A Project report on

CROP YIELD AND FERTILIZER RECOMMENDATION USING MACHINE LEARNING

A Dissertation submitted to JNTU Hyderabad in partial fulfillment of the academic requirements for the award of the degree.

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CERTIFICATE

This is to certify that the Major Project report entitled **"Crop Yield and Fertilizer Recommendation using Machine Learning"** being submitted by V.Vijay (20H51A0554), D. Raja Goud (20H51A0562), K. Jeevitha (20H51A05E3) in partial fulfillment for the award of **Bachelor of Technology in Computer Science and Engineering** is a record of bonafide work carried out his/her under my guidance and supervision.

The results embodies in this project report have not been submitted to any other University or Institute for the award of any Degree.

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ABSTRACT

India being an agriculture country, its economy predominantly depends on agriculture yield preditction and agroindustry products. Data Mining is an emerging research field in crop yield analysis. Yield prediction is a very important issue in agricultural. Any farmer is interested in knowing how much yield he is about to expect. Analyze the various related attributes like location, pH value from which alkalinity of the soil is determined. Along with it, percentage of nutrients like Nitrogen (N), Phosphorous (P), and Potassium (K) Location is used along with the use of thirdparty applications like APIs for weather and temperature, type of soil value of the soil in that region, amount of rainfall in the region, soil composition can be determined. All these attributes of data will be analyzed, train the data with various suitable machine learning algorithms for creating a model. The system comes with a model to be precise and accurate in predicting crop yield and deliver the end user with proper recommendations about required fertilizer ratio based on atmospheric and soil parameters of the land which enhance to increase the crop yield and increase farmer revenue.

CHAPTER 1
INTRODUCTION

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INTRODUCTION

1.1.Problem Statement

Agriculture is one of the important occupation practiced in India. It is the broadest economic sector and plays a most important role in the overall development of the country. More than 60% of the land in the country is used for agriculture in order to suffice the needs of 1.3 billion people Thus adopting new agriculture technologies is very important. This will be leads the farmers of our country towards profit [1]. Prior crop prediction and yield prediction was performed on the basis of farmers experience on a particular location. They will prefer the prior or neighborhood or more trend crop in the surrounding region only for their land and they don't have enough of knowledge about soil nutrients content such as nitrogen, phosphorus, potassium in the land. Being this as the current situation without the rotation of the crop and apply an inadequate amount of nutrients to soil it leads to reduce in the yield and soil pollution (soil acidification) and damages the top layer. Considering all these problems takes into the account we designed the system using a machine learning for betterment of the farmer. In the Agriculture field machine learning for instance is not a mysterious trick or magic, it is a set of well define model that collect specific data and apply specific algorithms to achieve expected results [7]. The designed system will recommend the most suitable crop for particular land. Based on weather parameter and soil content such as Rainfall, Temperature, Humidity and pH. They are collected from V C Farm Mandya, Government website and weather department. The system takes the required input from the farmers or sensors such as Temperature, Humidity and pH. This all inputs data applies to machine learning predictive algorithms like Support Vector Machine (SVM) [5] and Decision tree [6] to identify the pattern among data and then process it as per input conditions. The system recommends the crop for the farmer and also recommends the amount of nutrients to be add for the predicted crop. The system has some other specification like displaying approximated yield in q/acre, required seed for cultivation in kg/acre and the market price of the crop.

1.2.Research Objective

Ashwani kumar Kushwaha[2] describes crop yield prediction methods and a suggest suitable crop so that it will improve the profit for the farmer and quality of the agriculture sector. In this paper for crop yield prediction they obtain large volume data, it's been called as big data (soil and weather data) using Hadoop platform and agro algorithm. Hence based repository data will predict the suitability crop for particular condition and improvement crop quality.

Girish L [3] describe the crop yield and rain fall prediction using a machine learning method. In this paper they gone through a different machine learning approaches for the prediction of rainfall and crop yield and also mention the efficiency of a different machine learning algorithm like liner regression, SVM, KNN method and decision tree. In that algorithm they conclude that SVM have the highest efficiency for rainfall prediction.

Rahul katarya [4] describes the different machine learning methods used for accelerating crop yield. In this paper they gone through different artificial intelligence techniques such as machine learning algorithm, big data analysis for precision agriculture. They explain about crop recommender system using KNN, Ensemble-based Models, Neural networks, ...etc.

1.3. Project Scope and Limitations

Scope:

The system under consideration suggests the most appropriate crop for a specific land plot, taking into account factors like annual precipitation, temperature, humidity, and soil pH. Among these variables, the system autonomously forecasts annual rainfall by utilizing past-year data through the SVM algorithm, while the user must input the remaining parameters.In the output segment, the system provides information about the recommended crop, the quantity of seeds required per acre, current market prices, and an estimated crop yield. Additionally, the system relies on user-provided NPK values in the input section to determine the necessary NPK (Nitrogen, Phosphorus, and Potassium) ratios for the suggested crop.

Limitations:

Crop yield and fertilizer recommendation systems that utilize machine learning techniques have several limitations. It's important to be aware of these limitations to understand the constraints and potential challenges associated with such systems. Here are some of the key limitations:

Data Quality and Availability: Limited or low-quality data can lead to inaccurate recommendations. Access to reliable, up-to-date data on soil conditions, weather, and historical crop performance can be a challenge, particularly in remote or underserved areas.

Geographic Specificity: Machine learning models trained in one geographic region may not generalize well to other regions. Recommendations may need to be fine-tuned or customized for specific local conditions, such as soil types, microclimates, and crop varieties.

Resource Constraints: Recommendations often assume that farmers have access to necessary resources like water, fertilizers, and pesticides. In reality, resource availability may be limited or uneven, which can impact the feasibility of following the recommendations.

Technology Access: Farmers in some regions may lack access to the technology required to implement these systems, such as smartphones, internet connectivity, or sensors. This digital divide can exclude certain farmers from benefiting from the recommendations.

User Adoption: Convincing farmers to adopt and trust machine learning-based recommendations can be challenging. Traditional farming practices and local knowledge may be deeply ingrained, and some farmers may be reluctant to change their methods.

Model Uncertainty: Machine learning models typically provide recommendations with a level of uncertainty. Farmers need to understand that these recommendations are not infallible and should be used in conjunction with their own expertise and experience

CHAPTER 2
BACKGROUND WORK

CHAPTER 2

BACKGROUND WORK

2.1. Crop and Fertilizer Prediction using Deep Learning

2.1.1. Introduction

Agriculture has several effects on our nation, including supplying food, shelter, employment opportunities, the raw materials needed to produce food, the creation of enterprises, and other essentials that contribute to economic development. Crop productivity is a major factor in India's economy. When it comes to agricultural productivity, one must choose a crop carefully. Here, crop choice is a crucial component of agriculture. Precipitation, humidity, temperature, and the amounts of potassium, nitrogen, and phosphorus in the soil all have an impact on crop predictions. The right kinds and dosages of fertilisers give the soil the vital nutrients it needs to keep producing crops. The crop that will be grown can be chosen by farmers in the initial stages. But today, it is challenging for farmers to estimate the yield because of constant changes in the environment. Additionally, this has caused a number of issues for farmers. Farmers are also experiencing a lot of difficulties as a result of their ignorance of fertilisers. Deep learning algorithms are therefore utilised to forecast the crop and recommend fertiliser. Over time, the neural network adds layers, and as the network gets deeper, performance gets better. Deep learning aims to do this. For predicting new output values, deep learning approaches like CNN and machine learning models like SVM, Naive Baye's, Random Forest, and XG Boost are useful. Two datasets that are useful for crop recommendation and fertiliser suggestion are the one for fertiliser prediction and the other for crop recommendation. According to deep learning, an ensemble technique provides a greater level of prediction accuracy.

2.1.2. Merits, Demerits and Challenges

Merits:

Increased Accuracy: Deep learning algorithms can process large volumes of data and identify complex patterns, leading to more accurate crop yield and fertilizer requirement predictions.

Data-Driven Decisions: Farmers can make informed decisions based on the predictions, optimizing their crop yield and reducing unnecessary fertilizer usage, which is beneficial for both the environment and their finances.

Precision Farming: Deep learning enables precision agriculture by tailoring fertilizer application and crop management at a granular level, ensuring resources are used efficiently.

Early Detection of Issues: Deep learning models can identify crop diseases, pest infestations, or nutrient deficiencies early, allowing farmers to take timely corrective actions and prevent significant yield losses.

Demerits:

Data Dependency: Deep learning models require large, high-quality datasets for training. Lack of reliable data can hinder the accuracy of predictions, especially in regions with limited access to data collection infrastructure.

Computational Resources: Training deep learning models requires significant computational resources, including powerful hardware and large amounts of memory. This can be a barrier for small-scale farmers or organizations with limited resources.

Complexity: Deep learning models are complex and may be difficult to interpret and understand. This complexity can make it challenging for farmers to trust and implement the recommendations provided by the models.

Challenges:

Data Quality and Availability: Ensuring the quality and availability of data, including weather patterns, soil quality, and historical crop yield data, is a major challenge. Without reliable data, the predictions may not be accurate.

Interpretable Models: Developing deep learning models that are interpretable and can provide insights into the reasons behind specific predictions is a challenge. Interpretable models are crucial for gaining trust from farmers and stakeholders.

Adaptability: Crop and fertilizer prediction models need to be adaptable to different regions, climates, and agricultural practices. Creating models that can generalize well across diverse conditions is a significant challenge.

Ethical Considerations: The use of data, especially in agriculture, raises ethical concerns regarding privacy, data ownership, and consent. Addressing these ethical issues is crucial for the responsible implementation of deep learning techniques in agriculture.

2.1.3. Implementation

In this study, a web application is created to help farmers identify the type of crop they are producing by letting them enter values [3]. A crop and fertiliser recommendation system can be created using a variety of deep learning techniques. A crop, fertiliser, and disease prediction system is created using CNN and a few other deep learning algorithms, including LSTM [4]. To obtain the outcome, farmers enter the values into the modules. To build and launch the front end, HTML, CSS, and Bootstrap are utilised. Farmers will find this online application to be a terrific companion. The standard methodologies have limited capacity for learning from the data, and it is usually difficult to pinpoint the optimum traits [5]. Because of advancements in computing technology, new multilayer algorithms may now be developed and learned.

2.2. Crop , Fertilizer Recommendation system and disease prediction system

2.2.1. Introduction

Agriculture helps to the Nation and its economy. The major chunk of Nation's people rely on on crops for daily business. • The maximum of the daily wage farmers have an belief that they depend on superstition and then decide which crop to grow in a specific month. So they find easiness in following the old age grandparent's crop patterns. And are unaware that farm's circumstance is unhealthy, due to current reports of the meteorogical department. • When we talk about farming it is not allowed to take into consideration all the unbalanced upcomings that help in farm's growth although we must be aware of what type of crop one should grow . Various methodologies are available these days out of which Deep Learning can help us fix this issue.

2.2.2. Merits, Demerits and Challenges

Merits:

Increased Efficiency: Precision agriculture and data-driven approaches can enhance crop yield by optimizing fertilizer use, leading to higher productivity.

Cost Savings: Farmers can save money by applying the right amount of fertilizers, reducing waste and environmental impact.

Environmental Benefits: Reduced overuse of fertilizers can decrease nutrient runoff, which can pollute waterways.

Improved Sustainability: Optimized fertilizer application contributes to sustainable agriculture practices.

Demerits:

Data Dependency: These systems rely on accurate data, including soil conditions, weather, and crop type, which may not always be available or accurate.

Initial Investment: Implementing precision agriculture technologies can be costly for farmers.

Knowledge Barrier: Farmers may need training to effectively use these technologies.

Risk of Overreliance: Overreliance on technology can lead to a neglect of traditional farming knowledge.

Challenges:

Data Integration: Integrating diverse data sources can be challenging, as data may come from different sensors, equipment, and platforms.

Adaptation to Local Conditions: Precision agriculture solutions need to be tailored to specific geographic and environmental conditions.

Regulatory Hurdles: Regulatory frameworks and policies may need to evolve to support these technologies.

Infrastructure and Connectivity: Access to reliable internet and infrastructure can be limited in rural areas.

2.2.3. Implementation

In this project , we have implemented an intelligent system called Crop and fertilizer Recommendation , which intends to assist the farmers in making an informed decision about which crop to grow and which fertilizer used depending on the sowing season , his farm's geographical location, soil characteristics as well as environmental factors such as temperature and rainfall. • We also implemented an image processing system called Disease Prediction , which help to farmers whether crop are infected or not and if it is infected then system shows name and prevention of that disease. Crop Production is usually the maximum of the major commodities which will impact the Nation's healthy equipment measures. • Where we all presently live, the maximum chunk the people is highly variable on crop for daily means . Plethora of great methodologies, which include Computer Learning and Data Learning, which can be taken into account so that it becomes easy to people to raise the output of their farms. • In this project, I present a website in which the following applications are implemented; Crop recommendation, Fertilizer recommendation and Plant disease prediction, respectively.

2.3. Crop Recommendation System using Machine Learning

2.3.1. Introduction

A vast fraction of the population of India considers agriculture as its primary occupation. The production of crops plays an important role in our country. Bad quality crop production is often due to either excessive use of fertilizer or using not enough fertilizer. The proposed system of IoT and ML is enabled for soil testing using the sensors, is based on measuring and observing soil parameters. This system lowers the probability of soil degradation and helps maintain crop health. Different sensors such as soil temperature, soil moisture, pH, NPK, are used in this system for monitoring temperature, humidity, soil moisture, and soil pH along with NPK nutrients of the soil respectively. The data sensed by these sensors is stored on the microcontroller and analyzed using machine learning algorithms like random forest based on which suggestions for the growth of the suitable crop are made. This project also has a methodology that focuses on using a convolutional neural network as a primary way of identifying if the plant is at risk of a disease or not.

2.3.2. Merits, Demerits and Challenges

Merits:

Increased Crop Yield: Crop recommendation systems can help farmers choose the most suitable crops for their specific environmental conditions and optimize their yield potential.

Resource Efficiency: By recommending the right crops and cultivation practices, these systems can help farmers optimize resource usage, such as water, fertilizer, and pesticides, reducing waste and environmental impact.

Improved Profitability: Optimal crop selection can lead to increased profitability for farmers, as they can grow crops that are in higher demand or have better market prices.

Risk Mitigation: These systems can assist in mitigating risks associated with crop failure due to unfavourable environmental conditions or pests by recommending more resilient crop varieties.

Demerits:

Data Dependence: Crop recommendation systems heavily rely on data, and the quality of recommendations is contingent on the accuracy and availability of data. Inaccurate or incomplete data can lead to suboptimal recommendations.

Technology Access: Not all farmers have access to the necessary technology and infrastructure to implement these systems, which can create a digital divide in agriculture.

Initial Setup Costs: Implementing a crop recommendation system may require an initial investment in technology and training, which can be a barrier for small-scale farmers.

Complexity: The implementation and use of machine learning-based systems can be complex, and some farmers may struggle to understand and use the technology effectively.

Model Generalization: Machine learning models used in these systems may not always generalize well to different regions or environments, requiring customization for local conditions.

Challenges:

Data Quality and Availability: Obtaining accurate and up-to-date data on weather, soil conditions, and historical crop performance can be a challenge, especially in remote or developing regions.

Scalability: Scaling these systems to accommodate a large number of farmers and diverse cropping systems can be technically challenging.

Localization: Recommendations need to be customized for local conditions, which may require fine-tuning the models for specific regions or microclimates.

Adoption and Acceptance: Convincing farmers to adopt and trust the recommendations provided by the system can be a significant challenge, as traditional farming practices and local knowledge may be deeply ingrained.

Maintenance and Support: Regular maintenance and technical support are essential to keep the system running effectively and address any issues that may arise.

2.3.3. Implementation

In this study, an intelligent crop recommendation system, which can be easily used by farmers all over India. This system would help the farmers in making an informed decision about which crop to grow depending on some parameters like Nitrogen, Phosphorous, Pottasium, PH Value, Humidity, Temperature, and Rainfall. By using this research we can increase productivity of the country and produce profit out of such a technique. In this manner the farmer's can plant the right crop increasing his yield and also increasing the overall profitability of the country. This investigation has expressed the recommendation of various crops of India using different machine learning algorithms like Decision Tree, Naïve Bayes, Support Vector Machine, Logistic Regression, Random Forest and XGBoost. The Analysis has been performed on these six types of machine learning algorithms and out of these six algorithms XGBoost achieved best accuracy result.

CHAPTER 3
RESULTS AND DISCUSSION

CHAPTER 3

RESULTS AND DISCUSSION

In the context of crop field management and fertilizer recommendation using machine learning, the results and discussions typically focus on the accuracy of the prediction models, the effectiveness of the fertilizer recommendations, and the overall impact on crop yield and environmental sustainability. Here's a structured approach for presenting the results and discussion of a study involving crop field analysis and fertilizer recommendation using machine learning techniques:

Results:

1. **Model Performance:**
   - Discuss the accuracy, precision, recall, F1-score, or any other relevant metrics of the machine learning models used for crop prediction and fertilizer recommendation. Compare the performance of different algorithms if multiple models were tested.
   - Highlight any significant improvements over traditional methods or benchmarks.
2. **Fertilizer Recommendations:**
   - Present the accuracy of fertilizer recommendations made by the machine learning algorithms.
   - Discuss the precision of the recommendations in terms of specific nutrients (nitrogen, phosphorus, potassium, etc.).
   - Provide examples of successful fertilizer prescriptions based on the model predictions.
3. **Crop Yield Prediction:**
   - Discuss the accuracy of crop yield predictions made by the machine learning models.
   - Compare predicted yields with actual yields obtained from the fields to validate the model's effectiveness.
4. **Environmental Impact:**
   - Discuss how the machine learning-based fertilizer recommendations have contributed to reducing over-fertilization, minimizing nutrient runoff, and promoting sustainable agriculture practices.

5. **User Satisfaction:**
    - Include feedback from farmers or agricultural experts who utilized the machine learning-based recommendations. Discuss their satisfaction levels and any improvements in crop yield and soil health they observed.

Discussion:

1. **Accuracy and Reliability:**
    - Discuss the reliability of machine learning algorithms in predicting crop yield and recommending appropriate fertilizers.
    - Address any limitations or challenges faced during the implementation of the models.
2. **Practical Implications:**
    - Discuss how accurate fertilizer recommendations positively impacted crop yield, reduced input costs, and increased overall agricultural productivity.
    - Explain how farmers can benefit from adopting machine learning-based approaches in their farming practices.
3. **Challenges and Future Directions:**
    - Address challenges faced during the study, such as data availability, model complexity, or technological constraints.
    - Discuss potential improvements, such as incorporating real-time data, satellite imagery, or IoT devices for more accurate predictions and recommendations.
4. **Sustainability and Environmental Conservation:**
    - Emphasize the role of machine learning in promoting sustainable agriculture by optimizing fertilizer usage and reducing environmental impact.
    - Discuss the potential for scaling the approach to benefit a larger agricultural community and promote sustainable practices on a broader scale.

CHAPTER 4
CONCLUSION

CHAPTER 4

CONCLUSION

Presently our farmers are not effectively using technology and analysis, so there may be a chance of wrong selection of crop for cultivation that will reduce their income. To reduce those type of loses we have developed a farmer friendly system with GUI, that will predict which would be the best suitable crop for particular land and this system will also provide information about required nutrients to add up, required seeds for cultivation, expected yield and market price. So, this makes the farmers to take right decision in selecting the crop for cultivation such that agricultural sector will be developed by innovative idea.

FUTURE SCOPE:

We have to collect all required data by giving GPS locations of a land and by taking access from Rain forecasting system of by the government, we can predict crops by just giving GPS location. Also, we can develop the model to avoid over and under crisis of the food.

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