

SENSING AND DOSING FOR BETTER CROP YIELDS

The OPTIFERT project develops water and fertilisation technology

The project: Understanding the needs of crops and adapting irrigation and fertilizer doses accordingly

There is a growing need for an increase in productivity in modern agriculture and crops production. Increased productivity is the only solution to meeting future demand and restraining rising prices. Of course, this must be achieved in a sustainable way. Rising fuel and fertiliser prices, as well as their anticipated scarcity, add to the challenge. Climate change and the consequences such as weather unpredictability complete the picture. We need to be able to better monitor and understand the needs of crops in real time. We need to be able to achieve the targeted yield and at the same time use our resources efficiently and eliminate the risk of pollution to soil and ground water. The technology developed in OPTIFERT aims to deliver tailor-made irrigation and dosage of fertilisers simultaneously using high-tech solutions through 'fertigation'. This will help farmers and agricultural advisors to achieve better yields, environmental protection and resource preservation.

The product: Soil sensors, dosage units and software

Three modules have been developed in OPTIFERT:

- The OPTIFERT dosing unit has been designed to deliver any fertiliser combination needed for open-field crops like corn, sugar beet, rapeseed, potatoes or wheat, amongst others. The unit can be coupled with any irrigation system, adapting the fertiliser concentration according to the needs of the specific crops.

In the OPTIFERT dosing unit tanks, water-soluble fertilisers can be easily discharged using big bags. The two tanks allow the creation of any combination of fertilisers with no risk of precipitation. The OPTIFERT dosing unit has been designed to allow high flexibility. It can handle and deliver the required fertiliser concentrate no matter what the irrigation water flow might be. This fully automatic system will adapt the injection ratio according to the existing irrigation flow or speed, ensuring that the right fertiliser dose is delivered even if the irrigation rate is changed during the application. Once the fertiliser has been dispatched in the tanks and the system is switched on by the user, the mixing and dosing phases will follow automatically, with no other user input needed.

- OPTIFERT Soil Sensor

In modern agriculture the amount of the macronutrients NO₃, NH₄, K and PO₄ in soil is commonly adjusted by the application of fertilisers. The fertiliser dose has to be carefully adapted to the plant demands, since both under-supply and over-supply lead to reduced yield. In addition, excessive use seriously harms the environment if fertilisers are not taken up by crops, but get washed into ground water. In order to apply the appropriate amount of fertilisers, precise knowledge of nutrient concentrations in the soil is required.

At the moment there is no mobile and user-friendly system on the market, which allows the concentrations of all these soil nutrients to be measured. Therefore, a fast and simple method for the routine surveillance of these nutrients is not yet available. Laboratory analysis or the complex application of several measurement procedures have to be applied. As a consequence, the applied fertiliser dose is often based on estimations, with adverse effects on environment and profit.

We have developed a soil-nutrient sensor system for the combined measurement of NO₃, NH₄, K and PO₄ on site. For the measurement, a soil sample is suspended in a universal extraction liquid. After filtration, the amount of dissolved nutrients is measured in this liquid. In this way, only a single extraction procedure followed by a single measurement is required, minimising the work for the generation of nutrient concentration maps and depth profiles.



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The analysis of all macronutrients NO₃, NH₄, K and PO₄ is possible in a single run, within 120 seconds. Additionally, the sensor can be expanded to include a pollutant analysis by measuring further sample compounds like NO₂ or Cl.

- **OPTIFERT Software**

The required quantity of nutrients that crops need vary during the growth season, and depend on soil characteristics and weather conditions. The OPTIFERT software will align the relevant crop-growth model with on-site weather data and the soil data collected by the OPTIFERT soil sensor. This way, the software will provide a fertigation recipe, covering the nutrient demands of the crop for the following growth period. This allows precise use of fertilisers, based on on-site measurements. The fertigation recipe can be delivered by the OPTIFERT Dosing Unit.

The end-users: Farmers, cooperatives, fertilizer industries, agro-machinery producers

The future clients of the OPTIFERT system will span the entire primary production chain in crop production and horticulture, including agricultural-machinery producers, fertiliser manufacturers, agrochemical producers, irrigation-technology producers, farmers, and all cooperatives and organisations involved in agriculture and horticulture.

The inventors: Researchers, technology transfer institutes, industries

A multidisciplinary team of agronomists, biologists, physicists, software creators, electronic and chemical engineers, coordinated by ttz Bremerhaven, has taken part in developing the system. The applied research-and-development provider has been largely involved in different projects and approaches related to fertigation, collaborating with OPTIFERT partners such as Hydroair and UWM. The need for further optimisation and automatisisation in open fields became clear, and the idea of OPTIFERT was conceived. After developing the proposal, ttz has been in charge of the general coordination of the project and the design, construction and testing of the dosing unit. As for the sensor, the University of Bremen and the Technical University of Vienna have led the development, with support from UWM in the sample-extraction methods and SME Pessl in requirement specifications. The software module has been developed by TUW, with support in the agronomic aspects from UWM. All participating SMEs have guided the development and validation phases, and are now involved in the marketing.

Development stage: Prototypes

All three OPTIFERT modules (soil-nutrient sensor, dosage unit, software) have been developed and validated to a prototype stage.

Policy impact: Avoidance of soil degradation and over-fertilization

Many projects develop new policies as a main goal, or as a by-product of their research and developments. There is a general consensus that European farmland is over fertilised. The JRC reference report 2012, shows that many soil-degradation processes are accelerating in many parts of Europe, often exacerbated by inappropriate human activities and widely varying approaches to tackling the degradation processes.

OPTIFERT supports the EC legislation 'Pollution caused by nitrates from agricultural sources' 91/676/EEC, and will be key to tackling the problems in Nitrate Vulnerable Zones (NVZs), where the

application of the Codes of Good Agricultural Practice, limitation of fertiliser application (mineral and organic) is mandatory. In these regions, taking into account crop needs, all nitrogen inputs and soil nitrogen supply is essential.

Next steps: Final product validation, marketing, new projects

After validating the system in a 25-hectare corn field in Brandenburg, Germany during the season 2013, the prototypes now need to enter a final product-development and validation phase for them to be sold. Our research project ended in November 2013, when a market survey was conducted through our website. The market response has been very positive, and the OPTIFERT sensor was awarded a silver medal at the Agritechnica 2013 Innovation awards. The participating SMEs in the consortium are willing to continue the product development. A wider validation campaign across Europe will be needed in order to gather more statistical data, fine tune the details and offer guarantees to the customers.

The OPTIFERT consortium is involved in Horizon 2020 and national proposals to continue the development and make the technology marketable.



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