Soil EC maps and NRCS soil surveys—how do they compare? Is an EC map worth the investment?

Professional agronomists were among the first to recognize that grids wouldn't fit their clients' fields. They began their precision efforts using government soil surveys along with their personal knowledge of soil variability. Several leading agronomists have recently shifted to soil EC maps as the basis for their soil investigations. Why?

BACKGROUND INFORMATION

First, let's review what soil EC measures. In non-saline areas, soils conduct electricity based on soil texture. Clays, with high particle-to-particle contact and high moisture holding capacity are highly conductive. Sands are extremely poor conductors. Shown below in Figure 1 are a couple of examples from university research where fields were intensively sampled for clay--and how soil EC maps compare with those samples.

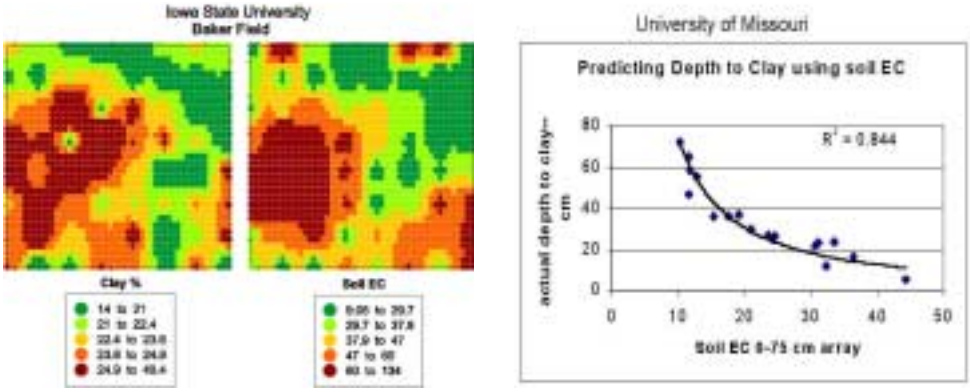

Figure 1. University research shows EC and soil texture relationship

CORRELATION BETWEEN EC AND SOIL SURVEY MAPS

If soil EC correlates well with clay content, a soil EC map should resemble the NRCS soil survey, since soil texture is a key element distinguishing one soil type from another. Shown below is a soil EC map from central Iowa with the published Order 2 county soil survey overlaid on it. There is a strong visual correlation between the two maps, with the main disagreements over line placement.

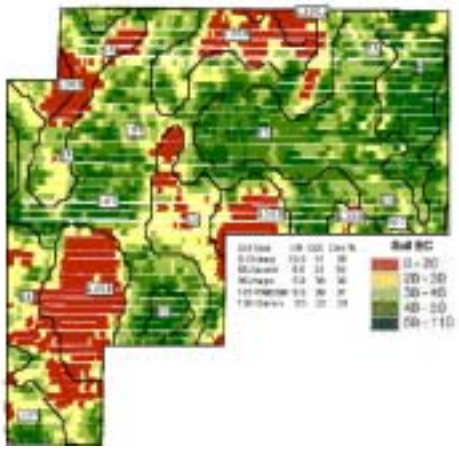

Figure 2. Iowa soil survey and soil EC map

Order 2 soil surveys account for the majority of published NRCS surveys in the US. The scale of the survey in Figure 1 above is 1:15,840, which allows up to 2.5 acre inclusions, meaning a given soil type may include one or more 2.5 acre areas of another soil type within it. Many surveys were published at coarser scales, which allow larger inclusions. The 1:20,000 scale survey from Kansas shown overlaid on a soil EC map below in Figure 2 allows inclusions up to 4 acres.

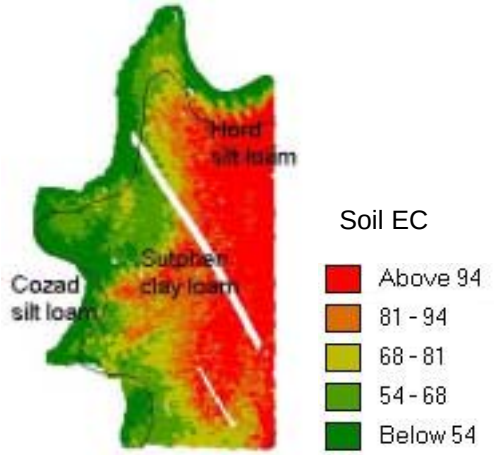

Figure 3. Kansas soil survey and soil EC map

Here are some points to consider:

Transitions…soils don't change on a line—but are a continuum. This is especially evident on the Kansas map in Figure 3. The clay loam Sutphen is gradually changing into a coarser textured soil on the west part of the field. The soil survey indicates this change as an abrupt line, when in reality the transition zone between the two soil types is its own soil type.

Inclusions…the inclusions allowed by soil surveys weren't much of a problem before precision agriculture. With site-specific management, a 2.5 to 4 acre area that is truly a different soil than is indicated by a survey, can represent a significant discrepancy.

Errors…Many of the errors in soil surveys were a result of not having GPS technology available when the surveys were done. Other sources of errors stem from the small number of sites investigated on a given field. The Veris map is geo-referenced, and with a transect width of 50', there are over 50 data points per acre collected—virtually solid coverage of a field.

Surveys have value...many surveys done at the 1:15:840 scale (or finer) are able to provide important supporting information about the field. Their lines may not be accurate, but these surveys can help supply the "what" information, while the soil EC map provides the "where".

GOING DEEPER

A soil EC map and soil survey from an Iowa State University research farm shown in Figure 4 provides a unique opportunity to examine the quality and precision of both maps. According to the soil survey tables for the soils present in this field, the Clarion series soil (138) has the lowest clay content, and the Webster series (107) has the highest clay content, with the Nicollet (55) in between. In looking at the map one can see that there is quite a bit of agreement, especially with the Clarion series. Wherever the soil survey indicates Clarion, there is low EC. Yet there are some significant discrepancies between the survey and the EC map in the boxed area—enlarged on the right. There are low EC areas within the Webster—the heaviest clay soil series. And the Nicollet shows up with the same EC as the highest EC within the Webster. Are these inclusions? Mis-classified soils? Is the EC map wrong?

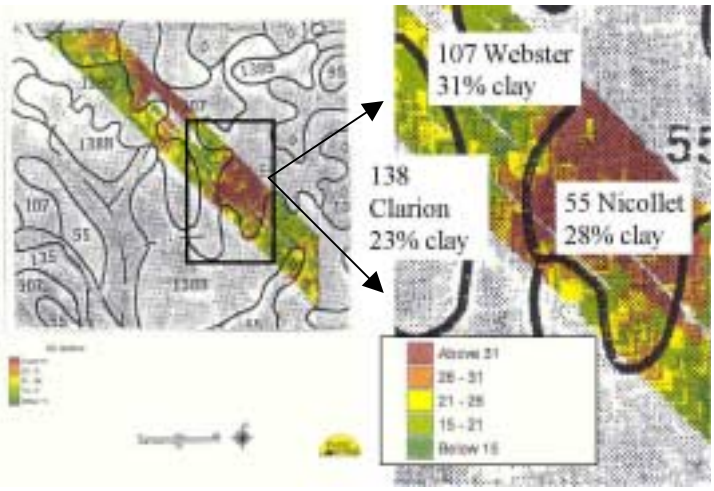

Figure 4. Published Iowa soil survey (Order 2) overlaid on soil EC map

Because this is a research field for a major university, there is an Order 1 soil survey available to help sort this out. Order 1 surveys are much more detailed, usually at a scale of 1:10,000 or greater intensity. (Even at this intensity, 1 acre inclusions are allowed) The intense Order 1 survey shows the area in question has been remapped. What had been mis-mapped on the published survey as a Webster is now a Clarion, and the Nicollet is now a Webster. In a matter of minutes, the soil EC map delineated the soil variability with equal or greater precision than even the more intense Order 1 survey.

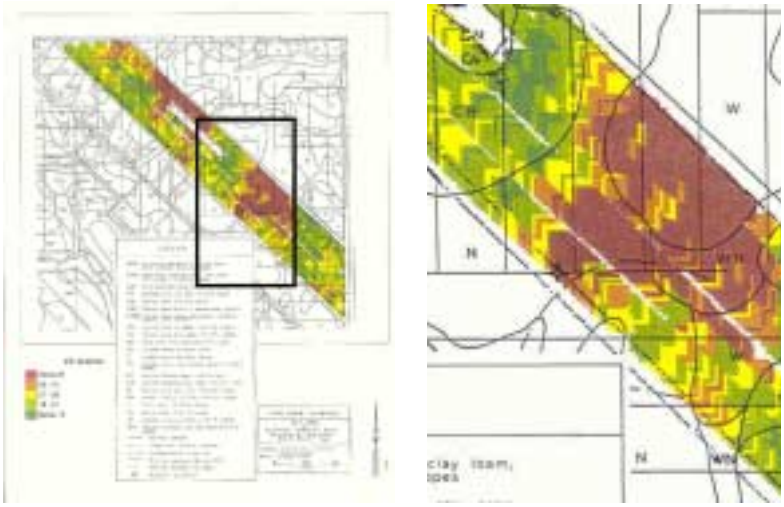

Figure 5. Order 1 soil survey and soil EC map

GROUND-TRUTHING and SOIL SAMPLING

Soil sampling based only on a soil survey can result in a wide range of variability within the samples. Shown below in Figure 6 are soil samples from three fields in Iowa, Ohio, and Kansas. Each pair of samples was taken within one soil type, using a soil EC map to find areas of soil variability within the soil type. This is an effective way of ground-truthing both the EC map and the soil survey. Note the variability that exists within a soil type and how well the relative soil EC value accurately captured the differences in soil texture.

Veris EC 32
Clay% 38
CEC 31.5
OM% 4.4

Veris EC 15
Clay% 16
CEC 12.4
OM% 2.0

IOWA: from a soil type mapped as a Webster silty clay loam.

Veris EC 25
Clay% 34
CEC 21.2
OM% 3.5

Veris EC 8
Clay% 8
CEC 7.4
OM% 2.4

OHIO: from a soil type mapped as a Mermill loam.

Veris EC 66
Clay% 36
CEC 26.8
OM% 2.5

Veris EC 21
Clay% 20
CEC 18.5
OM% 1.9

KANSAS: from a soil type mapped as a Sutphen clay loam.

Figure 6. Pairs of soil samples taken within a soil type.

Summary...

Soil EC maps and NRCS soil surveys—how do they compare?

Shown above a just a few examples of a phenomenon that can be repeated on field after field—soil EC maps delineate soil variability with greater precision than published soil surveys. When an EC map shows a low EC spot in the middle of a soil unit mapped as a clay loam—there's a silty or sandy inclusion. Ground-truthing with soil samples and Order 1 surveys show this is dependable.

"Soils change where the soil EC map shows they change."

Is an EC map worth the investment?

SOIL SAMPLING: Agronomists who have bought Veris systems say they did so when they realized they weren't sampling the soil variability adequately using the soil survey. They had rejected grids because soils don't follow a square grid—now they had found that soils didn't follow a soil survey precisely enough for precision agriculture. In the examples shown in Figure 6, sampling by soil survey alone would mix different soils in the same sample—defeating the purpose of sampling by soil type.

"If your objective is to sample by the soil, *then sample by the soil.*"

PRESCRIPTIONS FOR POPULATION AND NITROGEN: Inputs like N and seed require precision—there isn't a base level of the input already there like there usually is with immobile nutrients. How important is it to put the correct prescription where it belongs? Suppose you set a yield goal on corn based on the productivity rating from a soil survey, but the soil lines were wrong. A 50 bushel/acre yield goal error on 3% of the field would pay for an EC map the first year. That soil EC map will last for years, but the erroneous prescription could lower productivity for many more years.

"If you're varying populations and yield goals, do it where the soil truly changes."

ANALYZING AND AGGREGATING DATA: If the Clarion includes 30% Webster and the Webster includes 30% Nicollet, what have you learned by analyzing yield by soil type? A soil EC map can augment your data analysis efforts by insuring that the data and the analyses are valid.

"Yields and responses to inputs do vary according to soils—learn more with a better soils map."

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