Chapter 9
Data-Driven Precision Agriculture for Crop Prediction and Fertilizer Recommendation Using Machine Learning

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ABSTRACT

Crop prediction and fertilizer recommendation are essential for optimizing agricultural practices, a crucial concern for the agricultural sector. However, accurate crop and fertilizer prediction has long been challenging, requiring innovative solutions rooted in the vast pool of available data. This work presents a comprehensive system for predicting crops and fertilizers based on historical data, leveraging machine learning (ML) algorithms. This work involved research analysis of various ML algorithms to predict crops and recommend suitable fertilizers. It was observed that Naive Bayes and random forest models achieved an excellent accuracy of 99.54% and 99.31%, respectively, for soil classification, indicating their proficiency in distinguishing different soil types. The proposed system also suggests fertilizer recommendations tailored to each crop based on user-provided input and a comparative evaluation of the algorithms. These results highlight the potential of ML techniques in aiding farmers to make informed decisions about soil management and fertilizer selection.

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1. INTRODUCTION

ML has a vital role in the future and scope of humankind, so being an agrarian economy and a country where most of the economy depends on agriculture, combining agriculture and ML to increase the efficiency of the sector will play a vital role. In the contemporary world, using Machine Learning (ML) technology has led to a surge of research in crop and fertilizer prediction analysis, an area of utmost importance in agriculture. ML techniques have emerged as the preferred avenue for resolving this challenge because of their proven efficacy. Various ML algorithms and methodologies, have played a significant role in the agricultural domain by providing insights into forthcoming crop production trends. By analysing historical data, these algorithms can identify patterns and factors that influence crop production. This, in turn, empowers farmers with valuable insights, allowing them to adapt their cultivation strategies and maximise crop production.

A study (Sujatha & Nithya, 2017) takes into consideration the Artificial Intelligence (AI) for societal development and social being and highlights significance of AI in the sector. By harnessing the power of ML, farmers can make data-driven decisions on crop management, irrigation, and pest control, optimising resource allocation and reducing waste. This bolsters food security and contributes to sustainable agriculture practices, which is crucial for a nation heavily reliant on its agrarian economy. Furthermore, AI-driven technologies such as precision agriculture and autonomous farming machinery can alleviate the labour-intensive nature of farming, attracting the younger generation to engage in agriculture. This shift could rejuvenate rural areas and stimulate economic growth. In addition, AI-powered predictive models can assist in weather forecasting and disease outbreak detection, providing early warnings to farmers. This is especially vital in a country where climate variability poses significant challenges to crop production.

The growing role of AI and ML in the Agrarian sector is also taken into consideration by (Gautam et al., 2022) which will lead to sustainable development. Sustainable development is the need of the hour as it takes into consideration the needs of the future. In addressing the challenges posed by a burgeoning global population coupled with dwindling resources, this research serves as a beacon, raising pivotal questions about our obligations to future generations. The significance of this work lies in its capacity to bridge the gap between present needs and future demands, with a keen focus on the intricate dynamics of the agricultural supply chain. Integrating ML and AI technologies enables precision agriculture, optimising resource allocation and minimising waste. It empowers farmers with data-driven insights, thereby enhancing productivity and ensuring a more sustainable use of resources.

On the basis of IoT (Ahmed et al., 2016) evaluated soil monitoring based on remote features so that on the basis of the soil can be monitored and accessed from anywhere the component helps in featuring the soil characters and accessing it remotely so that we can have a better understanding of the features and base on this soil features the crop is recommended however it is a combination of hardware and software that have immense potential and gain serval advantage in recent years as here comes the way on which basis on sensor we test the soil and get the potential component which is on to it. The algorithms used here are supervised on the basis of input the data has been trained and the required output is being generated.

Smart agriculture has been proposed by (Sri & Reddy, 2017) based on web things as smart agriculture is considered an important use ease in today applying technology with soil has played a vital role. In the modern era, smart agriculture is increasingly recognised as a pivotal solution. Technology integration with soil management has emerged as a critical factor in enhancing agricultural efficiency. Through the