Vidhyayana - ISSN 2454-8596
An International Multidisciplinary Peer-Reviewed E-Journal
www.vidhyayanaejournal.org
Indexed in: Crossref, ROAD & Google Scholar

16

Review of Crop and Fertilizer Recommendation Systems

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Abstract

The agricultural industry is a crucial contributor to a country's economic growth and development. It is more difficult to choose crops, nevertheless, based on the nutrients in the soil. The present paper reviews the recommendation of crops to increase the production of yield, and their sustainability and suggests fertilizers accordingly. Further, it identifies and discusses various aspects of cultivating crops with the help of soil nutrients and finally puts forward suggestions for the variety of technologies and algorithms proposed to solve this problem. The selection of the best crops to grow in a given area while taking into account factors like soil type, climate, and other environmental conditions are crucial components of modern agriculture that are essential in achieving optimal crop yield and soil health. Fertilizer recommendation, on the other hand, involves determining the optimal type, amount, and timing of fertilizers to be applied to the soil to promote plant growth and health. To provide accurate and trustworthy crop and fertilizer recommendations, many methods and technologies, like machine learning and deep learning algorithms, have been created. These approaches help farmers optimize their crop production, reduce costs, and minimize environmental impact by reducing overuse of fertilizers.

Effective crop and fertilizer recommendations require a thorough understanding of the local environment, as well as the principles of soil fertility and crop management. By providing farmers with customized recommendations, we can promote sustainable and profitable agricultural practices while also safeguarding our natural resources.

Index Terms- Agriculture, Soil nutrients, Fertilizers, Crop Recommendation, Machine Learning.

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I. INTRODUCTION

Science & technology being an inevitable part of everyday life, has proved to be effective in agricultural innovations. Agriculture is undoubtedly the most crucial means of livelihood in India.[1] 58% of the population in India is involved in farming. Agriculture is primarily concerned with growing crops and cultivating the soil. During the cultivation process, it is essential to maintain the quality of the soil. Because they are so important in providing greater root nourishment to crops, the soil properties have a significant impact on how fertile an agricultural production is. In some cases, crops won't give much yield due to soil infertility, planting in the wrong season, and so on.[2] Crop suggestion is a procedure that informs farmers about the precise crop to grow on a certain field.

The technological advancement in the field of agriculture has opened that primarily will monitor the health of the plant, climatic factors affecting the crops, soil condition, etc over a complete farm. It is a severe problem when the farmer fails to use the conventional way to select the crops that are best suited for the soil.

The system is designed using machine learning and deep learning algorithms to recommend accurate crops based on the soil characteristics and micronutrient values to maximize crop production and increase fertility. Crop recommendation involves selecting the most appropriate crop species and varieties based on various environmental factors, such as soil type, climate, and water availability. This helps farmers to choose the most suitable crops for their region, which can increase yields, reduce crop failures, and decrease the risk of soil erosion and nutrient depletion. Fertilizer recommendation, on the other hand, involves determining the optimal type, amount, and timing of fertilizers to be applied to the soil to promote plant growth and health. This requires a thorough understanding of soil fertility and nutrient requirements of crops to ensure that fertilizer application is done in an efficient and sustainable manner.

II. LITERATURE SURVEY

The papers elaborate on the concept of various crops recommendation and fertilizers to increase the sustainability of crops. The following table gives the comparison based on various parameters like methodology use, Algorithm used in the paper, input values,

limitations, and future scope for the paper.

In [1], Micronutrients and the presence of N,P,K levels in the soil are used to classify it. Crop yield is predicted using the previous crop yield data & Location. The SVM model gives better accuracy than the RF model. Fertilizer is recommended based on the location, fertilizer data and crop data.

Humidity and temperature data s collected through third-party APIs.

[2] Farmers often take a wrong decision by selection crop for production that is not suitable for that soil type. Numerous variables, including soil type, pH level, nutrient concentration, geographic location, sowing season, and environmental circumstances, influence the recommendation of the best crop and the improvement of agricultural sustainability. A variety of machine learning techniques may be applied to this.

[3] Crops that are grown continuously over a lengthy period of time have lower nutrient levels in the soil, which affects the N-P-K value year after year. With the help of improved genetic algorithm they build the model. The analysis of time-series data can be used to identify patterns in nutrient levels regardless of the initial threshold. The model can analyze data and make suggestions for improving distant locations by using genetic algorithms. Both the pattern of recommendations and current sensor data may be compared to the final recommendation. This approach aids in striking a balance between crop yield and soil fertility.

[4] Agriculture is an important aspect of India as many people rely on farming as their major source of income. Crop yield or profit is partially dependent on the nutritional values present in the soil. Soil is tested based on NPK values. Crop yield can be negatively impacted by a lack of knowledge regarding the soil used for production. To overcome this challenge, machine learning techniques and neural networks can be employed to recommend the most suitable crops for a particular area and determine the necessary dosage of micronutrients required. Also, which type of fertilizer can be used is suggested. Farmers can make decisions that can be better based on this information. The yield and profit can be predicted using random forest based on the Soil health card prepared by the govt.

[5] The creation of intelligent agricultural systems using wireless networks, artificial intelligence (AI), and contemporary IoT communication technologies is covered in this study paper. Farmers are able to gather and analyze useful data by using IoT agricultural sensors. The farming community is under pressure to fulfil the rising demand as a result of the expanding population, and IoT solutions are crucial to making this happen. Based on chemical qualities, this study also aids farmers in calculating the right quantity of fertilizer required for their land. The suggested strategy has been examined and tried experimentally to increase crop output.

[6] Plant development in the soil depends on macronutrients like N,P,K However, farmers frequently use too much fertilizer on their crops because of a lack of information about nutritional levels. and in laboratory it is time consuming process.so in this paper with the help of Multiple LR(MLR) they predict the soil macro nutrients. Several soil characteristics, including N, P, K, pH, and E.C, are used in this nutritional prediction method. When compared to the real dataset, the predicted NPK data shows an accuracy of about 80%.

[7] Farming is the foundation of India. The main piece of cultivating is pesticides which prevent harvest from failing because bugs destroy crops. The amount of pesticides applied may also influence the yield, while too little may have little value for the crop. The proposed framework discusses which crop is suitable considering the N P K and PH value using machine learning algorithm

[8] The soil consists of various nutrients like Nitrogen, Potassium, Phosphorus, etc. which are important features required for the high yield of crops. The crops may have reduced yield if specific crops are not grown in the soil with nutrients favoring those crops. Thus, the crops are recommended based on its soil nutrients like N,P,K and live location which can give higher yield of crops. Many plants or crops reduce its nutritional value or unfit for use due to various diseases. So, prediction is done based on whether the plant is having a disease and then appropriated measures can be taken so that it will not destroy other crops.

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Paper Title	Author Details	Methodology Used	Limitations	Future Scope
Predication of Crop Yield and Fertilizer Recommendation Using Machine Learning Algoritham	Devdatta A. Bondre, Mr. Santosh Mahagaonkar	SVM, Random Forest (Soil Classification) Prediction model (Crop Yield prediction) Recommendation model (Fertilizer Recommendation)	In Fertilizer recommendation system weather conditions and humidity of the location can play an important role.	A mobile application can be developed for farmers to capture images of their crops, which can be analyzed using image processing techniques to detect crop diseases. The application can suggest appropriate pesticides based on the identified disease. Additionally, implementing a smart irrigation system can help optimize water usage and increase crop yield.
Intelligent Crop Recommendation System Using	Swapneel Chakraborty, Omen Rajendra Pooniwala, Priyadharshini	Linear Regression, neural network (crop	Each crop has its own suitable climatic features. changing	There is a potential audience of millions of agricultural workers for the

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Machine Learning	A, Aayush Kumar	sustainability)	variations in climate can affect the production of crops.	creation of a web interface and mobile application that offers crop cultivation advice to farmers.
A nutrient recommendation system for soil fertilization based on evolutionary computation	Usman Ahmed, Jerry Chun-Wei Lin, Gautam Srivastava, Youcef Djenouri	Improved genetic Algorithm Recommendation model.		Optimizing search tactics and individual repair techniques can assist to minimize and enhance recommendations for maintaining crops for soil fertilization by extracting useful factors.
A Machine Learning Approach to Recommend Suitable Crops and Fertilizers for Agriculture	Govind Kumar Jha, Preetish Ranjan, Manish Gaur	Naive Bayes (categorize document based on words), Bayes Net (probability calculations, Logistic Regression, Multilayer Perceptron	The dataset used in predictions is experimental data from ICAR	

		(distinguishing data using artificial neural network), Random Forest		
IoT Driven Artificial Intelligence Technique for Fertilizer Recommendation Model	Bhuvaneswari Swaminathan, Saravanan Palani, Ketan Kotecha, Vinay Kumar, Subramaniyaswamy Vairavasundaram	Four-layer architecture: - 1. Sensor The layer in issue consists of intelligent gadgets and farming sensors that are used to collect a large amount of agricultural data. 2. Network The key goal is to build intelligent farming application utilizing the right networking services so that it may operate well while using	There are considerable obstacles that must be overcome in order to fully realize the potential of AI-driven IoT technology in the agriculture industry, which is now in its infancy. These difficulties include sensor hardware failures, problems with data storage, long learning model computation periods, and the	In future work, a comprehensive framework for managing all farming activities can be built by integrating more agricultural sensors. The yield is closely related to sensor and application layers of smart farming can be increased and resource wastage can be reduced.

		the least amount of energy feasible. 3. Service The intelligent agriculture platform seeks to, among other things, anticipate the necessary quantity of fertilizer needed and choose appropriate crops for the specific plot of land through the use of ML algorithms. 4.Application As a result of the suggested design for the precise intelligent farming system, the farmer will be able to	incorporation of smart farm results into mobile modules. These difficulties might cause farmers to wait longer for replies from mobile applications	

		connect with mobile applications and remotely oversee the harvesting process.		
Soil NPK prediction Using Multiple Linear Regression	Madhumati R, Arumuganathan T, Shruthi R, Raghavendar S,	Multiple Linear Regression (MLR)	N-P-K value that are present in the dataset are taken as randomly not from a specific location, so applying NPK value from another location it may be change in accuracy of model	Future applications of this technology include utilizing MLR to anticipate micronutrients like iron, zinc, Sulphur, and others.
Efficient Crop Yield Recommendation System Using Machine Learning For Digital	Dr.G. Suresh, Dr.A. Senthil Kumar, r.S. Lekashri, r.S. Lekashri,	Support Vector Machine (SVM)	The primary challenges with the current crop yield prediction technique are accuracy and time-consuming processes. This	In order to anticipate the quantity of nutrients required for crop production, and to develop user-friendly interfaces

Farming			technique relies solely on soil parameters to recommend fertilizers.	for farmers, this research aims to provide an analysis of crop yield forecasts based on the data sets available.
Agriculture Based Recommendation System with Image Processing	Saranya K, Deena Dhayalan S, Prasanth R, Sathish M.	Artificial Neural Network, GBDT, Multiple LInear Regression, Fuzzy Logic, Perceptron, Naive Bayes, Decision Tree		A device that can detect all soil parameters and recommend crops to farmers through their mobile devices via the internet using data from the device. The dataset can be expanded to include a wide variety of crops.

III. DISCUSSION SESSION

The paper summarizes various aspects of technology that have been used for recommending crops and fertilizers considering essential parameters. It is difficult to recommend the crops as every village has different soil types, Geometrical parameters, and weather conditions. The various techniques are implemented to conclude the prediction of crop yield and fertilizer recommendations to maintain the erosion of soil and increase productivity in the field of agriculture.

Technology in Agriculture:

As farming and agriculture continue to develop, technology will play an increasingly important role. Farmers will be able to cut losses and boost efficiency by using this strategy, which will result in the highest crop output. Artificial intelligence, IoT sensors, ML, DL algorithms helps in seed technology, pesticides, fertilizers, and crop recommendation disease detection and so on, a use of technology improved productivity in agriculture.

Crops and fertilizer recommendation:

Farmers can determine the best crop to sow in their fields with help from a crop recommendation system using environmental parameters and soil nutrients. A recommendation of fertilizers can be made based on fertilizer and crop data as well as geometrical location. The objective of this approach is to suggest appropriate crops and fertilizers for specific soil types. To achieve this, several ML and Dl algorithm have been proposed to recommend suitable crops and fertilizers for a particular farm.

Algorithms used for prediction and recommendation:

To implement these functionalities, several ML and DL models are applied. Nave Bayes, Decision Tree, Support Vector Machines (SVM), Random Forest, and Logistic Regression, which are classification and regression models like Linear Regression, are some of the frequently used machine learning methods for crop and fertilizer recommendation. Additionally utilized for this are deep learning models like the multilayer perceptron, artificial neural networks, and convolutional neural networks. Using these algorithms along with some authors using Bayes Net, Fuzzy logic models for applications can be used for the prediction and recommendation of crops and fertilizers, and soil classification.

Profit analysis of various crops:

The farmers make decisions that directly and indirectly affect the efficiency of their farms, resource use, profitability, and productivity. Planting in the wrong season won't give much yield. So, the recommendation system analyses the soil conditions and predicts the crops and fertilizers accordingly. This solution will lead farmers to gain more profit.

IV. ADVANTAGES

It is important for farmers to select crops that will increase their profitability and productivity. Smart farming technology also supports farmers in their decision-making process by taking into account various factors, including climatic conditions, planting seasons, and soil nutrient values. This will benefit the farmer mainly in:

Increase in yield of crop production:

Yield depends on the nutritional values in the soil and various factors that affect the crop. Growing crops that are suitable for that soil type will lead to higher production as the nutrients required for the crop are present in the soil leading to higher yield.

Reduced Soil Degradation:

Loss of organic matter and decreased soil fertility can occur as a result of soil deterioration. Maintaining the health of the soil by taking into account soil degradation in crop recommendation procedures is crucial for ensuring optimal crop production. The soil degradation can be reduced by adding the appropriate fertilizer in that cultivated field which can help the farmer to maximize their profit.

Increase in sustainability of crops:

The sustainability of crops will increase as suitable crops would be produced in farms. It will make sure that the organic matter and nutrition of soil improve along with the improved quality of crops and less use of pesticides.

Forecasting of crop yield:

It is very important to predict crop yields in order to increase global food production. Globally, governments make informed decisions about import/export operations based on analytical data about crop yields.

V. LIMITATIONS

Irrespective of the benefits of ML and DL techniques in agriculture, there are still a few challenges. Some of these challenges include each crop having its own suitable climatic features & changing variations in climate can affect the production of crops. The model accuracy may be affected by applying NPK i.e., Nitrogen, Phosphorus, and potassium values

from another location since the NPK values in the dataset are chosen at random and not from a specific location. Along with this, In the recommendation system, some parameters are also not taken into consideration such as micronutrient values or nutrient concentration of the soil for predicting accurate crops. In addition, there is insufficient data on soil nutrients and crops. Also, the existing system for recommending the crops are very costly to maintain and cannot be easily accessed by the farmers. Crop and fertilizer recommendations can be impacted by various environmental factors such as weather, natural disasters, and pest outbreaks. These factors can lead to unexpected crop failures or reductions in yield, despite following the recommendations. Some of the technologies used to provide crop and fertilizer recommendations, such as soil testing and remote sensing, can be expensive. This cost may be a significant barrier for small-scale farmers who lack the resources to invest in such technologies.

VI. FUTURE SCOPE

The future scope of crop recommendation and fertilizer recommendation is promising, with ongoing research and development aimed at improving the accuracy and effectiveness of these tools. Here are some potential areas of future growth:

Various models and technologies are used for crop and fertilizer recommendations, but some features can be implemented in the future. Mobile applications and websites are available to farmers that allow them to upload images of their crops for disease detection and crop recommendation with the help of image processing, resulting in a pesticide recommendation based on the image. Also, In the future, more agricultural sensors may be included to create a comprehensive framework for overseeing all farming operations. Smart farming technology may boost crop output and decrease resource waste by taking extra care at the sensor and application layers. Precision farming collects and analyses real-time data on crop health and soil conditions using cutting-edge technologies including sensors, drones, and ML algorithms. This technology can be used to develop personalized crop and fertilizer recommendations for each field or crop, allowing farmers to optimize their yields while minimizing environmental impact.

VII. CONCLUSION

In conclusion, crop recommendation and fertilizer recommendation are crucial tools for modern agriculture. They aim to optimize crop yields while promoting soil health and sustainability. While there are limitations to these tools, ongoing research and development offer promising future scope to improve their accuracy and effectiveness.

By leveraging technology such as precision agriculture and Data Science, we can develop more personalized and sustainable crop and fertilizer recommendations. Furthermore, integrated crop and nutrient management and climate-smart agriculture has positive effects on climate. Overall, these recommendations play a critical role in ensuring food security, sustainable agriculture, and environmental stewardship. As we continue to invest in these tools and develop new approaches, we can create a more resilient and prosperous agricultural sector for the benefit of current and future generations.

India's economy is largely based on agriculture. Planting the right crops and the proper use of fertilizers leads to an increase in yield as well as the nation’s productivity. This paper reviews the use of machine learning or deep learning techniques for recommending suitable crops and fertilizers that would be effective for that particular soil type so that farmer does not incur any loss which will result in the maximum yield in crop production and increase the sustainability of crops.