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Predicting The Suitable Organic Fertilizer For Crop Based On Soil And Environmental Factors Using Various Feature Selection Techniques With Cassifiers

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Abstract: The efficient utilization of organic fertilizers plays a crucial role in sustainable agriculture by enhancing crop productivity while preserving soil health. This research introduces an Organic Fertilizer Prediction System, a machine learning-driven approach designed to recommend the optimal type and dosage of organic fertilizer based on specific soil and climatic conditions. The system leverages a comprehensive dataset encompassing key agricultural parameters, including soil pH, organic matter content, macronutrient levels (Nitrogen, Phosphorus, Potassium), soil texture, temperature, humidity, rainfall, crop type, and growth stage. To develop an accurate predictive model, multiple machine learning algorithms—Random Forest, Support Vector Machine (SVM), Decision Tree, K-Nearest Neighbors (KNN), and Gradient Boosting—were trained and evaluated. Among these, the Random Forest algorithm demonstrated superior performance and was selected as the final model for deployment. The trained model is integrated into a Flask-based web application that enables users to input real-time soil and environmental data, subsequently generating tailored fertilizer recommendations. By providing data-driven insights, this system supports farmers in making informed fertilization decisions, thereby improving agricultural efficiency, optimizing resource usage, and promoting environmentally sustainable farming practices. Future research will focus on expanding the dataset to improve model generalization and exploring advanced machine learning techniques to enhance prediction accuracy.

Index Terms **–** Organic fertilizer, Machine learning, random forest, fertilizer recommendation.

I. Introduction

Soil fertility is essential for agricultural productivity, influencing crop yields and food security. While chemical fertilizers boost production, their excessive use degrades soil quality and harms the environment.

Organic fertilizers, such as vermicompost and biofertilizers, offer a sustainable alternative by enriching soil health and ensuring long-term agricultural viability.

This study develops an Organic Fertilizer Prediction System that utilizes machine learning to recommend the most suitable organic fertilizer and dosage based on soil and climatic conditions. By analyzing parameters such as soil pH, nutrient content, texture, temperature, humidity, and rainfall, the system employs models like Random Forest, Decision Tree etc, with Random Forest demonstrating superior accuracy. Integrated into a Flask-based web application, the system provides real-time, data-driven recommendations to enhance fertilizer efficiency and promote sustainable farming practices.

II. PROBLEM STATEMENT

The main objective of the system is to develop a predictive framework using feature selection and machine learning to recommend suitable organic fertilizers, enhancing agricultural efficiency and promoting sustainable practices for improved crop yields.

III. EXISTING SYSTEM

Traditional organic fertilizer recommendations rely on soil testing, expert consultation, and empirical knowledge, which often lack scalability and real-time adaptability. Machine learning models have been introduced to enhance prediction accuracy, yet they face significant challenges.

These models are influenced by complex variables, with incomplete or biased data often leading to inaccuracies. Overfitting during feature selection further limits their generalization. Additionally, the high cost and limited accessibility of organic fertilizers pose challenges, particularly for smallholder farmers in developing regions. Ethical concerns regarding data privacy, consent, and reliance on automated decision-making also raise issues of transparency and accountability. Despite these limitations, advancements in data-driven agriculture continue to refine predictive models, emphasizing the need for more robust, inclusive, and ethical solutions.

IV. PROPOSED SYSTEM

The proposed Organic Fertilizer Prediction System leverages machine learning to recommend the most suitable organic fertilizer type and dosage based on soil and climatic conditions. By analyzing key parameters such as soil pH, nutrient levels, soil texture, temperature, humidity, and rainfall, the system enhances fertilizer application efficiency while promoting sustainable agricultural practices. Various machine learning models, including Random Forest, SVM, Decision Tree, KNN, and Gradient Boosting, are evaluated, with Random Forest selected for its superior predictive accuracy. The trained model is integrated into a Flask-based web application, allowing users to input real-time data and receive precise recommendations. This system addresses existing limitations by improving prediction reliability, ensuring accessibility, and supporting environmentally responsible farming. Future improvements will focus on expanding the dataset and incorporating advanced machine learning techniques to enhance accuracy and usability.

V. METHODOLOGY

A well-structured system architecture is essential for ensuring the efficiency, scalability, and maintainability of the Organic Fertilizer Recommendation System. The proposed system follows a modular approach, integrating various components, including data processing, machine learning model management, database operations, user management, and system security. The methodology is structured as follows:

1. Data Generation and Preprocessing

   The system generates synthetic crop data with strong feature-target correlations, incorporating key variables such as soil type, nutrient composition, temperature, and crop growth stage. The generated dataset is stored in a CSV file for model training, ensuring a clear relationship between input features and the target variable (organic fertilizer type).

2. Machine Learning Model Management

   Multiple machine learning models, including Random Forest, Logistic Regression, Support Vector Machine (SVM), K-Nearest Neighbors (KNN), Decision Tree, and Gradient Boosting, are trained on the dataset. Each model undergoes evaluation for accuracy and cross-validation to determine its performance. The best-performing model, Random Forest, is selected and saved for future predictions. Model performance metrics are visualized for comparative analysis.

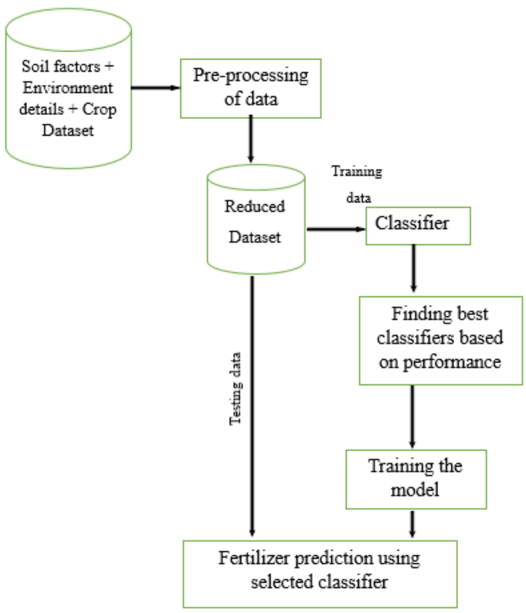
3. Database Management

   An SQLite database is used to store user credentials (username, email, hashed passwords, roles). And Passwords are securely hashed using bcrypt before storage to enhance security.

4. System Interaction Flow

   The system provides an interactive platform where allowing users to input crop conditions and receive fertilizer recommendation from the trained model.

   By integrating these components, the system ensures efficient data processing, reliable fertilizer recommendations, secure user management, and scalable deployment, contributing to precision agriculture and sustainable farming practices.



VI. IMPLIMENTATION

The implementation of the Organic Fertilizer Prediction System involves translating the system design into an executable framework that predicts the most suitable organic fertilizer for rice cultivation based on environmental and soil parameters. The system is developed using a structured approach, integrating data processing, machine learning model management, database operations, and user interaction through a Flask-based web application. The implementation is divided into five key stages:

1. Data Generation and Preprocessing

   A structured dataset is created, incorporating critical parameters such as soil pH, soil type, nitrogen, phosphorus, potassium levels, organic matter, moisture, temperature, rainfall, and sunlight hours. The dataset defines growth stages (Seeding, Tillering, Panicle Initiation, Flowering, Grain Filling, Harvesting) and assigns corresponding fertilizers (e.g., Compost, Vermicompost, Farmyard Manure). The data is stored as a CSV file, and categorical variables are encoded using LabelEncoder to convert textual values into numerical representations. The dataset is then split into training (80%) and testing (20%) subsets for model development.

2. Model Selection and Evaluation

   Multiple machine learning models, including Random Forest, SVM, Logistic Regression, KNN, Decision Tree, and Gradient Boosting, are trained and evaluated. The Random Forest model (with 100 estimators) is selected due to its superior accuracy and generalization ability. Performance metrics, including accuracy, precision, recall, and F1-score, are computed, and cross-validation is applied to ensure consistency. The trained model, along with the label encoders, is saved using joblib for future predictions.

3. Database Integration for User

   An SQLite database is implemented to store user credentials. The database maintains User Management Users are classified as Admins (managing users) and Regular Users (accessing fertilizer recommendations). Passwords are securely hashed using bcrypt.

4. Model Integration

   The trained Random Forest model is integrated into the system, allowing predictions based on real-time user input. The system loads the saved model and processes input parameters to generate optimal fertilizer recommendations.

5. Prediction and Recommendation

   Users input soil and environmental data via the Flask-based web interface, and the system provides fertilizer type. Secure authentication ensures restricted access based on user roles.

VII. RESULTS

The Organic Fertilizer Recommendation System successfully implemented an automated solution for recommending the most suitable organic fertilizers based on soil conditions and crop types. The system offers high accuracy and reliability, minimizing errors in fertilizer selection by analyzing specific soil and crop data inputs. It provides precise and tailored fertilizer recommendations, ensuring optimal growth for various crops while maintaining soil health. The system ensures real-time data processing and accurate recommendations, enabling farmers to make informed, data-driven decisions. It integrates smoothly with existing agricultural management platforms, enhancing efficiency and providing valuable insights for sustainable farming. The results demonstrate the system's effectiveness in optimizing fertilizer use and promoting eco-friendly farming practices.

VIII. CONCLUSION

The Organic Fertilizer Prediction System demonstrates the effective application of machine learning in precision agriculture, providing an efficient, data-driven solution for optimizing organic fertilizer recommendations. By leveraging Random Forest, the system ensures high prediction accuracy, assisting farmers in making informed decisions to enhance crop yield and soil fertility while promoting sustainable agricultural practices. The integration of a Flask-based web interface with secure authentication and database management enables user-friendly access and efficient data handling. Additionally, the system's scalability and adaptability allow for future enhancements, such as incorporating real-time IoT-based data collection and expanding to other crop varieties. Despite challenges related to data availability, model generalization, and accessibility, the system provides a practical and scalable framework for precision farming. Future improvements will focus on enhancing model robustness, increasing dataset diversity, and integrating advanced AI techniques to further refine fertilizer recommendations, contributing to more efficient and eco-friendly agricultural practices.

REFERENCES

[1] Pantazi, X. E., Moshou, D., Alexandridis, T., Whetton, R. L., & Mouazen, A. M. (2016). Wheat yield prediction using machine learning and advanced sensing techniques. *Computers and electronics in agriculture*, *121*, 57-65.

[2] Palm, C. A., Gachengo, C. N., Delve, R. J., Cadisch, G., & Giller, K. E. (2001). Organic inputs for soil fertility management in tropical agroecosystems: application of an organic resource database. *Agriculture, ecosystems & environment*, *83*(1-2), 27-42.

[3] Bonanomi, G., Antignani, V., Capodilupo, M., & Scala, F. (2010). Identifying the characteristics of organic soil amendments that suppress soilborne plant diseases. *Soil Biology and Biochemistry*, *42*(2), 136-144.

[4] Ghadge, R., Kulkarni, J., More, P., Nene, S., & Priya, R. L. (2018). Prediction of crop yield using machine learning. *Int. Res. J. Eng. Technol.(IRJET)*, *5*, 2237-2239.

[5] Sharma, A., & Chetani, R. (2017). A review on the effect of organic and chemical fertilizers on plants. *Int. J. Res. Appl. Sci. Eng. Technol*, *5*(2), 677-680.

[7] Adegoke, A. A., Awolusi, O. O., & Stenström, T. A. (2016). Organic fertilizers: public health intricacies. *Organic Fertilizers–From Basic Concepts to Applied Outcomes*, 343-374.

[8] Thomas, C. L., Acquah, G. E., Whitmore, A. P., McGrath, S. P., & Haefele, S. M. (2019). The effect of different organic fertilizers on yield and soil and crop nutrient concentrations. *Agronomy*, *9*(12), 776.

[9] Siavoshi, M., Nasiri, A., & Laware, S. L. (2011). Effect of organic fertilizer on growth and yield components in rice (Oryza sativa L.). *Journal of Agricultural science*, *3*(3), 217.

[10] Reda, R., Saffaj, T., Ilham, B., Saidi, O., Issam, K., Brahim, L., & El Hadrami, E. M. (2019). A comparative study between a new method and other machine learning algorithms for soil organic carbon and total nitrogen prediction using near infrared spectroscopy. *Chemometrics and Intelligent Laboratory Systems*, *195*, 103873.

[11] Skoraczyński, G., Dittwald, P., Miasojedow, B., Szymkuć, S., Gajewska, E. P., Grzybowski, B. A., & Gambin, A. (2017). Predicting the outcomes of organic reactions via machine learning: are current descriptors sufficient?. *Scientific reports*, *7*(1), 3582.

[12] Singh, T. B., Ali, A., Prasad, M., Yadav, A., Shrivastav, P., Goyal, D., & Dantu, P. K. (2020). Role of organic fertilizers in improving soil fertility. *Contaminants in agriculture: sources, impacts and management*, 61-77.