**MICROCONTROLLER - ESP32**

1.  **Connectivity**

* ESP32: Built-in Wi-Fi and Bluetooth enable easy, real-time data transmission without extra modules
* Other Microcontrollers: Generally lack built-in connectivity, requiring additional modules, which adds cost and complexity

2.  **Power Efficiency**

* ESP32: Offers advanced low-power modes like deep sleep, ideal for solar- or battery-powered applications
* Other Microcontrollers: Limited power-saving options, leading to higher energy consumption in field setups

3**. Processing Power**

* ESP32: Dual-core processor (up to 240 MHz) supports multitasking, ideal for simultaneous sensor readings and communication
* Other Microcontrollers: Typically single-core with lower speed, making it difficult to handle multiple tasks efficiently

4**. Memory Capacity**

* ESP32: 520 KB SRAM and up to 4 MB Flash, suitable for complex applications and data logging
* Other Microcontrollers: Limited memory (ex: 2 KB on Arduino Uno), restricting data storage and processing

5**. Cost-Effectiveness**

* ESP32: Affordable, high-functionality option for IoT projects, great for scaling in cost-sensitive applications
* Other Microcontrollers: Adding modules for connectivity or advanced features can increase cost

6.  **I/O and Sensor Compatibility**

* ESP32: High GPIO count and support for I2C, SPI, ADC, etc., making it versatile for connecting various sensors
* Other Microcontrollers: Typically fewer I/O pins and limited support for interfaces, reducing compatibility

7**. Scalability**

* ESP32: Supports MQTT, HTTP, and cloud integration, making it suitable for scalable projects
* Other Microcontrollers: Limited protocol support, making cloud integration and scalability challenging

8.  **User Interface Integration**

* ESP32: Connectivity and processing make it compatible with mobile apps for real-time monitoring and control
* Other Microcontrollers: Often require additional hardware for app integration, reducing convenience for end users

**SOIL MOISTURE SENSOR SELECTION**

**1. Capacitive Moisture Sensors: (best choice)**

* **Durability**: Capacitive sensors are highly durable as they do not suffer from corrosion, unlike resistive sensors. They can withstand varying soil conditions and long-term exposure, making them ideal for consistent and reliable data collection in agricultural fields.
* **Accuracy**: Capacitive sensors provide accurate and stable measurements of soil moisture, which is essential for optimizing irrigation and resource management. This ensures the farmer can make data-driven decisions for efficient water usage.
* **Cost-Effectiveness**: Although capacitive sensors are more expensive than resistive sensors, they strike the right balance between cost and performance. Their durability and accuracy reduce the need for frequent replacements and recalibrations, offering better long-term value.
* **Long-Term Reliability**: Unlike **Gypsum Blocks**, which degrade over time, capacitive sensors provide consistent performance without the need for frequent maintenance or replacement, making them more suitable for scalable, long-term use.

**2. Resistive Moisture Sensors: (not ideal)**

* **Corrosion Issues**: Resistive sensors suffer from corrosion, especially in moist or saline soils, which can result in inaccurate readings over time
* **Frequent Calibration**: Resistive sensors require frequent calibration to maintain accuracy, increasing maintenance efforts and reducing their efficiency for continuous use in the field.
* **Short-Term Solution**: Their need for constant maintenance and recalibration makes them less viable for large-scale, long-term agricultural use. Their short lifespan in harsh conditions makes them less suitable compared to capacitive sensors.

**3. Gypsum Blocks: (not suitable)**

* **Degradation Over Time**: Gypsum blocks degrade and break down after prolonged exposure to soil moisture.
* **Soil Sensitivity**: Gypsum blocks can be affected by soil salinity, and in dry conditions, they may not provide accurate readings

**4. HH2 Moisture Meter: (not cost-effective)**

* **High Cost**: The HH2 Moisture Meter provides very accurate measurements, its high cost makes it impractical for large-scale deployment in smallholder farming
* **Complexity and Calibration**: The HH2 requires complex setup and calibration, making it less user-friendly for farmers without technical expertise
* **Bulkiness**: Their size and complexity are a disadvantage when aiming to deploy a system with multiple sensors across a wide area

**OTHER COMPONENT SELECTION#still need to finalize**

1. Voltage regulator (HT7333)
2. Battery
3. Solar Panel
4. Wires/pcb or breadboard (if time there then custom pcb else breadboard)
5. Enclosing Container/Material