International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

AgroSphere: Smart Farming Solutions using ML Algorithms

Dr. Amol Dhakne[1], Sanjana Sunil Patel[2], Mayur Pandharinath Chakor[3], Saurabh Santosh Gaikwad[4], Akshata Arvind Bidwe[5]

[1] Associate Professor D Y Patil International University Akurdi , Pune , India
dhakne.amol5@gmail.com
[2] Department of Computer Engineering Dr. D. Y. Patil Institute of Engineering, Management and Research, Akurdi , Pune , India
patelsanjana872@gmail.com
[3] Department of Computer Engineering Dr. D. Y. Patil Institute of Engineering, Management and Research, Akurdi , Pune , India
mchakor26@gmail.com
[4] Department of Computer Engineering Dr. D. Y. Patil Institute of Engineering, Management and Research, Akurdi , Pune , India
saurabhg232003@gmail.com
[5] Department of Computer Engineering Dr. D. Y. Patil Institute of Engineering, Management and Research, Akurdi , Pune , India
akshatabidwe06@gmail.com

ABSTRACT—

Agriculture remains the backbone of many economies, that suffer from several challenges such as inefficient resource utilization, restricted market access, and limited awareness about government schemes. The system "AgroSphere: Smart Farming Solutions using ML Algorithms " is a web-based application designed to efficiently track and monitor employee activities within an organization provides an integrated platform comprising ML algorithms for crop predictions and fertilizer recommendations. It consists of a Farmer Portal and a Buyer Portal, which directly allows the parties to exchange and communicate using real-time chatting. The system provides solutions using Random Forest algorithms for crop prediction and fertilizer recommendations. For crop prediction it takes the various natural factor into consideration and on basis of it, predicts which crops should be grown over there. It provides farmers with enhanced market reach, direct access to buyers, and detailed information about government subsidies and support programs. The platform uses technologies such as PHP and MySQL based. This ensures safe and efficient data management. Its web interface is modern and emphasizes ease of use and accessibility to users of different technical levels. The accuracy levels of ML models are more than 95%. Farmers are, therefore empowered to maximize productivity while adopting sustainable practices to improve their profit margins.

Index Terms— Smart Farming, Machine Learning, Crop Prediction, Fertilizer Recommendation ways. It uses machine learning to help farmers choose the right crops and fertilizers based on real conditions like soil

INTRODUCTION

Agriculture has always been the backbone of India's economy, not just as a source of livelihood for millions, but also as a cultural and social foundation. Yet, despite its importance, many farmers continue to struggle with age-old problem unpredictable weather, poor crop choices, lack of access to good fertilizers, and limited exposure to fair markets. In many cases, decisions are still made based on tradition or guesswork, rather than solid data. This often results in lower yields, wasted resources, and unstable incomes. [1]
On top of that, selling their produce is another major hurdle. Most farmers rely on middlemen to get their crops to market, which often means they don't receive the full value of their hard work. Adding to this the complexity and inaccessibility of government schemes, and it becomes clear that there's a real gap between what's available to help farmers and what actually reaches them. [2]

That's where AgroSphere comes in. This project was created with the goal of bridging that gap bringing together the power of technology, data, and human connection to support farmers in smarter, more sustainable and climate. It offers a platform where farmers can connect directly with buyers, eliminating the need for middlemen. And it makes information about government support and subsidies easy to access and understand.

By giving farmers the tools to make informed decisions and directly participate in digital marketplaces, AgroSphere aims to change how farming is done from reactive to proactive, from isolated to connected. It's about using innovation not to replace traditional knowledge, but to enhance it making farming more productive, fair, and future- ready.
The AgroSphere FarmTech platform is designed to address these challenges by leveraging machine learning algorithms for Crop prediction and fertilizer recommendations and providing a direct marketplace for farmers and buyers. The system integrates real-time chat, predictive analytics, and access to government support to optimize farming decisions and enhance economic resilience in the agricultural sector.

Literature Survey

Year	Author(s)	Technique Used	Observation
2023	Deone, M. S., Thakare, R. D., and Thakare, V. M.	Various ML Models	Explored ML techniques for crop prediction and fertilizer recommendation based on soil nutrients.
2023	Sunandini, S., Sangeetha, S., and Pradeep, S.	IoT and ML Integration	Developed a system for soil nutrient monitoring and crop recommendation using IoT sensors and ML algorithms.
2023	Madondo, F., Chivasa, S., and Maposa, D.	Reinforceme nt Learning with SWAT	Introduced a framework using reinforcement learning for crop management decisions.
2024	Rajpoot, R. S., Sharma, A., and Kumar, R.	IoT and ML- Based Model	Proposed a model integrating IoT and ML for crop, irrigation, and fertilizer prediction.
2024	Thorat, S. P., and Jahirabadkar, P.	Ensemble ML Techniques	Analyzed soil nutrient data to predict optimal fertilizer application in India.
2024	De, S., Dey, A., and Das, A.	XGBoost, Random Forest, SVM, KNN, Decision Tree	Evaluated ML models for crop recommendations based on soil nutrients and climatic variables, finding XGBoost most accurate.
2024	Turgut, T., Kaya, A., and Yildirim, T.	Explainable AI (XAI)	Proposed AgroXAI, an explainable AI-driven crop recommendation system for Agriculture 4.0.
2025	Rafiq, M., Khan, N., and Ahmed, S.	Machine Learning-Based Platform	Developed a smartprediction platform for agricultural crops using ML techniques.

Over the years, many researchers have explored ways to improve farming outcomes by predicting crop yields and recommending the most suitable crops and fertilizers. These studies take into account changing weather patterns and aim to help farmers make choices that lead to better harvests and higher profits.

Deone M. S., Thakare R. D., and Thakare V. M. (2023) analyzed various machine learning models to predict suitable crops and fertilizers. The study focused on enhancing yield through optimized recommendations based on soil nutrient levels and climatic conditions. The model accuracy was validated with real-time data collected from agricultural fields [1].

Sunandini S., Sangeetha S., and Pradeep S. (2023) proposed an integrated approach combining IoT and machine learning for smart agriculture. Their system utilized sensors to gather soil and environmental data, which was then processed by ML models for recommending suitable crops. This system effectively helped farmers in making informed decisions, especially in resource- constrained areas [2].

Madondo F., Chivasa S., and Maposa D. (2023) developed a reinforcement learning framework integrated with the SWAT model for real-time crop management. Their approach used sensor data and environmental variables to dynamically update crop decisions. This helped improve crop yields and manage resources more efficiently [3].

Rajpoot R. S., Sharma A., and Kumar R. (2024) presented an IoT-ML integrated model that supported farmers in predicting crops, irrigation requirements, and fertilizer needs. The model was capable of analyzing real-time sensor data, thus allowing farmers to take timely decisions to boost crop productivity [4].

Thorat S. P. and Jahirabadkar P. (2024) implemented an ensemble of ML algorithms to determine fertilizer recommendations. Their model trained on soil nutrient datasets from various regions in India, providing insights into best practices for sustainable fertilizer usage and its impact on soil health [5].

De S., Dey A., and Das A. (2024) compared different ML classifiers like XGBoost, Random Forest, SVM, KNN, and Decision Trees. Their results concluded that XGBoost offered the highest accuracy in predicting crop types based on input parameters such as pH, temperature, and rainfall [6].

Turgut T., Kaya A., and Yildirim T. (2024) introduced AgroXAI, an explainable AI model for crop recommendation. Unlike black-box ML models, AgroXAI provided interpretability in its decision-making process, which improved trust among users. The model also incorporated soil and weather data for better predictions [7].

Rafiq M., Khan N., and Ahmed S. (2025) built a smart ML- based platform to recommend crops and manage agricultural data. Their platform was cloud-integrated, allowing for real- time predictions and scalability. It also supported remote monitoring features to aid farmers in distant rural areas [8].

Related Work

In recent years, a number of digital platforms have been introduced to help farmers by offering services like market access, expert advice, and agricultural input supply. While these tools have undoubtedly brought improvements in specific areas, most of them tend to address individual problems rather than providing a complete, end-to-end solution. As a result, even though they support farmers in meaningful ways, they often fall short of delivering the kind of all-in-one, integrated experience that **AgroSphere** is designed to offer.

Take the **National Agriculture Market (eNAM)** for instance this initiative by the Government of India allows farmers to participate in transparent, online trading through regulated APMC mandis. It has streamlined price discovery and reduced dependence on middlemen. However, eNAM's functionality is mostly limited to trading. It doesn't include intelligent crop or fertilizer recommendations powered by machine learning, nor does it offer real-time communication
tools or guidance about relevant government schemes, which are critical for supporting farmers beyond just pricing.
Similarly, **AgroStar**, a private agri-tech venture, offers a platform where farmers can buy high-quality seeds, fertilizers, and pesticides. It includes advisory support via phone and even allows farmers to upload photos of crop issues for basic AI-based diagnosis. Still, it lacks features like a direct buyer-seller marketplace and personalized, data- driven recommendations. Additionally, it does not assist farmers with government scheme applications or updates.

Kisan Suvidha, a mobile app from the Ministry of Agriculture, provides helpful information such as local weather forecasts, mandi prices, and updates on government initiatives. While it's a valuable source of general information, the app is limited in interactivity. It doesn't allow farmers to sell their produce directly, communicate with buyers, or get tailored suggestions based on their specific needs or farm conditions.

Over the past few years, researchers have shown growing interest in applying machine learning techniques to improve decision-making in agriculture. These efforts focus on helping farmers make smarter, more informed choices about what to grow and how to manage their land based on actual data, rather than relying only on traditional knowledge or intuition.

For example, in a study conducted by Ramesh and Manjula (2017), a crop recommendation system was developed using decision tree algorithms. This system considered several key factors such as the levels of nitrogen, phosphorus, and potassium in the soil, along with temperature, humidity, and pH. By analysing these variables, their model was able to suggest suitable crops for specific conditions and achieved an accuracy rate of around **91.66%**. This showed how machine learning could provide more precise recommendations compared to conventional farming methods.

Building on this, Chavan and Patil (2020) explored a more advanced approach by implementing a Random Forest-based model. They used a large dataset of over 2,200 entries covering various soil and environmental conditions. Their model performed exceptionally well, achieving a prediction accuracy of **95.8%**, and also outperformed other algorithms like K-Nearest Neighbours (KNN), Support Vector Machines (SVM), and Naive Bayes. This research highlighted how ensemble methods, especially Random Forests, can effectively manage complex agricultural data to guide farmers in selecting the most suitable crops.

Agrosphere : Smart farming Solutions Using ML Algorithms

Market Place

AgroSphere is a smart agricultural platform designed to empower farmers by integrating machine learning (ML) for crop and fertilizer recommendations, predictive analytics, and a direct marketplace. The system provides real-time communication, government scheme integration, and data- driven insights to optimize agricultural resources and improve economic resilience.
The system begins with login and registration, where users (farmers or buyers) create accounts or can login.
Farmers can access the Farmer Dashboard, which serves as the central hub for their activities. Farmers can navigate to the My Products section, where they can add new products, manage existing listings, and modify pricing based on demand and seasonal changes. The Farmer Portal enables farmers to access government scheme information, allowing them to easily obtain subsidies, financial aid, and compliance regulations. The Agriculture Knowledge Section provides educational resources on key farming practices such as rainwater management, soil fertility improvement, cropping techniques, and disease control strategies. This section helps farmers stay updated with modern agricultural methods to enhance their productivity.
The ML-based Crop and Fertilizer Recommendation Module allows farmers to input soil and climate data into the system. The model processes this information and generates accurate predictions on optimal crops and fertilizers suited for their land conditions. This ensures data-driven decision-making for higher agricultural efficiency.
Buyers, upon logging in, can explore the Marketplace Interface, where they can browse categorized listings of fruits, vegetables, grains, and farming equipment. Each product comes with a detailed description, pricing information, and seller contact details. Buyers can initiate conversations with farmers through the real-time chat system to discuss product availability and quality.
Software & Hardware Requirements
The platform is developed using HTML, CSS, and JavaScript for a responsive and user-friendly frontend. The backend is powered by PHP for secure server-side processing, while Flask is used for ML model execution.
The system's database is managed with PHPMyAdmin, ensuring secure storage of crop data and user profiles. Machine learning functionalities are implemented using Python-based frameworks such as Flask and Scikit-Learn for crop prediction and fertilizer recommendations.

Machine Learning Models

Dataset

The Crop Prediction and Fertilizer Recommendation datasets are both essential for optimizing agricultural practices based on environmental and soil conditions. The Crop Prediction dataset contains features such as Nitrogen, Phosphorus, Potassium, temperature, humidity, pH level, and rainfall, which help in predicting the most suitable crop for a given set of conditions. The label column in this dataset indicates the crop.

On the other hand, the Fertilizer Recommendation dataset includes features like temperature, humidity, soil moisture, soil type, and crop type, along with essential nutrients such as

Nitrogen, Potassium, and Phosphorus, to recommend the most suitable fertilizer for each crop. The Fertilizer Name column provides the recommended fertilizer based on the given conditions. Both datasets are used to train machine learning models that aim to enhance agricultural practices by suggesting the right crops and fertilizers, optimizing crop yield and soil health based on the specific environmental factors.

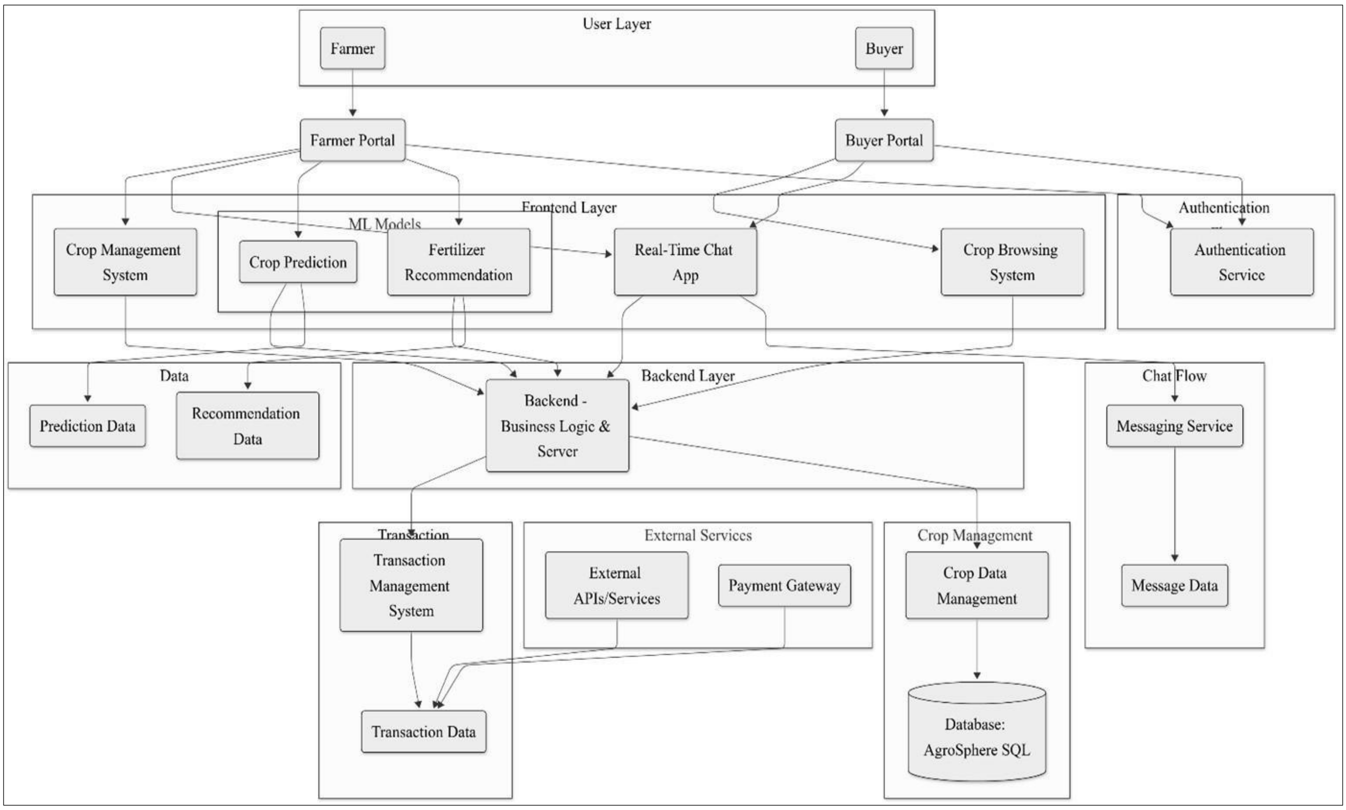

Fig.1. System Architecture

Data Preprocessing

After conducting an initial exploration of the dataset, the most relevant features influencing crop prediction were selected. These included the soil macronutrients nitrogen (N), phosphorus (P), and potassium (K), along with environmental parameters such as temperature, humidity, pH level, and rainfall. These seven variables were identified as key indicators affecting crop growth and were used as input features, while the crop label served as the target variable for prediction.

To ensure uniformity across different feature scales and improve the performance of distance-based models, feature scaling was applied using the Standard Scaler technique. This standardization process transformed all numerical values to a common scale with a mean of zero and a standard deviation of one. As the original features varied in range for instance, rainfall values ranged in the hundreds while pH was typically between 3 and 10 scaling was essential to prevent bias in the learning process.

For the fertilizer recommendation now we can see the numerical attributes such as temperature, humidity, soil moisture, nitrogen, and phosphorus—were identified as continuous variables, while soil type and crop type were considered categorical features.

Since machine learning models typically require numerical input, the categorical columns were converted into numeric form using label encoding. This technique assigns a unique integer to each category, allowing the model to interpret and process these values efficiently without assuming any ordinal relationship.

To get the data ready for our machine learning models, we first needed to convert the text columns (like soil type and crop type) into number since models don't understand words. We used **Label Encoding**, which simply assigns a unique number to each category. For example, "Sandy" soil might become 0, and "Loamy" might be 1. Once everything was in number form, we separated the data into two parts: one part with the inputs (like temperature, humidity, and soil type), and another part with the output we want to predict (the fertilizer name). This setup helps the model learn patterns and make accurate predictions.

Models Used

1. **K-Nearest Neighbours (KNN)**

K-Nearest Neighbours is a simple, instance-based learning algorithm used for classification. It predicts the class of a data point based on the majority class among its nearest neighbours. When applied to our dataset, KNN achieved an accuracy of 97.5% for crop prediction and 90% for fertilizer recommendation after applying feature scaling.

2. **Naive Bayes**

Naive Bayes is a probabilistic classifier based on Bayes' theorem, assuming independence between features. Despite its simplicity, it performed well on our clean and balanced crop dataset, achieving 90% accuracy for crop prediction.

3. **Logistic Regression**

Logistic Regression is a linear model used for classification tasks. It estimates the probability of a class using a logistic function. In our case, it yielded an accuracy of 95.23% for crop prediction, showcasing its effectiveness with linearly separable data.

4. **Support Vector Classifier (SVC)**

Support Vector Classifier is a powerful algorithm that finds the optimal hyperplane to separate different classes. It handled mixed-type features effectively in the fertilizer recommendation system and achieved 90% accuracy.

5. **Random Forest**

Random Forest is an ensemble learning technique that builds multiple decision trees and combines their outputs for better accuracy. It achieved 99.32% accuracy for crop prediction and 95% for fertilizer recommendation, making it one of the most robust models in our study

RESULT

The system is designed to bring meaningful improvements to farmers' lives by enhancing crop yields, increasing profitability, and providing direct access to markets ultimately helping farmers earn more. It also simplifies access to government financial assistance programs, making support more accessible when needed. Smarter resource management will help reduce costs and minimize environmental impact.

By offering personalized recommendations, the system encourages sustainable farming practices and improves the overall quality of crops. A transparent, traceable supply chain will also build greater trust among consumers. The system aim to support better cash flow management, reduce debt burdens, and help farmers make smarter budgeting and planning decisions.

One of the most significant strengths of the system lies in its improved machine learning models, which deliver highly accurate crop prediction and fertilizer recommendations. This level of precision ensures that advice given to farmers is both practical and reliable, leading to reduced risks and higher productivity. As the system continues to learn from growing volumes of agricultural data, it becomes smarter over time empowering farmers to make decisions backed by real insights.

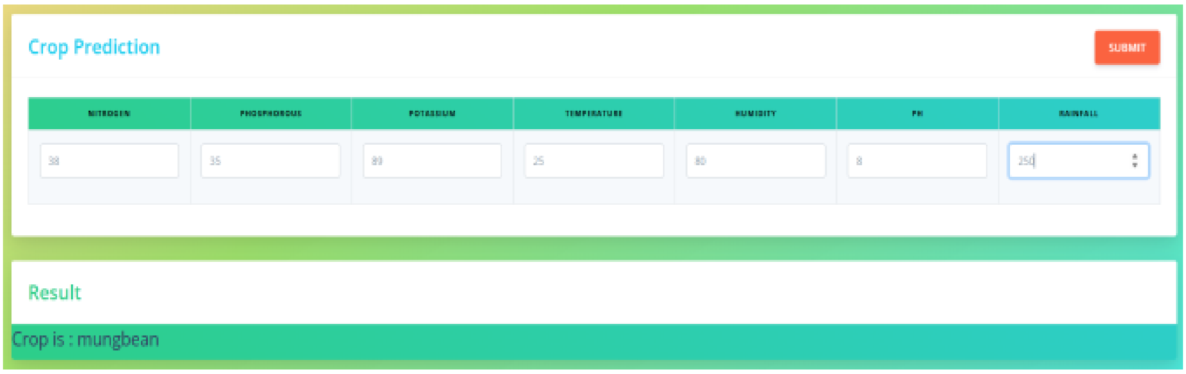

Fig. 2. Crop Prediction

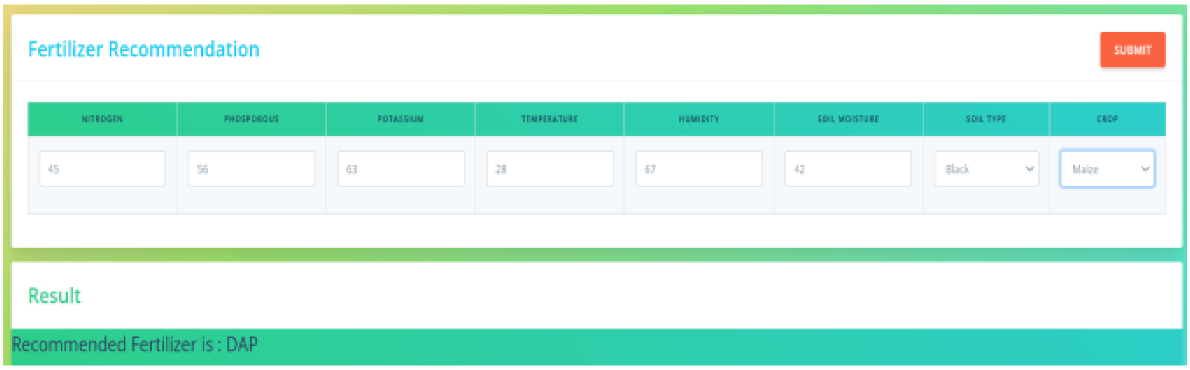

Fig. 3. Fertilizer Recommendation

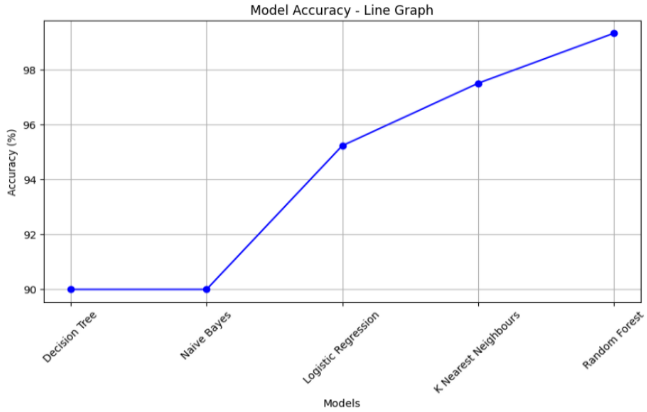

Fig. 4. Crop Prediction Models Accuracy

Here we have used different ML models but the one giving more accuracy and standing out is Random Forest . Hence we will use the Random Forest Model for further use.

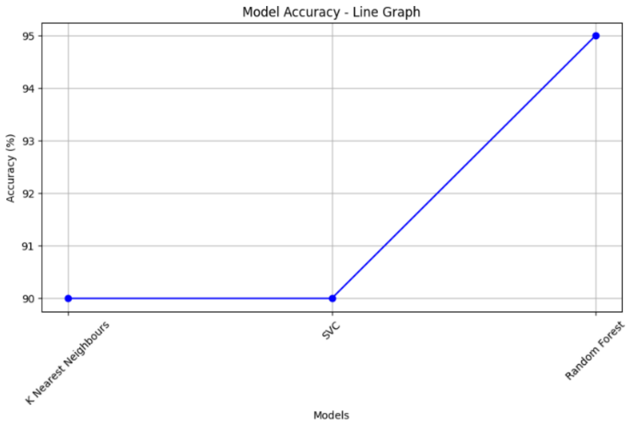

Fig. 5. Fertilizer Recommendation Models Accuracy

Here we have used different ML models but the one giving more accuracy and standing out is Random Forest . Hence we will use the Random Forest Model for further use.

Conclusion

AgroSphere has the ability to drastically change conventional farming by giving farmers data-driven insights that facilitate improved decision-making and direct market access. Through the integration of real-time communication elements and the provision of government resources to farmers, the platform promotes economic resilience and increases agricultural output.

An agricultural ecosystem that is more effective and sustainable is established by the smooth interaction between producers, buyers, and governmental support systems. Additionally, AgroSphere's machine learning models' increased accuracy guarantees that the suggestions made are extremely trustworthy and customized to particular soil and environmental circumstances. The platform's influence on contemporary agriculture is further strengthened as a result of better decision-making, reduced risks, and improved farming results.

REFERENCES

1. Deone, M. S., Thakare, R. D., & Thakare, V. M. (2023). Machine learning models for soil nutrient- based crop and fertilizer recommendation systems.
2. Sunandini, S., Sangeetha, S., & Pradeep, S. (2023). An IoT and machine learning-based approach for real-time soil nutrient monitoring and crop recommendation.
3. Madondo, F., Chivasa, S., & Maposa, D. (2023). Reinforcement learning integration with SWAT for optimized crop management decisions.
4. Rajpoot, R. S., Sharma, A., & Kumar, R. (2024). Smart agriculture using IoT and ML: Crop, irrigation, and fertilizer prediction model.
5. Thorat, S. P., & Jahirabadkar, P. (2024). Predictive modeling for fertilizer recommendation using ensemble machine learning in Indian agriculture.
6. De, S., Dey, A., & Das, A. (2024). A comparative study of ML models for crop recommendation: XGBoost, SVM, and beyond.
7. Turgut, T., Kaya, A., & Yildirim, T. (2024). AgroXAI: An explainable AI-based crop recommendation system for Agriculture 4.0.
8. Rafiq, M., Khan, N., & Ahmed, S. (2025). Smart prediction platform for agriculture using machine learning techniques.