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Title: Multilingual Ai-Driven Framework For Crop And Fertilizer Recommendation In Smart Agriculture

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1.ABSTRACT:¯Agriculture contributes to ensuring food security and stability in many countries including India. However, issues arise during the process of selecting crops and fertilizers due to variations in soil type, climatic condition, weather changes and shortage of agriculture specialists. Thus, this paper focuses on Multilingual AI Assistant for Crop and Fertilizer Suggestion which is a smart application intended to assist farmers on agricultural activities in various locations conveniently. The system utilize two machine learning algorithms such as Crop Suggestion and Fertilizer Suggestion Datasets. While the first algorithm utilizes Random Forest Classifier to provide recommendations on the most suitable crops through soil nutrient parameter that includes Nitrogen (N), Phosphorus (P) and Potassium (K), the second algorithm gives recommendation on the most appropriate fertilizers considering soil type, soil moisture, crops and nutrient values. In order to increase the convenience of using the application, it uses several regional languages including English, Kannada, Hindi, Tamil and Telugu. In addition to the crop and fertilizer suggestions, weather forecast, AI chatbot, irrigation, and pest management services, there are other services available like e-cart and buyer suggestions included in the application. Location mapping service has been provided in the app to provide location-based weather details along with location-based buyers. Python, Flask, Scikit-learn, HTML, CSS, Bootstrap, and JavaScript have been used to build this app.

2.KEYWORDS: Multilingual AI, Crop Recommendation, Fertilizer Recommendation, Machine Learning and Smart Agriculture.

3.INTRODUCTION:

Agriculture contributes to ensuring food security and stability in many countries including India. The Various factors play an important role in successful crop cultivation in the form of choice of crop, soil fertility, nutrients, weather, irrigation, and application of fertilizers. There have been new achievement in the domain of artificial intelligence and machine learning, and these developments have enabled AI and ML models to help farmers with recommendations and agricultural information. Machine learning can be used to analyse soil and environmental parameters for recommending suitable crops and fertilizers. Moreover, farmers can be provided with access to agricultural information using AI chatbot service, weather services, and location-based agricultural applications.

Farmers find it difficult to choose suitable crops and fertilizers because the conditions for agricultural purposes change based on location. Factors like type of soil, nitrogen, phosphorus, potassium, pH value, temperature, humidity, and rainfall affect the crop growth and fertilizer application. Inappropriate choice of either crop or fertilizers would lead to decreased productivity,

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unnecessary costs, and mismanagement of agricultural resources. Lack of access to agricultural expertise makes it difficult for farmers to get timely advice for their operations. Additionally, current digital agricultural systems lack multilingual support

The main aim of this study is the develop an efficient and user-friendly agricultural assistance system that could assist the farmers in making informed decisions. With the advent of machine learning algorithms, it becomes feasible to study agricultural data and recommend proper crop and fertilizer suggestions to the farmers. Another improvement that could be brought to the system is the presence of a language friendly platform that help farmers to use the system. Incorporation of various agricultural services like weather forecast, irrigation recommendation, pest management, artificial intelligence chatbot, suggestion of buyers, and e-cart service would avoid the usage of different platforms.

Current agricultural suggestion systems have already revealed the benefits of applying machine learning techniques in the recommendations of crops and fertilizers. Nevertheless, many such systems focus only on prediction tasks and lack a set of comprehensive agricultural services. Some of them also lack good multilingual interaction, meaning that this system will be of less help for farmers who have limited proficient in English. Moreover, the combination of predictions about crops and fertilizers with weather forecasts, irrigation tips, pest protection advice, location-based services, recommendations of buyers and AI-based communication is still not been widely applied. It is important to develop a multilingual agricultural assistant with various services included.

Primary objectives of the recommended system will be designing a machine learning-based system that recommends suitable crops based on soil and environmental conditions, also provides appropriate recommendations regarding using fertilizers depending on the data related to crops and soil. Besides, the system is also aimed at offering weather forecast based on the chosen or automatically detected location, guidance regarding irrigation and pest management, as well as a multilingual AI chatbot offering agriculture-related information. Moreover, the system is also aimed at providing buyer recommendations through the location, also the facility of e-cart to help buy agricultural goods.

The primary contribution of this research work is the development of a Multilingual AI Assistant for Crop and Fertilizer Recommendation which integrates the agriculture recommendations made through machine learning with several other supplementary services. This system integrates the usage of machine learning to recommend suitable crops and fertilizers based on the related agricultural parameters and also makes use of services such as multilingual interaction, weather forecasting, irrigation recommendations, pest management, AI chatbot assistance, location-based services, buyer suggestions, and also the e-cart service. This system has been created using English, Kannada, Hindi, Tamil, and Telugu languages, thus enabling farmers of various language backgrounds to communicate with the system easily.

4.LITERATURE REVIEW:

Ref. No.	What it Studies.	Relevance.

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[1]B.Dhingra,S. Agarwal,and R. Gupta.	It utilizes machine learning methods in combination with explainability techniques to recommend crops on the basis of agricultural and environmental parameters.	The proposed project would be able to resolve the problem of availability of the system through the integration of agricultural predictions with the easy-to-use multilingual interface and useful agricultural services.
[2]S.S.Bibi and B. Ghanti.	The research focused on the possibility of utilization of AI-based conversational assistance for farmers in several languages and provision of agricultural data.	The proposed project would be able to resolve the problem of multilingual communication and agricultural services sharing.
[3]S.M. Venkateswara and J. Padmanaban.	In this study, the explainable machine learning method was used to obtain recommendations along with an attempt to interpret the model's decisions.	Improved advanced machine-learning and explainability techniques and special attention to the implementation of the multilingual interface with other services for farmers.
[4] A. Kukkar.	The AgroAdvisor applies such machine-learning and deep-learning methods as Random Forest, Gradient Boosting, and DeepFM.	It covers all the services suggested in the current project, such as multilingual conversational assistant, weather information, e-commerce, suggestions of nearby buyers, etc.
[5] M. V. Abhishek, A. J. Sreekar, D. M. Mohith, S. Vekkot, and V. Bhavana.	The research highlights how the use of multilingual AI technology can enhance accessibility to agricultural data.	It improves the multilingual AI technology and agricultural Chatbot.
[6]S.Singhal,O. Suthar, and A. Mishra.	The research focuses on existing crop recommendation systems and examined the growth of approaches in machine learning, deep learning, ensemble learning, and IoT.	It improves the agricultural assistant in multiple languages.
[7] F. Liben.	In this work, it was observed that using machine learning, fertilizer recommendations can be personalized to a specific agricultural setting.	The limitation of certain types of crops in certain agricultural settings are improved.
[8] T. S. T. Tanaka.	The paper explores various techniques of machine learning using agricultural data and their influence on fertilizer recommendations.	Improved the ML model for fertilizer recommendations.

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 11, CONFLUENCE - 2026

[9] B. Dey, J. Ferdous, and R. Ahmed.	The research involved considering the following factors such as Nitrogen (N), Phosphorus (P), Potassium (K), soil pH, temperature, rainfall, and other climatic parameters for recommending suitable crops.	This research paper is quite relevant to the proposed project since it too involves using soil and agricultural parameters for crop recommendation.
[10] F. S. Prity, M. M. Hasan, S. H. Saif, M. M. Hossain, S. H. Bhuiyan, M. A. Islam, and M. T. H. Lavlu.	The study explored various machine-learning algorithms for crop recommendation. These algorithms included Logistic Regression, Decision Tree, Random Forest classifier.	It develops an entire agricultural assistant that would provide information about fertilizers , weather and have a multilingual feature.
[11] K. Patel and H. B. Patel.	This study proves that multiple parameter integration can be beneficial for agriculture recommendation systems.	It improved the account multilingual interaction with farmers and integration of all necessary agricultural services into one system.
[12]C. Musanase, A. Vodacek, D. Hanyurwimfura, A. Uwitonze, and I. Kabandana.	The study used crop recommendation together with fertilizer recommendation and explored the application of machine learning methods for agricultural decision making.	High accuracy in crop recommendation was obtained using classification method, while fertilizer recommendation was provided using agriculture rules.

Table 4.1 Literature research table.

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International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14, Issue 11, CONFLUENCE - 2026

5.RESEARCH METHODOLOGY:

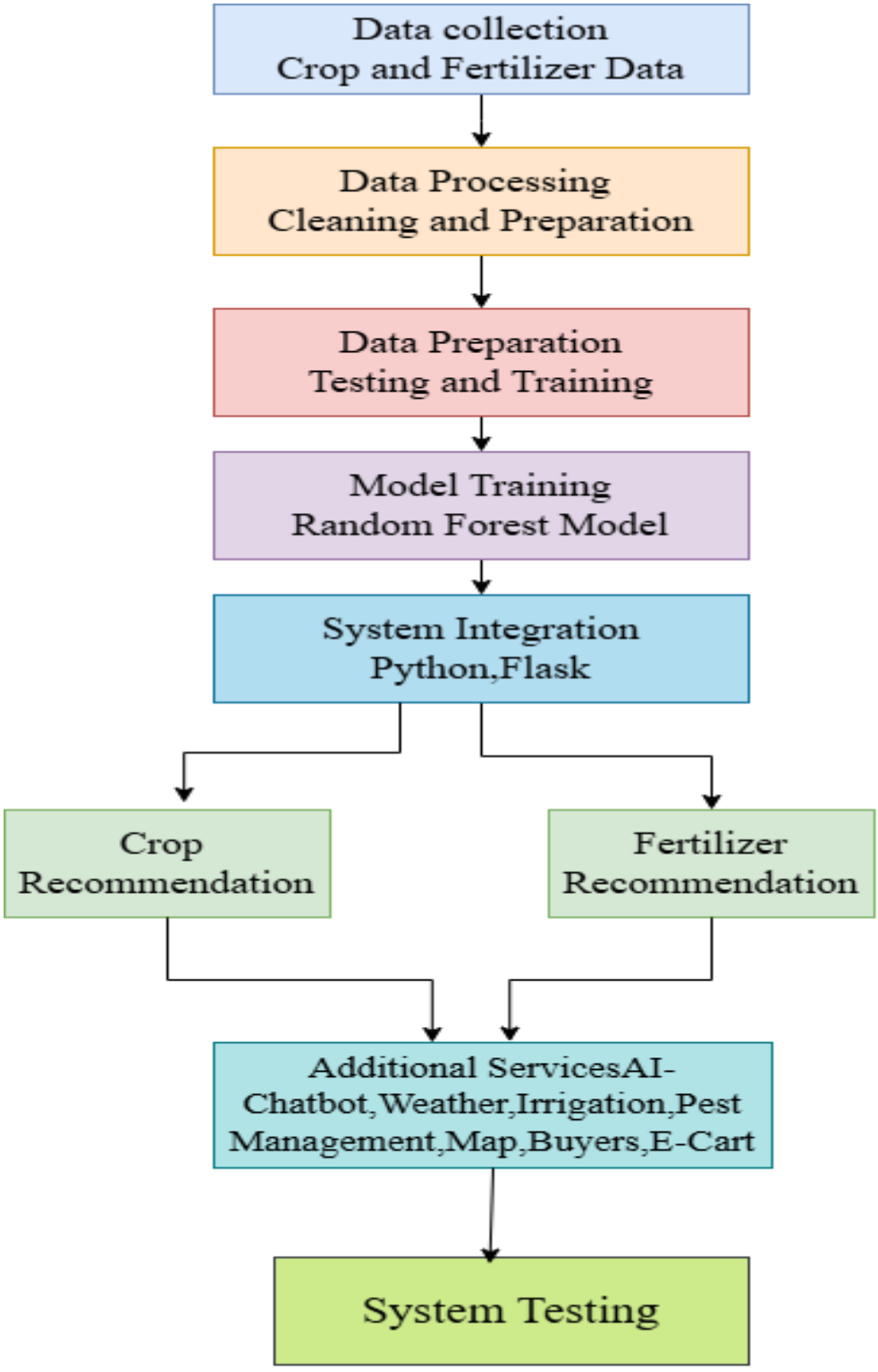


Figure:5.1 Methodology flow chart

5.1. Data - Source:

The datasets for agriculture are acquired from public sources to build machine learning models. The agricultural datasets include

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International Journal of Engineering Research & Technology (IJERT)
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Vol. 14, Issue 11, CONFLUENCE - 2026

details about the properties of soil, environment, crops, and fertilizers. The agricultural datasets will be used for testing and training recommendation models.

5.2.Data-Sets:

Two main datasets are considered in the proposed model. Crop Recommendation Dataset: Includes N (Nitrogen), P (Phosphorus), K (Potassium), Temperature, Humidity, pH Value, Rainfall and Crop. Fertilizer Recommendation Dataset: Includes the details like Soil Type, Soil Moisture, Crop Type, Nitrogen Humidity, Temperature and Nutrient Value. These factors are utilized to determine crops and fertilizers suitable to the provided conditions.

5.3. Tools and Technologies:

The implementation of this project involves the utilization of Python, Flask, HTML, CSS, and JavaScript languages. SQLite database is used for managing the databases. Pandas, NumPy, and Scikit-learn libraries in Python is applied for data processing and Machine Learning Method respectively. The APIs are used to obtain the weather data based on the location.

5.4. Algorithms/Models:

Random Forest Classifier algorithm is employed for recommending crops. This model is capable of understanding the relationship between soil and environmental parameters and crops. Fertilizer recommendation model is employed to recommend appropriate fertilizers according to soil and nutrient parameters and crop type. Incorporating NLP technology in an AI assistant to answer users' queries in agricultural field in various languages.

5.5. Proposed System:

Proposed system is a multilingual AI based farming assistant that helps farmers by suggesting crops and fertilizers.

Proposed system also offers following additional services related to agriculture:

- Weather forecasting AI chatbot
- Irrigation advice
- Pest control information
- Location-based services
- Buyers' advice
- E-Cart for agricultural goods

System works in English, Kannada, Hindi, Tamil and Telugu languages.

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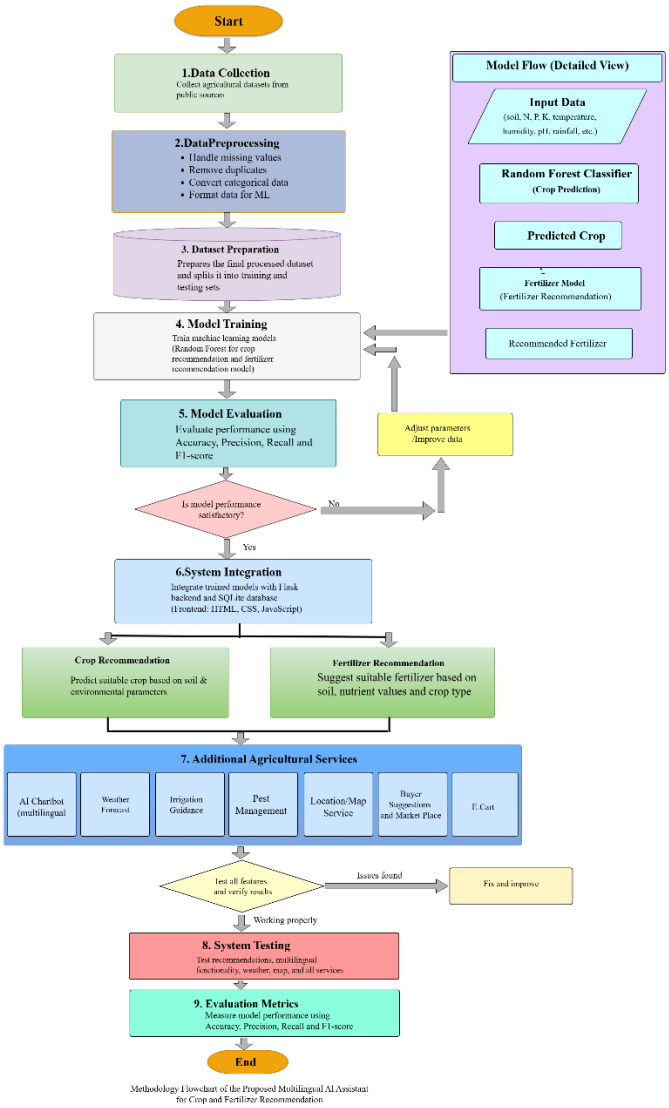


Figure:5.5.1 Architecture of Proposed System

5.5. Experimental Setup:

The datasets are first pre-processed and ready to be used for machine learning. The crop recommendation model is built by using the pre-processed dataset. The fertilizer recommendation model is trained by using appropriate agricultural parameters. Once training is complete the model, they are deployed into the Flask backend of the application. The front end is used as the medium from allowing farmers to provide their agricultural values and get recommendations from the application. The testing process is done by using various combinations of input values to confirm that the suggestions of crops and fertilizers generated by the system are appropriate.

6.RESULT AND DISCUSSION:

The result of this system is ,using the Weather and Soil nutrients it will predict the crop and using soil and crop it will predict the Fertilizer. And in addion it will suggest the nearby Buyers and Market place and and also include E-Cart.

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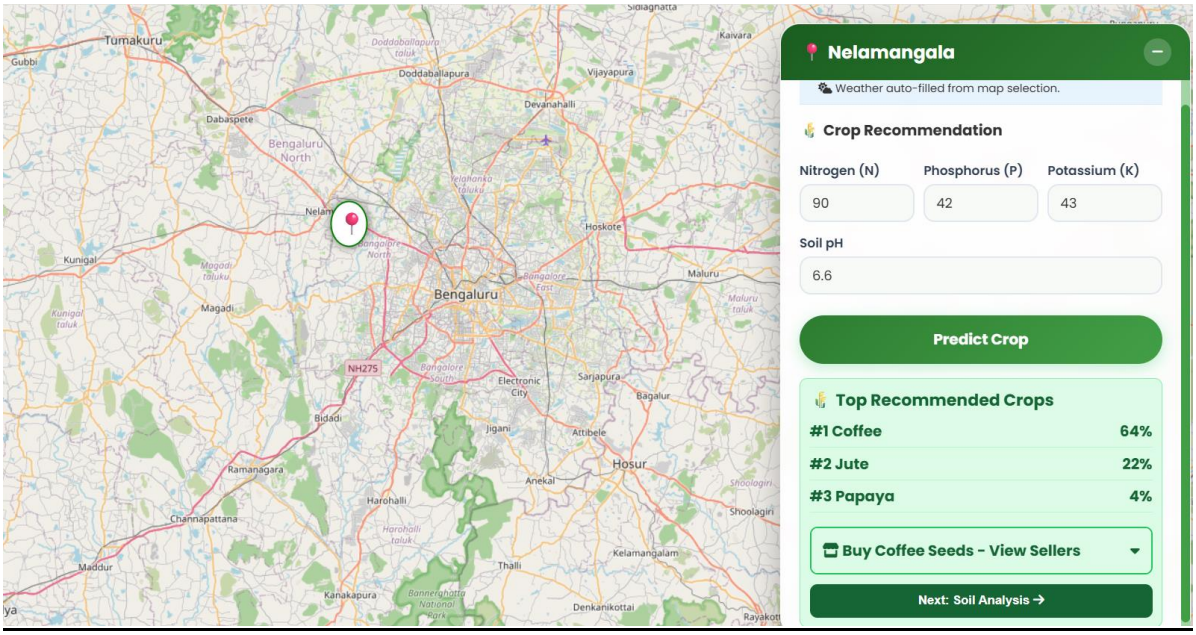


Figure6.1: Result of Crop Recommendation.

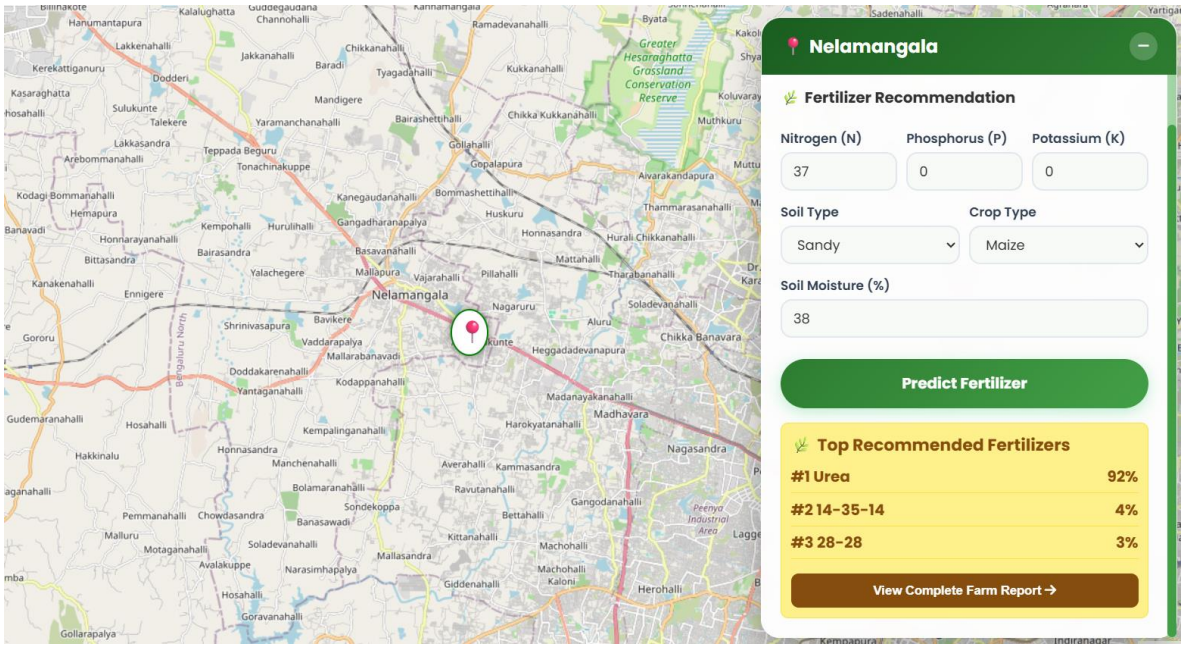


Figure6.2: Result of Fertilizer Recommendation.

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International Journal of Engineering Research & Technology (IJERT)
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Vol. 14, Issue 11, CONFLUENCE - 2026

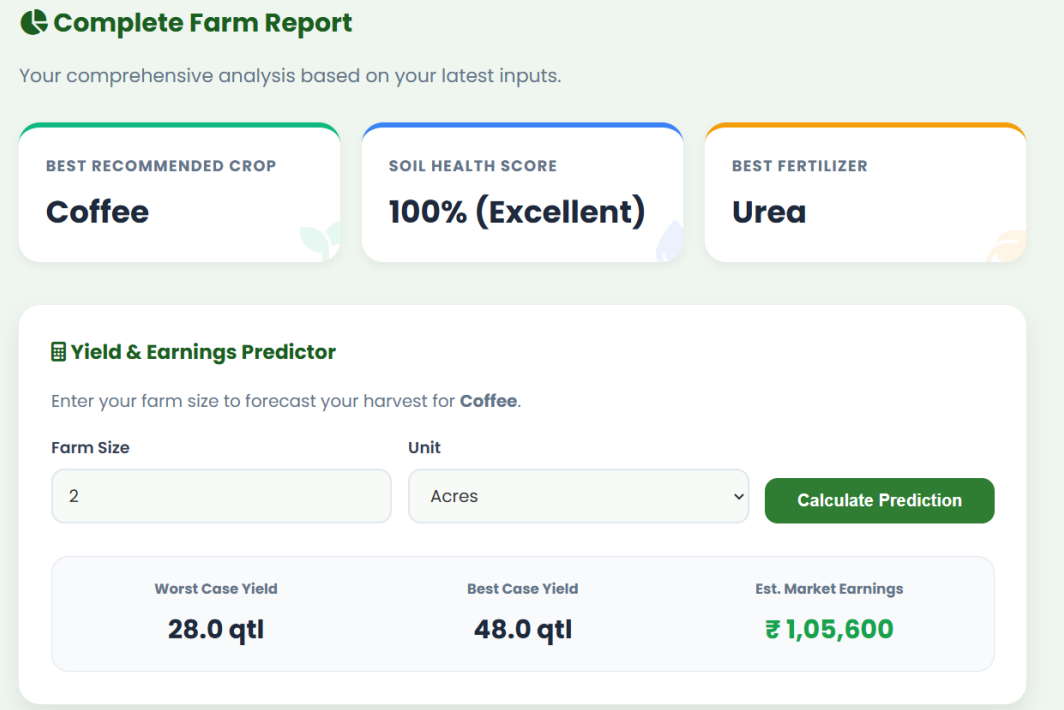


Figure6.3 Result of Complete Farm Report.

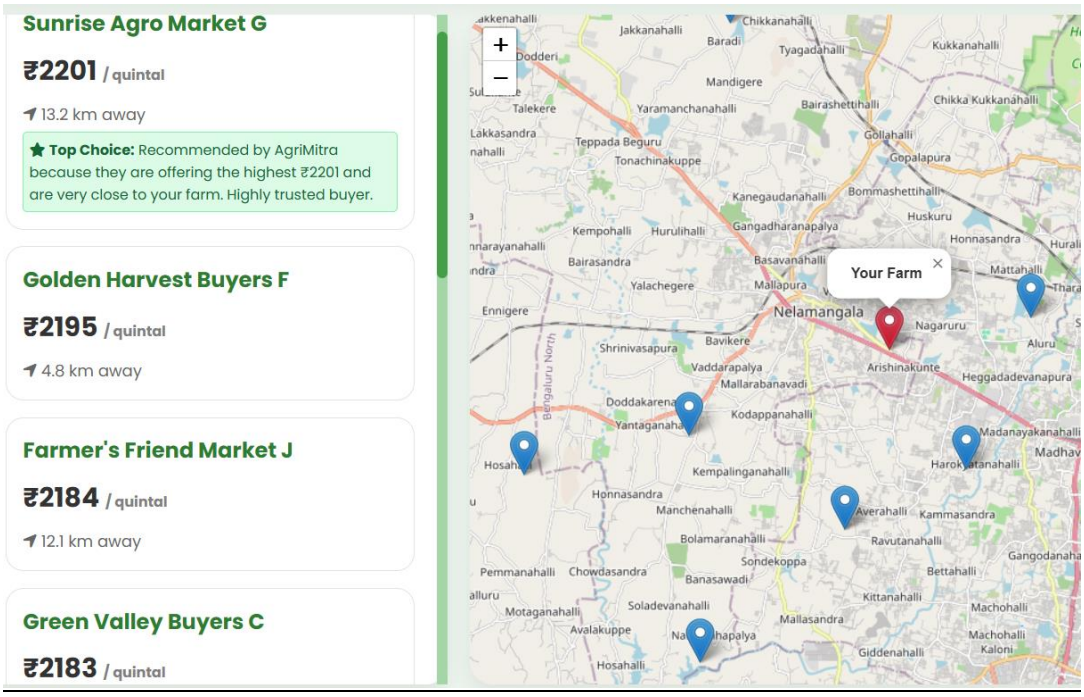


Figure6.4: Result of Market Place.

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Vol. 14, Issue 11, CONFLUENCE - 2026

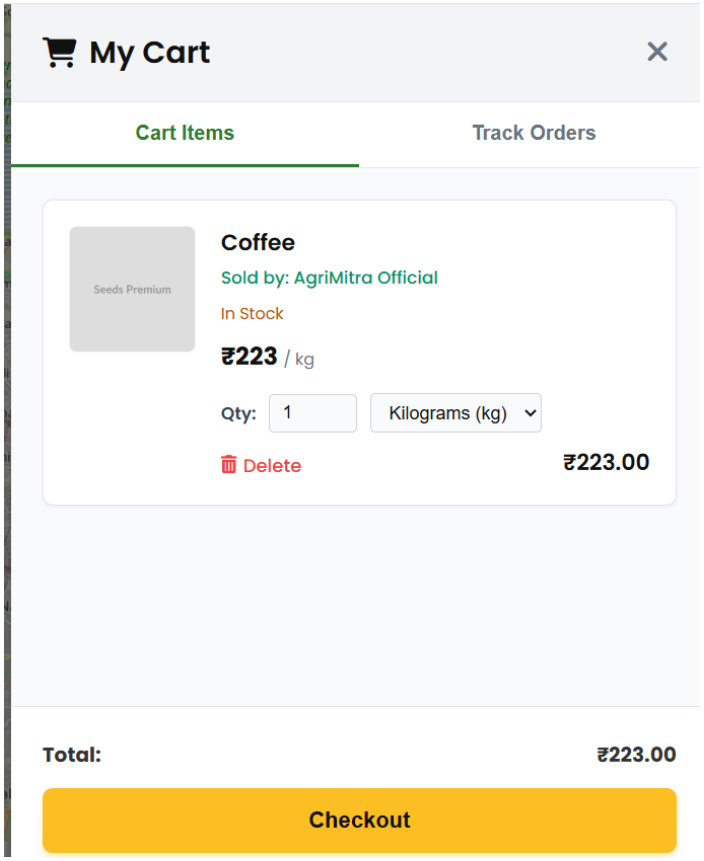


Figure6.5: Result of E-cart.

The above figures shows the some of the example result for Crop and Fertilizer Suggestion, along with nearby Buyers,Market Place and E-cart. Also it includes AI-chatbot,Multilingual Assistant.

6.1 Comparative analysis of existing systems:

Ref.	Crop Recommendation	Fertilizer Recommendation on	ML/AI	Multilingual Chatbot	Weather/ Climate	Other Farmer services
[12]	✓	✓	✓	X	Limited	X
[13]	✓	✓	✓	X	✓	Limited
[11]	✓	✓	✓	X	Limited	Economic factors
[10]	✓	X	✓	X	✓	X
[9]	✓	X	✓	X	✓	X
[8]	X	✓	✓	X	✓	X

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[7]	✗	✓	✓	✗	✓	✗
[6]	✓	Limited	✓	✗	✓	IoT-related
[5]	✗	✗	✓	✓	Limited	Agricultural nformation
[3]	✓	✓	✓	✗	✓	Explainability
[4]	✓	✓	✓	✗	Limited	Yield prediction
[1]	✓	✗	✓	✗	✓	Explainability
[2]	Limited	Limited	✓	✓	Limited	Shared economy
Proposed System	✓	✓	✓	✓	✓	✓

Table 6.1.1: Comparative Analysis

6.2 Performance Measurement:

The performance of the machine learning models is measured using the following metrics:
Accuracy:(Crop:99.2%&Fertilizer:98.5%)
Precision:(Crop:98.8&Fertilizer:97.9%)
Recall:(98.1%)
F1-Score:(99.0%)
The entire system is also tested for recommendation accuracy, multilingual support, weather fetch, and performance.

7. FUTURE ENHANCEMENT:

In the future, the suggested system can be developed through the incorporation of a more robust agricultural dataset consisting of information regarding agriculture in different locations, having various soil types, suitable crops, and climatic conditions. Another improvement includes implementing other machine learning algorithms and comparing them with the existing Random Forest algorithm to find out the optimal algorithm for making crop and fertilizer recommendations. Moreover, the system can be developed into a mobile application that allow farmers to access agricultural services in an easier and more convenient manner. Using data from IoT-based soil sensors, weather stations, and other agricultural tools will ensure up-to-date information and accurate recommendations. Model testing on different agricultural areas and organizations will help to understand the efficiency of the system in different environments. Also, Explainable Artificial Intelligence (XAI) can be used in order to give understandable explanation behind the crop and fertilizer recommendations.

8.CONCLUSION:

From the literature review, it is evident that AI and ML can be helpful in agricultural decision making. Earlier researchers have effieciently used machine learning methods in crop recommendations, fertilizer suggestions, prediction of crop output, and

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Vol. 14, Issue 11, CONFLUENCE - 2026

agricultural information system. Methods such as random forest, XGBoost, deep learning algorithms, and explainable AI have performed very well in the field of agricultural prediction.

On the other hand, multilingual agricultural chatbots have proved their capability of making agricultural information easily available to farmers. Nevertheless, from the reviewed literature, this suggests that prediction systems and multilingual agricultural assistants are normally designed separately.

The suggested Multilingual AI Assistant for Crop and Fertilizer Suggestions is an attempt to address this gap by applying machine learning for crop and fertilizer suggestions as well as multilingual AI interaction, weather information, agricultural guidance, e-commerce, buyers' recommendation, and location-based service.

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