BASIC USER ★ ☆ ☆

TOPSOIL MAPPER

General Remarks on the measurement principle

CONTENT

What are the principles of the TSM?

The Topsoil Mapper is a highly sensitive electromagnetic induction measurement device, measuring near surface electromagnetic conductivity. The device incorporates a multi coil array, consisting of one transmitter loop (Tx) and four receiver loops (Rx). The transmitter emits an electromagnetic field while the receivers are measuring the induced secondary field with a predefined sampling frequency.

Electrical conductivity is usually measured in S m-1 (siemens per meter) and siemens is the reciprocal of ohm. Electrical conductivity and resistivity are the stable properties of the material and do not depend on the conductor geometry. In practise we can measure electrical conductivity and resistivity of soils or other media with the same equipment.

The electrical conductivity measured with the Topsoil Mapper is termed apparent or bulk electrical conductivity, to distinguish it from the conductivity measured in a laboratory in homogeneous samples with uniform electrical fields.

Soil is a heterogeneous medium consisting of liquid, solid, and gaseous phases. The solid and liquid phase play an essential role in soil spontaneous electrical phenomena and in behaviour of electrical fields, artificially created in soil.

Soil surveys for different applications require quick and, when possible, non-disturbing estimations of numerous soil properties, such as salinity, texture, stone content, groundwater depth, and horizon sequence in soil profiles.

Utilizing geophysical methods, the measured soil electrical parameters provide information about volume density of mobile electrical charges in soils. In a second step, it is investigated how different soil properties influence the volume density of mobile electrical charges in soils and how these properties can be evaluated by measured electrical parameters.

Electrical conductivity and soil compaction

The density of mobile electrical charges increases with the soil compaction. Recent studies showed that there is a strong positive correlation between EC readings and yield production while predicted tillage depths where soil related cultivation depth is negative correlated to soil EC readings.

Therefore, there is a need for a technology to determine the tillage depth, based on the thickness and depth of the compacted layer and to apply tillage depth accordingly.

This type of variable-depth tillage technology is beneficial in optimizing the production costs by reducing fuel consumption and machine wear while increasing work performance and yield income.

The Topsoil Visualizer incorporates different implement control strategies based on soil compaction.

Electrical conductivity and soil water content

The soil water content influences the mobility of electrical charges in a complicated way. Soil water content variations affect ECa measurements.

Like salinity, soil water content is a dynamic soil property that varies with depth and across the landscape, generally with moderate to high local-scale variability. In areas under uniform irrigation management practices, the degree of spatial water content variability is typically minimal provided significant soil texture variation is not present.

However, some fields demonstrate gradual trends in water content across the extent of the field, which may be due to gradual changes in shallow water table levels close to the depth of penetration of measurement or to abrupt textural discontinuities, or due to non-uniformity of water application (e.g., flood irrigation has a trend of high to low from the head water to tail water ends of a field, respectively).

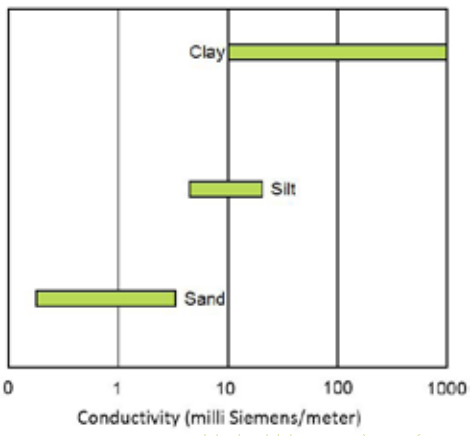
In instances where gradual changes in the soil water content level occur, trend surface parameters in the regression model can be used.

Electrical conductivity and soil texture

Soil electrical conductivity (EC) is a measurement that correlates with soil properties that affect crop productivity, including soil texture, cation exchange capacity (CEC), drainage conditions, organic matter level, salinity, and subsoil characteristics.

The electrical conductivity of soil varies depending on the amount of moisture held by soil particles. Sands have a low conductivity, silts have a medium conductivity, and clays have a high conductivity. Consequently, EC correlates strongly to soil particle size and texture.

It has been demonstrated in scientific literature as well as in extensive field testing that fields, mapped several times during the year with varying moisture contents showed that soil EC values changed but that the zone delineation did not. As a result, variations in soil type can be detected no matter what the moisture condition of the field is.



What are the benefits compared to other technologies

Sensor types commercially available are based on contact or non-contact methods. Measurements by both sensor types have given comparable results.

Ground contacted sensors use coulters as electrodes to make contact with the soil and to measure the electrical conductivity. In this approach, two to three pairs of coulters are mounted on a toolbar; one pair provides electrical current into the soil (transmitting electrodes) while the other coulters (receiving electrodes) measure the voltage drop between them.

Non-contact EC sensors work on the principle of electromagnetic induction (EMI). EMI does not contact the soil surface directly. The instrument is composed of a transmitter and a receiver coil, usually installed at the opposite ends of the unit. A sensor in the device measures the resulting electromagnetic field that the current induces.

The Topsoil Mapper belongs to the family of non-contact sensors. By installing the sensor on the tractors front linkage, the sensor can be operated on any field work of the farmers daily business. This provides the user with the highest flexibility The fact that no ground coupling is needed extends the operational period within the agricultural cycle. The Topsoil Mapper is designed as a non-expert system – it operates autonomously and does not require any expert knowledge in setup or operation.

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