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Soil Moisture Measurement

An Additional Input for Precision Farming

Measuring soil moisture for documentation and for control makes substantial innovation in agricultural applications possible. By combining diverse field data, interrelations can be ascertained and by including weather data, a fast site-specific assessment of hydrological properties of a plot can be carried out. Besides directly controlling farm machinery, the dynamic acquisition of the current soil moisture enhances precision farming with a further supportive information module.

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Soil moisture has been playing a minor role, considering the acquisition of field data in precision farming, although it affects nearly all field operations. The present data which is measured within precision farming encloses a wide range of measurements in order to optimise agricultural production. Procedures are aimed at attaining productions highest efficiency. An appreciative side effect is the sustainable use of farm land with an improved distribution of fertiliser and pesticides. At present, the measured farming data does not take soil moisture into account. Besides that, it doesn't support soil-moisture-based considerations of field operations. By means of a dynamic measurement system, which is derived from the Time Domain Reflectometry (TDR), it is possible to fit the observed value of soil moisture into the information pool of precision farming and to close this information gap. Consequently, applications of machine-controlling can be established in order to regulate machinery during field operations. This is most valid for soil cultivation, sowing, field irrigation and trafficability decisions.

In order to use this data analytically without a direct control of machinery, it is necessary to allocate the data spatially. This ends up in soil moisture mapping. It allows, considering existing soil maps and maps of electrical conductivity, to draw conclusions on hydrological properties of the site. Therefore precision farming gains another essential element which references to the widespread data collection of precision farming.

Current research

Varying water contents cause different specific soil-physical properties for each type of soil. This could limit factors of soil cultivation and will be mirrored later with harvest. From the angle of agricultural sustainability it has recently been discussed in points of field traffic frequency and therefore practicability [1]. For all that, soil moisture is the peak impact on trafficability. Another important facet concerning sustainability is irrigation farming. Without the control of soil moisture, solitary plant indicators can indicate failure irrigation. Even though operational quality of soil cultivation and sowing is decisively depend on present soil moisture. Unsuitable operating intensities and seeding depths are able to cause soil physical conditions, which affect the emergence and growth of plants. The integration of soil moisture as a resource of precision farming is one of the current research targets of the Institute of Agricultural Engineering, Process Engineering in Plant Production at the University of Hohenheim (Prof. Dr. K. Köller). In cooperation with IMKO-Micromodultechnik and close contact to the industry of agricultural machinery the objective of the research project is moreover to get the value into an application of precision farming. The centre of these endeavours are the aforementioned scopes.

Soil conservation through soil moisture measurement

The soil structure is decisive for an optimum air and water proportion within the soil and therefore most favourable for conditions of germination and growth of plants. This proportion stays under the influence of soil cultivation which ought to provide best crop germination conditions. Due to the soil-physical conditions of wet soils, a failure operation might therefore lead to a loss in crop-production. This unfavourable effects might be explained by compaction of subsoil, agglomerates, silting up and erosive losses of surface soils. Under knowledge of the current soil moisture it is possible to alleviate or avoid the described effects running an adapted and conservative soil cultivation. The variables to be adapted are predominantly an adjustment of cultivation depth and working speed. Meliorative effects of these measures can be anticipated. The sustainability of these effects could also be described as a valuable part of environmental protection.

Process reliability of no tillage drilling

The soil dries off late, as well as its slow warming up in spring is mainly seen as a disadvantage of direct seeding. Mulch decreases evaporation and provides a higher water content which raises the specific thermal capacity of the soil. Compared to a dry soil, a wet soil needs more energy regarding radiation to warm up. The higher water content causes a slower warming up, the other way around. To verify these observations it is necessary to establish procedures which take temperature and moisture conditions into account. Times of direct drilling must be reconsidered. It should occasionally be set to a later date, when favourable conditions of germination and emergence prevail. Providing a sufficient level of soil moisture and fine soil structure, a quick root growth and a fast plant maturity is supported. Variation of seeding depth represents a further opportunity of adaptation. No tillage sites show higher soil moisture contents. Therefore lower evaporation rates grant enough water for germination, particularly in low seeding depths [2, 3]. A management of seeding depth is able to suit the prevailing conditions on no tillage fields and give an important contribution to the process reliability of direct drilling.

Soil moisture as a decision parameter of the trafficability

The current discussion of soil science and agricultural engineering concerning federal regulations of maximum wheel load of agricultural vehicles has been spotted in detail in issue 2/2005 [1]. Actually the assessment of soil's trafficability is influenced by a blend of actual soil moisture and soil type. In contrast to set regulations, the knowledge of the aforementioned values allows for situation-determined actions. The adjustment of tire pressure with the help of an online soil moisture sensor offers great opportunities. Therefore the resulting relief of load per square unit on soil surfaces is a contribution to active soil conservation. The process combines sustainable soil conservation and improves the application of resources through varying tire pressure in order to minimise the rolling resistance wherever it is possible or necessary.

Irrigation management

The adjustment of irrigation quantities represents an obvious application for a dynamic soil moisture detection. It is already in use for stationary measurements at micro irrigated sites. An application of a dynamic system could serve as a reference tool for site specific farming. Regarding the measured value of soil moisture it has a great potential of saving precious irrigation water. Additionally the dynamic moisture detection provides a characterisation for symptomatic locations with regard to their hydrologic properties. Recording the water content over a defined period of time, it is possible to approximate the total of water per square unit, which has been transpired by crop and evaporated at soil surface. The difference of evapotranspiration [4] and detected soil moisture shows the water loss within the soil, therefore hydrologic properties can be portrayed [5].

Outlook

As soon as soil moisture is detected at defined time steps and weather data is given, it is possible to approximate site specific soil physical properties. Temperature, wind speed, humidity, radiation, and precipitation cause soil-temperature and soil-moisture conditions. Whenever water content and climatic data are known, numerical solutions qualify to draw conclusions of the hydrologic properties of soil. Subsequently, the hydrologic properties are able to be modelled exhaustively by means of an indirect method. Consequently it allows an agronomic site assessment.

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