Crop Recommendation System using Machine Learning and IoT

Melvin Tom Varghese
Computer and Engineering
Amal Jyothi College of Engineering
, India
melvintomvarghese2024@cs.ajce.in

Joseph V S
Computer Science and Engineering
Amal Jyothi College of Engineering
India
Josephvs977@gmail.com

Kevin Chacko
Computer Science and Engineering
Amal Jyothi College Of Engineering
India
kevinchacko2024@cs.ajce.in

Johns Benny
Computer Science and Engineering
Amal Jyothi College of Engineering
, India
Johnsbenny2024@cs.ajce.in

Tintu Alphonsa Thomas
Assistant Professor, Computer Science and Engineering
Amal Jyothi College of Engineering
India
tintualphonsathomas@cs.ajce.in

Abstract—In many regions across the globe, agriculture re- mains the cornerstone of livelihoods, with a significant portion of the population relying on it as their primary occupation. The success of agricultural endeavors hinges greatly on crop production, making it a crucial aspect of sustenance and economic stability. To address the challenge of ensuring optimal crop yields, a cutting-edge solution integrating IoT (Internet of Things) and ML (Machine Learning) technologies has emerged. This innovative system employs sensor-based soil testing to meticulously assess soil conditions, thereby mitigating the risk of soil degradation and fostering healthy crop growth. A variety of sensors are deployed within this system, each tasked with monitoring specific soil parameters essential for crop health. These sensors include those for measuring soil temperature, moisture levels, pH balance, and nutrient composition (NPK). By continuously gathering data on these crucial factors, the system builds a comprehensive understanding of soil dynamics. The collected data is then transmitted to a microcontroller, where it is subjected to rigorous analysis utilizing sophisticated machine learning algorithms such as random forest. Through this analytical process, the system generates actionable insights and recommendations tailored to optimize crop growth conditions. Ultimately, this integrated IoT and ML system represents a groundbreaking approach to agricultural management, empowering farmers with real- time, data-driven guidance to enhance crop productivity and sustainability.

Keywords—Iot, Machine learning, Crops, Sensors

I. Introduction

Agriculture stands as a crucial pillar of the global economy and sustenance, serving as a primary occupation vital for human survival [1]. However, amidst its significance, farmers often face daunting challenges, including financial distress leading to tragic outcomes like suicide due to crop failure and resultant debt burdens [12]. The ever-changing climate exacerbates these risks, posing threats to crop viability and farmer livelihoods [18].

To address these pressing issues, leveraging mathematical and statistical methods becomes imperative. By analyzing data, tailored recommendations for optimal crop selection can be provided, aiding farmers in maximizing profits and mitigating risks [12]. Precision agriculture, with its focus on site-specific farming, emerges as a key strategy. Despite advancements, pre- cision agriculture encounters obstacles, particularly in ensuring accurate crop recommendations, which are essential to prevent significant material and capital losses [11]. In this context, machine learning offers promising avenues. Supervised, unsupervised, and semi-supervised learning algo- rithms play distinct roles in constructing mathematical models from data, enabling accurate predictions and recommendations [8].

The objective of this paper is to recommend suitable crops based on input parameters such as soil nutrients, pH levels, humidity, temperature, and rainfall. It endeavors to predict crop production

accuracy for a range of crops in India, including rice, maize, pulses, fruits, and other staple crops [12]. Various machine learning algorithms, including Decision Trees, Na¨ıve Bayes, Support Vector Machine, Logistic Regression, Random Forest, and XGBoost, are applied to achieve this goal.
The paper is structured into five segments: Related Work and Comparative Study, Proposed System Approach, Ex- perimental Result Analysis, Conclusion, and Future Work. Through this comprehensive approach, the aim is to contribute to the advancement of crop recommendation systems using machine learning techniques.

II. SURVEY OF LITERATURE

[1] Kumar et al. propose a supervised machine learning approach for predicting crop yield based on historical data en- compassing factors such as temperature, humidity, pH, rainfall, and crop type. By employing the random forest and decision tree algorithms, this system aims to predict the best crop suited to the prevailing weather conditions across different districts of India. Higher accuracy in predictions translates to increased profits for crop yield. [9] Suresh et al. introduce an efficient crop yield rec- ommendation system utilizing machine learning, particularly the Support Vector Machine (SVM) algorithm. By analyzing datasets of location and crop information, the system recom- mends crops based on nutrient values (N, P, K, and pH) and determines required fertilizer quantities for crops like rice, maize, pulses, carrots, and radishes.

[10] Reddy et al. focus on maximizing crop yield in the Ramtek region through a crop recommendation system based on soil characteristics, types, and crop yield data. Employing various machine learning algorithms such as random forest, CHAID, K-Nearest Neighbor, and Na¨ıve Bayes, the system predicts suitable crops under specific weather conditions, states, and district values, aiding farmers in enhancing pro- ductivity.

[14] Rajak et al. propose a crop recommendation system based on soil database analysis. Utilizing classifiers like sup- port vector machine (SVM), artificial neural network (ANN), random forest, and Na¨ıve Bayes, the system recommends crops considering site-specific parameters such as depth, tex- ture, pH, soil color, permeability, drainage, water holding, and erosion. This system aims to increase agricultural productivity, prevent soil degradation, and optimize water resources.

[15] Doshi et al. introduce AgroConsultant, an intelligent crop recommendation system divided into crop suitable predic- tor and rainfall predictor sub-systems. By employing machine learning algorithms such as decision tree, K-Nearest Neigh- bor (K-NN), random forest, and neural network, the system achieves significant accuracy in predicting suitable crops and rainfall patterns for major and minor crops, aiding in smart farming practices.

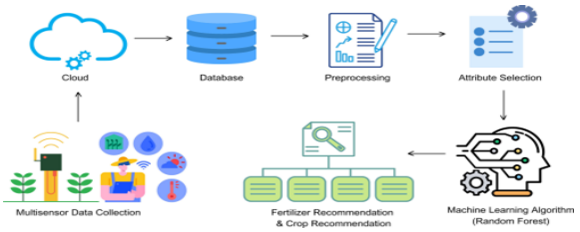
[18] Dighe et al. conduct a survey on crop recommendation systems, reviewing various machine learning algorithms such as CHAID, KNN, K-means, decision tree, neural network, Na¨ıve Bayes, C4.5, LAD, IBK, and SVM. Leveraging the Hadoop framework for intensive calculations, these systems aim to enhance accuracy in crop recommendations for smart farming applications.

[21] Kulkarni et al. propose a crop recommendation system utilizing ensembling techniques to recommend the right crop based on soil-specific characteristics, average rainfall, and surface temperature. Employing machine learning algorithms like random forest, Naive Bayes, and linear SVM, the sys- tem achieves high accuracy in classifying soil datasets into recommendable crop types for both Kharif and Rabi seasons

III. METHODOLOGY

The methodology for developing a crop recommendation system involves several key steps, starting from the collection of datasets to the final recommendation of suitable crops.

1. Collection of Datasets: The first step involves gath- ering relevant datasets containing agricultural data. These datasets may include information such as soil characteristics, weather patterns, historical crop yields, nutrient levels, and geographical data. Datasets can be sourced from agricultural research institutions, government databases, satellite imagery,



2. and field surveys. The datasets need to be comprehensive and representative of the target region's agricultural conditions.
3. Pre-processing (Noise Removal): Once the datasets are collected, pre-processing is essential

to clean the data and remove any noise or inconsistencies. This involves tasks such as handling missing values, eliminating outliers, normaliz- ing data, and resolving inconsistencies in data formats. Pre- processing ensures that the datasets are of high quality and suitable for analysis.

4. Feature Extraction: Feature extraction involves identi- fying and selecting relevant features or variables from the pre-processed datasets. These features serve as inputs for the machine learning algorithms. In the context of crop recom- mendation, features may include soil pH levels, temperature, humidity, rainfall, nutrient content, crop types, and historical crop yields. Feature selection techniques such as correlation analysis, principal component analysis (PCA), or domain expertise can be employed to determine the most important features for prediction.

5. Applied Various Machine Learning Algorithms: With the cleaned and feature-rich datasets prepared, various machine learning algorithms are applied to build predictive models. These algorithms include supervised learning algorithms such as decision trees, random forest, logistic regression and Un- supervised learning algorithms such as clustering algorithms may also be used for segmenting data or identifying patterns in the absence of labeled data. Each algorithm is trained using the training dataset and evaluated using appropriate performance metrics to assess its accuracy and effectiveness in crop recommendation.

6. Recommendation System: The recommendation system utilizes the trained machine learning models to provide crop recommendations based on input parameters such as soil characteristics, weather conditions, and historical data. When a farmer provides input data, such as soil pH, temperature, humidity, and rainfall for their agricultural land, the rec- ommendation system processes this data through the trained models to predict the most suitable crops for cultivation.

Recommended Crop: Based on the predictions generated by the recommendation system, the most suitable crops are recommended to the farmer. These recommendations consider factors such as crop yield potential, environmental sustain- ability, market demand, and the farmer's preferences and constraints. The recommended crops aim to maximize agricultural productivity while optimizing resource utilization and minimizing risks associated with crop cultivation.

V. CONCLUSION

In this paper, we have effectively proposed and implemented 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, Phos- phorous, 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 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

Future Work

The system can be enhanced further to add following functionality:

1. The main future work's aim is to improve the dataset with a larger number of attributes.
2. We need to build a model, which can classify between healthy and diseased crop leaves and also if the crop has any disease, predict which disease is it.
3. To build websites and mobile apps for easy to use.

REFERENCES

[1] Kumar, Y. Jeevan Nagendra, V. Spandana, V. S. Vaishnavi, K. Neha, and V. G. R. R. Devi. "Supervised Machine learning Approach for Crop Yield Prediction in Agriculture Sector." In 2020 5th International Conference on Communication and Electronics Systems (ICCES), pp. 736-741. IEEE, 2020.

[2] Nigam, Aruvansh, Saksham Garg, Archit Agrawal, and Parul Agrawal. "Crop yield prediction using machine learning algorithms." In 2019 Fifth International Conference on Image InformationProcessing (ICIIP), pp. 125-130. IEEE, 2019.

[3] Medar, Ramesh, Vijay S. Rajpurohit, and Shweta Shweta. "Crop yield prediction using machine learning techniques." In 2019 IEEE 5th In- ternational Conference for Convergence in Technology (I2CT), pp. 1-5. IEEE, 2019.

[4] Jain, Sonal, and Dharavath Ramesh. "Machine Learning convergence for weather based crop selection." In 2020 IEEE International Students' Conference on Electrical, Electronics and Computer Science (SCEECS), pp. 1-6. IEEE, 2020.

[5] Gandge, Yogesh. "A study on various data mining techniques for crop yield prediction." In 2017 International Conference on Electrical, Electronics, Communication, Computer, and Optimization Techniques (ICEECCOT), pp. 420-423. IEEE, 2017.

[6] Suresh, A., P. Ganesh Kumar, and M. Ramalatha. "Prediction of major crop yields of Tamilnadu using K-means and Modified KNN." In 2018 3rd International

Conference on Communication and Electronics Systems (ICCES), pp. 88-93. IEEE, 2018.

[7] Kamatchi, S. Bangaru, and R. Parvathi. ”Improvement of Crop Pro- duction Using Recommender System by Weather Forecasts.” Procedia Computer Science 165 (2019): 724-732.

[8] Bondre, Devdatta A., and Santosh Mahagaonkar. ”Prediction of Crop Yield and Fertilizer Recommendation Using Machine Learning Al- gorithms.” International Journal of Engineering Applied Sciences and Technology 4, no. 5 (2019): 371-376.

[9] Suresh, G., A. Senthil Kumar, S. Lekashri, and R. Manikandan. ”Effi- cient Crop Yield Recommendation System Using Machine Learning For International Digital Journal Farming.” of Modern Agriculture 10, no. 1 (2021): 906-914.

[10] Reddy, D. Anantha, Bhagyashri Dadore, and Aarti Watekar. ”Crop recommendation system to maximize crop yield in ramtek region using machine learning.” International Journal of Scientific Research in Science and Technology 6, no. 1 (2019): 485-489.

[11] Pudumalar, S., E. Ramanujam, R. Harine Rajashree, C. Kavya, T. Kiruthika, and J. Nisha. ”Crop recommendation system for precision agriculture.” In 2016 Eighth International Conference on Advanced Computing (ICoAC), pp. 32-36. IEEE, 2017.

[12] Garanayak, Mamata, Goutam Sahu, Sachi Nandan Mohanty, and Alok Kumar Jagadev. ”Agricultural Recommendation System for Crops Using Different Machine Learning Regression Methods.” International Journal of Agricultural and Environmental Information Systems (IJAEIS) 12, no. 1 (2021): 1-20.

[13] Jejurkar Siddhi, S., S. Bhosale Meghna, and D. N. Wavhal. ”Crop Predication and Diseases Detection Using Machine Learning.” (2021).

[14] Rajak, Rohit Kumar, Ankit Pawar, Mitalee Pendke, Pooja Shinde, Suresh Rathod, and Avinash Devare. ”Crop recommendation system to maximize crop yield using machine learning technique.” International Research Journal of Engineering and Technology 4, no. 12 (2017): 950-
953.

[15] Doshi, Zeel, Subhash Nadkarni, Rashi Agrawal, and ”AgroConsultant: Neepa Intelligent Shah. Crop Recommendation System Using Machine Learning Algorithms.” In 2018 Fourth International Conference on Computing Communication Control and Automation (ICCUBEA), pp. 1-6. IEEE, 2018.

[16] Mahule, Ankit Arun, and A. J. Agrawal. ”Hybrid Method for Improving Accuracy of Crop-Type Detection using Machine Learning.” Interna- tional Journal 9, no. 2 (2020).

[17] Akshatha, K. R., and K. S. Shreedhara. ”Implementation of machine learning algorithms for crop recommendation using precision agricul- ture.” International Journal of Research in Engineering, Science and Management (IJRESM) 1, no. 6 (2018): 58-60.

[18] Dighe, Deepti, Harshada Joshi, Aishwarya Katkar, Sneha Patil, and Shrikant Kokate. ”Survey of Crop Recommendation Systems.” (2018).

[19] Jaiswal, Sapna, Tejaswi Kharade, Nikita Kotambe, and Shilpa Shinde. ”Collaborative Recommendation System For Agriculture Sector.” In ITM Web of Conferences, vol. 32. EDP Sciences, 2020.

[20] Ghadge, Rushika, Juilee Kulkarni, Pooja More, Sachee Nene, and R.
L. Priya. ”Prediction of crop yield using machine learning.” Int. Res. J. Eng. Technol.(IRJET) 5 (2018).

[21] Kulkarni, Nidhi H., G. N. Srinivasan, B. M. Sagar, and N. K. Cauvery. ”Improving Crop Productivity Through Recommendation System A Crop Using Ensembling Tecchnique.” In 2018 3rd International Con- ference on Computational Systems and Information Technology for Sustainable Solutions (CSITSS), pp. 114-119. IEEE, 2018.

[22] Kumar, Avinash, Sobhangi Sarkar, and Chittaranjan Pradhan. ”Recom- mendation system for crop identification and pest control technique in agriculture.” In 2019 International Conference on Communication and Signal Processing (ICCSP), pp. 0185-0189. IEEE, 2019.