

D 1.4 Irrigation sensors

The set of sensors is intended for monitoring liquid, gaseous, non-aggressive media in the soil, or even soil temperature. The temperature sensors are insulated against the penetration of liquids, but they ensure sufficient thermal coupling with the environment.

Sensors are usually inexpensive.

To monitor the required area of the crop, a network of sensors must be created that monitor the ratio between the soil and water content, usually in a volume of 1 m³. At the same time, the temperature of the soil and its conductivity are also measured. The sensors are buried to the required measurement depth, so that the original composition of the soil is not disturbed.

1. Example: FATIMA42, Horizon 2020 project. The goal of the project was to create a local information network connecting soil sensors, agricultural machines with equipment for precision agriculture in order to minimise the pollution of water resources by nitrogen fertilisers. Smart sensor networks not only measured the amount and quality of water in the soil and/or plants and the health of crops, but groundwater pollution was also monitored through regular sampling. All sensors were connected by a wireless network and integrated into a cloud supporting sensor web standards. An interface was designed for managing sensor deployment and acquiring measured data. This was subsequently combined with other data outputs for the purpose of controlling agricultural machinery.



2. Example: Soil moisture and irrigation optimization. A network of sensors has helped to solve the problem of water retention in the soil of a vineyard that is located on a former landfill after a lignite mine. The special fertiliser Biochar (charred pulp, created by decomposition of biomass at high temperatures and limited access to air) can be used very effectively, which has a beneficial effect on the nutrient content of the soil and the amount of retained water. Biochar, mixed with soil in one row, was used as a planting substrate during the restoration of the vineyard on the original quarry dump. In the control line of the vineyard then the compost without treatment. In both rows of vine seedlings, volumetric soil moisture and soil temperature were measured directly under the planted plant. Control measurements were provided by a profile soil probe located outside the new planting.

The data was transmitted via wireless technology provided by Czech Radiocommunication.



a)

a) Control unit for soil sensors before assembly.



b)

b) Control unit for soil sensors and air temperature and humidity at ground level



c)

c) Control unit for soil sensors in the vineyard

The sensors are placed in the seeding depth, i.e. in the horizon of 3-5 cm. Each *telemetry unit* serves 8 sensors, half of which are in the treated pickling rows and the other half in the control rows, without treatment. Data were measured at hourly intervals.



Control unit for soil after installation in the middle of the vineyard

The total cost of acquisition and operation of sensor measurement can be divided into the following items:

Project – as part of the project, it is necessary to discuss and optimise the *solution design* with the supplier company in detail in terms of the measurement objective, i.e., suitable type of sensors, measurement periodicity, data transmission periodicity, availability of transmission networks at a specific installation location and the resulting type of telemetry unit. The project is usually prepared free of charge and includes a price proposal.

The optimal combination of required accuracy and cost must be considered: the possible solutions range quite widely.

Furthermore, it is necessary to consider which parameters are important to measure, whether the measurement will be used only internally within the farm, or if it will be shared and used with other data sets (e.g., with climate data).

The implementation consists of the delivery of sensors, a telemetry unit, mounting material and installation, including test operation and settings.

For orientation of some prices (as of 2022): sensors for measuring humidity and air temperature and soil moisture are in the range of €0.3 to 0.5 thousand, the price of a compact station approx. €2.1 thousand, the price of the telemetry unit (according to the number of connectable sensors) from approx. €0.4 thousand, the price of installation and installation material must be determined individually.

The cost of system operation consists of payments for data transmission and for storing and making data available on the server. Monthly payments for data transmission are in the units of *EUR* when using terrestrial wireless networks for each telemetry unit. Monthly payments for storing and making data available are around a unit of *EUR* per month per telemetry unit as well.

System maintenance: the systems are basically maintenance-free, for telemetry units powered by a primary battery, this battery needs to be replaced after a few years.

Data server maintenance is included in the price of monthly payments.



Installation of the soil sensor in the row with fertilizer

Links to relevant topics

<https://ahdb.org.uk/knowledge-library/satellites-for-agriculture>

Key words

solution design

temperature sensors

sensor network

volumetric soil moisture

profile soil probe

telemetry unit