SUSTAINABLE DEVELOPMENT GOALS

EMBEDDED PROJECT

TITLE:

PORTABLE SOIL TESTING SYSTEM FOR SUSTAINABLE AGRICULTURE

Team Details				
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CONTENT:

- Introduction
- Sustainable Development Goals
- Partnership and Collaboration possibilities
- Problem Statement
- Objective
- Causal loop

SUSTAINABLE DEVELOPMENT GOALS

Sustainable development, approach to social, economic, and environmental planning that attempts to balance the social and economic needs of present and future human generations with the impactive of preserving, or preventing undue damage to, the natural environment.

Introduction:

- The Sustainable Development Goals (SDGs), also known as the Global Goals, are a set of 17 interconnected objectives adopted by all countries of the United Nations in 2015. These goals serve as a blueprint to achieve a better and more sustainable future for all by 2030.
- The Sustainable Development Goals (SDGs) are a set of global objectives that promote cooperation among countries, organizations, and individuals to address interconnected issues like poverty, inequality, climate change, and peace. They provide a roadmap for a sustainable future, applicable to all nations, and come with targets and indicators to monitor progress and ensure that no one is left behind

SUSTAINABLE DEVELOPMENT GOALS

PARTNERSHIP AND COLLABORATION POSSIBILITIES

- Public-Private Partnerships (PPPs)
- Corporate Social Responsibility (CSR) Initiatives
- Academic and Research Partnerships
- Technology and Innovation Partnerships
- Youth and Volunteer Networks
- Global Platforms and Initiatives
- Local Government and Community Partnerships

OBJECTIVES:

1. Develop a portable soil testing system capable of providing quick and accurate measurements of key soil parameters directly in the field.
2. Ensure accuracy and reliability of soil parameter measurements across different soil types and environmental conditions.
3. Create a user-friendly interface for easy operation and interpretation of soil test results by farmers and agricultural professionals.
4. Enable real-time analysis and interpretation of soil data to support on-the-spot decision-making for crop management practices.
5. Facilitate data storage and retrieval for tracking changes in soil health over time and informing long-term soil management strategies.
6. Conduct extensive field testing to validate the performance and effectiveness of the soil testing system in diverse agricultural settings.

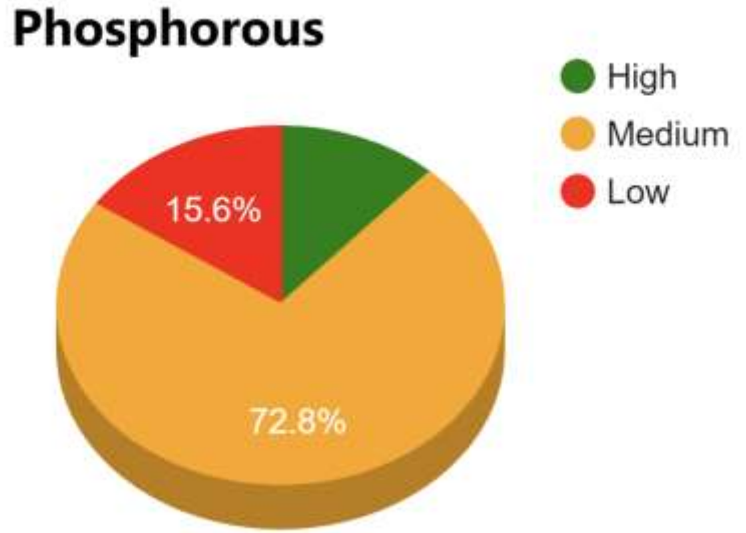
ALIGNMENT WITH SDGs :

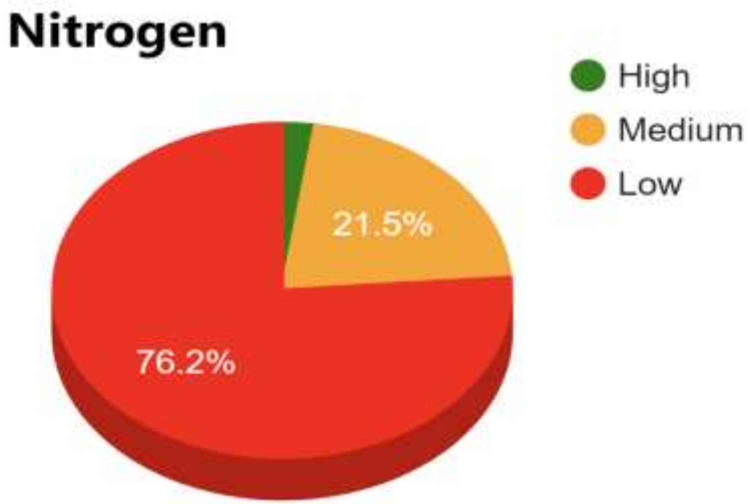
1. **SDG 2: Zero Hunger**: Soil testing helps optimize nutrient management in agriculture, leading to increased crop yields and improved food security. By ensuring that crops receive the right balance of nutrients, soil testing supports sustainable agricultural practices that enhance food production and contribute to ending hunger.
2. **SDG 12: Responsible Consumption and Production**: Soil testing promotes responsible consumption and production by optimizing the use of fertilizers and other agricultural inputs. By providing farmers with information about soil health and nutrient levels, soil testing helps minimize resource waste, reduce environmental pollution, and promote sustainable production practices.
3. **SDG 15: Life on Land**: Soil testing contributes to the conservation and sustainable use of terrestrial ecosystems. By promoting soil health and fertility, soil testing supports sustainable land management practices that help prevent land degradation, protect biodiversity, and maintain ecosystem services essential for life on land.

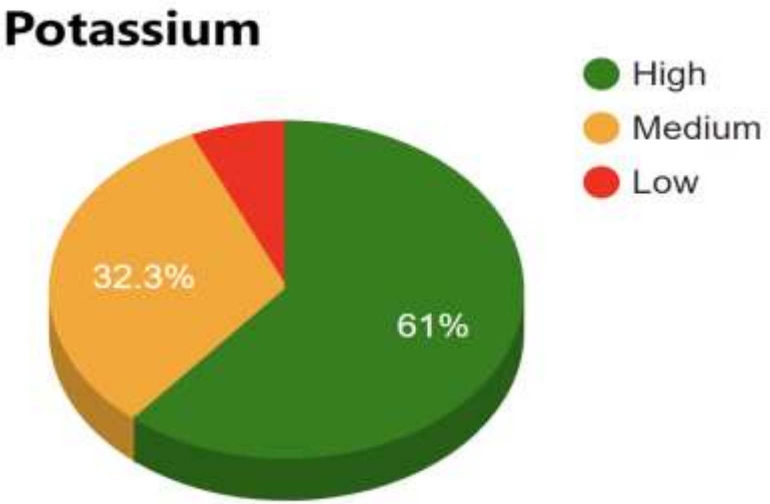
IMPORTANCE OF SOIL HEALTH

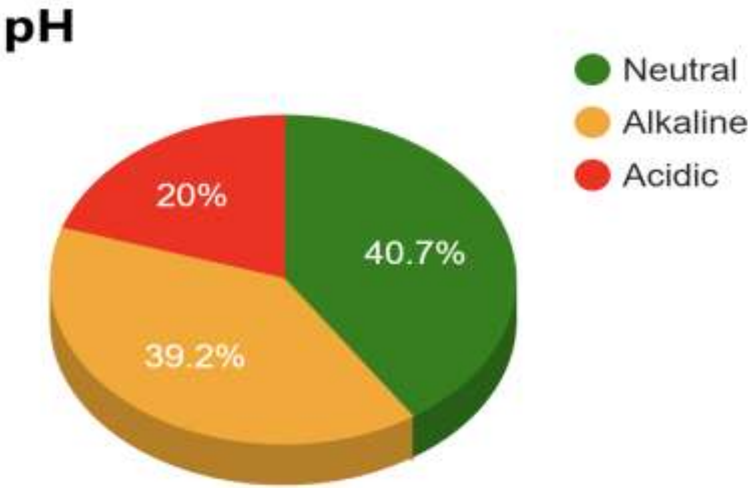
Maintaining soil health is essential for sustainable agriculture. Healthy soils provide essential nutrients, support plant growth, and improve water retention. By fostering biodiversity and carbon sequestration, healthy soils contribute to environmental resilience and long-term productivity. Practices like crop rotation and minimal tillage help preserve soil structure and fertility, ensuring food security and ecosystem stability. In essence, prioritizing soil health is fundamental for sustainable farming and environmental stewardship.

SOIL HEALTH PIE CHART INDIA 2023:









NUTRIENT TABLE :

State	Nitrogen - High	Medium	Low	Phosphorous - High	Medium	Low	pH - Acidic	pH - Neutral	pH - Alkaline
MEGHALAYA	0.78%	54.57%	44.65%	15.20%	70.98%	13.82%	99.04%	0.82%	0.14%
CHANDIGARH	0%	50%	50%	0%	50%	50%	0%	50%	50%
UTTARAKHAND	2.63%	0%	97.37%	8.79%	70.35%	20.87%	23.58%	33.21%	43.21%
MAHARASHTRA	5.64%	12.48%	81.88%	10.48%	58.97%	30.55%	11.97%	28.78%	59.26%
MADHYA PRADESH	0.45%	20.85%	78.70%	4.66%	85.71%	9.63%	7.72%	58.06%	34.23%
HARYANA	0%	0%	100%	12.92%	77.65%	9.43%	0.86%	15.68%	83.46%
JAMMU AND KASHMIR	16.30%	58.29%	25.41%	11.15%	83.46%	5.40%	15.28%	69.48%	15.23%
TAMILNADU	0.08%	0.88%	99.04%	10.52%	67.23%	22.25%	11.97%	37.75%	50.28%
TRIPURA	0.09%	52.91%	47.00%	2.31%	96.82%	0.86%	78.22%	19.23%	2.55%
ANDAMAN AND NICOBAR IS	0%	47.46%	52.54%	0%	30.51%	69.49%	91.53%	8.47%	0%
PUDUCHERRY	0%	0.66%	99.34%	0.66%	91.39%	7.95%	5.96%	77.48%	16.56%
SIKKIM	0.94%	48.78%	50.28%	22.33%	69.04%	8.63%	96.65%	3.09%	0.26%
WEST BENGAL	4.10%	58.78%	37.12%	37.72%	53.33%	8.95%	65.11%	22.87%	12.02%
JHARKHAND	0.73%	36.74%	62.52%	1.90%	95.46%	2.64%	82.54%	12.29%	5.18%
GUJARAT	3.06%	20.63%	76.31%	39.89%	58.24%	1.88%	2.30%	39.40%	58.30%
DELHI	0%	100%	0%	0%	100%	0%	0%	50%	50%
HIMACHAL PRADESH	0.48%	45.05%	54.46%	5.68%	81.01%	13.31%	33.56%	57.54%	8.90%
CHHATTISGARH	0.42%	23.00%	76.58%	0.93%	73.79%	25.28%	50.18%	40.27%	9.55%
ANDHRAPRADESH	2.85%	20.06%	77.09%	30.30%	50.16%	19.53%	8.59%	32.75%	58.66%
ODISHA	0.46%	15.94%	83.60%	11.38%	63.99%	24.63%	85.33%	13.99%	0.68%
NAGALAND	6.14%	57.53%	36.34%	13.11%	63.38%	23.51%	96.33%	3.47%	0.21%
ARUNACHAL PRADESH	0%	100%	0%	0%	0%	100%	100%	0%	0%
LADAKH	0%	0%	0%	0%	0%	0%	0%	0%	0%
GOA	40.07%	43.62%	16.30%	30.71%	30.88%	38.41%	87.73%	11.34%	0.93%
PUNJAB	0%	84.29%	15.71%	0.80%	45.60%	53.60%	0%	0.81%	99.19%
RAJASTHAN	0.07%	0.56%	99.37%	6.10%	92.32%	1.59%	0.08%	10.15%	89.77%
UTTAR PRADESH	0.10%	1.53%	98.37%	0.88%	75.10%	24.02%	0.93%	52.60%	46.47%
MIZORAM	3.44%	41.59%	54.97%	7.41%	88.97%	3.62%	99.64%	0.36%	0%
BIHAR	0.75%	40.24%	59.00%	20.54%	77.44%	2.02%	10.43%	57.93%	31.64%

Nutrient Table

TRIPURA	0.08%	40.94%	58.98%	2.07%	97.26%	0.67%	80.18%	17.01%	2.81%
ANDAMAN AND NICOBAR ISL	0%	22.95%	77.05%	0%	24.18%	75.82%	52.05%	44.67%	3.28%
GOA	29.92%	50%	20.08%	24.17%	30.33%	45.50%	90.71%	8.62%	0.67%
WEST BENGAL	4.10%	62.64%	33.26%	33.38%	56.05%	10.57%	66.57%	23.81%	9.62%
HARYANA	0.08%	6.74%	93.18%	9.78%	60.27%	29.94%	0.61%	17.18%	82.21%
JAMMU AND KASHMIR	15.89%	57.01%	27.09%	11.06%	83.64%	5.31%	15.33%	70.01%	14.66%
SIKKIM	1.10%	48.29%	50.61%	22.35%	70.23%	7.42%	97.40%	2.30%	0.30%
PUDUCHERRY	0%	0.10%	99.90%	11.89%	82.62%	5.49%	16.48%	53.15%	30.37%
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HIMACHAL PRADESH	0.61%	45.42%	53.97%	5.99%	80.93%	13.08%	35.14%	55.91%	8.94%
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KARNATAKA	6.46%	32.50%	61.04%	20.81%	70.81%	8.39%	33.88%	38.49%	27.63%
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MEGHALAYA	0.93%	68.54%	30.53%	10.24%	74.93%	14.83%	99.51%	0.40%	0.09%
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MAHARASHTRA	3.87%	14.09%	82.04%	11.77%	61.62%	26.61%	12.87%	26.51%	60.62%
ASSAM	33.03%	66.96%	0.01%	6.11%	93.02%	0.87%	89.54%	10.35%	0.11%
GUJARAT	3.64%	23.50%	72.86%	39.17%	58.70%	2.13%	2.02%	40.00%	57.99%
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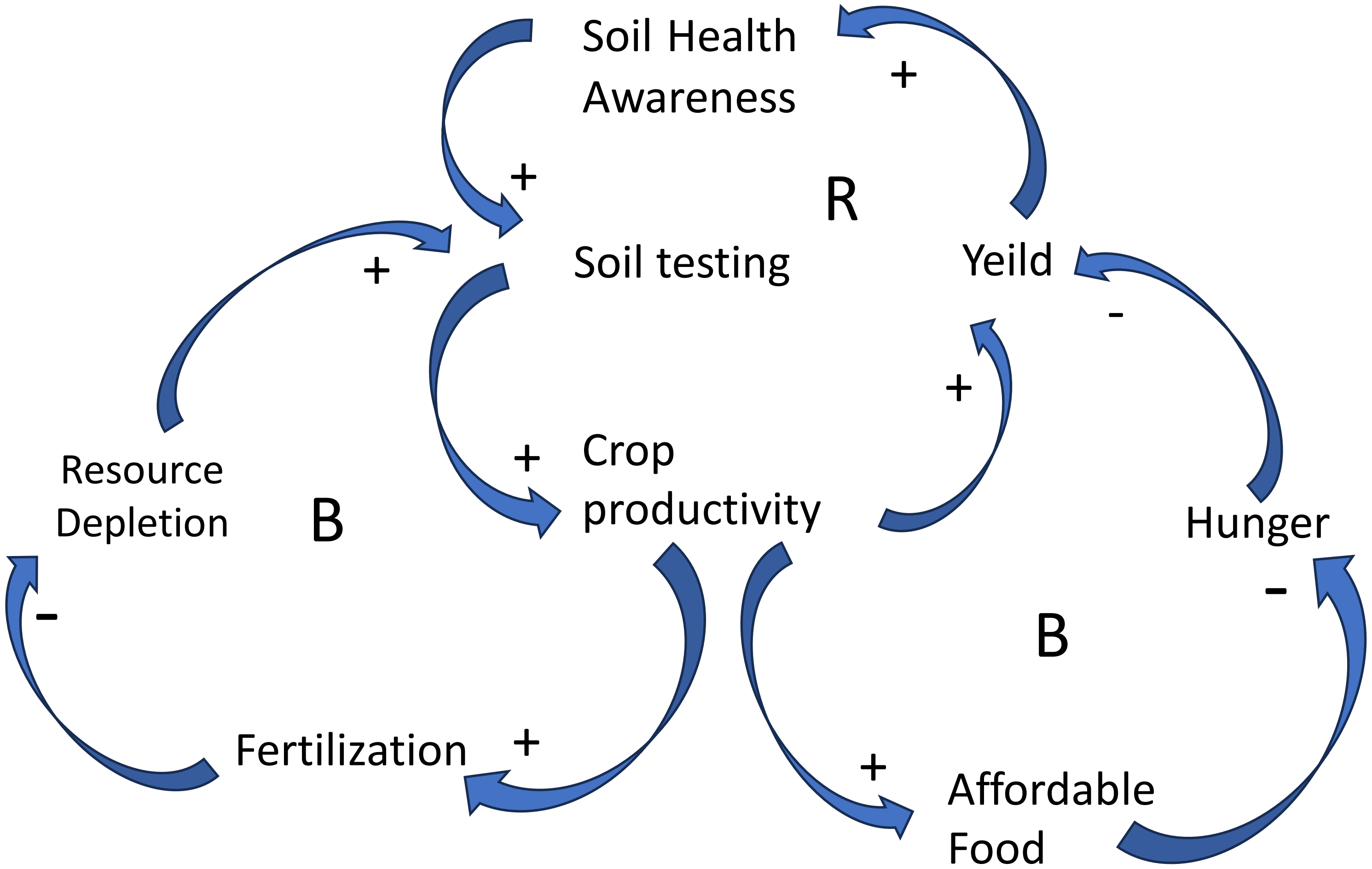
TAMILNADU	0.09%	0.76%	99.15%	11.10%	68.39%	20.51%	11.96%	37.72%	50.32%

CAUSAL LOOP :


Soil Health
Awareness
+
+
R
Soil testing
Yeild
+
-
+
+
Resource
Depletion
B
Crop
productivity
Hunger
-
-
B
Fertilization
+
+
Affordable
Food

TITLE:

Portable Soil Testing System for Sustainable Agriculture

PROBLEM STATEMENT:

Traditional soil testing methods are slow and labor-intensive, hindering real-time soil health assessment for farmers. A portable soil testing system is crucial for quick and accurate field measurements, enabling optimized crop management decisions and improved agricultural productivity.

PROBLEM:

NEED OF SOIL HEALTH AWARENESS :

1. **Nutrient Imbalance**: Without testing, farmers may misapply fertilizers, causing nutrient imbalances.
2. **Decreased Fertility**: Continuous farming without testing can deplete soil fertility.
3. **pH Imbalance**: Soil pH issues can arise without testing, affecting nutrient uptake.
4. **Contamination Risk**: Testing is crucial for identifying contaminants that may harm crops and humans.
5. **Suboptimal Crop Selection**: Lack of testing can lead to poor crop choices for the soil type.
6. **Resource Waste**: Farmers may waste resources on unnecessary inputs without testing.
7. **Unsustainable Practices**: Without testing, farming practices may harm soil health and biodiversity.

SOURCES FOR KNOWING SOIL HEALTH:

- Laboratory Testing
- On-Site Testing Kits
- Farmers Experience and Observation
- Soil Testing Using Embedded System

LITERATURE SURVEY:

- **Paper 1. August 2022**
- **IoT based Soil Nutrients Analysis and Monitoring System for Smart Agriculture**

The methodology of the IoT-based Soil Nutrients Analysis and Monitoring System for Smart Agriculture involves collecting soil samples from different locations and using NPK sensors to measure nitrogen, phosphorus, and potassium levels. Data from these sensors is transmitted to an IoT platform for analysis, utilizing components like Arduino UNO for data processing and communication. Analysis employs Kernel Density Estimation to understand the probability distribution of soil nutrients, visualized through ThingSpeak Cloud Charts. The system aims to assist farmers in making informed decisions about fertilizer usage to improve crop production while offering a cost-effective means for soil assessment. Future enhancements include incorporating various crops and addressing nutrient deficiencies for optimized smart agriculture applications..

Paper 2:2016
A Novel Approach for Soil Testing using Embedded System

The paper introduces a novel method for soil testing utilizing an embedded system. The methodology involves integrating sensors to measure nitrogen, potassium, phosphorus, and pH levels in the soil accurately. Real-time data acquisition, processing, and analysis within the system enable the assessment of soil fertility and acidity. Calibration ensures measurement accuracy, while data interpretation provides actionable insights for farmers. The system offers a feedback mechanism to optimize farming practices, with a user-friendly interface for easy interaction. Continuous monitoring supports real-time tracking of soil parameters, enhancing agricultural decision-making for sustainable crop production.

Paper 3:2023
Remote Embedded System for Agricultural Field Monitoring: Enhancing Resource Allocation in Agriculture

The research paper on "Remote Embedded System for Agricultural Field Monitoring: Enhancing Resource Allocation in Agriculture" employed a structured methodology comprising key steps. Firstly, it followed the Waterfall Model, progressing linearly through stages including system requirements definition, project development, implementation, and unit testing. A thorough literature review was conducted to grasp resource utilization in agricultural fields within the study region. An Entity-Relationship Diagram (ERD) was crafted to establish relationships among entities in the system's database. MySQL Workbench facilitated database creation and management, contributing to the research diagram's construction. This approach offers advantages such as a clear and easy-to-follow sequential process, detailed documentation at each phase, early issue detection, predictability in project timelines and deliverables, and accurate capture of client expectations from the outset. However, it comes with drawbacks, including rigidity in accommodating changes, limited opportunities for iterative refinement based on ongoing feedback, late testing in the development cycle increasing defect risks, potential for misunderstood or inaccurately documented requirements leading to costly rework, and limited suitability for large or complex projects with evolving requirements.

Paper 4: 08 February 2020
Design and Development of an Embedded Framework to test Soil for Urban Terrace Farming

- The methodology for developing the embedded system framework for urban terrace farming soil suitability assessment begins with a thorough requirement analysis, followed by sensor selection and integration for measuring pH and moisture content. The system architecture is designed and developed, leveraging FPGA technology for faster processing and re-programmability. Calibration ensures sensor accuracy, validated against standard pH meters. Rigorous testing in various soil conditions verifies system performance, while user-friendly interfaces are developed for effective data presentation. User feedback drives system improvements, with comprehensive documentation provided for future deployments. Overall, the methodology aims to empower urban farmers with actionable insights for informed crop management decisions and improved agricultural outcomes.

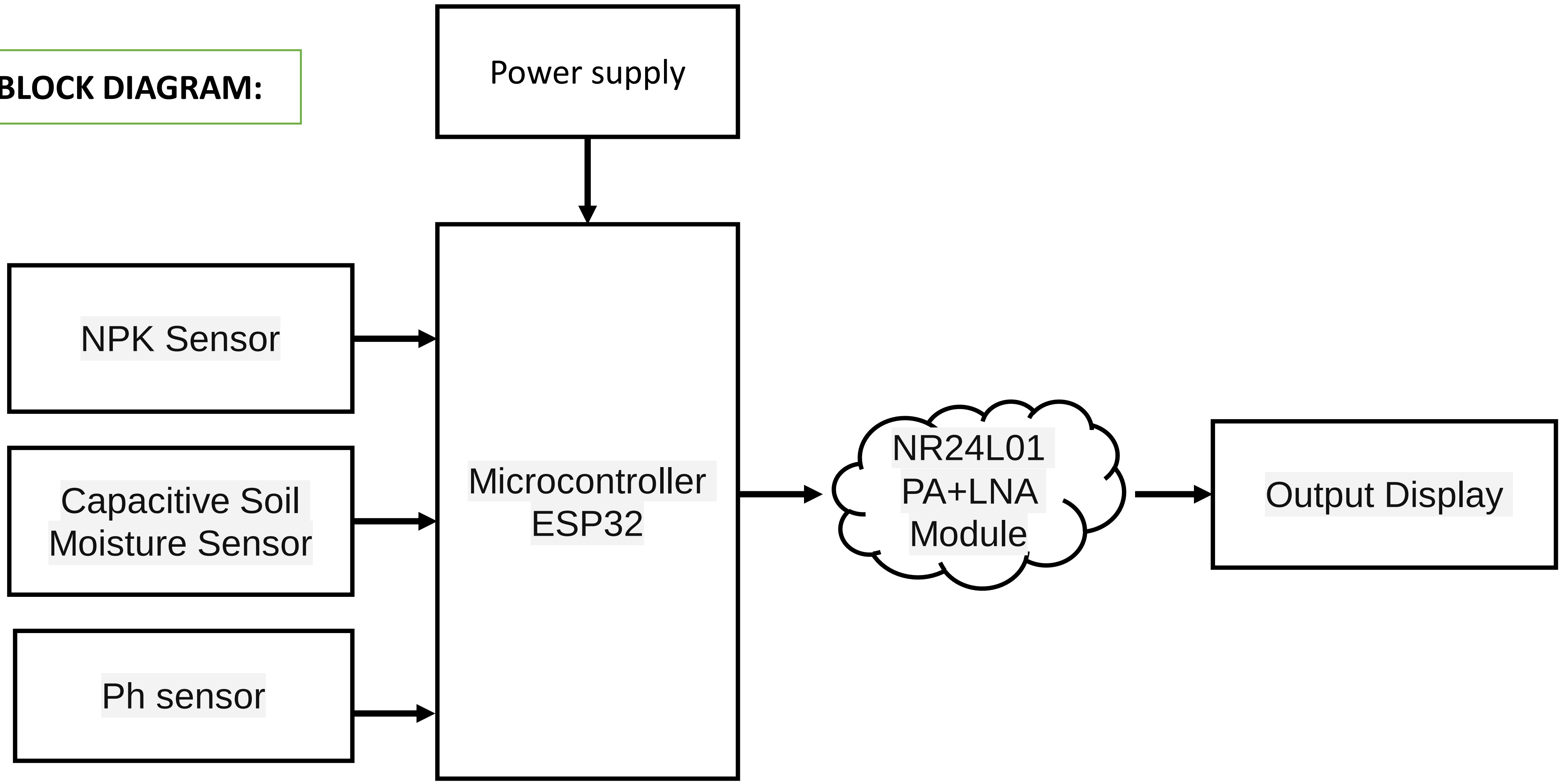
Required nutrients for soil health:

- **Nitrogen**: Range**:** 20 mg/kg to 100 mg/kg (parts per million) for most crops
- **Phosphorus**: Range**:** 10 mg/kg to 30 mg/kg for most crops.
- **Potassium**: Range**:** 20 mg/kg to 50 mg/kg for most crops.
- **Ph**: Ideal Range**:** Most plants prefer a slightly acidic to neutral pH range, between **6.0 and 7.0 ,**

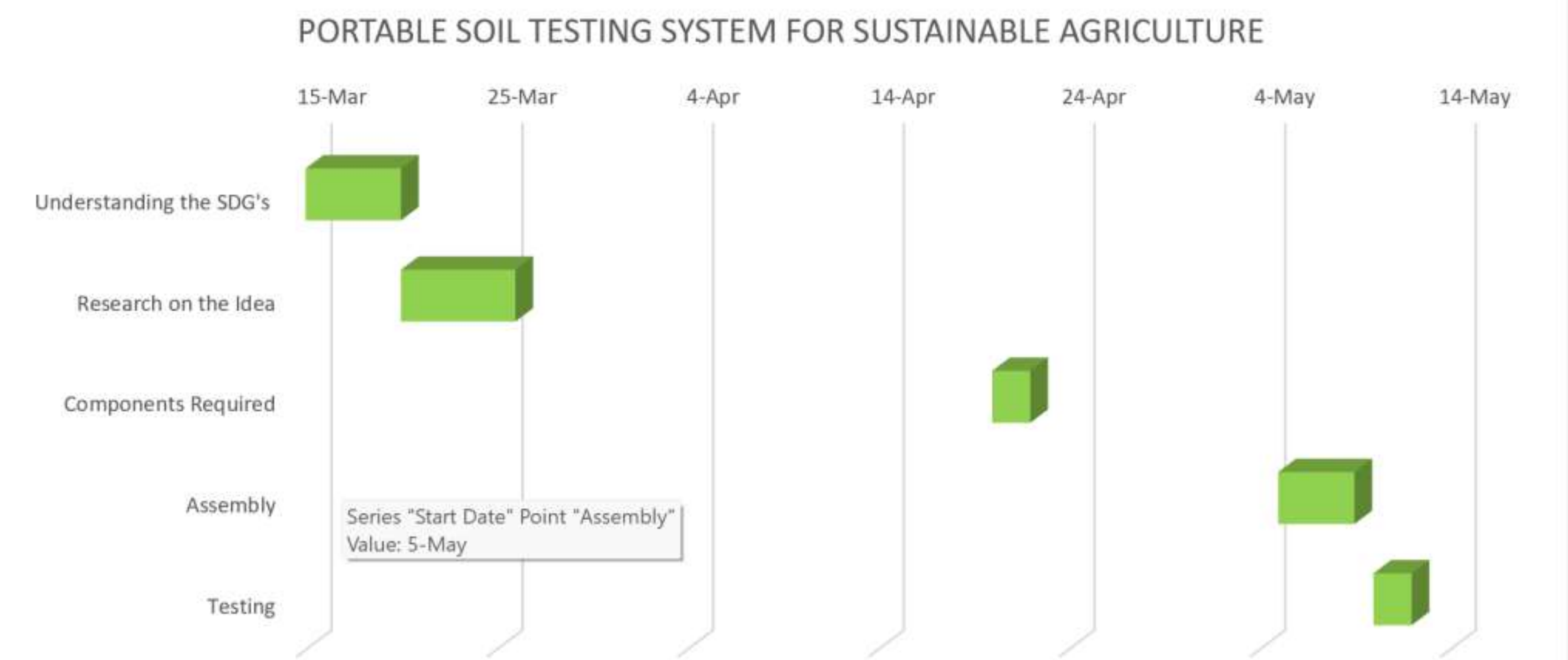
COMPONENTS REQUIRED:

- ESP32 Microcontroller
- NPK Sensor
- Ph sensor
- Capacitive Soil Moisture Sensor
- MAX485 Modbus Module
- Electronics components

BLOCK DIAGRAM:

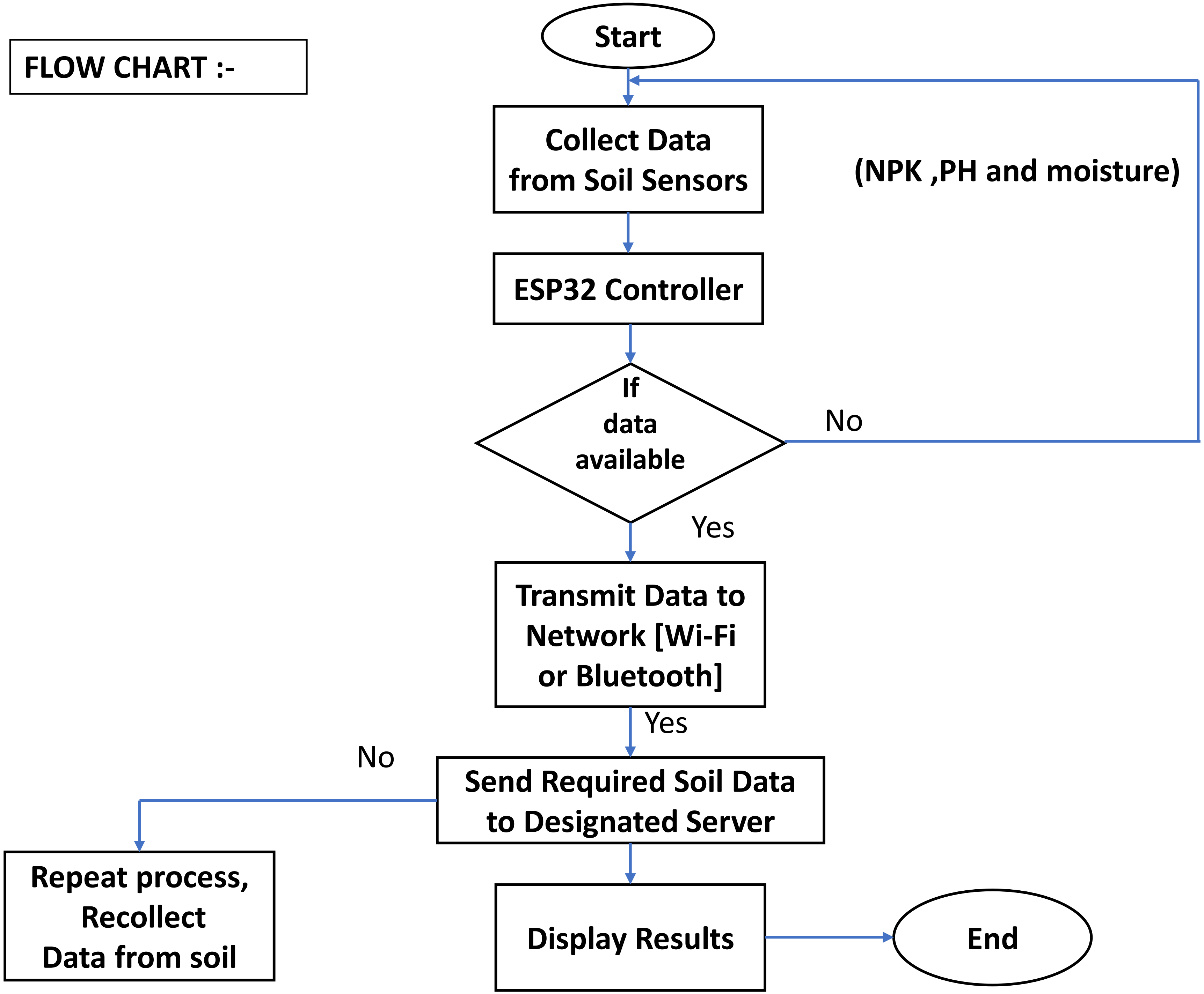


GANTT CHART:



	Testing	Assembly	Components Required	Research on the Idea	Understanding the SDG's
Start Date	10-May	5-May	20-Apr	20-Mar	15-Mar
Days To Complete	2	4	2	6	5

FLOW CHART :-


Start
Collect Data from Soil Sensors
(NPK ,PH and moisture)
ESP32 Controller
If data available
No
Yes
Transmit Data to Network [Wi-Fi or Bluetooth]
Yes
No
Send Required Soil Data to Designated Server
Repeat process, Recollect Data from soil
Display Results
End

SPECIFICATION AND IDENTIFICATION OF COMPONENTS:

1. **NPK SENSOR :**

- **Measured Parameters**: Nitrogen (N), Phosphorus (P), Potassium (K) content in the soil
- **Suitability**: Determines soil fertility
- **Communication Protocol**: Requires Modbus module (e.g., RS485/MAX485) for data reading
- **Operating Voltage**: 9-24V DC
- **Connection**: Modbus module connected to microcontroller and sensor
- **Input:** soil sample **output:** NPK concentration levels in the soil (Nitrogen, Phosphorus potassium

2. PH SENSOR:

- **Measurement Range:** Typically pH 0 to pH 14.
- **Operating Temperature Range:** Commonly 0°C to 50°C.
- **Output Signal:** Analog voltage, digital , or both.
- **Construction Material:** Can be glass, plastic, or a combination.

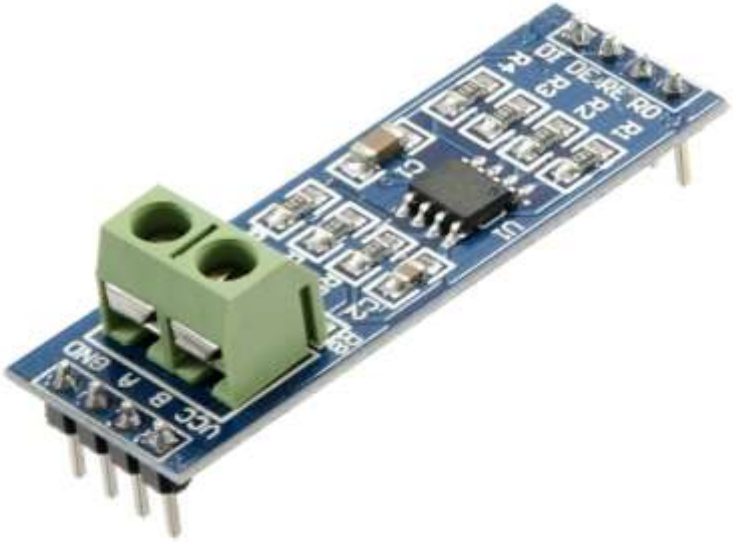
3.Capacitive Soil Moisture Sensor:

- **Operating Voltage**: 3.3V to 5.5V DC
- **Output Voltage**: Up to 3.0V (Analog)
- **Output Type**: Analog, convertible to percentage value
- **Power Consumption**: Low for prolonged battery life

Input:

- Soil moisture content
- **Output:**
  - Soil moisture level (analog or digital signal indicating moisture level)

4. MAX485 MODBUS MODULE



- Use MAX485 Interface chip
  Distances up to **1200 meters**
  Speeds up to **2.5Mbit/Sec**
  Multi-drop supports up to **32 devices** on same bus
- **Input:**
  - Modbus commands/data from the microcontroller
- **Output:**
  - Modbus signals transmitted over the RS-485 bus

THANK YOU