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An Integrated Mobile Application for Agricultural Schemes, Weather Forecasting, and Fertilizer Prediction

Kanishka S [1], Madhumitha R [2], Mr. Prabhu M.Sc. (Agri) [3].,

[1,2]*Department of Agricultural Engineering, Rathinam Technical Campus, Coimbatore, Tamil Nadu, India*

[3] *Assistant Professor Department of Agricultural Engineering, Rathinam Technical Campus, Coimbatore, Tamil Nadu, India*

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Abstract - The growing demand for technology-driven farming has prompted the development of intelligent digital platforms to support farmers in effective decision-making. This paper presents an integrated web-based Smart Agriculture Assistance Application that combines agricultural scheme information, weather forecasting, and soil-based fertilizer recommendations into a unified digital platform. The system provides comprehensive details about central and state government agricultural schemes, including eligibility criteria, benefits, and application procedures, enabling farmers to make informed financial and developmental decisions. The weather forecasting module retrieves historical climate data and generates accurate five-day predictions using a trusted meteorological API. A key feature is the Fertilizer Recommendation Module, which employs the Decision Tree algorithm to analyze soil nutrient content—Nitrogen, Phosphorus, and Potassium—and recommends the most suitable fertilizer type and optimal application quantity. The application is developed using HTML, CSS, JavaScript for the frontend and Python-Flask for the backend, offering a practical and accessible decision-support tool aimed at enhancing agricultural productivity and sustainability.

Key Words: *Smart Agriculture, Fertilizer Recommendation, Decision Tree Algorithm, Weather Forecasting, Government Schemes, Flask, Machine Learning.*

1.INTRODUCTION

Agriculture remains the backbone of many economies worldwide, providing food security, employment, and raw materials for various industries. Traditional farming methods often rely heavily on manual experience and intuition, resulting in inefficiencies, low productivity, and economic losses. With rapid technological advancement, intelligent digital solutions can assist farmers in making timely and accurate decisions, bridging the gap between modern tools and agricultural knowledge.

A critical challenge facing farmers today is accessing accurate information regarding government schemes and subsidies. Many farming households remain unaware of beneficial programs due to limited outreach or complex application procedures. The proposed system addresses this by delivering a centralized platform with complete details on state and central government agricultural schemes, empowering farmers with guidance on eligibility, benefits, and application steps.

Weather unpredictability directly impacts crop growth, irrigation schedules, and harvesting activities. The system incorporates a weather forecasting module that analyzes historical data and generates accurate short-term forecasts, enabling proactive planning and reduced crop damage. Furthermore, the Fertilizer Recommendation Module applies machine learning to analyze soil nutrient content, recommending the most suitable fertilizer type and precise quantity required, thereby enhancing productivity while reducing chemical overuse.

1.1 Objectives of the Project

The primary objective of this application is to provide farmers with a comprehensive digital platform that simplifies decision-making in agricultural practices. Key objectives include:

• Enhancing farmer awareness about central and state government agricultural schemes, financial support, and subsidies.

• Delivering accurate short-term weather forecasts to support strategic planning for sowing, irrigation, and harvesting.

• Providing soil nutrient-based fertilizer recommendations using machine learning to optimize crop yield and reduce chemical waste.

• Creating an integrated, user-friendly platform accessible to farmers with basic technical knowledge.

1.2 Scope of the Project

The Smart Agriculture Assistance Application is designed to serve farmers, agricultural planners, and related stakeholders across diverse regions. It provides a centralized platform for accessing government scheme information, weather-based activity planning, and intelligent fertilizer recommendations. The application can be extended to integrate additional smart agriculture technologies such as IoT-based monitoring, pest detection, and automated irrigation systems, positioning it as a scalable foundation for future digital farming initiatives.

2. LITERATURE REVIEW

Wolfert et al. (2017) explored big data analytics in smart agriculture, demonstrating how datasets from sensors, drones, satellites, and farm equipment can generate actionable insights for crop management, weather planning, and pest control. Their findings underscore the central role of data-driven technologies in modern farming efficiency.

Kumar and Singh (2019) proposed a mobile-based agricultural advisory system that delivers real-time updates on weather forecasts, crop diseases, pest control, and government schemes to farmers. Their work highlights how digital platforms can bridge the information gap between agricultural experts and rural farming communities.

Li et al. (2020) developed a precision agriculture system integrating IoT sensors with machine learning to monitor soil conditions and recommend irrigation and fertilizer schedules. Predictive analytics significantly improved crop yield while minimizing water and chemical resource wastage in their experimental findings.

Talaviya et al. (2020) demonstrated an IoT-based smart farming system using environmental sensors to monitor soil moisture, temperature, and humidity. Real-time data transmission enabled automated irrigation, reducing water consumption and supporting remote crop health monitoring.

Sharma et al. (2021) applied Decision Tree and Random Forest algorithms for predicting soil nutrient requirements, achieving accurate fertilizer recommendations that prevented soil degradation. Their study validates machine learning as an effective approach for soil nutrient management and sustainable fertilizer application.

Patel et al. (2022) developed a weather prediction module specifically for agricultural applications using historical climate data and predictive analytics. Accurate five-day forecasts enabled farmers to reduce crop losses caused by unexpected weather events and schedule critical farm activities more effectively.

Rehman et al. (2022) conducted a comprehensive review of artificial intelligence applications in agriculture, covering crop monitoring, yield prediction, and pest detection. AI-powered analysis of satellite imagery and sensor data was found to significantly improve resource efficiency and agricultural decision-making.

Collectively, this body of literature validates the integration of IoT, AI, machine learning, and data analytics as transformative approaches in modern agriculture—directly informing the design and objectives of the proposed Smart Agriculture Assistance Application.

3. METHODOLOGY

The Smart Agriculture Assistance Application is developed using a combination of frontend and backend technologies to deliver an integrated platform for farmers. The frontend employs HTML, CSS, and JavaScript for a responsive, interactive interface, while Python with the Flask framework handles backend processing and API integration. The system architecture comprises six interconnected modules, each addressing a distinct agricultural decision-support need.

3.1 User Input Module

This module collects essential information from the farmer, including soil nutrient levels (Nitrogen, Phosphorus, Potassium), geographic location, and crop type. The interface is designed to be simple and accessible for users with limited technical experience, with validation checks to ensure data accuracy before processing.

3.2 Government Schemes Module

This module retrieves and displays comprehensive information about central and state government agricultural schemes. It presents eligibility criteria, financial benefits, and step-by-step application procedures, enabling farmers to make informed decisions about available financial and developmental resources.

3.3 Weather Forecasting Module

Historical weather data for the preceding two years is retrieved using the OpenWeatherMap meteorological API, and an accurate five-day forecast is generated. By analyzing past climate trends alongside upcoming conditions, farmers can strategically plan sowing, irrigation, fertilization, and harvesting activities while minimizing weather-related crop risks.

3.4 Fertilizer Recommendation Module

The Fertilizer Recommendation Module uses the Decision Tree algorithm to analyze soil nutrient content and recommend the most suitable fertilizer type and application quantity. This prevents nutrient overuse and deficiency, maintains soil fertility, reduces cultivation costs, and promotes sustainable farming practices. The model is trained on historical soil and fertilizer datasets and deployed via a serialized pickle model within the Flask backend.

3.5 Decision Support Module

This module integrates outputs from the government schemes, weather forecasting, and fertilizer recommendation modules to generate holistic, personalized recommendations. Serving as the core intelligence of the system, it ensures all guidance is contextualized to the farmer's specific inputs and local agricultural conditions.

3.6 Output Module

The output module presents all recommendations and data in a clear, structured format through the application dashboard. Government scheme details, weather forecasts, and fertilizer suggestions are displayed with visual clarity, supporting actionable decision-making for real-world agricultural operations.

4. MATERIALS AND METHODS

4.1 System Specification

Table 1: System Specification

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Component	Specification
Processor	Intel Core i7 5th Gen
RAM	12 GB
Storage	500 GB HDD
GPU	NVIDIA GeForce GTX 1650
Operating System	Windows 10 (64-bit)
Frontend	HTML, CSS, Bootstrap, JavaScript
Backend	Python 3.x, Flask Framework
ML Algorithm	Decision Tree (scikit-learn)
Weather API	OpenWeatherMap API

Table 1: System Specification

4.2 Technology Stack

Python serves as the primary backend language, selected for its extensive machine learning ecosystem, interpretability, and open-source availability. Flask provides a lightweight and modular web framework, enabling efficient routing, API integration, and template rendering via Jinja2. The frontend employs HTML5, CSS3, Bootstrap 5, and JavaScript to deliver a responsive and visually accessible interface. The Decision Tree classifier from scikit-learn is trained on historical soil-fertilizer datasets and serialized using Python's pickle module for production deployment.

5. RESULTS AND DISCUSSION

The Smart Agriculture Assistance Application was developed and tested across multiple functional areas. The following screenshots illustrate the key interface modules implemented in the system.

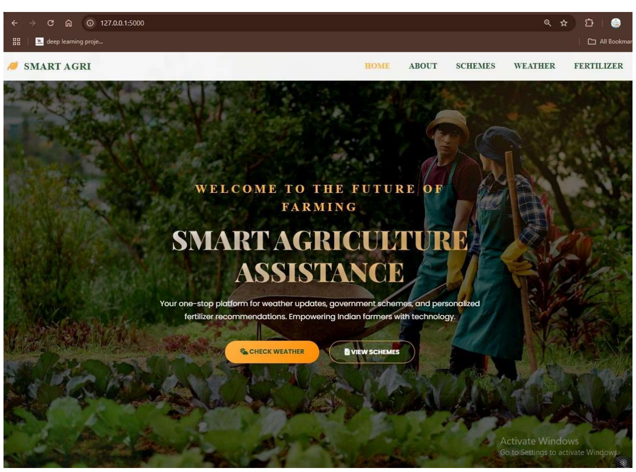

Fig. 1: Home Page – Main landing interface of the Smart Agriculture Assistance Application

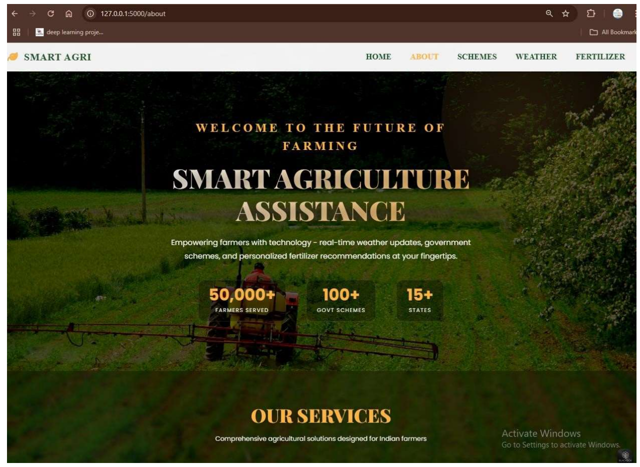

Fig. 2: About Page – Overview of the application purpose and features

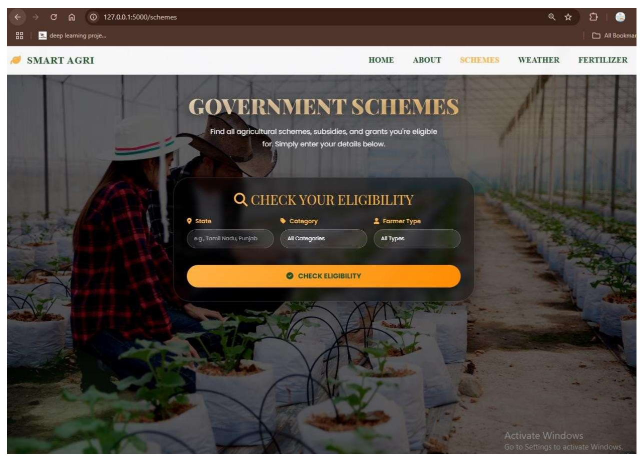

Fig. 3: Schemes Page – Government agricultural scheme search interface

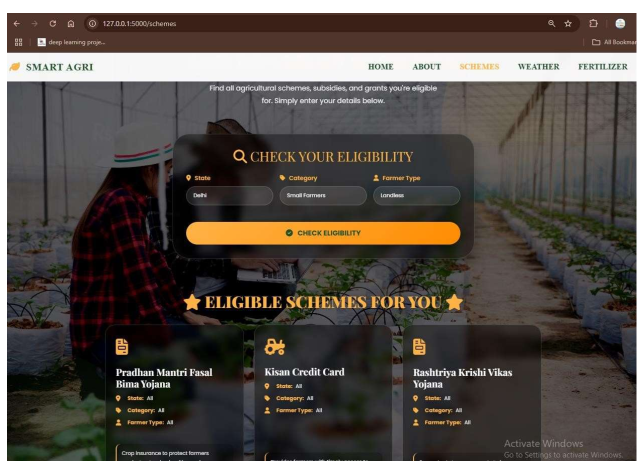

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Fig. 4: Schemes Result Page – Filtered scheme details including eligibility and benefits

Fig. 5: Weather Page – Location-based weather query interface

Fig. 6: Weather Result & Forecast Page – Current conditions and five-day predictions

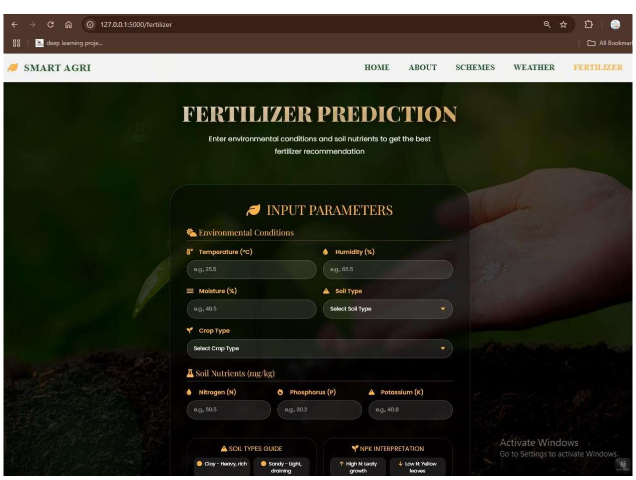

Fig. 7: Fertilizer Recommendation Page – Soil nutrient input and prediction interface

5.1 System Testing

Comprehensive system testing was conducted across seven testing dimensions to verify reliability and usability prior to deployment. Functional testing confirmed that all modules—user input, schemes retrieval, weather API integration, and fertilizer prediction—generated correct outputs for valid inputs. Performance testing validated acceptable page load times and system responsiveness under concurrent user conditions.

Security testing identified and resolved vulnerabilities related to input validation and data handling. Integration testing confirmed seamless communication between the frontend interface, Flask backend, external weather API, and the serialized Decision Tree model. Usability testing with representative farmers confirmed that the interface was intuitive and accessible without advanced technical knowledge. Compatibility testing verified consistent performance across Chrome, Firefox, and Edge browsers on desktop and mobile devices.

User acceptance testing conducted with agricultural stakeholders confirmed that the application met practical farming needs, with positive feedback regarding scheme discovery, weather planning, and fertilizer guidance features.

5.2 System Implementation

All modules were developed iteratively and subsequently integrated into a cohesive Flask application. Frontend templates utilize Jinja2 for dynamic data rendering, while RESTful routes handle user requests and return processed recommendations. The fertilizer prediction model was trained offline on a labeled soil-fertilizer dataset and integrated via pickle deserialization into the prediction endpoint. Weather data is retrieved in real-time through parameterized API calls to OpenWeatherMap, with both current conditions and five-day forecasts displayed in structured output templates.

6. CONCLUSION

The Smart Agriculture Assistance Application provides an effective technological solution to support modern farming practices by integrating weather forecasting, fertilizer recommendation, and agricultural scheme information into a single accessible platform. The system enables farmers to make scientifically informed decisions based on real-time data and machine learning analysis, reducing reliance on fragmented information sources and manual judgment.

The Decision Tree-based Fertilizer Recommendation Module demonstrated practical effectiveness in recommending appropriate fertilizer types and quantities, promoting soil health and reducing chemical overuse. Weather forecasting capabilities equipped farmers with the planning information needed to schedule critical agricultural activities effectively. The government schemes module improved farmer awareness of financial support programs.

Future enhancements will include mobile application development for improved rural accessibility, IoT sensor integration for real-time soil monitoring, deep learning-based crop disease detection using image processing, multilingual support, and AI chatbot assistance for 24/7 farming advisory services. These enhancements will further strengthen the system as a comprehensive digital companion for sustainable and productive agriculture.

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BIOGRAPHIES

Kanishka S
B. Tech Agricultural Engineering,
Rathinam Technical Campus,
Coimbatore, Tamil Nadu, India.

Madhumitha R
B. Tech Agricultural Engineering,
Rathinam Technical Campus,
Coimbatore, Tamil Nadu, India.