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# THEORETICAL MODEL FOR IMPLEMENTING DIGITAL TWINS IN FARMS FROM DOBROGEA REGION

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**Abstract**: *This paper presents a theoretical model for implementing Digital Twin (DT) technology in farms from Dobrogea, Romania. The proposed framework integrates data from sensors, satellite imagery, climate records, and farm operations to create dynamic virtual replicas. By enabling real-time monitoring, predictive simulation, and decision support, DTs can improve farm productivity, resource use, and climate resilience in this drought-prone region.*

## • Introduction

A Digital Twin (DT) is a dynamic virtual replica of a physical system, continuously updated with real-time data to enable monitoring, simulation, and prediction. Originally used in industry, DTs are now emerging in agriculture as tools for smarter, more responsive farm management.

In Dobrogea—Romania's most arid farming region—frequent droughts and resource pressures demand precise, data-driven decisions. This study proposes a theoretical DT model tailored to local conditions, integrating sensors, satellite data, and predictive models to support climate-resilient and efficient agriculture..

## • Material and method

The Digital Twin model is structured in five layers:

- **Data Acquisition** – Real-time data from IoT sensors, drones, and satellites: soil, weather, crop status, and farm inputs.
- **Integration** – Data is transmitted via LoRaWAN/NB-IoT and processed in cloud platforms (e.g., AWS IoT, ThingsBoard).
- **Modeling** – Crop simulation (AquaCrop, DSSAT), machine learning, and climate indices enable scenario forecasting.
- **Decision Support** – Generates alerts, recommends actions, and provides visual tools (NDVI, growth maps).
- **Feedback Control** – Automated responses

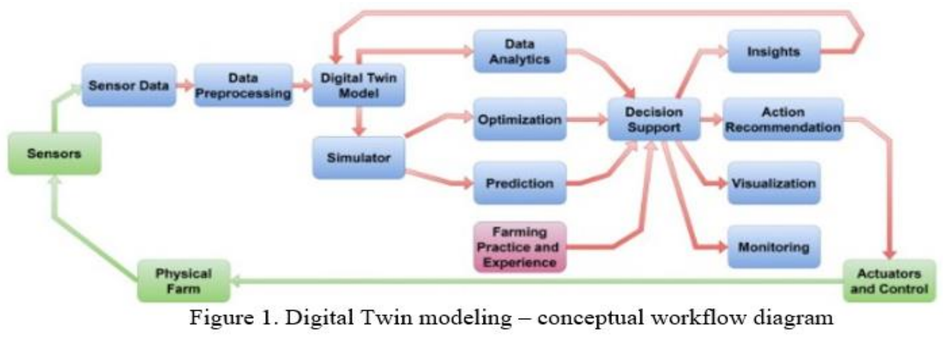

Figure 1. Digital Twin modeling – conceptual workflow diagram

## • Results and discussions

Comparative Insights from Existing Models:

- **Jeju, South Korea** – Mandarin Orchards:Digital Twin with strong spatial analytics and yield prediction using GIS and ML. Focused on perennial crops; lacks real-time feedback.
- **EU–Brazil Pilot** – Smart Irrigation:Real-time control via sensors and cloud-based simulation; optimized irrigation. Narrow scope, but high automation value.

**Dobrogea Framework Positioning**

The proposed DT model combines macro monitoring with micro-level automation, targeting cereals and oilseeds in a semi-arid climate. It builds on the strengths of both models while addressing Dobrogea's specific needs – modular, scalable, multi-source data fusion, real-time decision support.

## • Conclusions

This study presents a theoretical Digital Twin framework for Dobrogea's farms, integrating sensor data, satellite imagery, and predictive models to support real-time decision-making. By combining spatial monitoring with automation, the model addresses climate risks and resource constraints in semi-arid agriculture. Although conceptual, it aligns with EU sustainability strategies and offers a foundation for pilot implementation and future