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Digital Water Management for Improving Resilience of Agriculture, Food and Health as a Response to Global Risks

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RESONATE Sustainable Water Management

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Background

- The Program for Sustainable Water Management offered 11 courses in five modules. These courses were co-created and were offered in joint collaboration of academic and business organisations from 4 countries (N. Macedonia, Serbia, Spain and Portugal).

The Global Risks Report 2021 16th Edition (WEF, 2021)

- Among the highest likelihood risks of the next ten years are extreme weather, climate action failure and human-led environmental damage; as well as digital power concentration, digital inequality and cybersecurity failure.

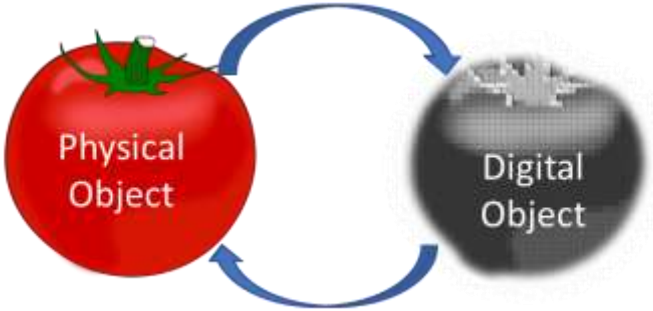
Food security and climate change

Ariel Dinar, Amanda Tieu, Helen Huynh, Water scarcity impacts on global food production, Global Food Security, Volume 23, 2019, Pages 212-226, https://doi.org/10.1016/j.gfs.2019.07.007.

Digital twin

Digital Twins from an IoT perspective, in which physical objects have virtual, digital equivalents that are real-time and remotely connected.

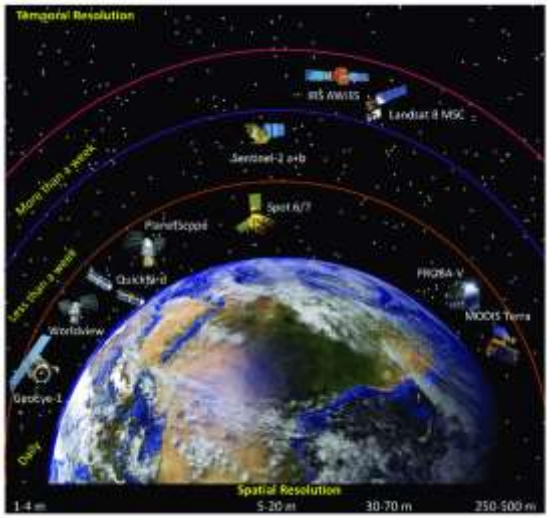
Digital twins of a farm can be used to:



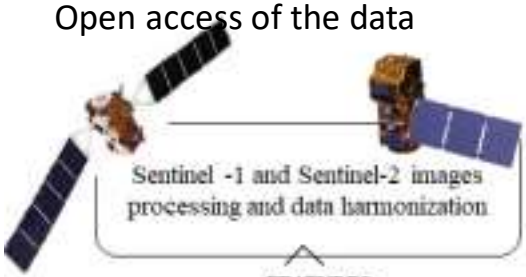
- **identify plant pests and diseases,**
- **other crops information,**
- **soil data,**
- **energy and water consumption,**

aiding in the decision-making process, improving management operations, reducing operational costs, and increasing farm productivity.

Data acquisition
Remote Sensing



High spatial and time resolution
Open access of the data



Sentinel -1 and Sentinel-2 images processing and data harmonization

Field measurement of SMC, the definition of threshold value and indicator kriging

FEATURES

TARGET VARIABLE

LEARNING

Training and performance of Logistic Regression and Random Forest → Feature Selection → DEM is best variable to describe SMC levels (probabilities high/low according to a threshold value)

CLASSIFICATION

Mapping SMC probability classes (high/low) using Logistic Regression and Random Forest:

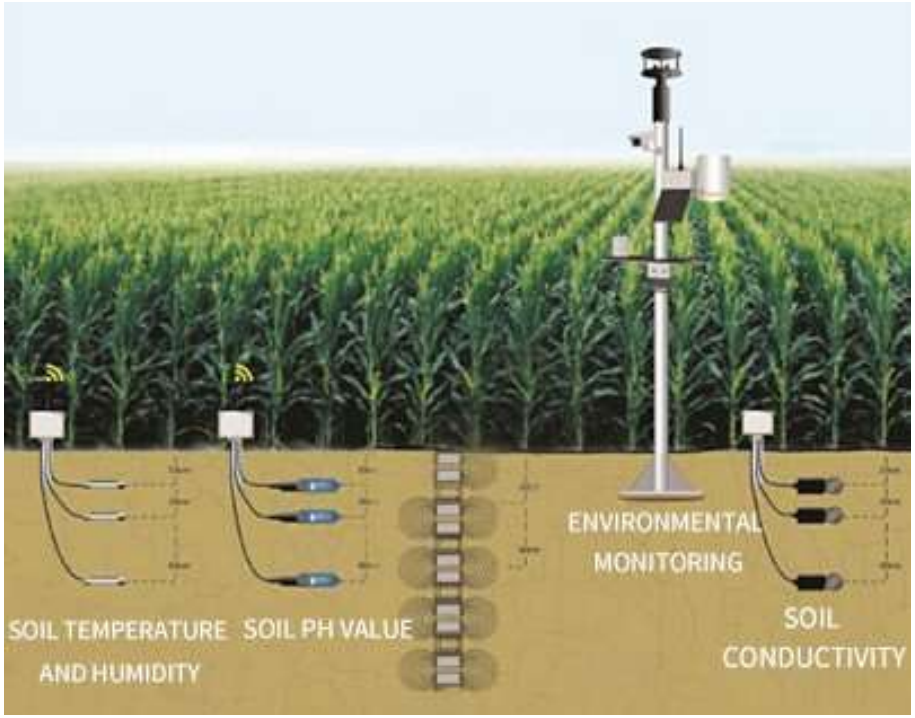
- ✓ Identified zones more susceptible in time and in space to soil salinization.

https://www.xyonix.com/crop-monitoring

Segarra, Joel & Buchaillot, Maria & Araus, Jose & Kefauver, Shawn. (2020). Remote Sensing for Precision Agriculture: Sentinel-2 Improved Features and Applications. Agronomy. 10. 641. 10.3390/agronomy10050641.

Mendes M.P., Matias M., Gomes R.C., Falcão A.P. (2021): Delimitation of low topsoil moisture content areas in a vineyard using remote sensing imagery (Sentinel-1 and Sentinel-2) in a Mediterranean-climate region. Soil & Water Res., 16: 85–94.

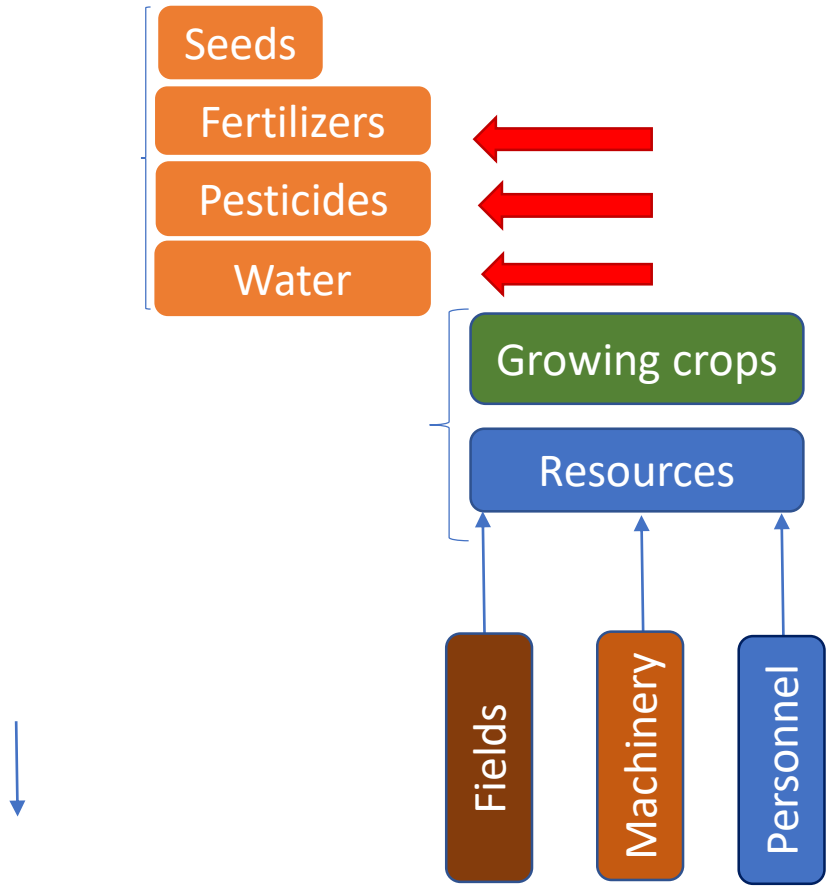
Data acquisition
Sensors



Plant-based sensors that measure the thickness and electrical capacitance of leaves show great promise for telling farmers when to activate their irrigation systems.

https://pbs.twimg.com/media/ERQu2OhVUAIpNk7?format=jpg&name=small
https://news.psu.edu/story/480105/2017/08/30/research/leaf-sensors-can-tell-farmers-when-crops-need-be-watered

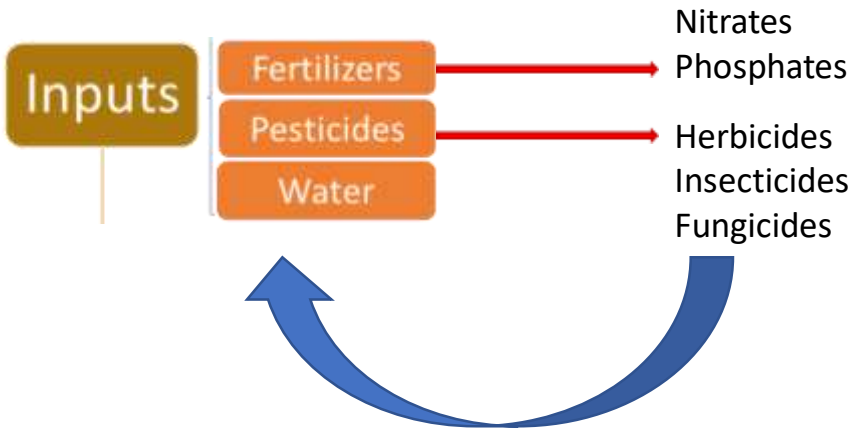
Implementation challenges



Farms are part of a dynamic network and share data with many stakeholders including customers, input suppliers, farmer cooperatives, advisors, contractors, and certification and inspection organizations.

Cor Verdouw, Bedir Tekinerdogan, Adrie Beulens, Sjaak Wolfert, Digital twins in smart farming, Agricultural Systems, Volume 189, 2021, https://doi.org/10.1016/j.agsy.2020.103046.

SMART FARM



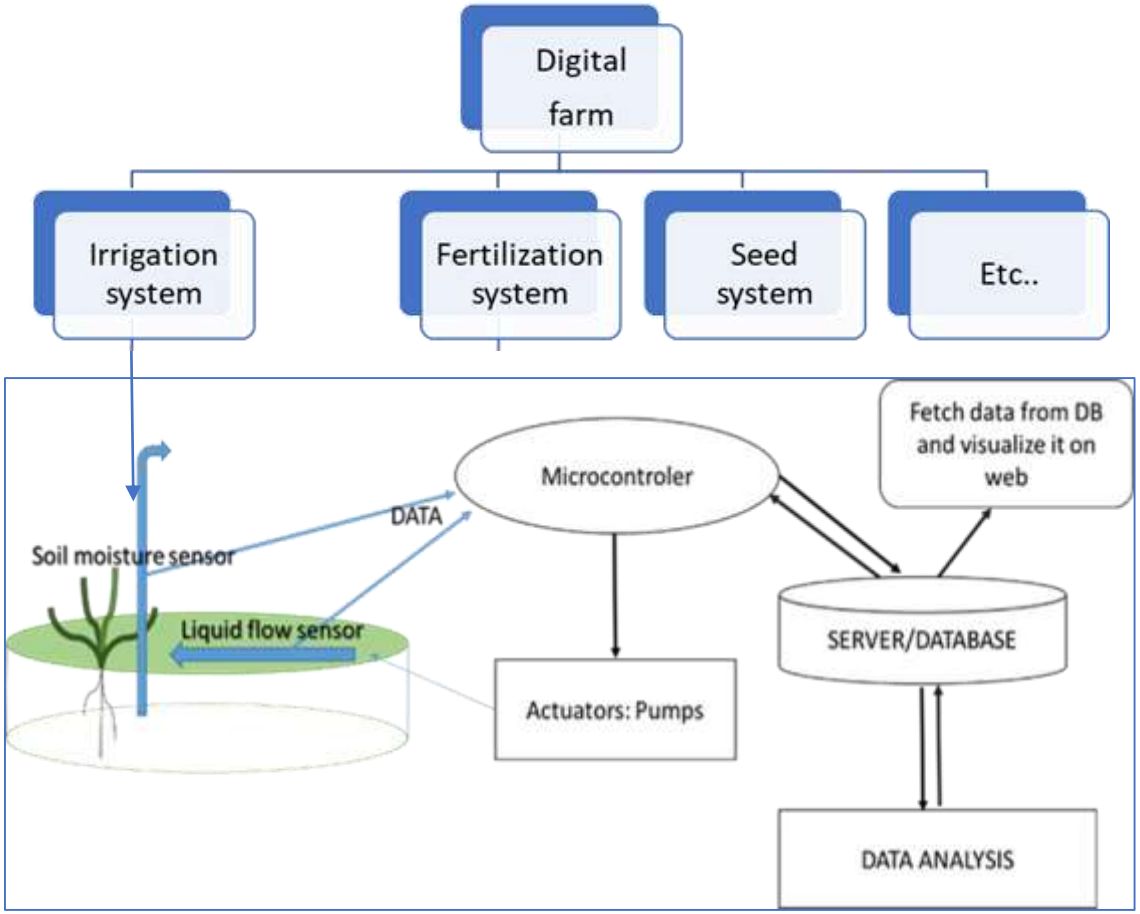
Eutrophication

The presence of undesirable substances in food is a critical indicator of their quality and safety.

Special attention is paid to chemical pollutants, including heavy metals, polycyclic aromatic hydro-carbons, antibiotics, nitrates/nitrites and pesticides.

Farmers can simulate corrective and preventive actions and evaluate its impact on the digital representation.

Digital farm



Historical and forecasted data
Satellite data
Soil-, water- and air-analyses

Large-scale digital twins of an agricultural landscape, consisting of many individual farms, each with several learning components could be able to establish water flow, fertilizer dispersion, and nutrient leaching.

Figure Adapted: Burger, G. S. I. E., Chen, S., Fatras, N., & Su, H. (n.d.). Smart Water Irrigation System.

Digital farm

- Great advantages for the prevention and control of water pollution, reliability and efficiency of water supply, and food security;
- Sensors are decreasing costs;
- Components of an IoT for monitoring (sensors, protocols, controllers, cloud platforms) are diverse and can be selected according to the farmer needs.

Thank you for paying attention,

- Efficiency is not the same as water saving;
- digital twins in agriculture are usually at lower levels of readiness for technology, as they require knowledge of a variety of disciplines, such as the IoT, cloud computing, machine learning algorithms, and big data analytics.
- digital inequality and cybersecurity failure.