# INTELLIGNET SENSING SYSTEM FOR CROP MANAGEMENT

A PROJECT REPORT

(21AIE221T – Internet of Things Architecture and Protocols)

*Submitted by*

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*partial fulfilment of the requirements for the degree of*

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## SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

## KATTANKULATHUR – 603 203

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# **ABSTRACT**

**Agriculture plays a vital role in the economic development of India**, employing a significant portion of the population and contributing substantially to the nation's GDP. As the demand for food increases with the rising population, traditional farming methods alone are no longer sufficient to meet the challenges of modern agricultural production. To improve efficiency, productivity, and sustainability, **smart farming techniques and intelligent systems** are becoming essential tools for farmers.

One such innovative approach is the implementation of **intelligent sensing systems**, which utilize modern sensors and microcontrollers to collect real-time data from the agricultural environment. In this research, an intelligent system is developed to monitor critical soil and environmental parameters such as **soil pH, moisture content, and ambient temperature**, which are crucial for determining suitable crops for a given piece of land.

The system employs various components including:

- **pH Sensor**: Measures the acidity or alkalinity of the soil. This is important because different crops thrive at different pH levels.

- **Soil Moisture Sensor**: Detects the water content present in the soil to assess whether irrigation is needed and to evaluate suitability for crop cultivation.

- **LM35 Temperature Sensor**: Monitors the surrounding temperature, helping to understand the local climatic condition, which also influences crop selection.

- **Arduino UNO**: Acts as the central processing unit of the system, collecting data from all sensors and processing it to give meaningful output.

The collected data is processed using pre-programmed logic within the Arduino, which then **suggests a crop best suited for the current soil and environmental conditions**. This ensures optimal utilization of land resources and promotes better crop yields.
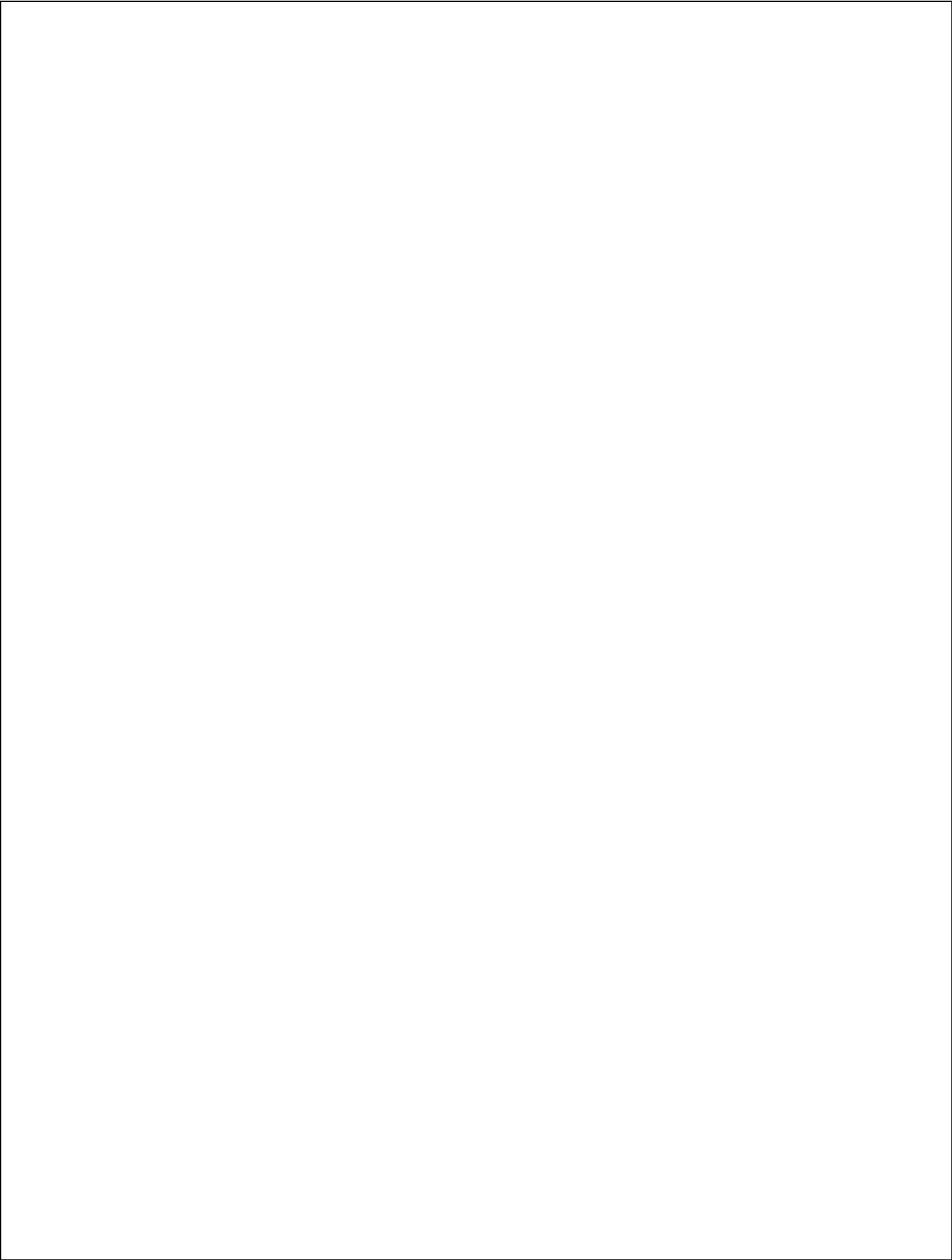
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## ABBREVIATIONS

IoT - Internet of Things
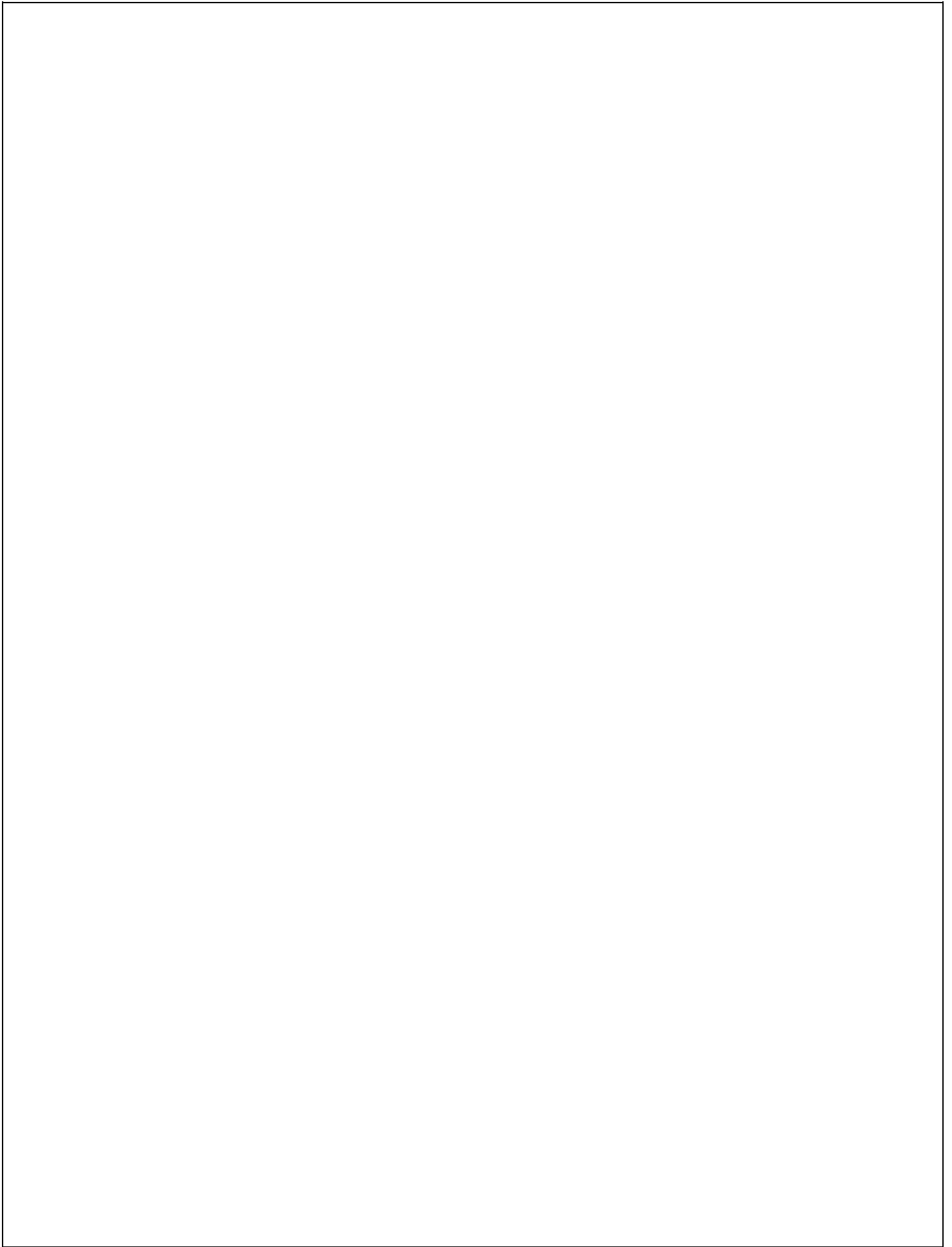
# CHAPTER 1 : INTRODUCTION

## 1.1 Introduction to Project

This project focuses on the development of an **Intelligent Sensing System for Crop Management**, which leverages embedded systems and sensor technologies to provide real-time data about soil and environmental conditions. The system is designed to monitor **soil pH**, **moisture content**, and **ambient temperature** using sensors connected to an **Arduino UNO microcontroller**. Based on the readings collected, the system intelligently suggests a suitable crop that can be cultivated under the given conditions.

By automating the process of data collection and crop recommendation, this system aims to **optimize crop yields**, **reduce resource wastage**, and **enhance decision-making for farmers**. It also lays the foundation for smart farming practices, contributing to precision agriculture and food security in the long run.

## 1.2 Motivation

India, being an agrarian country, depends heavily on agriculture for economic growth and food security. However, farmers often rely on traditional knowledge and guesswork when it comes to crop selection and soil management, which can lead to poor yields, crop failures, and resource inefficiencies. The lack of awareness about soil health, inadequate use of fertilizers, and improper irrigation practices further aggravate the problem.

With the advancement of technology and the rise of smart agriculture, there is a growing opportunity to bridge this gap by providing **real-time, data-driven solutions**. The motivation behind this project is to empower farmers and agricultural workers with an affordable, easy-to-use system that **analyzes soil and environmental parameters** and provides intelligent recommendations for crop cultivation.

By using sensors and microcontrollers, the system not only **reduces manual effort and human error**, but also enhances accuracy in decision-making. This leads to **better crop productivity**, **efficient use of natural resources**, and **sustainable farming practices**. Our goal is to make smart farming accessible to even small-scale farmers, contributing to the larger vision of digital and precision agriculture in India.

# CHAPTER 2 : PROBLEM STATEMENT AND OBJECTIVE

## 2.1 PROBLEM STATEMENT

In India, a significant number of farmers lack access to timely and accurate information about their soil and environmental conditions, leading to poor decisions in crop selection and resource usage. Traditional farming practices often rely on assumptions rather than scientific data, resulting in reduced crop yields, soil degradation, and inefficient water use.

There is a need for a **low-cost, real-time system** that can accurately measure soil pH, moisture content, and ambient temperature, and use this data to **recommend suitable crops** based on current field conditions. The absence of such intelligent systems at the grassroots level prevents farmers from optimizing their land's potential and adapting to changing climatic and soil conditions.

This project aims to solve this problem by designing an **intelligent sensing system** using Arduino UNO and environmental sensors that can assist farmers in making informed decisions to **improve productivity, sustainability, and profitability** in agriculture.

## 2.2 Objective

The primary objective of this project is to design and develop an **Intelligent Sensing System** that can monitor key environmental and soil parameters to assist in efficient crop management. This system aims to empower farmers with real-time data and intelligent recommendations to improve agricultural productivity and sustainability.

**Specific Objectives:**

1. **To measure soil pH, moisture content, and ambient temperature** using appropriate sensors (pH sensor, soil moisture sensor, LM35 temperature sensor).

2. **To integrate these sensors with an Arduino UNO** microcontroller for real-time data acquisition and processing.

3. **To develop a logic-based decision system** that recommends suitable crops based on the collected data and pre-defined crop requirements.

4. **To provide the output through a user-friendly interface**, such as an LCD display or serial monitor, for easy interpretation by farmers or users.

5. **To promote smart and sustainable agriculture practices** by minimizing resource wastage and improving crop selection accuracy.

6. ## CHAPTER 3 : . LITERATURE REVIEW / EXISTING SYSTEMS

## Literature Review / Existing Systems

To design more effective intelligent sensing systems for crop management, it's essential to evaluate current technologies and solutions in use today. These include traditional systems like soil sensors, vision-based & systems for crop health monitoring

### 3.1 Traditional Motion Detection Systems

**Soil Sensors**

Soil moisture and nutrient sensors are among the most widely used traditional sensing methods in agricultural monitoring systems. These sensors measure parameters such as soil moisture, pH, temperature, and nutrient levels to help optimize irrigation and fertilization strategies. While soil sensors provide precise data about the soil condition, their performance is limited by installation complexity and potential interference from environmental factors such as soil texture and variability.

**Strengths:**

- Accurate and reliable measurements of soil conditions.

- Widely used in irrigation management systems to prevent overwatering or underwatering.

**Limitations:**

- Require periodic calibration and maintenance.

- Limited to specific zones where the sensors are deployed.

- May not provide real-time updates over large areas.

### 3.2 IoT-Enabled Solutions

Modern agricultural systems often integrate multiple sensors and IoT technologies to provide a comprehensive understanding of crop health and environmental conditions. These IoT-based systems enable real-time data collection, remote monitoring, and automation of agricultural tasks.

**Smart Irrigation Systems** integrate soil moisture sensors with weather data and IoT platforms to optimize water usage. These systems help farmers reduce water waste and improve irrigation efficiency. However, they depend heavily on accurate sensor data and can be limited by the availability of reliable weather forecasts or soil sensor performance.

**Crop Health Monitoring Platforms** such as **CropX** and **Sentera** use IoT-enabled sensors to track various environmental parameters and provide actionable insights. These platforms offer features like automatic irrigation adjustments, pest and disease alerts, and yield predictions. While these systems have significantly improved precision agriculture, their effectiveness is often hampered by sensor calibration issues and the difficulty of integrating diverse data sources.

## CHAPTER 4 : SYSTEM DESIGN AND ARCHITECTURE
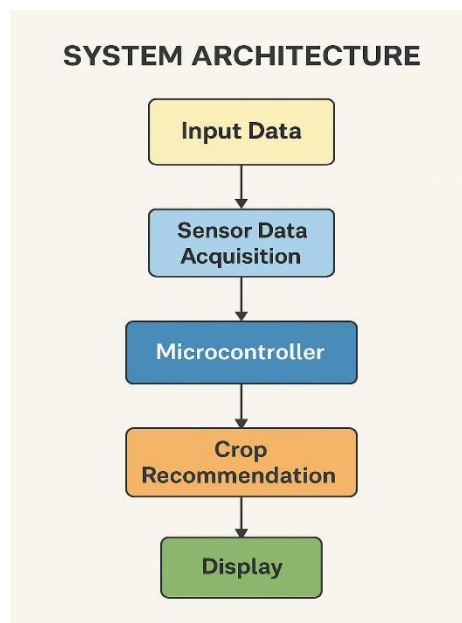


**Fig.4.1 System Design**

# CHAPTER 5 : HARDWARE AND SOFTWARE REQUIREMENTS

## 5.1 Hardware Requirements

| LM35 | PH4 SENSOR |
|---|---|
| BREAD BOARD | ARDUINO UNO |
| SOIL MOISTURE SENSOR | LCD DISPLAY |

## 5.2 Software Requirements

BACKEND : ARDUINO IDE

PROGRAMMING LANGUAGE : C++

DATABASE : FIREBASE REALTIME

# CHAPTER 6 : PROTOCOLS AND SECURITY PARAMETERS USED

## 6.1 Communication Protocols

**Protocol Purpose**

**Zigbee** Low-power, short-range communication for sensor networks.

**LoRa**    Long-range, low-power communication for remote sensor data collection.

## 6.2 Security Considerations

| Measure | Purpose |
|---|---|
| **Physical Security** | Ensure the Arduino and components are protected in a casing to avoid tampering or damage. |
| **Data Encryption** | Ensures that data transmitted between sensors, gateways, and servers is protected from unauthorized access. |
| **Access Control** | Limits access to sensitive data and system functions based on user roles and permissions to prevent unauthorized changes. |

# CHAPTER 7 : IMPLEMENTATION DETAILS

## 7.1 System Overview

The Intelligent Sensing System for Crop Management is designed to optimize agricultural practices by monitoring and controlling environmental factors, crop health, soil conditions, and irrigation systems using advanced sensors, data analytics, and communication technologies. The system aims to increase crop yield, reduce resource consumption, and improve sustainability through precise, realtime data collection and decision-making.

## 7.2 Hardware Setup

➔ pH Sensor (Analog)  pH Sensor Pin    Arduino Uno

VCC              5V

GND              GND

Analog Out       A0

➔ Soil Moisture Sensor (Analog type)

Soil Sensor Pin        Arduino Uno

VCC                    5V

GND                    GND

Analog Out             A1

➔ Temperature Sensor (e.g., LM35)

LM35 Pin          Arduino Uno

Left (VCC)        5V

Middle (Output)   A2

Right (GND)       GND

(Flat side facing you: Left → VCC, Middle → Output, Right → GND)

## 7.3 System Behavior

- Continuously monitors environmental and soil conditions using sensors.

- Transmits sensor data to a central system via wireless communication protocols.

- Processes and analyzes data in real-time or periodically using algorithms.

- Detects anomalies, trends, and conditions affecting crop health or soil quality.

# CHAPTER 8 : RESULT AND OBSERVATION

**Observations**

- The system significantly improves crop productivity by enabling data-driven decisions.
- Real-time monitoring helps detect issues early, such as water stress or disease outbreaks.
- Automated irrigation and fertilization reduce manual labor and resource wastage.
- Wireless communication protocols (e.g., LoRa, Zigbee) enable remote field monitoring even in rural areas.
- Integration with mobile and web platforms offers convenience and ease of use for farmers.
- Energy-efficient sensors and devices extend the operational lifespan in remote areas.
- Environmental data collection supports precision agriculture and sustainable practices.
- Predictive analytics enhances planning for irrigation, harvesting, and pest control.

## Limitations

- Limited Connectivity in Remote Areas – Internet or network access may be poor in rural regions, affecting real-time data transmission.
- Power Supply Dependency – Systems reliant on electricity or solar power can be disrupted in adverse conditions.
- Sensor Accuracy and Calibration – Sensors may give inaccurate readings over time if not regularly calibrated.

## RESULT

The implementation of an Intelligent Sensing System for Crop Management has led to significant improvements in agricultural productivity and efficiency. By enabling real-time monitoring of soil, crop, and environmental conditions, the system allows farmers to make timely, data-driven decisions. This results in optimized use of resources such as water, fertilizers, and pesticides, reducing waste and input costs. Automation of key processes like irrigation and fertilization also lowers the need for manual labor and improves consistency in crop care. The system supports early detection of issues such as pests, diseases, or unfavorable weather conditions, helping to prevent crop losses. Additionally, the collected data enhances planning, forecasting, and overall farm management, while promoting sustainable practices by minimizing environmental impact. Ultimately, the use of intelligent sensing technologies leads to increased crop yields, better profitability, and a more resilient and efficient farming ecosystem.

# CHAPTER 9 : Testing and Evaluation

The testing and evaluation of the Intelligent Sensing System for Crop Management are critical to ensuring its accuracy, reliability, and overall performance in real-world agricultural environments. Initially, sensors and communication modules are tested in controlled settings to verify data accuracy, response times, and compatibility with other system components. Field testing is then conducted to evaluate the system under various environmental conditions, including changes in temperature, humidity, and soil type. The effectiveness of automated responses, such as irrigation or fertilization, is assessed based on crop growth outcomes and resource usage. User feedback is also gathered to evaluate the usability of the dashboard and mobile interface. Data collected during testing is analyzed to identify any inconsistencies, communication delays, or system failures. Based on these results, necessary adjustments are made to optimize performance. Overall, rigorous testing ensures the system meets its objectives of improving crop management, enhancing efficiency, and supporting sustainable agricultural practices.

# CHAPTER 10 : Applications and Future Enhancements

## 10.1 Applications

**Soil Monitoring** – Tracks soil moisture, temperature, pH, and nutrient levels for better crop planning and irrigation.

**Precision Irrigation** – Automatically adjusts water supply based on real-time soil and weather data.

**Yield Prediction** – Analyzes field and plant data to estimate potential harvest outcomes.

**Sustainable Agriculture** – Promotes efficient resource usage and environmentally friendly farming practices.

## 10.2 Future Enhancements

➜ By maintaining various sensors information on cloud, user can access or control over farm activities,

➜ We can develop a robot with this intelligent system.

➜ Extensible feature of sensors we can add as per our crop specific need.

➜ We can add motion sensors for monitoring any intruder.

# CHAPTER 11 : CONCLUSION

The current work illustrated the importance of smart agriculture on improving and increasing agricultural production in order to contribute to reducing the food demand gap. Concerning the use of an Intelligent system in agriculture, it can be used in many practices such as farm monitoring, irrigation, pest control, harvesting, etc.

From this project we can infer that the intelligent sensing system can improve the yield, also the economy of the country.

# APPENDIX

**Arduino Code:**

```
#include <Wire.h>

#include <LiquidCrystal_I2C.h>

// Set the LCD address, 0x27 is the default address for most I2C LCD modules

LiquidCrystal_I2C lcd(0x27, 16, 2); // Change the address if necessary

// Define the pH sensor analog pin const

int pHSensorPin = A0;

// Define the soil moisture sensor pin const

int soilSensorPin = A1;

// Define the LM35 temperature sensor

pin const int temperatureSensorPin = A2;

void setup() {

  // Initialize the LCD

lcd.init();

 // Turn on the backlight (if available)

lcd.backlight();

 // Print a message to the LCD

lcd.setCursor(0, 0);

lcd.print("intelligent crop");

lcd.setCursor(1, 1);
```

```
lcd.print("sensing device");

delay(5000);   lcd.clear();
```

```
lcd.print("sensing device");

delay(5000);   lcd.clear();
```

```
lcd.setCursor(0, 0);

lcd.print("insert moisture sensor,");

lcd.setCursor(1, 1);    lcd.print("Ph

sensor ");    delay(5000);

lcd.clear();   lcd.setCursor(0, 0);

lcd.print("in the required ");

lcd.setCursor(1, 1);

lcd.print("soil");    delay(5000);

lcd.clear();   lcd.setCursor(0, 0);

lcd.print("Calculating The");

lcd.setCursor(1, 1);

lcd.print("Readings.");

delay(500);    lcd.setCursor(9, 9);

lcd.print("..");       delay(500);

lcd.setCursor(9, 9);

lcd.print("...");       delay(500);

lcd.setCursor(9, 9);
```

```
    lcd.print("....");

delay(500);        lcd.clear();

lcd.setCursor(0,            0);

lcd.print("Calculating    The");

lcd.setCursor(1,            1);

lcd.print("Readings.");

delay(500);    lcd.setCursor(9,

9);                lcd.print("..");

delay(500);

lcd.setCursor(9,            9);

lcd.print("...");      delay(500);

lcd.setCursor(9,            9);

lcd.print(".....");

delay(500);        lcd.clear();

lcd.print("Calculating    The");

lcd.setCursor(1,            1);

lcd.print("Readings.");

delay(500);    lcd.setCursor(9,

9);      lcd.print("..");
```

```
      delay(500);

lcd.setCursor(9, 9);

lcd.print("...");

delay(500);

lcd.setCursor(9, 9);

lcd.print(".....");

delay(500);    lcd.clear();

  // Set up the serial communication for debugging

  Serial.begin(9600);

} void loop()

{

  // Read soil moisture sensor value    int

soilMoisture = analogRead(soilSensorPin);

  // Map the sensor value to a moisture percentage (adjust according to your sensor)

int moisturePercentage = map(soilMoisture, 0, 1023, 0, 100);

  // Read LM35 temperature sensor value    int temperatureValue =

analogRead(temperatureSensorPin); float temperatureCelsius =

(((analogRead(temperatureSensorPin) * 5.0) / 1024.0) - 0.5) * 14.0; float pH =

(analogRead(pHSensorPin)*5 / 1024.0) * 16.0;

// Display the moisture percentage, temperature, and pH on the

LCD   lcd.clear(); // Clear the LCD to update values
```

```
lcd.setCursor(0, 0);   lcd.print("Moisture: " +

String(moisturePercentage) + "%  ");
```

```
    delay(4000);    lcd.clear();  lcd.setCursor(0, 0);

lcd.print("Temp: " + String(temperatureCelsius) + " C  ");

delay(4000);  lcd.clear();  lcd.setCursor(0, 0);

lcd.print("pH: " + String(pH) + "  ");   delay(4000);

lcd.clear();

  // Print the moisture, temperature, and pH values to the Serial Monitor for debugging

  Serial.print("Soil Moisture: ");

  Serial.print(moisturePercentage);

  Serial.print("%, Temperature: ");

  Serial.print(temperatureCelsius);

  Serial.print(" C, pH: ");

  Serial.println(pH);

// Determine and display the soil type and recommended crops

determineSoilTypeAndCrops(moisturePercentage, temperatureCelsius, pH);

  // Delay for stability (adjust as needed)

delay(5000);

} void determineSoilTypeAndCrops(int moisture, float temperature, float

pH) {

  // Add your logic here to determine soil type and recommended crops
```

```
  // Use the sensor readings (moisture, temperature, pH) directly in your conditions

if (moisture < 30 && temperature < 20 && pH > 6.5) {

  // Display information for a specific

condition    lcd.setCursor(0, 0);

lcd.print("Soil Type: Sandy");    delay(4000);

lcd.clear();    lcd.setCursor(0, 0);

lcd.print("Recommended Crops");

lcd.setCursor(1, 0);    lcd.print("Carrot,

Radish");    delay(5000);    lcd.clear();

  } else if (moisture >= 30 && moisture < 60 && temperature >= 20 && temperature < 30 && pH >=
6.0 && pH <= 6.5) {    // Another

condition    lcd.setCursor(0, 0);

lcd.print("Soil Type: Loamy");

delay(4000);    lcd.clear();

lcd.setCursor(0, 0);

lcd.print("Recommended Crops");

lcd.setCursor(1, 0);

lcd.print("Tomato, Pepper");

delay(5000);
```

```
  lcd.clear();

 } else if (moisture >= 60 && temperature >= 30 && pH <= 6.0)

{    lcd.setCursor(0, 0);    lcd.print("Soil Type: Clay");

delay(4000);    lcd.clear();    lcd.setCursor(0, 0);

lcd.print("Recommended Crops");    lcd.setCursor(1, 1);

lcd.print("Spinach,Cabbage");    delay(5000);    lcd.clear();    }

else {    lcd.setCursor(0, 0);    lcd.print("Soil Type: Ideal");

delay(4000);    lcd.clear();    lcd.setCursor(0, 0);

lcd.print("Recommended Crops");    lcd.setCursor(1, 1);

lcd.print("Lettuce, Beans");    delay(5000);    lcd.clear();

 }}
```
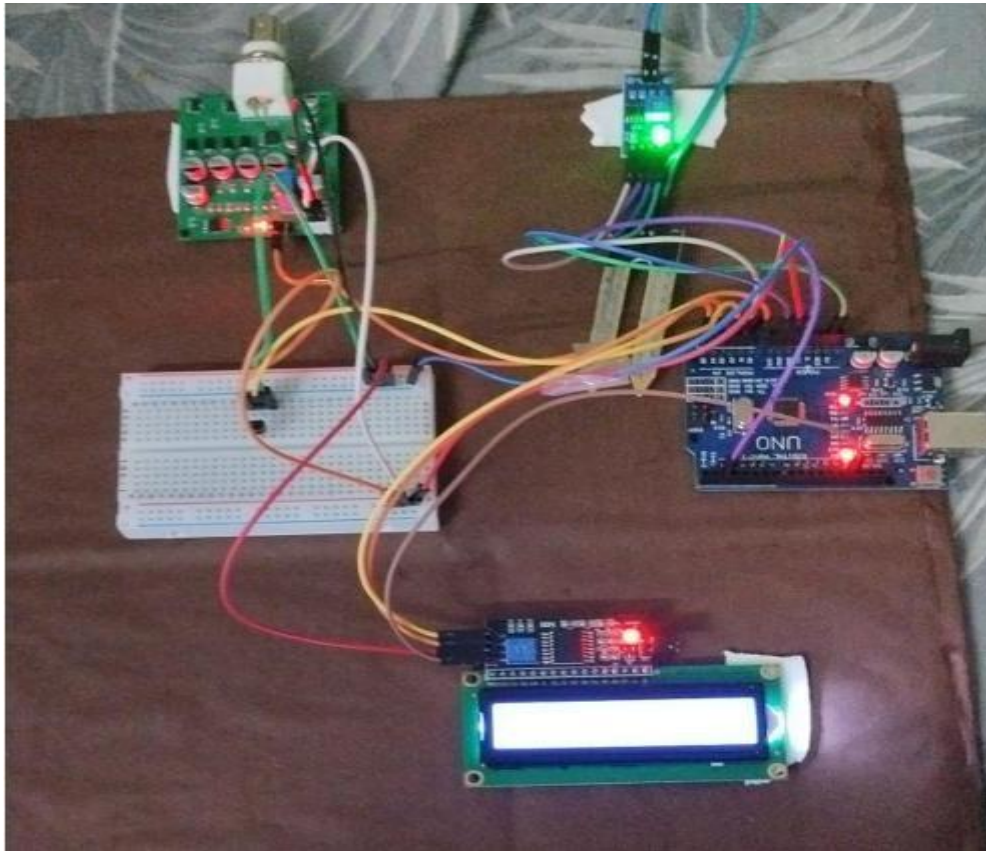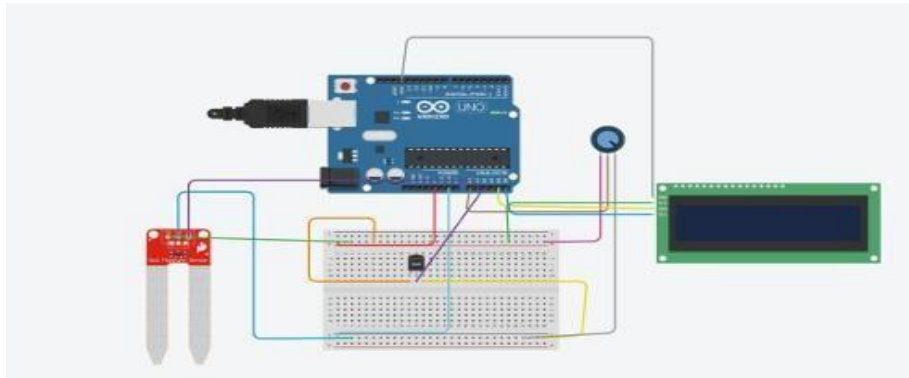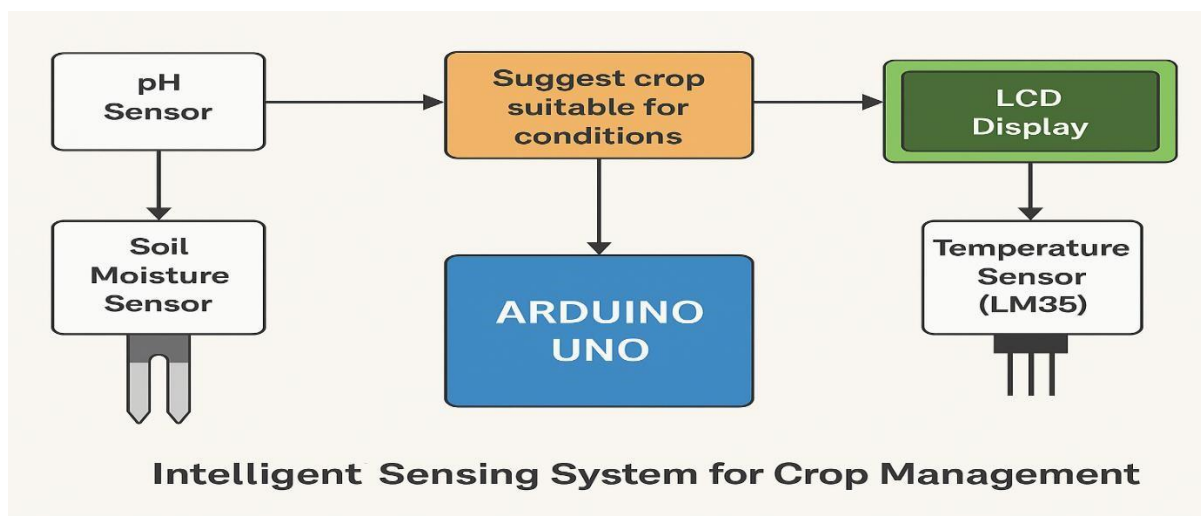
**Fig 11.1 – Real Project Image**

**Fig 11.2 – Software Output for Radar**

## Circuit Diagram



**Fig 11.3 – Circuit Diagram**

## System Design



Intelligent Sensing System for Crop Management

**Fig 11.4 – System Design**

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