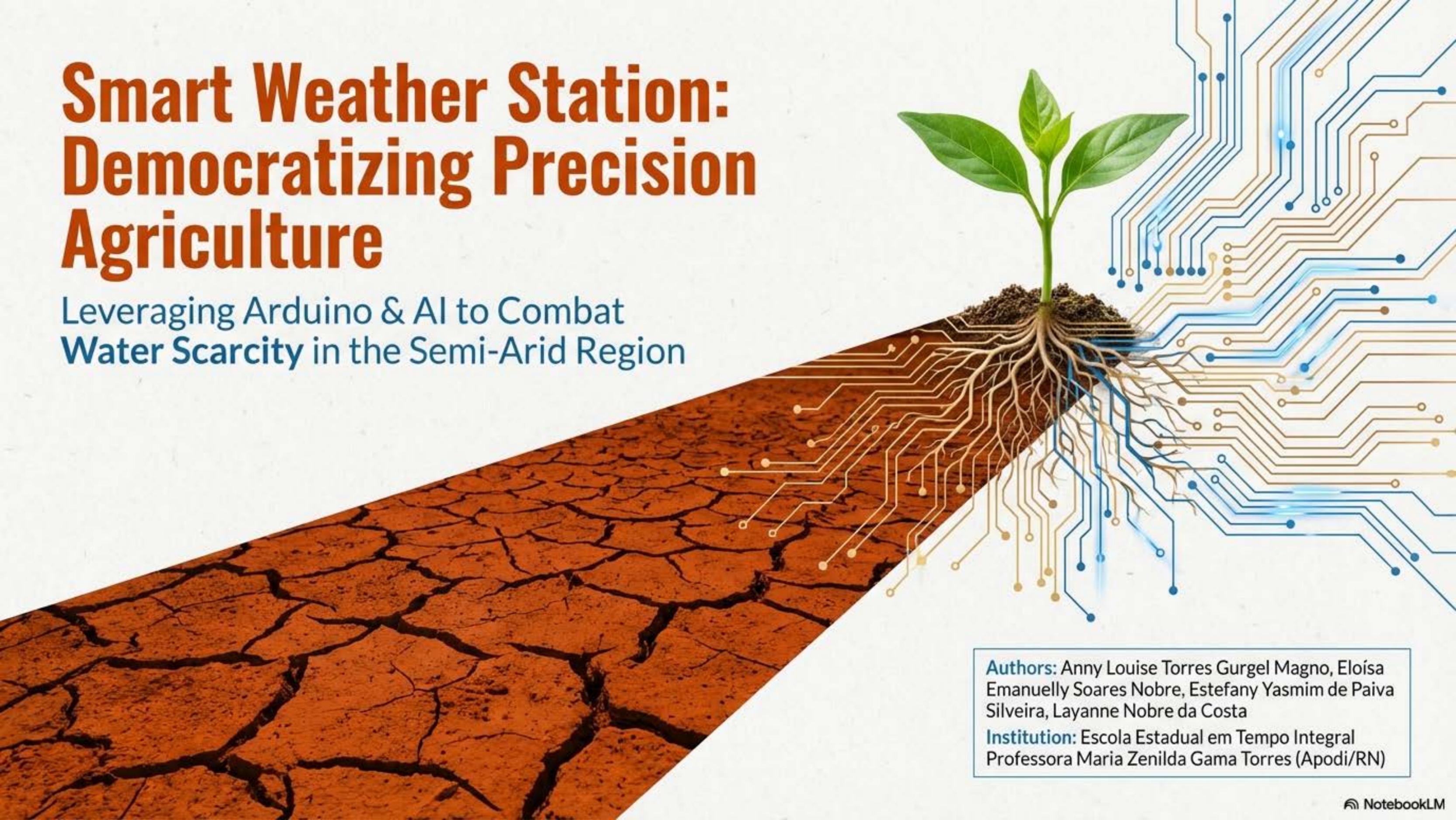


Smart Weather Station: Democratizing Precision Agriculture

Leveraging Arduino & AI to Combat
Water Scarcity in the Semi-Arid Region



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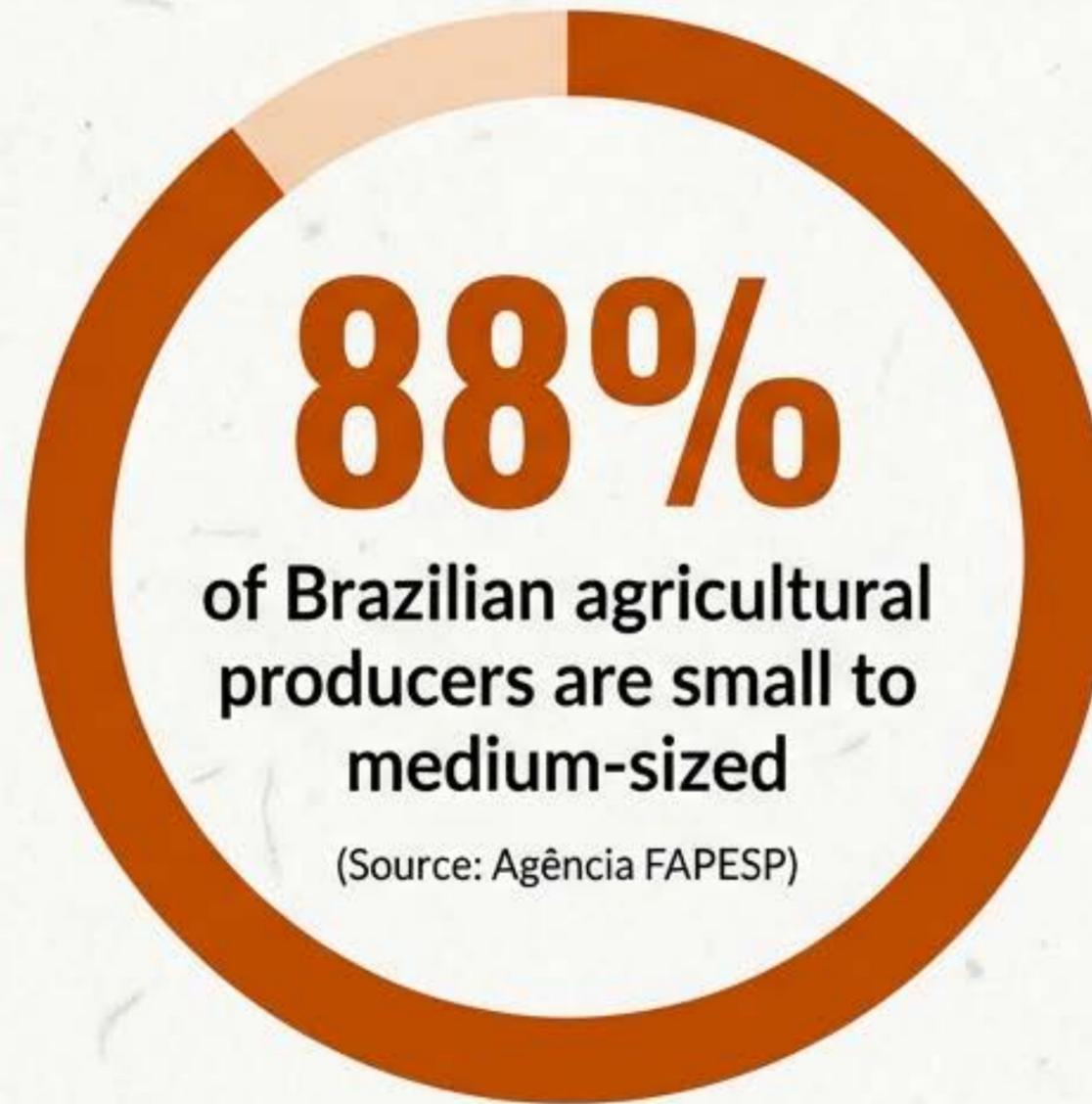
Institution: Escola Estadual em Tempo Integral Professora Maria Zenilda Gama Torres (Apodi/RN)

The Reality of Apodi: Water Scarcity and Inequality



Large Producers

- Automated Irrigation
- Remote Monitoring
- Advanced Climate Data



Family Farmers

- Financial Barriers
- Technical Limitations
- High Vulnerability

The Consequence: Without technology, small farmers in the semi-arid region face crop loss and economic instability.

Research Mission: Bridging the Technological Divide



Democratize Technology

Create a solution that reduces structural inequalities between small and large producers.

Optimize Resources

Automate irrigation to reduce water waste.

Integrate Ecology

Align technology with the natural environment (Atmosphere, Biosphere, Hydrosphere, Pedosphere).

Primary Question: How can low-cost automation (Arduino) contribute to water sustainability for family farming in the Brazilian semi-arid region?

A Holistic Approach: The Four Spheres

Atmosfera (Air)

Monitoring temperature, light, and climatic variations



Hidrosfera (Water)

Managing irrigation and rainfall data.



Pedosfera (Soil)

Monitoring soil moisture and nutrient cycles.



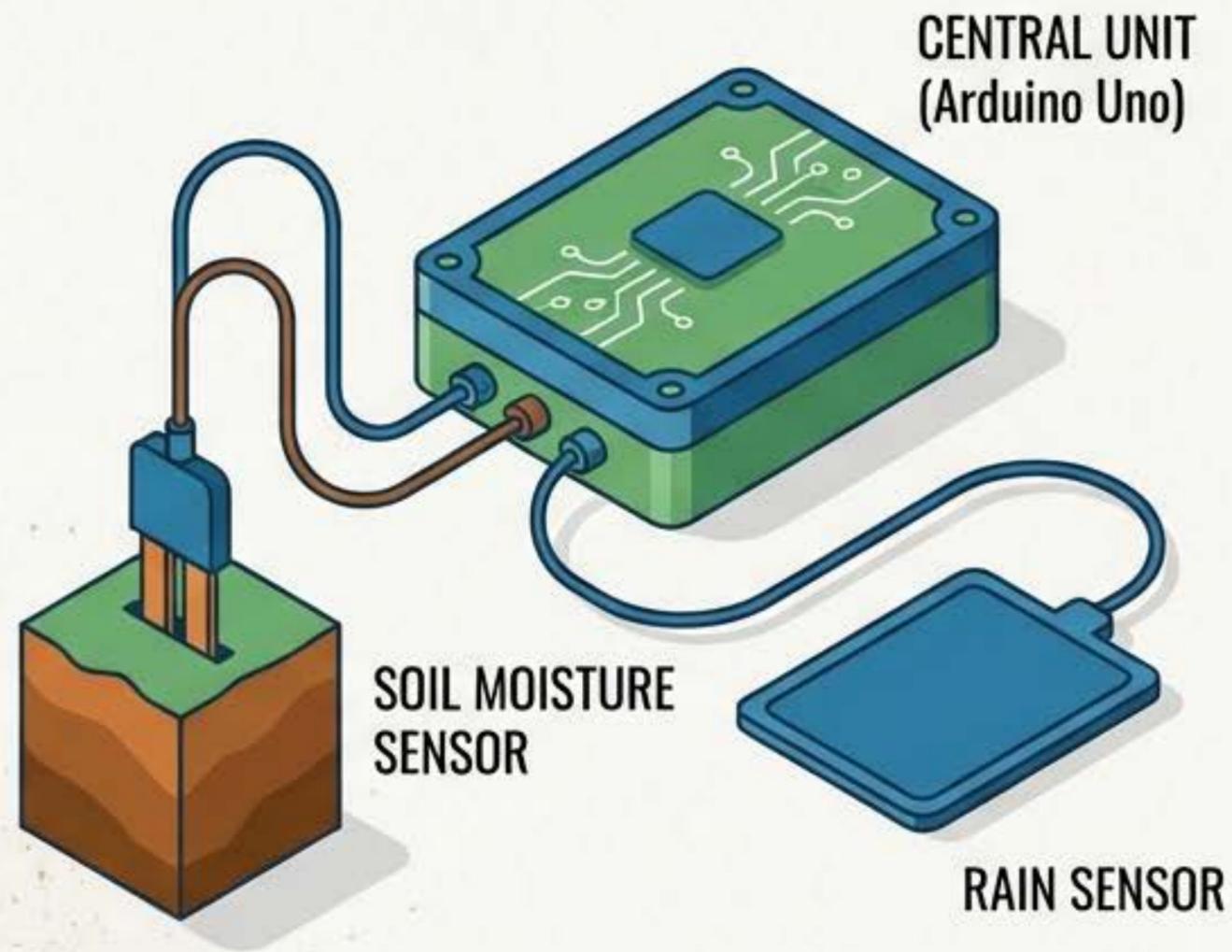
Biosfera (Life)

Ensuring plant health and human survival.



Any sustainable agricultural technology must balance these four environmental protocols.

The Solution: An Autonomous Weather Station



Core Capabilities



Smart Sensing: Measures soil moisture, ambient light, and rainfall presence.



Environmental Awareness: Distinguishes between Day/Night and Sunny/Cloudy conditions.



Action: Automatically triggers irrigation pumps only when necessary.



Feedback: Displays real-time data on an LCD 16x2 screen.

A low-cost system based on Arduino Uno acting as a simplified weather station and automated irrigation controller.

Methodology: From Theory to Prototype

Exploratory Research

Technical Planning

Prototyping

Validation

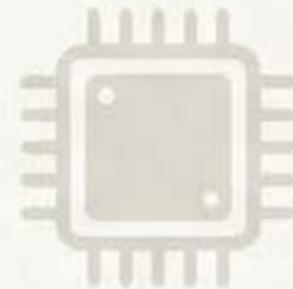
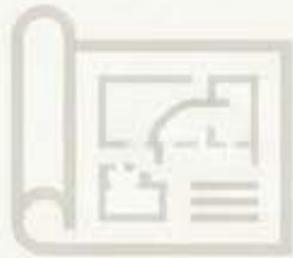


Understanding pain points of local farmers & tech limits.

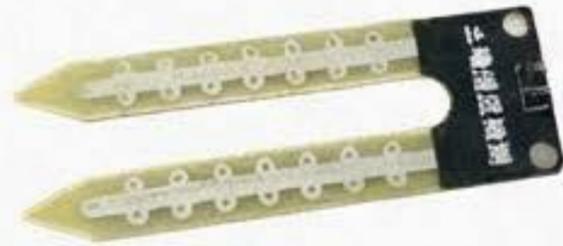
Selection of sensors and circuit design logic.

Assembly of Arduino, relay modules, and sensors.

Testing in simulated environments (dry vs. wet, sunny vs. rain).



The Hardware Ecosystem



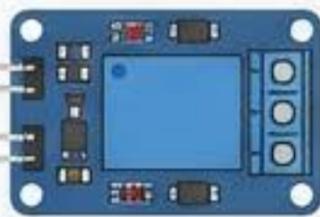
The Touch:
Soil Moisture Sensor
(Detects water deficit)



The Reflex:
Rain Sensor
(Stops watering during rain)



The Brain:
Arduino Uno
(Central Unit)

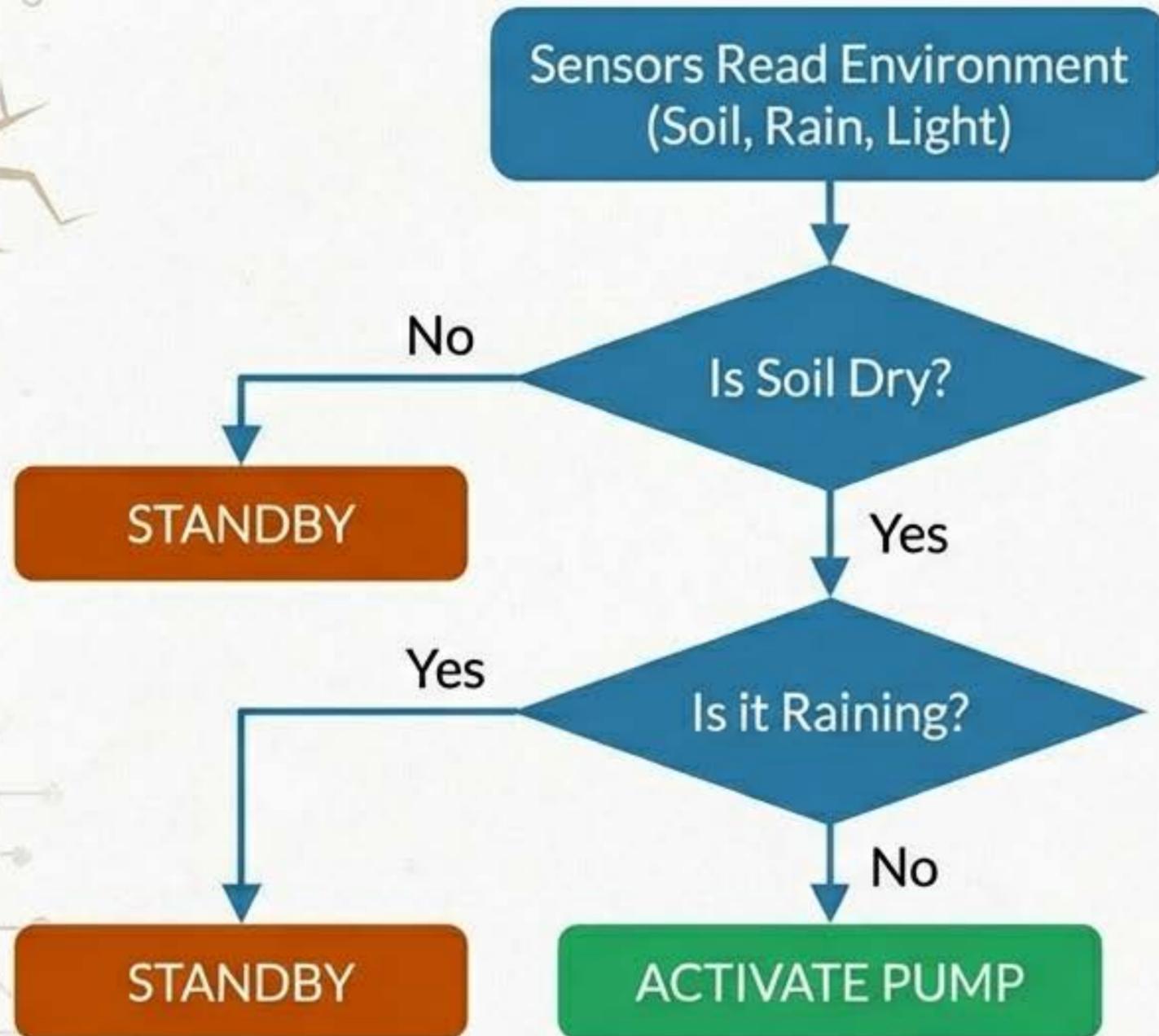


The Muscle:
Relay Module & Water Pump
(Executes command)



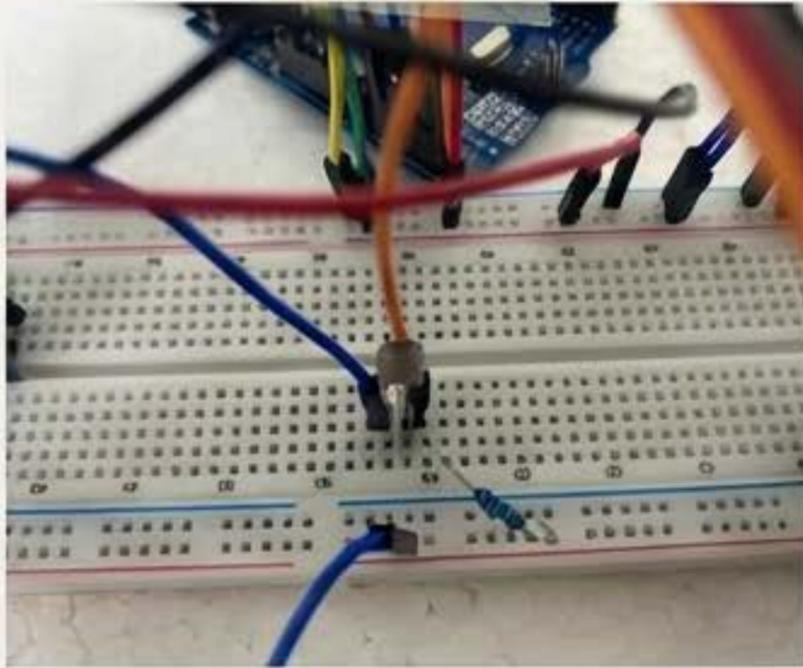
The Eyes:
LDR Sensor
(Detects light intensity)

Automated Decision Logic

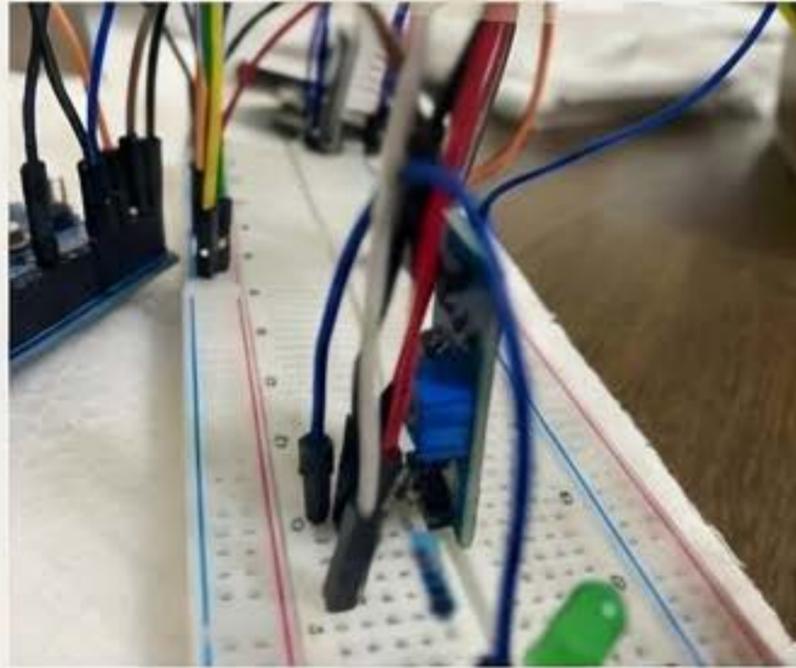


“The system reacts autonomously, triggering irrigation only when a real water deficit is identified combined with a lack of rain.”

Prototyping and Assembly



LDR Sensor Wiring



Relay Module Integration



LCD Screen Display

- Utilized a Protoboard for flexible circuit design and iteration.
- Integrated an LCD 16x2 for immediate data visualization.
- Calibrated sensors to distinguish specific moisture and light thresholds.

Performance Results



Precision

Sensors accurately measured humidity, light, and rain without error.



Autonomy

System successfully automated decision-making, eliminating manual intervention.



Stability

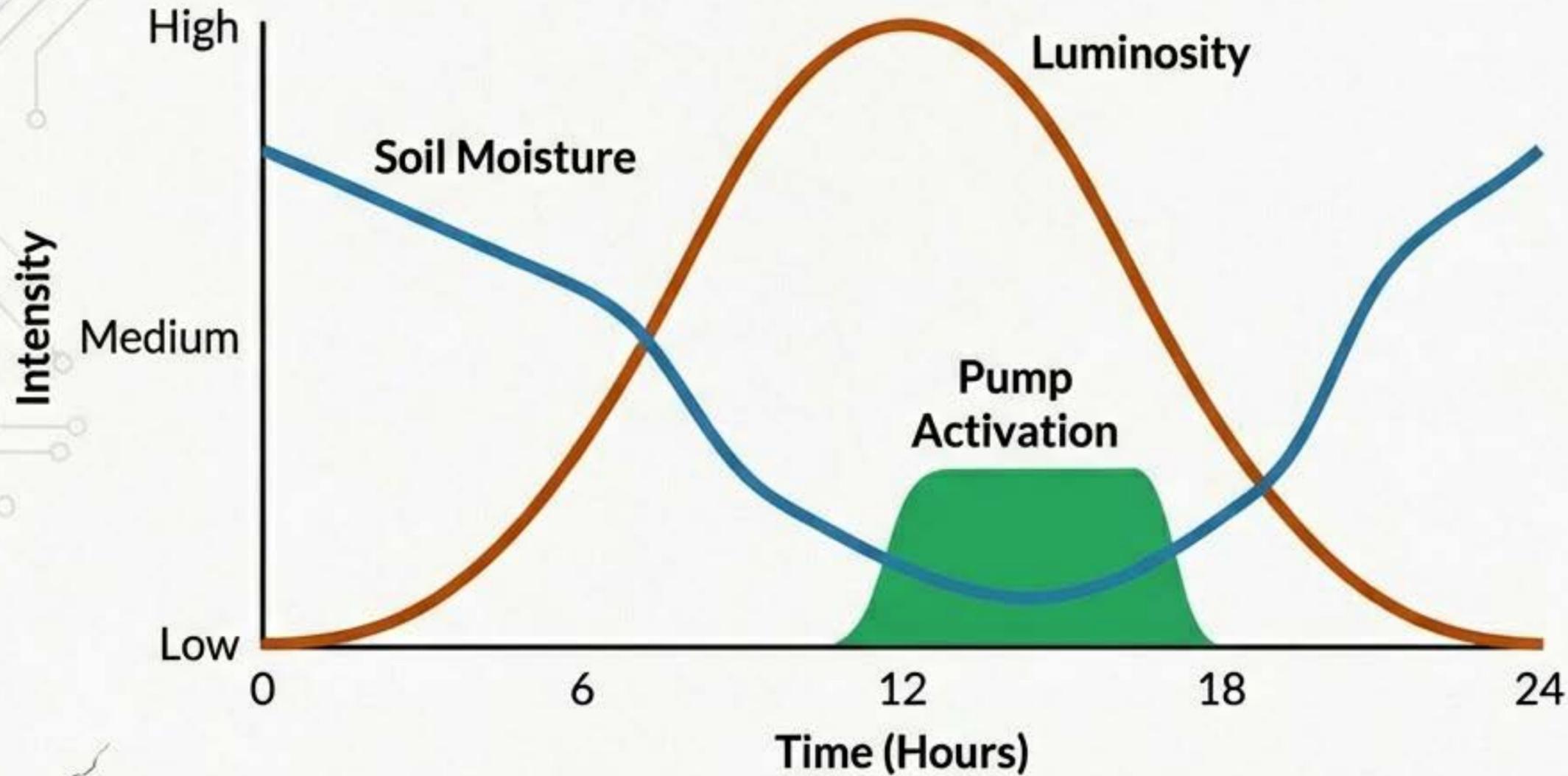
Maintained reliability during rapid light/humidity changes.



Efficiency

Irrigation matched real-time data, avoiding unnecessary activation.

Data Analysis & Trends



Value: Provides small producers with precision data for smarter resource management.

Mapping the relationship between irrigation frequency and soil recovery.

Impact: Education and Social Justice



Educational Impact

Sparked student interest in science, technology, and sustainability in public schools.



Social Impact

Promotes 'Technological Justice' by making precision agriculture accessible to families.



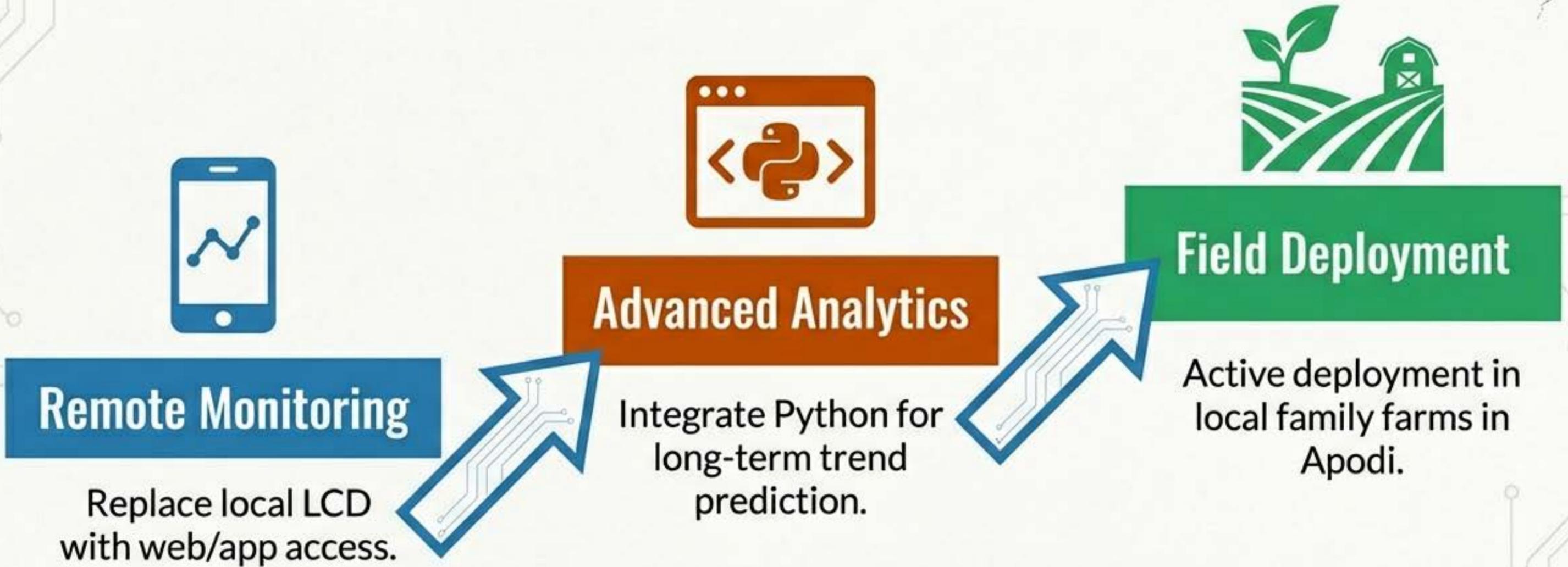
Environmental Impact

Concrete development of environmental awareness among youth.

“The next step for Brazilian agriculture... is the democratization of access to technology.”

– Silvia Massruhá, President of Embrapa

Future Roadmap: Toward IoT Integration



Goal: Remove physical proximity constraints.

Conclusion: A Sustainable Path Forward

Technically Viable

The Arduino station is a low-cost, effective monitoring tool.

Environmentally Necessary

Directly contributes to the rational use of water in scarce regions.

Socially Urgent

Strengthens family farming resilience and food security.

Innovation, when accessible, transforms vulnerability into autonomy.

References & Credits

Project Team

- Anny Magno
- Eloísa Nobre
- Estefany Silveira
- Layanne Costa
- School: E.E.T.I. Professora Maria Zenilda Gama Torres

Selected References

- Agência FAPESP (2023) on democratizing tech access.
- Alves & Lima (2020) on Family Farming Sustainability.
- Silva & Costa (2020) on Arduino in Agriculture.
- Ministry of Science, Technology and Innovation (2019).