



THE CONNECTED FIELD: IoT SENSOR NETWORKS AND DATA ANALYSIS FOR REAL-TIME MONITORING OF ORGANIC CROPS

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Abstract: Organic agriculture requires technological solutions to compensate for restrictions on synthetic inputs. The Internet of Things (IoT) enables sensor networks monitoring key cultivation parameters: soil moisture, temperature, pH, light, humidity, CO₂ and electrical conductivity. This article describes the layered architecture of an agricultural IoT system, analyses sensor types and platforms (Arduino, Raspberry Pi, ThingSpeak, Node-RED), proposes the SmartField interdisciplinary educational project, and discusses opportunities and limitations within a STEM education context.

• Introduction

In organic farming, where synthetic inputs are restricted, continuous monitoring of growing conditions is critical. IoT transforms observation from a manual process into an automatic, data-driven one [2]. LoRaWAN covers up to 15 km in open fields with years of battery life [3]. The EU Farm to Fork strategy targets 25% organic land by 2030 [1].

• Material and Method

Theoretical-applied approach: (1) literature review on IoT in agriculture (Google Scholar, IEEE Xplore, Elsevier); (2) comparative analysis of hardware (Arduino, Raspberry Pi) and cloud platforms (ThingSpeak, Node-RED) on cost and accessibility; (3) design of the SmartField project using project-based learning [7].

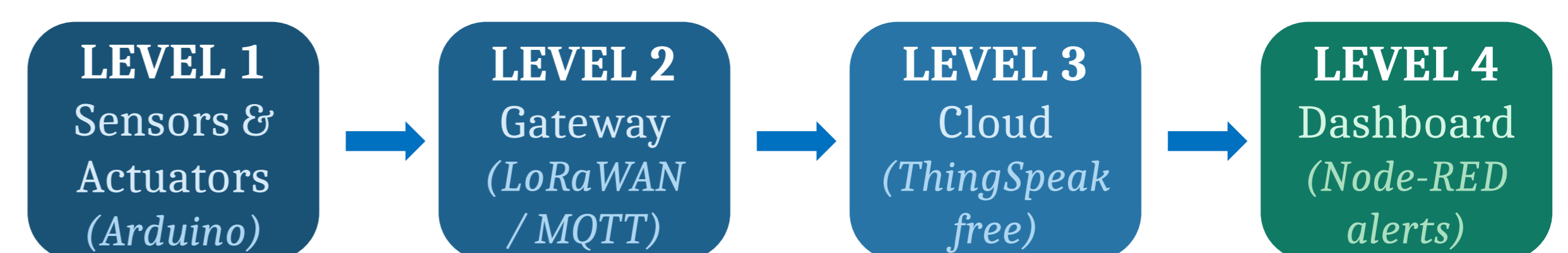
• Conclusions

IoT in organic agriculture is an accessible reality — in the classroom too. The SmartField project demonstrates that informatics, biology, physics and organic agriculture form a fertile STEM triad. Future work: pilot validation and extension toward AI-based predictive analysis and drone imagery.

• Results and Discussions

An agricultural IoT system operates across 4 functional levels (Fig. 1). Key sensors monitor 8 parameters in real time. Arduino (~15-20 EUR) handles data acquisition; ThingSpeak and Node-RED enable free cloud visualisation and automation. Studies report 30-50% water savings versus conventional irrigation [6].

Fig. 1. 4-Level IoT Architecture for Smart Organic Farming



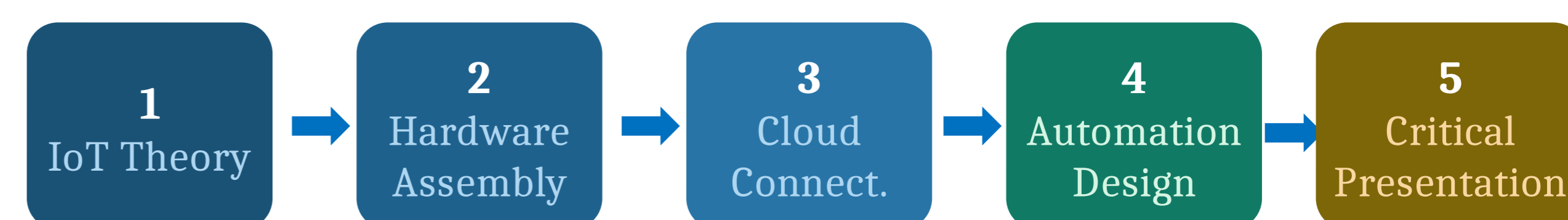
IoT-based irrigation: 30-50% water savings vs. conventional [6]
 ✓ Autonomous alerts ✓ Real-time data

Table 1. Key sensors and IoT platforms for organic crop monitoring

Parameter	Sensor Model	Platform / Tool	Cost
Soil moisture	Capacitive sensor	Arduino + ThingSpeak	~5 EUR
Temp. & Humidity	DHT22 / SHT31	Raspberry Pi + Node-RED	~4 EUR
Soil pH	Electrode + ADC	Arduino + ThingSpeak	~10 EUR
Light intensity	BH1750	ThingSpeak (free)	~3 EUR
CO ₂ concentration	MH-Z19	Raspberry Pi + Node-RED	~20 EUR
Soil temperature	DS18B20	Arduino + LoRaWAN	~3 EUR
Total system cost: ~50-80 EUR LoRaWAN range: up to 15 km Battery life: 1-3 years			

Source: Bacco et al., 2019; Liakos et al., 2018; MathWorks, 2023

Fig. 2. SmartField Project — 5-Stage Educational Cycle (5-6 weeks)



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