Journal of Advanced Zoology

ISSN: 0253-7214

*Volume **44** Issue **S-5 Year 2023** Page **1260:1263***

A Study of Crop Yield Prediction Using Machine Learning Approaches

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Article History

Received: 06 June 2023
Revised: 05 Sept 2023
Accepted: 23 Oct 2023

Abstract

Agriculture plays a pivotal role in our society by providing food, fiber, and raw materials for various industries. The world's population is steadily growing, and there is increasing pressure on agriculture to meet the rising global food demand. In this context, the use of machine learning approaches to predict crop yields has gained significant importance. This paper aim is to study the significance of crop yield prediction through machine learning, its methods, applications, and its potential to revolutionize the agricultural sector.

Keywords: *Agriculture, food, crop, machine learning, raw materials*

1. Introduction

Agriculture, the foundation of human civilization, has continually evolved to meet the ever-increasing demands of our burgeoning global population. In this era of unprecedented demographic growth, climate uncertainty, and a pressing need for sustainable resource management, the agricultural sector faces an enormous challenge: ensuring food security while minimizing environmental impact. To address these challenges and revolutionize the way we approach farming, a new frontier has emerged at the intersection of agriculture and technology - the study of crop yield prediction using machine learning approaches.

As the world's population approaches 8 billion and beyond, the critical importance of agriculture in sustaining human life cannot be overstated. It is the source of the food on our tables, the fibers in our clothing, and the raw materials for countless industries. In the face of a rising global demand for food, the agricultural sector is tasked with the herculean responsibility of enhancing productivity, minimizing resource waste, and reducing the environmental footprint of farming practices. Crop yield prediction through the prism of machine learning offers a transformative pathway toward these objectives.

Now, Machine learning, a subset of artificial intelligence, empowers computers to learn and make predictions or decisions without being explicitly programmed. When applied to agriculture, this technology becomes a potent tool for forecasting crop yields with unprecedented accuracy and granularity. It can harness the power of vast datasets, including historical crop performance, meteorological data, soil characteristics, and more, to unveil intricate relationships that influence crop yields. By doing so, machine learning enables us to not only anticipate crop outcomes but to empower farmers, policymakers, and stakeholders in the agricultural ecosystem with data-driven insights.

Sheenoy et al. represented a paper that places an answer for the decrement in cost of transportation. The IOT-based methodology is used to decrease quantity of agents and middle hops between the clients and the ranchers that further supports the rancher. The paper ends up being the inspiration for the research work. The paper executes mechanisms that are integrated and provides a prediction-based mechanism that advise for crops which yield maximum profit [1]. Monali et al. said, to make prediction of the crop yields, an analysis of crops is made and based on it, they are classified. The classification is performed on the basis of data mining algorithms [2]. Various rules of classification such as K-Nearest Neighbor,

Naive Bayes are taken care of in this paper. These rules are studied and recognized that will be exact for dataset used in this research work [3]. Abdullah et al. provided a smartphone-based application that calculates the pH values for soil, humidity and temperature progressively. A microcontroller block, communication block and sensing block are used by the system. Sensors are utilized in ranch in order to set a communication link with cellphones using Bluetooth continuously. This paper gives methods for remote investigation of soil through different procedures. It urged us to search for different methods through which the information can be passed on that will be taken from sensors for development and in the end producing the yield [4]. Hemageetha et al. gave various data mining techniques such as Association Rule Mining, Classification, Clustering, Market-based analysis, Decision Trees. It totally wraps the data mining idea. In this paper, different data mining algorithms, for example, K-Means, Naïve Bayes classifier, J48 are discussed [5]. Likewise, the soil classification depending on Genetic algorithm, Naïve Bayes, Association Rule Mining. In the end, the clustering in database of soil is covered. It supported us in comprehension along with various data mining algorithms analysis. While building up the task of this research work, it ends up being very beneficiary. It helps in dataset mining acquired from remotely used sensors [6]. Nagini et al. displayed an Explorative data study shown in this paper along with an explaination of creating a number of predictive models is given. The different regression techniques are used on a sample dataset so as to recognize and examine their properties separately. The methods explained in the paper are Linear, non-Linear, Multiple-Linear, Polynomial, Ridge and Logistic regression [7]. A comparative study of a number of algorithms in data analytics is achieved. It further helps to take a better decision of the best suitable algorithm for the proposed structure [8].

In this Paper, we will embark on a journey into the realm of crop yield prediction using machine learning approaches. We will delve into the significance of accurate yield forecasting, explore the methodologies employed in this field, investigate its real-world applications, and discuss the challenges and opportunities that lie ahead. As we navigate this landscape, it becomes apparent that the fusion of agriculture and machine learning is not merely a promising frontier but a necessity for addressing the pressing global challenges of food security and sustainability.

2. Materials And Methods

The system uses machine learning to make predictions of the crop and Python as the programming language since Python has been accepted widely as a language for experimenting in the machine learning area. Machine learning uses historical data and information to gain experiences and generate a trained model by training it with the data. This model then makes output predictions. The better the collection of datasets, the better will be the accuracy of the classifier. It has been observed that machine learning methods such as regression and classification perform better than various statistical models. Crop production is completely dependent upon geographical factors such as soil chemical composition, rainfall, terrain, soil type, temperature etc. These factors play a major role in increasing crop yield. Also, markets situation affects the crop to be grown to gain maximum benefit. We need to consider all the factors to predict the yield. Hence, using machine learning techniques in the agriculture field, we build a system that uses machine learning to make predictions of the production of crops by studying the factors as rainfall, temperature, area, season, etc.

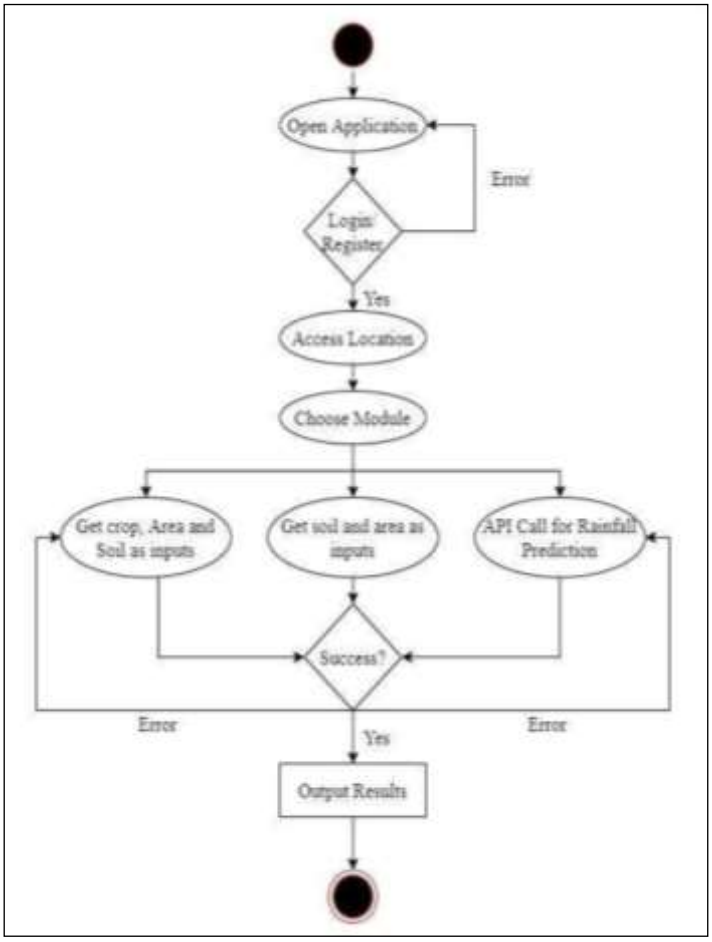

Fig: 1 Basic block diagram of Application

Importance Of Crop Yield Prediction

i). **Food Security**: Crop yield prediction is crucial for ensuring food security. By accurately forecasting crop yields, we can make better decisions about planting, harvesting, and distribution, ultimately reducing food shortages and ensuring that everyone has enough to eat.

ii). **Resource Management**: Effective resource management is key to sustainable agriculture. Predictive models help in optimizing the use of resources like water, fertilizers, and pesticides, minimizing waste and environmental impact.

iii). **Risk Mitigation**: Farmers face numerous risks, from adverse weather conditions to pests and diseases. Crop yield prediction allows for risk assessment and the implementation of proactive measures to mitigate potential losses.

Methods Of Crop Yield Prediction Using Machine Learning

i). **Data Collection**: The first step is to gather data, including historical crop yields, climate data, soil properties, and other relevant information.

ii). **Feature Engineering**: Researchers select and engineer meaningful features from the data, such as temperature, rainfall, and soil quality, which influence crop yields.

iii). **Model Selection**: Different machine learning algorithms, such as regression models, decision trees, and neural networks, are tested to determine which is most effective for the specific prediction task.

iv). **Model Training**: The chosen algorithm is trained on the historical data, allowing it to learn patterns and relationships that impact crop yields.

v). **Model Validation**: The model's performance is rigorously tested using independent datasets to ensure its accuracy and generalization abilities.

3. Results and Discussion

Applications Of Crop Yield Prediction

i). **Precision Agriculture**: Farmers can use predictive models to make informed decisions about planting, irrigation, and fertilization, resulting in more efficient farming practices.

ii). **Crop Insurance**: Crop yield predictions enable the development of crop insurance policies that protect farmers from financial losses caused by poor yields due to adverse weather or other factors.

iii). **Government Policy**: Governments can use crop yield forecasts to formulate agricultural policies, allocate resources, and support farmers in times of crisis.

Challenges And Future Prospects

i). **Data Quality**: Ensuring high-quality data is essential for accurate predictions. Inconsistent or incomplete data can lead to unreliable results.

ii). **Model Scalability**: Scaling up predictive models to cover larger regions or multiple crops is a challenge, and it requires efficient algorithms.

iii). **Continuous Learning**: Crop yield prediction models need to continuously update themselves with new data to remain accurate over time.

4. Conclusion

In conclusion, the study of crop yield prediction using machine learning approaches is a game-changer for agriculture. By leveraging technology and data, we can make more informed decisions, enhance food security, and promote sustainable farming practices. As machine learning techniques continue to advance, we can expect even more accurate and reliable predictions, ultimately benefiting both farmers and society at large. The future of agriculture is being shaped by data and technology, and the potential for positive change is immense.

Future Scope

In the future, all farming devices can be connected over the internet using IOT. The sensors can be employed in farm which will collect the information about the current farm conditions and devices can increase the moisture, acidity, etc. In the future, we can use real-time weather and soil data sets that are personally collected by equipment or the data sets. We can merge distinct classifiers to construct a single model called ensemble.

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