a soil map that is dominated by one major kind of soil or an area dominated by several kinds of soil.
      2. Rarely occupied by only one soil taxonomic class; usually contains several soils, called **inclusions** or included soils.
      3. Most inclusions have properties and behavior similar to those of the dominant soil or soils in the map unit (called **noncontrasting inclusions**), so they do not affect use and management.
      4. Some minor inclusions may have properties and behavior divergent enough to affect use or require different management (called contrasting inclusions).
      5. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements.

b. General Soil Map Units
   i. Soils of the Manmade areas (urban land).
   ii. Soils of the Flatwoods, Sloughs, and Hammocks.
   iii. Soils of the Prairies, Swamps, and Freshwater Marshes.
   iv. Soils of the Tidal Areas.

   Each general map unit is detailed with respect to major soils, extent and geographical location, landscape position(s), native vegetation, minor soils, general descriptions of major soils, and major land uses. Its suitability or potential for major land uses and properties that limit its use are listed.

c. Detailed Soil Map Units
   i. Detailed soil map unit descriptions can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. Each map unit on the

detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

ii. Soils that have profiles that are almost alike make up a **soil series**. Except for differences in texture of the surface layer or of the underlying material, all the soils within a series have major horizons that are similar in composition, thickness, and arrangement.
iii. Soils of one series can differ in surface or underlying texture, and can also differ in slope, salinity, wetness, or other characteristics that affect their use. On this basis, a soil series is divided into **soil phases**. The name of a soil phase commonly indicates a feature that affects use or management. For example, Boca fine sand, slough, is one of several phases in the Boca series.
iv. Some map units are made up of two or more major soils. These units are called **soil complexes**, which consist of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps.
v. Each detailed map unit is detailed with respect to slope, drainage, landscape position, color and texture of diagnostic horizons, included soils, water table depth, water-holding capacity, permeability, native fertility, natural vegetation, and suitability for crops, dwellings, excavations, and recreation.

d. Use and Management of the Soils
This information can be used to adjust land uses to the limitations and potentials of natural resources and the environment, and can help avoid soil-related failures in land uses. It is used by planners to maintain or create a land use pattern in harmony with the natural soil. It is used by contractors to locate sources of sand and gravel, road fill, and topsoil, and to identify areas where bedrock or wetness can cause difficulty in excavation. Health officials and engineers can use it to plan for the safe disposal of wastes.
   i. Crops
      1. Major factors to consider include erodability, drainage and wetness, fertility, and tilth.
      2. Yields per acre.
      3. Land capability classification shows in a general way the suitability of soils for most kinds of field crops. Capability classes are designated by Roman numerals I (best) through VIII (worst); **subclasses** are soil groups within one class, designated by adding a small letter **e** (erosion), **w** (wetness), **s** (shallow), or **c** (climate) to the class numeral.
   ii. Rangeland and Pasture
   The landscape position of the range site has a major influence on the type of forage that will grow there; Range sites include: South Florida Flatwoods, Slough, Fresh Water Marshes and Ponds, Sand Pine Scrub, Cabbage Palm Flatwoods, Scrub Cypress, Upland Hardwood Hammock, and Wetland Hardwood Hammock.

iii. Windbreaks and Environmental Plantings
iv. Recreation
v. Wildlife Habitat
vi. Engineering
    1. Building site development.
    2. Sanitary facilities.
    3. Construction materials.
    4. Water management.

e. Soil Properties
   i. Engineering index properties.
   ii. Physical and chemical properties.
   iii. Soil and water features.

f. Classification of the Soils

Order	e.g.	Spodosol, Histosol, Entisol, Alfisol, Ultisol, Mollisol
Suborder	e.g.	Aquic, Udic
Great group	e.g.	Psamm, Hapl, Argi, Ochr
Subgroup	e.g.	Typic, Arenic, Alfic, Aeric
Family	e.g.	Sandy, siliceous, hyperthermic
Series	e.g.	Immokalee, Oldsmar, Boca, Hallandale

g. Factors of Soil Formation
   Soil is produced by forces of weathering acting on the parent material that has been deposited by geologic processes.
   i. CLIMATE under which the soil has existed (probably the most influential of all factors, it determines the nature of weathering).
   ii. PLANT AND ANIMAL LIFE in and on the soil - addition of organic matter, mixing processes, nutrient cycling (e.g. differences in soil formation under trees than under grass).
   iii. PARENT MATERIAL - the unconsolidated mass from which a soil is formed, e.g. the marine sediments which have given southwest Florida its sandy soils.
   iv. RELIEF, or the lay of the land (hastens or delays the work of climatic forces; get erosion in rolling areas, have poor drainage in flat areas like southwest Florida).
   v. TIME, or the length that the previous four factors have acted on the soil material. Sometimes one or two of the factors will dominate over the others (e.g. quartz sand parent material).

   A modification in any one of the five factors results in a different kind of soil.

7. **Specifics of Soil Formation in Southwest Florida**
    a. The PARENT MATERIAL consisted of beds of sandy and clayey materials transported from Appalachian erosion and deposited by waters of the sea several different times (collectively known as marine sediments). Sediments were eroded by streams, deposited in oceans, moved by wave action, and deposited as seas rose and fell. Material is more worn, contains fewer nutrient elements.

    b. The CLIMATE is humid-subtropical (different near the coast due to the Gulf of Mexico). Temperatures are more extreme inland. The average rainfall is over 50 inches per year. Few differences in soils are caused by climate; the climate aids in breakdown of organic matter and hastens chemical reactions (the reason for the low organic matter content of most soils). Rainfall causes leaching of nutrients, fine-textured material, and produces acid conditions in the surface soil. The southwest Florida climate causes soils to be sandy at the surface, have low organic matter, low natural fertility, and low water-holding capacity.

    c. Plants are the principal biological factor involved in soil formation (also contributing are animals, insects, bacteria, and fungi). PLANTS AND ANIMALS furnish organic matter to the soil and move nutrients around. Most of the activity occurs in the upper few inches of soil. Humans affect soil formation by clearing forests, cultivating soils, draining wet areas, and introducing new kinds of plants. The effect has been mostly to lower the soil organic matter content.

    d. RELIEF affects the formation of soils mainly through the influence on soil-water relationships. Differences among soils in the flatwoods, fresh water swamps and marshes, sloughs, and ponds are directly related to relief. Other relief factors such as erosion, temperature, and plant cover are of minor importance.

    e. TIME - physical changes brought about by climate, living organisms, and relief are slow. Some minerals are easier to weather than others. The formation of horizons in soil is due to the translocation of particles through the soil, which always takes a long time.

8. **Processes of Soil Development**
    a. Mineral soils have developed from the unconsolidated materials (regolith) that cover the underlying bedrock. The weathering processes that have created the regolith are destructive processes. Thus, rocks and minerals are destroyed or altered, and soluble nutrients are leached. There are no distinct stages in the development of soils. Any stages that might be there tend to overlap one another. Only a few of the obvious happenings can be identified as movement occurs from solid rock or recently-deposited soil material to a well-developed soil profile.

b. Disintegration and synthesis - this occurs where rocks were present at the surface. Decomposing minerals release plant nutrients, disintegration allows plants to gain a foothold. As primary minerals are destroyed, other minerals (clays) are synthesized. These clays hold reserves of water and nutrients, providing an even better medium for plant growth. Residues from plants accumulate in the soil and are altered to humus, which is even better than clay at holding water and nutrients. Thus, clays, humus, and living organisms together with water become prime constituents and soil characteristics develop. They affect the kind and extent of layering or horizon differentiation that occurs.

c. Organisms and organic matter - As soon as plants gain a foothold in weathering parent material, the development of a soil profile begins. Plant and animal residues decay and are mixed with the mineral matter near the surface. The upper part of the soil becomes slightly darker than deeper layers, and the surface horizon begins to appear. Acids from decaying organic matter help break down minerals, yielding soluble nutrients and secondary minerals such as clays and aluminum and iron oxides. These products enrich the surface soil for awhile, then are moved downward by percolating water, eventually to accumulate as layers at a lower depth in the developing soil. The downward movement dictates layer or horizon formation. Upper horizons are depleted and lower horizons are enriched in clay minerals, nutrients, and organic matter.

d. Nutrient recycling - Water-soluble nutrients are absorbed by plants from the soil, translocated to the upper parts, released upon the death of the plant, and moved downward into the soil by percolating water, ready to be recycled again. The nutrient content of the plants and the amount of rainfall establish the nutritional regime of the developing soil. Native plants under southwest Florida conditions are of low nutrient content; they do not maintain high concentrations of plant nutrients in the soil solution due to high leaching potential.

e. Water is necessary for plant growth and most of the chemical reactions whereby mineral breakdown occurs. Water movement is involved in nutrient cycling and leaching of clays, organic matter, and soluble nutrients. Water is the principal transport media within a soil. Water also affects the nature of soil horizons by affecting the oxygen status of the soil. If a soil profile can freely drain, there is no shortage of oxygen and the resulting soil is generally weathered to a considerable depth. Root penetration is uninhibited. In wet areas (e.g. depressional areas in southwest Florida) weathering is minimized and non-decomposed organic matter tends to accumulate at or near the surface. The soil horizons are exploited only to a minimal extent by plants, except for water-loving species. Vegetation is a good indicator of wetness, as is mottling (spotting) of the lower horizons.

9. **Relation of Soil Formation Factors to Citrus Production**

   a. Soil genesis refers to the formation of soil horizons. The differentiation of horizons in southwest Florida soils is the result of accumulation of organic matter at the surface, leaching of carbonates and salts, and transfer of iron (iron is responsible for the orange or yellowish-brown horizons).

   b. In comparison with central Florida ridge soils, flatwoods sands are not nearly as deep and have more fine-textured material. The major difference between the two areas is drainage or wetness (due to relief factor and subsurface restrictive horizons). Therefore, relief is one process which has influenced the soil types and the way that citrus must be grown in the flatwoods (poor drainage necessitates the installation of artificial drainage so that excessively wet conditions can be avoided).

   c. The southwest Florida climate is generally warm, humid, and wet (in terms of amount of rainfall). Soil microorganisms flourish in warm, wet conditions; their action is to break down organic matter which they use as an energy source. Thus, organic matter deposited on the soil is generally broken down quickly. High rainfall has increased the amount of leaching of water-soluble elements, clays, and organic matter with time. Thus, due to the above factors, southwest Florida soils generally end up acidic, and low in organic matter, fertility, and water-holding capacity.

      Implications are: Fertilization must be relatively frequent; fertilizer is dissolved easily and can move out of the root zone too quickly with excess water. Native soils usually are acidic and need to be limed to increase citrus productivity. Addition of organic matter usually helps the water and nutrient-holding capacity. Irrigation is needed on a frequent basis during periods of dry weather.

   d. Since parent materials were marine sediments, they have caused the formation of sandy soils in southwest Florida. Many clays were carried away by the ocean and deposited elsewhere. However, there still are some clays present that have been moved lower in the soil profile. Some parent materials are calcareous (limestone or shell fragment origin). These can be brought to the surface when digging canals or water furrow ditches for drainage. Often the tops of citrus beds become high in pH if the calcareous material has been brought out of the water furrow to build the bed. High pH soil can cause micronutrient deficiencies in citrus.

   e. The time for soil formation was sufficient for leaching to occur. The original plant material had little effect on present productivity of citrus, except that soil formed under forest is more acid with less organic matter than soil formed under grass. Therefore, citrus planted where grass was previously growing will probably need less management to grow a productive tree than if planted on land which was forested.

10. **Florida Soils used for Citrus Production**

a. Soils classified as to general drainage character:

   i. Well-drained soils (Central Highlands: Clermont to Lake Placid)

      1. Predominant soil series is Astatula fine sand.
      2. Topography can be flat or gently rolling.
      3. Deep sandy soils; rooting zone is extensive.
      4. No subsoil layers that restrict downward water flow.
      5. Ground water is deep below the soil.
      6. Leaching of nitrate is potentially a problem.
      7. Soil is naturally acidic, and low in organic matter.
      8. Low water-holding and nutrient-holding capacity.

   ii. Poorly-drained soils (Coastal Lowlands: Indian River Area and SW Florida)

      1. Major soil series are Oldsmar, Immokalee, Riviera, Pineda, Winder.
      2. Topography is flat.
      3. Shallow sandy soils with high water table; root zone is limited.
      4. Soils are poorly-drained due to subsurface hardpans (can be sandy or loamy).
      5. More finer-textured material in subsoil.
      6. Can be acidic or alkaline; alkaline subsoil is common.
      7. Somewhat higher in organic matter.
      8. Must be drained and bedded before these soils can be used for citrus.

b. Factors to consider when choosing soils for citrus production

   i. Water drainage (acute vs. chronic).
   ii. Air drainage (important in the more northen citrus locations).
   iii. Depth for rooting.
   iv. Lime rock at the surface or in the subsoil.

11. **Soil Orders Pertinent to South Florida**

Alfisols	Mineral soils; relatively low in organic matter; relatively high base saturation; an illuvial horizon of silicate clays; moisture available to a mature crop.
Entisols	Mineral soils; weak or no pedogenic horizons.
Mollisols	Mineral soils; thick dark surface horizon, relatively rich in organic matter; high base saturation throughout.
Spodosols	Mineral soils; an illuvial horizon of amorphous aluminum and organic matter, with or without amorphous iron.
Histosols	Organic soils of the Everglades Agricultural Area.

12. **Flatwoods Soils of Importance to Citrus Production**

The top five mineral soils in four south Florida citrus-producing counties:

Rank	DeSoto	Hendry	Indian River	St. Lucie
1	Smyrna FS	Oldsmar S	Riviera FS	Pineda S
2	Immokalee FS	Immokalee S	Pineda FS	Riviera S, FS
3	Myakka FS	Holopaw S	Wabasso FS	Winder S, LS
4	Farmton FS	Boca S	Eau Gallie FS	Wabasso S
5	Malabar FS	Riviera S	Winder FS	Nettles S

Some general soil properties:

Soil	Order	Landscape position	Can find in depressions?	Spodic horizon	Argillic horizon	Can have limestone substratum?
Basinger	Entisol	Slough	No	No	No	No
Boca	Alfisol	Flatwoods	Yes	No	Yes	Yes
Chobee	Mollisol	Depression	Yes	No	Yes	Yes
Eau Gallie	Spodosol	Flatwoods	No	Yes	Yes	No
Farmton	Spodosol	Flatwoods	No	Yes	Yes	No
Floridana	Mollisol	Depression	Yes	No	Yes	No
Holopaw	Alfisol	Slough	Yes	No	Yes	Yes
Immokalee	Spodosol	Flatwoods	No	Yes	No	No
Malabar	Alfisol	Slough	Yes	No	Yes	No
Myakka	Spodosol	Flatwoods	Yes	Yes	No	No
Nettles	Spodosol	Flatwoods	No	Yes	Yes	No
Oldsmar	Spodosol	Flatwoods	Yes	Yes	Yes	Yes
Pineda	Alfisol	Slough	Yes	No	Yes	Yes
Riviera	Alfisol	Slough	Yes	No	Yes	Yes
Smyrna	Spodosol	Flatwoods	No	Yes	No	No
Wabasso	Spodosol	Flatwoods	No	Yes	Yes	Yes
Winder	Alfisol	Slough	Yes	No	Yes	Yes