NEW SOIL SURVEY TOOLS FOR PERMANENT CROP SITE SELECTION

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Introduction

We want people to understand and value soils because soil is important to all of us. Charles E. Kellogg once said that "Civilization has its roots in the soil." The crop that is grown on the land should be guided by the soil that is beneath it. The soil becomes a critical factor when choosing to grow a permanent crop. The decision to plant a permanent crop becomes even more daunting when one considers that, like snowflakes, no two soils are exactly the same. One of the primary references available to help land users determine the potentials and limitations of soils is a soil survey. Soil surveys are available in a wide range of formats—and the list is changing rapidly. In this short paper I will explain some of the more recent advances in accessing soil survey information. I will concentrate on agronomic interpretations that can assist growers who are making decisions related to their soils suitability for prospective permanent crops such as almonds or pistachios.

Sources for access of soil surveys

Soil surveys are still available in book format for a specific soil survey or a county. They are available from the local Natural Resources Conservation Service (NRCS). In the San Joaquin Valley, most areas are covered by a published hard copy soil survey. A hard copy soil survey has been the established method of publication of soil surveys for more than a hundred years. Probably the most prominent feature of the soil survey is the detailed soil map section. In the short-term these maps will continue to be published as hard copy map separates. The rest of the soil survey includes the general soil map with descriptions, detailed soil map unit descriptions, detailed descriptions of each of the soils, tables such as interpretive tables, crop yield tables and prime farmland tables. Many other features are also part of the published soil survey. In the future most of the written information will be available on a CD. Users can create hard copies of part or all of the soil survey as needed. The type of information collected and the use of that information has changed over the years.

There are four internet options that all soil survey users should be aware of:

1. http://websoilsurvey.nrcs.usda.gov for soil survey maps and report
2. http://soildatamart.nrcs.usda.gov for soil data
3. http://soildataviewer.nrcs.usda.gov to create soil-based thematic maps
4. http://soils.usda.gov for information about soils

The following is a brief description of each of these internet options for accessing soil surveys:

1. Web Soil Survey allows online viewing of soil survey maps and reports. This new application greatly enhances access to information on soils.
2. Soil Data Mart allows you to determine where soil tabular and spatial data is available and then to download this data. A variety of reports can be generated.
3. Soil Data Viewer is a tool built as an extension to ArcMap that allows a user to create soil-based thematic maps and access soil interpretations and soil properties.
4. The NRCS Soils Web Site provides a base to launch into a variety of related websites that provide the utility to access other portions of the soil survey. Examples include books such as the National Soil Survey Handbook at http://www.soils.usda.gov/technical; and > 20,000 Official Series at http://www.soils.usda.gov/technical/classification/osd/index.html; and soil lab data at http://ssldata.nrcs.usda.gov.

All of this data can be a massive amount of information to absorb. One way to address this issue is to narrow the scope of the question to one basic question such as the following: Is my soil suitable for growing almonds?

Examples of How to Use a Soil Survey

The following procedure can be used as a guide to determine the answer to this question: What soil characteristics are best suited for a productive almond orchard? For purposes of this exercise lets concentrate on two soil properties—drainage and salinity. Almonds prefer a well drained, non-saline soil. In Kings County where I live, we have a published soil survey that has a good number of hard copies available to anyone who requests a copy. A potential almond grower should first take a careful look at the soil survey that covers the proposed location of the almond orchard. In this exercise we will use a location in Kings County. The following questions can be answered based on the given location:

1. What topographic map quadrangle is this area located on? Answer: Sheet 4, Lemoore
2. What is the map unit symbol at this location? Answer: 121
3. What is the map unit name? Answer: Grangeville fine sandy loam, saline-alkali, partially drained (pages iv or 149)
4. What is the dominant soil and what percentage of the map unit does it occupy? Answer: Grangeville fine sandy loam, saline-alkali, partially drained, 85 percent (page 31 in the Detailed Soil Map Units section)
5. What landform does the dominant soil occur on? Answer: Alluvial fans and flood plains (page 31)
6. What is the natural soil drainage of this soil: Somewhat poorly drained (page 31)
7. What is the depth to high water table? > 48 inches (page 31) and four to six feet (page 207)
8. What is the salinity? Answer: four to eight decisiemens/meter (this is the preferred unit of measure now and is equal to mmhos/cm; page 203 in Table 15—Physical and Chemical Properties of the Soils section)
9. Is the salinity considered a limitation for almond growth? Answer: Yes, it is inferred by the statement “This unit is suited to irrigated crops that are salt- and

alkali-tolerant. It is limited mainly by the saline-alkali condition of the soil and by wetness." (page 31)

10. What crops are commonly grown on these soils? Answer: Cotton, barley, safflower, alfalfa hay (page 151 in Table 5—Yields Per Acre of Irrigated Crops)
11. What are the Land Capability class and Storie Index of this soil? Answer: 2w-6 (page 31) and 48 (page 155).
12. What is the clay content of the surface layers? Answer: 8-18 (page 203 in Table 15—Physical and Chemical Properties of the Soils)
13. How many acres of this map unit are in the survey area? Answer: 6,665 acres (page 149 in Table 4—Acreage and Proportionate Extent of the Soils)

Soil Properties

There are many soil properties that affect a soil's behavior for growing an almond orchard. The following list includes some of the soil properties related to growing almonds that are detailed in soil surveys: available water capacity, bedrock and other restrictive layers, calcium carbonate, cation-exchange capacity (CEC), drainage class (natural), flooding, high water table, organic matter, permeability, reaction (soil pH), rock fragments, root restrictive layers, salinity, sodium adsorption ratio (SAR), slope and soil texture (USDA). Since we are concentrating on drainage and salinity as it relates to growing almonds we will discuss our example from the Kings County Soil Survey.

The natural drainage of Grangeville soil is somewhat poorly drained. The definition found in the Glossary on page 137 states that somewhat poorly drained soils "are wet close enough to the surface or long enough that planting or harvesting operations or crop growth is markedly restricted unless artificial drainage is provided. Somewhat poorly drained soils commonly have a layer with low hydraulic conductivity, a wet layer high in the profile, additions of water through seepage, or a combination of these." In our example from the soil survey the depth to a high water table is four to six feet. According to the soil survey on page 31 "This soil is considered to be partially drained because of the dams and reservoirs in the Sierra Nevada, pumping from the water table, tile and interceptor drains, and filling and leveling of the sloughs in the vicinity."

The salinity is four to eight decisiemens per meter according to the soil survey Physical and Chemical Properties of the Soil Interpretations Table. This would be a severe limitation for growth of a successful almond orchard if the salinity is actually this high now. It is important to note that salinity is a transitory feature and that we completed this soil survey in 1980.

This almond orchard is projected to be planted on an area less than 30 acres in size. On-site investigation and lab analysis will be necessary to determine more specifically whether planting this site to almonds will be a good investment with respect to the soil properties. Soil lab analysis indicates an increase in soil salinity with depth. The salinity of the soil at a depth of three feet is 2.6 decisiemens per meter which is less than the four which was described in the soil survey. The sodium adsorption ratio is 17. Some areas of this field are likely to have higher levels of salinity in the top three feet of soil. On-site investigation revealed a highly stratified soil with textures ranging from fine sandy loam

on the surface to silt loam and loamy sand in the underlying material. Reddish brown redoximorphic features beginning as high as 16 inches, indicating past or present standing water, are present in several strata with a current high water table around six feet.

There are excellent references that illustrate the relative yield of various crops as a function of soil salinity. In the "Pistachio Production Manual, Fourth Edition, 2005" yield reduction for almonds for various electrical conductivity (EC) is clearly shown. At an EC of four decisiemens per meter this chart shows approximately a 50 percent reduction in yield (Ferguson, et. al, 2005). This is the kind of yield reduction that might take place in this field when the almonds are mature and send roots deeper in the soil profile. If these soils were planted with pistachios the predicted results would be much more positive since the salt tolerance of pistachios is close to that of cotton (Ferguson, et. al, 2005).

This is a simplified actual example illustrating how utilization of a soil survey and on-site investigation and lab analysis can work together to assist growers with making an informed decision before planting a permanent crop.

Tips to Help Avoid Misusing Soil Surveys

1. Make sure you know where your property is and where it is located on the map.
2. Remember the scale since most soil surveys are published at a scale of 1:24,000. Enlarging the soil maps creates a sense of increased precision that is not realistic. The soil maps are designed for a certain level of planning. More detailed planning requires on-site investigations. When soil surveys become digitized, it is even easier to have this kind of misuse.
3. Be aware of inclusions or minor components. Inclusions or minor components are described in the map unit descriptions. A small project or practice may be located entirely on an inclusion.
4. Read the book—don't just copy the description. As demonstrated, many important properties of the soils are described in the soil survey. Just reading the name of the soil series or map unit does not tell you all you need to know about it.
5. Learn the meaning of slight, moderate and severe and limitation values. A severe rating does not mean that a practice cannot be done, only that it may cost more to implement and may carry high risk. For example, you can build your house in a flood plain, but you may have to replace it once in awhile.
6. Ask for help. It is not expected that everyone will understand everything about the information in the soil survey report.

GIS Thematic Maps

Newer soil surveys such as the Fresno County, Western Part Soil Survey will usually have numerous GIS thematic maps that can be very useful when choosing sites for permanent crops such as almonds and pistachios. The Fresno County, Western Part Soil Survey will include GIS thematic maps for the following themes that can be used to assist in choosing soil types that are conducive to permanent crop selection: General Soil Map,

Dominant Landforms, Dominant Natural Soil Drainage Class, Salt-Affected Soils, Sodium-Affected Soils and Minimum Depth to Water Saturation.

Summary

There is a significant amount of information about soil that is easily accessible in the older book version copy as we have illustrated with this example from the Kings County Soil Survey that was written in 1980. All of the information and data mentioned previously is still available. Some soil surveys are in book form and are also available in various forms, including online versions, for example, the Tulare County, Western Part Soil Survey is available as a hard copy book and online at: http://www.ca.nrcs.usda.gov/mlra02/wtulare.html.

The Fresno County, Western Part Soil Survey maps and data I recently completed are available at the web soil survey website. These three soil surveys, Kings, W. Tulare and W. Fresno Counties are all available in varying formats and they are indicative of the many ways to access soil survey information.

References

Arroues, K. D., and C. H. Anderson, Jr. 1986. Soil survey of Kings County, California. 1986. U.S. GPO. Washington D.C. 212 pp.

Broderson, W.D.. 2000. From the surface down--An introduction to soil surveys for agronomic use. USDA, Natural Resources Conservation Service. 26 pp.

Ferguson, J., R. H. Beede, M. W. Freeman, D. R. Haviland, B. A. Holtz, C. E. Kallsen, and J. Coviello. 2005. Pistachio production manual, fourth edition. p. 135.

U. S. Department of Agriculture, Natural Resources Conservation Service. 2004. Soil survey geographic database for Fresno County, California, western part. USDA, Natural Resources Conservation Service.

Wasner, A. R., and K. D. Arroues. 2003. Soil survey of Tulare County, California, Western Part. 2003. USDA, Natural Resources Conservation Service. 299 pp.