SAVITRIBAI PHULE PUNE UNIVERSITY

A PROJECT REPORT ON

AI – Driven Farmer Support System

SUBMITTED TOWARDS THE

PARTIAL FULFILLMENT OF THE REQUIREMENTS OF

BACHELOR OF ENGINEERING (Computer Engineering)

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Abstract

Agriculture stays a critical industry, but many smallholder farmers face challenges in optimizing crop choice and yields due to loss of access to professional steerage and facts- driven decision aid equipment. This project proposes an AI-driven mobile utility to provide localized, personalized crop tips to farmers based totally on geographical data and consumer inputs. Through a simple interface, farmers can input information about their land and preferences, and get hold of ML-generated predictions on which plants are satisfactory suitable for maximum productiveness and profitability. As our machine took root, its impact on Indian agriculture and rural development became palpable. Beyond mere statistics, we witnessed tangible enhancements: crop yields flourished, farmer incomes determined stability, and a dedication to environmental sustainability took root. The system's intuitive consumer interface and a dynamic feedback mechanism were pivotal in ensuring that it not best met the practical needs of farmers but was embraced with enthusiasm. The ML model will even provide supplementary information on most efficient planting times, farming techniques, and capability troubles to watch for. By democratizing get admission to this agricultural intelligence, the intention is to empower smallholder farmers to make more informed choices, enhance crop yields, growth income resilience, and make contributions to worldwide food protection. Initial pilots will cognizance on key plants and regions, with a framework to amplify the knowledge base over the years. This system aims to be a sustainable, scalable tool for the digital transformation of smallholder agriculture worldwide.

Acknowledgments

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CHAPTER 1

SYNOPSIS

1.1 PROJECT TITLE

AI – Driven Farmer Support System

1.2 PROJECT OPTION

Internal project

1.3 INTERNAL GUIDE

Mrs. Hema Kumbhar

1.4 SPONSORSHIP AND EXTERNAL GUIDE

None

1.5 TECHNICAL KEYWORDS (AS PER ACM KEYWORDS)

Farmer Support, Crop Prediction, Data-Driven Farming, Machine Learning, Random Forest, Classification, Ensemble Learning

1.6 PROBLEM STATEMENT

To briefly highlight the challenges that farmers face in making informed crop decisions and to emphasize the potential impact of data-driven solutions and address the issue.

1.7 ABSTRACT

The AI Driven Farmer Support System is introduced as a transformative tool empowering Indian farmers with data-driven insights for informed crop planning. Through meticulous research, the system has positively impacted Indian agriculture and rural development, improving crop yields, income stability, and environmental sustainability. Its user-friendly interface and robust feedback mechanism ensure practicality and user acceptance, holding promise for scalable application in diverse agricultural regions. This project represents a significant stride towards enhancing the economic viability of Indian agriculture and contributing to a sustainable and prosperous future for farmers and rural communities, unlocking a new era in agriculture and empowering farmers across diverse regions.

1.8 GOALS AND OBJECTIVES

- To revolutionize and enhance the agricultural sector by leveraging artificial intelligence (AI) technologies to support and empower farmers in numerous ways.

- To utilize AI algorithms to optimize farming practices, including crop management, irrigation, fertilization, and pest control, to maximize yields and reduce resource wastage.

- To enhance crop health and yield through early detection of diseases, pests, and nutrient deficiencies using AI-powered monitoring and analysis, allowing timely interventions.

- To enable farmers to use resources such as water, fertilizers, and energy more efficiently, minimizing waste and reducing the environmental impact of agriculture.

- To provide farmers with data-driven insights and recommendations to support informed decision-making regarding planting, harvesting, market timing, and resource allocation.

1.9 RELEVANT MATHEMATICS ASSOCIATED WITH THE PROJECT

Random Forest Equation:

A Random Forest consists of an ensemble of decision trees. The equation for a Random Forest involves aggregating the predictions of multiple decision trees to make a final prediction. The general equation for a Random Forest prediction can be represented as follows:

$$\text{Random Forest}(X) = \frac{1}{N_{\text{trees}}} \sum_{i=1}^{N_{\text{trees}}} \text{Decision Tree}_i(X)$$

Where:

- XX is the input feature matrix.
- N_{trees} N_{trees} is the number of trees in the Random Forest.
- Decision Tree$i(X)$Decision Tree$_i$(X) represents the prediction of the ii-th decision tree in the Random Forest.

Machine Learning and Data Mining:

For Machine Learning and Data Mining, various algorithms use mathematical models to predict outcomes based on input data:

1. Supervised Learning (e.g., Random Forest for regression):

- Decision Tree Split Criterion (Information Gain):

$$\text{Information Gain} = \text{Entropy(parent)} - \left(\frac{N_{\text{left}}}{N}\text{Entropy(left child)} + \frac{N_{\text{right}}}{N}\text{Entropy(right child)}\right)$$

where N_{left} and N_{right} are the numbers of samples in the left and right splits, and NN is the total number of samples.

2. Unsupervised Learning (e.g., K-means clustering):

- Objective Function:

$$J = \sum_{i=1}^{k} \sum_{x \in S_i} \|x - \mu_i\|^2$$

where k is the number of clusters, S_i is the set of points in the ith cluster, and μi is the mean of points in S_i

1.10 NAMES OF CONFERENCES/JOURNALS WHERE PAPERS CAN BE PUBLISHED

• IJIRSET -International Journal of Innovative Research in Science, Engineering and Technology

• IJIRCCE - International Journal of Innovative Research in Computer and Communication Engineering

• IJRDT - International Journal for Research DevelopmentIn Technology

• IJAREEIE - International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering.

1.11 REVIEW OF CONFERENCE/JOURNAL PAPERS SUPPORTING PROJECT IDEA

Sr. No	Paper Title	Author	Advantages	Disadvantages
1	Artificial Intelligence-based decision support systems in smart agriculture: Biblio-metric analysis for operational insights and future directions.	Arslan Yousaf, Vahid Kayvanfar, Annamaria Mazzoni, Adel Elomori	1.Thorough Analysis**:** Provides a detailed review of AI in smart agriculture.	1. Limited Scope: May miss some relevant studies due to database and keyword choices. 2. Practical Challenges**:** Doesn't fully address the real-world difficulties farmers face in using AI.
2	Crop Recommender System Using Machine Learning Approach.	Shilpa Pandey, Dr. Prem Ramesh, Anmol, B.R Aishwarya, Karuna Rohilla, Kumar Shaurya	1. Improves Yield: Aims to increase agricultural productivity and efficiency.	1. Maintenance Required: Needs regular updates to stay accurate and relevant. 2. Data Dependency: Effectiveness depends on the quality and availability of data.
3	Demand Based Crop Recommender System for Farmers	S. Kanga Suba Raja, Rishi R, Sundaresan E, Srijit V	1. Market Focused: Recommends crops based on market demand, helping farmers maximize profits.	1. Complexity**:** May be difficult for some farmers to use without training. 2. Regular Updates Needed: Needs frequent updates to remain useful and accurate.

4	Performance Evaluation of Best Feature Subsets for Crop Yield Prediction Using Machine Learning Algorithms	Maya Gopal P. S. Bhargavi R	1. Optimized Predictions: Identifies the best features for accurate crop yield prediction.	1. Technical Knowledge: Requires understanding of machine learning to implement. 2. Generalization Limits: May not account for all unique local factors affecting yield.
5	A Survey on Rice Crop Yield Prediction in India Using Improved Classification Technique	Kolin Sukhadia, M. B. Chaudhari	1. Enhanced Techniques: Uses improved classification methods for better accuracy. 2. Comprehensive Survey: Provides a detailed overview of existing prediction techniques.	1. Technical Complexity: Implementation may require specialized knowledge. 2. Limited Practical Application: May not address all practical challenges faced by farmers.
6	Prediction ofLand Suitability for Crop Cultivation Based on Soil and Environmental Char acteristics sing Modified Recursive Feature Elimination Technique with Vari-ous Classifiers	G. Mariammal, A. Suruliandi, S. P. Raja, and E. Poongothai	1. Algorithm Comparison: Evaluates different algorithms to find the most effective ones.	1. Complexity: The technique might be difficult for some users to understand and implement. 2. Data Intensive: Requires detailed soil and environmental data.

Fig.1.1: Literature Survey

1.12 PLAN OF PROJECT EXECUTION

Schedule		Date	Project Activity
July	1st Week	01/07/2023	Project Topic Searching
	2nd Week	08/07/2023	Project Topic Selection
	3rd Week	15/07/2023	Synopsis Submission
August	1st Week	05/08/2023	Presentation On Project Ideas
	2nd Week	12/08/2023	Submission Of Literature Survey
	3rd Week	19/08/2023	Feasibility Assessment
September	1st Week	02/09/2023	Documentation for paper publishing.
	3rd Week	16/09/2023	Design Of Mathematical Model
	4th Week	24/09/2023	Paper is publish.
October	1st Week	09/10/2023	Report Preparation And Submission
December	3rd Week	19/12/2023	1st module presentation
	4th Week	26/12/2023	Discussion and implementation of 2nd module
January	1st Week	02/01/2024	Preparation for conference
	2nd Week	09/01/2024	Study of algorithm.
	3rd Week	16/01/2024	Discussion about modification.
	4th Week	24/01/2024	1st and 2nd module presentation
	5th Week	30/01/2024	Discussion on flow of project and designing new module
February	1st Week	06/02/2024	Modification of modules.
	2nd Week	13/02/2024	Designed test cases for our module.
	3rd Week	20/02/2024	Worked on user interface.
March	1st Week	06/03/2024	Integration of all modules.
April	1st Week	8/04/2024	Final Report.
May	1st Week	10/05/2024	Final Presentation.

Figure 1.2: Plan of Project Execution

CHAPTER 2

TECHNICAL KEYWORDS

2.1 AREA OF PROJECT

- Machine Learning
- Agriculture

2.2 TECHNICAL KEYWORDS

- Farm Support
- Crop forecasting
- Data-driven agriculture
- Machine Learning
- Random forest
- Classification
- Ensemble Learning

CHAPTER 3

INTRODUCTION

3.1 PROJECT IDEA

Agriculture, as the backbone of many economies, faces challenges stemming from uncertainties in weather conditions, market dynamics, and resource management. In response to these challenges, we present the AI Farmer Support System a transformative solution aimed at predicting crop yield and market prices to empower farmers with data-driven insights. In this era of technological advancements, theintegration of artificial intelligence and data analytics holds immense potential for revolutionizing traditional farming practices.

The AI Farmer Support System employs a novel sliding window non-linear regression technique, allowing for a dynamic and accurate analysis of multiple factors influencing agricultural production. By considering historical data related to rain-fall, temperature, market dynamics, and prior crop yields, the system goes beyond conventional approaches, providing a comprehensive understanding of the agricultural ecosystem. This approach enables the generation of precise predictions forcrop yield and market prices.

Our system is not just a predictive tool; it is a decision support system crafted to empower farmers in making informed choices about the crops they cultivate. Byaligning these choices with market demand and optimizing yields, the system con- tributes to the economic viability of agriculture. The impact of such a technological intervention extends beyond individual farms, representing a promising step to-wards improving the economic sustainability of agriculture and enhancing the livelihoods of millions of Indian farmers.

The architecture, methodologies, and key components of the AI Farmer Support System. We present our findings, including the accuracy of pre- dictions, user feedback, and the system's potential for societal impact. As we delve into the intricacies of this innovative approach, we invite the reader to explorehow technology can be harnessed to address real-world challenges and contribute tothe sustainable development of the agricultural sector.

3.2 MOTIVATION OF THE PROJECT

- Empower farmers with data-driven insights to make informed decisions about their crops and planting strategies.
- To equip farmers with the tools they deserve to enhance their livelihoods, increase yields, and secure our food future.
- Contribute to rural economic development by enhancing the productivity of agricultural communities.

3.3 LITERATURE SURVEY

“Artificial intelligence-based decision support systems in smart agriculture: Bibliometric analysis for operational insights and future directions.” This paper introduces that it predicts the world population is expected to touch 9.73 billion by 2050, according to the Food and Agri- culture Organization (FAO), the demand for agricultural needs is increasing proportionately. Smart Agriculture is replacing conventional farming systems, employing advanced technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML) to ensure higher productivity and precise agriculture management to overcome food demand. In recent years, there has been an increased interest in researchers within Smart Agriculture. Previous literature re- views have also conducted similar bibliometric analyses; however, there is a lack of research in Operations Research (OR) insights into Smart Agriculture. This paper conducts a Bibliometric Analysis of past research work in OR knowledge which has been done over the last two decades in Agriculture 4.0, to understand the trends and the gaps. Biblioshiny, an advanced data mining tool, was used in conducting bibliometric analysis on a total number of 1,305 articles collected from the Scopus database between the years 2000–2022. Researchers and decision makers will be able to visualize how newer advanced OR theories are being applied and how they can contribute toward some research gaps highlighted in this review paper.[1]

“Demand Based Crop Recommender System for Farmers.” This paper introduces about half of the population of India depends on agriculture for its livelihood, but its contribution to- wards the GDP of India is only 14 per cent. One possible reason for this is the lack of adequate crop planning by farmers. There is no system in place to advice farmers what

crops to grow. In this paper we present an attempt to predict crop yield and price that a farmer can obtain from his land, by analyzing patterns in past data. We make use of a sliding window non-linear regression technique to predict based on different factors affecting agricultural production such as rainfall, temperature. market prices, area of land and past yield of a crap. The analysis is done for several districts of the state of Tamil Nadu, India. Our system intends to suggest the best crop choices for a farmer to adapt to the demand of the prevailing social crisis facing many farmers today.[2]

:Crop Recommender System Using Machine Learning Approach." This paper introduces about the agriculture and its allied sectors are undoubtedly the largest providers of livelihoods in rural India. The agriculture sector is also a significant contributor factor to the country's Gross Domestic Product (GDP). Blessing to the country is the overwhelming size of the agricultural sector. However, regrettable is the yield per hectare of crops in comparison to international standards. This is one of the possible causes for a higher suicide rate among marginal farmers in India. This paper proposes a viable and user-friendly yield prediction system for the farmers. The proposed system provides connectivity to farmers via a mobile application. GPS helps to identify the user location. The user provides the area soil type as input. Machine learning algorithms allow choosing the most profitable crop list or predicting the crop yield for a user- selected crop. To predict the crop yield, selected Machine Learning algorithms such as Support Vector Machine (SVM), Artificial Neural Network (ANN), Random Forest (RF), Multivariate Linear Regression (MIR), and K-Nearest Neighbour (KNN) are used. Among them, the Random Forest showed the best results with 95% ac- curacy. Additionally, the system also suggests the best time to use the fertilizers to boost up the yield.[3]

"A Survey on Rice Crop Yield Prediction in India Using Improved Classification Technique" This paper introduces India is an agricultural country. Agriculture is the important contributor to the Indian economy. There are many classification techniques like Support Vector Machine (SVM), LAD Tree, Naıve Bayes, Bayesnet, K. Nearest Neighbour(KNN), Locally Weighted Learning(LWL) on rice crop production datasets. They have some drawbacks like low accuracy and more errors. To achieve more significant result. To increase classification accuracy and reducing classification errors, our research uses classification method Bayesnet based adaboost will be proposed in work. Rice crop yield depend on environment's parameters like Rainfall, minimum temperature, average

temperature. Maximum temperature, Vapour Pressure, potential evapotranspiration, reference crop evapotranspiration, cloud cover, wet day frequency for the kharif season, our dataset containing these environmental parameters for accurate prediction of Rice crop yield.[4]

“Performance Evaluation of Best Feature Subsets for Crop Yield Prediction Using Machine Learning Algorithms” This paper introduces the rapid innovations and Iberalized market economy in agriculture demand accuracy in Crop Yield Prediction (CYP). In accurate prediction, machine leaming (M) algorithms and the selected features play a major role. The performance of any M algorithm may improve with the utilication of a distinct set of features in the same training dataset. This research work evaluates the most needed features for accurate CYP. The ML algorithms, namely, Artificial Neural Network, Support Vector Regression, K-Nearest Neighbour and Random Forest are proposed for better accuracy. Agricultural dataset consists of 745 instances; 70% of data are randomly selected and are used to train the model and 30% are used for testing the model to assess the predictive ability. The results show that the RF algorithm reaches the highest accuracy by means of its emoranalysis values for all the distinct feature subsets using the same training agricultural data.[5]

“Prediction of Land Suitability for Crop Cultivation Based on Soil and Environmental Characteristics Using Modified Recursive Feature Elimination Technique with Various Classifiers.” This paper introduces the crop cultivation prediction is an integral part of agriculture and is primarily based on factors such as soil, environmental features like rainfall and temperature, and the quantum of fertilizer used, particularly nitrogen and phosphorus. These factors, however, vary from region to region: consequently, farmers are unable to cultivate similar crops in every region. This is where machine learning (ML) techniques step in to help find the most suitable crops for a particular region, thus assisting farmers a great deal in crop prediction. The feature selection (FS) facet of MI. is a major component in the selection of key features for a particular region and keeps the crop prediction process constantly upgraded. This work pro- poses a novel FS approach called modified recursive feature elimination (MRFE) to select appropriate features from a data set for crop prediction. The proposed MRFE technique selects and ranks salient features using a ranking method. The experimental results show that the MRFE method selects the most accurate features. while the hagging technique helps accurately predict a suitable

crop. The performance of proposed MRFE technique is evaluated by various metrics such as accuracy (ACC), precision, recall, specificity. F1 score, area under the curve, mean absolute error, and log loss. From the performance analysis, it is justified that the MRFE technique performs well with 95% ACC than other FS methods.[6]

“Design of a smart hydroponics monitoring system using an ESP32 microcontroller and the Internet of Things” This paper presents the design and construction of a hydroponics monitoring system that can collect parameters of hydroponic systems, such as temperature, water limit, pH level, and nutrient levels. The monitoring system was developed using an ESP32 microcontroller and several sensors, including total dissolved solids (TDS), pH, water level, and temperature sensors.[7]

“Smart irrigation system based on IoT and machine learning” This paper proposes an intelligent and flexible irrigation approach with low consumption and cost that can be deployed in different contexts. This approach is based on machine learning algorithms for smart agricultured a set of sensors (soil humidity, temperature, and rain) in an environment that ensures better plant growth for months, from which we collected data based on an acquisition map using the Node-RED platform and MongoDB.[8]

“Design and Implementation of Smart Hydroponics Farming Using IoT-Based AI Controller with Mobile Application System” This article presented the design and implementations of AISHES with IoT, which is developed by integrating the Raspberry Pi, IoT environment with mobile application. The farmer observes and manages his hydroponics farm field using the Agri-Hydroponic program, which has manual and automated control modes. A Raspberry Pi controller based hardware design is installed in hydroponics farm field to monitor plant statics using various sensors.[9]

“A Smart Hydroponics Farming System Using Exact Inference in Bayesian Network” This study developed a smart hydroponics system that is used in automating the growing process of the crops using exact inference in Bayesian Network (BN). Sensors and actuators are installed in order to monitor and control the physical events such as light intensity, pH, electrical conductivity, water temperature, and relative humidity.[10]

“IoT Based Low Cost Smart Indoor Farming Management System Using an Assistant Robot and Mobile App” In this paper, a system will be acquainted through which it is possible to manage an indoor farm automatically at a very low cost. Whereby it is possible

to water the farm plants when required, provide specific light to each plant for photosynthesis, constrain the concentration of CO2 on the farm.[11]

“Wireless Sensor Network Based Machine Learning for Precision Agriculture” This paper provides an overview of the synergy between WSNs and machine learning in precision agriculture, emphasizing their applications, advantages, and challenges. A more productive and sustainable future for agriculture throughout the world depends on the use of sensors and the Internet of Things (IoT).[12]

“Farmers agricultural portal” This portal will help farmers to get a clear idea about customer requirements and it will also provide information about how to grow required crop and what it will cost. The max-prior algorithm used helps in allocating the highest requirement customer to the farmers to gain better profit. It also helps the farmers in selling their produce quicker.[13]

“Smart Farming using IoT and Machine Learning with Image Processing” The proposed framework causes Farmer to enhance quality and amount of their farm yield by detecting surrounding temperature and moistness esteems, soil dampness esteem and water level of the tank from the eld with no human intercession. By utilizing the idea of IOT framework can be more effective. In proposed work, IoT and Machine Learning are both put to use together.[14]

“Towards an ICT Enabled Farming Community” This paper presents a proposed use of virtual community for farmers in Sri Lanka by reviewing Information and communication technology perspective with reference to past and present political strategies adopted by Sri Lankan government. In this study, it also analyzes Virtual Community portal as a frame work for agri information system, and their role in implementing e-Government in the country.[15]

“Smart Farm Application: A Modern Farming Technique Using Android Ap- plication” The analysis of current farmers knowledge about modern farming techniques and actual development of modern techniques this application will more helpful them to get all kind of information only in one touch on anytime at any place.[16]

CHAPTER 4

PROBLEM DEFINITION AND SCOPE

4.1 PROBLEM STATEMENT

To briefly highlight the challenges that farmers face in making informed crop decisions and to emphasize the potential impact of data-driven solutions and address the issue.

4.1.1 Goals and objectives

- To revolutionize and enhance the agricultural sector by leveraging artificial intelligence (AI) technologies to support and empower farmers in numerous ways.
- To utilize AI algorithms to optimize farming practices, including crop management, irrigation, fertilization, and pest control, to maximize yields and reduceresource wastage.
- To enhance crop health and yield through early detection of diseases, pests, and nutrient deficiencies using AI-powered monitoring and analysis, allowing timely interventions.
- To enable farmers to use resources such as water, fertilizers, and energy more efficiently, minimizing waste and reducing the environmental impact of agriculture.
- To provide farmers with data-driven insights and recommendations to supportinformed decision-making regarding planting, harvesting, market timing, andresource allocation.

4.1.2 Statement of scope

An AI-driven Farmer Support System encompasses a range of technologies and applications designed to assist farmers in improving their agricultural practices, optimizing resource usage, enhancing productivity, and ultimately increasing their yields and profits. Remote sensing and satellite imagery analysis to monitor crop health, detect diseases, pests, and assess overall crop conditions. The scope of an AI-driven Farmer Support System typically involvesleveraging artificial intelligence (AI) technologies to provide various forms ofsupport and assistance to farmers. The ultimate goal of an AI-driven Farmer Support System is to empower farmers with valuable insights, automation, anddecision support, contributing to improved agricultural outcomes, sustainability, and the overall well-being of farmers and their communities.

4.2 SOFTWARE CONTEXT

Machine Learning:

- Implementing algorithms like decision trees, random forests and clustering algorithms for crop yield prediction, market analysis, and other data-driven tasks.

Data Processing and Analysis Tools:

- Using data processing tools like pandas, NumPy, and SQL for data cleaning, transformation, and aggregation tasks.

- Performing exploratory data analysis (EDA) to gain insights into agricultural data, identify patterns, and understand relationships between variables.

Mobile Application Development:

- Utilize Android Studio's UI design tools to create a farmer-friendly interface with easy navigation and clear labeling for key features like crop selection and market analysis.

- Implementing interactive dashboards, visualization tools, and decision support features to present insights, recommendations, and actionable information.

Database Management Systems (DBMS):

- Using relational database management systems (RDBMS) like MySQL for storing structured data related to crops, farms, weather, market prices, etc.

4.3 MAJOR CONSTRAINTS

Cost Constraint:

- Leveraging Android Studio because the primary development device gives a fee-effective solution, as it is open-source and loose to use. By using the functions and libraries to be had within Android Studio, developers can successfully construct the cellular application for crop advice and marketplace analysis without incurring licensing fees.

- For example, using Android Studio, the task develops a value-green cellular application that enables farmers acquire actual-time crop suggestions without incurring any software

program licensing prices.

Time Constraint:

- Implementing efficient algorithms and parallel processing techniques to make sure well timed crop pointers and market analysis.

- For instance, optimizing the Random Forest algorithm's education manner to lessen computation time whilst keeping prediction accuracy. This ought to contain parallelizing computations throughout multiple processors or the use of allotted computing frameworks.

Memory Constraint:

- Designing facts storage and processing systems that limit reminiscence utilization at the same time as managing large agricultural datasets.

- For example, using statistics compression strategies or streaming processing to efficiently manage and analyze spatial facts, climate facts, and historic crop data without exceeding memory constraints.

4.4 METHODOLOGIES OF PROBLEM SOLVING AND EFFICIENCY ISSUES

1. Understand the Problem:

- Conduct stakeholder interviews and workshops to accumulate insights into the trouble area, together with farmer desires, market dynamics, and technological constraints.

- Utilize strategies like hassle framing, root purpose analysis, and brainstorming sessions to gain a complete understanding of the demanding situations confronted in agricultural decision-making.

2. Gather Information:

- Collect information from various sources such as agricultural studies papers, authorities reviews, marketplace surveys, and discipline observations to gather information on applicable elements affecting crop advice and marketplace analysis.

- Employ statistics series strategies like surveys, interviews, and facts mining to collect insights into farmer possibilities, crop overall performance, and marketplace tendencies.

3. Analyze the Requirements:

- Use techniques like necessities elicitation, prioritization matrices, and user story mapping to investigate and prioritize the collected information.

- Identify key necessities and constraints for the crop recommendation system, thinking about factors which include geographical situations, crop traits, consumer alternatives, and technological feasibility.

4. Generate Potential Solutions:

- Explore diverse solution processes, along with set of rules selection, machine architecture design, and user interface prototypes.

- Conduct feasibility research, evidence-of-idea implementations, and comparative analyses of different solution options to assess their viability and effectiveness in addressing the diagnosed requirements.

5. Evaluate and Select Solutions:

- Develop evaluation criteria based on key metrics together with accuracy, scalability, usability, and price-effectiveness.

- Use techniques like prototype checking out, person comments periods, and fee-gain analyses to evaluate and compare the ability answers in opposition to the mounted standards.

- Select the maximum suitable answer based totally at the assessment effects, stakeholder input, and alignment with challenge desires and constraints.

4.5 APPLICATIONS

Market Demand Forecasting:

- Integrate monetary data and market traits to forecast the call for for various crops.

- Provide farmers with insights on which crops are probable to be in excessive call for, allowing them to make informed planting decisions that align with marketplace needs.

Risk Assessment and Mitigation Strategies:

- Evaluate potential risks associated with exclusive crop alternatives in precise geographical areas, which include susceptibility to intense climate events or monetary fluctuations affecting certain plants.

- Provide farmers with strategic recommendation on danger mitigation, which includes crop insurance options, diversification techniques, and emergency preparedness plans.

Economic Modeling and Profitability Analysis:

- Integrate economic fashions that analyze the fee of cultivation, potential yield, and marketplace costs to offer farmers with profitability forecasts for different vegetation.

- Assist farmers in making economically possible choices that no longer simplest cater to marketplace needs but also make certain sustainable and worthwhile farming practices.

4.6 HARDWARE RESOURCES REQUIRED

1. System: i5/i7 2.4 GHz.
2. Hard Disk: 256 GB.
3. Monitor: 15 VGA Color.
4. RAM: 8 GB

4.7 SOFTWARE RESOURCES REQUIRED

1. Operating system: Windows.
2. Open source IDE: Android Studio & Anaconda
3. Coding Language: Java & Python
4. Database: MySQL

CHAPTER 5

PROJECT PLAN

5.1 PROJECT ESTIMATES

5.1.1 Reconciled Estimates

1. Software installation and setup

- Installing the required operating system (e.g. Android Studio & Anaconda)
- Installing necessary libraries and dependencies.

2. Dataset Creation:

- Data Collection via Google Forms: We designed and disseminated Google Forms to 500 farmers in diverse agricultural regions, capturing key variables such as soil type, climate conditions, historical crop choices, and temporal factors, ensuring comprehensive and uniform data input.
- Data Export and Organization in Excel: Upon collection, the responses from Google Forms were exported into Excel, where the data was systematically organized and prepared for analysis, facilitating easier manipulation and integration into the decision support system.

3. Algorithm research and selection

- Exploring different algorithms for prediction purpose and analysis.
- Comparing those selected algorithms and choosing the suitable for our project.

4. Algorithm implementation

- Random Forest Algorithm Implementation: Utilized the scikit-analyze library in Python to put into effect the Random Forest set of rules, leveraging its pre-constructed functionalities for schooling and predicting on the agricultural dataset.

Tuned hyperparameters such as the variety of timber, most intensity, and function selection techniques to optimize model performance and generalization at the same time as ensuring sturdy crop recommendation abilties.

5. Performance optimization

- Random Forest: Applied go-validation strategies to evaluate the Random Forest model's overall performance and identify the most appropriate model configuration, ensuring that the model does not overfit or underfit.

Implemented feature selection techniques to lessen the dimensionality of the dataset, focusing at the most influential variables to beautify model performance and prediction speed.

Identifying performance bottlenecks and optimizing code.

6. Testing and refinement

Conducting thorough testing to validate the accuracy and reliability of the system.

Refining the algorithm and parameters based on test results and user feedback.

7. Documentation and Finalization

Documenting the project details, including software installation.

5.2 RISK MANAGEMENT W.R.T. NP HARD ANALYSIS

NP-hard (Non-deterministic Polynomial-time hard), is a class of problems that are, informally, at least as hard as the hardest problems in NP". More precisely, a problem H is NP-hard when every problem L in NP can be reduced in polynomial time. As a consequence finding a polynomial algorithm to solve any NP-hard problem would give polynomial algorithms for all the problems in NP, which is unlikely as many of them are considered as hard. The class NP also contains all problems which can be solved in polynomial time.
The risks for the Project can be analyzed within the constraints of time and quality

5.2.1 Risk Identification:

Risks are problems that can occur or may have occurred while development and actual implementation of the project. Risks may be related to the hardware or software.

1. Scalability Challenges

2. Data Complexity

3. Resource Constraints

4. Algorithm Complexity

5. Algorithm Selection

6. Loss of internet

5.2.2 Overview Of Risk Mitigation, Monitoring, Management

Risk ID	R001
Risk Description	Inaccurate or incomplete data inputs from farmers leading to unreliable predictions.
Likelihood	Medium
Impact	High
Severity	High
Mitigation Strategies	Implement data validation checks in the UI. Use data cleansing techniques to preprocess and sanitize collected data.

Risk ID	R002
Risk Description	Underperforming or biased machine learning models due to inadequate training data or complexity.
Likelihood	Medium
Impact	High
Severity	High
Mitigation Strategies	Collect diverse and sufficient data for model training. - Regularly evaluate and fine-tune the model. Use ensemble methods or multiple models for robust predictions.

Risk ID	R003
Risk Description	Inaccurate crop predictions leading to suboptimal recommendations
Likelihood	Low
Impact	High
Severity	Medium
Mitigation Strategies	Validate prediction model against historical data and ground truth observations. Incorporate feedback mechanisms from farmers. Use ensemble models or combine multiple prediction approaches for improved accuracy.

Risk ID	R004
Risk Description	Recommendation engine failing to consider all relevant factors or insights.
Likelihood	Medium
Impact	High
Severity	High
Mitigation Strategies	Enhance recommendation algorithms considering multiple variables. Conduct thorough testing and validation of the recommendation engine. Implement explainable AI techniques to provide transparency in recommendation rationale.

Risk ID	R005
Risk Description	Poor user experience or unclear communication of recommendations.
Likelihood	Medium
Impact	Medium
Severity	Medium
Mitigation Strategies	Design intuitive and user-friendly UI with clear guidance. Provide interactive visualizations and explanations for recommendations. Conduct user testing and feedback sessions to refine UI and communication strategies.

Risk ID	R006
Risk Description	Inefficient management of crop cultivation levels disrupting the supply-demand chain.
Likelihood	High
Impact	High
Severity	High
Mitigation Strategies	Collaborate closely with supply chain experts and stakeholders. Monitor and analyze market trends and demand-supply dynamics in real-time. Implement dynamic adjustment mechanisms based on market feedback and demand fluctuations.

Risk ID	R007
Risk Description	System failures, scalability issues, or data security breaches affecting project performance.
Likelihood	Low
Impact	Medium
Severity	High
Mitigation Strategies	Conduct regular system audits and security assessments. Implement robust backup and recovery processes. Use scalable cloud infrastructure with redundancy and failover mechanisms. Ensure data encryption and compliance with industry standards

Risk ID	R008
Risk Description	Non-compliance with agricultural regulations or data privacy laws impacting project continuity.
Likelihood	Low
Impact	Medium
Severity	High
Mitigation Strategies	Stay updated with relevant regulations and compliance requirements. Obtain necessary approvals and certifications. Implement data anonymization and privacy protection measures. Conduct regular compliance audits and risk assessments.

Risk ID	R009
Risk Description	Fluctuations in crop prices, demand-supply imbalances, or unforeseen market disruptions.
Likelihood	High
Impact	High
Severity	High
Mitigation Strategies	Conduct thorough market research and analysis. Diversify crop recommendations based on market trends. Implement risk hedging strategies for price fluctuations. Maintain agility and flexibility to adapt to changing market conditions.

5.2.3 Risk Analysis

ID	Risk Description	Probability	Impact		
			Schedule	Quality	Overall
1	Login Details	Low	Low	Low	Low
2	Internet Connection	Medium	Medium	Medium	Medium
3	Inaccurate Prediction	Medium	Medium	High	High

Figure 5.1: Risk Analysis

5.3 PROJECT SCHEDULE

5.3.1 Project task set

Major Tasks in the Project stages are:

- Task 1: Requirement Analysis (Base Paper Explanation).
- Task 2: Project Specification (Paper Work).
- Task 3: Technology Study and Design.
- Task 4: Coding and Implementation (Module Development).

5.3.2 Task network

Figure 5.2: Task network

5.3.3 Timeline Chart

Activity	I week	II week	III week	IV week	V Week	VI week	VII week	VIII week	IX week
	Aug 4	Aug 11	Aug 18	Aug 25	Sept 1	Sept 8	Sept 15	Sept 22	Sept 29
Initiate the project									
Communication									
Literature survey									
Define scope									
Develop SRS									
Plan the project									
Design mathematical model									
Feasibility Analysis									
Develop work breakdown structure									
Planning project schedule									
Design UML and other diagrams									
Design test plan									
Design risk management plan									

Figure 5.3: Timeline Chart

Activity	XI week	XII week	XIII week	XIV week	XV week	XVI week	XVII week	XVIII week	XIX week	XX week	XXI week	XXII week
	Jan 5	Jan 15	Jan 19	Jan 26	Feb 2	Feb 9	Feb 16	Feb 23	Mar 2	Mar 9	Mar 16	April 25
Execute the project												
Build and test basic functional unit												
Build and test database with login and session maintenance facility												
Build and test Bluetooth mode												
Build and test security features												

Figure 5.4: Timeline Chart

5.4 TEAM ORGANIZATION

5.4.1 Team Structure

Sr. No.	Member	Responsibilities
1	Tejas Hirurkar	Project Analysis and Developer
2	Shreyash Jadhav	Requirement gathering
3	Utkarsh Khalkar	Developer
4	Pratik Patil	Testing and Designing

Table 5.4: Team Structure

5.4.2 Management Reporting and Communication

Project status reporting is done once in week. Students meet guide on this day to know the further process of the project requirement and planning. Issues are cleared by guide. A workbook is maintained which has all details of the presentation reviews conducted in 7th Semester. Changes and improvements in various sectors were noted by guide accordingly when the changes were made RMDSSOE, Department of Computer Engineering to fulfillment of the guide the changes were appreciated and remarks regarding the details were marked.

CHAPTER 6

SOFTWARE REQUIREMENT SPECIFICATION

6.1 INTRODUCTION

6.1.1 Purpose and Scope of Document

Purpose: This project makes the action recognition techniques more valuable andwidely used in diversified applications of our daily lives.

6.1.2 Overview of responsibilities of Developer

The developer is responsible for:

1. Developing the system, which meets the SRS and solving all the requirements ofthe system.

2. Demonstrating the system and installing the system at client's location after the acceptance testing is successful.

3. Submitting the required user manual describing the system interfaces to work on itand also the documents of the system.

4. Conducting any user training that might be needed for using the system.

5. Maintaining the system for a period of one year after installation.

6.2 USAGE SCENARIO

Pre-Season Planning:

Farmers enter their geographical facts, soil conditions, and to be had resources into the app.

The device analyzes the facts the usage of the Random Forest algorithm and provides crop tips that maximize yield and suit nearby marketplace needs.

Real-Time Decision Making:

During the growing season, farmers can update facts regarding climate modifications or pest infestations.

The app recalculates recommendations to include changes in crop care, potential shifts in

crop types, or changes in useful resource allocation (like irrigation needs).

Market Analysis:

Farmers use the device to input modern-day crop repute and harvest projections.

The app offers insights into market developments, suggesting the first-class times to promote vegetation or modify manufacturing based on actual-time demand and deliver forecasts.

Resource Management:

The utility permits farmers to input information about their aid usage, together with water consumption and fertilizer use.

Recommendations are furnished to optimize useful resource usage at the same time as keeping or increasing crop yields.

Long-Term Agricultural Planning:

Farmers and agricultural planners use historic facts and forecast fashions from the app to plan for future planting seasons.

The system offers insights into sustainable practices and crop rotation techniques that stability soil fitness with marketplace opportunities.

6.2.1 Use-cases

A use case diagram is a graphical representation of a user's interaction with the system and depicting the specifications of a use case. A use case diagram can show the different types of users of a system and the various ways in which they interact with the system. Use case diagrams are used to gather the requirements of a systemincluding internal and external influences. These requirements are mostly design requirements. So when a system is analyzed to gather its functionality use cases are prepared and actors are identified. The purposes of use case diagrams can be as follows:

- Used to gather requirements of a system.
- Used to get an outside view of a system.

- Identify external and internal factors influencing the system.
- Show the interaction among the actors.

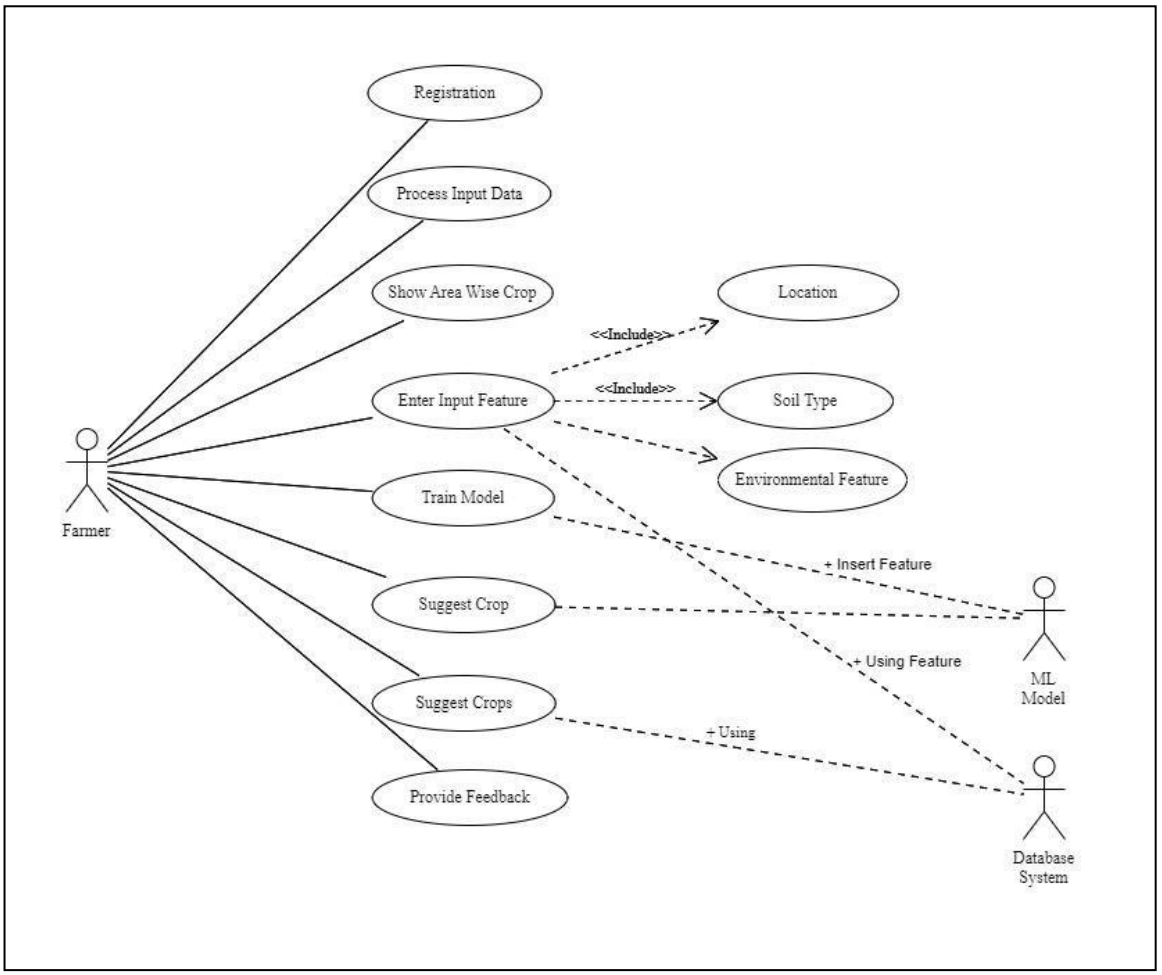


Figure 6.1: Usecase Diagram

6.3 DATA MODEL AND DESCRIPTION

6.3.1 Data Description

The database system is responsible for responding to user input and performs interactions on the data model objects. The database system receives the input; it validates the input and then performs the business operation that modifies the state of the data model.

6.4 FUNCTIONAL MODEL AND DESCRIPTION

6.4.1 Data Flow Diagram

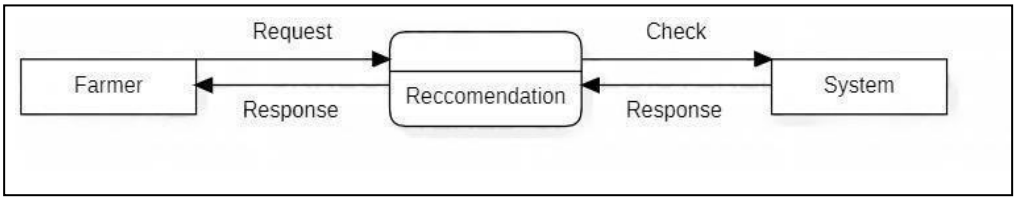


Figure 6.2: DFD Level-0

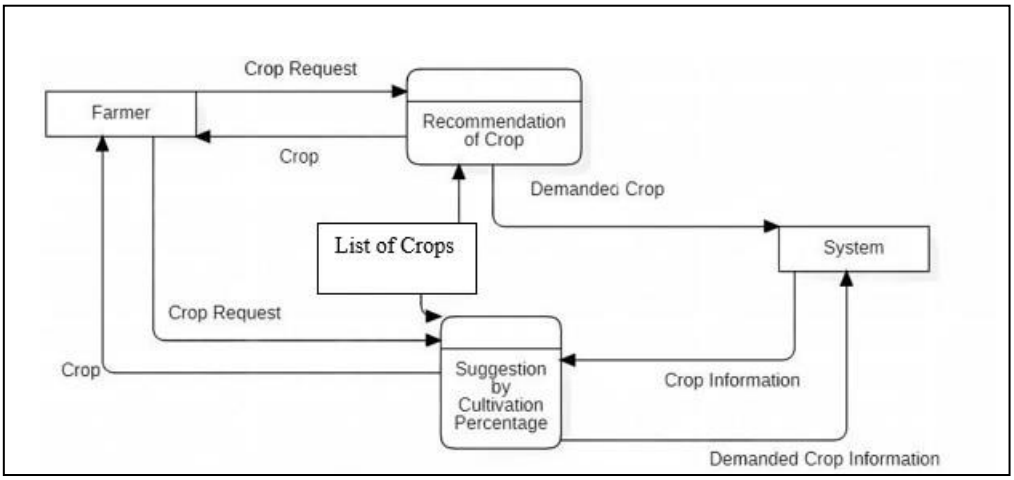


Figure 6.3: DFD Level-1

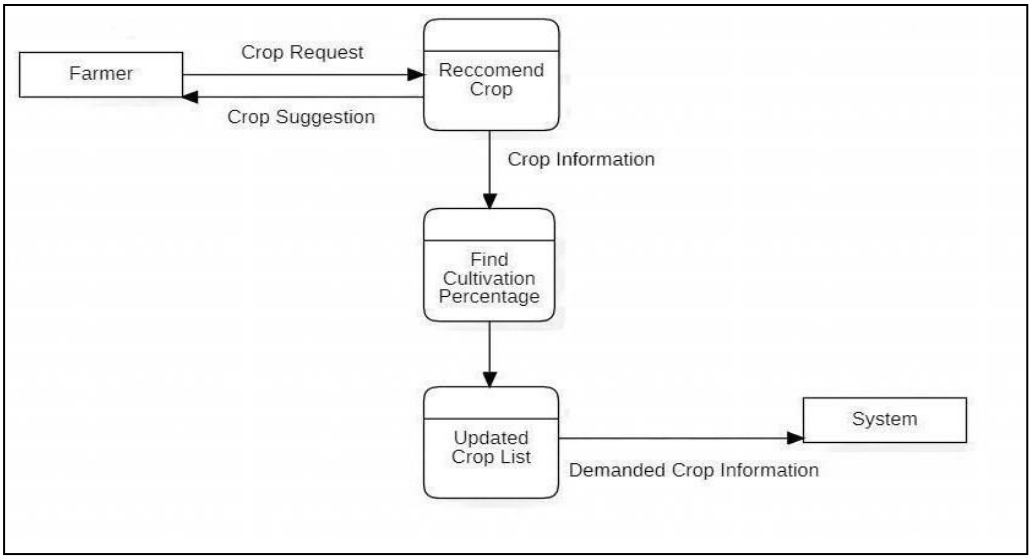


Figure 6.4: DFD Level-2

6.4.2 Activity Diagram

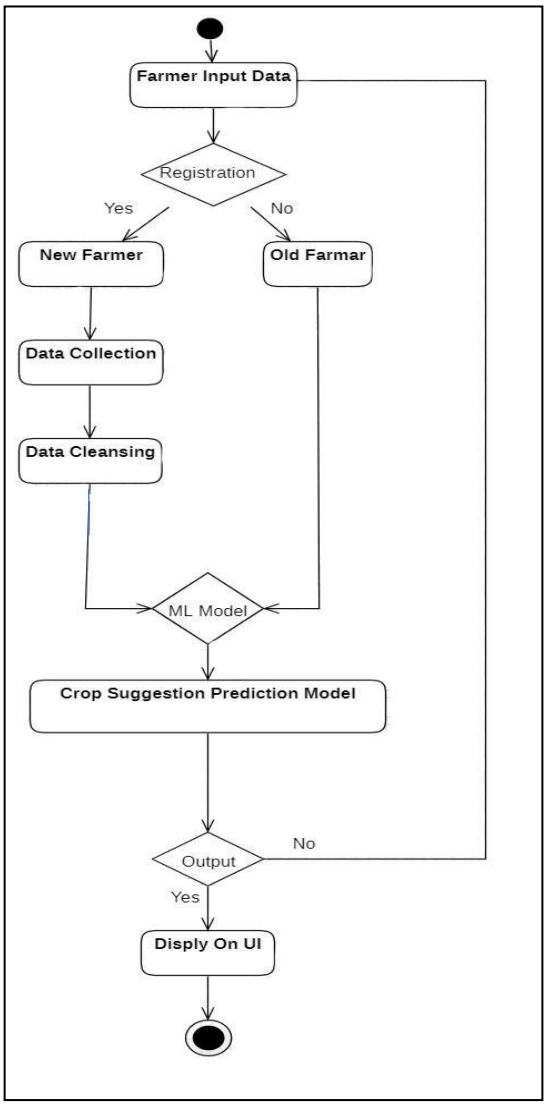


Figure 6.5: Activity Diagram

6.4.3 Non-Functional Requirements:

Interface Requirements

Home page

Login Page

Processing Page.

Result Page

Hardware Interfaces

The entire software requires a completely equipped computer system including monitor, keyboard, and other input output devices.

Software Interfaces

The system can use Microsoft as the operating system platform. System also makes use of certain GUI tools. To run this application we need java andabove as windows platform. To store data we need MySQL database.

Communication Interfaces

The system should also use to trained model file so we are uses variouslibrary for our project.

Performance Requirement

The performance of the system lies in the way it is handled. Every usermust be given proper guidance regarding how to use the system. The other factor which affects the performance is the absence of any of the suggested requirements

6.4.4 Sequence Diagram

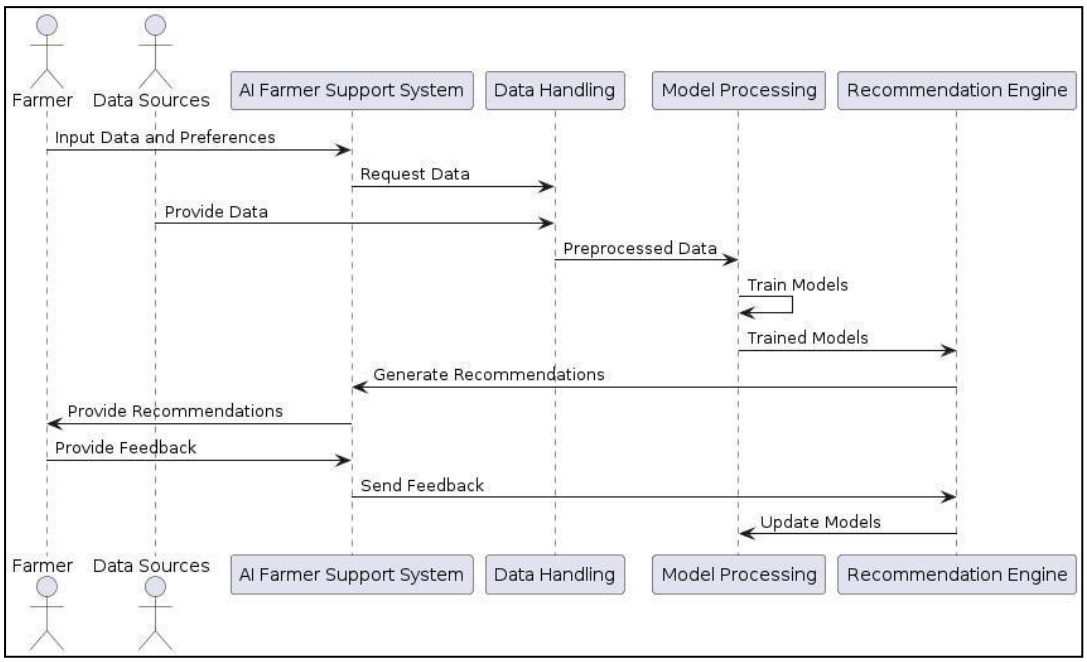


Fig. 6.6: Sequence Diagram

6.4.5 Design Constraints

1. Algorithm is designed to for preparation of actual functions in system.

2. System interface is designed in window for proper execution users have to provideproper input.

6.4.6 Software Interface Description

The software interface(s) to the outside world is (are) described. The requirements for Interfaces to other devices/systems/networks/human are stated.

Operating System: Windows11

Coding language: Java & Python

Database: My SQL

Tool: Android Studio

CHAPTER 7

DETAILED DESIGN DOCUMENT USING APPENDIX A AND B

7.1 INTRODUCTION

The workflow of a crop proposal prediction model begins with the user interacting through a consumer interface, commonly a cell application. The user enter is then processed, and the relevant facts is retrieved from a dataset. The facts undergoes pre-processing steps to put together it for the prediction model. The pre-processed statistics is used as enter for the crop thought prediction version, which employs a Random Forest Decision Tree algorithm to research the statistics and make predictions. The model's predictions are then provided to the person thru the end result prediction thing, possibly imparting crop hints or guidelines primarily based on the analyzed records. The process objectives to assist farmers or agricultural stakeholders in making informed decisions approximately crop selection and cultivation.

7.2 ARCHITECTURAL DESIGN

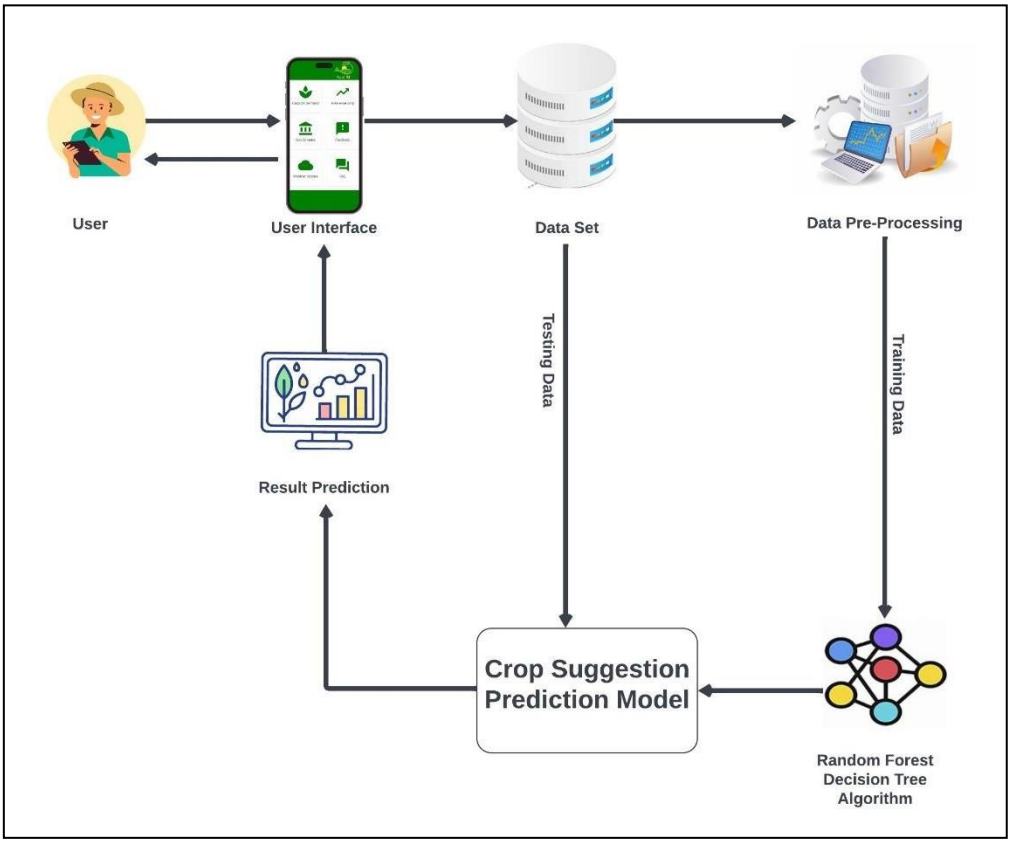


Fig.7.1: Architecture Diagram

7.3 DATA DESIGN (USING APPENDICES A AND B)

7.3.1 Internal software data structure

Data structures that are passed among components the software are described. The java.sql package defines an interface called Java.sql.Driver that makes to be imple-mented by all the JDBC drivers and a class called java.sql.Driver Manager that acts as the interface to the database clients for performing tasks like connecting to external resource managers, and setting log streams. When a JDBC client requests the Driver Manager to make a connection to an external resource manager, it delegates the task to an appropriate driver class implemented by the JDBC driver provided either by the resource manager vendor or a third party.

7.3.2 Database description

Farmer_ID: A unique identifier for each farmer in the dataset.

Geographical_Location: Coordinates or region name detailing the farmer's location.

Soil_Type: Classification of the soil found on the farmer's land (e.g., loamy, sandy, clay, etc.).

Weather_Condition: Descriptive data on typical weather patterns or current weather conditions affecting the area.

Crop_History: List of previously cultivated crops by the farmer over past seasons.

Month: The month or months during which the data was recorded, relevant for seasonal analysis.

Recommended_Crop: The crop recommended by the system based on the analysis of the provided data.

7.4 COMPONENT DESIGN

7.4.1 Class Diagram

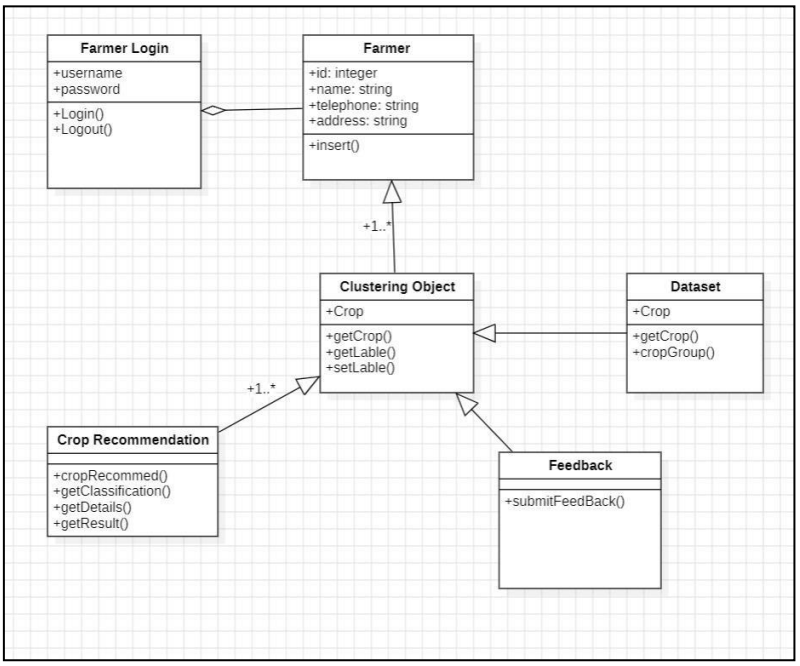


Fig.7.2: Class Diagram

CHAPTER 8

PROJECT IMPLEMENTATION

8.1 INTRODUCTION

Agriculture, as the backbone of many economies, faces challenges stemming from uncertainties in weather conditions, market dynamics, and resource management. In response to these challenges, we present the AI Farmer Support System—a trans-formative solution aimed at predicting crop yield and market prices to empower farmers with data-driven insights. In this era of technological advancements, theintegration of artificial intelligence and data analytics holds immense potential for revolutionizing traditional farming practices

8.2 TOOLS AND TECHNOLOGIES USED

Operating System: Windows11

Application Server: Apache Tomcat7.0

Coding language: Java & Python

Database: My SQL

Tool: Android Studio

8.3 ALGORITHM DETAILS

8.3.1 Random Forest

The algorithm used here is Random Forest. Random Forest is the most popular andpowerful algorithm of machine learning.

- Step 1: Assume N as number of training samples and M as number of variableswithin the classifier.

- Step 2: The number m as input variables to decide the decision at each node of thetree; m should be much less than M.

- Step 3: Consider training set by picking n times with replacement from all N avail-able training samples. Use the remaining of the cases to estimate the error of the tree, by forecasting their classes.

- Step 4: Randomly select m variables for each node on which to base the choice atthat

node. Evaluate the best split based on these m variables in the training set.

• Step 5: Each tree is fully grown and not pruned (as may be done in constructinga normal tree classifier). For forecasting, a new sample is pushed down the tree. It is assigned the label of the training sample in the terminal node it ends up in. This procedure is repeated over all trees in the ensemble, and the average vote of all treesis reported as random forest prediction. i.e. classifier having most votes.

8.3.2 Clustering

1. Data Preparation:

Gather and preprocess the dataset of 500 farmers, such as relevant variables along with soil type, climate conditions, and crop records.

2. Feature Selection:

Identify and pick out the maximum relevant capabilities or variables for clustering, together with soil kind, climate situations, and crop records.

3. Algorithm Selection:

Choose a suitable clustering algorithm (e.g., K-means, hierarchical clustering) primarily based on the nature of the dataset and clustering objectives.

4. Clustering Analysis:

Apply the selected clustering set of rules to partition farmers into distinct clusters primarily based on similarities of their agricultural traits.

5. Cluster Interpretation:

Analyze the ensuing clusters to apprehend the underlying patterns and traits of various agricultural practices or situations.

6. Integration with Decision Support System:

Incorporate the clustered information into the choice support system to enhance customized suggestions for farmers based on cluster-precise characteristics.

8.4 VERIFICATION AND VALIDATION

Verification:

Verification within the context of your crop advice machine entails ensuring that the software program successfully implements the specified functionalities. This procedure tests whether or not the device is built efficiently in keeping with the design specs and necessities. Verification sports encompass reviewing code, accomplishing peer code reviews, acting static code analysis, and walking unit assessments to make certain that every factor of the machine capabilities as meant. For example, verifying the suitable implementation of the Random Forest set of rules includes checking if the algorithm makes use of the proper parameters and well integrates with different system additives, which include information enter paperwork and output interfaces. This step is vital for catching and fixing logical errors, syntax problems, or implementation flaws early in the improvement segment.

Validation:

Validation, on the other hand, makes a speciality of ensuring that the software meets the person's desires and that the very last product provides the meant service. For your crop recommendation system, validation includes activities like undertaking consumer popularity checking out, in which farmers and other end-customers engage with the gadget to make certain it meets their requirements and expectations. This can consist of checking out the gadget’s capability to offer correct crop hints below various situations and verifying that it handles actual-international records successfully. Validation allows verify that the software program is able to operating in its meant environment and plays nicely in sensible, operational conditions. This segment ensures the machine now not simplest works successfully technically but is also certainly useful and usable for the farmers it's miles designed to help.

CHAPTER 9

SOFTWARE TESTING

9.1 TYPES OF TESTINGS

Software testing is a method for examining the ability of a framework and confirms thatit meets its results. It is produced by developers to keep up the quality of programming, software testing still remains a craftsmanship, because of less comprehension of the terms of testing. Fundamental issue in regards to the software testing is from the complication of programming: we can't test entire program with less complexity.

Unit Testing:

Theory: Unit trying out involves testing person devices or additives of the machine in isolation to make sure they characteristic as anticipated.

Application to Project: Each function or module liable for specific duties such as facts preprocessing, feature choice, clustering, and advice era must be examined independently. For instance, unit tests can validate that the information preprocessing characteristic efficaciously handles lacking values and outliers, the clustering set of rules walls statistics into significant clusters, and the recommendation engine generates accurate crop pointers primarily based on input facts.

White Box Testing:

Theory: White box trying out examines the inner shape and implementation of the device to validate its logic and code paths.

Application to Project: White container testing includes studying the source code of the machine to pick out capacity vulnerabilities, errors, or inefficiencies. Test instances can be designed to execute precise code paths, validate conditional statements, and make sure that facet instances are treated correctly. For instance, white field checking out can verify that the choice-making logic inside the recommendation engine follows the meant rules and produces constant results across extraordinary situations.

Black Box Testing:

Theory: Black container checking out evaluates the capability of the device without considering its inner shape or implementation information.

Application to Project: Black field checking out makes a speciality of validating the

outside behavior of the device from an stop-user angle. Test instances can be designed to simulate various person interactions, input information situations, and machine outputs. For example, black box testing can verify that the user interface accepts input information effectively, the clustering algorithm produces significant clusters, and the advice engine generates accurate crop hints primarily based on distinct agricultural contexts.

Integration Testing:

Theory: Integration checking out verifies the interactions and interfaces among extraordinary modules or components of the machine to make sure they paintings collectively seamlessly.

Application to Project: Integration testing entails checking out the mixing factors among the numerous modules or additives of the system. Test instances may be designed to validate information flows, communication protocols, and mistakes handling mechanisms between special subsystems. For instance, integration checking out can affirm that records preprocessing outcomes are efficiently handed to the clustering set of rules, and the clustering outcomes are appropriately utilized by the recommendation engine to generate personalised crop suggestions.

Functional Testing:

Theory: Functional testing evaluates the functional requirements of the system to ensure it plays as expected.

Application to Project: Functional trying out makes a speciality of validating precise functionalities or functions of the machine. Test cases can be designed to verify that each practical requirement is met and that the machine behaves in step with the specified user situations. For instance, purposeful trying out can validate that the person interface permits users to enter records correctly, the clustering algorithm as it should be agencies similar farmers collectively, and the advice engine affords applicable crop hints based totally on consumer inputs.

System Testing:

Theory: System trying out assesses the behavior and performance of the complete machine as a whole.

Application to Project: System testing includes comparing the overall capability, usability, and overall performance of the AI-pushed agricultural guide gadget. Test instances may be designed to validate the machine's give up-to-quit workflow, inclusive of data input, processing, clustering, recommendation technology, and consumer remarks mechanisms. For example, device testing can affirm that the device meets scalability necessities, plays successfully underneath one-of-a-kind load situations, and gives you accurate crop tips to farmers even as presenting a unbroken person experience.

9.2 TEST CASES AND TEST RESULTS

Testing of project problem statement using generated test data (using mathematicalmodels, GUI, Function testing principles, if any) selection and appropriate use of testing tools, testing of UML diagram's reliability.

Module-ID: 01

Modules to be tested: Registration

1. Enter the case insensitive Username click on Submit button.

Expected: It should display error.

2. Enter the case sensitive Username click on Submit button.

Expected: It should accept.

3. Enter the case insensitive Password click on Submit button.

Expected: It should display error.

4. Enter the case sensitive Password click on Submit button.

Expected: It should accept.

5. Enter the case insensitive Mobile Number click on Submit button.

Expected: It should display error.

6. Enter the case sensitive Mobile Number click on Submit button.

Expected: It should accept.

7. Enter the wrong address and click on Submit button.

Expected: It should display error.

8. Enter the correct address and click on Submit button.

Expected: It should accept.

Test Case_ID	Description	Test case I/P	Actual Result	Expected result	Test case criteria (P/F)
101	Enter the case insensitive Username click on Submit button.	Username	Error comes	Error Should come	P
102	Enter the case sensitive Username click on Submit button.	Username	Accept	Accept Username	P
201	Enter the case insensitive Password click on Submit button.	Password	Error comes	Error Should come	P
202	Enter the case sensitive Password click on Submit button	Password	Accept	Accept	P
301	Enter the case insensitive Mobile Number click on Submit button	Mobile Number	Error comes	Error Should come	P
302	Enter the case sensitive Mobile Number click on Submit button.	Mobile Number	Accept	Accept	P

Table 9.1: Registration Test Cases

Module-ID: 2

Modules to be tested: Login

1. Enter the correct username and wrong password click on Submit button.

Expected: It should display error.

2. Enter the wrong username and correct password and click on Submit button.

Expected: It should display error.

3. Enter the correct username and password and click on Login button.

Expected: It should display welcome page.

4. After login with valid credentials click on back button.

Expected: The page should be expired.

5. After login with valid credentials copy the URL and paste in another browser.

Expected: It should not display the user's welcome page.

6. Check the password with Lower case and upper case.

Expected: Password should be case sensitive.

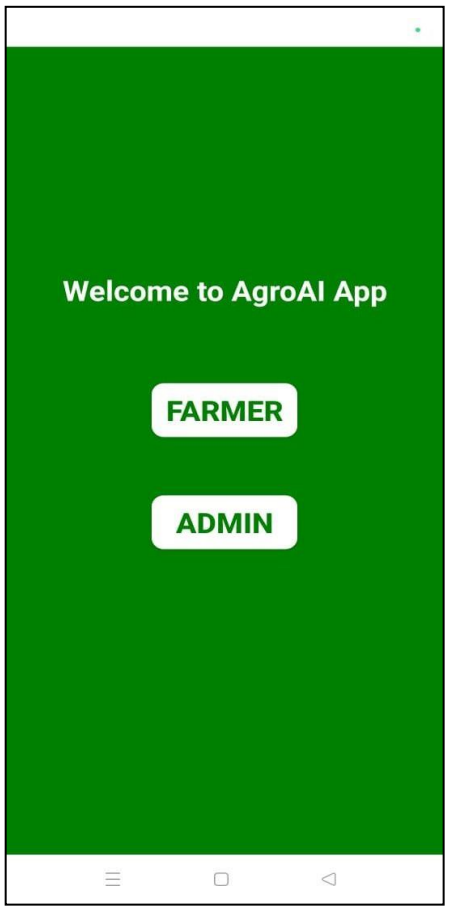
Test Case_ID	Description	Test case I/P	Actual Result	Expected result	Test case criteria (P/F)
001	Enter the correct username and wrong password click on Login button.	Username Password	Error comes	Error Should come	P
002	Enter the wrong username and correct password click on Login button,	Username Password	Error comes	Error Should come	P
003	Enter the correct username and password and click on Login button.	Username Password	Accept	Accept	P

Table 9.2: Login Test Cases

CHAPTER 10

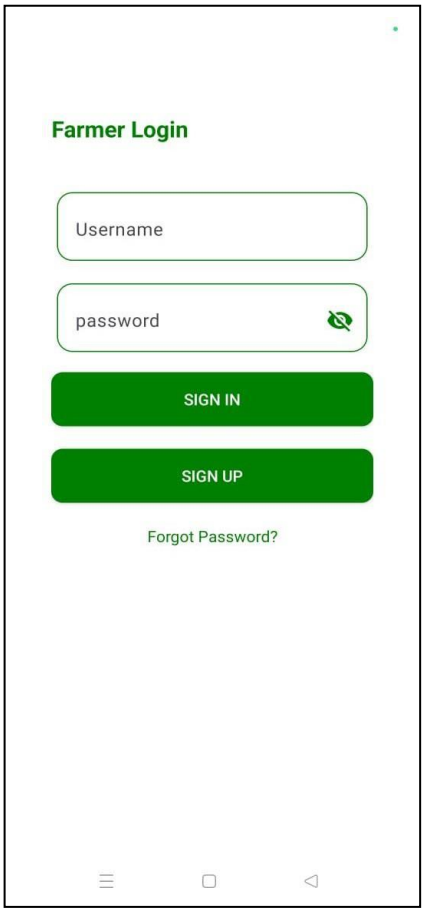
RESULTS

10.1 SCREENSHOTS



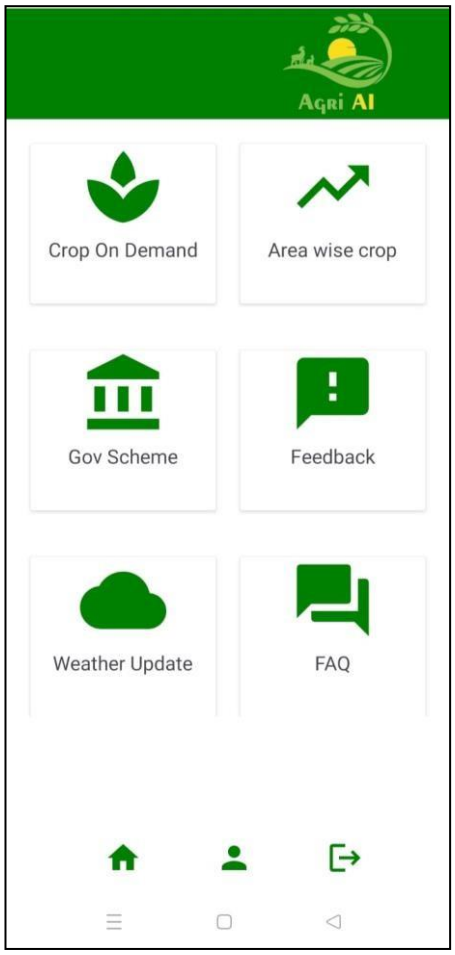
Welcome Page:

The welcome screen of the AI-driven Farmer Support System app serves as the initial interface that introduces users to the application's purpose and key features.



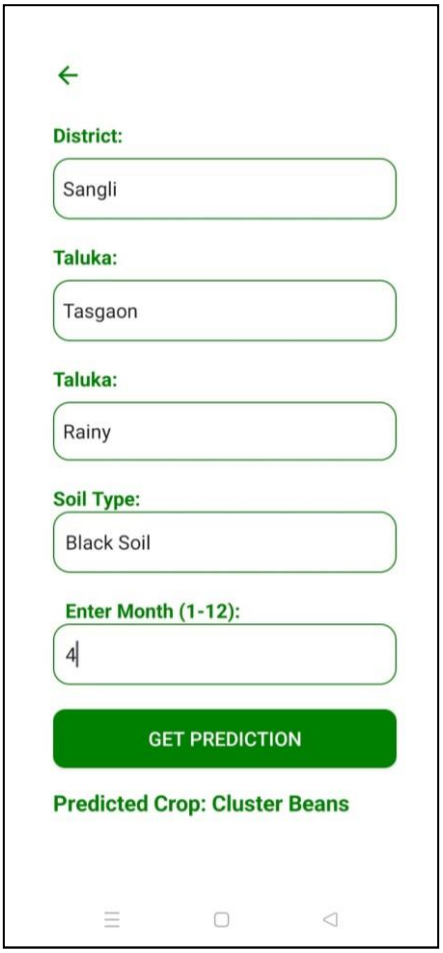
Sign in/Sign up Screen:

The Sign In/Sign Up screen is a critical component of the AI-driven Farmer Support System app, designed to allow users to securely access their personalized dashboards and features.



Main Dashboard:

The Main Dashboard screen is the central hub of the AI-driven Farmer Support System app, providing users with an overview of key information and quick access to various features.



Crop on Demand Screen:

The Crop on Demand screen within the AI-driven Farmer Support System app is designed to provide users with real-time information about crop demand in their region.

User Profile Screen:

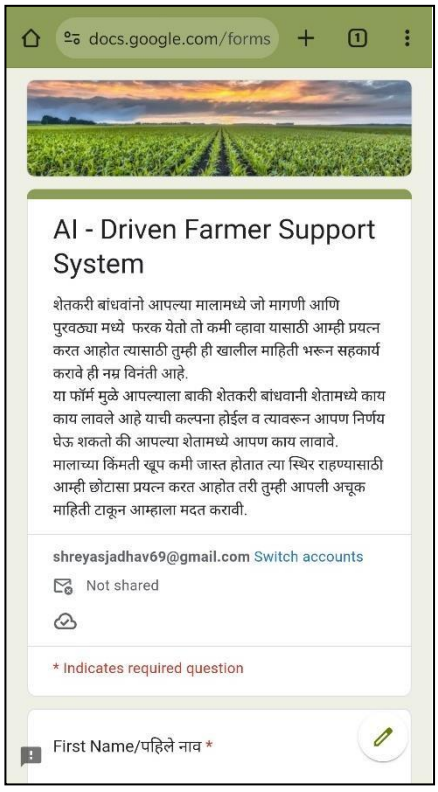
The User Profile screen in the AI-driven Farmer Support System app is where users can view and manage their personal information, settings, and preferences.

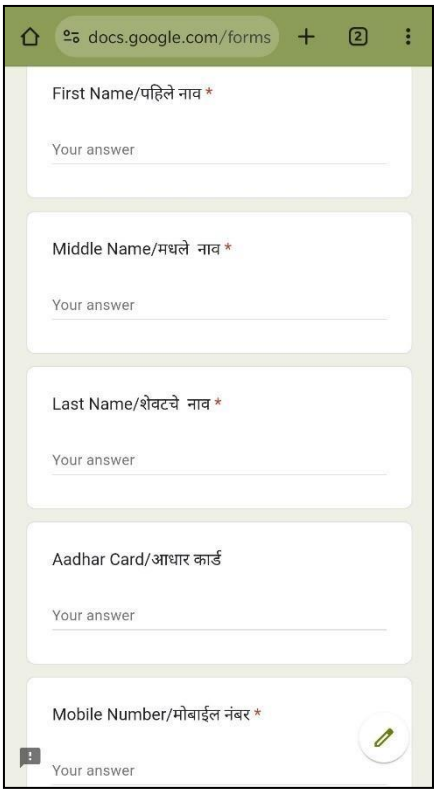
10.2 DATASET CREATION

- Data Collection via Google Forms: We designed and disseminated Google Forms to 500 farmers in diverse agricultural regions, capturing key variables such as soil type, climate conditions, historical crop choices, and temporal factors, ensuring comprehensive and uniform data input.

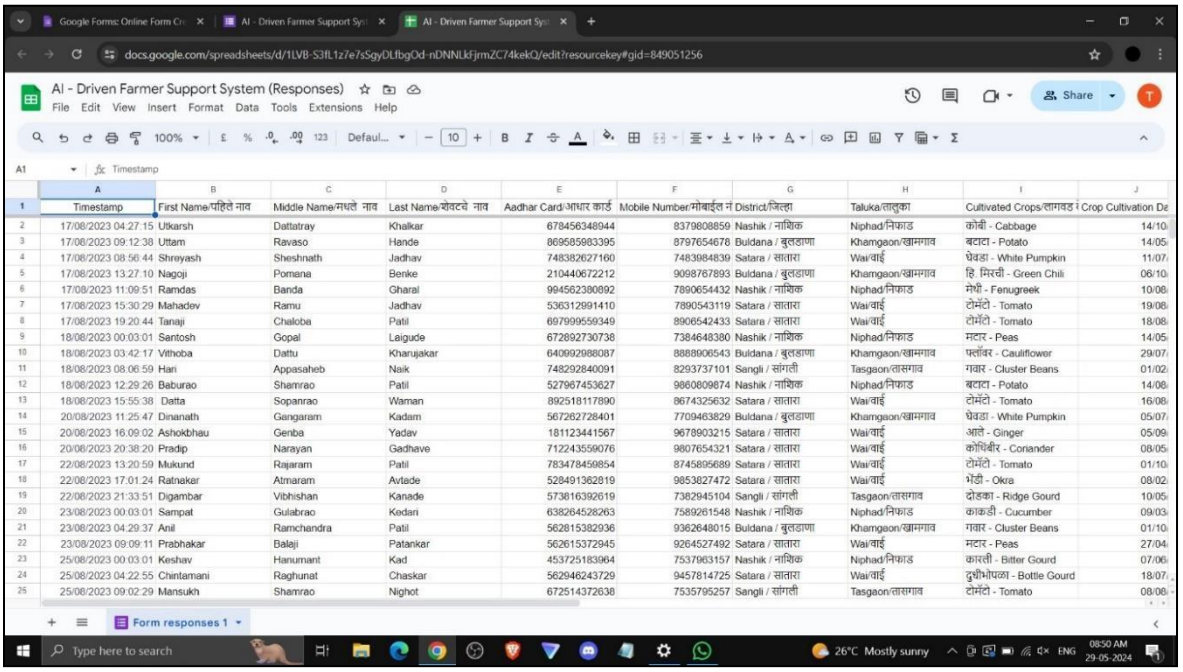
- Data Export and Organization in Excel: Upon collection, the responses from Google Forms were exported into Excel, where the data was systematically organized and prepared for analysis, facilitating easier manipulation and integration into the decision support system.

- Google Form:

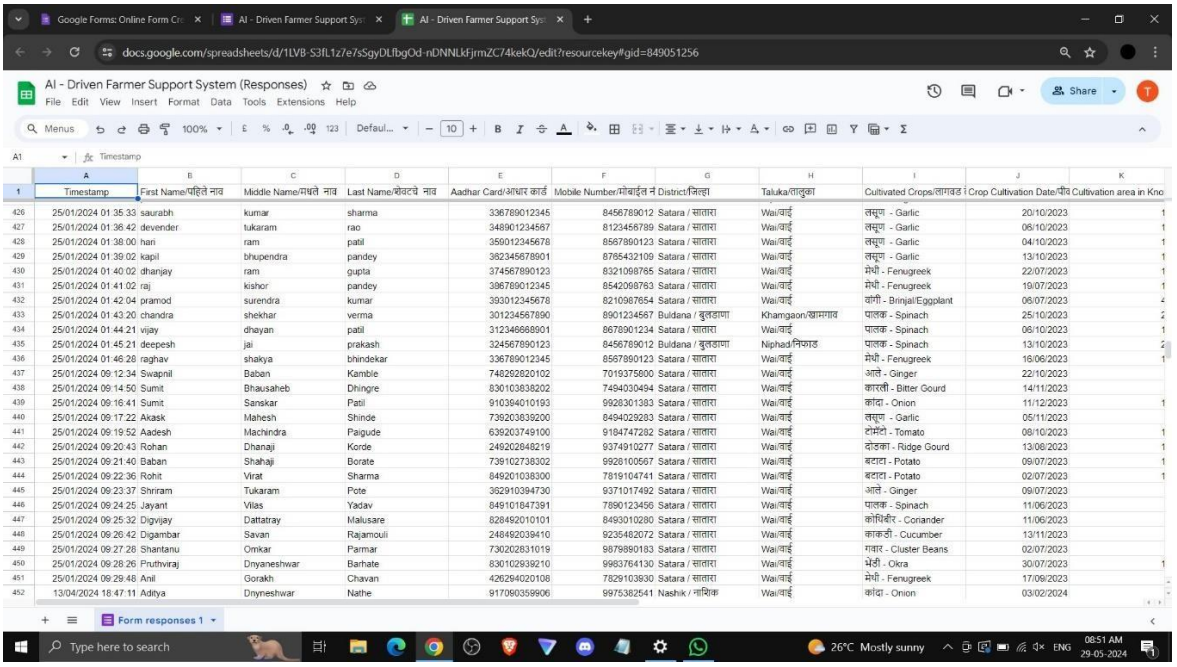




- Farmer Dataset



	Timestamp	First Name/पहिले नाव	Middle Name/मधले नाव	Last Name/शेवटचे नाव	Aadhar Card/आधार कार्ड	Mobile Number/मोबाईल नं	District/जिल्हा	Taluka/तालुका	Cultivated Crops/लागवड	Crop Cultivation Da
2	17/08/2023 04:27:15	Utkarsh	Dattatray	Khalkar	678456348944	8379808859	Nashik / नाशिक	Niphad/निफाड	कोबी - Cabbage	14/10
3	17/08/2023 09:12:38	Uttam	Ravaso	Hande	869585983395	8797654678	Buldana / बुलडाणा	Khamgaon/खामगाव	बटाटा - Potato	14/05
4	17/08/2023 08:56:44	Shreyash	Sheshnath	Jadhav	748382627160	7483984839	Satara / सातारा	Wai/वाई	घेवडा - White Pumpkin	11/07
5	17/08/2023 13:27:10	Nagoji	Pomana	Benke	210440672212	9098767893	Buldana / बुलडाणा	Khamgaon/खामगाव	हि. मिरची - Green Chili	06/10
6	17/08/2023 11:09:51	Ramdas	Banda	Gharal	994562380892	7890654432	Nashik / नाशिक	Niphad/निफाड	मेथी - Fenugreek	10/08
7	17/08/2023 15:30:29	Mahadev	Ramu	Jadhav	536312991410	7890543119	Satara / सातारा	Wai/वाई	टोमॅटो - Tomato	19/08
8	17/08/2023 19:20:44	Tanaji	Chalobа	Patil	697999559349	8906542433	Satara / सातारा	Wai/वाई	टोमॅटो - Tomato	18/08
9	18/08/2023 00:03:01	Santosh	Gopal	Laigude	672892730738	7384648380	Nashik / नाशिक	Niphad/निफाड	मटार - Peas	14/05
10	18/08/2023 03:42:17	Vithoba	Dattu	Kharujakar	640092988087	8888906543	Buldana / बुलडाणा	Khamgaon/खामगाव	फ्लॉवर - Cauliflower	29/07
11	18/08/2023 08:06:59	Hari	Appasaheb	Naik	748292840091	8293737101	Sangli / सांगली	Tasgaon/तासगाव	गवार - Cluster Beans	01/02
12	18/08/2023 12:29:26	Baburao	Shamrao	Patil	527967453627	9860809874	Nashik / नाशिक	Niphad/निफाड	बटाटा - Potato	14/08
13	18/08/2023 15:55:38	Datta	Sopanrao	Waman	892518117890	8674325632	Satara / सातारा	Wai/वाई	टोमॅटो - Tomato	16/08
14	20/08/2023 11:25:47	Dinanath	Gangaram	Kadam	567262728401	7709463829	Buldana / बुलडाणा	Khamgaon/खामगाव	घेवडा - White Pumpkin	05/07
15	20/08/2023 16:09:02	Ashokbhau	Genba	Yadav	181123441567	9678903215	Satara / सातारा	Wai/वाई	आले - Ginger	05/09
16	20/08/2023 20:38:20	Pradip	Narayan	Gadhave	712243559076	9807654321	Satara / सातारा	Wai/वाई	कोथिंबीर - Coriander	08/05
17	22/08/2023 13:20:59	Mukund	Rajaram	Patil	783478459854	8745895689	Satara / सातारा	Wai/वाई	टोमॅटो - Tomato	01/10
18	22/08/2023 17:01:24	Ratnakar	Atmaram	Avtade	528491362819	9853627472	Satara / सातारा	Wai/वाई	भेंडी - Okra	08/02
19	22/08/2023 21:33:51	Digambar	Vibhishan	Kanade	573816392619	7382945104	Sangli / सांगली	Tasgaon/तासगाव	दोडका - Ridge Gourd	10/05
20	23/08/2023 00:03:01	Sampat	Gulabrao	Kedari	638264528263	7589261548	Nashik / नाशिक	Niphad/निफाड	काकडी - Cucumber	09/03
21	23/08/2023 04:29:37	Anil	Ramchandra	Patil	562815382936	9362648015	Buldana / बुलडाणा	Khamgaon/खामगाव	गवार - Cluster Beans	01/10
22	23/08/2023 09:09:11	Prabhakar	Balaji	Patankar	562615372945	9264527492	Satara / सातारा	Wai/वाई	मटार - Peas	27/04
23	25/08/2023 00:03:01	Keshav	Hanumant	Kad	453725183064	7537963157	Nashik / नाशिक	Niphad/निफाड	कारली - Bitter Gourd	07/06
24	25/08/2023 04:22:55	Chintamani	Raghunat	Chaskar	562946243729	9457814725	Satara / सातारा	Wai/वाई	दुधीभोपळा - Bottle Gourd	18/07
25	25/08/2023 09:02:29	Mansukh	Shamrao	Nighot	672514372638	7535795257	Sangli / सांगली	Tasgaon/तासगाव	टोमॅटो - Tomato	08/06



	Timestamp	First Name/पहिले नाव	Middle Name/मधले नाव	Last Name/शेवटचे नाव	Aadhar Card/आधार कार्ड	Mobile Number/मोबाईल नं	District/जिल्हा	Taluka/तालुका	Cultivated Crops/लागवड	Crop Cultivation Date/पीक	Cultivation area in Knc
426	25/01/2024 01:35:33	saurabh	kumar	sharma	336789012345	8456789012	Satara / सातारा	Wai/वाई	लसूण - Garlic	20/10/2023	1
427	25/01/2024 01:36:42	devender	tukaram	rao	348901234567	8123456789	Satara / सातारा	Wai/वाई	लसूण - Garlic	06/10/2023	1
428	25/01/2024 01:38:00	hari	ram	patil	359012345678	8567890123	Satara / सातारा	Wai/वाई	लसूण - Garlic	04/10/2023	1
429	25/01/2024 01:39:02	kapil	bhupendra	pandey	362345678901	8765432109	Satara / सातारा	Wai/वाई	लसूण - Garlic	13/10/2023	1
430	25/01/2024 01:40:02	dhanjay	ram	gupta	374567890123	8321098765	Satara / सातारा	Wai/वाई	मेथी - Fenugreek	22/07/2023	1
431	25/01/2024 01:41:02	raj	kishor	pandey	386789012345	8542098763	Satara / सातारा	Wai/वाई	मेथी - Fenugreek	19/07/2023	1
432	25/01/2024 01:42:04	pramod	surendra	kumar	393012345678	8210987654	Satara / सातारा	Wai/वाई	वांगी - Brinjal/Eggplant	06/07/2023	4
433	25/01/2024 01:43:20	chandra	shekhar	verma	301234567890	8901234567	Buldana / बुलडाणा	Khamgaon/खामगाव	पालक - Spinach	25/10/2023	2
434	25/01/2024 01:44:21	vijay	dhayan	patil	312346668901	8678901234	Satara / सातारा	Wai/वाई	पालक - Spinach	06/10/2023	1
435	25/01/2024 01:45:21	deepesh	jai	prakash	324567890123	8456789012	Buldana / बुलडाणा	Niphad/निफाड	पालक - Spinach	13/10/2023	2
436	25/01/2024 01:46:28	raghav	shakya	bhindekar	336789012345	8567890123	Satara / सातारा	Wai/वाई	मेथी - Fenugreek	16/06/2023	1
437	25/01/2024 09:12:34	Swapnil	Baban	Kamble	748292820102	7019375600	Satara / सातारा	Wai/वाई	आले - Ginger	22/10/2023	
438	25/01/2024 09:14:50	Sumit	Bhausaheb	Dhingre	830103838202	7494030494	Satara / सातारा	Wai/वाई	कारली - Bitter Gourd	14/11/2023	
439	25/01/2024 09:16:41	Sumit	Sanskar	Patil	910394010193	9928301383	Satara / सातारा	Wai/वाई	कांदा - Onion	11/12/2023	1
440	25/01/2024 09:17:22	Akask	Mahesh	Shinde	739203839200	8494029283	Satara / सातारा	Wai/वाई	लसूण - Garlic	05/11/2023	
441	25/01/2024 09:19:52	Aadesh	Machindra	Paigude	639203749100	9184747282	Satara / सातारा	Wai/वाई	टोमॅटो - Tomato	08/10/2023	1
442	25/01/2024 09:20:43	Rohan	Dhanaji	Korde	249202648219	9374910277	Satara / सातारा	Wai/वाई	दोडका - Ridge Gourd	13/06/2023	1
443	25/01/2024 09:21:40	Baban	Shahaji	Borate	739102738302	9928100567	Satara / सातारा	Wai/वाई	बटाटा - Potato	09/07/2023	1
444	25/01/2024 09:22:36	Rohit	Virat	Sharma	849201038300	7819104741	Satara / सातारा	Wai/वाई	बटाटा - Potato	02/07/2023	1
445	25/01/2024 09:23:37	Shriram	Tukaram	Pote	362910394730	9371017492	Satara / सातारा	Wai/वाई	आले - Ginger	09/07/2023	
446	25/01/2024 09:24:25	Jayant	Vilas	Yadav	849101847391	7890123456	Satara / सातारा	Wai/वाई	पालक - Spinach	11/06/2023	
447	25/01/2024 09:25:32	Digvijay	Dattatray	Malusare	828492010101	8493010280	Satara / सातारा	Wai/वाई	कोथिंबीर - Coriander	11/06/2023	
448	25/01/2024 09:26:42	Digambar	Savan	Rajamouli	248492039410	9235482072	Satara / सातारा	Wai/वाई	काकडी - Cucumber	13/11/2023	
449	25/01/2024 09:27:28	Shantanu	Omkar	Parmar	730202831019	9879890183	Satara / सातारा	Wai/वाई	गवार - Cluster Beans	02/07/2023	
450	25/01/2024 09:28:26	Pruthviraj	Dnyaneshwar	Barhate	830102939210	9983764130	Satara / सातारा	Wai/वाई	भेंडी - Okra	30/07/2023	1
451	25/01/2024 09:29:48	Anil	Gorakh	Chavan	426294020108	7829103930	Satara / सातारा	Wai/वाई	मेथी - Fenugreek	17/09/2023	
452	13/04/2024 18:47:11	Aditya	Dnyneshwar	Nathe	917090359906	9975382541	Nashik / नाशिक	Wai/वाई	कांदा - Onion	03/02/2024	

CHAPTER 11

DEPLOYMENT AND MAINTENANCE

11.1 INSTALLATION AND UN-INSTALLATION

Installation of Android Studio:

1. Download Android Studio: Visit the official Android Studio website [17] and download the installer suitable for your operating system. (Windows, macOS, or Linux).

2. Run the Installer: Once the download is complete, run the installer file to start the installation process.

3. Follow Installation Wizard: The installation wizard will guide you through the setup process. Follow the on-screen instructions, including accepting the license agreement and choosing the installation location.

4. Install Android SDK: During the installation, Android Studio will prompt you to install the Android SDK (Software Development Kit). Allow the installer to download and install the necessary components.

5. Configure Android Studio: After the installation is complete, launch Android Studio. Follow the initial setup wizard to configure preferences such as theme, UI layout, and SDK components.

6. Create or Import Projects: Once Android Studio is set up, you can create a new project from scratch or import existing projects from version control or local directories.

Installation of Python and Necessary Packages for Random Forest:

1. Install Python:

Download the latest version of Python from the official website [18] and run the installer.

During installation, ensure to check the box that says "Add Python to PATH" to make Python accessible from the command line.

Follow the prompts in the installation wizard to complete the installation.

2. Verify Python Installation:

Open a command prompt (Windows) or terminal (macOS/Linux).

Type python --version and press Enter. This command should display the installed Python version, confirming a successful installation.

3. Install Required Libraries:

Use pip, the Python package manager, to install the necessary libraries for working with Random Forest: pip install numpy pandas scikit-learn

4. Verify Library Installation:

After installing the required libraries, verify their installation by importing them in a Python script or interactive Python shell:

python

import numpy

import pandas

import sklearn

If no errors occur, the libraries are successfully installed and ready for use.

Uninstallation of Android Studio:

1. Close Android Studio: Ensure that Android Studio and any associated processes (such as the Android Emulator) are closed before proceeding with uninstallation.

2. Remove Android Studio Files: On Windows, go to "Control Panel" > "Programs" > "Programs and Features." Find Android Studio in the list of installed programs, right-click, and select "Uninstall." Follow the on-screen prompts to complete the uninstallation process. On macOS, drag the Android Studio application to the Trash and empty the Trash to remove it. On Linux, use the package manager or remove the Android Studio directory manually.

3. Delete Android Studio Settings: After uninstalling Android Studio, delete any remaining settings or cache files. These are typically located in the user's home directory under folders such as ".android" and ".AndroidStudio"

4. Remove Android SDK: Optionally, you can also remove the Android SDK files if you no longer need them. The SDK is typically installed in a separate directory from Android Studio and can be deleted manually.

5. Clean Up System Variables (Optional): Remove any environment variables or system paths that were added during the Android Studio installation. This step is optional but can help clean up your system configuration.

By following these steps, you can install and uninstall Android Studio effectively, ensuring a smooth developer experience on your machine.

Uninstallation of Python and Libraries (Optional):

1. Uninstall Python:

To uninstall Python, follow the standard procedure for your operating system:

On Windows: Go to "Control Panel" > "Programs" > "Programs and Features." Find Python in the list of installed programs, right-click, and select "Uninstall."

On macOS: Remove the Python framework from the /Applications directory and any Python-related entries from the PATH environment variable in the shell configuration files.

On Linux: Use the package manager or manually remove Python and its associated files.

2. Uninstall Python Libraries:

To uninstall Python libraries installed via pip, use the following command:

pip uninstall numpy pandas scikit-learn

Confirm the removal when prompted.

By following these steps, we can installed Python and the necessary libraries for working with Random Forest.

11.2 USER HELP

1. Complete and Accurate Data Entry: Ensure you input all relevant farm data accurately to receive precise recommendations tailored to your specific farming needs.

2. Regular Updates: Keep your data up to date by regularly updating information such as crop choices, soil conditions, and any changes in climate patterns.

3. Feedback and Interaction: Provide feedback on the recommendations received and interact with the app to improve the accuracy of future suggestions.

4. Understand Recommendations: Take the time to understand the rationale behind the recommendations provided by the app, as this can help you make informed decisions for your farm.

5. Regular Monitoring: Monitor the performance of your crops based on the app's recommendations and adjust your strategies as needed for optimal results.

6. FAQs: Include a list of frequently asked questions (FAQs) with answers to common user queries and issues.

CHAPTER 12

CONCLUSION AND FUTURE SCOPE

12.1 CONCLUSION

The AI Farmer Support System is a transformative tool for Indian farmers, offeringdata-driven insights for informed decision-making. Our research and implementation have demonstrated its significant impact on Indian agriculture and rural development. Key findings include improved crop yields and income stability among adopting farmers, reducing income fluctuations. The system's commitment to eco-friendly practices contributes to sustainability and environmental responsibility. Strong user adoption and engagement underline the system's practicality and acceptance. The feedback mechanism plays a pivotal role in its continuous improvement. As we lookahead, the AI Farmer Support System holds promise for empowering farmers, promoting sustainability, and expanding its impact through scalability and collaboration. In conclusion, this system represents a significant step towards improving Indian agriculture, benefiting millions of farmers, and promoting a sustainable future.

12.2 FUTURE SCOPE

The project can be enhanced by integrating IoT sensors that collect real-time data on soil moisture, nutrient levels, and weather conditions, facilitating more precise and dynamic crop recommendations. Additionally, incorporating a collaboration platform within the app enables farmers to share insights and compare performance metrics with peers, both locally and globally, promoting a community-based approach to agricultural improvement. Extending the application's compatibility from Android Studio to Flutter ensures multi-platform support, including web browsers and desktop environments, which broadens user accessibility and ensures consistent data synchronization across various devices.

ANNEXURE A

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[18] https://www.python.org/downloads/

ANNEXURE B

PROJECT PLANNER

Schedule		Date	Project Activity
July	1st Week	01/07/2023	Project Topic Searching
	2nd Week	08/07/2023	Project Topic Selection
	3rd Week	15/07/2023	Synopsis Submission
August	1st Week	05/08/2023	Presentation On Project Ideas
	2nd Week	12/08/2023	Submission Of Literature Survey
	3rd Week	19/08/2023	Feasibility Assessment
September	1st Week	02/09/2023	Documentation for paper publishing.
	3rd Week	16/09/2023	Design Of Mathematical Model
	4th Week	24/09/2023	Paper is publish.
October	1st Week	09/10/2023	Report Preparation And Submission
December	3rd Week	19/12/2023	1st module presentation
	4th Week	26/12/2023	Discussion and implementation of 2nd module
January	1st Week	02/01/2024	Preparation for conference
	2nd Week	09/01/2024	Study of algorithm.
	3rd Week	16/01/2024	Discussion about modification.
	4th Week	24/01/2024	1st and 2nd module presentation
	5th Week	30/01/2024	Discussion on flow of project and designing new module
February	1st Week	06/02/2024	Modification of modules.
	2nd Week	13/02/2024	Designed test cases for our module.
	3rd Week	20/02/2024	Worked on user interface.
March	1st Week	06/03/2024	Integration of all modules.
April	1st Week	8/04/2024	Final Report.
May	1st Week	10/05/2024	Final Presentation.

Table B. Project Planner

ANNEXURE C

REVIEWERS COMMENTS OF PAPER SUBMITTED

1. Paper Title: AI- Driven Farmer Support System

2. Name of the Conference/Journal where paper submitted: Journal of Emerging Technologies and Innovative Research

3. Paper accepted/rejected: Accepted

4. Review comments by reviewer: NA

5. Corrective actions if any: NA

Journal of Emerging Technologies and Innovative Research

An International Open Access Journal Peer-reviewed, Refereed Journal

www.jetir.org | editor@jetir.org An International Scholarly Indexed Journal

Certificate of Publication

The Board of

Journal of Emerging Technologies and Innovative Research (ISSN : 2349-5162)

Is hereby awarding this certificate to

Tejas Hirurkar

In recognition of the publication of the paper entitled

AI-Driven Farmer Support System

Published In JETIR (www.jetir.org) ISSN UGC Approved (Journal No: 63975) & 7.95 Impact Factor

Published in Volume 10 Issue 12 , December-2023 | Date of Publication: 2023-12-12

EDITOR

EDITOR IN CHIEF

JETIR2312223 Research Paper Weblink http://www.jetir.org/view?paper=JETIR2312223 Registration ID : 529836

An International Scholarly Open Access Journal, Peer-Reviewed, Refereed Journal Impact Factor Calculate by Google Scholar and Semantic Scholar | AI-Powered Research Tool, Multidisciplinary, Monthly, Multilanguage Journal Indexing in All Major Database & Metadata, Citation Generator

1. Paper Title: AI- Driven Farmer Support System

2. Name of the Conference/Journal where paper submitted: STM Journals (UGCON)

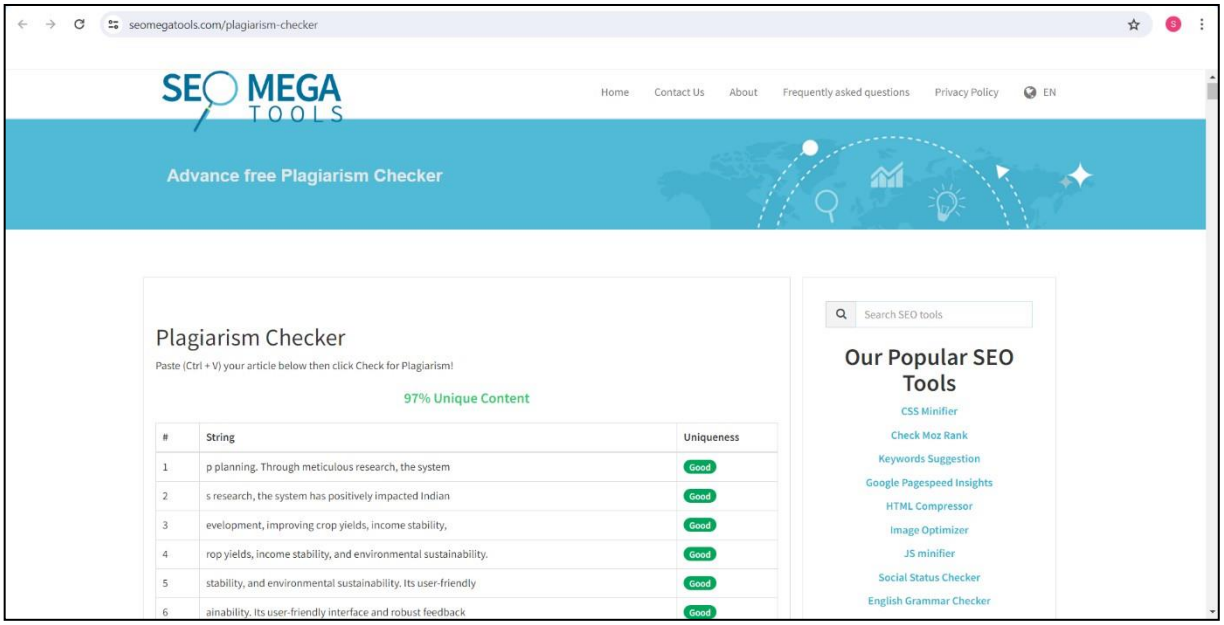
3. Paper accepted/rejected: Accepted

4. Review comments by reviewer: Work on Literature Survey & write in brief about Proposed System

5. Corrective actions if any: Increased Dataset.

ANNEXURE D

PLAGIARISM REPORT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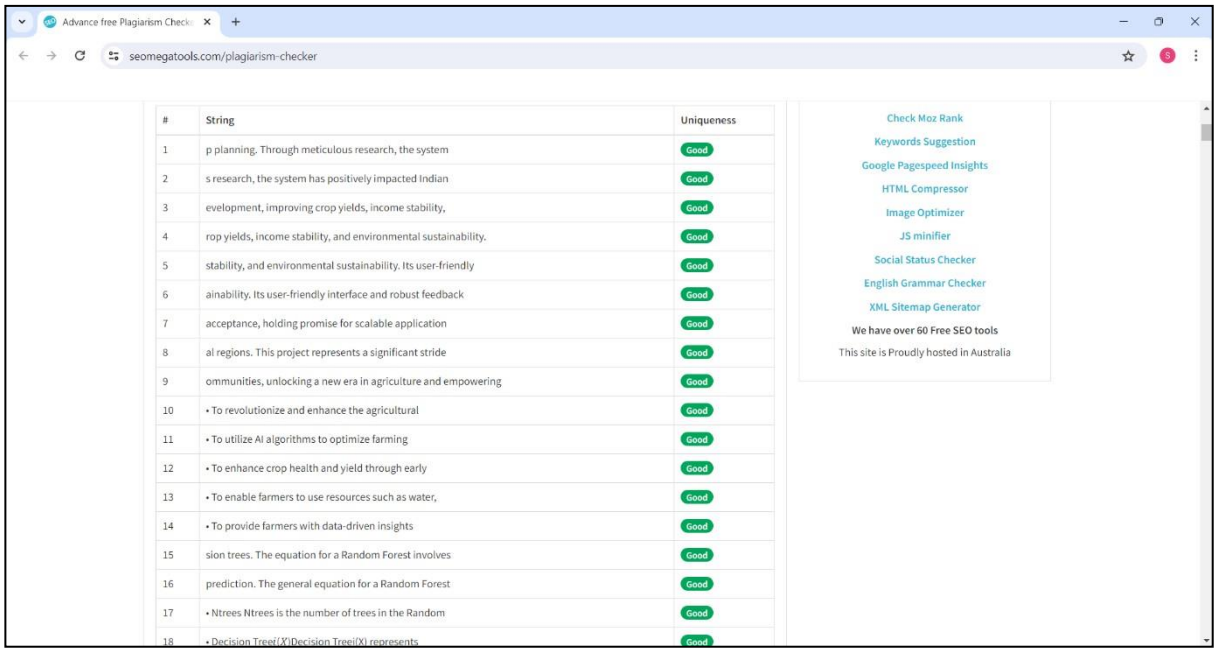
Paste (Ctrl + V) your article below then click Check for Plagiarism!
97% Unique Content
String Uniqueness
1 p planning. Through meticulous research, the system Good
2 s research, the system has positively impacted Indian Good
3 evelopment, improving crop yields, income stability, Good
4 rop yields, income stability, and environmental sustainability. Good
5 stability, and environmental sustainability. Its user-friendly Good
6 ainability. Its user-friendly interface and robust feedback Good
Search SEO tools
Our Popular SEO Tools
CSS Minifier
Check Moz Rank
Keywords Suggestion
Google Pagespeed Insights
HTML Compressor
Image Optimizer
JS minifier
Social Status Checker
English Grammar Checker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String Uniqueness
1 p planning. Through meticulous research, the system Good
2 s research, the system has positively impacted Indian Good
3 evelopment, improving crop yields, income stability, Good
4 rop yields, income stability, and environmental sustainability. Good
5 stability, and environmental sustainability. Its user-friendly Good
6 ainability. Its user-friendly interface and robust feedback Good
7 acceptance, holding promise for scalable application Good
8 al regions. This project represents a significant stride Good
9 ommunities, unlocking a new era in agriculture and empowering Good
10 • To revolutionize and enhance the agricultural Good
11 • To utilize AI algorithms to optimize farming Good
12 • To enhance crop health and yield through early Good
13 • To enable farmers to use resources such as water, Good
14 • To provide farmers with data-driven insights Good
15 sion trees. The equation for a Random Forest involves Good
16 prediction. The general equation for a Random Forest Good
17 • Ntrees Ntrees is the number of trees in the Random Good
18 • Decision Tree(X)Decision Tree(X) represents Good
Check Moz Rank
Keywords Suggestion
Google Pagespeed Insights
HTML Compressor
Image Optimizer
JS minifier
Social Status Checker
English Grammar Checker
XML Sitemap Generator
We have over 60 Free SEO tools
This site is Proudly hosted in Australia

ANNEXURE E

INFORMATION OF PROJECT GROUP MEMBERS

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2. Date of Birth: 14/08/2002

3. Gender: Male

4. Permanent Address: Flat no. 305, Meghmalhar Building, Warje, Pune-411058

5. E-Mail: Tejashirurkar78@gmail.com

6. Mobile/Contact No.: 8551970945

7. Placement Details:

8. Paper Published: Yes

1. Name: Shreyash Sheshnath Jadhav

2. Date of Birth: 27/02/2002

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6. Mobile/Contact No.: 9370329927

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8. Paper Published: Yes

1. Name: Utkarsh Dattatray Khalkar

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8. Paper Published: Yes

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6. Mobile/Contact No.: 8669823635
7. Placement Details:
8. Paper Published: Yes