Archives available at journals.mriindia.com

International Journal on Advanced Computer Engineering and Communication Technology

ISSN: 2278-5140
Volume 14 Issue 01, 2025

Agri-Weather Smartcrop Management

Prof. Shivani Ambulkar[1], Mr. Shantanu Kholkute[2], Mr. Vaibhav Gaidhane[3], Mr. Udyan Deshmukh[4], Mr. Ayush khadgi[5]

[1]Assistant Professor Suryodaya College of Engineering and Technology/ Computer Engineering, Nagpur, India
[2-3] Suryodaya college of engineering/Computer Engineering, Nagpur, India
[1]scetshivani1@gmail.com, [2]shantanukholkute@gmail.com, [3]vaibhavgaidhane7@gmail.com, [4]udyandeshmukh36@gmail.com, [5]ayushscet56@gmail.com

Peer Review Information

Submission: 05 Feb 2025
Revision: 17 Mar 2025
Acceptance: 18 April 2025

Keywords

Smart Crop Selection
Fertilizer Guidance
Crop Disease Diagnostics

Abstract

Agriculture is the backbone of many economies, and technological advancements can significantly enhance farmers' productivity and decision-making. This web-based platform is designed to assist farmers by providing intelligent insights into crop selection, soil health, plant disease detection, and weather forecasting. The platform utilizes advanced data analytics and machine learning algorithms to analyze soil and pH samples, helping farmers determine the most suitable crops based on soil composition and fertility. Additionally, the system conducts a detailed chemical analysis of the soil, measuring essential nutrient levels to recommend appropriate fertilizers and soil treatments. Furthermore, the platform incorporates a plant disease detection feature, where farmers can upload images of infected crops. Using deep learning techniques, the system identifies the disease and suggests possible treatments, thereby preventing crop loss and ensuring healthy yield. To enhance agricultural planning, the platform also provides real-time weather forecasting, allowing farmers to make informed decisions regarding irrigation, sowing, and harvesting schedules. By integrating multiple agricultural assistance tools into a single web-based system, this platform aims to empower farmers with precise, data-driven recommendations, ultimately leading to increased efficiency, reduced losses, and improved sustainability in farming practices.

INTRODUCTION

Agriculture has been the backbone of human civilization for centuries, providing sustenance, employment, and economic growth to millions of people worldwide. However, modern agricultural practices face numerous challenges, including unpredictable weather patterns, soil degradation, pest infestations, and the overuse or underuse of fertilizers. These challenges necessitate the adoption of advanced technological solutions that can enhance decision-making processes, improve crop yield, and ensure sustainable farming practices. One such innovative solution is Agri-Weather, a web-based platform designed to assist farmers in making informed agricultural decisions by leveraging modern data analytics, machine learning, and weather forecasting technologies.

The Agri-Weather platform is an intelligent agricultural advisory system that incorporates multiple critical features aimed at optimizing farming practices. It encompasses four core functionalities: soil analysis, crop analysis, disease detection, and fertilizer recommendations, all integrated with precise weather forecasting. By combining these features into a single digital platform, Agri-Weather empowers farmers with real-time insights that can significantly enhance productivity and reduce risks associated with uncertain environmental conditions.

One of the primary components of Agri-Weather is *soil analysis*, which evaluates the chemical composition of the soil based on user-input data. Farmers can enter soil parameters such as nitrogen, phosphorus, potassium, pH levels, and organic matter content, and the system provides recommendations on soil enhancement strategies. The platform suggests necessary soil amendments, including fertilizers, organic matter, and micronutrients, to optimize soil fertility and improve crop yields. This feature enables farmers to take precise actions to maintain soil health and enhance agricultural productivity.

Another critical aspect of Agri-Weather is *crop analysis and selection*. This functionality assists farmers in determining the most suitable crops for their land by analyzing soil conditions and historical weather data. By leveraging machine learning algorithms, the platform evaluates key parameters such as soil type, nutrient levels, rainfall, and temperature patterns. Based on this analysis, it recommends crops that are best suited for the given conditions, thereby increasing the chances of successful cultivation. This feature not only helps in maximizing yield but also ensures efficient resource utilization, reducing wastage of water, fertilizers, and other agricultural inputs.

Disease detection and management is another vital feature of Agri-Weather. Plant diseases can severely impact crop yield and quality, leading to economic losses and food shortages. To address this issue, Agri-Weather incorporates an advanced image processing and machine learning-based disease detection system. Farmers can upload images of diseased plants, and the platform analyzes these images to identify the type of disease affecting the crop. The system then provides detailed information about the disease, including its causes, symptoms, and potential treatments. Additionally, it offers scientifically validated recommendations on how to control and prevent the disease, including the use of organic or chemical treatments, crop rotation strategies, and integrated pest management techniques.

The *fertilizer recommendation system* of Agri-Weather is designed to optimize the application of fertilizers to enhance crop growth while minimizing environmental impact. By analyzing soil nutrient levels and crop requirements, the platform provides precise recommendations on the type and quantity of fertilizers needed. This ensures that crops receive the appropriate nutrients without excessive or insufficient fertilizer application, leading to improved crop health, better yields, and reduced soil degradation over time. The integration of fertilizer recommendations with soil analysis allows for a holistic approach to nutrient management, promoting sustainable agricultural practices.

To complement these agricultural features, Agri-Weather integrates *weather forecasting capabilities*, which play a crucial role in farm management. Weather conditions significantly impact farming activities such as sowing, irrigation, pest

control, and harvesting. The platform utilizes meteorological data and predictive models to provide accurate short-term and long-term weather forecasts. By offering insights into temperature variations, rainfall predictions, humidity levels, and extreme weather events, Agri-Weather enables farmers to plan their agricultural activities efficiently. This helps in mitigating risks associated with adverse weather conditions, reducing crop losses, and optimizing resource allocation.

AIM AND OBJECTIVES

The aim of the Agri-Weather project is to develop an intelligent web-based platform that empowers farmers with data-driven insights for smarter agricultural decision-making. This system integrates multiple functionalities, including soil analysis, crop analysis, disease detection, fertilizer recommendations, and weather forecasting, to enhance farming efficiency and sustainability. Through soil analysis, farmers can input soil chemical values to receive recommendations on necessary nutrients and suitable fertilizers, ensuring optimal soil health. The crop analysis module considers soil properties and rainfall data to suggest the most suitable crops for a given region, maximizing yield potential. The disease detection feature allows users to upload images of infected plants, enabling the system to diagnose diseases and provide effective treatment recommendations. Additionally, the fertilizer recommendation system suggests appropriate fertilizers based on soil deficiencies, while the weather forecasting component helps farmers plan their agricultural activities according to real-time climatic conditions. By integrating these features, Agri-Weather aims to revolutionize farming practices, reduce crop losses, improve productivity, and support sustainable agriculture through AI-driven insights.

LITERATURE SURVEY

Agriculture is the backbone of many economies, and advancements in technology have significantly improved farming practices. Traditional farming methods rely heavily on manual expertise, which may not always be accurate or efficient. With the rise of artificial intelligence and data-driven decision-making, modern agricultural systems now incorporate smart solutions to enhance productivity. Several studies highlight the importance of precision farming, which utilizes soil analysis, crop analysis, disease detection, and fertilizer recommendations to optimize yields.

Soil analysis is a crucial aspect of precision farming, as it helps determine the chemical composition of the soil, enabling farmers to make informed decisions about nutrient management. Studies have shown that AI-driven models can accurately predict soil health and recommend suitable fertilizers to improve soil fertility. Similarly, crop selection based on soil and climatic conditions has gained importance. Research indicates that integrating weather forecasting with crop recommendation systems significantly enhances yield predictability by considering parameters such as temperature, rainfall, and soil moisture levels.

Plant disease detection is another key area in agricultural technology. Conventional disease identification relies on visual inspection, which is time-consuming and prone to errors. Machine learning and deep learning techniques have demonstrated high accuracy in diagnosing plant diseases through image processing. Various studies propose convolutional neural networks (CNNs) for classifying plant diseases based on leaf images, providing farmers with instant diagnoses and treatment suggestions. Additionally, fertilizer recommendation systems have evolved to assist in soil nutrient management. Research suggests that AI-based decision-support systems can analyze soil chemical values and provide customized fertilizer recommendations, thereby reducing excessive or insufficient fertilizer use. The integration of these technologies into a unified web-based platform, such as the proposed Agri-Weather system, is a step forward in modernizing agriculture. By incorporating AI-driven soil analysis, crop suitability assessment, disease detection, and weather forecasting, farmers can make data-backed decisions that improve productivity and sustainability.

RELATED WORK

Several research and technological advancements have contributed to the development of web-based platforms like

Agri- Agricultural technology has seen significant advancements in recent years, leveraging artificial intelligence, machine learning, and data analytics to support precision farming. Several related works have explored similar domains to enhance agricultural productivity and efficiency. For instance, various soil analysis platforms utilize machine learning models to assess soil health based on chemical composition inputs. These models analyze parameters such as nitrogen, phosphorus, and potassium (NPK) levels, soil pH, and organic matter content to determine deficiencies and recommend appropriate fertilizers. Research studies have demonstrated the effectiveness of deep learning models in predicting soil fertility and optimizing fertilizer use, thereby improving crop yield while reducing environmental impact.

Similarly, crop recommendation systems have gained prominence by integrating climate data, historical yield statistics, and soil parameters to suggest the best-suited crops for a given region. Several studies have employed decision tree algorithms, support vector machines (SVMs), and deep neural networks to predict optimal crop choices based on past weather conditions, rainfall data, and soil health indicators. By utilizing predictive analytics, such systems help farmers make informed decisions, minimizing the risk of crop failure and maximizing productivity.

Plant disease detection is another critical area where computer vision and deep learning techniques have shown remarkable progress. Existing works in this domain leverage convolutional neural networks (CNNs) to analyze images of diseased crops and classify them based on known plant diseases. Datasets like Plant Village and AI-powered applications have contributed to the accuracy of plant disease identification. Some studies have developed smartphone-based applications where farmers can upload plant images, receive disease classifications, and obtain treatment recommendations, helping them take timely action.

Furthermore, weather forecasting integration in agriculture is widely explored to enhance decision-making. Many related works utilize satellite imagery, IoT sensors, and meteorological data to provide real-time weather predictions. Machine learning models such as recurrent neural networks (RNNs) and long short-term memory (LSTM) networks are frequently used to analyze weather patterns and forecast future climate conditions. These predictions assist in planning agricultural activities such as irrigation scheduling, sowing periods, and pest control measures.

Combining these technologies into a single web-based platform, such as Agri-Weather , presents an innovative and holistic approach to smart farming. By integrating soil analysis, crop recommendation, disease detection, and weather forecasting, such a platform can significantly enhance farming efficiency, reduce losses, and promote sustainable agricultural practices. Many recent studies highlight the necessity of unified systems that provide real-time, AI-driven insights for farmers, ensuring they receive actionable recommendations for better yield and resource management.

PROPOSED METHODOLOGY

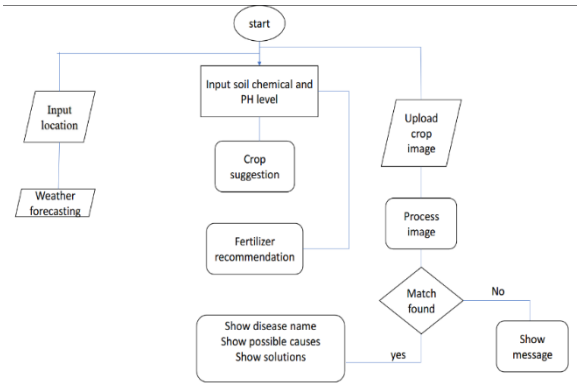

Fig 1.

The Agri-Weather project is structured around four key objectives: soil analysis, crop analysis, disease detection, and fertilizer recommendations, all integrated with weather forecasting to provide farmers with data-driven agricultural insights. The platform will be developed as a web-based application, leveraging machine learning models, remote sensing techniques, and real-time weather APIs to assist farmers in making informed decisions.

For disease detection, the platform will allow users to upload images of infected plant leaves. A deep learning-based image classification model, such as a Convolutional Neural Network (CNN), will be trained on a diverse dataset of plant diseases. The model

will analyze the uploaded image, identify the type of disease affecting the plant, and provide detailed information about its causes, symptoms, and severity. Additionally, the system will offer scientifically-backed recommendations for disease control, including organic and chemical treatment options, preventive measures, and optimal environmental conditions to mitigate the disease's spread.

For soil analysis, farmers will manually input chemical properties of the soil, such as pH, nitrogen (N), phosphorus (P), potassium (K), organic matter content, and moisture levels. Using data-driven algorithms and an expert knowledge database, the system will evaluate soil health and provide personalized suggestions on improving soil quality. If any deficiencies are detected, the platform will recommend necessary fertilizers or soil amendments (e.g., lime for acidic soils, compost for nutrient enrichment) to optimize soil productivity.

The crop analysis module will combine historical agricultural data, soil parameters, and rainfall patterns to suggest the most suitable crops for a particular region. The system will demand key inputs such as soil fertility, temperature trends, and seasonal rainfall to identify the best crop options. Machine learning models trained on agricultural datasets will use classification algorithms like Random Forest or Decision Trees to predict which crops have the highest probability of yielding better results in the given soil and climatic conditions.

The fertilizer recommendation module will work in conjunction with soil and crop analysis. Based on the soil nutrient status and the selected crop, the system will determine the optimal type and quantity of fertilizers required to achieve balanced soil fertility. It will suggest whether organic fertilizers (e.g., compost, manure) or synthetic fertilizers (e.g., NPK, urea, DAP) should be applied, along with application methods and schedules.

To enhance accuracy, weather forecasting will be integrated using real-time meteorological APIs to provide insights into temperature, humidity, rainfall probability, and wind conditions. This data will help farmers decide the best time for planting, irrigation, fertilization, and pest control. Weather-based alerts and notifications will be incorporated to warn farmers about extreme climatic events, such as droughts, heavy rainfall, or frost, ensuring proactive farm management.

The platform will be developed using a user-friendly web interface, where farmers can interact with the system through a dashboard, input forms, image uploads, and recommendation reports. A cloud-based backend will store and process data, ensuring scalability and efficient handling of large datasets. The system will be continuously improved through machine learning model retraining and real-time feedback from users, making it more adaptive and precise over time.

By integrating advanced AI techniques, data analytics, and weather forecasting, Agri-Weather aims to become an intelligent decision-support tool for farmers, enabling sustainable and efficient farming practices while maximizing crop productivity and minimizing risks.

PROJECT REQUIREMENT

1. Web-Based Platform Development: The project requires the development of a user-friendly web-based platform that integrates multiple agricultural services. The platform should be designed with an intuitive UI/UX, ensuring ease of use for farmers and agricultural stakeholders. It must support user authentication, data input, and real-time recommendations. The system should be scalable, allowing future integration of additional agricultural insights.

2. Image-Based Disease Detection: The platform should incorporate a machine learning-based image recognition system capable of identifying plant diseases. Users will upload images of diseased plants, and the system will analyze the images to detect specific diseases. This will require a well-trained deep learning model, possibly using convolutional neural networks (CNNs), trained on a diverse dataset of plant diseases. The system should provide details about the detected disease and offer treatment recommendations.

3. Soil Analysis and Fertilizer Recommendation: A module must be developed for soil analysis, where users input soil chemical values such as pH,

nitrogen, phosphorus, and potassium levels. The system should analyze these values and provide recommendations on soil amendments required to improve fertility. Additionally, it should suggest the appropriate fertilizers needed to balance the soil composition. A database of soil types and fertilizer compositions will be required for accurate recommendations.

4. Smart Crop Selection: The platform should have a feature to recommend suitable crops based on soil quality and climatic conditions. Users will input data regarding soil properties and expected rainfall. The system should analyze this data and suggest the most viable crops that can thrive under the given conditions. A knowledge base of crop requirements based on scientific agricultural data will be needed for this functionality.

5. Weather Forecasting Integration: For informed decision-making, the platform must integrate a weather forecasting module. This will require API integration with reliable weather data providers to fetch real-time weather updates, including temperature, precipitation, and humidity levels. The system should present weather predictions in an easy-to-understand format, helping users plan their farming activities effectively.

6. Database and Backend Development: A robust database is required to store user data, soil and crop information, disease detection models, and weather records. The backend should be designed to handle real-time data processing efficiently. Technologies such as Python with Flask/Django for the backend, TensorFlow/PyTorch for machine learning models, and PostgreSQL/MySQL for database management are recommended.

7. Hosting and Deployment: The web application should be hosted on a cloud platform like AWS, Google Cloud, or Microsoft Azure to ensure scalability and availability. Security measures, including data encryption and user authentication protocols, must be implemented to protect user information.

This comprehensive approach ensures that the Agri-Weather platform provides actionable insights to farmers, optimizing their agricultural practices and improving overall productivity.

RESULT AND DISCUSSION

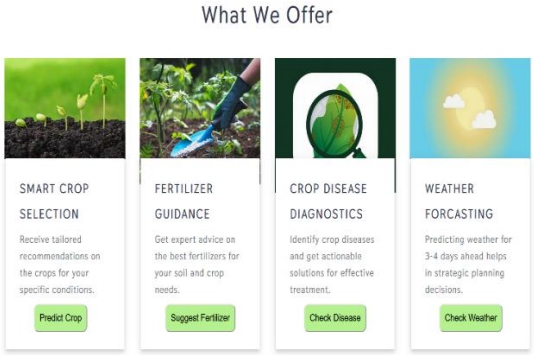

Fig .2

The Agri-Weather platform is designed to assist farmers with smart agricultural decision-making through a combination of soil analysis, crop analysis, disease detection, and fertilizer recommendations, integrated with weather forecasting. The system effectively processes multiple agricultural data inputs and provides detailed insights to improve crop yield and farm productivity.

The soil analysis module allows farmers to input soil chemical values such as nitrogen, phosphorus, potassium, pH, and organic carbon content. Based on these inputs, the platform assesses the soil's fertility and provides recommendations on what nutrients are deficient. It then suggests appropriate fertilizers and soil amendments to enhance soil quality. By integrating weather forecasting, the system ensures that fertilizer recommendations align with expected rainfall and temperature conditions, optimizing nutrient uptake efficiency.

The crop analysis module evaluates soil composition and weather parameters, including rainfall and temperature trends. Using this data, it predicts which crops are best suited for cultivation in a specific region. This feature aids farmers in making informed decisions about crop selection, reducing the risk of crop failure and maximizing yield potential.

The disease detection module operates using image processing techniques and machine

learning algorithms. Farmers can upload an image of a diseased plant, and the system analyzes it to identify the disease affecting the crop. The platform then provides detailed information on the disease, including its causes, symptoms, and potential spread. Furthermore, it suggests effective treatments, including organic and chemical control methods, to mitigate the disease and prevent further damage.

The fertilizer recommendation module complements the soil and crop analysis features by advising on the most suitable fertilizers based on soil composition and crop requirements. This ensures balanced nutrient application, preventing overuse or underuse of fertilizers, which can affect both crop health and soil sustainability. By integrating weather forecasts, the system also advises on the best time to apply fertilizers to minimize nutrient loss due to leaching or volatilization.

The combination of these four modules makes Agri-Weather a powerful tool for precision agriculture. By leveraging AI, machine learning, and meteorological data, it offers an advanced decision-support system for farmers. The real-time analysis and tailored recommendations significantly reduce guesswork, enhance productivity, and contribute to sustainable agricultural practices. Overall, Agri-Weather has the potential to revolutionize farming by enabling data-driven agricultural decisions, leading to increased crop yield, reduced input costs, and improved environmental sustainability.

CONCLUSION

The Agri-Weather project is a comprehensive web-based platform designed to support farmers with data-driven insights for better agricultural decision-making. By integrating soil analysis, crop analysis, disease detection, fertilizer recommendations, and weather forecasting, this platform aims to enhance farm productivity and sustainability.

Disease Detection: Farmers can upload images of affected plants, and the system will diagnose the disease while providing treatment recommendations.

Soil Analysis & Fertilizer Recommendation: By inputting soil chemical values, the platform will assess soil health and suggest necessary improvements, including suitable fertilizers.

Crop Suitability Analysis: Based on soil composition and rainfall data, the system will recommend the most suitable crops for the land, optimizing yield and resource use.

Weather Forecasting: Helps farmers plan their agricultural activities by providing real-time weather predictions.

By leveraging AI and data analytics, Agri-Weather empowers farmers to make informed decisions, reduce crop losses, and improve overall agricultural efficiency. This initiative aligns with modern precision farming techniques, ensuring sustainable and profitable farming practices.

References

Satish Babu (2023), "A Software Model for Precision Agriculture for Small and Marginal Farmers," International Centre for Free and OpenSource Software (ICFOSS), Trivandrum, India.

Anshal Savla, Parul Dhawan, HimtanayaBhadada, Nivedita Israni, AlishaMandholia, Sanya Bhardwaj (2023), "Survey of classification algorithms for formulating yield prediction accuracy in precision agriculture," Innovations in Information, Embedded, and Communication Systems (ICIIECS).

Aakunuri Manjula, Dr. G. Narsimha (2022), "XCYPF: A Flexible and Extensible Framework for Agricultural Crop Yield Prediction," Conference on Intelligent Systems and Control (ISCO).

Basso, B., Carone, M.T., Fiorentino, C., Lops, F., Lovergine, F.P., Mariani, A., Mastronardi, M., Pietranera, L., Scarascia-Mugnozza, G.E., Siviero, M. (2022). Advances in precision agriculture: Remote sensing of soil and crop variability. Precision Agriculture, 18(5), 517-521.

Zhang, N., Wang, R., Zhu, Y., Tang, J., Chen, Q., Xu, Y., Tang, H. (2020). Predicting crop yield, nitrogen use efficiency and profit with a dynamic model: the Crop-N model. European Journal of Agronomy, 89, 71-82 .

Shireesha, B., Vinitha, M., Vamsi, K., Shabber Ali, S., & Anuhya Nunna, U. (2024). Crop Care Tech: A Web Based Application for Crop, Fertilizer Recommendation, Disease Detection by Using ML, DL. International Research Journal on Advanced Engineering Hub (IRJAEH), 2(09), 2252-2259. Irjaeh

Mohite, S., Mohite, S., Jadhav, S., Jadhav, P. A., Singh, A., Surma, P., & Namdeo, K. (2023). Revolutionizing Agriculture: Machine Learning-Driven Crop Recommendations and Disease Detection in Fertilizer Management. International Journal on Recent and Innovation Trends in Computing and Communication, 11(11s), 385–391. IJRITCC, Revistas Tec

Sudharshanan, M., Manikandan, Sumithra, & Padmaraj, K. (2024). Crop Recommendation with Fertilizer Suggestion and Plant Disease Detection. Tec Empresarial, 19(1), 580–590. Revistas Tec

Patel, K., & Patel, H. B. (2023). Multi-criteria Agriculture Recommendation System using Machine Learning for Crop and Fertilizers Prediction. Current Agriculture Research Journal, 11(1).

Irjaeh, Agriculture Journal,Revistas Tec.

Gosai, D., Raval, C., Nayak, R., Jayswal, H., & Patel, A. (2021). Crop Recommendation System using Machine Learning. International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 7(3), 558-569. Agriculture Journal, Revistas Tec, IJRITCC

Rani, G. E., Venkatesh, E., Balaji, K., Yugandher, B., Kumar, A. N., & SakthiMohan, M. (2022). An Automated Prediction of Crop and Fertilizer Disease using Convolutional Neural Networks (CNN). In 2022 2nd International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE) (pp. 1990-1993). IEEE.Revistas Tec

Siddiqua, A., Kabir, M. A., Ferdous, T., Ali, I. B., & Weston, L. A. (2022). Evaluating Plant Disease Detection Mobile Applications: Quality and Limitations. Agronomy, 12(8), 1869.Revistas Tec

Meenakshi, M., & Naresh, R. (2022). Soil Health Analysis and Fertilizer Prediction for Crop Image Identification by Inception-V3 and Random Forest. Remote Sensing Applications: Society and Environment, 28, 100846.Revistas Tec

Varshney, D., Babukhanwala, B., Khan, J., Saxena, D., & Kumar Singh, A. (2021). Machine Learning Techniques for Plant Disease Detection. In 2021 5th International Conference on Trends in Electronics and Informatics (ICOEI) (pp. 1574-1581). IEEE. Revistas Tec

Vaishnavi, S., Shobana, M., Sabitha, R., & Karthik, S. (2021). Agricultural Crop Recommendations Based on Productivity and Season. In 2021 7th International Conference on Advanced Computing and Communication Systems (ICACCS) (Vol. 1, pp. 883-886). IEEE.Revistas Tec

Dharani, M. K., Thamilselvan, R., & Natesan, P. (2020). IoT-Based Smart Agriculture Monitoring System. International Journal of Advanced Science and Technology, 29(3), 6027-6031.

Kumar, A., Sarkar, S., & Pradhan, C. (2019). Recommendation System for Crop Identification and Pest Control Technique in Agriculture. In 2019 International Conference on Communication and Signal Processing (ICCSP) (pp. 0185-0189). IEEE. IJRITCC

Paul, M., Vishwakarma, S. K., & Verma, A. (2015). Analysis of Soil Behavior and Prediction of Crop Yield Data Mining Approach. In 2015 International Conference on Computational Intelligence and Communication Networks (CICN) (pp. 766-771). IEEE. IJRITCC