Integrated Agricultural Environmental Monitoring System

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***Abstract*—** Farmers often struggle with uninformed choices and limited access to real-time field data. This leads to excessive pesticide and fertilizer usage, harming the environment. Our system offers a solution: IoT sensors collect soil moisture, humidity, temperature and pH readings. An Arduino NANO transmits this data to a web framework. There, an MLP classifier analyzes the conditions and recommends suitable crops and fertilizers. By harnessing AI and IoT, our approach modernizes agriculture, empowering farmers with informed decision making based on field specific insights. A transformative leap towards sustainable, data-driven farming practices. MLP helps study sensor data. The data has complex patterns which show how things in nature go together. MLP learns from the data to suggest crops and fertilizer. This is useful because farm data is multifaceted. The system gives farmers real-time data and crop ideas. Farmers can then smartly manage crops using this information. Proper resource use and higher yields result. Sustainable farming is possible when farmers use live data and expert tips to adjust practices

Keywords*— *IoT; Smart farming; precision agriculture; Artificial Intelligence;

I. INTRODUCTION

Our world's farms are facing big issues. More people need food, but climate changes hurt crops. We need better ways to grow food without damaging nature. This paper talks about a new system called IAEMS. IAEMS watches over farms and helps farmers grow crops safely. It uses smart devices to check soil health, moisture, and weather. IAEMS connects to the Internet, giving farmers fresh data. With this data, farmers can make wise choices. Experts and leaders also get this info to guide farming policies. IAEMS combines technology to boost sustainable farming practices. By monitoring key factors, IAEMS aims to balance food production and environmental protection. This balanced approach could solve major agricultural challenges. Through IAEMS, we can grow more food while caring for our planet. The IAEMS system is poised to transform agricultural practices. It helps optimize resource use, reduce environmental impact, and improve overall sustainability. By detecting soil conditions early, IAEMS allows timely interventions to address issues like pests, water scarcity, and soil degradation. This empowers farmers to make informed decisions about crop selection and fertilizer use. IAEMS promotes data-driven precision agriculture, encouraging the adoption of efficient farming methods. This is crucial for meeting the needs of our growing global population while preserving the health of our ecosystems.

II. EXISTING SYSTEM

Current agricultural monitoring systems typically fail to combine environmental factors and analyze data in real-time, hindering their support for sustainable farming. They primarily rely on manual data collection and occasional sampling, resulting in delayed and unreliable decision-making. Furthermore, most systems focus narrowly on specific agricultural aspects, such as soil quality or plant health, instead of providing a comprehensive perspective on the farming ecosystem. Additionally, they often lack scalability and compatibility, making it challenging to combine data from various sources. Lastly, these systems may not utilize advanced analysis techniques to extract valuable insights from collected data, limiting their effectiveness.

III. PROBLEMS IN EXISTING SYSTEM

i. Lack of comprehensive integration

ii. Inability to address dynamic environmental conditions

iii. Insufficient real-time data analysis

iv. Existing systems may focus on individual aspects of agriculture (such as soil quality or crop health, rather than providing a holistic view of the farming ecosystem) Proposed system

IV. PROPOSED SYSTEM

Farmers today face many challenges, including making decisions without enough information and limited access to real-time data about their fields. Additionally, the overuse of chemical fertilizers and pesticides has led to changes in soil quality and reduced crop yields. However, new technologies offer a solution. Smart farming, enabled by IoT sensors and AI can help transform agriculture. This integrated system combines various sensors, such as those for soil moisture, humidity, temperature and pH, with an Arduino NANO to collect data. This data is then transmitted to a web framework for analysis, where a machine learning algorithm recommends suitable crops and fertilizers based on the specific field conditions. By providing farmers with real-time data and personalized recommendations, the system empowers them to make more informed decisions about crop management practices. This can lead to more efficient and sustainable farming practices, ultimately benefiting both the farmers and the environment. The smart farming system helps optimize resource use and boost crop yields. It allows farmers to monitor soil conditions, get alerts about potential problems, and receive personalized recommendations for crops and fertilizers. The user-friendly interface makes it easy for farmers to access this information. Adopting smart farming practices can lead to more sustainable agriculture. Farmers can adjust their methods based on real-time data and expert advice. This helps reduce the impact of chemicals like fertilizers and pesticides, maintain soil health and increase crop production. Block diagram of proposed system is shown in Fig. 1.

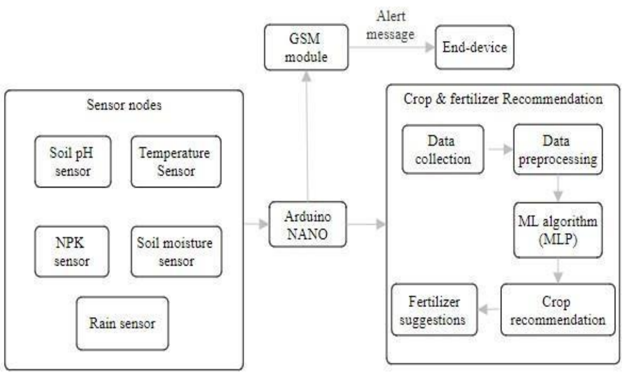

Fig. 1. Block diagram of proposed system

A. Advantages of Proposed System

i. Provides a dynamic aspects of the farming ecosystem
ii. Real-time Monitoring
iii. Personalized Recommendations
iv. Cost-effective
v. User-friendly Interface

V. HARDWARE

A. Arduino NANO Board

The Arduino NANO is a small microcontroller that can connect to sensors and send information to the main system.

B. Soil Moisture Sensor

The soil moisture sensor is used to compute the gravimetric data of the ground. The value of the sensor varies from 0 to 1023. 0 being most wet conditioned and 1023 being very dry condition. This sensor examines the resistance and moisture value to know the soil condition. When the soil is in dry condition means less water leads to poor electricity.

C. pH Sensor

pH monitoring is a important device in the crop area for maintaining soil situation. The good pH values for soil is commonly in the middle of 5.5 and 6.5. few crops will achieve more than this pH value. The pH of a solution can be measured by the pH meter. The value is less than 7, it is considered as acid and the value is greater than 7, it is base and the value is equal to 7, it is a neutral.

D. NPK Sensor

The NPK Sensor uses advanced technology to measure the levels of nitrogen, phosphorus and potassium in the soil. This information is crucial for applying the right amount of fertilizer precisely, helping farmers optimize their crop production.

E. Humidity Sensor

The humidity sensor measures the amount of water vapor in the air, using either capacitive or resistive components. This information is crucial for managing plant diseases and keeping greenhouse conditions optimal.

F. Temperature Sensor

The temperature sensor uses specialized devices like thermocouples, thermistors, or infrared technology to measure soil and air temperatures. This helps farmers detect frost early and take steps to protect their crops. It also allows them to manage heat stress in their crops more effectively.

G. Rain Sensor

The rain sensor used in the system measures rainfall by counting the number of times a small bucket tips. It is set up in an open spot and connected to the main system to send the data right away. The sensor's accuracy is very important for planning irrigation at the right time. It gives farmers helpful information to manage water well in farming.

H. Zigbee Module

The Zigbee Module uses the Zigbee wireless protocol to enable reliable and energy efficient communication between sensors and the main system. This allows for smooth data transfer between various components in the network.

I. GSM Module

The SIM800C is a willingly available in the GSM/GPRS device which is used in many cellular/digital phones and radio devices. These modules are used to design the IOT devices.

J. LCD Screen

A liquid crystal display (LCD) is an digital display screen that produces the result in an image using liquid crystals for its output. Here we had used 16x2 LCD display.

VI. WORKING PRINCIPLES

This paper proposes an integrated system that combines the Internet of Things (IoT) and Artificial Intelligence (AI) to enhance precision agriculture. The goal is to optimize crop yield and resource utilization. The system integrates various sensors, including soil moisture, humidity, rainfall, pH, water level and temperature sensors, which are connected to an Arduino NANO microcontroller. This allows for data acquisition and visualization on an LCD display. The collected sensor data is transmitted to a web framework for analysis. A

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Multilayer Perceptron (MLP) classifier is employed to recommend suitable crops and fertilizers based on the specific field conditions. The MLP is well suited for this task because it can effectively analyze sensor data, which often contains nonlinear patterns and complex interactions between environmental factors. The MLP's ability to learn from the data and make predictions makes it a valuable tool for providing tailored recommendations to farmers.

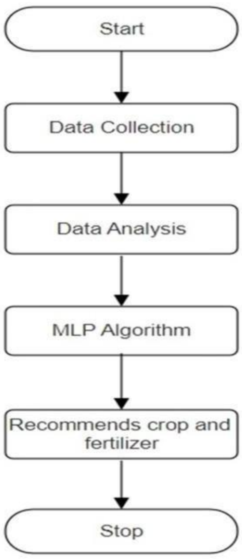

Fig. 2. Work flow of IAEMS

VII. EXPLANATION

Farmers can now use smart technology to improve their operations. IoT sensors and AI help address issues like uninformed decisions and excessive fertilizer use. The system uses sensors to collect real-time data on conditions like humidity and soil pH. This information is fed into a machine learning model that provides recommendations on crops and fertilizers. With these insights, farmers can refine their methods to be more efficient and boost their yields. Overall, smart agriculture helps farmers make informed decisions based on real-time data, promoting sustainable practices.

VIII. RESULTS

The Integrated Agricultural Environmental Monitoring System (IAEMS) made significant improvements in tracking and managing crucial environmental factors for agriculture. Real-time data collection and analysis allowed for precise farming practices. The system's ability to provide personalized suggestions for crops and fertilizers based on sensor data and machine learning algorithms led to more informed decisions by farmers. The user-friendly interface of IAEMS made it easy for farmers to access data and recommendations, boosting usability and adoption. Overall, IAEMS showed promising results in optimizing resource use and enhancing sustainability in agriculture.

Fig. 3. Starting IoT kit

Fig. 4. Displaying Temperature, Humidity, Soil moisture, Rainfall and Soil temperature

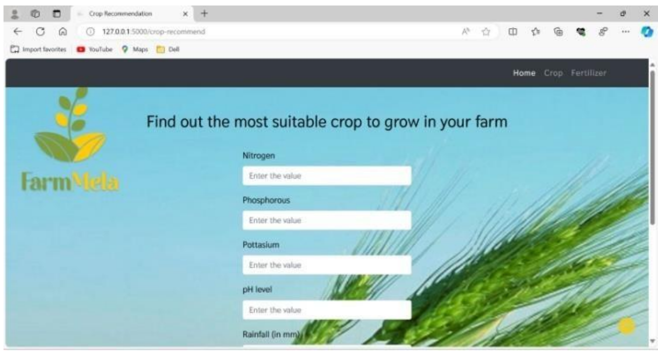

Fig. 5. Crop recommendation input

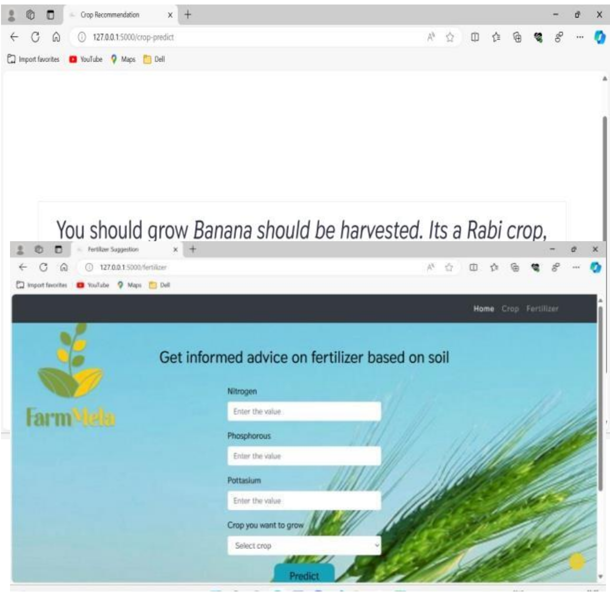

Fig.7. Fertilizer suggestion input

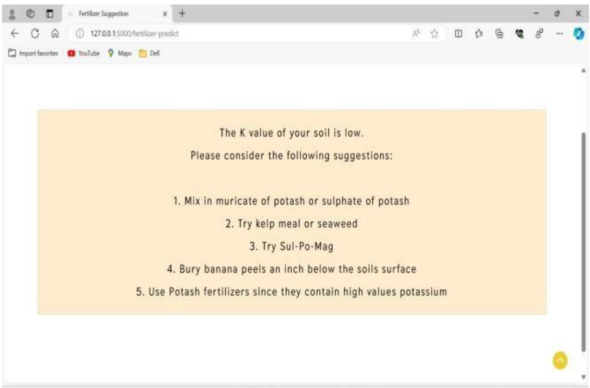

Fig. 8. Fertilizer suggestion output

IX. CONCLUSION

The IAEMS is an important advancement in precision agriculture. It combines sensor technologies, data analysis, and machine learning to give farmers valuable insights about their fields. This helps them make better decisions to improve crop yields and sustainability. The IAEMS system can be used in different agricultural settings, making it adaptable and effective across regions and farming practices. By supporting sustainable farming and enhancing food security, the IAEMS has the potential to transform the agriculture industry.

X. FUTURE ENHANCEMENT

To further improve the Integrated Agricultural Environmental Monitoring System (IAEMS), integrating additional sensors to track air quality and crop health could provide a more comprehensive picture of the farming ecosystem. Creating a mobile app to work alongside the web interface would allow farmers to access real-time data and receive alerts on their phones. Incorporating precise irrigation methods, like drip systems and soil moisture-based watering, could optimize water use and minimize wastage. Adding remote control capabilities for irrigation and fertilization equipment would empower farmers to adjust settings based on the latest data and recommendations. Finally, incorporating energy efficient designs and technologies could reduce power consumption and boost sustainability.

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