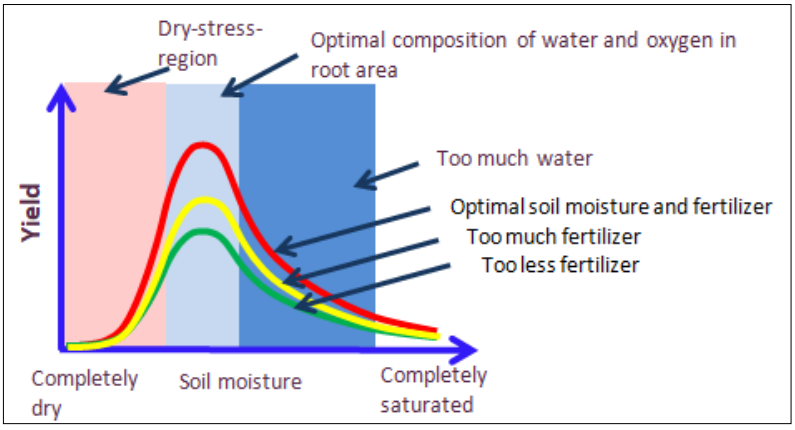
A Real Clever Idea……

The world is increasingly "digital" and agriculture can not escape this trend. At the same time, sensors play an extremely important role because, without reliable readings, digitization can be "cool" but not successful. Sensors today not only monitor tractors and other agricultural machines, but also cows, pigs and sheep and drones try to detect the pest infestation of cultures as early as possible.

However, the highest good of agriculture, the soil, is largely still an unknown terrain. Besides the naturally grown soils which show an incredible variety of the composition, specially prepared substrates of organic or inorganic materials are more and more used which makes the characterization with regard to soil moisture, fertilizer content, etc. very difficult.

PlantCare has set itself the goal of taking a leading position in the characterization of soils.

The soil moisture is an extremely important parameter for agriculture. It has a great influence on the yield, but also on the costs, because too much water means higher costs for energy and fertilizer, too little water leads to a reduction in yield. The optimal ratio of water and oxygen in the root area is, in addition to correct fertilization, of crucial importance for a stress-free plant growth and increases the resistance of the plants against the pest infestation. Proper, appropriate irrigation is therefore also very important from the point of view of sustainability.



PlantCare has set new standards with the development of a completely new type of soil moisture sensor. To date, more than 240,000 sensors have been sold worldwide and the most renowned agricultural research institutes in Europe use PlantCare sensors. By connecting these sensors directly to a very intelligent, self-learning irrigation control center (PlantControl CX), water efficiency increases by a factor of 2-3 were achieved in a scientifically conducted comparison test. The PlantControl CX system determines the amount of water exactly according to the actual needs of the plants, regardless of the current climatic conditions as well as the growth status.

The existing sensor concept will also be expanded in the near future in the direction of other measurement variables. It is planned to monitor the humidity and the air temperature in the leaf area in order to plan the use of fungicides better. In addition, the measurement of the water level in well shafts etc. is simply possible. The sensors can already be connected to existing IoT networks so that large agricultural areas can be monitored.

In addition to soil moisture, proper fertilization is a daily problem for the farmer. In addition to the right quantity at the right time, the right composition, which still changes depending on the growth status, is of decisive importance.

PlantCare has therefore set itself the goal of solving the problem of in situ measurement of fertilizer so that the fertilizer status is always known. Furthermore, it is also planned to determine residues of plant protection products in situ.

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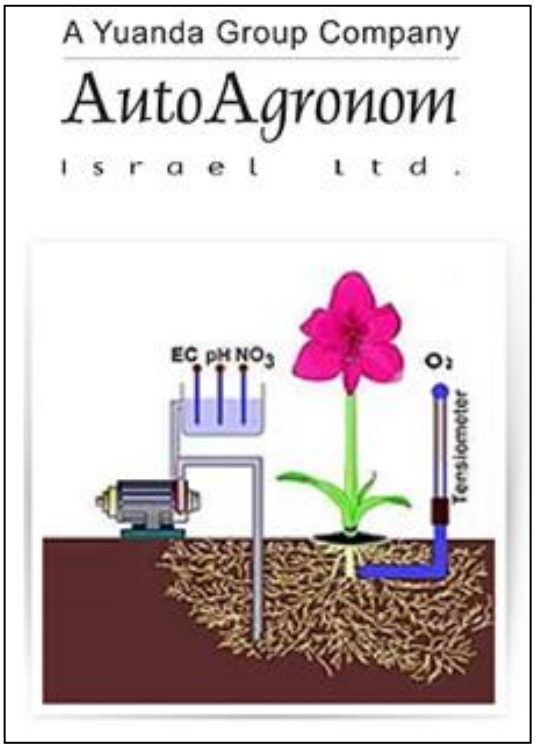
The Problem

The main problem that occurs in the determination of the EC value and the fertilizer components in the soil is the fact that only a few percent of the water, with the substances dissolved therein, are present in the soil. The remainder is composed of a variety of different substances and it is virtually impossible to carry out an in situ measurement. It is therefore always necessary to take samples and prepare them in a chemical laboratory in order to isolate the substances to be determined. This not only costs money but also time, because it is getting more and more important to get the values up to date to make adjustments.

In order to avoid this problem, the Argo Autonom company in Israel developed a process in which the water is pumped to the top by means of a strong suction pump and collected in a storage tank. Various measurements can now be made in this collected water.



As one can easily imagine, such a method is not economical, then one has to install such expensive device with every culture and therefore this technique has not been able to penetrate the market so far.

Another approach to solve this problem is the use of a Near Infrared Spectroscope (NIR). The company SoilCares from the Netherlands has developed a portable spectrometer, which has to be pressed on the ground for some time. A spectrum is recorded which is transmitted to a Smartphone via Bluetooth. The spectrum can then be sent to Holland, where it is analyzed. To be able to do this, the soil to be examined must first be examined using conventional methods and the device must then be calibrated. This must be done for all types of soil within an agricultural area.

PlantCare has therefore set itself the goal of being able to carry out the measurements in the soil, without sampling or preparation. In addition, the measurements should be feasible independently of the water content. As in the case of the soil moisture sensors, the measured values can then be continuously transmitted to a central station by radio.

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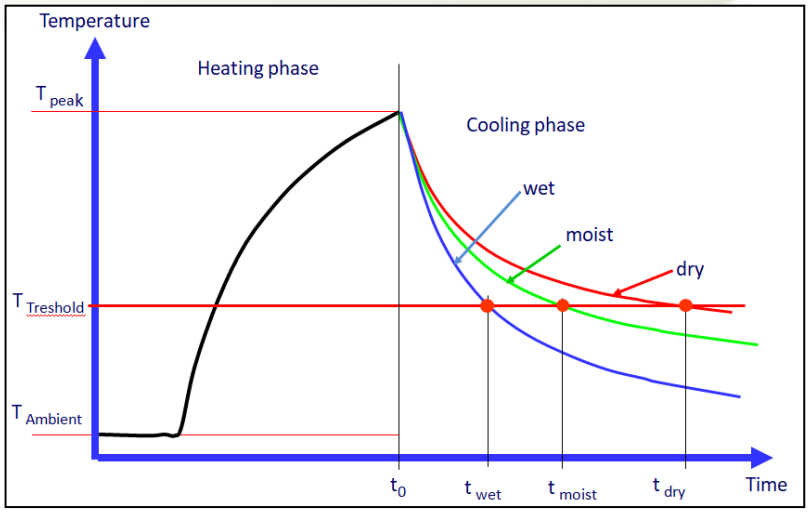
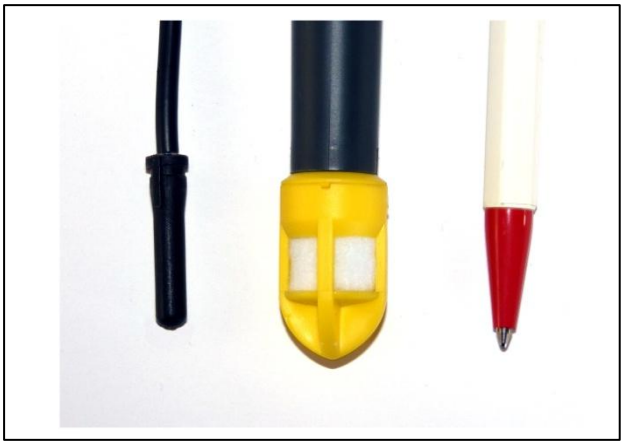
The Solution

The starting point of this development is the existing soil moisture sensor, which is already proven and based on a micro heat pulse method. A small sensor tip is heated briefly by a few degrees Celsius and the cooling curve is then measured precisely. The time that elapses before the tip has cooled down to a certain value is a measure of the water content in the soil.



This method would not work if the naked tip were placed in the ground, because the heat transfer from the tip into the soil would be completely undefined. Therefore, a jacket is used which, thanks to its absorbency, attracts the water from the soil until a moisture equilibrium is established between the jacket and the soil. The sensor therefore measures only the water in the jacket. If the matrix potential of the jacket material is approximately equal to that of the surrounding soil, the sensor measures the soil moisture, which also corresponds to that of the soil.



The absorbent material used is a special felt which is chemically inert and remains stable in the soil even after a long period of use. It also acts as a very effective filter so that only filtered water can reach the sensor. Due to small volumes of 1-2 cm3, it is also guaranteed that after a change in the fertilizer content, this can be detected very quickly in the jacket as well.

The felt can therefore be regarded as a medium that accumulates filtered water from the soil. This fact can now be used to carry out other measurements in this medium without the influence of the soil material.

This revolutionary new idea forms the basis for a whole range of possibilities and applications, not only in agriculture, but whenever an analysis of liquid components has to be carried out by sampling. In the following, some of these possibilities will be described in more details.

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Method 1

A very simple solution is to place the suction body at the end of a guide tube, and when a measurement is necessary, the suction body is pulled out of the tube, the water collected therein is squeezed out through a small device, so that by the use of known technologies including disposable test strips, EC value, the pH value, and the content of NOx, etc., can easily be determined.

If a detailed analysis is to be carried out, one can send the suction body or the expelled water in an air-tight container to a laboratory which can determine by means of spectroscopy or chromatography practically all desired substances, including micro-nutrients and residues of plant protection products. The complex sample preparation is omitted, which speeds up the process also reduces the cost of an analysis.
After the water has been pressed out, the suction body can again be introduced into the tube.

A device for inserting and removing the suction body as well as the suction bodies themselves are very cheep and can be fixed in many places on a farmable surface.

Method 2

Method 2 goes one step further and uses NIR spectroscopy to determine the most important fertilizer components. The absorbent body is left in the ground and a permanently installed or a transportable NIR spectrometer is optically connected to the suction body from the top through the guide tube by means of a light guide.

The further sequence is analogous to the SoilCares technology, only the calibration of the ground is not necessary and the accuracy of the measurement is increased considerably.

By using other wavelengths, residues of plant protection products or the leaching of nitrate or nitrite can also be monitored.

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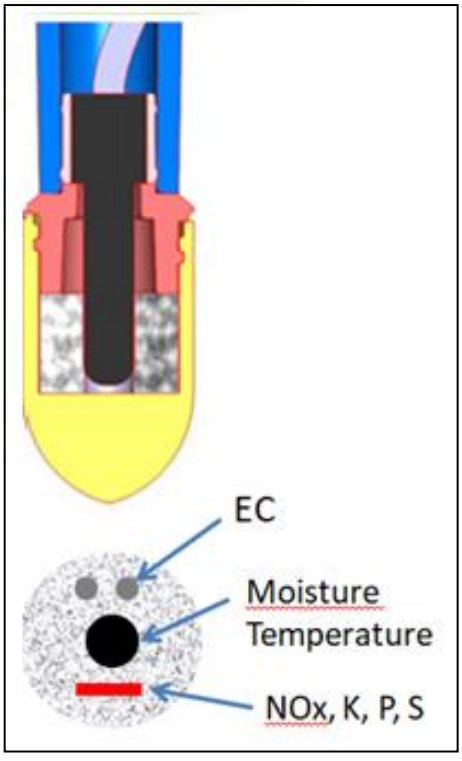
Method 3

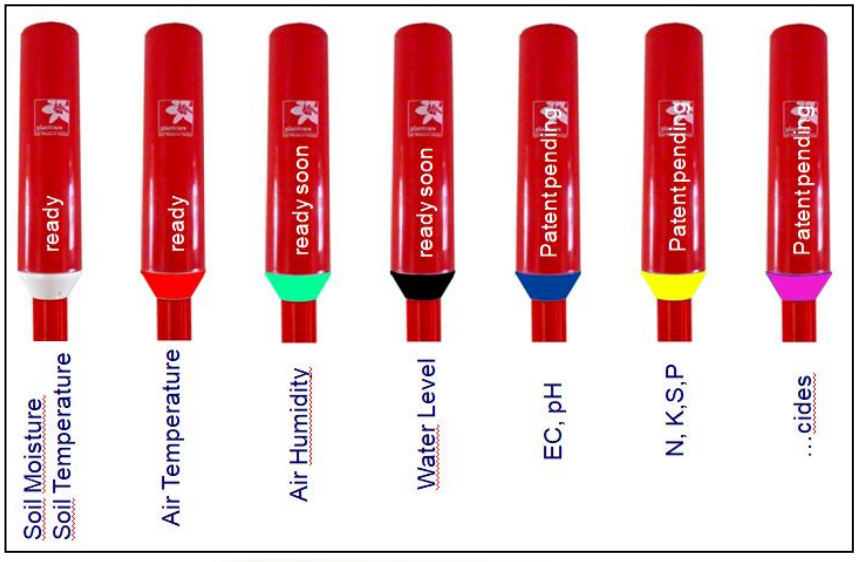
In method 3, the known soil moisture sensor is equipped with additional sensors, where the additional sensors being placed directly into the suction body of the soil moisture sensor. For the measurement of the EC value two additional electrodes can be provided very simply. These can remain in the ground for as long as necessary, and the existing sensor electronics regularly transmits the EC values to the control center, where they can be used for automatic fertilizer dosing. The simultaneous measurement of the water content and also the temperature in the absorbent body is very advantageous in this context, since the dependence of the measured value on the water content and on the temperature can be easily compensated.

In addition, it is possible to place ion-sensitive electrodes or ISFETS (ion-sensitive field effect transistors) in the suction body in order to continuously measure the fertilizer components.



The technologies presented here represent a quantum leap in soil analysis and are suited to give agriculture finally a tool which allows it to handle the problem “fertilizer” on site. In addition, a simple way is opened to detect residues of plant protection products.

At the end of the day, PlantCare will be able to offer a standard platform for a wide range of soil- and other sensors and will further strengthen its leading position in this extremely important sector of digital farming.



The patent application can be downloaded from:

https://worldwide.espacenet.com/publicationDetails/originalDocument?CC=CH&NR=712184A1&KC=A1&FT=D&ND=3&date=20170915&DB=EPODOC&locale=en_EP#

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