Team Name :GardenKeeper

Project Name:
Cost-effective agricultural garden automation with remote monitoring and additional features for sustainable operation and improved student nutrition in underfunded elementary schools of Panama and Central America

Maker Fair

Zero Hunger, SDG: 2.1, 2.2 , 2.3, 2.4

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Problem Statement:

Child malnutrition in Latin American schools, particularly in Panama, represents a critical public health challenge exacerbated by economic barriers and systemic inequalities

Despite regional economic growth, approximately 45.4% of children in Latin America face some form of malnutrition, with school-age children being particularly vulnerable.**[4]** In Panama, 19.1% of children under five suffer from malnutrition, with rates up to three times higher in rural and indigenous communities compared to urban areas. **[7]** This situation is aggravated by the fact that 32% of Latin American families cannot afford nutritionally adequate school meals, and food insecurity affects 47% of households with school-age children in Panama. The effects of malnutrition include a 28% lower academic performance, and a 60% increase in school dropout rates in areas with high food insecurity… [4]. Additionally, nutritional deficiencies such as iron deficiency (40% in school-age children in Latin America) and vitamin A deficiency (23.4% in Panamanian children) are prevalent.**[4][7]** Regional disparities are notable, with malnutrition rates varying from 12% in urban areas to up to 62% in indigenous communities in Panama**.[7]**

Socioeconomic factors such as rising food prices, limited household income, and high unemployment rates along with inadequate school feeding programs, limited access to clean water, and poor nutritional education, contribute to this problem.**[9][10][11]** Malnutrition not only leads to immediate health issues but also has long-term consequences, such as a reduction in lifetime earning potential by up to 20% and an increased risk of chronic diseases in adulthood **[4][12] [13]**. Therefore, it is crucial to address child malnutrition in schools through a multi-sectoral approach involving governments, schools, NGOs, and the private sector to implement effective school feeding programs, improve access to nutritious foods, strengthen nutritional education, and establish continuous monitoring systems

Problem Statement:

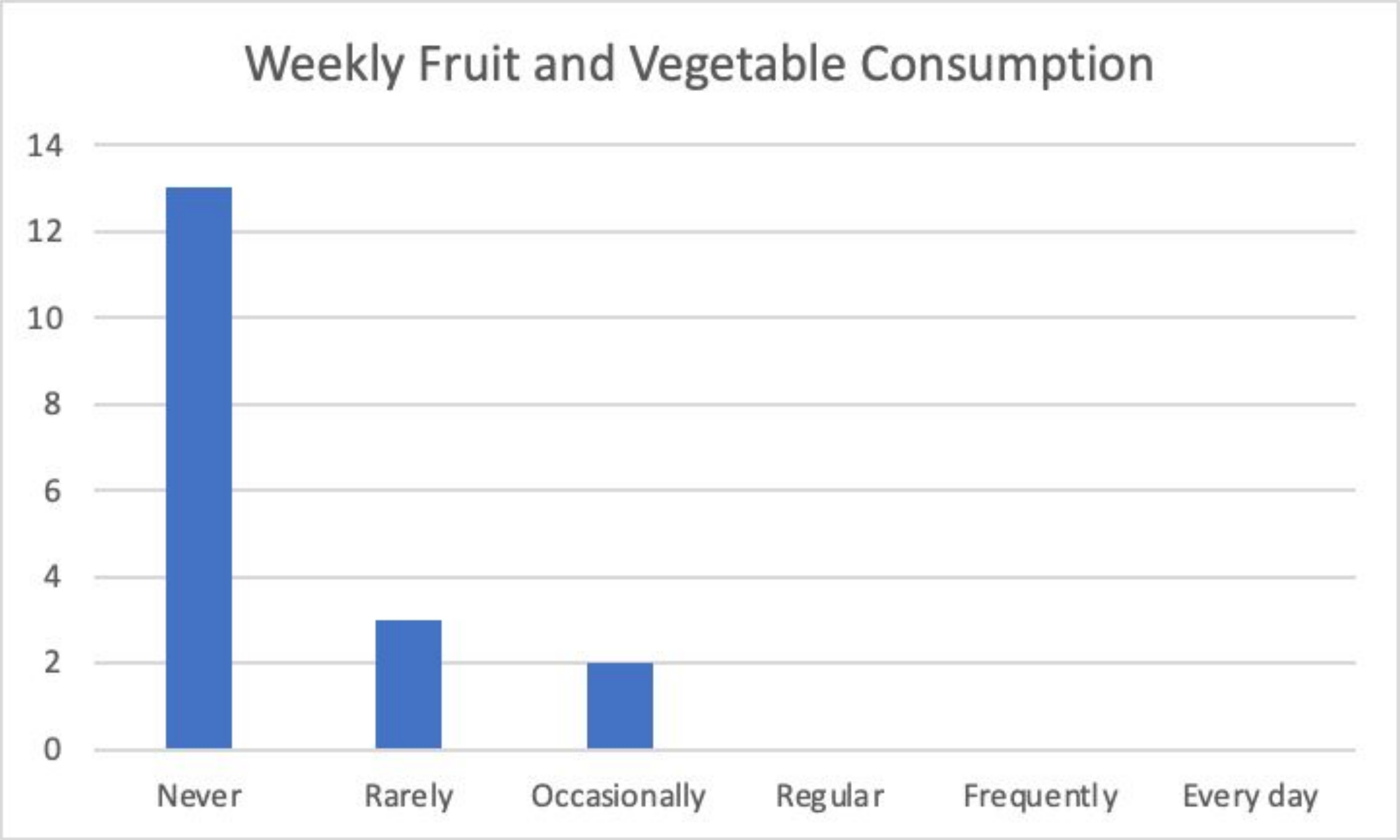
The implementation of agricultural gardens in mid-schools is a common practice in Panama. However, agricultural gardens present diverse requirements of knowledge regarding agricultural management. To add up, the demand for a good yield in the agricultural garden is particularly high, considering there are groups of students dependent on it for their meals. Even with the proper skills, maintaining an agricultural garden still requires a good amount of staff and time. As of today, there are many solutions for automated irrigation, however these are particularly expensive. Due to the expenses it requires, it is unlikely that small mid-schools will invest in an automated irrigation system. A particularly expensive part of an automated irrigation system is its control panel, ranging from $100- $200 US dollars in panama**[1]**. Another factor to take in consideration is the additional subscription costs for services charged to optimize irrigation with weather data, or the costs of implementing a weather stations to gather such data. **[2]**

Introduction:

Child malnutrition in schools, especially in economically challenged regions like Panama, remains a pressing public health issue that negatively impacts both academic performance and long-term health outcomes. In many mid-schools, agricultural gardens are a vital resource, providing much-needed nutritional support to students. However, these gardens face significant hurdles, including limited staff, high operational costs, and the technical demands of maintaining a consistent, high-yield production. Our project aims to address these challenges by developing a cost-effective, automated irrigation control panel. This system is designed to be easily managed via mobile devices or computers, thereby streamlining garden maintenance, optimizing water use, and ultimately contributing to improved nutritional outcomes for children.

Research Survey:

- During a charity handout organized by WONDER PANAMÁ In the Community of Barriales, Darién, Panamá, surveys were carried out among heads of households,with the amount of children ranging from 3 to 6 per household, asking questions regarding eating habits, medical histories, and current health conditions of the children in the community. The community had around 150 children.



: Bar chart representing the weekly consumption of fruits and vegetables in the studied population (y-axis represents the amount of kids that answered each option).

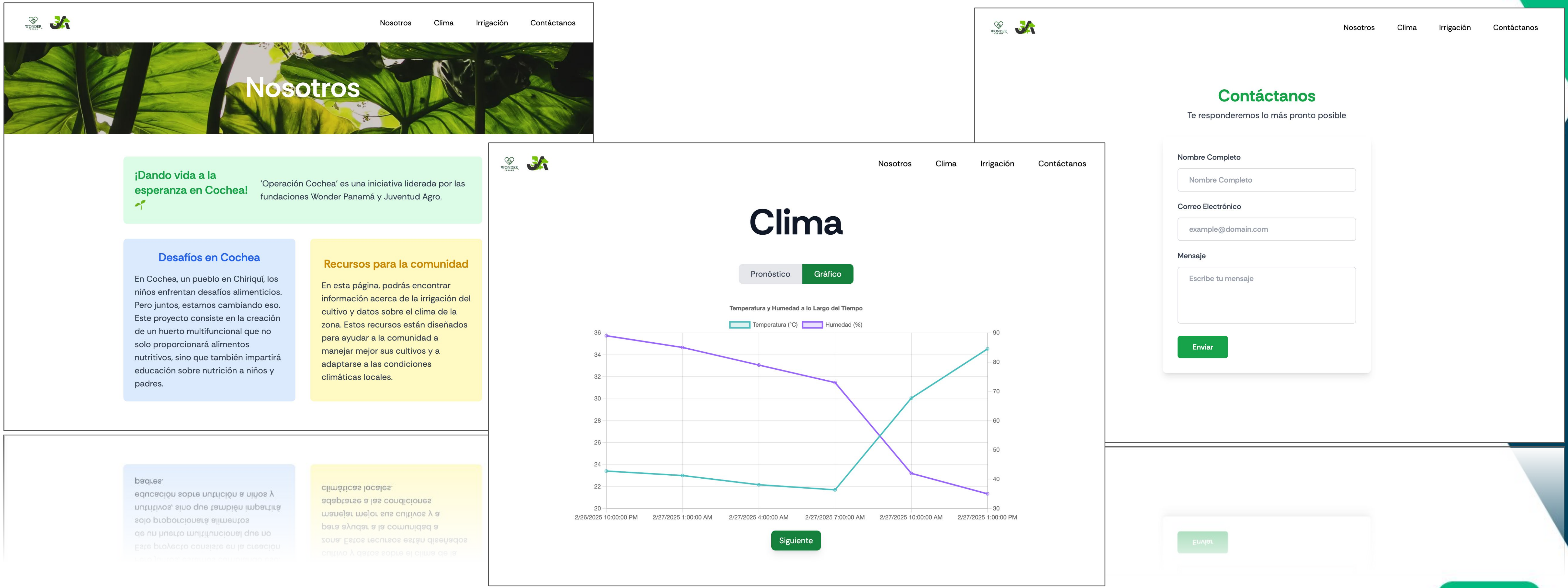
Proposed Solution:

The development of a cost-effective control panel for automated irrigation could potentially reduce the work, time, and staff required to properly maintain a school's agricultural garden. For this we propose designing a small control panel adjustable by phones or computers through Bluetooth or other suitable protocols. The control panel should consist of only essential components: Breakers, a microcontroller, power supplies, transformer, etc. The control panel is to be connected to Solenoid-Valves to activate the irrigation for the sections of an agricultural garden.

To enhance accessibility and ease of use, we propose the development of the website where the users can monitor and control the irrigation system remotely. The website would have a dashboard displaying real-time data such as soil moisture levels, temperature, humidity levels, etc. If schools have a stable internet service provider, remote monitoring and irrigation optimization can be implemented through open source databases, weather APIs, web controls. Constant values such as soil type can be predetermined before use, and complex values such as evapotranspiration can be approximated using established models**[2]**. The website could also have historical data, irrigation schedule, and notifications for maintenance in the system and potential issues related to efficient water management and sustainability. Finally, the cultivation cycles, along with rations and consumption rates, can be adjusted with aid of simulation using Simulink. This ensures that the frequent consumption of crops is sustainable and available for the forthcoming days without interruption. Additionally, a small portion of the crops can be used as potential revenue to cover maintenance of the garden or other supplies.

Prototype

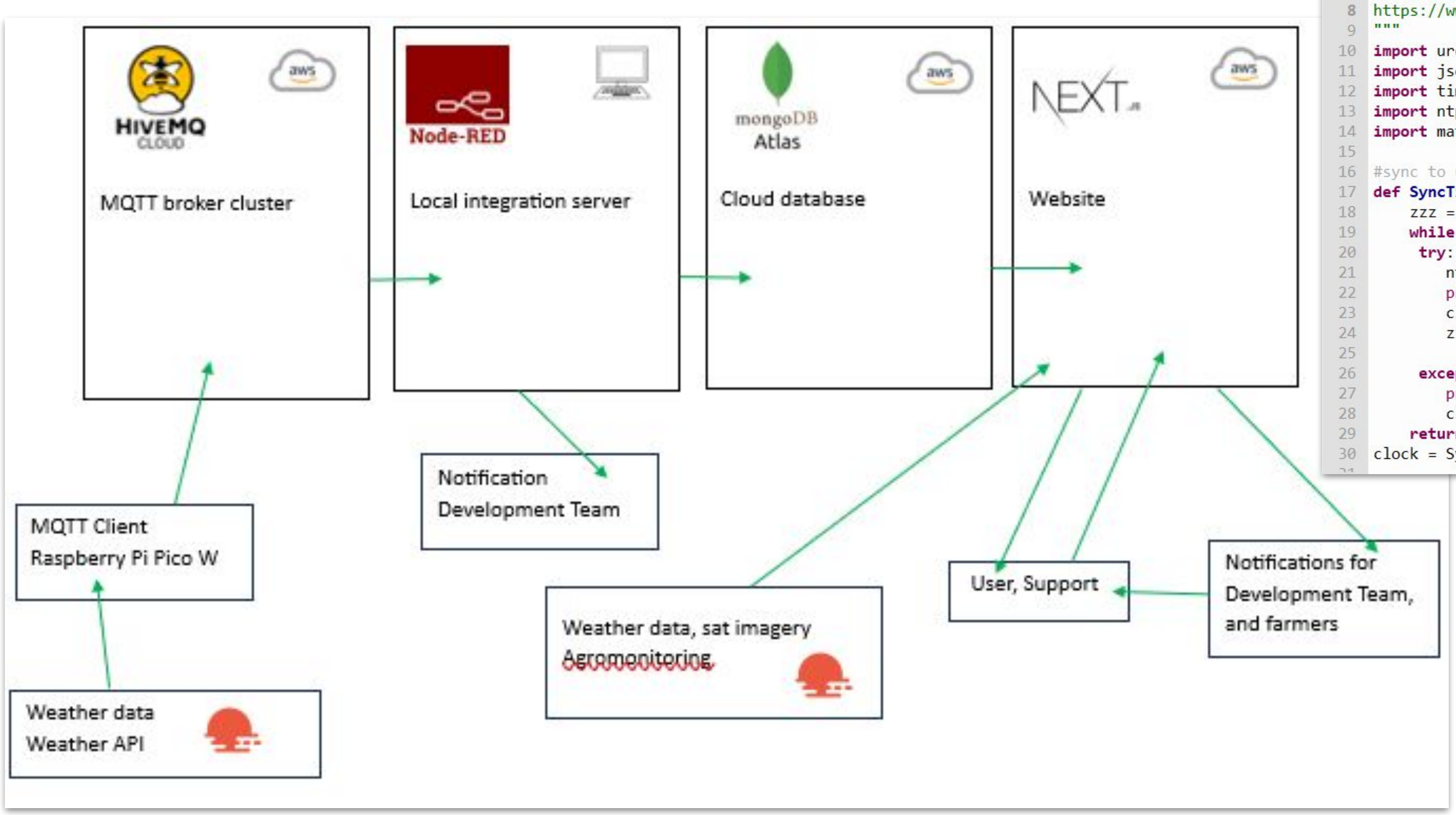
Website for remote monitoring, data visualization



- **Website Prototype: https://cochea-arriba.vercel.app/**

Prototype

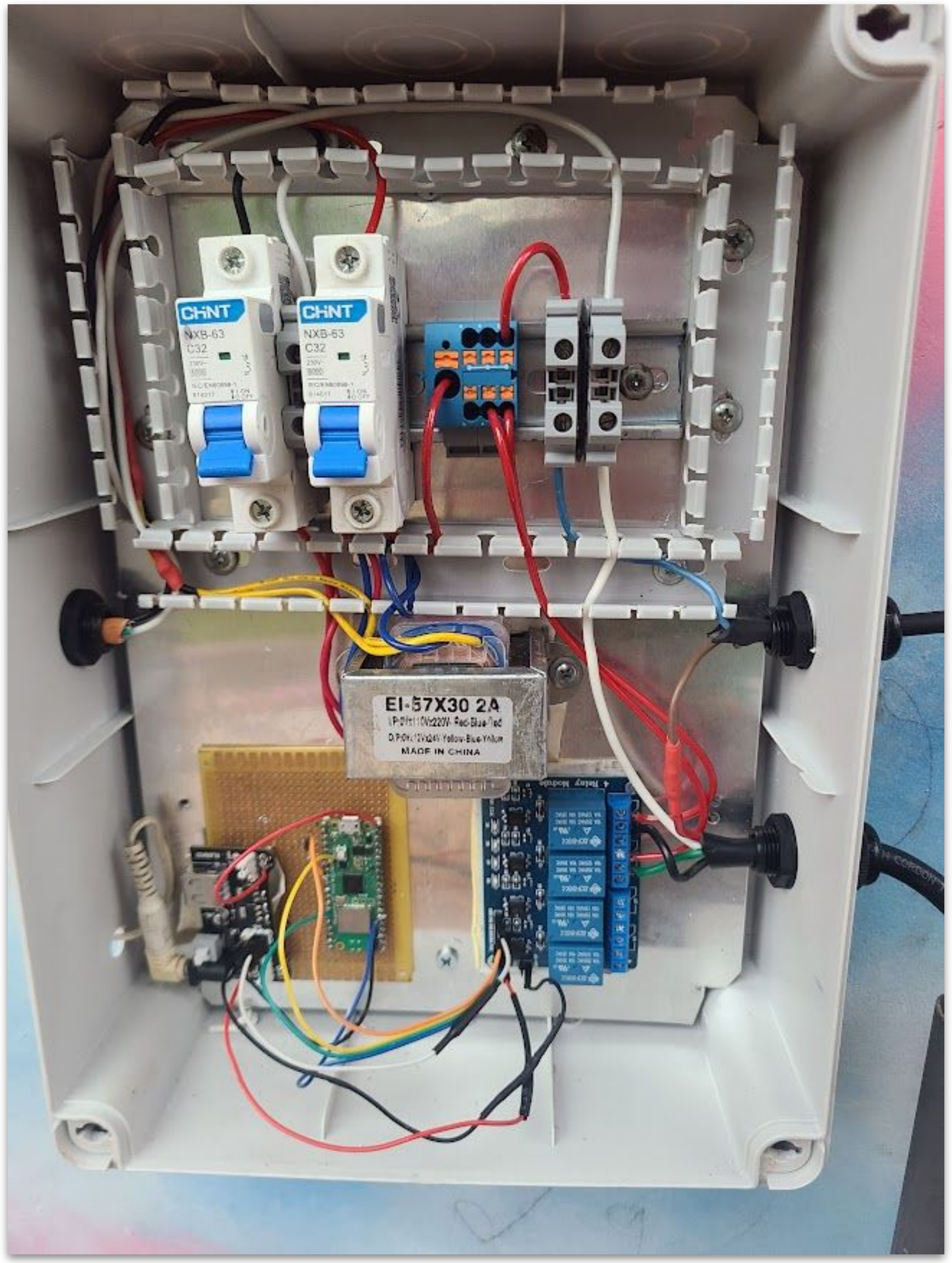
Data flow diagram, Weather APIs Implementation for Optimized Irrigation Using Approximation Of Evapotranspiration Values With Limited Data.

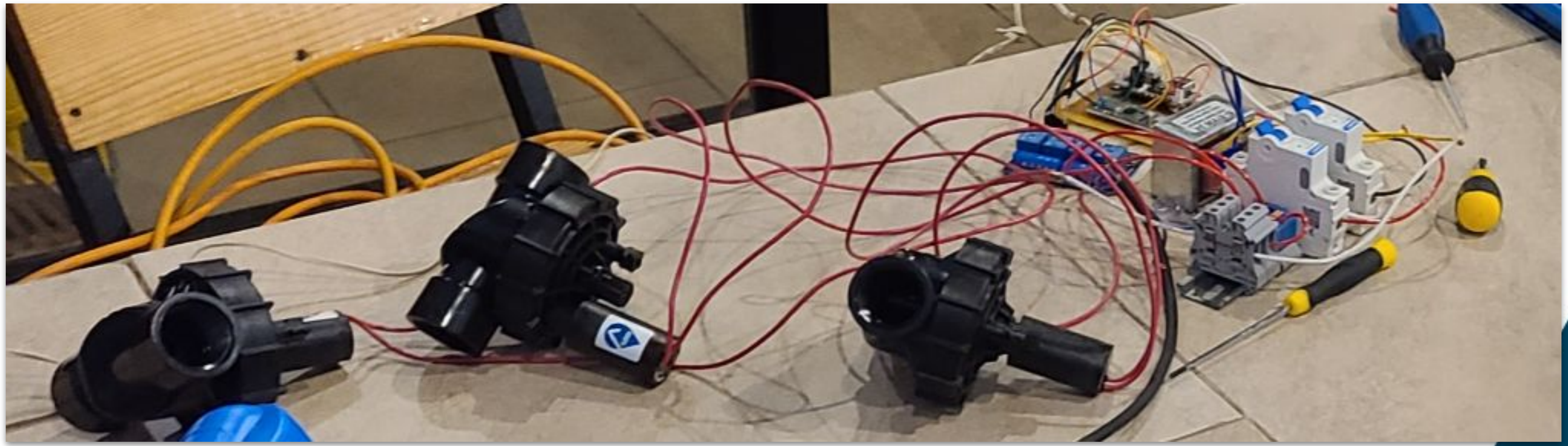


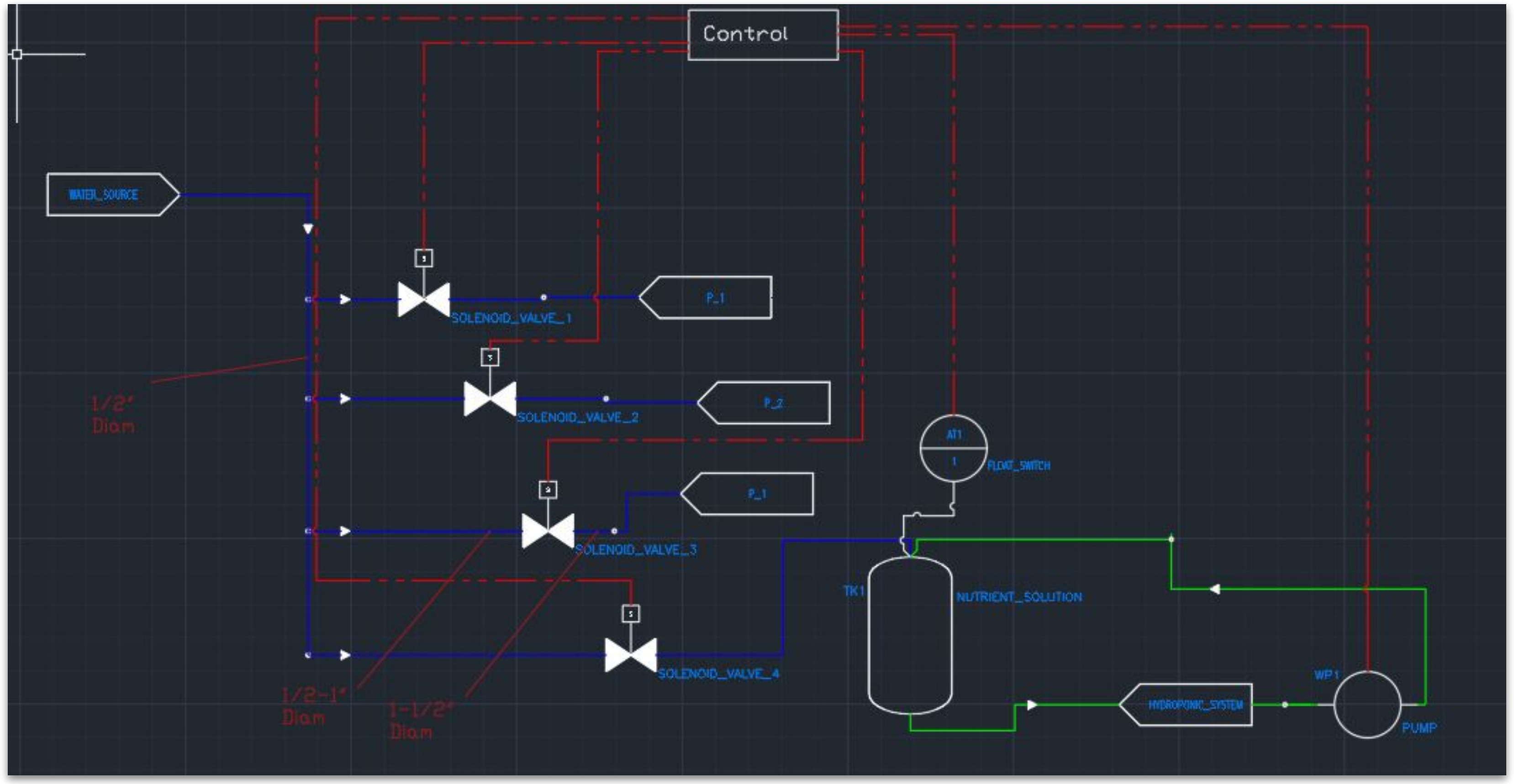

```python
"""
ETo approximation function
--------------
recollection of Weather data through APIs for ETo approximation

Reference:
Simplified forms for the standardized FAO-56 Penman-Monteith reference evapotranspiration using limited weather data
https://www.sciencedirect.com/science/article/abs/pii/S0022169413006501?via%3Dihub S
"""
import urequests
import json
import time
import ntptime
import math

#sync to utf - 5
def SyncTime():
    zzz = True
    while zzz == True:
     try:
        ntptime.settime()
        print("Synced to NTP")
        clock = time.localtime(time.time() - 5 * 3600)
        zzz = False

     except Exception as e:
        print("ERROR", e)
        clock = time.localtime(time.time() - 5 * 3600)
    return clock
clock = SyncTime()
```

Prototype

Control panel, solenoid valves, conceptual P&ID including potential system expansion and Hydroponics integration.



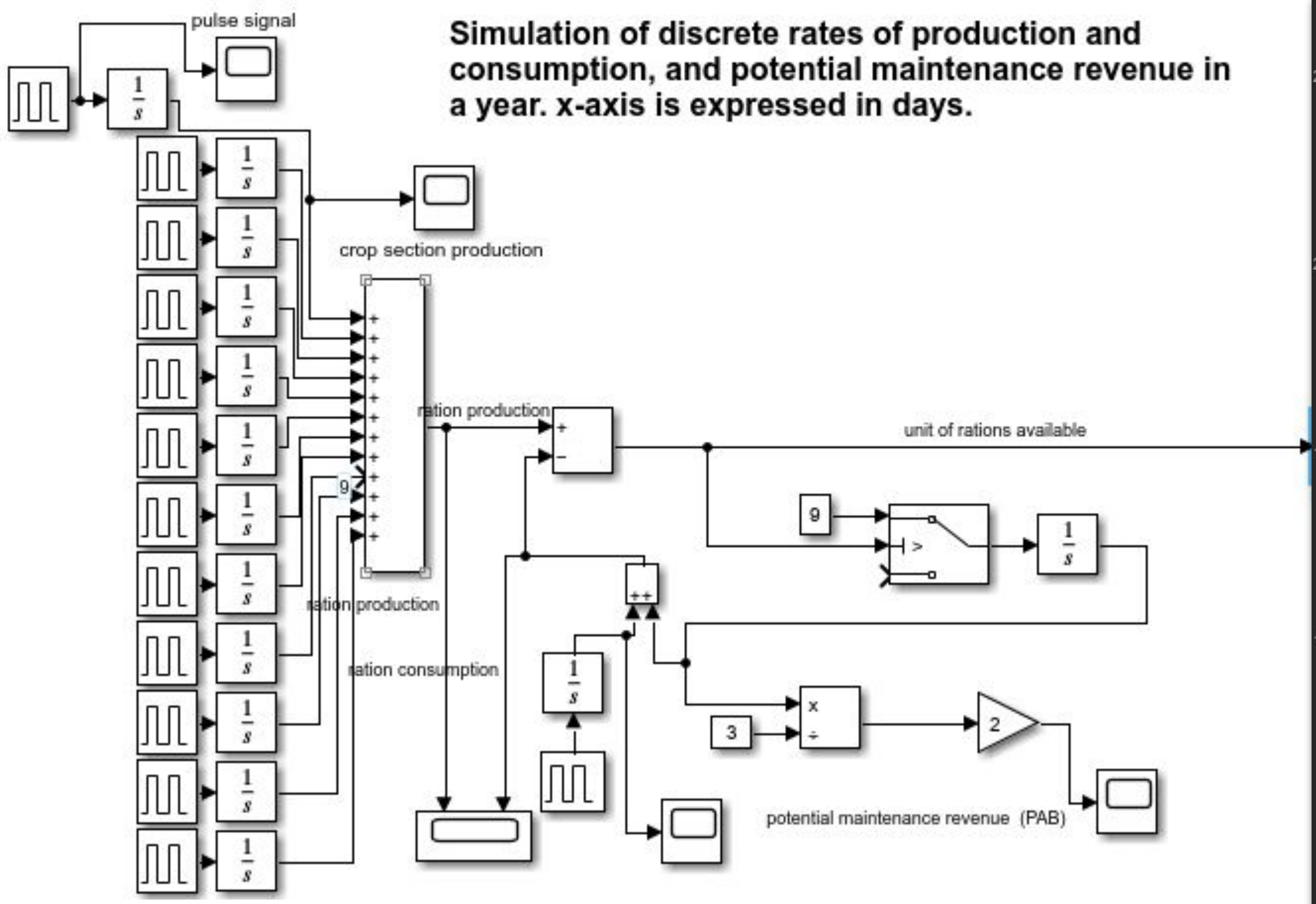


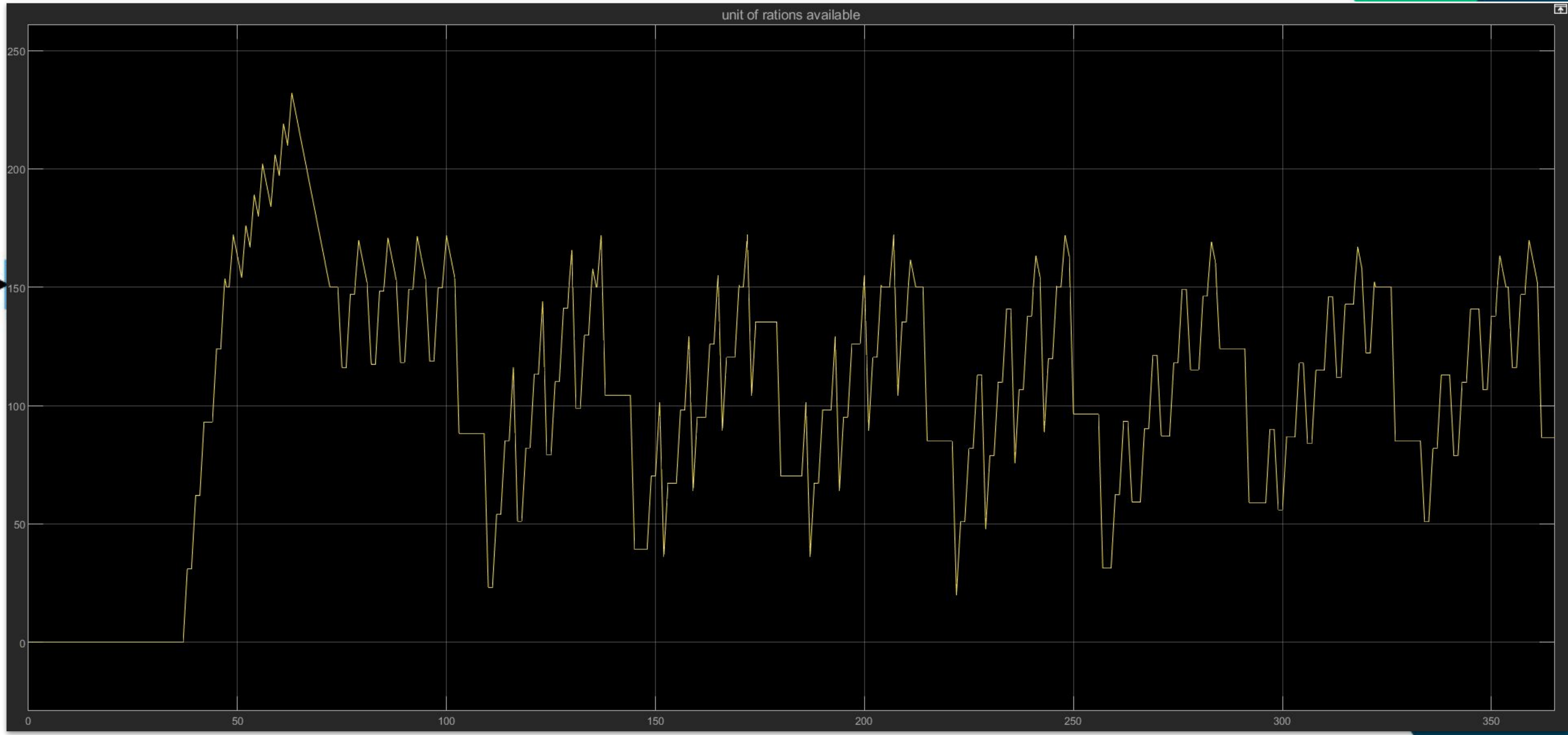


Prototype

Simulation-Based Determination of Cultivation Cycles, Weekly Consumption, and Ration Allocation for a Sustainable School Garden Using Simulink.

Simulation of discrete rates of production and consumption, and potential maintenance revenue in a year. x-axis is expressed in days.





Advantages:

- **Cost-Effective:** The proposed solution is significantly less expensive than traditional automated irrigation systems, which can cost between $100 and $200 USD, plus ongoing subscription fees for additional services.

- **User-Friendly Operation:** By enabling control through Bluetooth-connected devices, the system simplifies the irrigation process, making it accessible even to users with limited technical expertise.

- **Reduced Labor Requirements:** Automation alleviates the need for extensive manual oversight, saving valuable time and labor—resources that are often in short supply in economically challenged schools.

- **Enhanced Crop Yield:** Consistent and optimized irrigation can lead to healthier, more productive crops, directly supporting the nutritional needs of students.

- **Scalability:** The system is designed to be easily replicated in similar school environments, allowing broader application across various regions facing comparable challenges.

- **Remote Accessibility:** A website allows teachers and administrators to adjust irrigation schedules, check water usage, and optimize settings without needing to be physically present.

Disadvantages:

- **Technical Dependence:** Successful operation of the system requires a basic level of technical knowledge for setup and maintenance, which may pose a challenge in some educational settings.

- **Initial Implementation Costs:** Despite its long-term affordability, there are upfront expenses associated with the purchase and installation of hardware components.

- **Connectivity Requirements:** Features like remote monitoring depend on reliable internet access, which might not be consistently available in rural or underdeveloped areas.

- **Ongoing Maintenance:** Like any technological solution, the system will require periodic technical support and maintenance to ensure optimal performance over time.

- **Limited Flexibility:** While highly effective for school-based agricultural gardens, the system may need further adaptation to suit other agricultural environments or larger-scale operations.

- **Dependence on Internet Connectivity:** Schools with unstable or no internet access may experience limitations in functionality, reducing the effectiveness of real-time irrigation management.

Conclusion:

Child malnutrition in Latin America, particularly in Panama, remains a major public health issue with severe social and economic consequences. Socioeconomic disparities, high food prices, and inadequate school feeding programs contribute to the persistence of this problem, affecting children's health, academic performance, and long-term prospects. Implementing sustainable solutions such as school agricultural gardens with automated irrigation systems can help alleviate food insecurity in educational institutions. However, financial constraints and the technical expertise required for maintenance pose challenges. To combat malnutrition effectively, a multi-sectoral approach is needed, integrating government policies, private sector investment, and technological innovation to enhance food accessibility, education, and monitoring systems. By fostering collaboration among stakeholders, sustainable strategies can be developed to ensure that all children have access to proper nutrition, enabling them to achieve better health and educational outcomes.

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AGE OF INNOVATION

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Thank You