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ML-based Flutter Application for Smart Agriculture to Predict Crop Disease and NPK Ratio

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Abstract*— Agriculture, the backbone of India's economy, sustains millions of livelihoods. Despite its significance, Indian farmers encounter numerous difficulties, especially limited access to important information on nutrients, climatic predictions, unclear plant conditions, and unfulfilled government initiatives. This study uses machine learning to provide an original approach to these problems. Depending on the crop and the present-day weather, the system delivers location-specific recommendations for nutrition (NPK, or nitrogen, phosphorus, and potassium). The system also offers a seven-day weather forecast, helping farmers plan their agricultural operations efficiently and be aware of the forthcoming weather. Using the input of a camera or snap of the plant leaf, the platform's Plant Disease Identification system can detect plant diseases. A separate section of the guidelines also lists current government schemes that are essential to farmers, ensuring that they are aware of assistance solutions that are available to them.

***Index Terms*— Smart Agriculture, NPK, Farming Techniques in India, Plant Disease Detection**

I. INTRODUCTION

The backbone of the Indian economy on the agricultural sector supporting the livelihoods millions. Despite its significance, Indian farmers face numerous challenges, including limited access to vital information about nutrients, weather forecasts, uncertain plant health conditions, and issues with governmental initiatives [1]-[9]. These obstacles highlight the urgent need for innovative solutions to empower farmers with knowledge and resources, ultimately boosting productivity in agriculture.

To tackle these challenges, this research aims to utilize technology and machine learning to transform the agricultural industry. By utilizing advanced machine learning techniques like Random Forest and ResNet architectures [10], [11], this study introduces a unique solution tailored to the specific requirements of Indian farmers. The proposed system provides customized recommendations on time and location, addressing issues such as nutrient management and crop health monitoring. A key feature of this system is its ability to offer optimized nutritional advice, focusing on nitrogen, phosphorus, and potassium (NPK) according to the crop and climate conditions. By incorporating machine learning algorithms like Extreme Learning Machine [1], the system ensures that farmers receive personalized guidance to make informed decisions regarding fertilization. Additionally, farmers can access a seven-day weather forecast to plan agricultural operations proactively in response to changing weather patterns [11]. By utilizing data analysis and machine learning [2], the system enhances farmers' ability to manage risks and optimize resource utilization effectively.

Moreover, the research addresses the challenge of identifying plant diseases. By using machine learning and computer vision techniques like ResNet models [4], the system enables accurate detection and recognition of plant diseases through image analysis. This functionality allows farmers to take immediate corrective measures to minimize crop losses and promote agricultural sustainability. Furthermore, the system includes a dedicated section informing farmers about available governmental schemes [12] to ensure they can access crucial assistance tailored to their needs, fostering collaboration between technology and government efforts to improve the agricultural sector.

This research is motivated by a commitment to leverage technology for social good by developing a machine learning application customized for farmers, aiming to enhance productivity and positively impact the lives of individuals involved in food production [12], [13]. Aligning with government initiatives to modernize farming practices and boost agricultural outcomes, this study contributes to a broader strategy for transforming the agricultural landscape [14]. This research aims to fill knowledge gaps, empower farmers with timely information and actionable insights, and ultimately improve agricultural sustainability and farmers' livelihoods. By democratizing information and embracing technological advancements, this project strives to create a resilient and prosperous agricultural sector capable of adapting to a rapidly changing world.

II. RELATED WORK

In recent years, there has been a surge in research aimed at integrating technology and machine learning to address agricultural challenges and enhance productivity. A notable study by Yin et al. [1] delved into the estimation of NPK requirements for rice production across diverse Chinese environments. Their methodology involved empirical data analysis and statistical modeling to tailor fertilization strategies to specific conditions, underscoring the significance of precision nutrient management in optimizing crop yields. Similarly, Kumar et al. [2] proposed a soil sensors-based prediction system for plant diseases, leveraging exploratory data analysis and machine learning algorithms. By analyzing soil sensor data and applying machine learning techniques, they aimed to detect diseases early and facilitate timely intervention, showcasing the potential for technology-driven solutions in disease management.

Focused on predicting crop fertilizer consumption using data mining techniques. Analyzing historical fertilizer usage data and crop yield information to develop predictive models, optimizing fertilizer application rates for improved productivity. This underscores the importance of data-driven insights in optimizing agricultural practices and resource allocation.[3] In the domain of disease forecasting, Godi et al. [4] introduced a ResNet model for forecasting plant leaf diseases. By leveraging deep learning techniques, they aimed to classify and predict disease outbreaks accurately, enabling proactive disease management strategies. Their methodology involved training convolutional neural networks on large-scale image datasets of diseased plant leaves, demonstrating the potential of artificial intelligence in disease diagnosis and management.

Exploring smart farming approaches integrating machine learning and deep learning techniques. Their methodology involved deploying sensor networks and data analytics platforms to collect and analyze agricultural data in real-time. By applying supervised and unsupervised machine learning algorithms, they aimed to optimize crop management practices and resource allocation decisions, showcasing the transformative potential of data-driven insights in agriculture.[5] Approach of analyzing sensor data collected from farm equipment and environmental sensors to optimize irrigation scheduling and pest management strategies. By leveraging machine learning algorithms, they aimed to enhance agricultural productivity and sustainability, demonstrating the efficacy of data-driven decision-making in modern farming practices.[6] Predicting crop fertilizer consumption using machine learning algorithms. Study of analyzing historical fertilizer usage data and environmental factors to develop predictive models for optimizing fertilizer application rates, emphasizing the importance of data-driven approaches in agricultural decision-making.[7]

In the realm of crop yield prediction, Nishant et al. [8] focused on predicting crop yields in Indian agriculture using machine learning approaches. Their methodology involved analyzing historical crop yield data and environmental variables to develop predictive models, facilitating better decision-making for farmers and policymakers. Integrating sensor data with machine learning algorithms to optimize resource utilization and automate agricultural processes, showcasing the potential for technology-driven solutions in agriculture.[9] A method for improving the prediction accuracy of soil nutrient classification using machine learning algorithms. Their approach involved optimizing machine learning parameters to enhance the accuracy of soil nutrient predictions, enabling better soil nutrient management practices.[10] Additionally, Amora developed a method for predicting NPK levels based on pH colorimetry using machine learning algorithms. Their approach involved utilizing ResNet architecture to develop a fertilizer recommender system, enabling optimized nutrient management in agriculture.[12]

Moreover, Monica et al. [13] proposed a soil NPK prediction method using an enhanced genetic algorithm. Their approach involved optimizing genetic algorithm parameters to improve the accuracy of soil NPK predictions, facilitating precision agriculture by optimizing nutrient application strategies. Proposing a machine learning-based approach for crop yield prediction and fertilizer recommendation.[14] Developing predictive models for crop yield prediction and fertilizer recommendation using machine learning algorithms, aiming to improve agricultural productivity through optimized nutrient management. Approach of analyzing soil samples and environmental variables to predict soil nutrient levels and recommend suitable crops for cultivation, facilitating sustainable agriculture practices.[15]

Optimization MobileNet for plant disease classification using machine learning techniques. Their approach involved fine-tuning MobileNet parameters to improve the accuracy of plant disease classification, enabling more effective disease diagnosis and management in agriculture.[16] Development of a smart system for crop and disease prediction using Random Forest and ResNet architecture involves integrating RF and ResNet algorithms to predict crop yields and identify plant diseases, enabling proactive agricultural management strategies. Investigating the impact of cropping systems on soil health and microbial communities.[19] Their study involved analyzing soil samples from different cropping systems to assess the diversity and composition of soil microbial communities, highlighting the importance of sustainable cropping practices in maintaining soil health.

III. METHODOLOGY

A. Structure of the Project

The initiative encompasses multiple elements designed to support farmers in increasing crop yield by detecting diseases and offering personalized nutrient recommendations. Information gathering involved the utilization of datasets obtained from Kaggle, wherein the NPK Model utilized a Crop Recommendation dataset trained through Random Forest Regression. Users input their Crop Name and City Name to receive individualized suggestions. Disease identification is made possible by submitting photos from the gallery or directly through the camera. MobileNet is utilized as the algorithm for disease detection, with the model trained via Teachable Machine from Google. This holistic approach

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blends machine learning methods with user-friendly interfaces to empower farmers in optimizing their farming techniques.

B. Datasets

The dataset identified as the Crop Recommendation Dataset contains a wide range of agricultural factors essential for making informed decisions in precision farming. It was created by enhancing existing data sets related to rainfall, climate, and fertilizer information customized specifically for India, offering valuable insights for predictive analysis. Included in the dataset are significant variables such as Nitrogen (N), Phosphorous (P), Potassium (K) content ratios in the soil, temperature, humidity, soil pH levels, and rainfall amounts measured in millimeters. These aspects empowered us to develop predictive model that suggest the most appropriate crops for cultivation based on the unique conditions of a particular farm.

The up-to-date Plant Diseases Dataset carefully organized from its source repository, comprising approximately 87,000 RGB images showing healthy and infected crop leaves across 38 distinct categories. The dataset's content is evenly divided into a training set with 80 of the data and a validation set with the remaining 20, preserving the initial directory structure for easy accessibility and organization. Additionally, an extra folder containing 33 trial images was included later to support predictive tasks, enriching the dataset's effectiveness for research and development pursuits.

C. Training model of NPK Predictive Model

In the pursuit of refining the NPK prediction model, a meticulous method was adopted, integrating advanced techniques and methodologies. The essence of this effort is in the use of the Random Forest algorithm, an enduring ensemble learning technique consisting of multiple decision trees, each trained on different subsets of data. To enhance accuracy, the algorithm underwent rigorous fine-tuning, employing k-fold cross-validation to assess its performance across diverse data subsets. Through this iterative process, the optimal hyperparameters, like the number of estimators, were identified, resulting in an impressive accuracy of 0.87 for the N Label. This achievement emphasizes the effectiveness of the Random Forest method in predicting Nitrogen, Phosphorus, and Potassium levels in the soil. Moreover, including input variables such as crop type, temperature, humidity, and precipitation enhances the model's predictive abilities, making it adaptable to various environmental conditions.

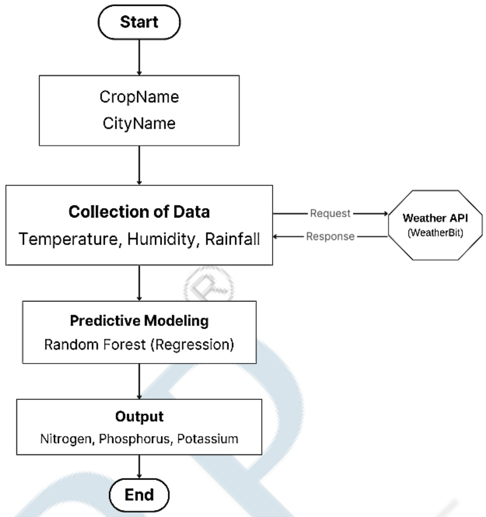

Fig. 1 NPK Flow Diagram

The output features, which include the amount of Nitrogen (N), Phosphorous (P), and Potassium (K) in the soil, offer valuable insights necessary for strategic decision-making in agriculture. Supported by a comprehensive workflow outlined in Fig. 1 and Fig. 2, this project exemplifies a holistic approach to eco-fertilization, utilizing state-of-the-art data mining techniques like Support Vector Machines (SVM) and K-Nearest Neighbor (KNN). Following the CRISP-DM framework, this research not only advances the understanding of predictive modeling in agriculture but also emphasizes the significance of utilizing historical data for sustainable agricultural practices.

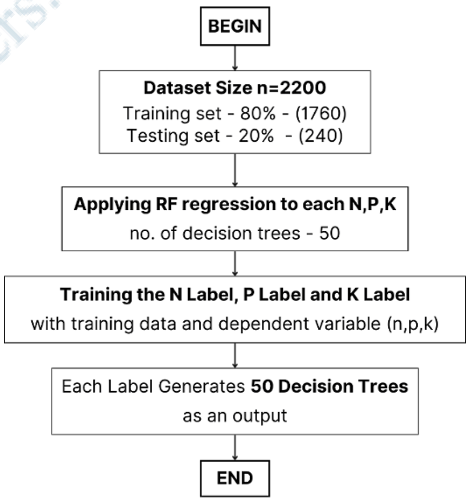

Fig. 2 Random Forest Algorithm

D. Training model for Plant Disease

To ensure accurate operation and precision, the plant disease detection system was carefully fine-tuned on the Google's Teachable machine. Using Google's MobileNet architecture, the model was trained on a wide range of datasets, including about 87,000 RGB photos showing both healthy and damaged crop leaves in 38 different categories. The training procedure, made possible by Google's Teachable

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Machine platform, allowed for easy parameter tuning and tweaks, resulting in a detection system that is both extremely accurate and highly efficient. By means of a thorough assessment employing cross-validation methodologies and confusion matrix analysis, the model manifested its capacity to precisely categorize crop leaves and detect possible ailments instantly. Through the combination of cutting-edge machine learning algorithms and intuitive interfaces, this program provides farmers with practical insights to reduce crop illnesses and improve overall agricultural productivity.

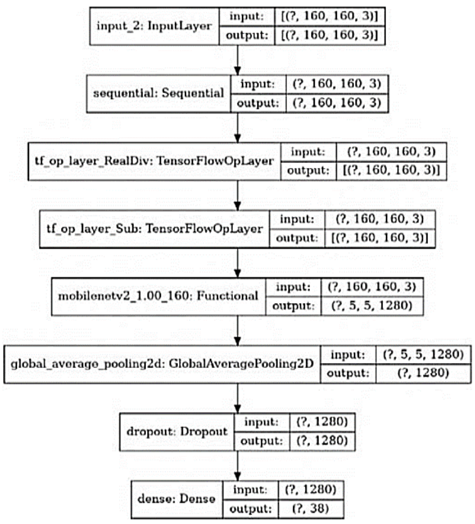

Fig. 3 Utilized MobileNet Architecture (Source:[20])

E. Developing Flutter Application and Integration

To ensure smooth functioning and user experience of integration of the plant disease detection model and the NPK predictive model into the Flutter application. By utilizing the powerful features of the Flutter framework for cross-platform app development, an intuitive user experience was created to effectively meet the various needs of farmers. By asking users to enter information about their crop and location, the application leverages the predictive capabilities of the NPK model to provide customized nutrient recommendations based on their unique farming circumstances. Furthermore, farmers can quickly and accurately diagnose crop diseases with the help of the trained MobileNet model's plant disease detection functionality by using uploaded photos or live camera feeds. In order to achieve seamless interaction between the models and the user interface, the integration process entailed implementing Flutter's widgets and state management techniques while following Flutter's documentation and Android development guidelines for maximum usability and performance. The application effortlessly merges both models by closely following Flutter's instructions and best practices. This gives farmers access to an extensive toolset that helps them maximize farming techniques and increase crop productivity.

IV. RESULT AND ANALYSIS

This Flutter application, created with the Dart programming language, offers a simple but reliable user experience. Its multitude of features, which allow users to check the optimal NPK ratio location-wise as depicted in the Fig. 4, are designed to make farming easier for farmers.

By picking the plant leaf image, the program offers characteristics to identify any plant diseases found in the dataset and provides information on the sources of the diseases along with a solution depicted in Fig. Illnesses that are visible on leaves can be identified with the program.

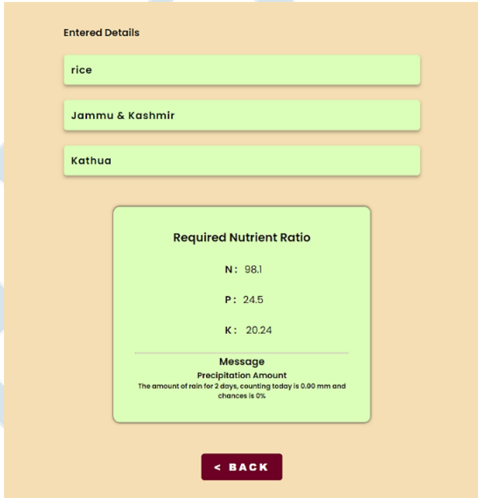

Fig. 4 NPK Prediction

The efficiency analysis of this application demonstrates the platform's smoothness and compatibility with lower-end devices. which improved farmers' experiences because most operations are carried out online and with the aid of APIs. It demonstrates how contemporary technologies can be applied to boost the agriculture sector.

Fig. 5 Plant Diseases Detection

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V. CONCLUSION

The research showcases the implementation of machine learning models, including Random Forest and MobileNet, to address agricultural challenges effectively. Through integration into a Flutter application, farmers gain access to personalized nutrient recommendations and plant disease detection. Leveraging Android development principles ensures seamless functionality and user interaction. The research underscores the potential of machine learning in modernizing agricultural practices and enhancing productivity.

REFERENCES

[1] Yulong Yin, Hao Ying, Huifang Zhen, Q ingsong Zhang, Y anfang Xue, Zhenling I, "Estimation of NPK requirements for rice production in diverse Chinese environments under optimal fertilization rate," Agricultural and Forest Meteorology, vol-279, 2019, PP. 1-6J. U. Duncombe, “Infrared navigation—Part I: An assessment of feasibility,” IEEE Trans. Electron Devices, vol. ED-11, pp. 34-39, Jan. 1959.

[2] M. Kumar, A. Kumar and V. S. Palaparthy, "Soil Sensors-Based Prediction System for Plant Diseases Using Exploratory Data Analysis and Machine Learning," in IEEE Sensors Journal, vol. 21, no. 16, pp. 17455-17468.

[3] Krutika Hampannavar, Vijay Bhajantri, Shashikumar G. Totad "Prediction of Crop Fertilizer Consumption," Fourth International Conference on Computing Communication Control and Automation (ICCUBEA),2018, PP.1-5

[4] B. Godi, A. S. Muttipati, M. P. Rao, G. V. Satyanarayana, G. M. Padmaja and S. R. Gadiraju, "ResNet Model to Forecast Plant Leaf Disease," 2022 International Conference on Computing, Communication and Power Technology (IC3P), Visakhapatnam, India, 2022, pp. 38-43

[5] P. Dwivedi, S. Kumar, S. Vijh and Y. Chaturvedi, "Study of Machine Learning Techniques for Plant Disease Recognition in Agriculture," 2021 11th International Conference on Cloud Computing, Data Science & Engineering (Confluence), Noida, India, 2021, pp. 752-756

[6] Shital Bhojani, Nirav Bhatt, "Data Mining Techniques for Crop Yield Prediction," Computers and Electronics in Agriculture, vol-6, 2018, PP. 357-358

[7] Sai Nishant, Potnuru & Venkat, Pinapa & Avinash, Bollu & Jabber, B.,"Crop Yield Prediction based on Indian Agriculture using Machine Learning," 2020 1-4

[8] Samantaray, Rashmirani & Azeez, Abdul & Hegde, Nayana. (2023),"Efficient Smart Farm System Using Machine Learning," 2023, 576-581

[9] Tony Yang, Kadambot H.M., Siddique, Kui Liu, “Cropping systems in agriculture and their impact on soil health,” Global Ecology and Conservation, vol-23, year, PP. 1-13

[10] János Kátai, Ágnes Oláh Zsuposné, Magdolna Tállai, Tarek Alshaal, “Would fertilization history render the soil microbial communities and their activities more resistant to rainfall fluctuations? ,” Ecotoxicology and Environmental Safety, vol-201, 2020, PP. 1-11

[11] T. Kavitha, S. Deepika, K. Nattaraj, P. Shanthini and M. Puranaraja, "Smart System for Crop and Diseases Prediction using Random Forest and Resnet Architecture," 2022 International Conference on Sustainable Computing and Data Communication Systems (ICSCDS), Erode, India, 2022, pp. 1513-1519

[12] Senthil Kumar Swami Durai, Mary Divya Shamili, “Smart farming using Machine Learning and Deep Learning techniques,” Decision Analytics Journal, vol-2, 2022, PP. 1-30

[13] Kaggle, “https://www.kaggle.com/datasets/atharvaingle/crop-recommendation-dataset”

[14] Yin, Yulong & Ying, Hao & Zheng, Huifang & Zhang, Qingsong & Xue, Yanfang & Cui, Zhenling, "Estimation of NPK requirements for rice production in diverse Chinese environments under optimal fertilization rates," Agricultural and Forest Meteorology, 2019, 279

[15] M.S. Suchithra, Maya L. Pai, “Improving the prediction accuracy of soil nutrient classification by optimizing extreme learning machine parameters,” Information Processing in Agriculture, vol-7, 2022, PP. 1-11

[16] D. J. A. Amora, A. B. Deocadiz, G. L. Sañejo, C. J. R. Santiago, M. G. Umali and S. U. Arenas, "NPK Prediction based on pH Colorimetry Utilizing ResNet for Fertilizer Recommender System," 2022 IET International Conference on Engineering Technologies and Applications (IET-ICETA), Changhua, Taiwan, 2022, pp. 1-2

[17] N. Irene Monica, S. R. Pooja, S. Rithiga and R. Madhumathi, "Soil NPK Prediction using Enhanced Genetic Algorithm," 2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2023, pp. 2014-2018

[18] J. R, H. D and P. B, "A Machine Learning-based Approach for Crop Yield Prediction and Fertilizer Recommendation," 2022 6th International Conference on Trends in Electronics and Informatics (ICOEI), Tirunelveli, India, 2022, pp. 1330-1334

[19] M. R, A. Kumar K, C. K. N, D. A and A. T, "Soil Nutrient Prediction and Crop Recommendation System," 2023 International Conference on Circuit Power and Computing Technologies (ICCPCT), Kollam, India, 2023, pp. 976-981

[20] H. Younis, M. Z. Khan, M. U. G. Khan and H. Mukhtar, "Robust Optimization of MobileNet for Plant Disease Classification with Fine Tuned Parameters," 2021 International Conference on Artificial Intelligence (ICAI), Islamabad, Pakistan, 2021, pp. 146-151