CROP YIELD PREDICTION AND FERTILIZER RECOMMENDATION

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ABSTRACT

Agriculture plays a vital role in India. India is the world's largest producer of different crops but still, it uses traditional framing methods therefore crop yield becomes down. Hence, with the introduction of newer seed varieties, new methods of agriculture crop production have increased. But without using the smarter ways, the agricultural field still having an imperfection. And due to these farmers need a smarter way to increase crop production. Hence, to maximize the crop yield some smart methods came into the picture used in IoT and Machine Learning. In this paper, we will review the algorithms like Random Forest, Decision Tree, ANN to get better accuracy for the system.

The core components of this system include a network of IoT sensors and actuators, data analytics, machine learning algorithms, and a user-friendly interface. IoT sensors are strategically deployed in the fields to continuously measure crucial parameters such as soil moisture, temperature, humidity, and light intensity. This real-time data is transmitted to a centralized database, which is then processed and analyzed using advanced machine learning algorithms.

The system utilizes machine learning models to provide accurate crop yield predictions based on historical data, current conditions, and crop-specific characteristics. By considering factors like soil quality, weather conditions, and crop type, the system generates optimal fertilizer recommendations. These recommendations aim to optimize nutrient supply, reduce over-fertilization, and minimize environmental impact.

Farmers and agricultural professionals can access the system through a user-friendly interface, such as a mobile application or web platform. Here, they can receive personalized recommendations for fertilization and access real-time data on their crops' health and environmental conditions. This not only enhances crop yield but also streamlines decision-making processes for farmers, reducing costs and environmental harm.

Keyword *Precision Agriculture crop recommendation system, crop disease prediction, Internet of Things, Machine Learning*

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1. Introduction

India is an agricultural nation, where the population is over 1.2 billion, out of which around 70% of the population depends upon agriculture. Agriculture is a primary source of earning for Indian citizens and agriculture also has made an influence on India's economy. Agriculturists have an immeasurable variety to choose equitable products of the soil crops. The selection of the crop by the farmer plays a vital role in the economical returns to the farmer.

Agriculture, as the backbone of our global food supply, faces increasing pressure to meet the ever-growing demand for crops while simultaneously addressing concerns related to sustainability, resource optimization, and environmental impact. In response to these challenges, modern technology has paved the way for innovative solutions that can revolutionize farming practices. One such groundbreaking advancement is the "IoT-Based Crop Yield Prediction and Fertilizer Recommendation System."

The Internet of Things (IoT) has emerged as a transformative force in various industries, and agriculture is no exception. By integrating IoT technology with data analytics and artificial intelligence, this system offers an intelligent and data-driven approach to agriculture, aiming to improve crop yield, reduce resource waste, and ensure responsible land management.This system's core concept revolves around harnessing the power of IoT to monitor, collect, and analyze real-time data from agricultural fields. Through an extensive network of sensors and actuators strategically deployed in the fields, essential environmental parameters such as soil moisture, temperature, humidity, and light intensity are continuously measured. This data is then transmitted to a centralized database, where it is processed and subjected to advanced machine learning algorithms.

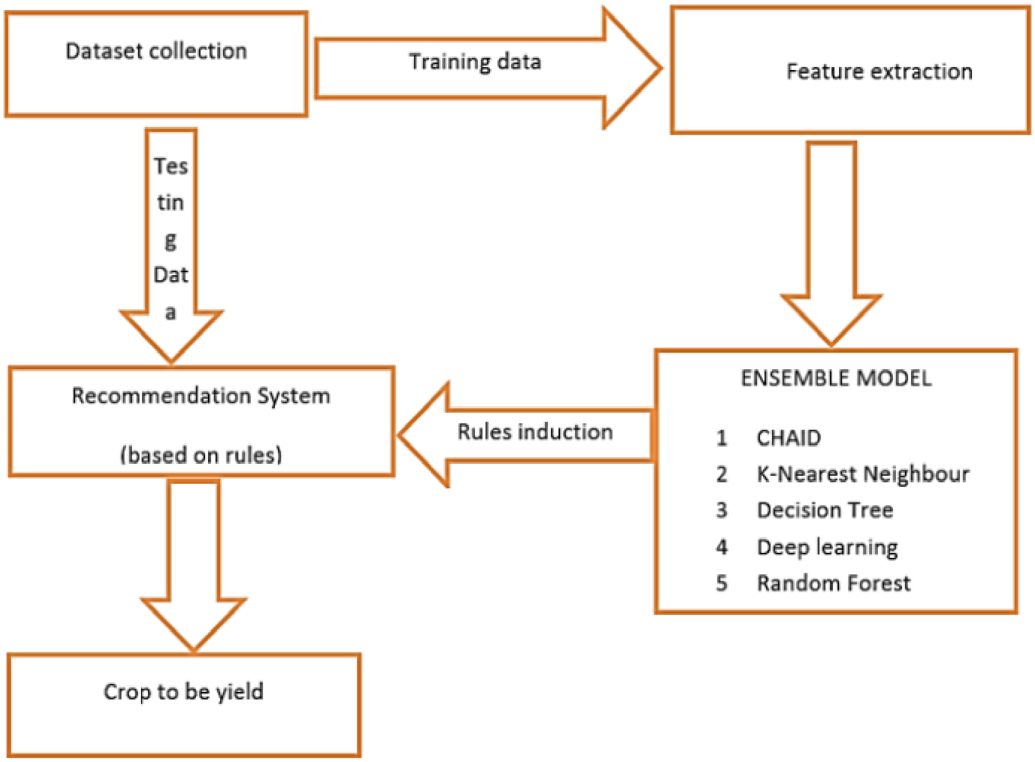
The proposed system is a smart agriculture system which is automated to help farmers to increase crop production by predicting the crop to be sown. The system will detect soil quality and provided a list of selected general crops placed on a database. The system used different sensors that measured pH level, soil moisture, temperature, and humidity. After designing the system for pH, soil moisture, humidity, and temperature sensor, the next step is to build a model for crop recommendation. The databasewill compose of recommended minimum and maximum values of temperature, humidity, pH, soil moisture recommended for growing crops commonly planted in the country. After that weather forecasting will be done. In that weather forecasting, google API is used for taking the real-time weather values. Then by checking the weather condition, recommend the crop to be sown. Due to changing environmental conditions continuously crop arises the different diseases for controlling that system will recommend the solution to destroy disease. For maximizing the crop yield farmers use the pesticide, fertilizer in the high amount due to this toxicity of soil increases for controlling this activity system will recommend the best pesticide and fertilizer with best measurements.

1.1 Problem Definition

With every change in weather condition the fertility of soil keeps on changing. The Monitoring is necessary for healthy crop production since the fertility of a soil varies at Different parts of field. pH electrodes are used for determining pH of a soil. Electrical Conductivity and soil alkalinity are sensed by pH electrodes. Nutrient contents are determined on the basis of sensed parameters. The soil fertility state is considered by obtaining average of all observation from different parts of land. After calculating fertility, system will determine suitable crops for tested land and farmer gets an idea of what fertilizer is required

1.2 Proposed System:

Human Life is Fully depend upon Food. Due to increasing population and tremendous climate change Production of Crop is a major deal. Therefor Fertilizers are used to gain the Production of crop. Our Proposed System will replace the old fashioned Farming Technique with Smart Agriculture system. In this system, Automated Remotely Monitored Fertility monitoring Technique are used. Detection and Quality of Soil is determined by calculating different Parameters and Nutrients contents of soil i.e. nitrogen, phosphorus & potassium (NPK). A ph of soil is detected by PH sensor, Water content of Soil is calculated by Moisture sensor which is attached to Remote system. Portable device is used to take samples of the soil from different parts of that particular Land. Results will be shown on the which is F itted on model. Framer will get an User Friendly Mobile Application that works very efficiently. In that application Farmer need to Insert the calculated data physically which is present on the display Screen. After Inserting that Data, The Application will digitally calculate the result and Present Farmer the Fertilizer name which can be suitable for that particular Soil and also recommends which Crop will be suitable to grow in that Soil. So Farmer can make their Strategies for farming accordingly with data that has generated and can take steps to increase the effectiveness of Fertilizer and effectiveness of crops and use them relevantly.



2. Literature Review

In 2018, Komal Bodake et al [2], developed a soil based fertilizer recommendation system that can be used for regional soil analysis. The advanced farming involves various techniques as IOT, Cloud computing and data mining. This helps the farmers to gather details regarding the fertilizers he can use from his soil sample. The tool was constructed in such a way involving regional languages. This makes it understandable to all the farmers and yield maximum production.

Dharmesh Vadalia, Minal Vaity, Krutika Tawate, Dynaneshwar Kapse developed a system in which PH electrodes are used for determining PH of a soil. In this project microcontroller is also used for identifying PH of diluted acid soil sample using glass pH electrode. It's range is from 0 to 14 with 7 being neutral. PH above 7 is alkaline in nature and PH below 7 is acidic in nature. Here, Human errors are reduced by system by monitoring the soil quality. The system determines suitable crops and fertilizers for soil's current state.

In 2019, R.Neela et al [4], proposed a new method for finding leaf diseases in plants. Plant disease, especially on leaves, is one of the major factors for reduction in both quality and quantity of the food crops. Finding the leaf disease is an important role of agriculture preservation. To identify the disease the image of the affected leaf is fed as input into the system. As a first step preprocessing of the image is carried out using median filter. The filtered image then undergoes segmentation, which is carried out by Guided Active Contour method. Classification of the leaf disease was performed by using Support Vector Machine. They compared the performance of their proposed method with the existing CNN method. With the same set of given images for CNN was 0.7 and 0.8 for SVM. The accuracy in the identification of the disease was 0.6 for CNN and 0.8 for SVM

In 2020, Shravani V et al [12], proposed a suggestion for crop and soil classification using machine learning approach. The results of such classification can be further combined with crop dataset to predict those crops that are suitable for the soil series of a particular region and its climatic conditions. Soil and crop dataset used by them comprises of chemical attributes and 14 geographical attributes. In the proposed method algorithms like SVM and Ensembling technique were used to classify the soil series data and predict the suitable crops.

2.1 Sub Title-1
2.1 Existing Systems:

1) **Remote Sensing and Satellite Imagery**: Remote sensing technologies, including satellite imagery and drones, are used to monitor crop health, identify anomalies, and predict yield. These systems capture data on factors such as vegetation indices, soil moisture, and temperature, which are then analyzed to make predictions.
2) **Data Analytics and Machine Learning:** Machine learning algorithms analyze historical data, including crop performance, weather patterns, and soil characteristics, to predict future crop yields. These systems continuously learn and improve their predictions over time as more data becomes available.
3) **Weather Stations and IoT Sensors:** On-field weather stations and Internet of Things (IoT) sensors provide real-time data on temperature, humidity, and other weather conditions. Integrating this data into prediction models helps account for current environmental factors influencing crop growth.
4) **Crop Modelling Software:** Crop modeling software simulates crop growth based on various parameters, helping farmers and researchers understand how different factors affect yield. These models can be used for scenario analysis and predicting outcomes under different conditions.
5) **Precision Agriculture Platforms:** Precision agriculture involves using technologies like GPS, sensors, and automation to optimize field-level management with regard to crop farming. These platforms may provide recommendations on planting density, irrigation, and fertilizer application.

2.2 Sub Title-2
2.2 Drawback of Existing Systems:

While existing systems for crop yield prediction and fertilizer recommendation have made significant advancements, there are certain drawbacks and challenges associated with these systems. Here are some common drawbacks:

1) **Data Limitations:** Many systems heavily rely on historical data for predictions. Limited or inaccurate data can lead to less reliable predictions. Data gaps, especially in developing regions, can hinder the accuracy of the models.
2) **Dependency on Weather Conditions:** Predictive models are often sensitive to changes in weather conditions. Extreme weather events or unexpected variations can impact the accuracy of yield predictions. Lack of real-time weather data in certain areas can affect the precision of forecasts.
3) **Soil Variability:** Soil characteristics can vary significantly within a single field, and existing systems may not account for this level of granularity. Some systems may provide generalized recommendations that do not consider the specific soil conditions of individual plots.
4) **Integration Challenges:** Integration of diverse data sources, such as satellite imagery, soil sensors, and weather data, can be complex. Incompatibility and lack of standardization may hinder seamless integration. Limited interoperability between different systems can be a barrier to the holistic management of agricultural data.
5) **Cost of Technology Adoption:** Implementation of advanced technologies, such as precision agriculture tools, drones, and sensors, can be expensive for small-scale farmers. The initial investment and maintenance costs may be a deterrent for widespread adoption, particularly in resource-constrained regions.

3. TITLE-3

Requirement analysis is a crucial phase in the development of any system or software, including complex systems like crop yield prediction and fertilizer recommendation tools. During this phase, a comprehensive understanding of the needs, objectives, and constraints of the users and stakeholders is established. It involves gathering, documenting, and prioritizing the functional and non-functional requirements that the system must fulfill. For a crop yield prediction and fertilizer recommendation system, the analysis would typically involve interactions with farmers, agronomists, researchers, and other stakeholders. The requirements may encompass data sources such as soil quality, weather conditions, and historical crop performance. Additionally, the system's capabilities in terms of predictive modeling, recommendation algorithms, and user interfaces need careful consideration. The analysis should also address issues of scalability, data security, and usability. Clear communication with end-users is essential to capture their expectations and preferences accurately. The success of the system hinges on a thorough and well-documented requirement analysis, providing a solid foundation for subsequent stages of development and ensuring that the final solution aligns with the practical needs of the agricultural community it serves.

3.1 Functional Requirements:

Functional requirements outline the specific features and capabilities that a system must have to meet its intended purpose. For a crop yield prediction and fertilizer recommendation system, functional requirements can be diverse and include elements related to data processing, analysis, user interactions, and output generation. Here are some potential functional requirements for such a system:

Data Collection and Integration: The system should be able to collect data from various sources, including soil sensors, satellite imagery, weather stations, and historical agricultural databases. It must integrate these diverse data sets to create a comprehensive and up-to-date profile of the agricultural environment.

Predictive Modeling: Implement machine learning algorithms to analyze historical data and predict crop yields based on current and future conditions. The system should continuously update and refine its models as new data becomes available.

Fertilizer Recommendation Engine: Develop an algorithm that recommends specific types and quantities of fertilizers based on soil nutrient levels, crop type, and growth stage. Consider environmental sustainability by promoting optimal fertilizer usage.

User Authentication and Access Control: Implement secure user authentication to ensure that only authorized individuals, such as farmers and agronomists, can access the system. Define role-based access controls to manage different levels of user permissions.

User Interface (UI): Design an intuitive and user-friendly interface accessible through various devices, such as desktop computers and mobile devices. Include interactive visualizations to present crop yield predictions, fertilizer recommendations, and other relevant information.

Reporting and Notifications: Generate detailed reports on predicted crop yields, fertilizer recommendations, and any other relevant insights. Provide notification features to alert users about critical events, such as extreme weather conditions or changes in recommended practices.

4. CONCLUSIONS

Agriculture being an important part of our economy, it is essential to ensure that even the smallest investment done in the agriculture sector should be taken care of when it comes to farming and crop seeds are one of them. So it is essential to check if the correct crop has been chosen for suitable soil that matches its requirements to benefit the farmer. This system would assist the farmers in making an informed decision about which crop to grow depending on a variety of environmental and geographical factors. The ML and IoT based suggestions will significantly educate the farmer and help them minimize costs and make strategic decisions by replacing intuition and passed-down knowledge with far more reliable data-driven ML models. This allows for a scalable, reliable solution to an important problem affecting hundreds of millions of people. Our future work aims at developing this model with more soil attributes and with a larger data set.

The IoT-Based Crop Yield Prediction and Fertilizer Recommendation System represents a remarkable advancement in modern agriculture, addressing the critical challenges of improving crop productivity, resource efficiency, and sustainable farming practices. This innovative system harnesses the potential of IoT technology, data analytics, and machine learning to empower farmers and stakeholders with invaluable insights and recommendations.

By seamlessly integrating IoT sensors for real-time data collection and advanced machine learning models for yield predictions, this system offers a holistic solution for optimizing agricultural practices. Its benefits extend to various facets of agriculture and related industries, from precision farming to environmental conservation and supply chain management.

Through accurate crop yield predictions, the system assists farmers in maximizing their production, reducing waste, and minimizing over-fertilization. These factors, in turn, lead to substantial cost savings and contribute to environmental sustainability by curbing harmful agricultural runoff and soil degradation.

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