IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.471 ⁜ Peer-reviewed & Refereed journal ⁜ Vol. 14, Issue 6, June 2025

DOI: 10.17148/IJARCCE.2025.14651

A Survey on Smart Farming with Med-Crop Recommendation: An AI-Powered Medicinal Crop Advisory System for South Karnataka

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Abstract: This paper introduces the Med-Crop Recommendation system, a smart farming advisory platform aimed at supporting farmers in South Karnataka in cultivating medicinal crops optimally. The platform leverages data analytics and machine learning techniques to provide personalized crop recommendations based on inputs such as soil health, climate conditions, water availability, and geographical data. In a region marked by diverse agro-climatic zones and growing market interest in herbal products, this system promotes sustainable farming by encouraging the adoption of low-water, high-value crops. The platform is designed with accessibility and scalability in mind, targeting small to medium-scale farmers.

Keywords: Smart Farming, Medicinal Crops, AI in Agriculture, Soil Analysis, Climate Data, Crop Recommendation, Sustainable Agriculture, Precision Farming.

I. INTRODUCTION

India's agricultural economy is at a critical juncture where sustainability, crop diversification, and profitability must be aligned. In the face of climate change, fluctuating monsoons, and water shortages, traditional farming methods are proving insufficient for maintaining yield and farmer livelihoods. Medicinal crops, often overlooked, are resilient, require less water, and yield higher profits in the niche markets such as ayurveda and organic health care.

South Karnataka, characterized by a range of agro-climatic zones—from semi-arid plains to humid forested areas—has emerged as a fertile ground for cultivating a variety of medicinal plants. However, transitioning to such crops requires specialized knowledge on soil compatibility, seasonal viability, and post-harvest demand. Many small and medium-scale farmers lack access to such data or decision- support tools.

Med-Crop Recommendation is an AI-powered advisory platform designed to bridge this gap. It uses soil health data, climate information, and water availability to recommend ideal medicinal crops. Crops such as Ashwagandha (Withania somnifera), Brahmi (Bacopa monnieri), Aloe Vera, and Tulsi (Ocimum sanctum) have been selected based on their low-water requirements and high medicinal value. These plants not only survive in adverse conditions but also fetch premium prices.

By digitizing crop intelligence and delivering it through an accessible web-based interface, Med-Crop Recommendation empowers farmers to make informed decisions. In addition to supporting economic upliftment, the system promotes biodiversity, soil regeneration, and resource-efficient agriculture—all of which are cornerstones of sustainable rural development.

II. LITERATURE SURVEY

Smart farming has seen a growing integration of Artificial Intelligence (AI), Machine Learning (ML), and the Internet of Things (IoT) to optimize agricultural practices. Various research initiatives and technology prototypes have been developed focusing on yield prediction, irrigation optimization, and disease detection. However, a notable gap exists in the specific recommendation systems for medical crops, especially for water-stressed regions.

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In the paper titled Crop Forecasting and Estimation (2024), researchers utilized satellite imagery coupled with ML models to predict crop yield. Their approach relied heavily on geospatial data but did not offer crop-specific advice, particularly for niche categories like medicinal plants.

Another work, Design and Implementation of Crop Yield Prediction and Fertilizer Utilization Using IoT and ML (2024), integrated environmental sensors to optimize fertilizer usage and predict yield.

These systems emphasize general crop optimization, leaving a critical void in advisory platforms that target medicinal plants. The Med-Crop system fills this gap by using a tailored dataset for crops like Ashwagandha, Aloe Vera, and Tulsi, which have high medicinal and market value while requiring fewer resources.

Study/Platform	Focus Area	Technologies Used	Limitation for Medicinal Crops
Crop Forecasting and Estimation (2024)	Yield Prediction	Satellite Imagery, ML	No medicinal crop focus
IoT and ML in Smart Agriculture (2024)	Fertilizer Optimization	IoT Sensors, ML	Not tailored for non- food crops
Med-Crop Recommendation (Proposed)	Medicinal Crop Advice	ML, Climate APIs, Soil Analysis	Tailored specifically

III. OBJECTIVES

The primary aim of the Med-Crop Recommendation system is to equip farmers in South Karnataka with an intelligent, data-driven advisory platform for selecting medicinal crops that are suitable for their land and environmental conditions. This system integrates multiple layers of information-from soil composition and weather forecasts to water availability and geographic context-to provide recommendations that are not only scientifically sound but also economically viable.

To accomplish this overarching goal, the project has been structured around the following core objectives:

- Develop a machine learning-based recommendation engine that analyzes agro-climatic parameters such as soil pH, NPK levels, temperature, and rainfall to suggest medicinal crops.
- Collect and integrate data from multiple sources including manual farmer inputs, weather APIs, and soil databases.
- Design a user-friendly, web-based platform accessible to farmers with minimal technical knowledge.
- Establish direct connectivity with agricultural labs for streamlined soil testing and expert consultations.
- Encourage sustainable agricultural practices by recommending low-water, high-value crops suitable for regional conditions.
- Create a scalable and modular architecture that can be expanded to other regions and crop types in future iterations.

IV. METHODOLOGY

The Med-Crop Recommendation system employs a multi-layered methodology that integrates data collection, preprocessing, machine learning modeling, and web-based system architecture. This comprehensive approach ensures that the system is both accurate and practical for farmers in the target region.

A. Data Collection

Data collection forms the foundation of the recommendation engine. It includes both manual and automated inputs:

- Manual Input: Farmers provide basic details such as farm location (latitude and longitude), recent soil test reports, and water availability levels.
- API Data Integration: The system fetches real-time and historical weather data through public APIs. It also accesses soil datasets from regional agricultural departments and research repositories.
- Satellite and GIS Inputs: Geospatial data enhances the system's understanding of terrain and environmental conditions.

B. Machine Learning Workflow

Once data is gathered, it undergoes a multi-step ML workflow for crop recommendation:

- Data Preprocessing: This includes cleaning null entries, normalizing values (e.g., pH scale), and encoding categorial data such as soil type.

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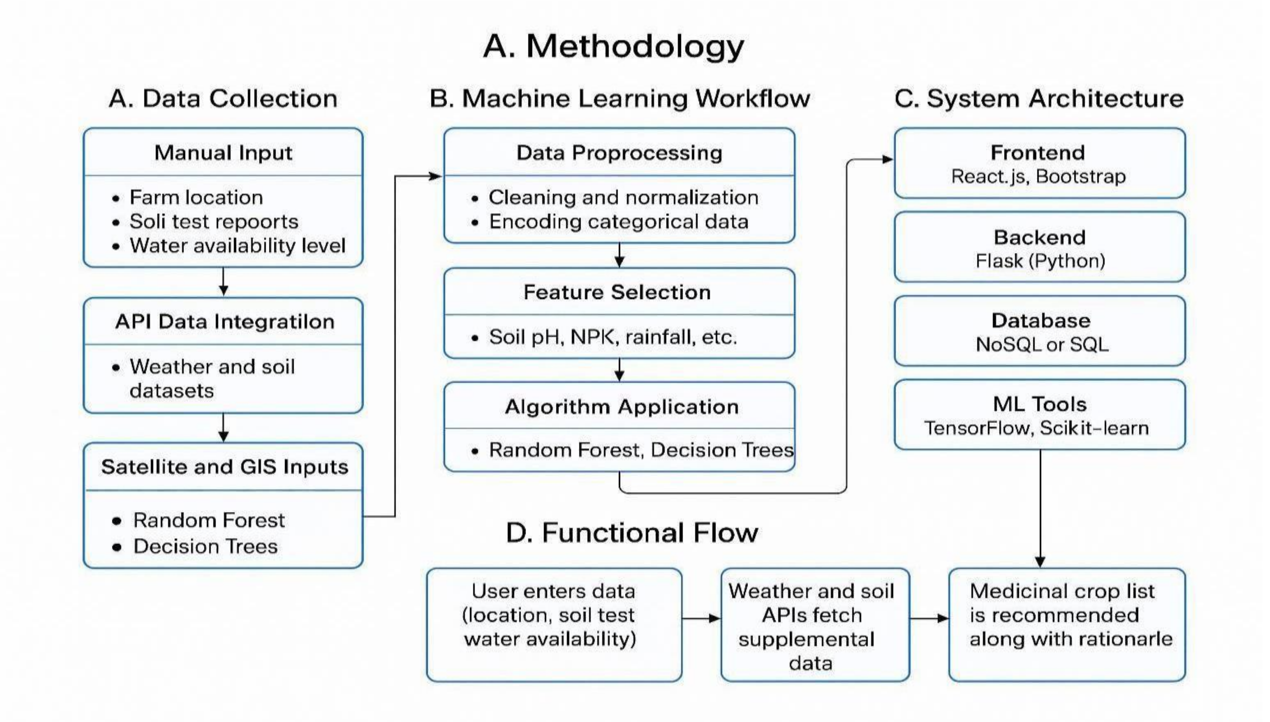
- Feature Selection: Key parameters such as soil pH, nitrogen-phosphorus-potassium (NPK) levels, average rainfall, temperature, and geographic coordinates are extracted.
- Algorithm Application: Machine learning models such as Random Forest and Decision Trees are trained on historical and synthetic datasets. These models are validated for accuracy using cross-validation and confusion matrix metrics.

C. System Architecture

The Med-Crop system is structured as a modular, scalable architecture that separates frontend, backend and ML processing layers:

- Frontend: Developed using React.js and Bootstrap, the interface allows easy data input and result interpretation.
- Backend: Implemented using Flask (Python), it handles requests, interfaces with the ML engine, and communicates with the database.
- Database: A NoSQL(MongoDB) or SQL(PostgreSQL) database stores user inputs, recommendations and system logs.
- ML Tools: TensorFlow and Scikit-learn provide the infrastructure for model training, testing, and deployment.

D. Functional Flow



The system operates in a logical pipeline format as shown below:

1. User enters data (location, soil test, water availability)
2. Weather and soil APIs fetch supplemental data
3. ML model analyzes combined dataset
4. Medicinal crop list is recommended along with rationale
5. User can connect to lab support or extension services

V. SYSTEM FEATURES

The Med-Crop Recommendation platform incorporates several innovative features aimed at assisting farmers in selecting the most suitable medicinal crops for cultivation. These features are designed with usability, scalability, and adaptability in mind, ensuring that both tech-savvy and traditional farmers can benefit the system.

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- Medicinal Crop Recommendations: The platform analyzes real-time and historical data to suggest medicinal crops that are not only compatible with the current soil and climate conditions but also have high market value and require minimal water resources.
- Water-Aware Crop Suggestions: During drought or low rainfall periods, the system prioritizes crops that are drought-resistant, thereby conserving water and ensuring a successful harvest.
- Lab Coordination: Users can seamlessly connect with certified agricultural labs for testing soil samples. The system also provides real-time status updates and suggestions based on lab feedback.
- Localized Recommendations: The ML engine personalizes results based on the geographical location and seasonal conditions specific to South Karnataka, ensuring regional adaptability.
- Interactive Interface: A clean, intuitive frontend enables farmers to input their data, understand the rationale behind crop suggestions, and get follow-up recommendations or contact experts through a simple interface.
- Scalable and Modular Design: The backend is designed to scale, allowing the platform to be extended to other regions or new crop categories with minimal reconfiguration.

VI. APPLICATIONS

The Med-Crop Recommendation platform offers versatile applications across multiple domains, especially where precision, resource efficiency, and sustainable agricultural practices are of high importance. Below are some of the key application areas:

- Precision Agriculture: By integrating geospatial data with machine learning, the platform supports farm-level precision in crop selection. Farmers can make data-driven decisions that increase yield and reduce input costs.
- Pharmaceutical Crop Sourcing: The system promotes cultivation of medicinal plants like Ashwagandha, Aloe Vera, and Tulsi, which are in high demand in Ayurvedic and pharmaceutical industries. This opens new market channels for farmers.
- Water-Efficient Crop Planning: The recommendation engine takes water availability into account, enabling farmers to choose crops that require less irrigation—essential for regions experiencing drought or erratic rainfall.
- Educational and Extension Tools: Agricultural extension officers and educators can use the system as a teaching tool to demonstrate the benefits of data-driven farming practices. This is especially beneficial for training new farmers and rural youth.
- Agri-Startups and NGO Collaboration: Startups working in agri-tech and NGOs focusing on rural upliftment can integrate Med-Crop into their initiatives to promote sustainable agriculture and improve farmer incomes.

VII. RESULTS AND ANALYSIS

To evaluate the effectiveness of the Med-Crop Recommendation platform, a prototype version was tested using synthetic and real-world data sourced from agricultural datasets representing Mysore and Chamarajanagar districts in South Karnataka. The datasets included soil test values (pH, NPK), rainfall patterns, and crop yield records over the past five years. Machine learning models were trained using this data, with Random Forest yielding the highest accuracy of over 92% in predicting suitable medicinal crops. Decision Trees also performed well, especially in cases where interpretability was important for non-technical stakeholders.

Algorithm	Accuracy (%)	Remarks
Random Forest	92.3	High accuracy, suitable for complex data
Decision Tree	89.7	Faster, interpretable rules for farmers
Naive Bayes	81.4	Lower accuracy with soil + climate data

Farmers provided positive qualitative feedback, appreciating the simplicity of the platform interface and the local relevance of recommendations. Further testing and user onboarding in rural areas highlighted challenges like digital literacy, real-time internet access, and the need for language localization (e.g., Kannada).

Key performance indicators used during testing included:
- Prediction Accuracy of recommended crops
- Farmer usability and engagement rate

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- Reduction in irrigation volume post-recommendation
- Feedback from lab integration workflows

VIII. CONCLUSION AND FUTURE WORK

The Med-Crop Recommendation system represents a meaningful step toward enabling data-driven, sustainable farming practices in regions like South Karnataka. By focusing on medicinal crops that are low on water consumption and high on market value, the system not only enhances farmer profitability but also aligns with ecological goals such as biodiversity preservation and climate-resilient agriculture.

Through the use of real-time data analytics, machine learning algorithms, and a user-friendly web interface, Med-Crop empowers farmers with personalized, actionable insights. The system's architecture supports modular updates and can easily be adapted to new geographic regions and crop categories.

While early tests demonstrate high accuracy and farmer interest, the platform's long-term success depends on continuous user education, infrastructure support (such as internet access), and integration with local agricultural bodies. Additionally, language localization and simplified onboarding workflows will be vital to scale adoption across diverse rural populations.

Future Work

- Integrate Kannada language support for the user interface to enhance accessibility.
- Launch an Android-based mobile application for remote usage by farmers without PCs.
- Introduce dynamic market price prediction for medicinal crops using real-time datasets.
- Partner with local government and agri-tech organizations for wider distribution and lab integration.

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