REVOLUTIONIZING AGRICULTURE:
CROP HEALTH MONITORING FOR ENHANCED PRODUCTIVITY

A PROJECT REPORT

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Under the guidance of,
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in partial fulfillment for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

At

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY

BENGALURU

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PRESIDENCY UNIVERSITY

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

This is to certify that the Project report **"REVOLUTIONIZING AGRICULTURE: CROP HEALTH MONITORING FOR ENHANCED PRODUCTIVITY"** being submitted by "Srishti Singh, Neha, Kadiri Manasi, Rahul S, Shreyanth R" bearing roll number(s) "20201CSE0865, 20201CSE0897, 20201CSE0859, 20201CSE0855, 20201CSE0869" in partial fulfilment of requirement for the award of degree of Bachelor of Technology in Computer Science and Engineering is a bonafide work carried out under mysupervision.

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DECLARATION

We hereby declare that the work, which is being presented in the project report entitled **Revolutionizing Agriculture: Crop Health Monitoring System in** partial fulfilment for the award of Degree of **Bachelor of Technology** in **Computer Science and Engineering**, is a record of our own investigations carried under the guidance of Ms. Ruhin Kouser R, **School of Computer Science and Engineering, Presidency University, Bengaluru**.

We have not submitted the matter presented in this report anywhere for the award ofany other Degree.

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ABSTRACT

This project's Crop Health Monitoring System is a comprehensive and creative solution meant to transform contemporary agriculture. The system provides real-time insights on the health and conditions of crops by utilizing cutting-edge technologies like machine learning, remote sensing, and the Internet of Things (IoT). This empowers farmers to make well-informed decisions for the best possible crop management.

The system incorporates a network of sensors, including satellite imaging and Internet of Things devices, to continuously gather data on important parameters including temperature, humidity, soil moisture, and crop spectral characteristics. Advanced machine learning algorithms are used to process this data, and the results include precise yield projections, disease detection, and crop health assessments.

The Crop Health Monitoring System's primary characteristics include accurate resource management, early disease and pest identification, and the capacity to use precision agriculture techniques to enhance farming practices. By converting complex data into useful insights, the decision support system enables farmers to take prompt action, lessen their influence on the environment, and increase crop output overall.

Additionally, the project places a strong emphasis on usability, scalability, and adaptability. The system's user-friendly interfaces provide accessibility for farmers with diverse degrees of technological experience, and it is easily adaptable to handle different crops and field sizes.

To further improve data accuracy, security, and traceability, future improvements will incorporate blockchain technology, artificial intelligence, and sophisticated sensors. To stay at the forefront of agricultural innovation, the system's cycle of continuous improvement includes ongoing research, incorporating emerging technology, and engaging stakeholders.

A major step towards precision and sustainable agriculture is the Crop Health Monitoring System this research delivers. The system offers farmers practical insights and proactive decision-making tools, which enhance crop yields, lessen environmental impact, and boost the resilience of agricultural ecosystems as a whole. The study demonstrates how technology may be used to solve complicated problems in contemporary farming, opening the door to a more productive and sustainable agricultural future.

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CHAPTER-1

INTRODUCTION

1.1 INTRODUCTION TO DOMAIN

1.1.1. Introduction

In a world where agriculture is essential to life support, using cutting-edge technology is not a choice but rather a need. In order to revolutionize farming techniques, our project, "Revolutionizing Agriculture with IoT and ML: Crop Health Monitoring for Enhanced Productivity," uses machine learning (ML) and the internet of things (IoT) to monitor and optimize crop health. Our survival depends heavily on agriculture, which faces many obstacles such as shifting weather patterns and a rising global food demand. In this case, agricultural efficiency and precision are critical.

Regretfully, the majority of farmers in our nation practice conventional farming, which may be a laborious procedure to manually analyses facts related to soil and crops. Modern farming techniques and cutting-edge agricultural technologies, such automation and the Internet of Things, could help alleviate this issue by improving crop productivity and fostering economic growth. When automation is used in agriculture, crop health can be effectively monitored without the need for field personnel. The network of physical items integrated with sensors, software, and electronic parts like microcontrollers—sensors and microcontrollers being unable of being directly connected to the internet—makes up the Internet of Things.

1.1.2. About the project

In order to achieve our goal of creating a user-interactive web interface for rainfall and crop prediction, we have designed an easy-to-use platform that enables users to input pertinent data, visualize predictions, and gain insightful knowledge. The interface needs to be engaging, easy to use, and able to process and display data in a comprehensible manner.

Input forms for users to enter details about their location, soil type, past crop statistics, and other pertinent characteristics may be included in the web interface. Users may be able to enter information such as crop type, planting date, and any particular agricultural practices being used into the interface for crop prediction.

Users can enter their geographic location and previous rainfall data to predict the amount of rainfall. Prediction accuracy can be increased by integrating with satellite data or real-time weather APIs. Charts, graphs, and maps are examples of visualization tools that can aid users in properly interpreting the forecasts. Weather forecasts, historical patterns, and current conditions may all be seen on a dashboard. Sliders, dropdown menus, and date pickers are examples of interactive components that let users explore various scenarios and comprehend how they might affect crop yield or water requirement.

Instructive tooltips or pop-ups that explain the data inputs and forecasts help guarantee user engagement and comprehension. Predictive analytics using AI algorithms and machine learning models will also eventually improve the accuracy of crop and rainfall forecasts. The web interface's overall success and usability will be aided by frequent upgrades, user feedback channels, and a responsive design that works on a variety of devices. Giving customers access to lessons or assistance sections can help them get the most out of the platform's predictive features for managing crops and rains.

CHAPTER-2
LITERATURE SURVEY

2.1 Existing methods

2.1.1. Rietra, R.; Heinen, M.; Oenema, O. A Review of Crop Husbandry and Soil Management Practices Using Meta-Analysis Studies: Towards Soil-Improving Cropping

Coherent improvements in crop varieties and crop husbandry and soil management practices are needed to increase global crop production in a sustainable manner. However, these practices are often discussed separately, and as a result there is little overview. Here, we present a database and synthesis of 154 meta-analysis studies related to ten main crop husbandry and soil management practices, including crop type and rotations, tillage, drainage, nutrient management, irrigation and fertigation, weed management, pest management, crop residue management, mechanization and technology, and landscape management. Most meta-analysis studies were related to tillage (55), followed by crop type and rotations (32), nutrient management (25), crop residue management (19), and irrigation and fertigation (18). Few studies were related to landscape management (6) and mechanization and technology (2). In terms of outcome, studies focused on crop yield and quality (81), soil quality (73), and environmental impacts (56), and little on economic effects (7) or resource use efficiency (24). Reported effects of alternative practices, relative to conventional practice, were positive in general. Effect sizes were relatively large for environmental effects (nutrient leaching, greenhouse gas emissions), and small for soil quality (except for soil life) and crop yield. Together, meta-analysis studies indicate that there is large scope for increasing cropland productivity and minimizing environmental impacts. A roadmap is provided for integration and optimization of all ten practices, and recommendations are formulated to address the gaps in meta-analysis studies.

2.1.2. Shah, F.; Wu, W. Soil and Crop Management Strategies to Ensure Higher Crop Productivity within Sustainable Environments. *Sustainability* **2019**, *11*, 1485

The rising population and reduction in the amount of land and some other resources have created tremendous pressure on current agricultural producers to meet the increasing food demands. To cope with this challenge, certain key inputs, such as fertilizers and other chemicals, are overused, which are worsening the surroundings. This intensive agricultural production without adherence to ecological sustainability has led to declining soil health, land degradation, and severe environmental problems. So, future efforts to feed the growing population should aim for greater agricultural production within sustainable environments. In this regard, innovative steps are needed, as business-as-usual policies lack the potential to cope with these challenges. The concept of agricultural sustainability and various soil and crop management strategies (SCMS) that have been designed to optimize crop yield under sustainable environmental conditions are discussed, including nutrient management, site specific nutrient management (SSNM), integrated nutrient management (INM), integrated soil fertility management (ISFM), integrated soil-crop system management (ISSM), ridge-furrow mulching systems (RFMS), sustainable water management (SWM), conservation agriculture (CA), sustainable land management (SLM), vertical/sky farming, and integrated crop management, and breeding strategies as well as other approaches combined with technological and behavioural changes. The present review suggests that a sustainable production system can be developed by combining the multifaceted efforts under SCMS practices with short- and long-term preventive measures. Reducing chemicals' usage, such as that of fertilizers and pesticides, plus improvements in the crop input use efficiency could minimize greenhouse gases emissions while protecting the environment. Sustainable agriculture holds promise for humankind and the planet Earth, and it can be successful if all developed and developing nations stand together to seek 'our common future' to produce more food while generating less environmental pressure.

2.1.3. O. Ahumada *et al.*

Application of planning models in the agri-food supply chain: a review

Agriculture plays an important role in sustaining all human activities. Major challenges such as overpopulation, competition for resources poses a threat to the food security of the planet. In order to tackle the ever-increasing complex problems in agricultural production systems, advancements in smart farming and precision agriculture offers important tools to address agricultural sustainability challenges. Data analytics hold the key to ensure future food security, food safety, and ecological sustainability. Disruptive information and communication technologies such as machine learning, big data analytics, cloud computing, and blockchain can address several problems such as productivity and yield improvement, water conservation, ensuring soil and plant health, and enhance environmental stewardship. The current study presents a systematic review of machine learning (ML) applications in agricultural supply chains (ASCs). Ninety three research papers were reviewed based on the applications of different ML algorithms in different phases of the ASCs. The study highlights how ASCs can benefit from ML techniques and lead to ASC sustainability. Based on the study findings an ML applications framework for sustainable ASC is proposed. The framework identifies the role of ML algorithms in providing real-time analytic insights for pro-active data-driven decision-making in the ASCs and provides the researchers, practitioners, and policymakers with guidelines on the successful management of ASCs for improved agricultural productivity and sustainability.

2.1.4. Farooq, M.S.; Riaz, S.; Abid, A.; Umer, T.; Zikria, Y.B. Role of IoT Technology in Agriculture: A Systematic Literature Review. *Electronics* **2020**, *9*, 319.

The growing demand for food in terms of quality and quantity has increased the need for industrialization and intensification in the agriculture field. Internet of Things (IoT) is a highly promising technology that is offering many innovative solutions to modernize the agriculture sector. Research institutions and scientific groups are continuously working to deliver solutions and products using IoT to address different domains of agriculture. This paper presents a systematic literature review (SLR) by conducting a survey of IoT technologies and their current utilization in different application domains of the agriculture sector. The underlying SLR has been compiled by reviewing research articles published in well-reputed venues between 2006 and 2019. A total of 67 papers were carefully selected through a systematic process and classified accordingly. The primary objective of this systematic study is the collection of all relevant research on IoT agricultural applications, sensors/devices, communication protocols, and network types. Furthermore, it also discusses the main issues and challenges that are being investigated in the field of agriculture. Moreover, an IoT agriculture framework has been presented that contextualizes the representation of a wide range of current solutions in the field of agriculture. Similarly, country policies for IoT-based agriculture have also been presented. Lastly, open issues and challenges have been presented to provide the researchers promising future directions in the domain of IoT agriculture.

2.1.5. K. Vikranth, & Krishna Prasad K. (2021). An Implementation of IoT and Data Analytics in Smart Agricultural System – A Systematic Literature Review. *International*

Journal of Management, Technology and Social Sciences (IJMTS), *6*(1), 41–70.

India is a country that depends on agriculture, where about half the population relies heavily on agriculture for their livelihood. However, most of the practices undertaken in the agricultural process are not for profit and yield favorable. It should upgrade with current technologies to boost seed quality, check soil infertility, check the water level, environmental changes, and market price prediction, and achieve in agriculture sensitivity of faults and background understanding. The advancement in technology and developments is seen as a significant aspect in their financial development and agricultural production growth. The Internet of Things (IoT), Wireless Sensor Networks (WSN), and data analytics accomplish these upgrades. These technologies help in providing solutions to agricultural issues such as resource optimization, agricultural land monitoring, and decision-making support, awareness of the crop, land, weather, and market conditions for farmers. Smart agriculture is based on data from sensors, data from cloud platform storage and data from databases, all three concepts need to be implemented. The data are collected from different sensors and stored in a cloud-based back-end support, which is then analyzed using proper analytics techniques, and then the relevant information is transferred to a user interface, which naturally supported the decision to conclude. The IoT applications mainly use sensors to monitor the situation, which collects a large size of data every time, so in the case of the Internet of Things (IoT) application, sensors contribute more. Data analytics requires data storage, data aggregation, data processing and data extraction. To retrieve data and information from database, we must use data mining techniques. It acts a significant position in the selection-making process on several agricultural issues. The eventual objective of data mining is to acquire information form data transform it for some advanced use into a unique human-comprehensible format. Big data's role in Agriculture affords prospect to increase the farmers' economic gain by undergoing a digital revolution in this aspect that we examine with precision. This paper includes reviewing a summary of some of the conference papers, journals, and books that have been going in favor of smart agriculture. The type of data required for smart farming system are analyzed and the architecture and schematic diagram of a proposed intelligent farming system are included. It also involves implementing different components of the smart farming system and integrating IoT and data analytics in the smart farming system. Based on the review, research gap, research agendas to carry out further research are identified.

2.2 Observations:

By referring to the above-mentioned papers, we can draw out the following observations which will be considered while designing the models:

- Using ensemble methods can help improve the system's accuracy.
- To create a robust and centralized system that the user can use, it is possible to combine all the seasonal, soil, weather, temperature, topographical, crop production, and economic conditions of the farmer into a single model.
- Aspects like the number of workers needed for maintenance and the area of cultivable land were not taken into account in earlier proposed recommendation systems. It's possible to include such a feature.
- In remote locations without dependable internet connectivity, implementing IoT architecture and WSN, which require cloud services for data storage and processing, is a major problem. So, in order to create a more straightforward but effective model, we will pursue other practical approaches.
- Deployment of smart sensors and other electronic gadgets requires heavy energy consumption.
- The majority of crops have very poor yields, but there is a lot of room for improvement by using more inputs, like fertilizers.

  Higher rise in the nation's crop production was mostly attributed to the adoption of modern varieties, irrigation, and fertilizers. According to the crop output growth model, increased capital creation, stronger irrigation infrastructure, regular rainfall, and increased fertilizer usage will all contribute to increased crop output in the nation

SL.no	Paper Title	Method	Advantage	Disadvantage
1.	Remote Sensing Image in the Application of Agricultural Tourism Planning -By Guojing Fan	Remote Sensing Technologies in Agriculture:	Regular satellite passes allow for temporal monitoring of crops, helping track changes over time.	Some satellites may have limited spatial resolution, making it challenging to capture fine details on a smaller scale.
2.	Smart farming using Machine Learning and Deep Learning techniques -By Senthil Kumar Swami Durai	Machine Learning Algorithms for Crop Health Monitoring:	Pre-trained models on large datasets can be fine-tuned for specific crop health monitoring tasks with limited labelled data.	The choice of clustering algorithms and parameters may impact the outcomes.
3.	Internet of Things and smart sensors in agriculture -By Prem Rajak	IoT Sensors for Real-Time Crop Monitoring:	Enables farmers to optimize irrigation schedules	The upfront cost of purchasing and installing soil moisture

			based on real-time soil moisture levels	sensors can be a barrier for some farmers.

Table 2.1 Comparison of Existing Methods

CHAPTER-3
RESEARCH GAPS OF EXISTING METHODS

3.1 Remote Sensing Technologies in Agriculture

3.1.1. Integration of Multi-Source Data:

Investigate methods for seamless integration of data from various remote sensing sources, such as satellites, drones, and ground-based sensors, to provide a comprehensive and accurate view of agricultural landscapes.

3.1.2. Crop-Specific Monitoring Techniques:

Develop specialized remote sensing techniques tailored to the characteristics of specific crops, addressing the diverse needs of different agricultural regions and the varied spectral responses of various crops.

3.1.3. Advanced Image Processing and Analysis:

Investigate advanced image processing and analysis techniques, including machine learning and artificial intelligence, to extract more detailed and accurate information about crop health, stress factors, and yield predictions from remote sensing data.

3.2 Machine Learning Algorithms for Crop Disease Detection

3.2.1. Transferability of Models:

Investigate the transferability of machine learning models across different regions and crops. Assess the challenges associated with deploying models trained on one set of conditions to diverse agricultural landscapes.

3.2.2. Robustness to Heterogeneous Data:

Explore methods to improve the robustness of machine learning algorithms to handle heterogeneous and unstructured data sources, considering variations in imaging technologies, resolutions, and data quality.

3.2.3. Explain ability and Interpretability:

Address the lack of interpretability in some complex machine learning models. Develop approaches to make predictions more understandable for farmers, agronomists, and other stakeholders to foster trust and adoption.

3.3. IoT and Sensors for Precision Agriculture

3.3.1. Energy-Efficient Sensor Technologies:

Explore and develop energy-efficient sensor technologies that can operate for extended periods without frequent battery replacements, especially in remote or off-grid agricultural areas.

3.3.2. Low-Cost Sensor Solutions:

Explore cost-effective sensor solutions that maintain accuracy and reliability, making precision agriculture technologies more accessible to smallholder farmers and resource-limited agricultural operations.

3.3.3. Scalability of IoT Networks:

Investigate methods to enhance the scalability of IoT networks, allowing for the efficient deployment and management of large numbers of sensors across extensive agricultural landscapes.

3.4. Data Analytics and Decision Support Systems:

Research gaps in data analytics and decision support systems for crop monitoring highlight areas where further investigation and development are needed to enhance the effectiveness and utility of these systems in agriculture. Here are some potential research gaps in this domain:

3.4.1. Integration of Multi-Modal Data:

Investigate methods to effectively integrate data from various sources, including satellite imagery, drones, ground sensors, and weather data, to provide a holistic view of crop health and environmental conditions.

3.4.2. Dynamic Decision Models:

Explore the development of dynamic decision models that can adapt to changing environmental conditions, crop growth stages, and evolving pest and disease pressures, providing real-time recommendations for farmers.

3.4.3 Optimal Resource Allocation Models:

Investigate models for optimal resource allocation, considering factors such as water, fertilizers, and pesticides, to enhance overall resource use efficiency while maintaining or improving crop yields.

Author's Name	Area	Finding	Gap
[3] I. Charania *et al.*	Smart Farming	IoT role to detect pest Robotic harvesting	No any discussion on real time observing No discussion on how to collect data
[4] X. Hu *et al.*	Precision Agriculture	Technologies related to agriculture discussed Collaborative research in the field of agriculture	No discussion on IoT framework
[5] A. Khanna *et al.*	Precision Agriculture	Address various challenges and communication system IoT role in agriculture	No discussion on sensors role in IoT No any discussion on IoT framework
[6][63] A. D. Boursianis *et al.*	Smart Farming	IoT and Unmanned Aerial Vehicle roles discussed for making system smart Focused on areas which affect the production of crops	How to collect data, not discussed Issues faced in IoT not discussed
[24] U. Sha *et al.*	Precision Agriculture	Description on WSN Smart system for monitoring plant health	Role of IoT for growth of economy not described Various challenges faced while employing IoT module
[26] M. S. Farooq *et al.*	Precision Agriculture	Discuss types of sensors used in IoT Communication protocols are discussed	No discussion on IoT operating system

Table 3.1: Specific research gaps

CHAPTER-4
PROPOSED METHODOLOGY

4.1 Crop Recommendation Model:

An ML model is trained with data sets containing information about major crops grown across India along with the soil parameters, temperature, and rainfall. Using this information, we are able to write an algorithm that can accurately predict what crop will be feasible for profitable growth. Along with this, a crop yield calculator will be available for farmers to use to predict production and yield per area/hectare.

4.2 Rainfall Recommendation Model:

Rainfall prediction using machine learning (ML) involves building models that can learn patterns and relationships from historical meteorological data to forecast future rainfall.

Gather historical meteorological data for the region of interest. Include variables such as temperature, humidity, wind speed, atmospheric pressure, and any other relevant features.

Evaluate the model's performance on the testing set using metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), or coefficient of determination (R-squared).

4.3 Market Trend Model:

Using market trends and growth of the previous years in India, we can to an extent predict what crop will be profitable during which season.

4.4 Use of Python

Python has become the language of choice for data scientists and machine learning experts due to its versatility and ease of use. One of the main reasons Python is popular for machine learning is its clean and simple syntax. The code is easy to read and write, making it ideal for developers to understand the complex algorithms required for machine learning. Python also offers a variety of libraries and frameworks that simplify the process of developing machine learning models.

Another reason why Python is excellent for machine learning is the vast collection of open-source libraries it offers. Libraries such as NumPy, Pandas, and SciPy provide robust support for numerical and scientific computing, while Scikit-learn offers a comprehensive set of tools for machine learning tasks such as classification, regression, and clustering. With these libraries, developers can focus on building machine learning models instead of reinventing the wheel.

Python is also a cross-platform language, meaning that developers can write code that can run on any operating system. This feature makes it easy for teams to collaborate on projects without worrying about compatibility issues. Additionally, Python is an interpreted language, which means that code can be executed on the fly without the need for compiling. This feature makes it ideal for rapid prototyping and testing.

4.5 Use of PHP

PHP (Hypertext Preprocessor) is a server-side scripting language primarily designed for web development. While it is commonly associated with server-side scripting, PHP can also be utilized as a front-end technology to enhance user interfaces and create dynamic web applications. In this context, PHP functions as a versatile tool for handling both server-side logic and client-side interactions. Here are key aspects of using PHP as a front-end for a project:

4.6 Use of CSS3

Cascading Style Sheets (CSS) is a fundamental technology in web development that allows designers and developers to control the presentation and layout of web pages. CSS3, the latest version of CSS as of my last update in January 2022, introduces a range of powerful features and enhancements, making it a versatile tool for creating visually appealing and responsive front-end designs.

4.7 Use of JavaScript

JavaScript is a powerful and versatile programming language that plays a crucial role in modern web development. It is primarily used as a frontend language to enhance the interactivity and user experience of websites and web applications. As the internet has evolved, JavaScript has become an integral part of creating dynamic and responsive user interfaces.

4.8 Use of XAMPP

It stands for Cross-Platform (X), Apache (A), MariaDB/MySQL (M), PHP (P), and Perl (P), is a free and open-source web server solution stack. It is designed to facilitate the development and testing of web applications on a local machine before deploying them to a live server. XAMPP provides a convenient and integrated environment that includes essential components for web development, making it an ideal tool for developers and testers working on projects.

Algorithm Details:

1. **K-Nearest Neighbor:**

KNN is a sort of supervised machine learning that may be used for a variety of problems. Classification and regression are two instances of problems that may be solved. The symbol K represents the number of nearest neighbors to a newly forecasted unknown variable. The Euclidean distance formula is used to compute the distance between the data points.

$$Euclidean\ Distance\ b/w\ A\ and\ B = \sqrt{(x2 - x1)^2 + (y2 - y1)^2}$$

2. **Random Forest:**

Random Forest is a method of ensemble learning that generates a large number of different models to tackle classification, regression, and other problems. Decision trees are utilized during training. The random forest algorithm generates decision trees based on numerous data samples, predicts data from each subset, and then votes on it to provide the system with a better option. For data training, RF employs the bagging approach, which increases the outcome's accuracy

$$Gini\ Index = 1 - \sum_{i=1}^{\infty} (Pi)^2 = 1 - [(P_+)^2 + (P_-)^2]$$

3. Decision Tree:

For classification and regression, Decision Trees (DTs) are part of supervised learning. To overcome the problem, a tree representation is utilized, with each leaf node representing a class label. The interior node of the tree represents qualities

$$\begin{aligned}
&Entropy:\\
&H(S) = -\sum Pi(S)\, log_2 Pi(S)\\
&Information\ Gain:\\
&IG(S, A) = H(S) - \sum_{v \in Values(A)} (|S_v|/S)\, H(S_v)
\end{aligned}$$

CHAPTER-5
OBJECTIVES

- Optimization of Resource Use:
  Monitor and manage resources such as water, fertilizers, and pesticides efficiently to minimize waste and environmental impact while maximizing crop yields.
- Yield Prediction and Planning:
  Predict crop yields based on real-time data and historical trends, aiding farmers in better planning for harvesting, storage, and marketing.
- Precision Agriculture Practices:
  Implement precision agriculture techniques to tailor farming practices to the specific needs of different parts of the field, optimizing inputs and increasing overall efficiency.
- Weather Monitoring and Risk Management:
  Monitor weather conditions to assess potential risks such as frost, drought, or excessive rainfall, enabling farmers to take preventive measures and mitigate losses.
- Decision Support for Farmers:
  Provide actionable insights and recommendations to farmers through user-friendly interfaces, empowering them to make informed decisions in real-time.
- Improved Crop Quality:
  Enhance the quality of harvested crops by identifying and addressing factors such as nutrient deficiencies, water stress, or contamination early in the growth cycle.
- Sustainable Agriculture Practices:
  Promote environmentally sustainable farming practices by optimizing resource use, reducing chemical inputs, and minimizing the environmental impact of agricultural activities.
- Reduction of Environmental Footprint:
  Minimize the negative impact of agriculture on the environment by optimizing inputs, reducing greenhouse gas emissions, and promoting sustainable land management practices.
- Data-Driven Research and Innovation:
  Contribute to agricultural research and innovation by generating large datasets that can be analyzed for trends, patterns, and insights, leading to advancements in crop management practices

CHAPTER-6
SYSTEM DESIGN & IMPLEMENTATION

6.1 METHODOLOGY

6.1.1 Data Collection

The initial stage is acquiring and interpreting information from multiple open-source websites.

Crop Dataset: This contains information about characteristics such as nitrogen (N), phosphorus (P), potassium (K), soil pH, temperature, humidity, and rainfall for general crops such as apple, orange, lentils, rice, chickpea, coffee, and so on. The entire dataset has 2201 instances.

Fertilizer Dataset: It includes soil-based factors such as moisture, pH, and NPK for the crops in the datasets.

Figure 5.1 depicts an analysis based on the number of data instances available in the dataset for each crop. It has numerous entries for every crop in order to generate the most accurate recommendation achievable.

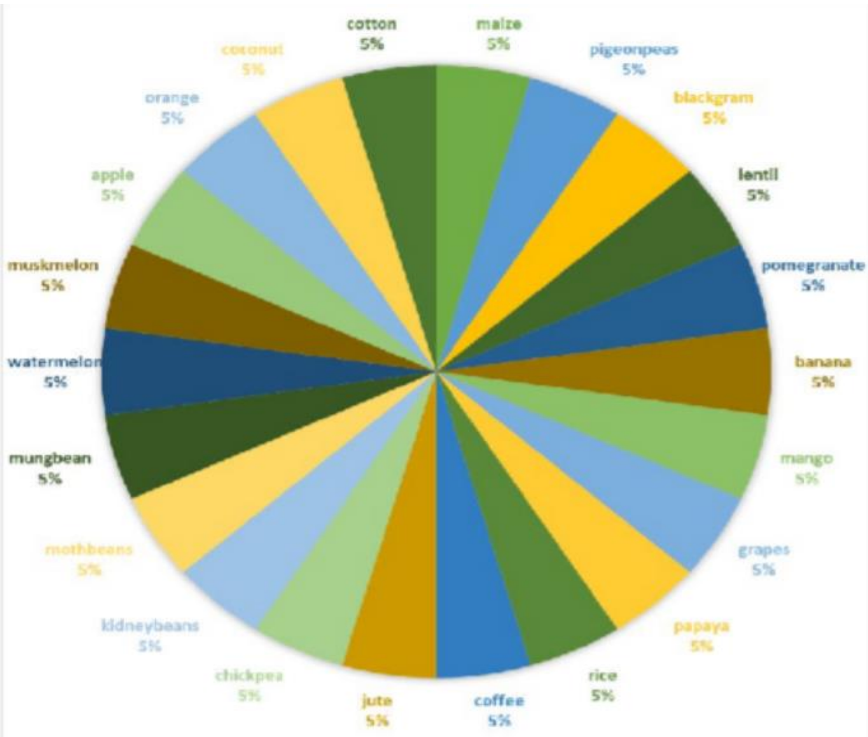


Fig 6.1 Analysis of Crop Dataset

6.1.2 Data Pre-Processing:

Data pre-processing is a method for converting raw data with undesired qualities into a clean data set. The data is acquired from many sources and is in raw format, which makes analysis problematic. Starting with reading the collected dataset and going through data purification, data pre-processing comprises changing the null and 0 values so that it does not affect the overall prediction. The final step in data pre-processing is to separate training and testing data. The data is frequently split unequally since training the model requires as many data points (nearly up to 80% of the data) as feasible to produce better predictions.

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

Fig 6.2 Example of Preprocessed Data

6.1.3 System Design (Architecture)

A system architecture is a conceptual model and formal representation that allows us to define a system's structure and function. The system architecture shows how the necessary information will be obtained from the user and passed to the server module. The trained Machine Learning (Random Forest) model that has been deployed on the server will then get the data from the database and compare it to the user input to offer one of the most accurate predictions possible.

6.1.4 Feature Extraction

By limiting the amount of data needed to represent the original dataset, feature extraction's main objective is to preserve vital information. In order to apply classifiers, this technique purges unnecessary and redundant data. As contrast to utilizing machine learning algorithms directly on the raw data, adopting feature extraction techniques allows us to attain better outcomes.

6.1.5 Crop Recommendation:

The Random Forest Classifier with the highest accuracy is used as a bridge to predict the crop that can be grown in a specific district at a given period.
The names of commonly grown crops around the country were predicted based on NPK values, pH level, temperature, humidity, and rainfall. The Random Forest classifier was used to train the pre-processed dataset. While considering meteorological conditions, the trained model can predict the correct crop for the given parameters.

6.1.6 Crop Yield Prediction:

The user is prompted to submit information such as crop, season, district, state, and land area (in Hectare). The crop yield is then calculated by dividing the user's entered area by the amount of produce.

Yield = Production/Area

Farmers can use this to determine the best time to plant the proper crop in order to achieve the highest possible yield by using the crop.

6.1.7 Fertilizer Recommendation:

This function's purpose is to aid in the selection of the type of fertilizer needed for a certain crop depending on variables such soil moisture levels, nitrogen (N), phosphorus (P), and potassium (K) values. The Random Forest model uses the training data from the fertilizer dataset to forecast the appropriate amount of fertilizer needed, depending on the crop and other factors provided by the user. By ensuring that crops and soil receive the right nutrients, crop damage and soil sterility can be prevented.

6.2 Training Data

After the pre-processing of data, there are two datasets - training and testing dataset.

6.2.1 Training stage:

It is the initial stage where; dataset is used to train machine learning algorithms. This tagged data provided as input by the users is utilized by supervised learning models to generate and refine their rules. It is a collection of data samples that are used to fit the parameters of a machine learning model in order to train it by example. It teaches how to produce the desired results. The model analyses the dataset frequently in order to fully comprehend its characteristics and to improve its performance.

When using the Random Forest Model, the inputs are put into decision trees and then compared to the existing data under various scenarios based on the stated parameters. An output is obtained once the model completes the comparison and selection processes. The final selection is then taken after all the potential outcomes have been compared for likelihood. This model generalizes effectively in practice due to its high accuracy, short training duration, and lack of overfitting.

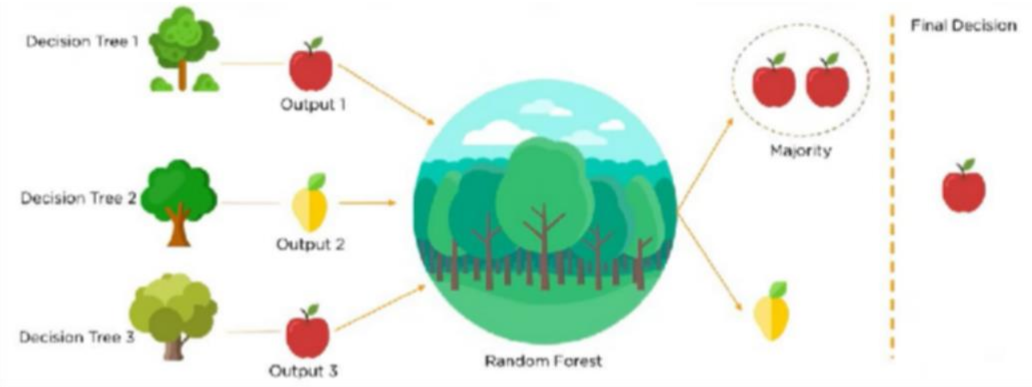


Fig.6.3 Illustration of Random Forest Algorithm

6.2.2 Testing set:

A testing set is a data set that contains no tagged data. It is used to evaluate the performance or accuracy of the model. It forecasts the outcome with the help of the training data set. The training data set has no effect on it.

6.2.3 Software Requirements:

- Operating System: Windows XP/7/8/8.1/10, Linux or Max
- Coding Language: Python

  Libraries:
    - pandas
    - sci-kit learn
    - matplotlib
    - NumPy
    - Seaborn

6.3 Design Procedure:

a) **Examining the requirements and problem statement:** Consider how we want to predict the situation and what kinds of observational evidence we have to support our predictions. Predictions typically involve a label or a target response; it could be a binary classification with a yes/no label, a multi-class classification with a category, or a regression with a real number.

b) **Gather and clean the data:** Determine what kind of historical data we have for prediction modelling before gathering the data from databases or other sources.

c) **Transform the data:** into a format that the system can understand for ML application.

d) **Train the model:** In order to track how successfully a model generalizes to new data, it is crucial to divide the data into training and evaluation sets before training the model. A pattern and mapping between the feature and the label will now be learned by the algorithm.

e) **Assess model accuracy and make improvements:** Model accuracy is a gauge of how well or poorly a model is doing on an unobserved validation set. Evaluate the model using the validation sets in light of the present learning.

f) **Model testing:** Use unknown data to test the model. The model is finished once the system begins operating correctly.

CHAPTER-7
TIMELINE FOR EXECUTION OF PROJECT (GANTT CHART)

TASK	DURATION (Weeks)	START DATE	END DATE	DEPENDENCIES
Project Initiation	1	15/08/2023	08/10/2023	-
Requirement Analysis	1	17/08/2023	24/10/2023	Project Initiation
System Design (Database, User Interface (UI) & Integration)	2	25/10/2023	07/11/2023	Requirement Analysis
Development (Frontend & Backend)	4	08/11/2023	29/11/2023	System Design (All)
Database Implementation	1	30/11/2023	07/12/2023	Development (Backend)
Testing (Unit & Integration) + User Acceptance Testing	2	08/12/2023	22/12/2023	Testing (All)
Project Documentation & Closure	1	23/12/2023	30/12/2023	Monitoring and Maintenance Planning

CHAPTER-8
OUTCOMES

Integration of the models in the website:

Using algorithms like Random Forest, KNN, or Decision Tree and can reliably forecast crop prices, suggest fertilizers, and forecast future market trends. It would be preferable to use the algorithm with the maximum accuracy. Models that can make judgements based on a farmer's inputs accurately can be constructed using a big pool of data collected from numerous surveys and government websites. Based on the information the farmers submit, the viability of the crops can be predicted, making decision-making easier and certain.

Crop Suggestion System:

Crop and fertilizer recommendations as well as a market trend prediction can be integrated on the website. By comparing the real values with the ideal conditions, which will be provided by the database that we generate, it can anticipate crop compatibility by taking into account growing conditions, soil type, geographic location, temperature, humidity, and rainfall. The crop recommendation model suggests the best crop to be grown, one that is suitable for the highest profit and yield, after comparing the inputs with the optimum values.

Rainfall Recommendation model:

This project aims to harness the power of data analytics and predictive modeling to develop a robust rainfall prediction system tailored for crop management. By integrating historical weather data, geographical specifics, and cutting-edge machine learning algorithms, our project seeks to provide farmers with timely and accurate rainfall predictions. The anticipated outcome is a user-friendly web interface that empowers farmers to make proactive choices in irrigation scheduling, crop selection, and resource allocation. This innovative approach not only enhances agricultural productivity but also contributes to the overall sustainability of farming practices by optimizing water usage and minimizing environmental impact.

Crop Buying and Selling

In recent years, the agricultural industry has witnessed a significant transformation due to the advent of technology and the internet. One notable aspect of this evolution is the

emergence of online platforms for crop buying and selling. These platforms offer a digital marketplace that connects farmers, agricultural producers, and buyers, facilitating seamless transactions and providing numerous benefits to all stakeholders involved.
The shift towards online crop buying and selling is part of the broader digital agriculture revolution. With the integration of digital technologies, farmers and buyers now have access to efficient, transparent, and convenient platforms to conduct their agricultural transactions.
Online crop trading platforms break down geographical barriers, allowing farmers to showcase their produce to a broader audience. This access to global markets enhances market reach, creates opportunities for better pricing, and enables farmers to explore diverse customer bases.

The outcomes of a crop health monitoring system project can have wide-ranging impacts on agricultural practices, sustainability, and overall food production. Here are several potential outcomes that can result from the successful implementation of a crop health monitoring system:

1. Improved Yield Prediction:
   - Accurate predictions of crop yields provide farmers with valuable insights for planning harvesting, storage, and marketing activities, contributing to better overall farm management.

3. Optimized Resource Use:
   - The system enables precise resource management by optimizing the use of water, fertilizers, and pesticides. This leads to improved resource efficiency and reduced environmental impact.

4. Enhanced Crop Quality:
   - Continuous monitoring helps identify factors affecting crop quality, such as nutrient deficiencies or stress conditions, allowing for interventions that enhance the overall quality of harvested crops.

5. Precision Agriculture Practices:
   - Implementation of precision agriculture techniques improve the overall efficiency of farming practices, tailoring actions to the specific needs of different areas within a field.

CHAPTER-9
RESULTS AND DISCUSSIONS

9.1 Acquired Results:

For the multiple features to be executed, the collection and cleaning of data was done by first removing the null and void values and redundant values that were observed in the datasets. As we are working with multiple datasets like information about crops, rainfall pattern, soil content and NPK values for the respected crops, the data has to be integrated and regressed multiple times. We've used Python (executed on Jupyter) for training of the models with multiple algorithms to check the most accurate one and implement that to recommend the crop, yield and fertilizers to be used. Among our data set, it was divided into two where the test set size - 440 rows (20%) and the training set size - 1761 rows (80%).

9.2 Correlation:

A correlation graph or a heat map is used to check the correlation between attributes and to check if they are strongly or weakly related to one another. The brighter colours are used to represent the high correlation among the values and the less bright colours are used to represent less common values. The values with 1 show absolute positive relationship between variables and >1 values as they start having negative relationship. Heatmap generated below using our dataset shows positive relationship and low correlation. Heatmap generated concludes that no rows had to be dropped and that we could use them all.

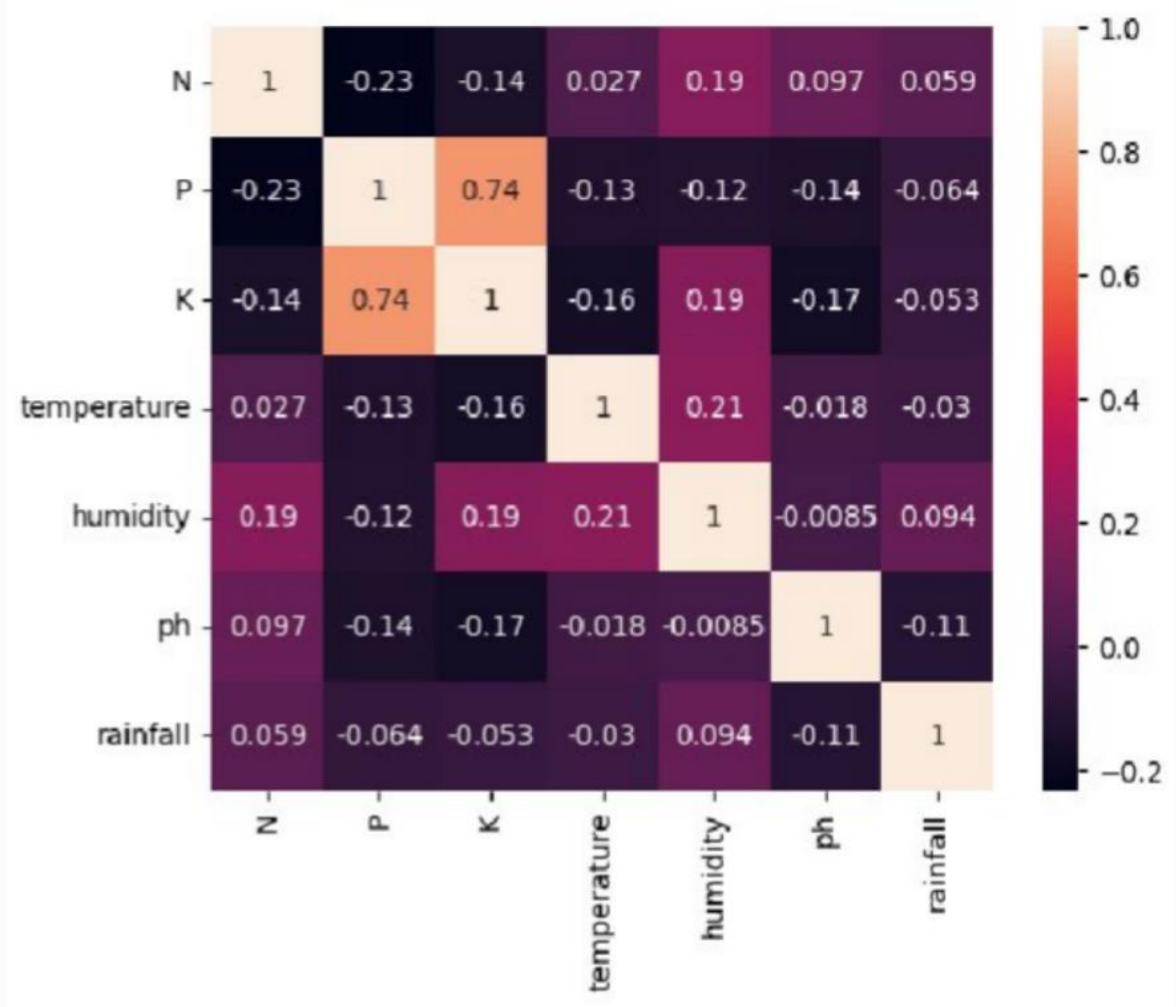


Fig 9.1 Correlation Matrix for crop recommendation dataset

8.1 Market trend analysis:

Over the years of growing lifestyle changes, demand for exotic cuisine and research in nutrition have brought about changes over the market demand and supply chain. Upon research the need to integrate the current growing market trends for the list of crops we have taken and integrating the demand factor into the suggestion list is incorporated.

Upon research and extraction, the modal price for various crops were taken from Kaggle and a custom-built dataset was built. To check the accuracy of the dataset, the prices of certain crops were forecasted using information taken from government sources.

The below graph is a representation of consolidated crops prices and the drastic demand increase over the course of years between 2014-2020. As we can observe, increase in demand will cause the price to shoot up which makes it an even more desirable crop to grow and will not fall in deficit and benefit the crop yield in terms of prices and profitability.

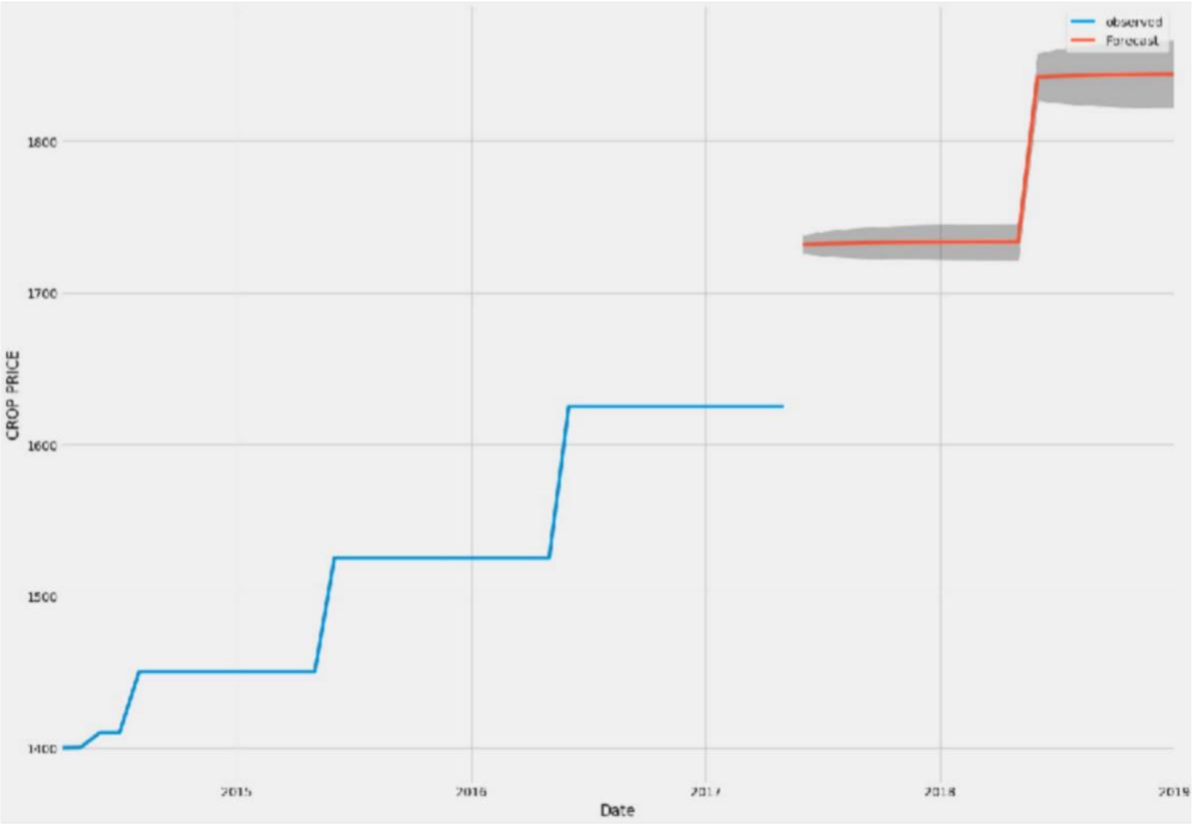
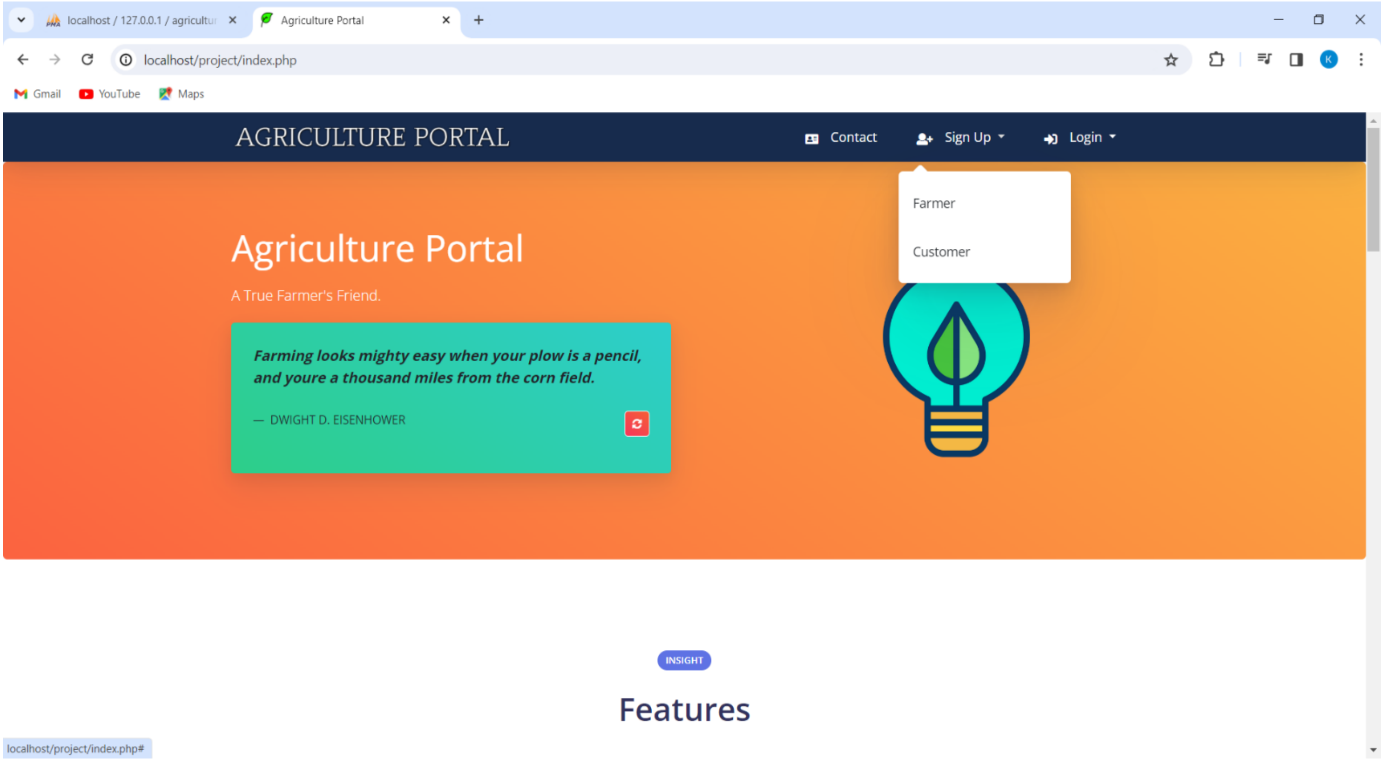
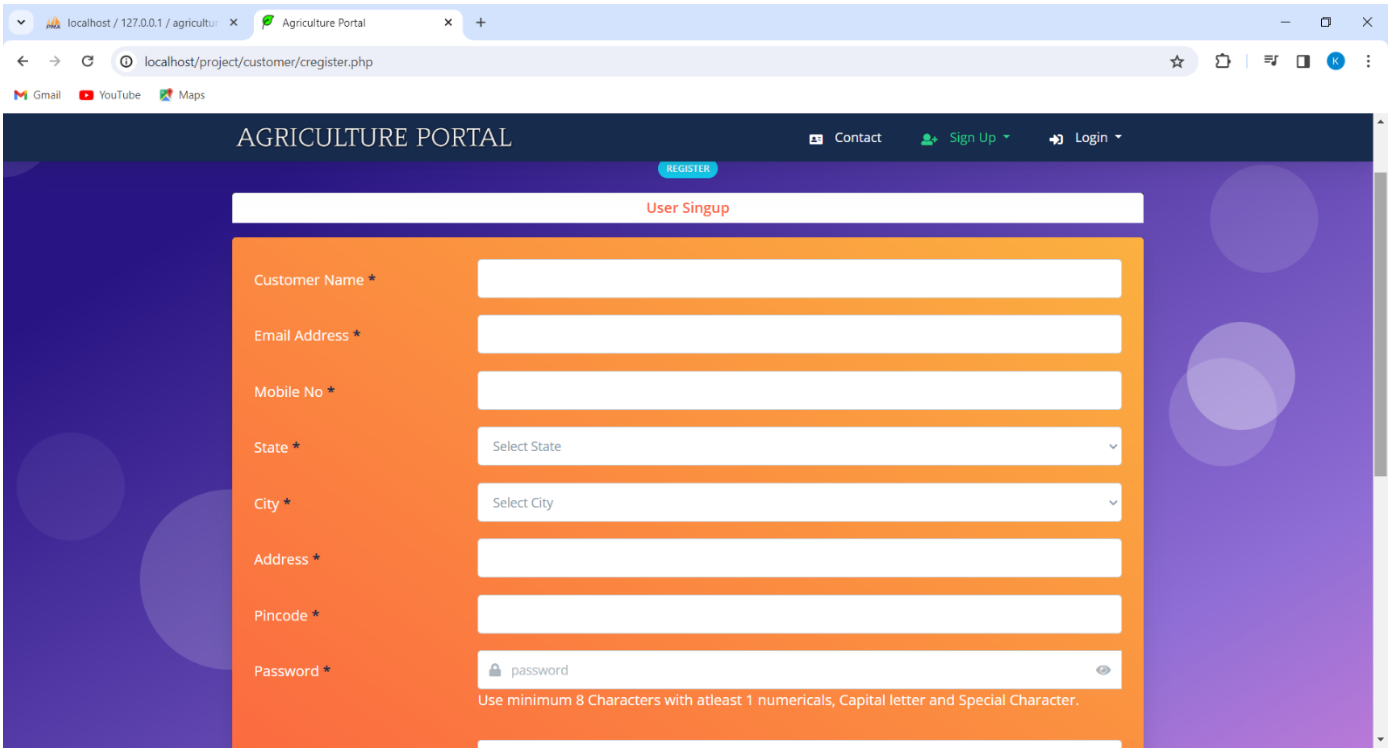
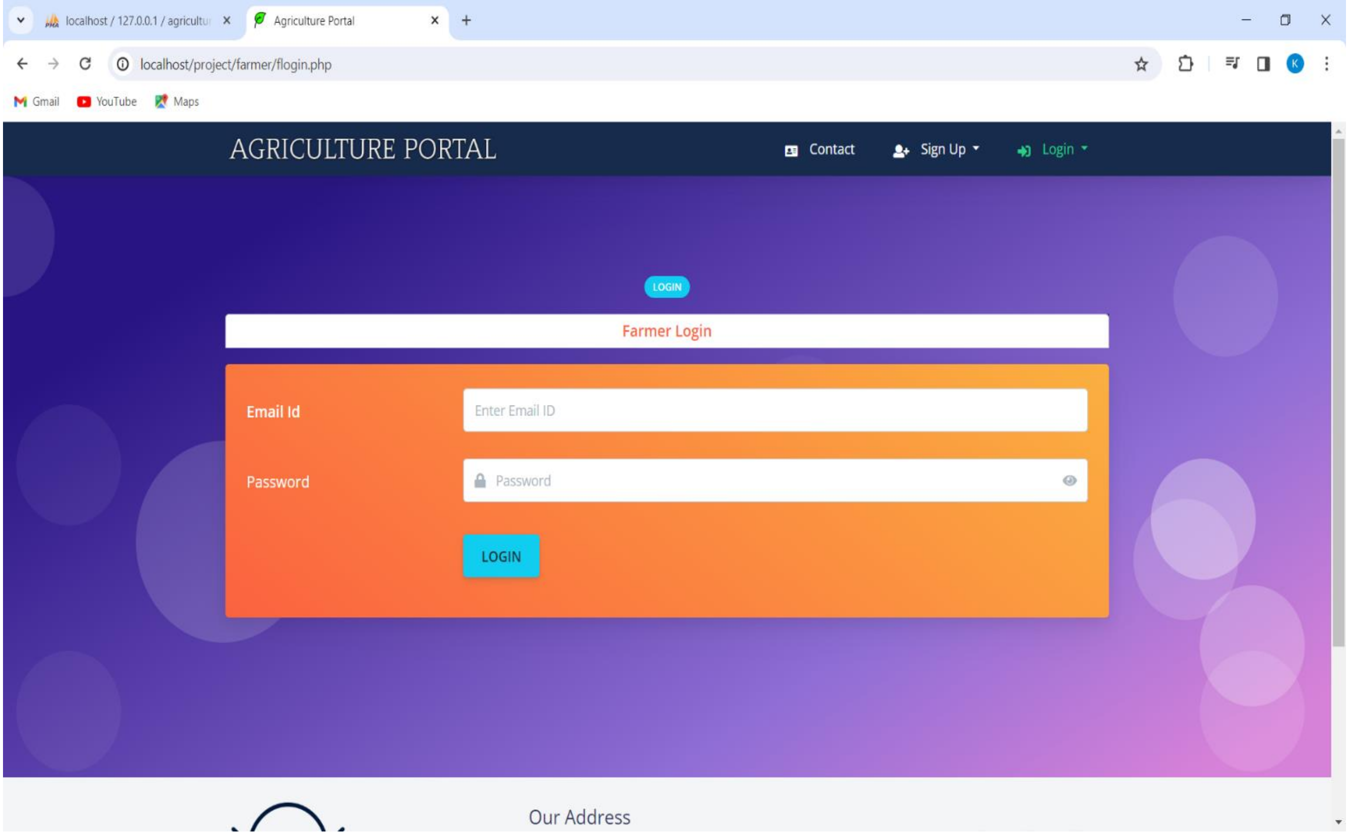


Fig 9.2 Forecasted Price vs Recorded Price in Market

Output Visualization:



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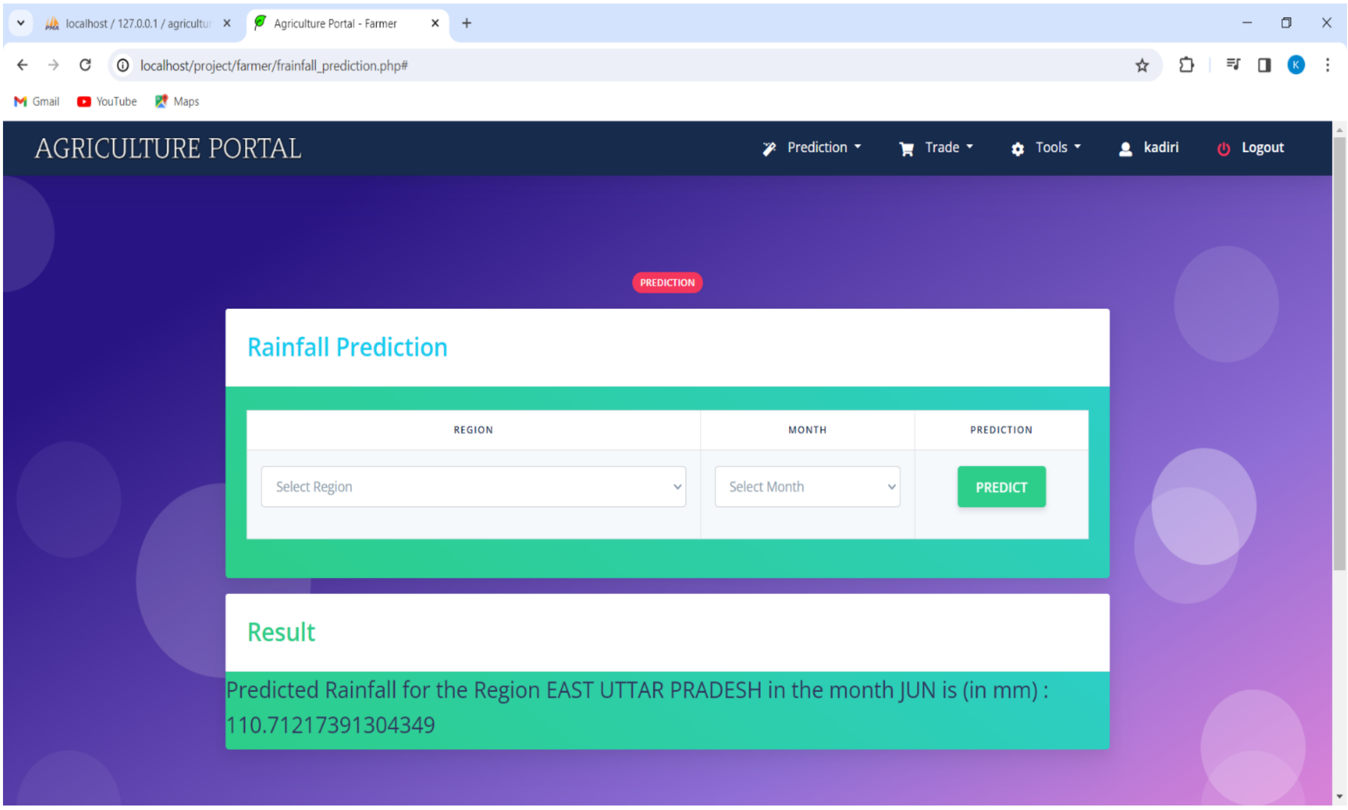
Password
Password
LOGIN
Our Address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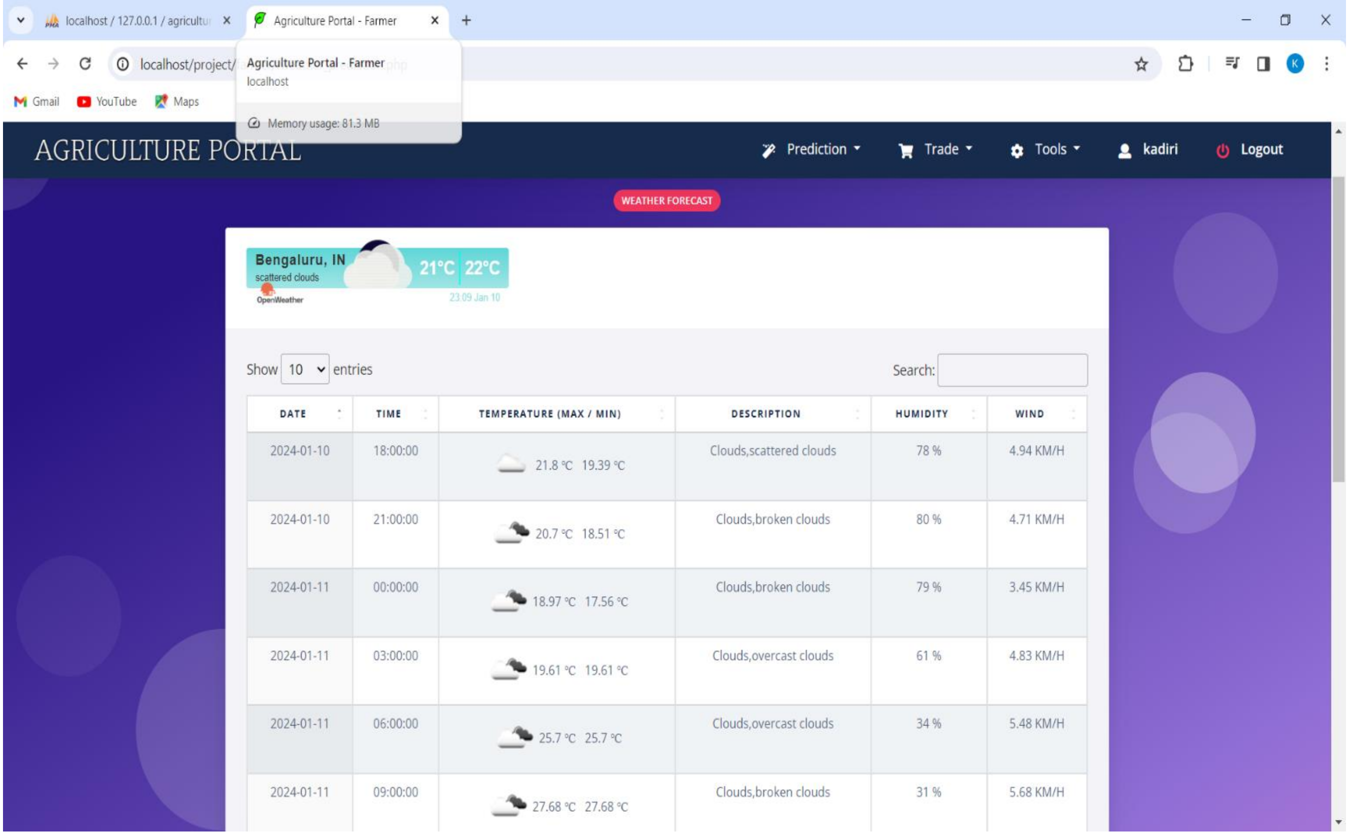
PREDICTION
Rainfall Prediction
REGION
MONTH
PREDICTION
Select Region
Select Month
PREDICT
Result
Predicted Rainfall for the Region EAST UTTAR PRADESH in the month JUN is (in mm) : 110.71217391304349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WEATHER FORECAST
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DATE | TIME | TEMPERATURE (MAX / MIN) | DESCRIPTION | HUMIDITY | WIND
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2024-01-10 | 21:00:00 | 20.7 °C 18.51 °C | Clouds,broken clouds | 80 % | 4.71 KM/H
2024-01-11 | 00:00:00 | 18.97 °C 17.56 °C | Clouds,broken clouds | 79 % | 3.45 KM/H
2024-01-11 | 03:00:00 | 19.61 °C 19.61 °C | Clouds,overcast clouds | 61 % | 4.83 KM/H
2024-01-11 | 06:00:00 | 25.7 °C 25.7 °C | Clouds,overcast clouds | 34 % | 5.48 KM/H
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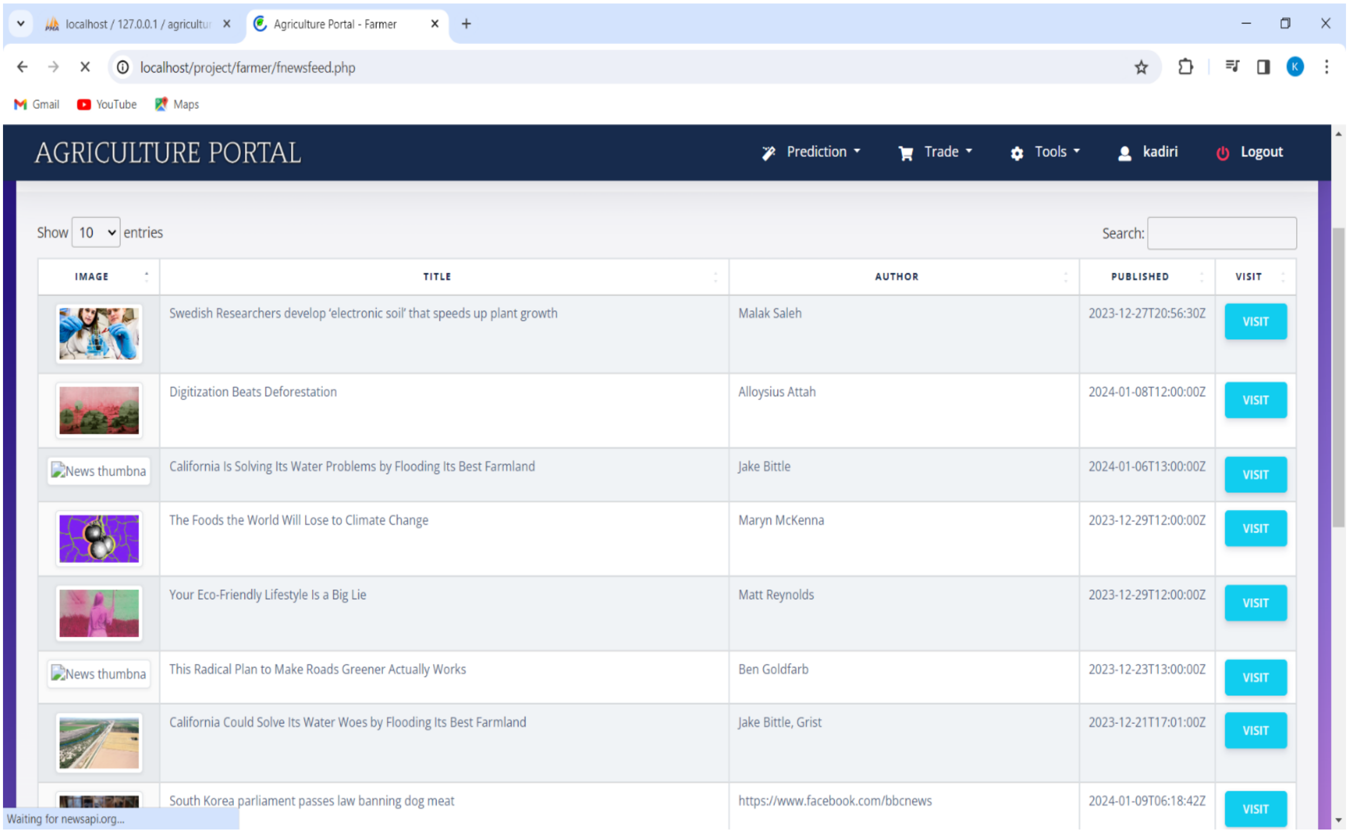
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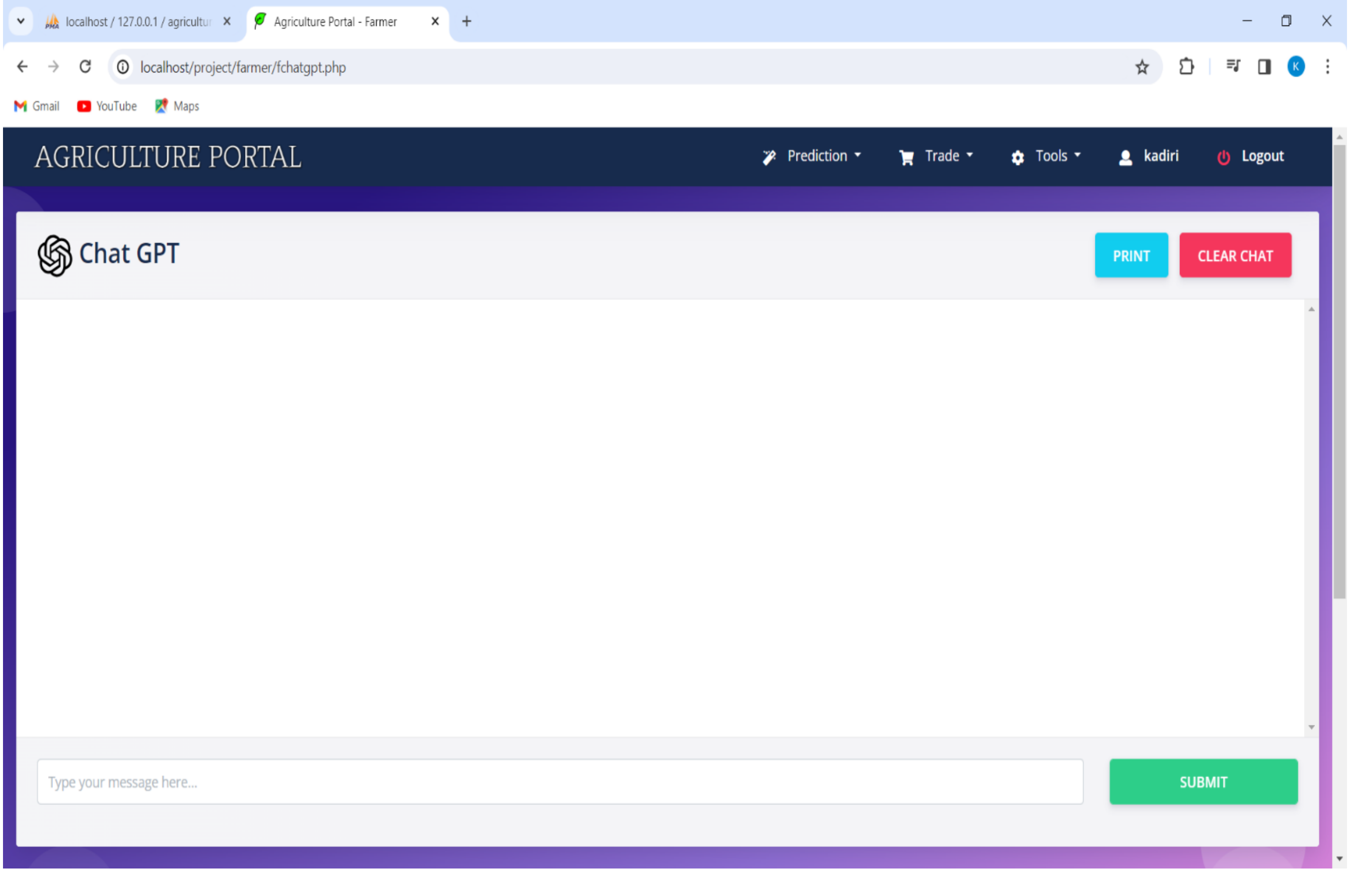
Digitization Beats Deforestation | Alloysius Attah | 2024-01-08T12:00:00Z | VISIT
California Is Solving Its Water Problems by Flooding Its Best Farmland | Jake Bittle | 2024-01-06T13:00:00Z | VISIT
The Foods the World Will Lose to Climate Change | Maryn McKenna | 2023-12-29T12:00:00Z | VISIT
Your Eco-Friendly Lifestyle Is a Big Lie | Matt Reynolds | 2023-12-29T12:00:00Z | VISIT
This Radical Plan to Make Roads Greener Actually Works | Ben Goldfarb | 2023-12-23T13:00:00Z | VISIT
California Could Solve Its Water Woes by Flooding Its Best Farmland | Jake Bittle, Grist | 2023-12-21T17:01:00Z | VISIT
South Korea parliament passes law banning dog meat | https://www.facebook.com/bbcnews | 2024-01-09T06:18:42Z | VISIT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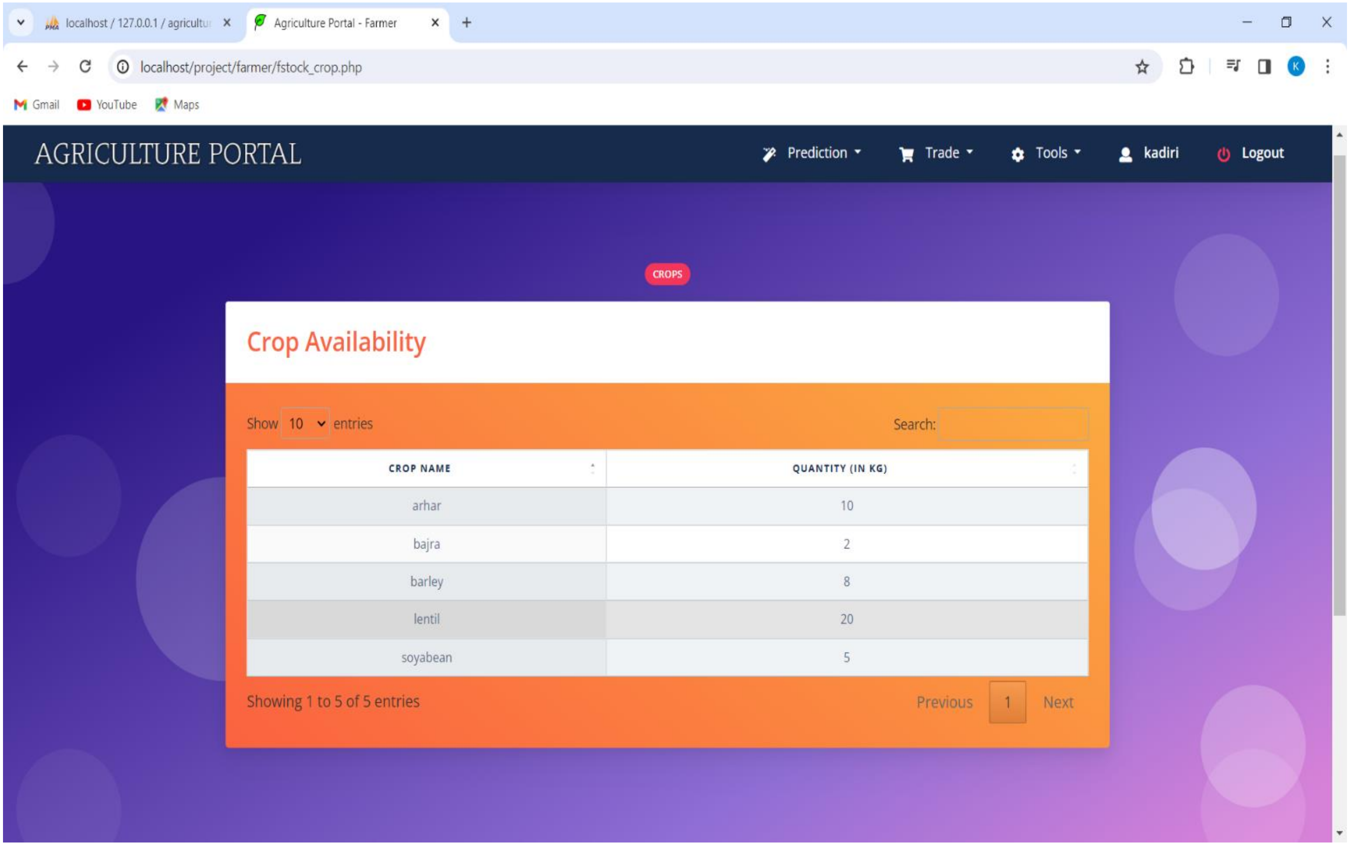
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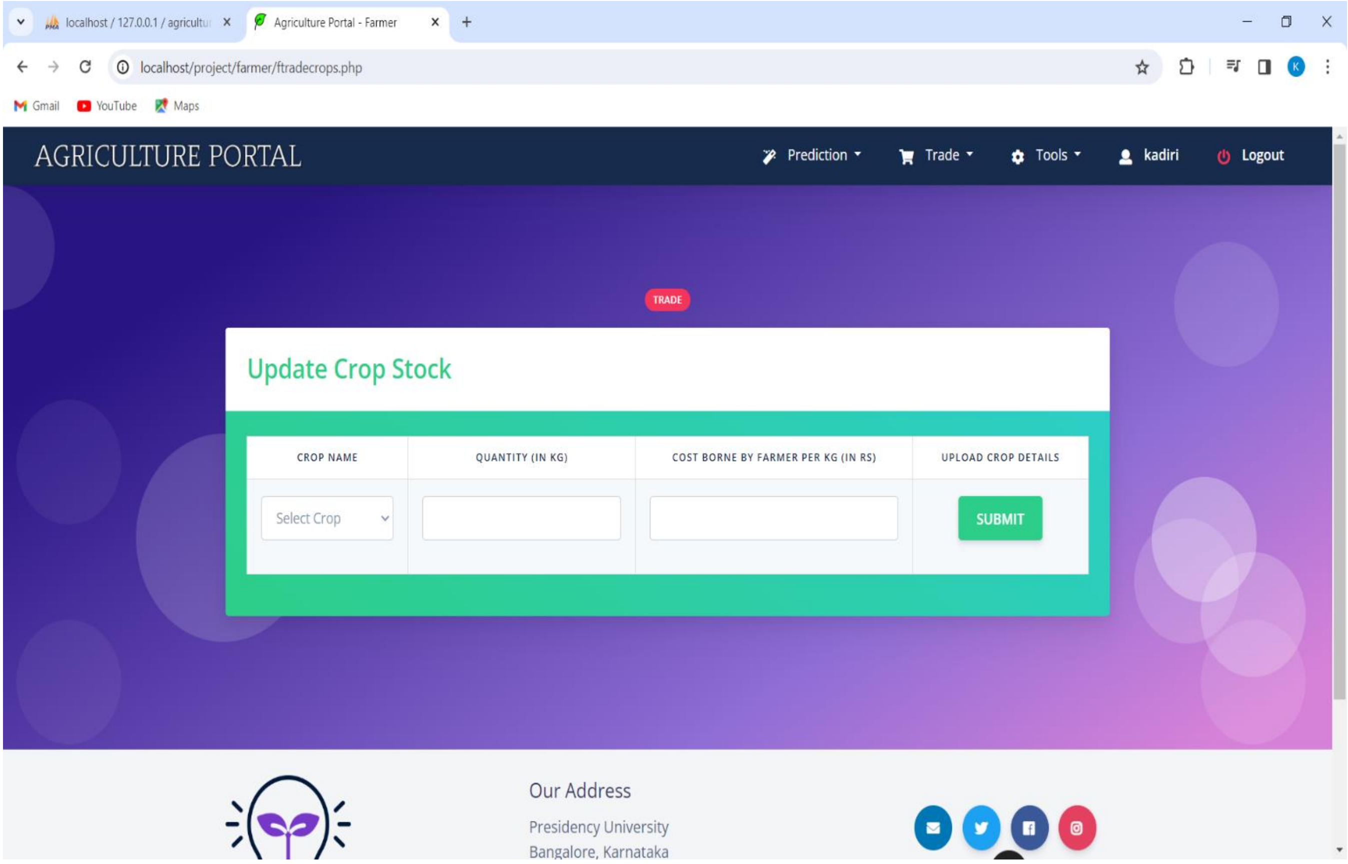
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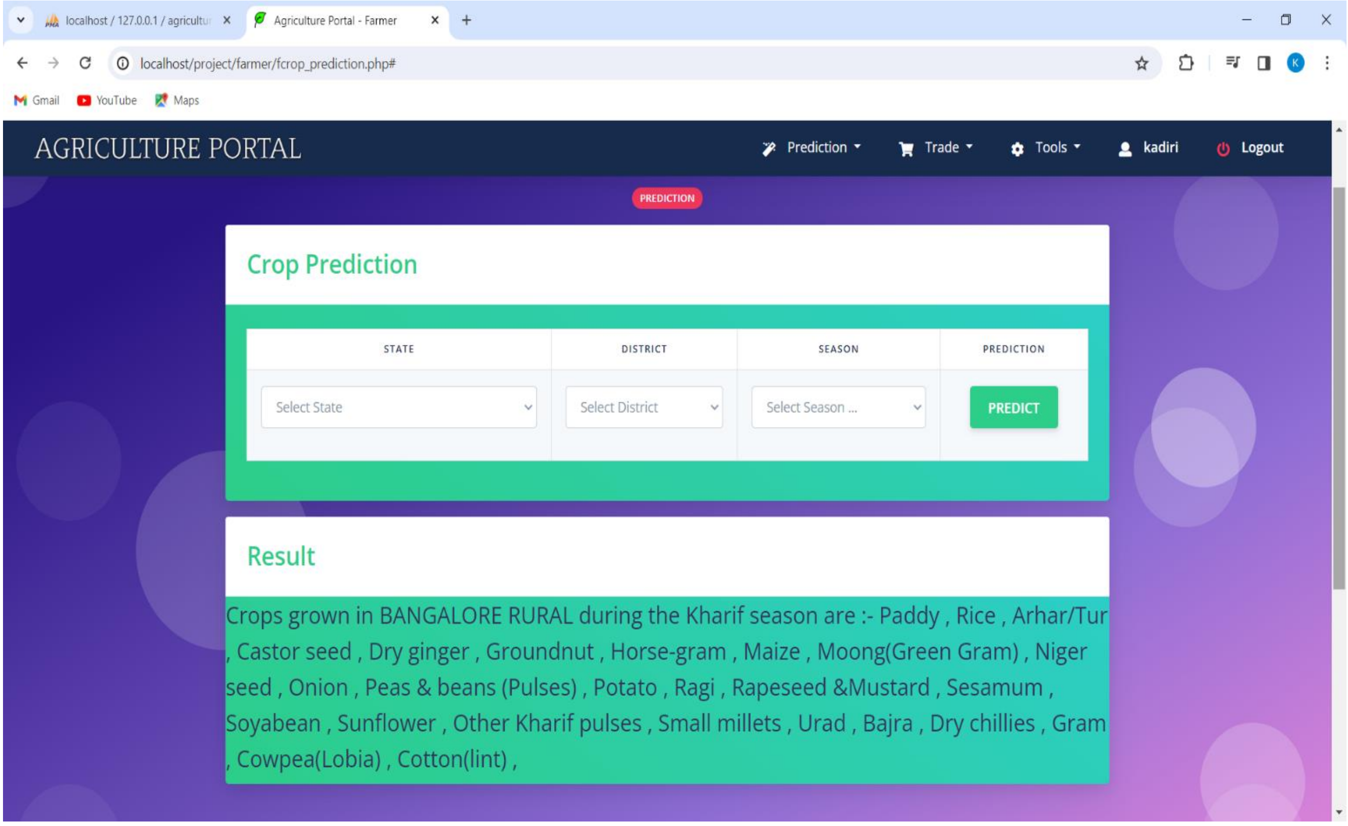
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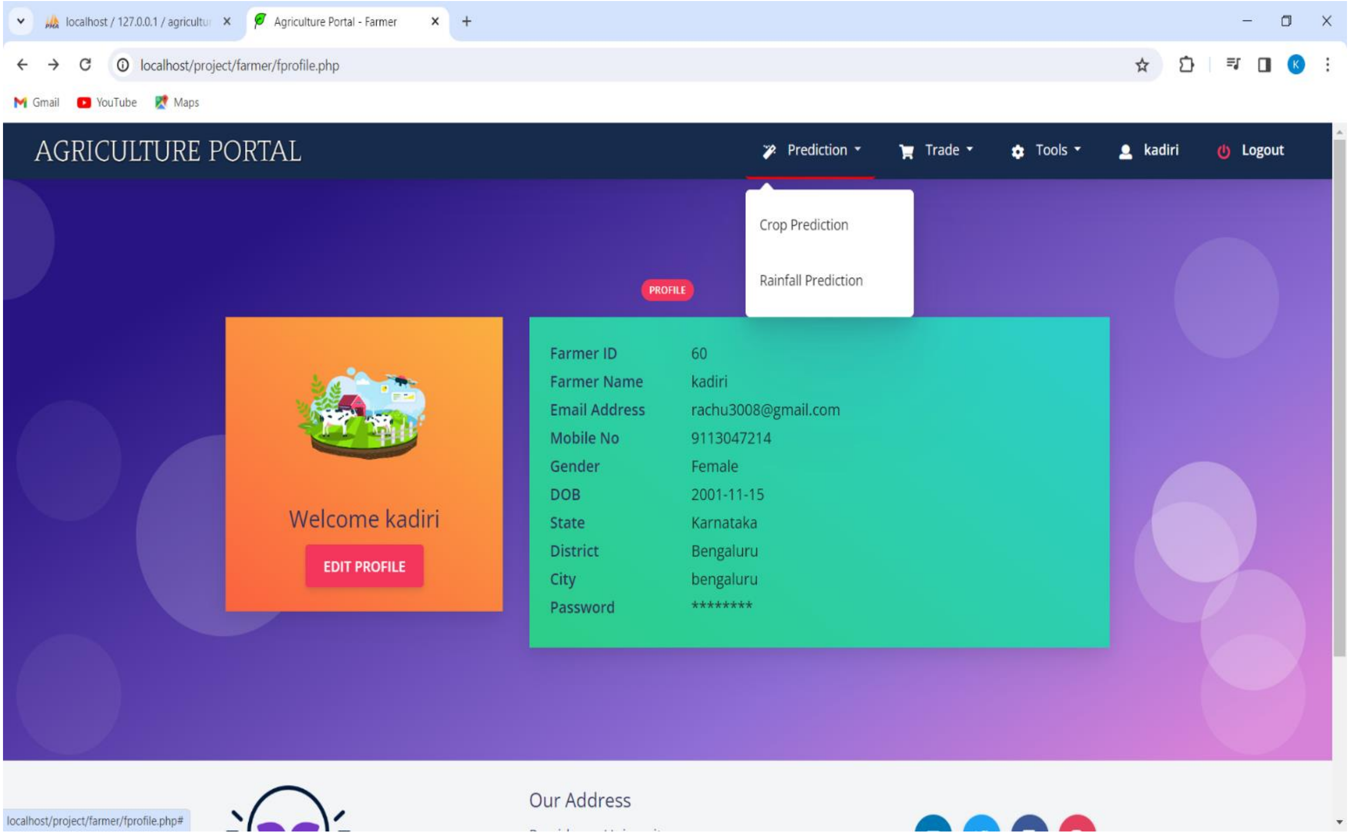
PREDICT
Result
Crops grown in BANGALORE RURAL during the Kharif season are :- Paddy , Rice , Arhar/Tur , Castor seed , Dry ginger , Groundnut , Horse-gram , Maize , Moong(Green Gram) , Niger seed , Onion , Peas & beans (Pulses) , Potato , Ragi , Rapeseed &Mustard , Sesamum , Soyabean , Sunflower , Other Kharif pulses , Small millets , Urad , Bajra , Dry chillies , Gram , Cowpea(Lobia) , Cotton(lint) ,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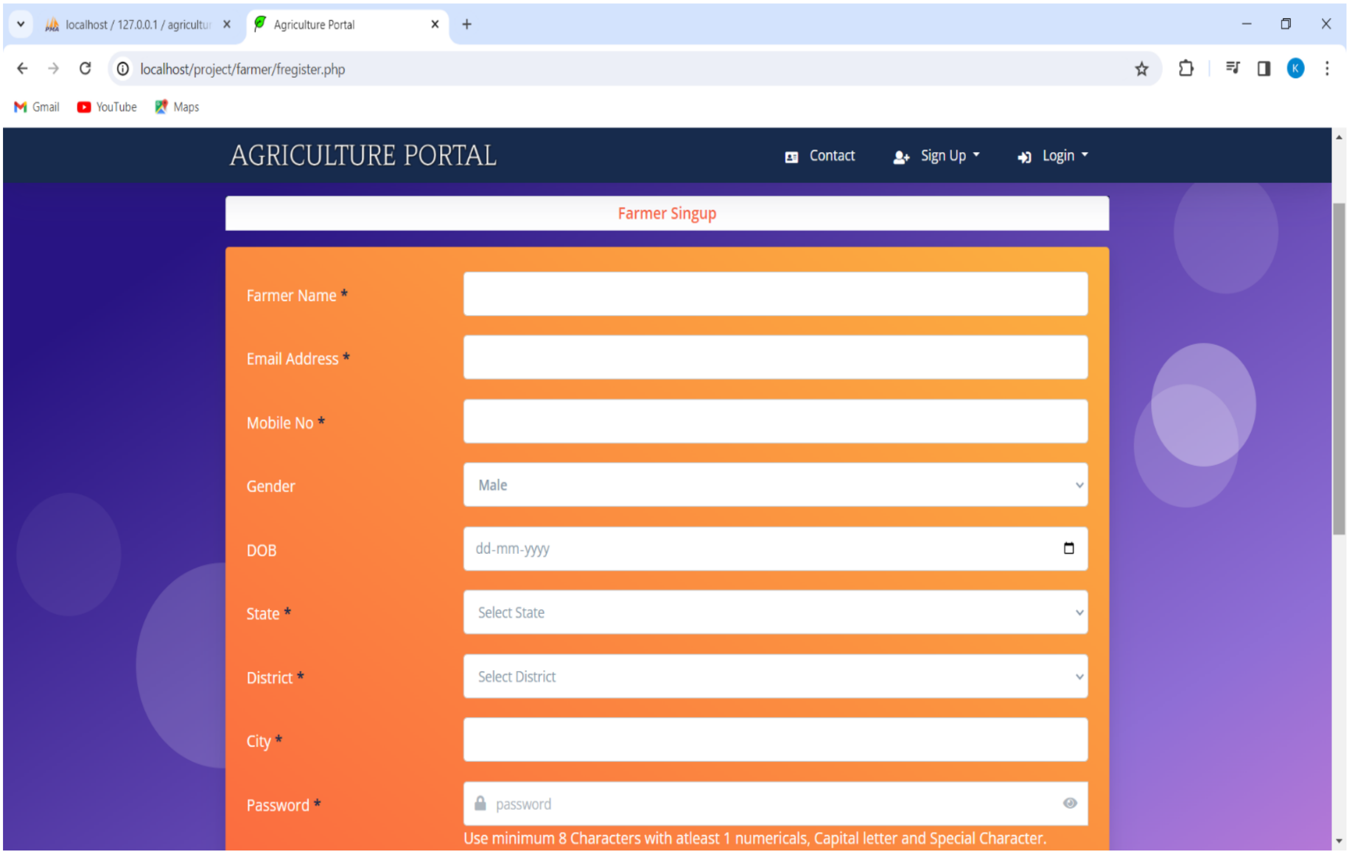
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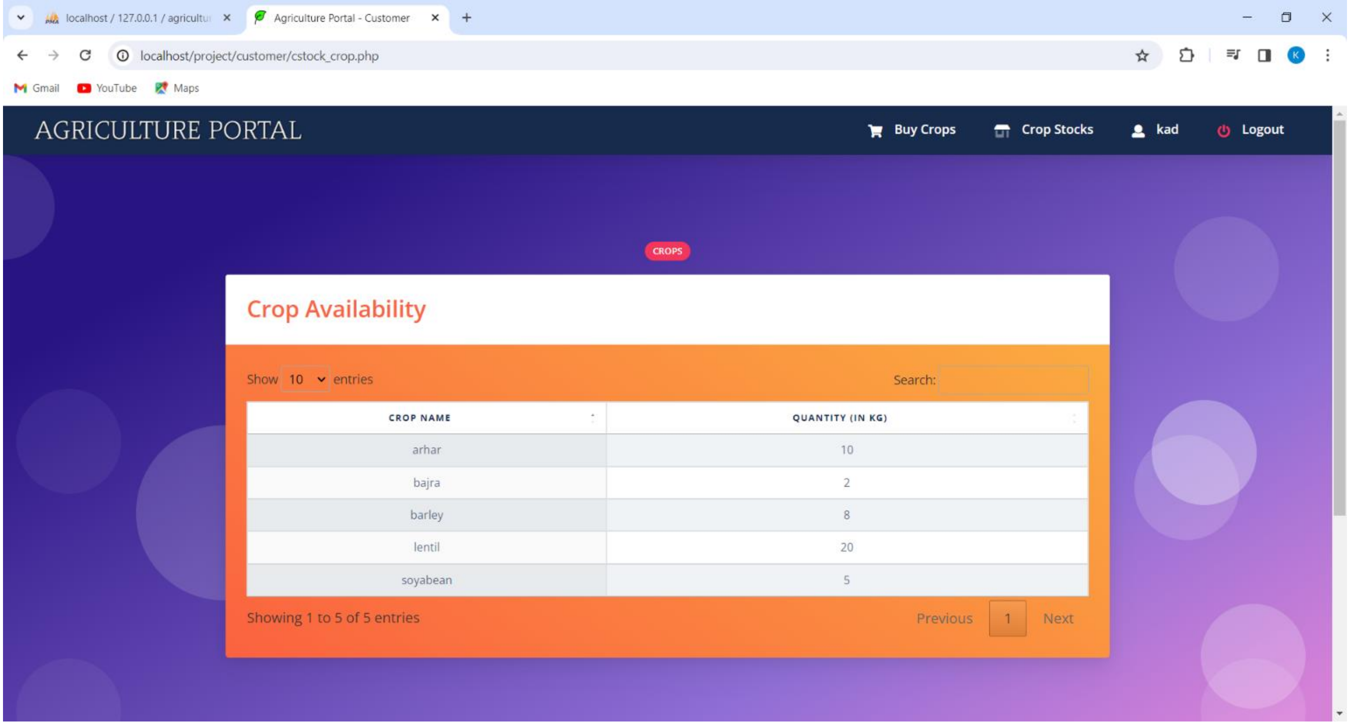
password
Use minimum 8 Characters with atleast 1 numericals, Capital letter and Special Character.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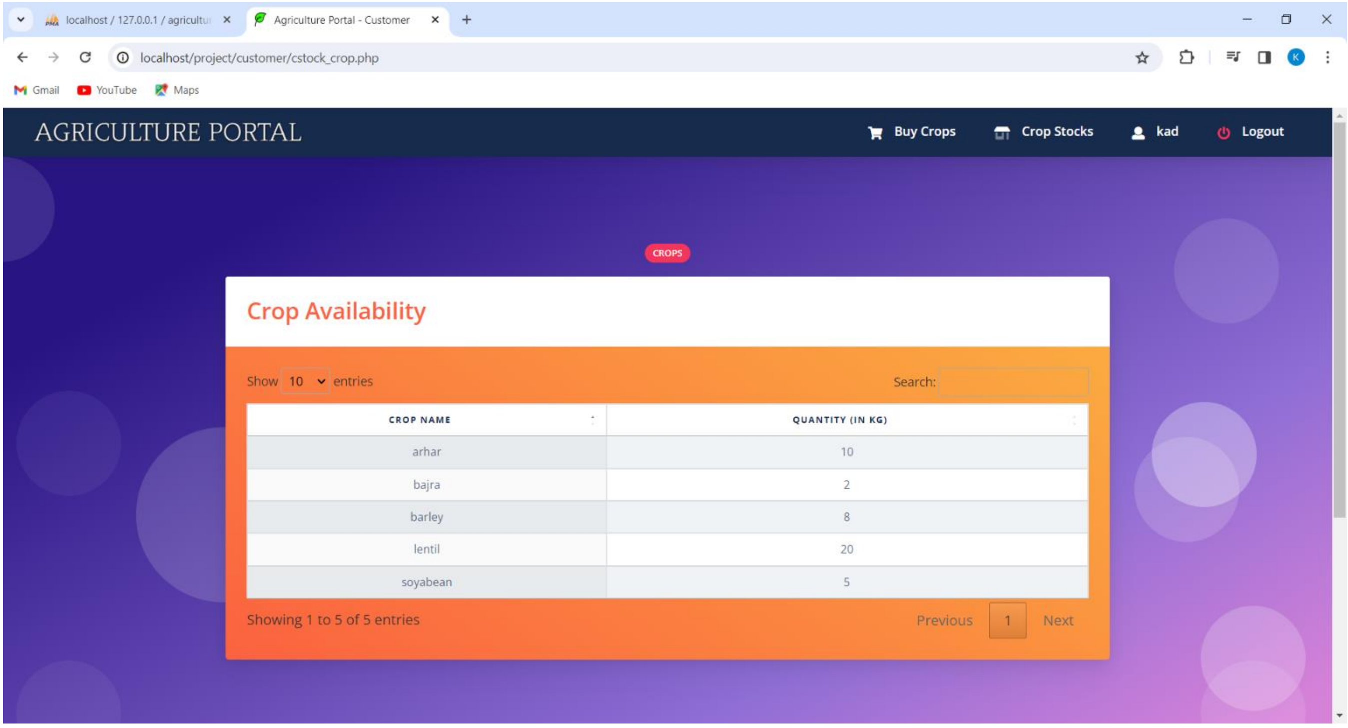
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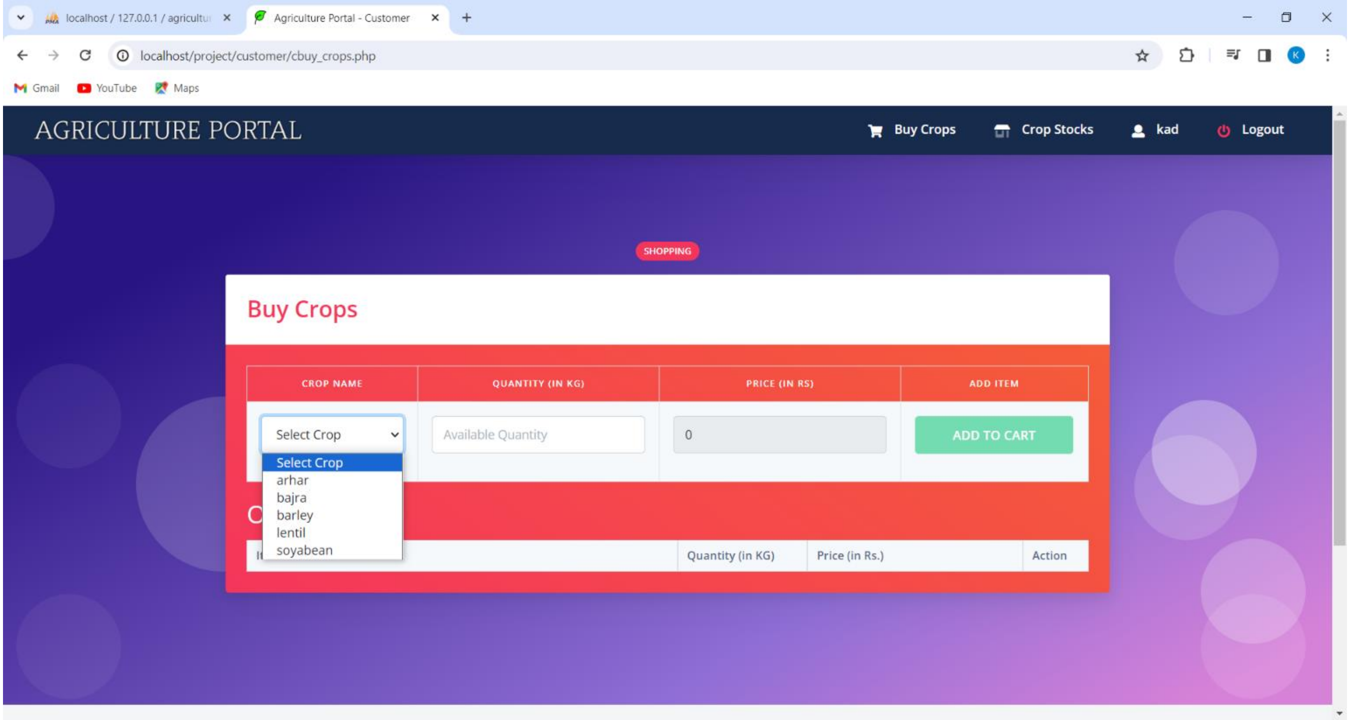
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PRICE (IN RS)
ADD ITEM
Select Crop
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Quantity (in KG)
Price (in Rs.)
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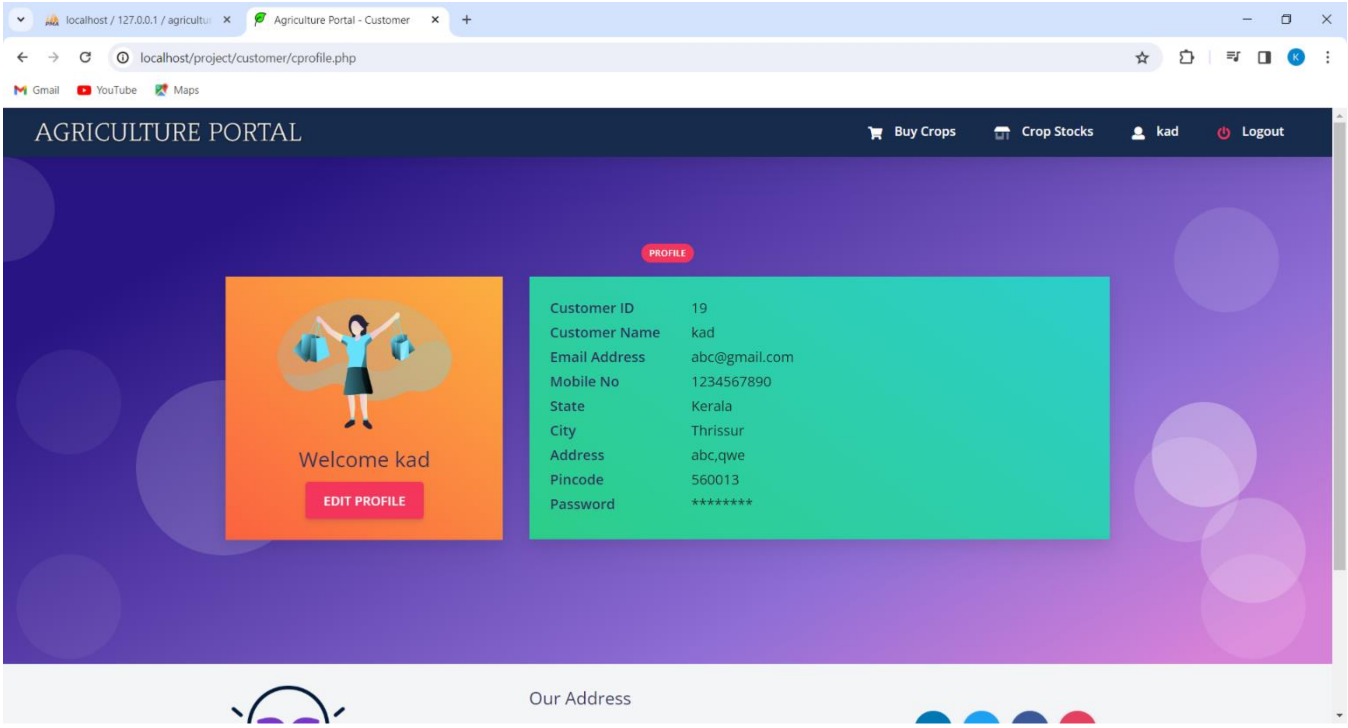
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Welcome kad
EDIT PROFILE
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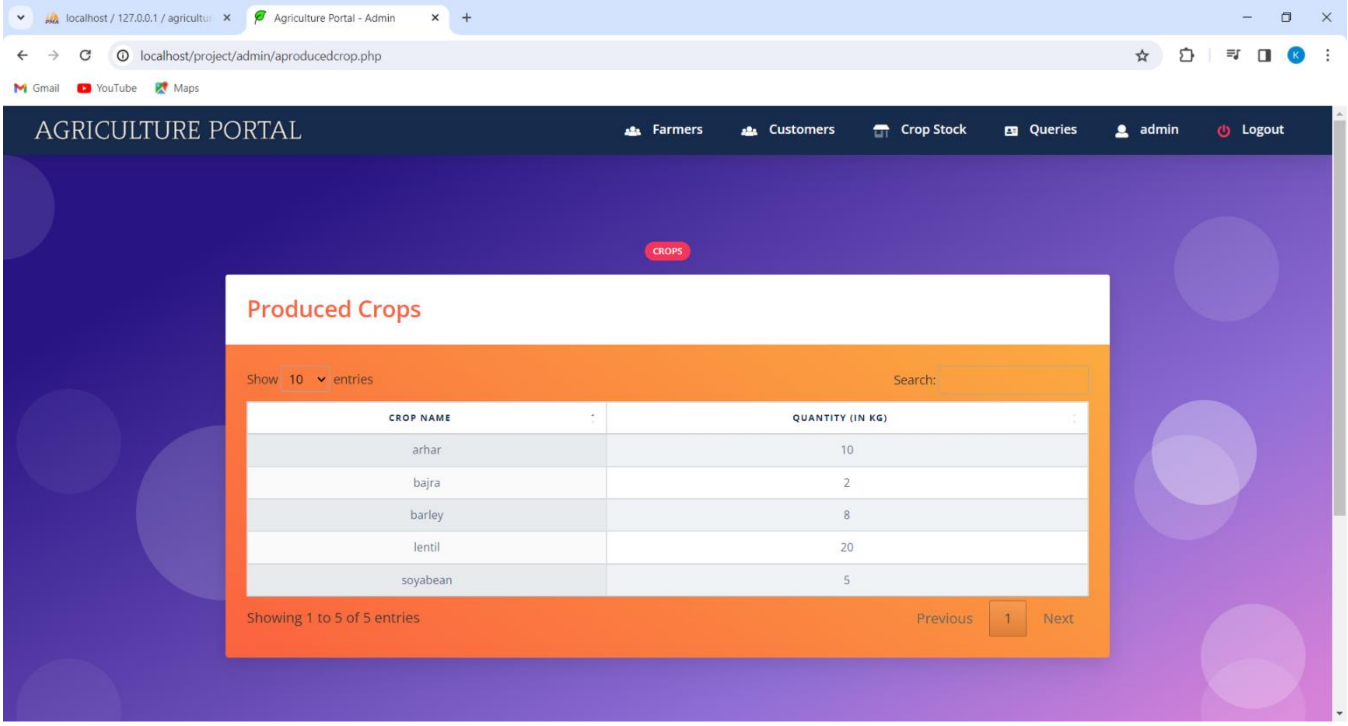
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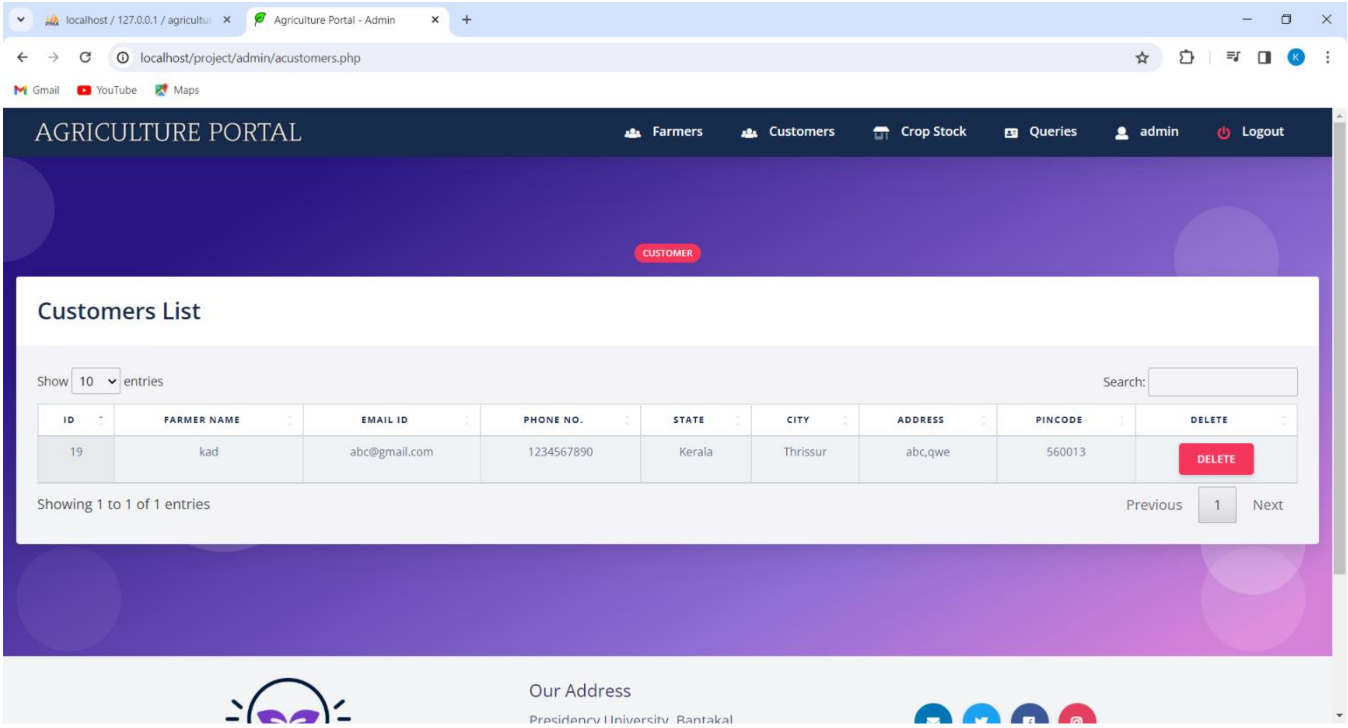
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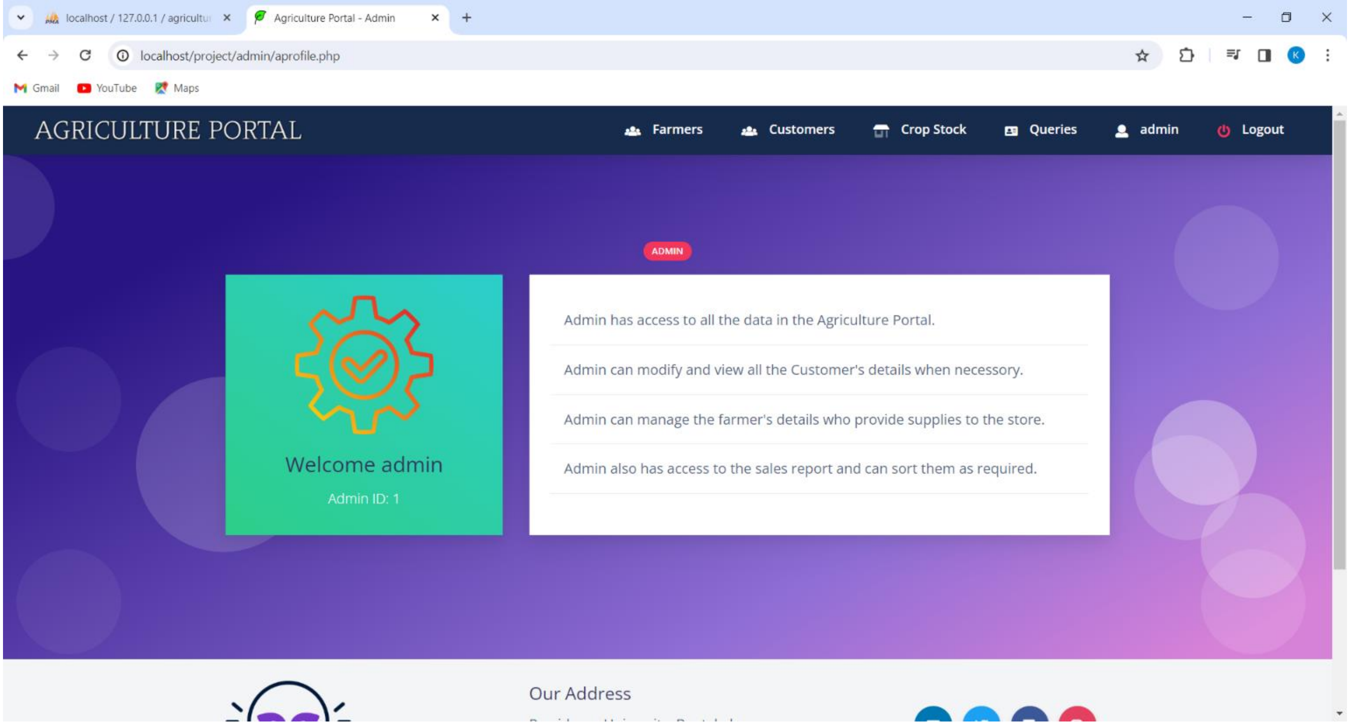
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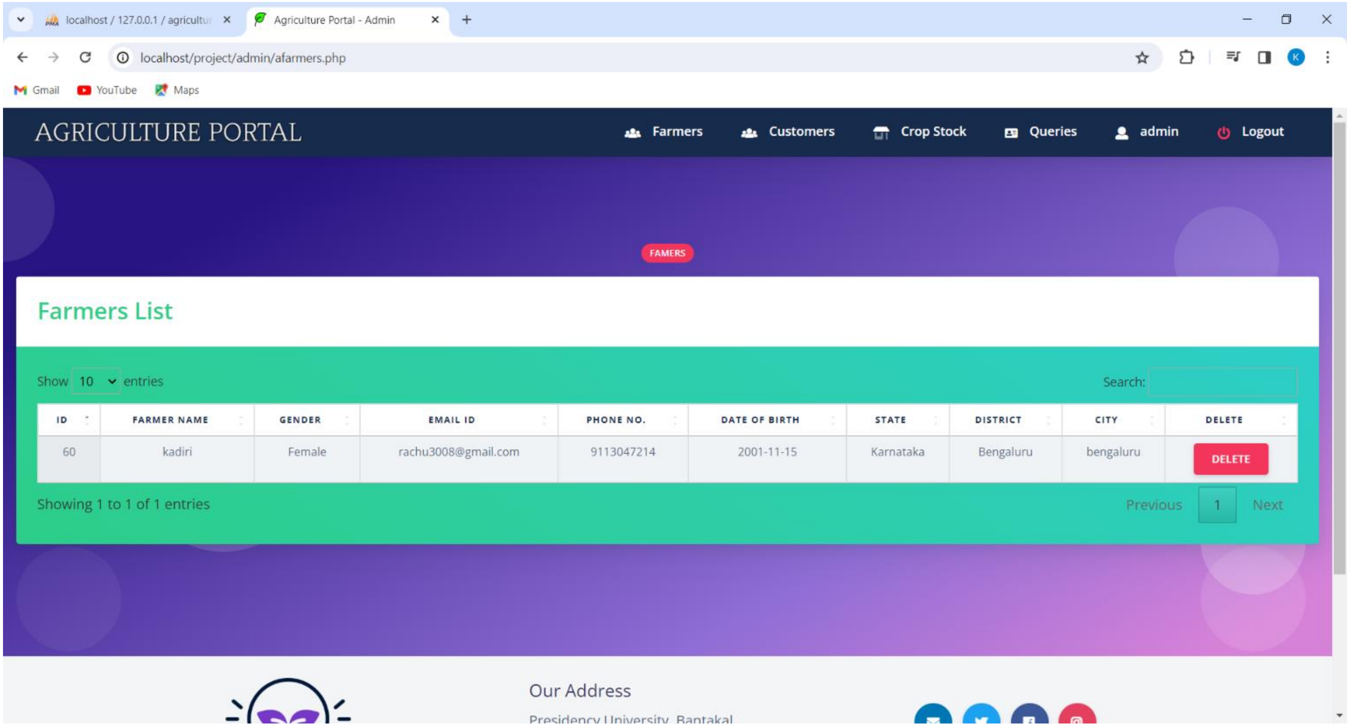
ADMIN
Welcome admin
Admin ID: 1
Admin has access to all the data in the Agriculture Portal.
Admin can modify and view all the Customer's details when necessary.
Admin can manage the farmer's details who provide supplies to the store.
Admin also has access to the sales report and can sort them as required.
Our Address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Show 10 entries
Search:
ID
FARMER NAME
GENDER
EMAIL ID
PHONE NO.
DATE OF BIRTH
STATE
DISTRICT
CITY
DELETE
60
kadiri
Female
rachu3008@gmail.com
9113047214
2001-11-15
Karnataka
Bengaluru
bengaluru
DELETE
Showing 1 to 1 of 1 entries
Previous
1
Next
Our Address
Presidency University, Bantakal

CHAPTER-10

CONCLUSION

In conclusion, the implementation of a crop health monitoring system represents a significant stride towards revolutionizing agriculture and fostering sustainable practices. Through the integration of advanced technologies, data-driven analytics, and precision agriculture principles, this project has aimed to address key challenges in crop management and contribute to the enhancement of overall agricultural productivity.

The systematic monitoring of crop health has provided farmers and stakeholders with valuable insights into the condition of their fields. Early disease detection, precise resource management, and improved decision-making have become pivotal components of this transformative system. The outcomes reflect a commitment to promoting resilience, sustainability, and economic viability within the agricultural landscape.

By empowering farmers with real-time data and actionable recommendations, the project strives to reduce uncertainties associated with crop management. The incorporation of machine learning algorithms, remote sensing technologies, and IoT sensors has ushered in a new era of precision agriculture, allowing for a targeted and efficient approach to farming practices.

Furthermore, the project emphasizes the importance of adaptability and continuous improvement. The flexibility embedded in the system design enables future enhancements, ensuring that the crop health monitoring system remains at the forefront of technological advancements and evolving agricultural needs.

In addition to the tangible benefits of increased yields, cost reduction, and environmental impact reduction, the project underscores the broader significance of contributing to global food security. By mitigating the risks associated with pests, diseases, and climate variability, the crop health monitoring system plays a crucial role in building resilient agricultural systems capable of meeting the demands of a growing population.

As we conclude this project, it is with optimism that we anticipate the long-lasting positive impacts it will have on farmers' livelihoods, environmental sustainability, and the agricultural industry as a whole. The journey towards revolutionizing agriculture through innovative technologies and data-driven solutions is ongoing, and this project serves as a stepping stone towards a more efficient, sustainable, and resilient future for global agriculture.

Future enhancements

1. Integration of Advanced Sensors:
   - Explore the integration of more advanced sensors, such as hyperspectral and multispectral sensors, to capture a broader range of spectral data. This can provide more detailed insights into crop health and early signs of stress or diseases.

2. Edge Computing for Real-Time Analysis:
   - Implement edge computing solutions to perform real-time data analysis directly on the sensors or devices. This can reduce latency and enhance the system's ability to provide instant insights to farmers.

3. Artificial Intelligence and Deep Learning:
   - Further advance machine learning models by exploring the application of artificial intelligence and deep learning techniques. This can improve the accuracy and efficiency of disease detection, yield prediction, and decision support.

4. Automated Robotic Systems:
   - Investigate the use of automated robotic systems equipped with sensors for in-field monitoring and intervention. These systems could perform tasks such as targeted pesticide application or crop sampling, enhancing precision agriculture practices.

5. Blockchain Technology for Data Security:
   - Integrate blockchain technology to enhance data security and traceability. This ensures the integrity of the data collected and shared among stakeholders, addressing concerns related to data privacy and unauthorized access.

6. Drones with LiDAR Technology:

- Explore the use of drones equipped with LiDAR (Light Detection and Ranging) technology for high-resolution mapping of crop structure. LiDAR can provide three-dimensional information about the crop canopy, aiding in precise monitoring.

7. Mobile Application for Farmer Engagement:

- Develop a user-friendly mobile application for farmers, enabling them to access real-time information, receive alerts, and interact with the system. This enhances user engagement and encourages broader adoption among farmers.

8. Weather Forecast Integration:

- Integrate real-time weather forecasts into the decision support system. This allows farmers to make informed decisions based not only on historical weather data but also on predictive models for upcoming weather conditions.

9. Community-Based Monitoring Networks:

- Establish community-based monitoring networks where farmers can share data and insights. This collaborative approach can enhance the collective understanding of regional crop health patterns and facilitate community-driven interventions.

10. Incorporation of Climate Smart Agriculture Practices:

- Integrate the crop health monitoring system with climate-smart agriculture practices. This involves incorporating data on climate resilience, adaptive strategies, and sustainable practices to enhance overall farm resilience to climate change.

11. Data Visualization and Augmented Reality:

- Develop advanced data visualization tools and explore the use of augmented reality (AR) for presenting complex data in an easily understandable format. This enhances the interpretability of monitoring results for farmers and stakeholders.

12. Energy-Efficient Sensor Technologies:

- Research and implement energy-efficient sensor technologies to prolong the lifespan of sensors and reduce the overall energy consumption of the monitoring system.

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AMA Style

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Atmos. Res. (2018)

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AMA Style

Farooq MS, Riaz S, Abid A, Umer T, Zikria YB. Role of IoT Technology in Agriculture: A Systematic Literature Review. *Electronics*. 2020; 9(2):319.

https://doi.org/10.3390/electronics9020319

Chicago/Turabian Style

Farooq, Muhammad Shoaib, Shamyla Riaz, Adnan Abid, Tariq Umer, and Yousaf Bin Zikria. 2020. "Role of IoT Technology in Agriculture: A Systematic Literature Review" *Electronics* 9, no. 2: 319.

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APPENDIX-A
PSUEDOCODE

Index.php

```
<!DOCTYPE html>
<html>
<head>
  <meta charset="utf-8">
  <meta name="viewport" content="width=device-width, initial-scale=1, shrink-to-fit=no">
  <link rel="icon" type="image/png" href="assets/img/logo.png" />
    <title>Agriculture Portal</title>
  <!--     Fonts and icons     -->
          <link rel="stylesheet"
href="https://stackpath.bootstrapcdn.com/bootstrap/4.3.1/css/bootstrap.min.css"
          integrity="sha384-
ggOyR0iXCbMQv3Xipma34MD+dH/1fQ784/j6cY/iJTQUOhcWr7x9JvoRxT2MZw1T"
crossorigin="anonymous">
          <link rel="stylesheet"
href="https://pro.fontawesome.com/releases/v5.10.0/css/all.css"
          integrity="sha384-
AYmEC3Yw5cVb3ZcuHtOA93w35dYTsvhLPVnYs9eStHfGJvOvKxVfELGroGkvsg+p"
crossorigin="anonymous"/>
          <link rel="stylesheet" href=" https://cdnjs.cloudflare.com/ajax/libs/bootstrap-
social/5.1.1/bootstrap-social.min.css "/>
  <link href="https://fonts.googleapis.com/css?family=Open+Sans:300,400,600,700"
rel="stylesheet">
  <link href="https://use.fontawesome.com/releases/v5.0.6/css/all.css" rel="stylesheet">
  <!-- Nucleo Icons -->
  <link href="assets/css/nucleo-icons.css" rel="stylesheet" />
  <link href="assets/css/nucleo-svg.css" rel="stylesheet" />
  <link rel="stylesheet" href="assets/css/creativetim.min.css" type="text/css">
</head>
  <body class="bg-white" id="top" onload="myFunction()">
    <!-- Navbar -->
    <nav
      id="navbar-main"
      class="
        navbar navbar-main navbar-expand-lg
        bg-default
        navbar-light
        position-sticky
        top-0
        shadow
        py-0
      "
    >
      <div class="container">
        <ul class="navbar-nav navbar-nav-hover align-items-lg-center">
```

```
  <li class="nav-item dropdown">
    <a href="index.php" class="navbar-brand mr-lg-5 text-white">
                  <img src="assets/img/nav.png" />
    </a>
  </li>
</ul>
<button
  class="navbar-toggler bg-white"
  type="button"
  data-toggle="collapse"
  data-target="#navbar_global"
  aria-controls="navbar_global"
  aria-expanded="false"
  aria-label="Toggle navigation"
>
  <span class="navbar-toggler-icon text-white"></span>
</button>
<div class="navbar-collapse collapse bg-default" id="navbar_global">
  <div class="navbar-collapse-header">
    <div class="row">
      <div class="col-10 collapse-brand">
        <a href="index.html">
          <img src="assets/img/nav.png" />
        </a>
      </div>
      <div class="col-2 collapse-close bg-danger">
        <button
          type="button"
          class="navbar-toggler"
          data-toggle="collapse"
          data-target="#navbar_global"
          aria-controls="navbar_global"
          aria-expanded="false"
          aria-label="Toggle navigation"
        >
          <span></span>
          <span></span>
        </button>
      </div>
    </div>
  </div>
  <ul class="navbar-nav align-items-lg-center ml-auto">
                <li class="nav-item">
      <a href="contact.php" class="nav-link">
        <span class="text-white nav-link-inner--text"
          ><i class="text-white fas fa-address-card"></i> Contact</span
        >
      </a>
    </li>
                        <li class="nav-item">
                         <div class="dropdown show ">
```

```
                    <a class="nav-link dropdown-toggle text-white " href="#" role="button"
id="dropdownMenuLink" data-toggle="dropdown" aria-haspopup="true" aria-
expanded="false">
                                <span class="text-white nav-link-inner--text"
              ><i class="text-white fas fa-user-plus"></i> Sign Up</span
            >
                    </a>
                    <div class="dropdown-menu" aria-labelledby="dropdownMenuLink">
                            <a class="dropdown-item" href="farmer/fregister.php">Farmer</a>
                            <a class="dropdown-item"
href="customer/cregister.php">Customer</a>
                    </div>
                  </div>
                            </li>
                                      <li class="nav-item">
                              <div class="dropdown show ">
                    <a class="nav-link dropdown-toggle text-white " href="#" role="button"
id="dropdownMenuLink" data-toggle="dropdown" aria-haspopup="true" aria-
expanded="false">
                                <span class="text-white nav-link-inner--text"
              ><i class="text-white fas fa-sign-in-alt"></i> Login</span
            >
                    </a>
                    <div class="dropdown-menu" aria-labelledby="dropdownMenuLink">
                            <a class="dropdown-item" href="farmer/flogin.php">Farmer</a>
                            <a class="dropdown-item"
href="customer/clogin.php">Customer</a>
                            <a class="dropdown-item" href="admin/alogin.php">Admin </a>
                    </div>
                  </div>
                            </li>
        </ul>
      </div>
    </div>
  </nav>
  <!-- End Navbar -->
<div class="wrapper" >
  <div class="wrapper">
    <header class="jumbotron bg-gradient-warning">
      <div class="container">
        <div class="row row-header">
          <div class="col-12 col-sm-6">
            <h1 class="text-white">Agriculture Portal</h1>
            <p class="text-white">
             A True Farmer's Friend.
            </p>
            <div class="cg">
              <div class="card card-body bg-gradient-success">
                <blockquote cite="blockquote">
                  <h6 class="mb-0 text-dark">
                    <em><b  id="quote"> “Farming looks mighty easy when your plow is a
```

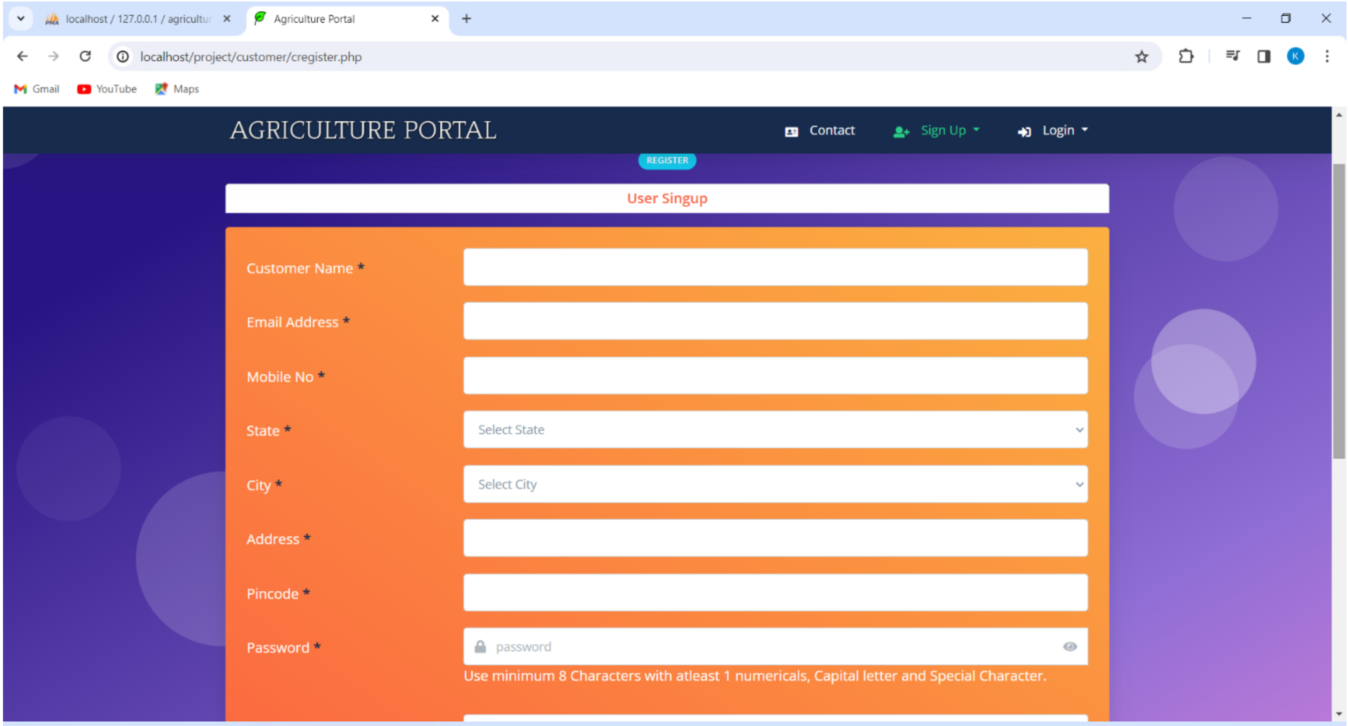
```
pencil, and you're a thousand miles from the corn field..”</b ></em>
          </h6>
          <br />
          <footer class="blockquote-footer vg text-dark"  >
            <span id="author"> DWIGHT D. EISENHOWER     </span>
                                   <button id="sendButton" class="btn btn-sm btn-
outline-secondary pull-right mx-auto mr-auto bg-gradient-danger" onclick="myFunction()">
                                    <i class="fa fa-refresh text-white"></i>
                                   </button>
          </footer>
         </blockquote>
        </div>
       </div>
      </div>
      <div class="col-12 col-sm-3 offset-sm-2 align-self-center">
       <img src="assets/img/plant-bulb.png" class="img-fluid" alt="" />
      </div>
     </div>
    </div>
   </header>
<!-- Page Content -->
<!--
===============================================================
===============================================================
==== -->
   <div class="section features-2 text-dark bg-white" id="features">
    <div class="container">
     <div class="row align-items-center">
      <div class="col-lg-5 col-md-8 mr-auto text-left">
       <div class="pr-md-5">
        <div class="icon icon-lg icon-shape icon-shape-primary shadow rounded-circle
mb-5"> <i class="ni ni-favourite-28"> </i></div>
        <h3 class="display-3 text-justify">Features</h3>
        <p>The time is now for the next step in farming. We bring you the future of
farming along with great tools for asisting the farmers.</p>
        <ul class="list-unstyled mt-5">
         <li class="py-2">
          <div class="d-flex align-items-center">
           <div>
            <div class="badge badge-circle badge-primary mr-3"> <i class="ni ni-
settings-gear-65"> </i></div>
           </div>
           <div>
            <h6 class="mb-0">Highly Reliable and Accurate.</h6>
           </div>
          </div>
         </li>
         <li class="py-2">
          <div class="d-flex align-items-center">
           <div>
            <div class="badge badge-circle badge-primary mr-3"> <i class="ni ni-
```

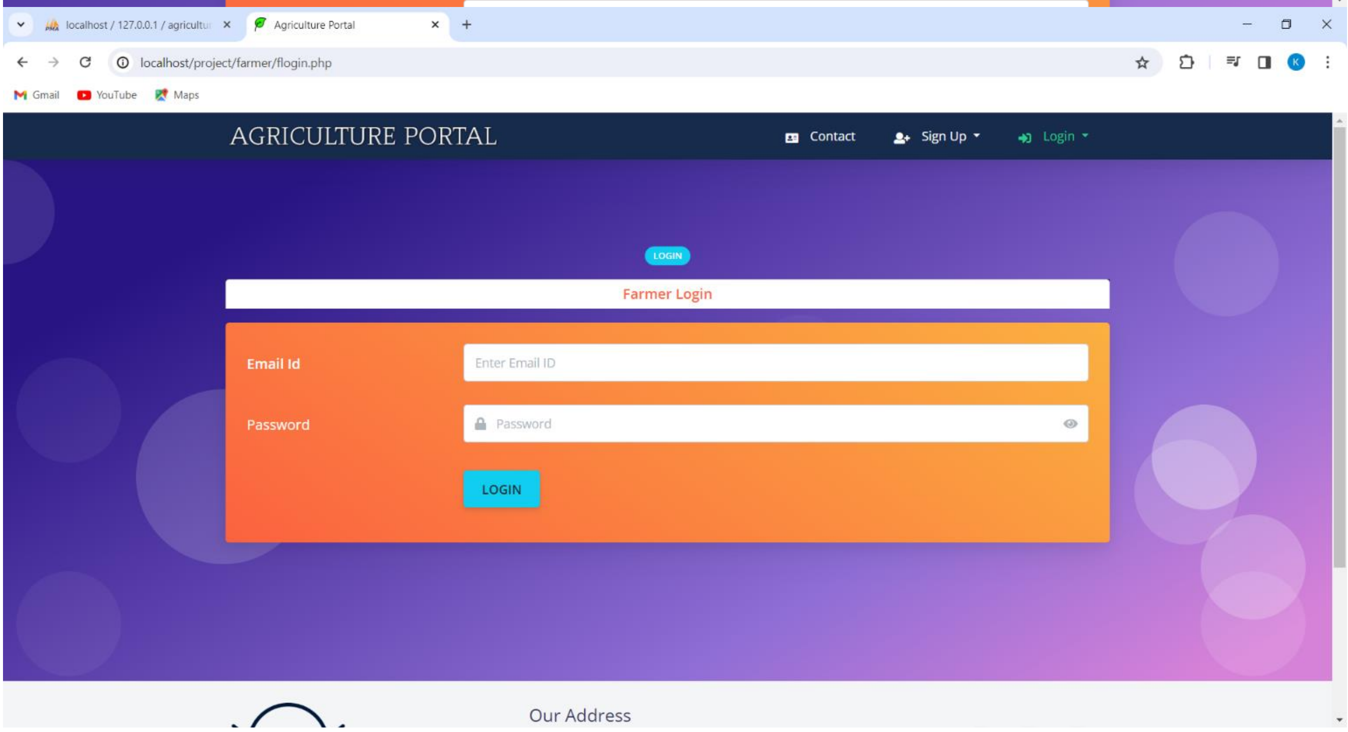
```
html5"> </i></div>
                </div>
                <div>
                  <h6 class="mb-0">Faster & Responsive website.</h6>
                </div>
              </div>
            </li>
            <li class="py-2">
              <div class="d-flex align-items-center">
                <div>
                  <div class="badge badge-circle badge-primary mr-3"> <i class="ni ni-
settings-gear-65"> </i></div>
                </div>
                <div>
                  <h6 class="mb-0">Real time weather forecast.</h6>
                </div>
              </div>
            </li>
            <li class="py-2">
              <div class="d-flex align-items-center">
                <div>
                  <div class="badge badge-circle badge-primary mr-3"> <i class="ni ni-
satisfied"> </i></div>
                </div>
                <div>
                  <h6 class="mb-0">Integrated news feature.</h6>
                </div>
              </div>
            </li>
          </ul>
        </div>
      </div>
      <div class="col-lg-7 col-md-12 pl-md-0">
 <img class="img-fluid ml-lg-5" src="assets/img/features.png" width="100%">
 </div>
      </div>
    </div>
    <span > </span>
  </div>
      <!--
================================================================
================================================================
==== -->
 <div class="section features-6 text-dark bg-white" id="tech">
    <div class="container-fluid shado">
      <div class="row">
        <div class="col-md-8 mx-auto text-center">
          <span class="badge badge-primary badge-pill mb-3">stack</span>
          <h3 class="display-3 ">Technologies Used</h3>
          <p class="" >Our Development Stack</p>
        </div>
```

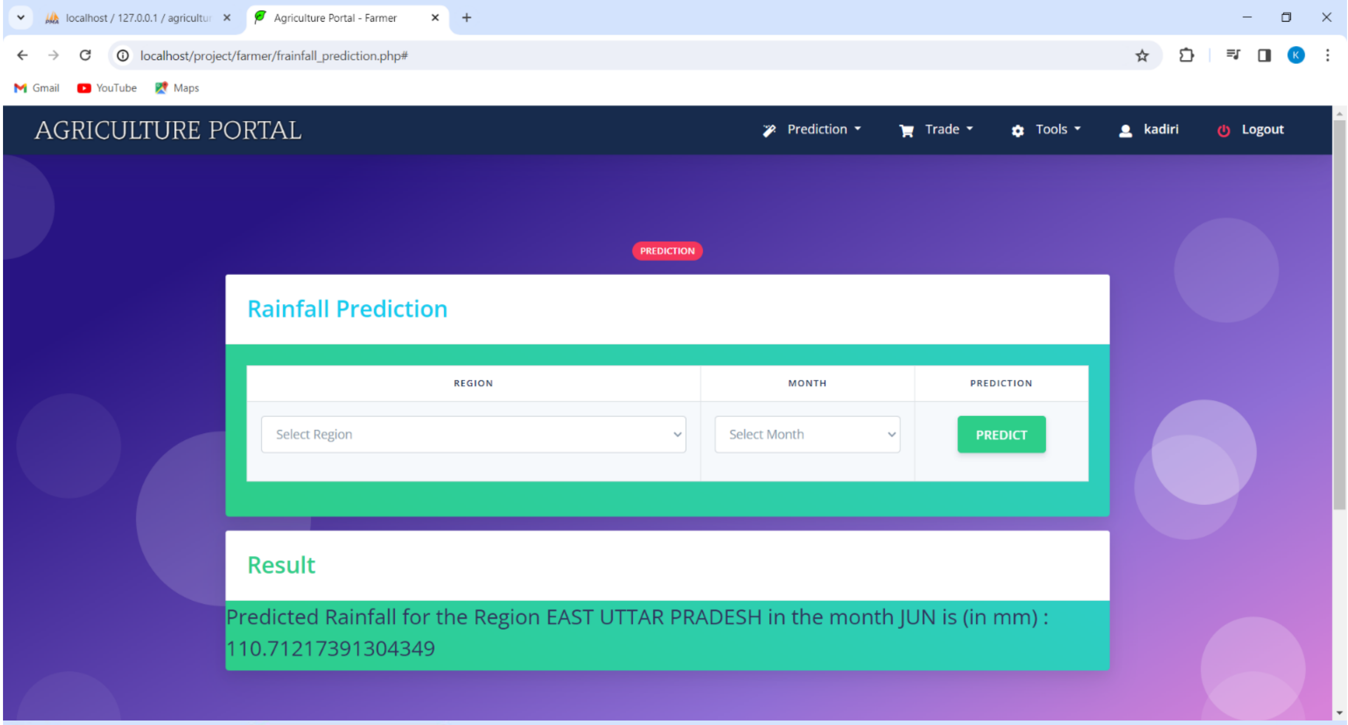
```
        </div>
        <div class="row text-lg-center align-self-center">
            <div class="col-md-4">
              <div class="info">
              <img class=" img-fluid" src="assets/img/html.png" alt="HTML5">
                 <h6 class="info-title text-uppercase text-primary">HTML5</h6>
              </div>
           </div>
          <div class="col-md-4">
              <div class="info">
              <img class=" img-fluid" src="assets/img/css3.png" alt="CSS3">
                 <h6 class="info-title text-uppercase text-primary">CSS3</h6>
              </div>
           </div>
          <div class="col-md-4">
              <div class="info">
              <img class=" img-fluid" src="assets/img/js.png" alt="JavaScript">
                 <h6 class="info-title text-uppercase text-primary">JavaScript</h6>
              </div>
           </div>
</div>
<div class="row text-center ">
            <div class="col-md-4 d-none d-md-block">
              <div class="info">
              <img class=" img-fluid" src="assets/img/bootstrap.png" alt="BootStrap4">
                 <h6 class="info-title text-uppercase text-primary">BootStrap4</h6>
              </div>
           </div>
            <div class="col-md-4 d-none d-md-block">
              <div class="info">
              <img class=" img-fluid" src="assets/img/apache.png" alt="Apache">
                 <h6 class="info-title text-uppercase text-primary">Apache</h6>
              </div>
           </div>
            <div class="col-md-4 d-none d-md-block">
              <div class="info">
              <img class=" img-fluid" src="assets/img/mysql.png" alt="MySQL">
                 <h6 class="info-title text-uppercase text-primary">MySQL</h6>
              </div>
           </div>
        </div>
<div class="row text-center ">
            <div class="col-md-4 d-none d-md-block">
              <div class="info">
              <img class=" img-fluid" src="assets/img/jquery.png" alt="BootStrap4">
                 <h6 class="info-title text-uppercase text-primary">JQUERY</h6>
              </div>
           </div>
            <div class="col-md-4 d-none d-md-block">
              <div class="info">
              <img class=" img-fluid" src="assets/img/openai2.png" alt="Apache">
```

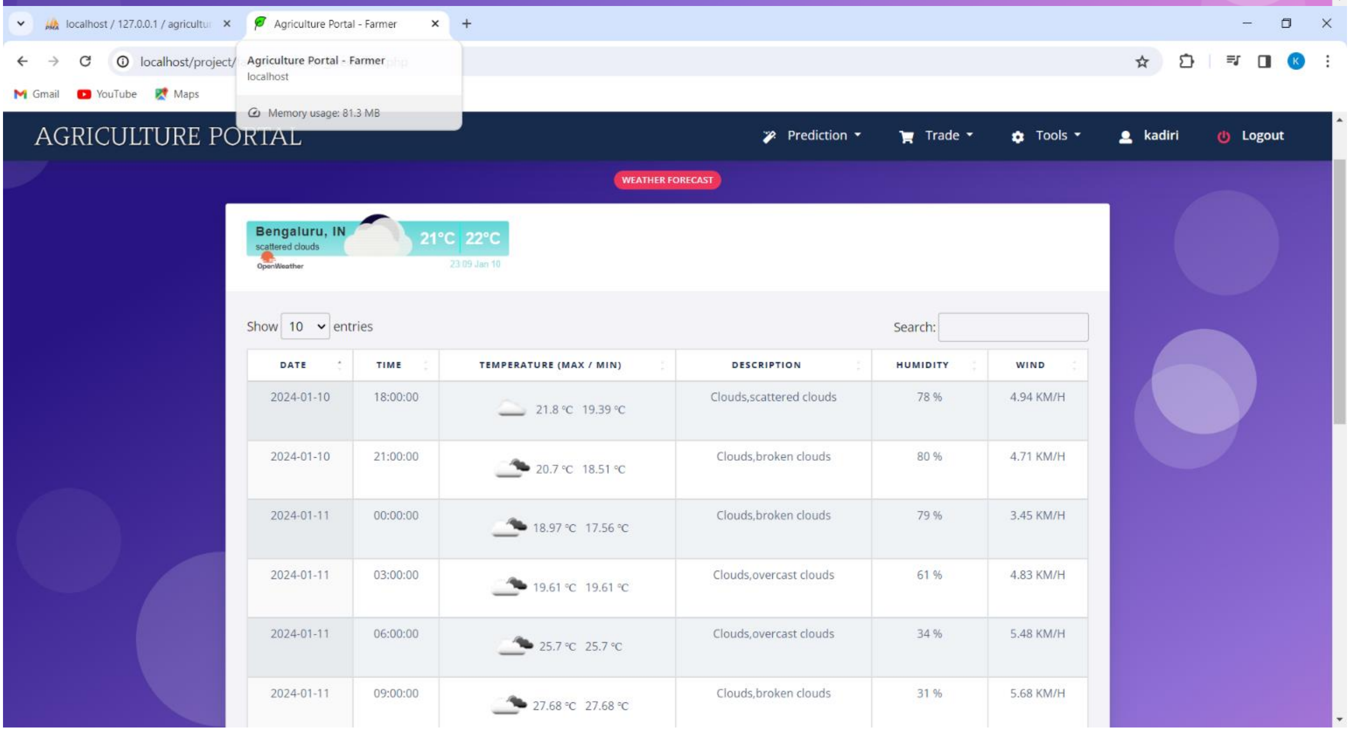
```
                    <h6 class="info-title text-uppercase text-primary">OPEN AI</h6>
                </div>
            </div>
             <div class="col-md-4 d-none d-md-block">
                <div class="info">
                <img class=" img-fluid" src="assets/img/php2.png" alt="MySQL">
                    <h6 class="info-title text-uppercase text-primary">PHP</h6>
                </div>
            </div>
        </div>
    </div>
</div><?php require("footer.php");?>
<script>
const apiKey = "sk-xxxxxxxxxxxxxxxxxxxx";   // Enter your apikey here
const chatbox = document.getElementById("quote");
const authorN = document.getElementById("author");
let messages = [];
function myFunction(){
        const msg = "give me a quote related to agriculture and farming";
    if (msg) {
        messages.push({
            "role": "user",
            "content": msg
        });
        fetchMessages();
    }
};
```

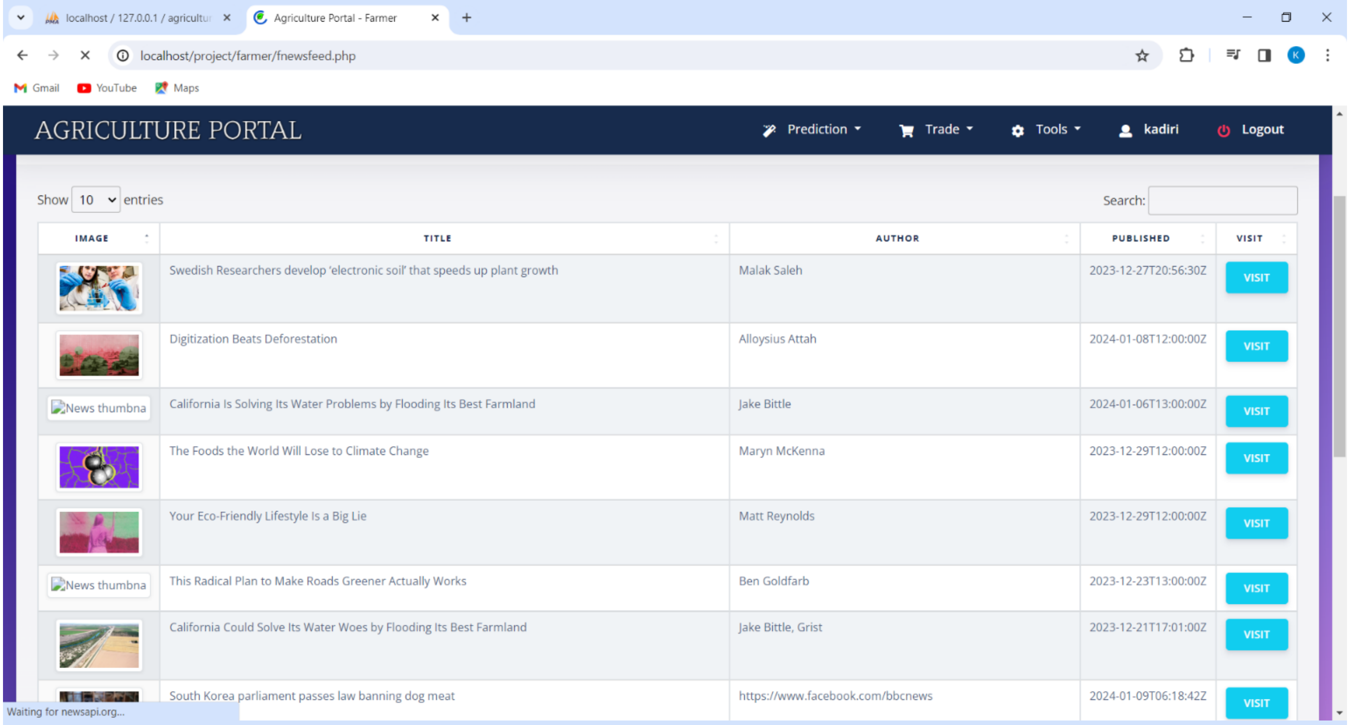
APPENDIX-B
SCREENSHOTS

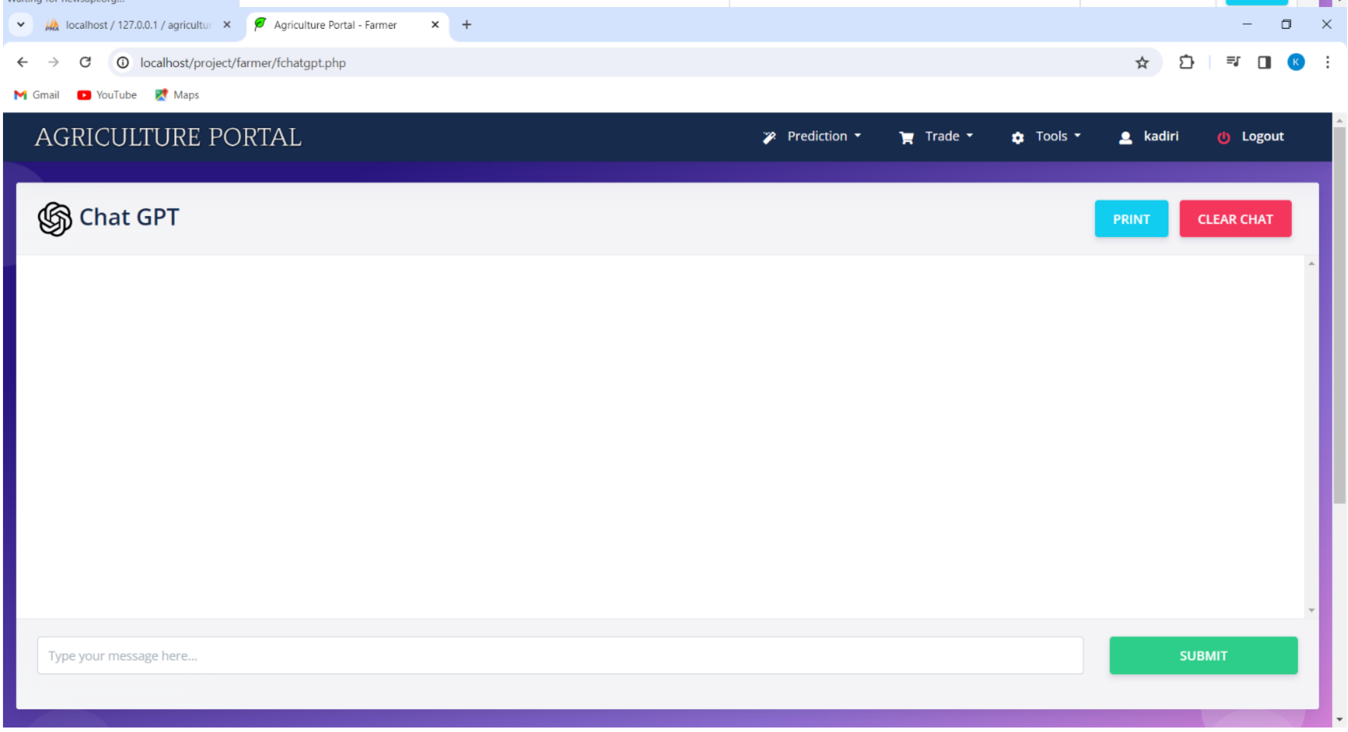


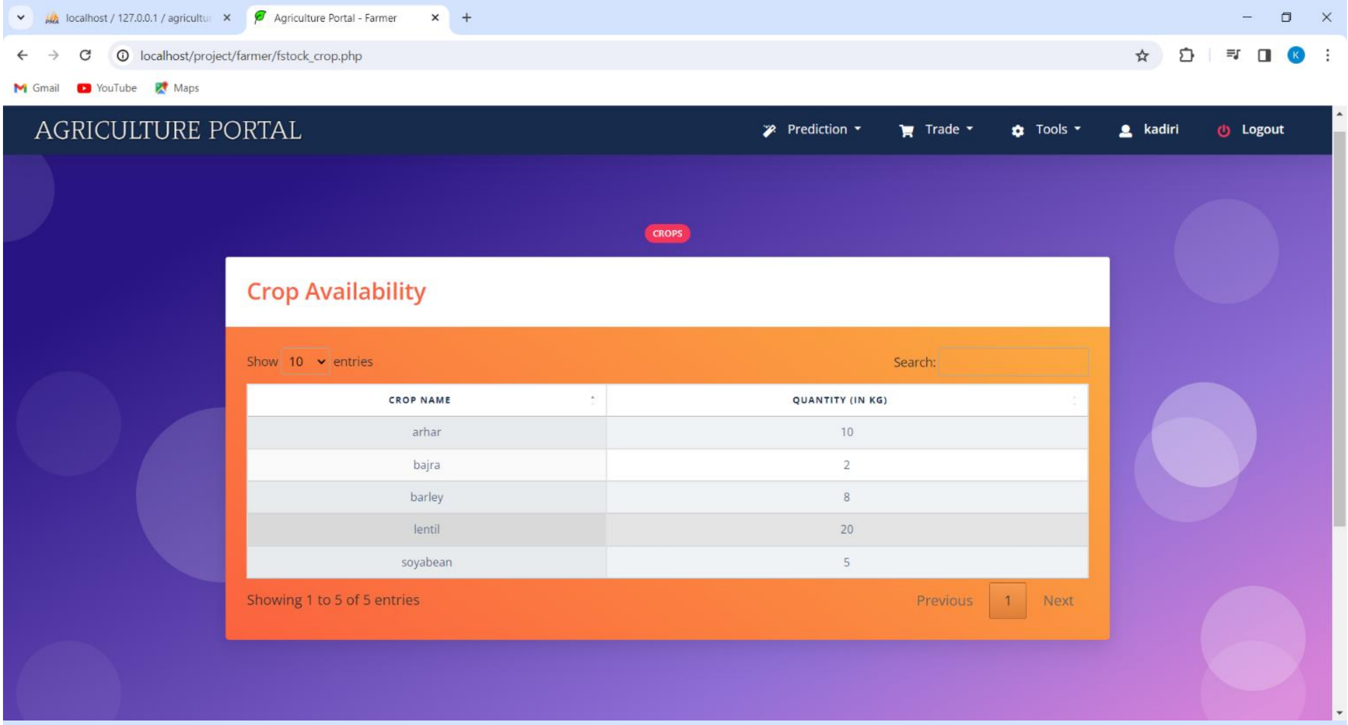


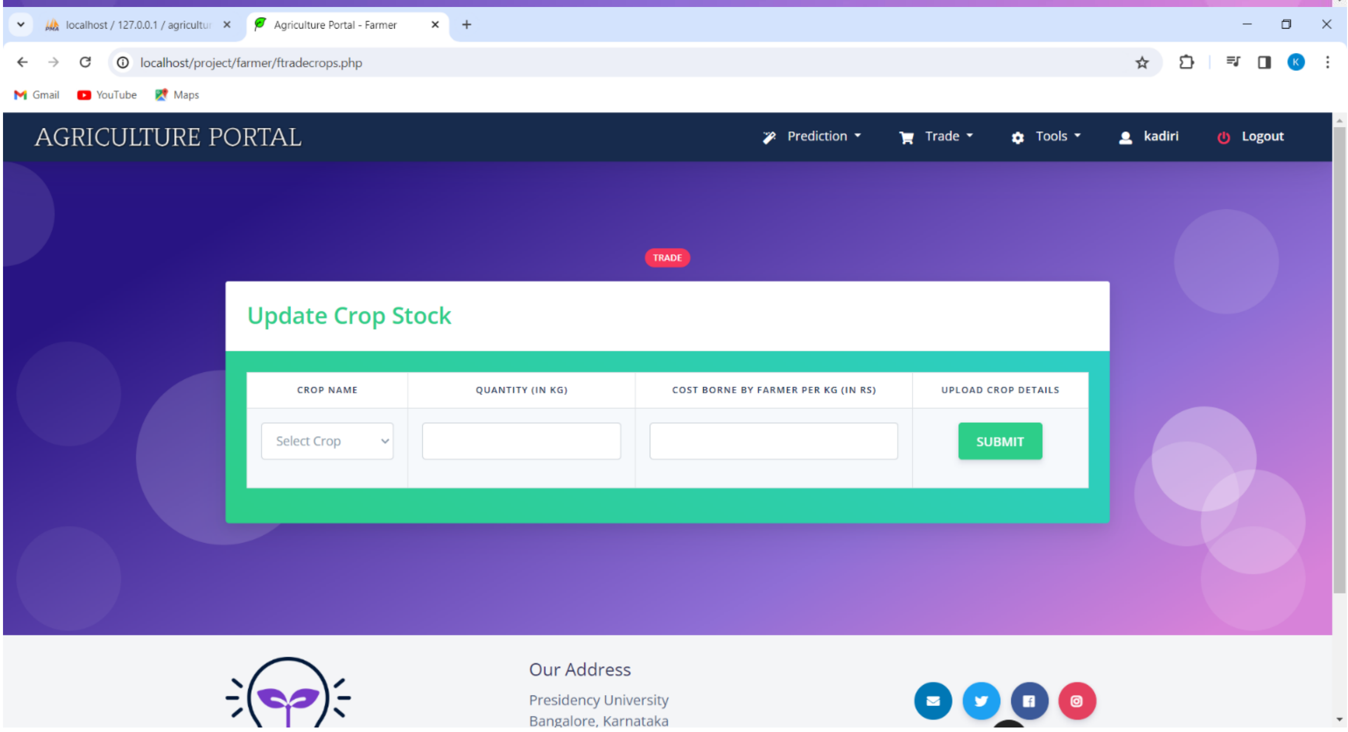

localhost / 127.0.0.1 / agricultur
Agriculture Portal - Farmer
localhost/project/farmer/frainfall_prediction.php#
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Prediction
Trade
Tools
kadiri
Logout
PREDICTION
Rainfall Prediction
REGION
MONTH
PREDICTION
Select Region
Select Month
PREDICT
Result
Predicted Rainfall for the Region EAST UTTAR PRADESH in the month JUN is (in mm) : 110.71217391304349

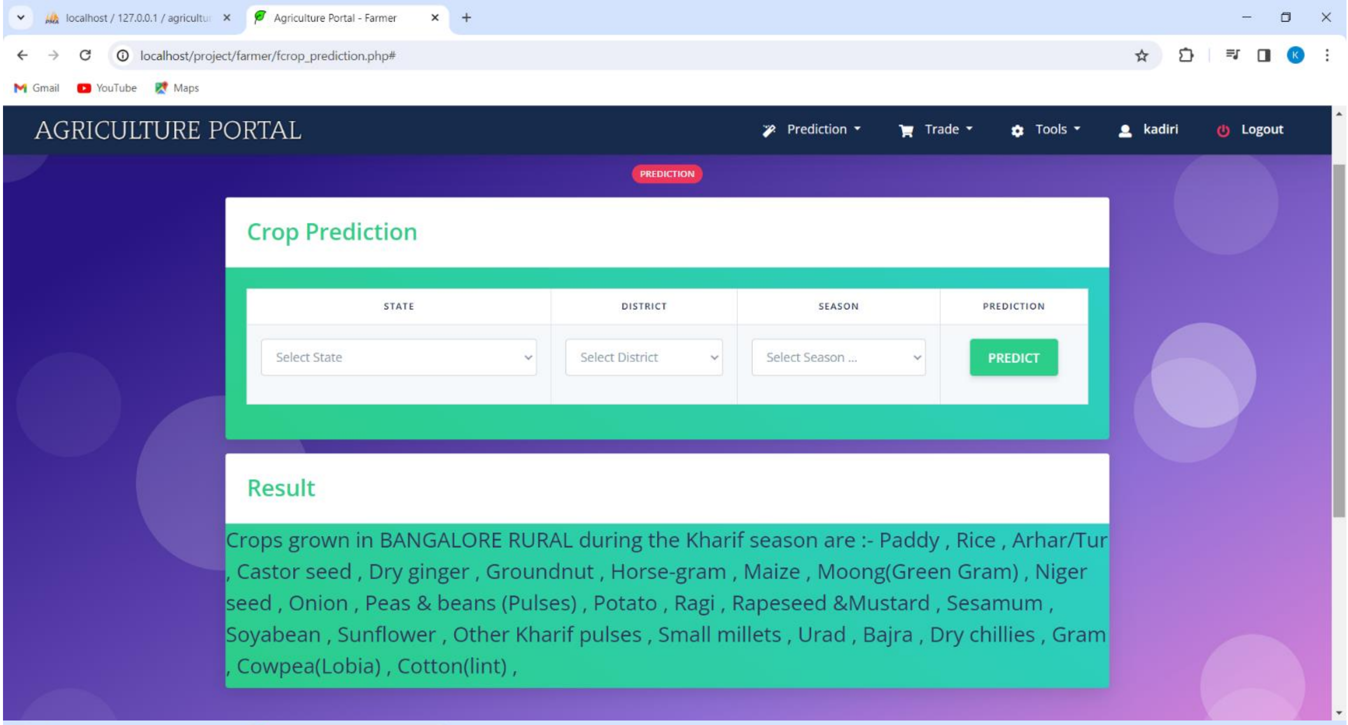

localhost / 127.0.0.1 / agricultur
Agriculture Portal - Farmer
localhost/project/
Agriculture Portal - Farmer
localhost
Memory usage: 81.3 MB
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Prediction
Trade
Tools
kadiri
Logout
WEATHER FORECAST
Bengaluru, IN
scattered clouds
21°C 22°C
Show 10 entries
Search:
DATE
TIME
TEMPERATURE (MAX / MIN)
DESCRIPTION
HUMIDITY
WIND
2024-01-10 18:00:00 21.8 °C 19.39 °C Clouds,scattered clouds 78 % 4.94 KM/H
2024-01-10 21:00:00 20.7 °C 18.51 °C Clouds,broken clouds 80 % 4.71 KM/H
2024-01-11 00:00:00 18.97 °C 17.56 °C Clouds,broken clouds 79 % 3.45 KM/H
2024-01-11 03:00:00 19.61 °C 19.61 °C Clouds,overcast clouds 61 % 4.83 KM/H
2024-01-11 06:00:00 25.7 °C 25.7 °C Clouds,overcast clouds 34 % 5.48 KM/H
2024-01-11 09:00:00 27.68 °C 27.68 °C Clouds,broken clouds 31 % 5.68 KM/H

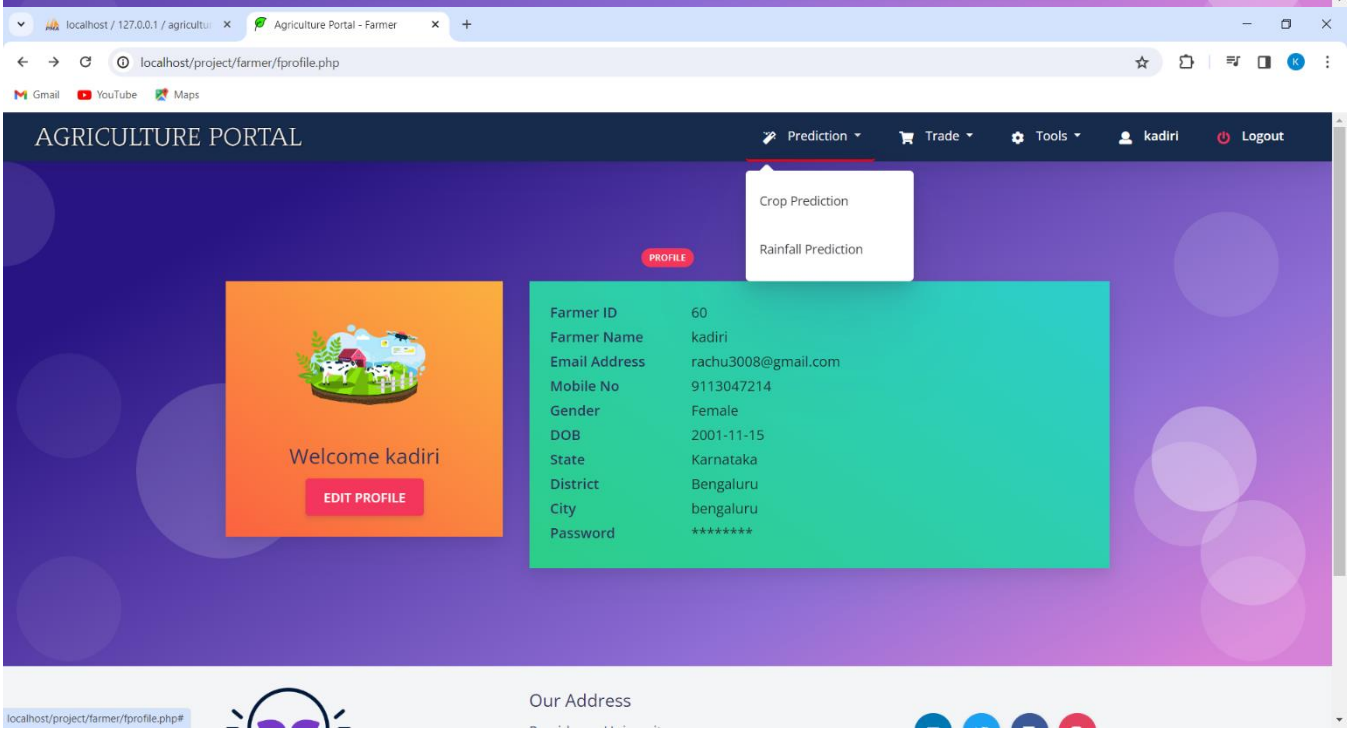

localhost/project/farmer/fnewsfeed.php
AGRICULTURE PORTAL
Prediction
Trade
Tools
kadiri
Logout
Show 10 entries
Search:
IMAGE
TITLE
AUTHOR
PUBLISHED
VISIT
Swedish Researchers develop 'electronic soil' that speeds up plant growth
Malak Saleh
2023-12-27T20:56:30Z
Digitization Beats Deforestation
Alloysius Attah
2024-01-08T12:00:00Z
California Is Solving Its Water Problems by Flooding Its Best Farmland
Jake Bittle
2024-01-06T13:00:00Z
The Foods the World Will Lose to Climate Change
Maryn McKenna
2023-12-29T12:00:00Z
Your Eco-Friendly Lifestyle Is a Big Lie
Matt Reynolds
2023-12-29T12:00:00Z
This Radical Plan to Make Roads Greener Actually Works
Ben Goldfarb
2023-12-23T13:00:00Z
California Could Solve Its Water Woes by Flooding Its Best Farmland
Jake Bittle, Grist
2023-12-21T17:01:00Z
South Korea parliament passes law banning dog meat
https://www.facebook.com/bbcnews
2024-01-09T06:18:42Z
VISIT
Waiting for newsapi.org...

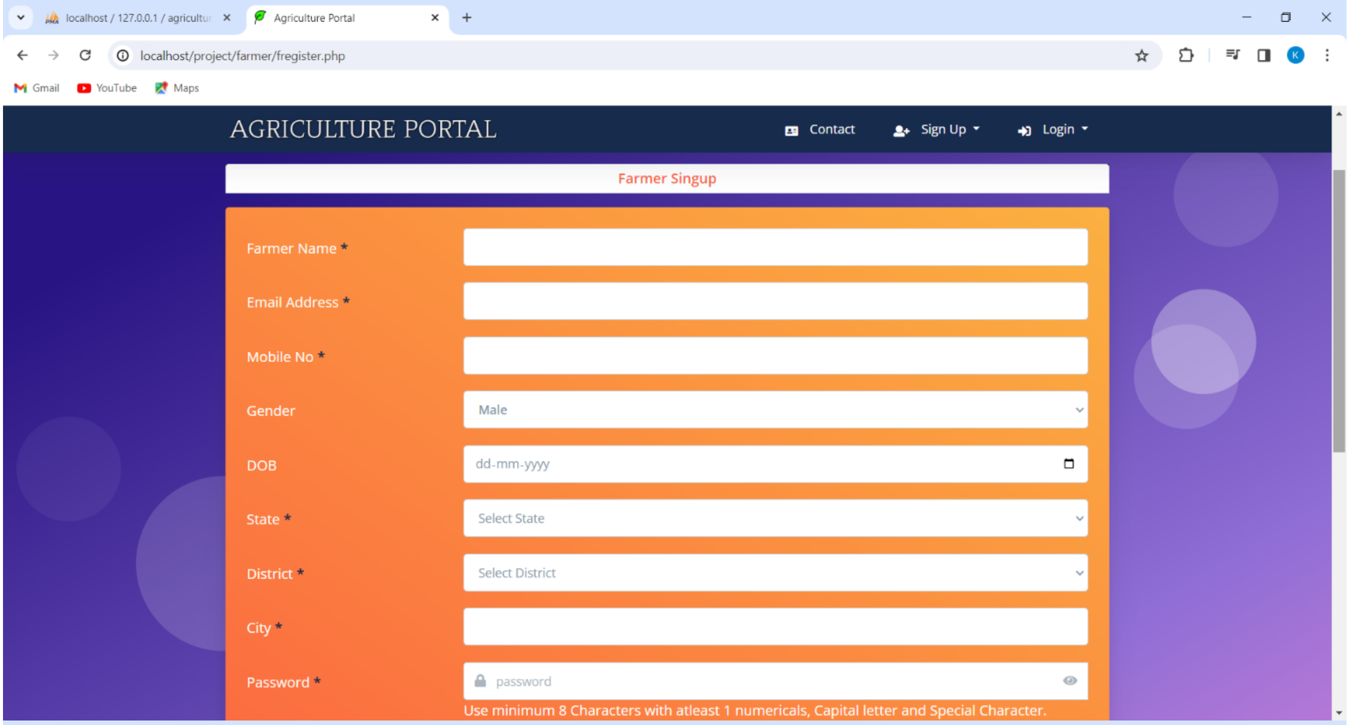

localhost/project/farmer/fchatgpt.php
AGRICULTURE PORTAL
Prediction
Trade
Tools
kadiri
Logout
Chat GPT
PRINT
CLEAR CHAT
Type your message here...
SUBMIT

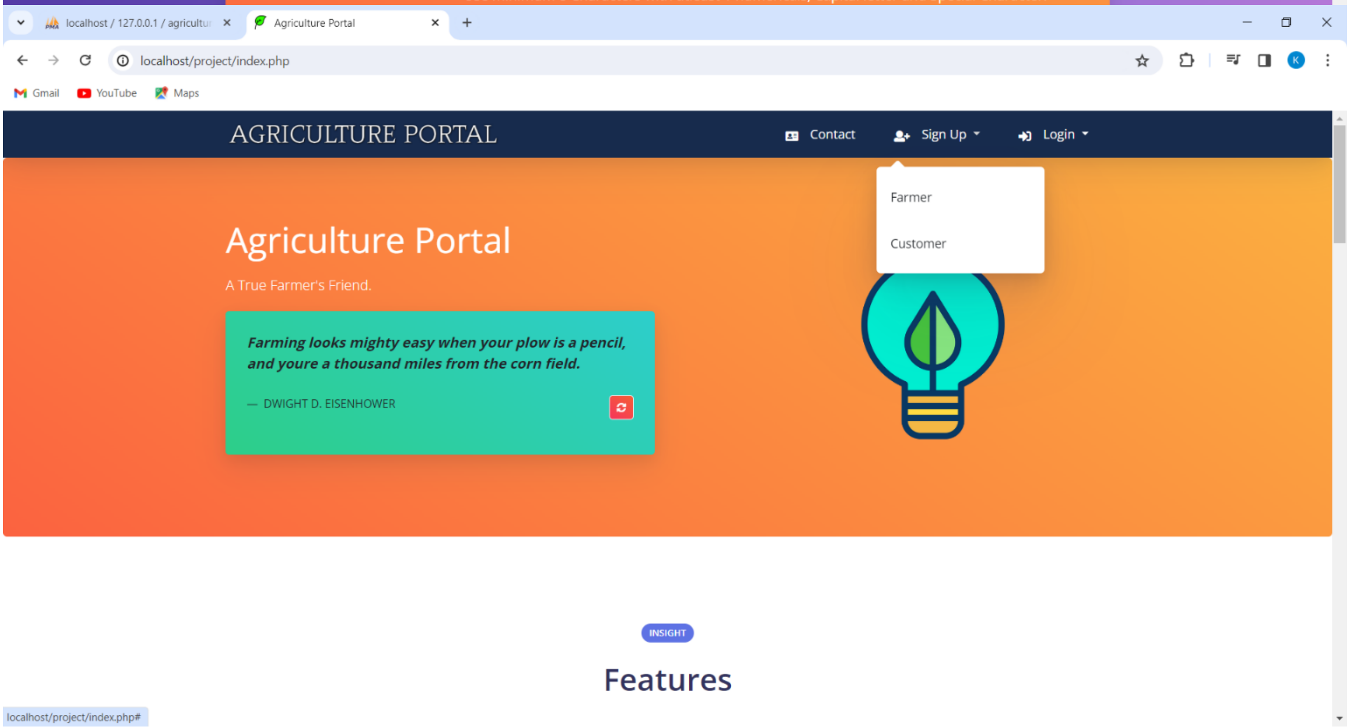

localhost/project/farmer/fstock_crop.php
AGRICULTURE PORTAL
Prediction
Trade
Tools
kadiri
Logout
CROPS
Crop Availability
Show 10 entries
Search:
CROP NAME
QUANTITY (IN KG)
arhar 10
bajra 2
barley 8
lentil 20
soyabean 5
Showing 1 to 5 of 5 entries
Previous 1 Next

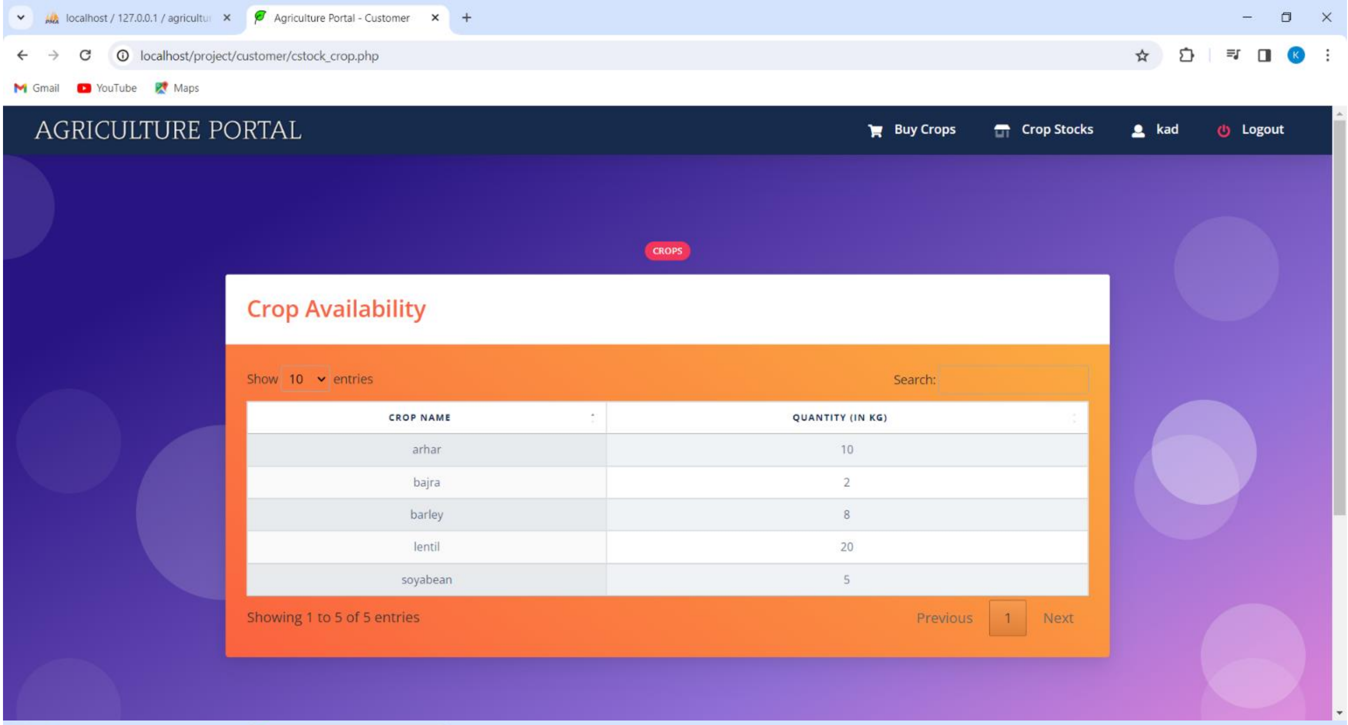

localhost/project/farmer/ftradecrops.php
AGRICULTURE PORTAL
Prediction
Trade
Tools
kadiri
Logout
TRADE
Update Crop Stock
CROP NAME
QUANTITY (IN KG)
COST BORNE BY FARMER PER KG (IN RS)
UPLOAD CROP DETAILS
Select Crop
SUBMIT
Our Address
Presidency University
Bangalore, Karnataka

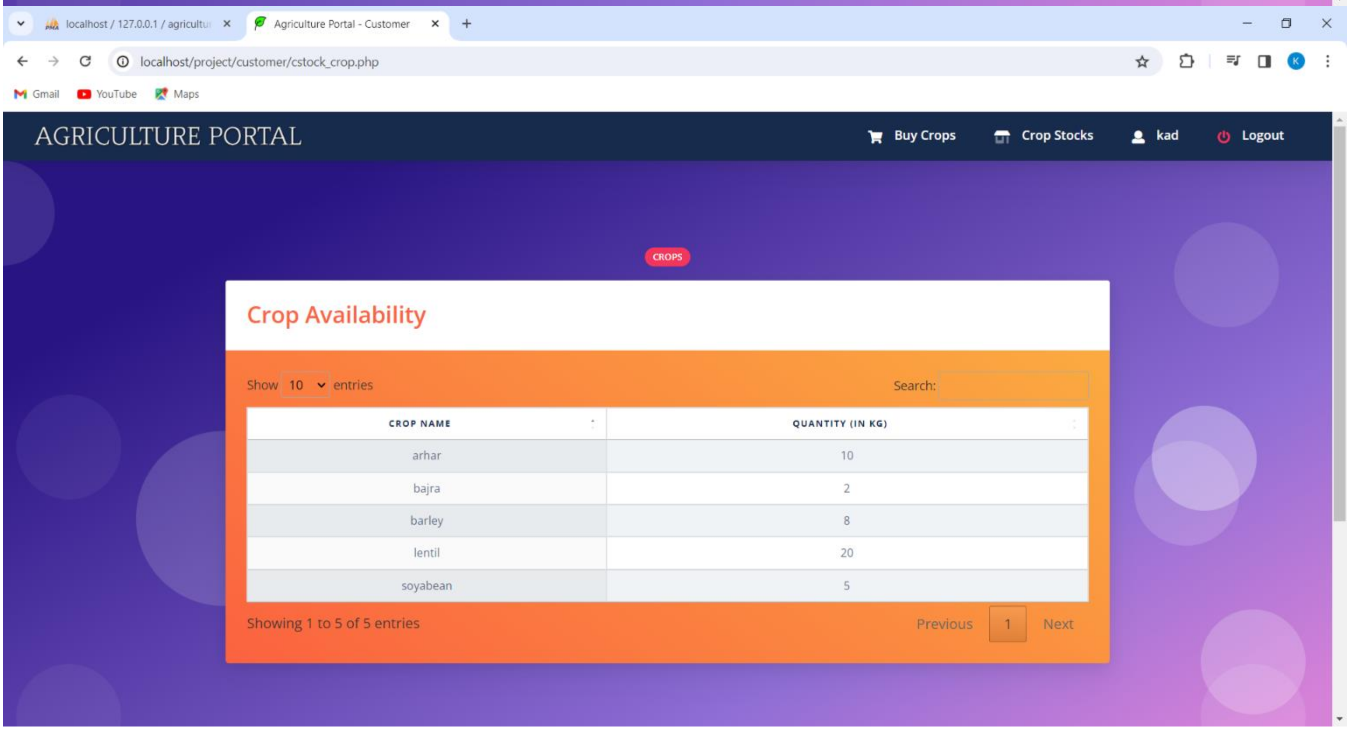

localhost / 127.0.0.1 / agricultu
Agriculture Portal - Farmer
localhost/project/farmer/fcrop_prediction.php#
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Prediction
Trade
Tools
kadiri
Logout
PREDICTION
Crop Prediction
STATE
DISTRICT
SEASON
PREDICTION
Select State
Select District
Select Season ...
PREDICT
Result
Crops grown in BANGALORE RURAL during the Kharif season are :- Paddy , Rice , Arhar/Tur , Castor seed , Dry ginger , Groundnut , Horse-gram , Maize , Moong(Green Gram) , Niger seed , Onion , Peas & beans (Pulses) , Potato , Ragi , Rapeseed &Mustard , Sesamum , Soyabean , Sunflower , Other Kharif pulses , Small millets , Urad , Bajra , Dry chillies , Gram , Cowpea(Lobia) , Cotton(lint) ,

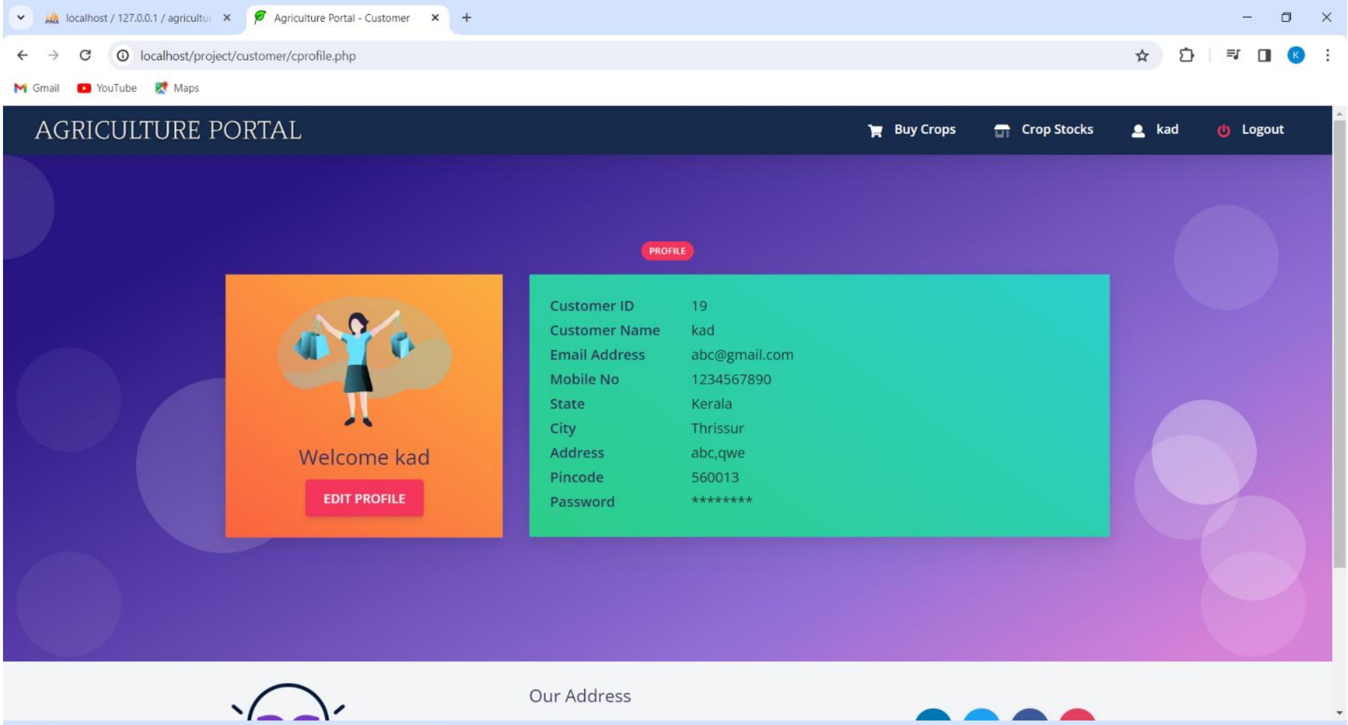

localhost / 127.0.0.1 / agricultu
Agriculture Portal - Farmer
localhost/project/farmer/fprofile.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Prediction
Trade
Tools
kadiri
Logout
Crop Prediction
Rainfall Prediction
PROFILE
Welcome kadiri
EDIT PROFILE
Farmer ID 60
Farmer Name kadiri
Email Address rachu3008@gmail.com
Mobile No 9113047214
Gender Female
DOB 2001-11-15
State Karnataka
District Bengaluru
City bengaluru
Password ********
Our Address
localhost/project/farmer/fprofile.php#

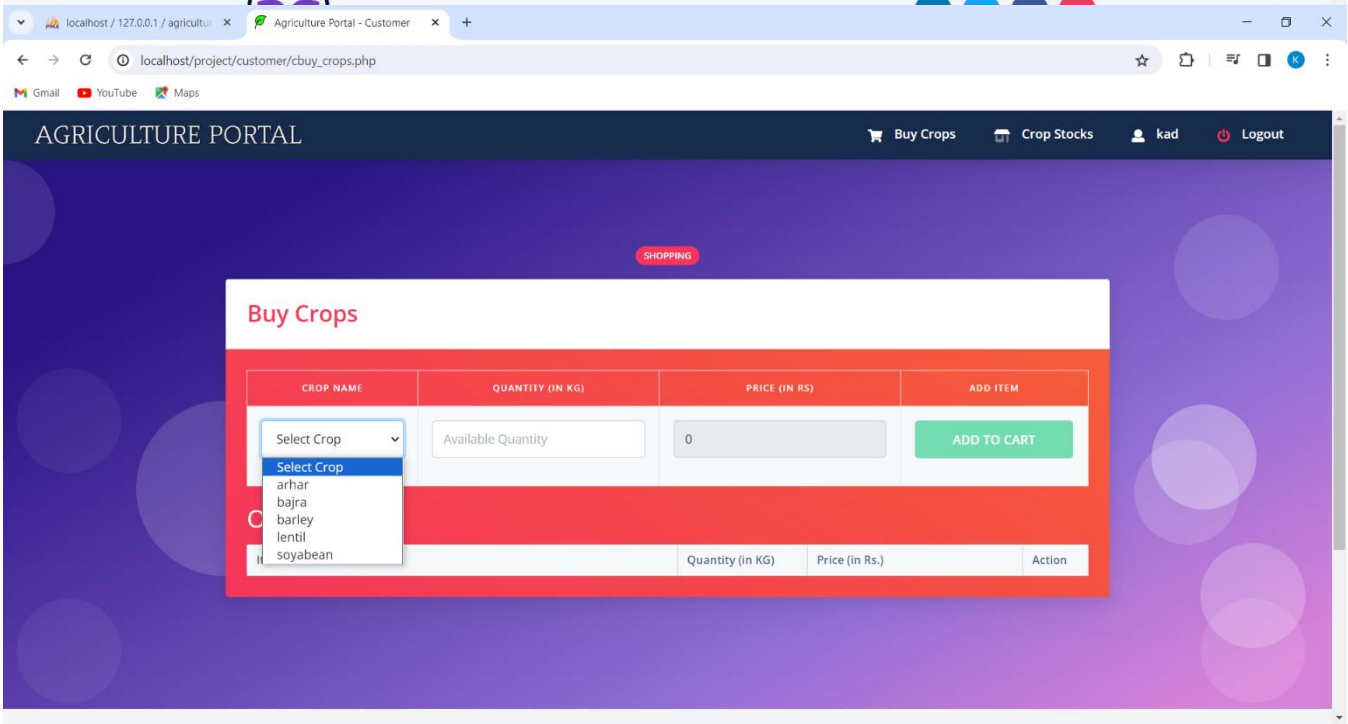

localhost / 127.0.0.1 / agricultu
Agriculture Portal
localhost/project/farmer/fregister.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Contact
Sign Up
Login
Farmer Singup
Farmer Name *
Email Address *
Mobile No *
Gender
Male
DOB
dd-mm-yyyy
State *
Select State
District *
Select District
City *
Password *
password
Use minimum 8 Characters with atleast 1 numericals, Capital letter and Special Character.

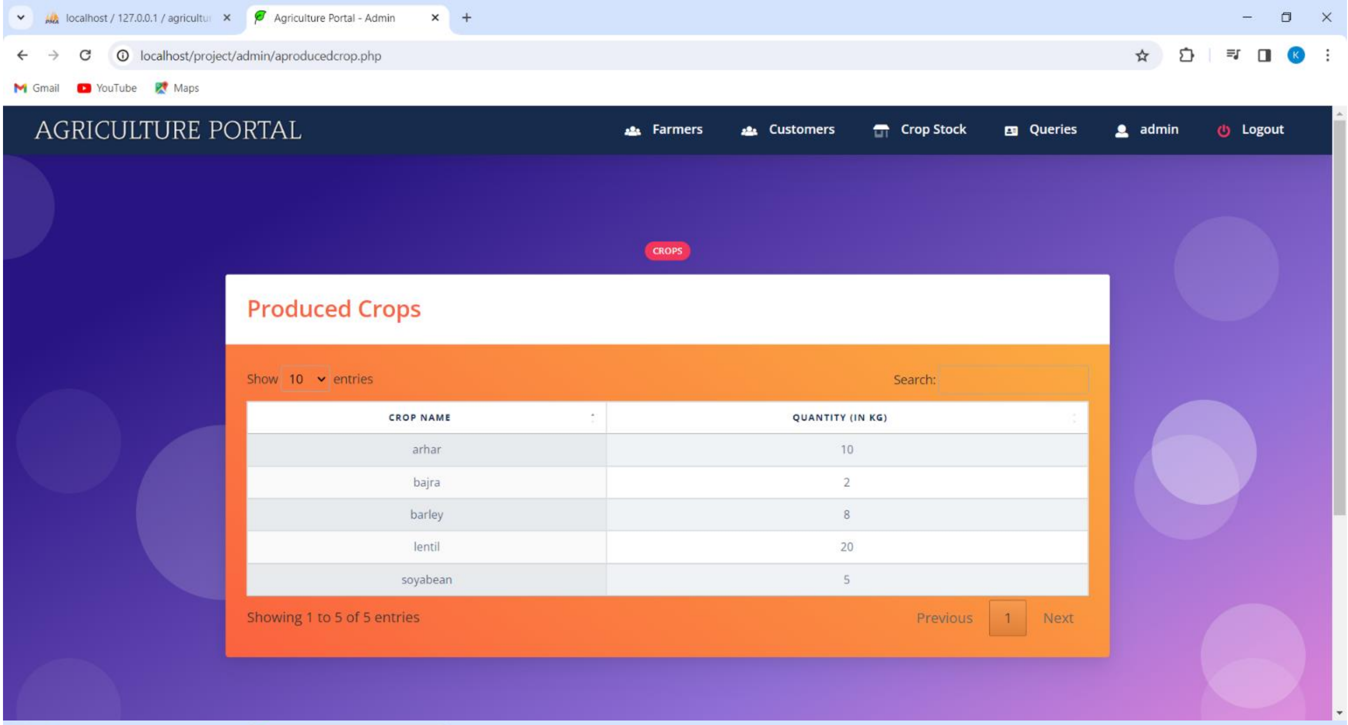

localhost / 127.0.0.1 / agricultu
Agriculture Portal
localhost/project/index.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Contact
Sign Up
Login
Farmer
Customer
Agriculture Portal
A True Farmer's Friend.
Farming looks mighty easy when your plow is a pencil, and youre a thousand miles from the corn field.
— DWIGHT D. EISENHOWER
INSIGHT
Features
localhost/project/index.php#

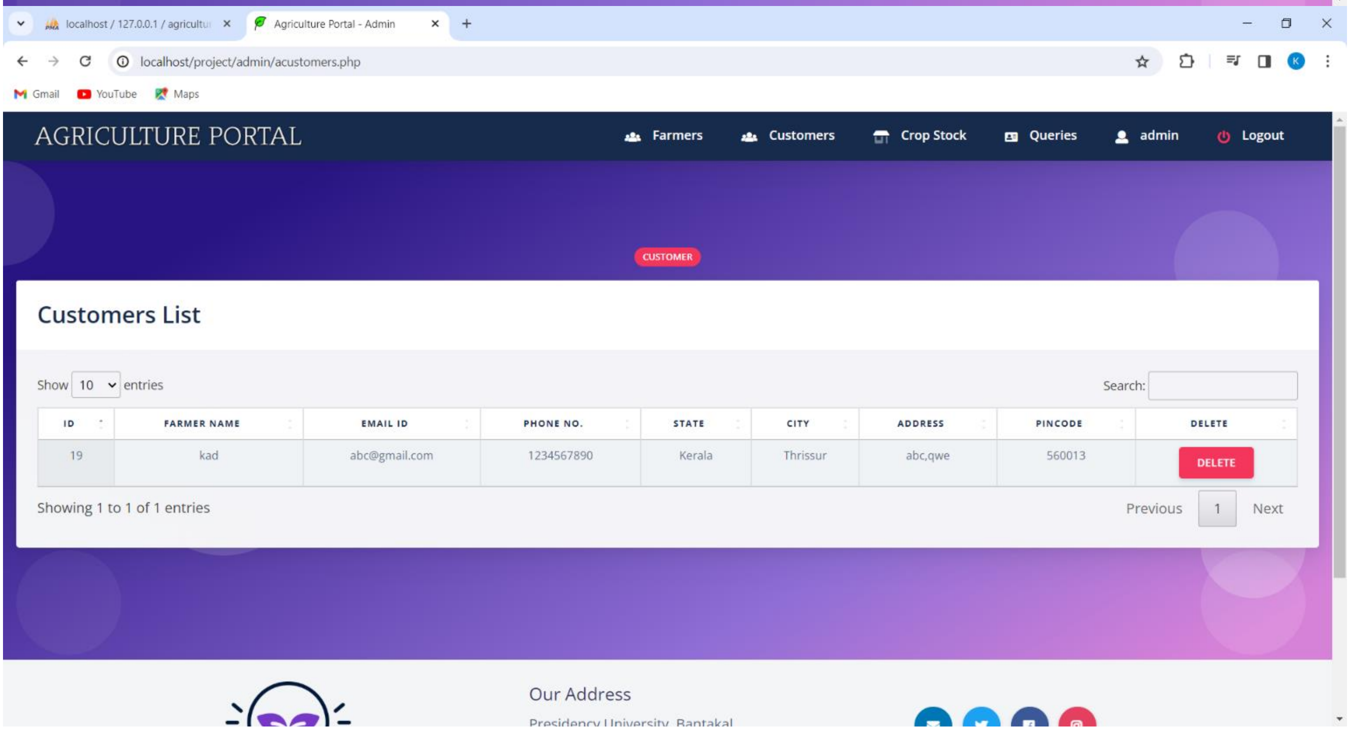

localhost / 127.0.0.1 / agricultu
Agriculture Portal - Customer
localhost/project/customer/cstock_crop.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Buy Crops
Crop Stocks
kad
Logout
CROPS
Crop Availability
Show 10 entries
Search:
CROP NAME
QUANTITY (IN KG)
arhar
10
bajra
2
barley
8
lentil
20
soyabean
5
Showing 1 to 5 of 5 entries
Previous
1
Next

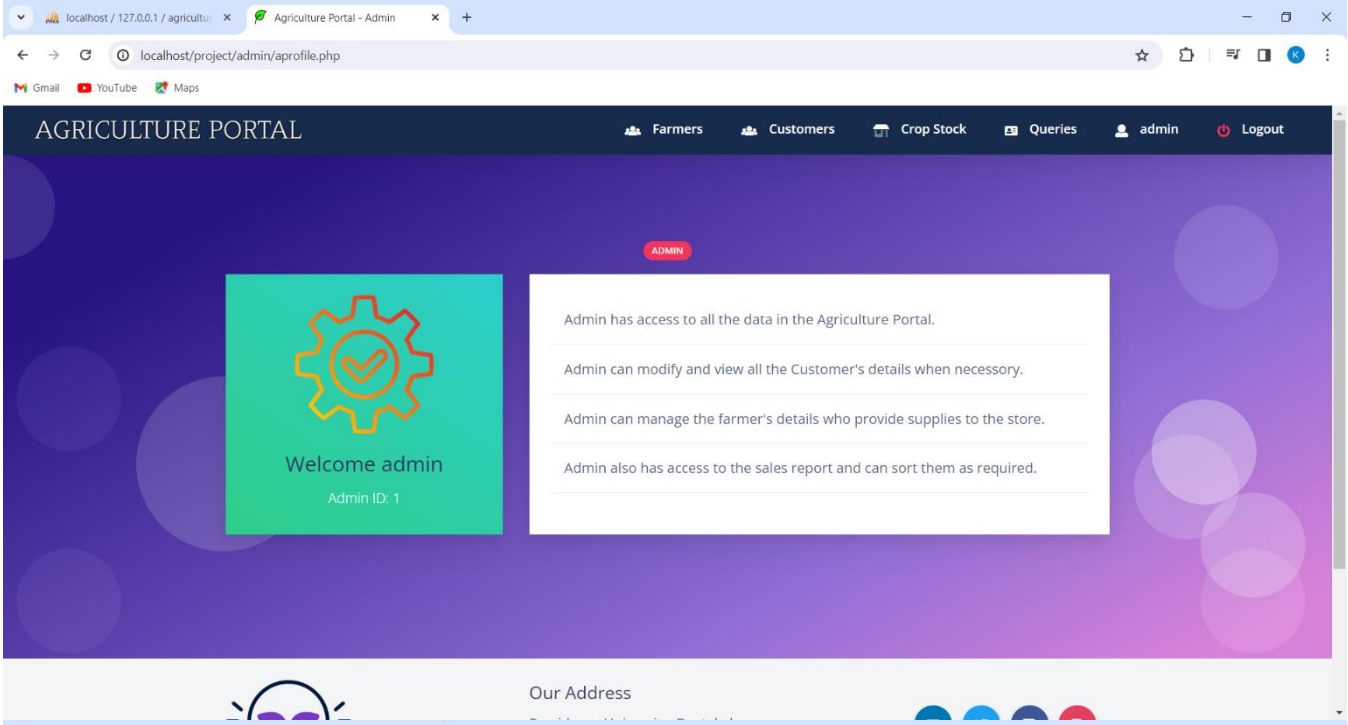

localhost / 127.0.0.1 / agricultu
Agriculture Portal - Customer
localhost/project/customer/cstock_crop.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Buy Crops
Crop Stocks
kad
Logout
CROPS
Crop Availability
Show 10 entries
Search:
CROP NAME
QUANTITY (IN KG)
arhar
10
bajra
2
barley
8
lentil
20
soyabean
5
Showing 1 to 5 of 5 entries
Previous
1
Next

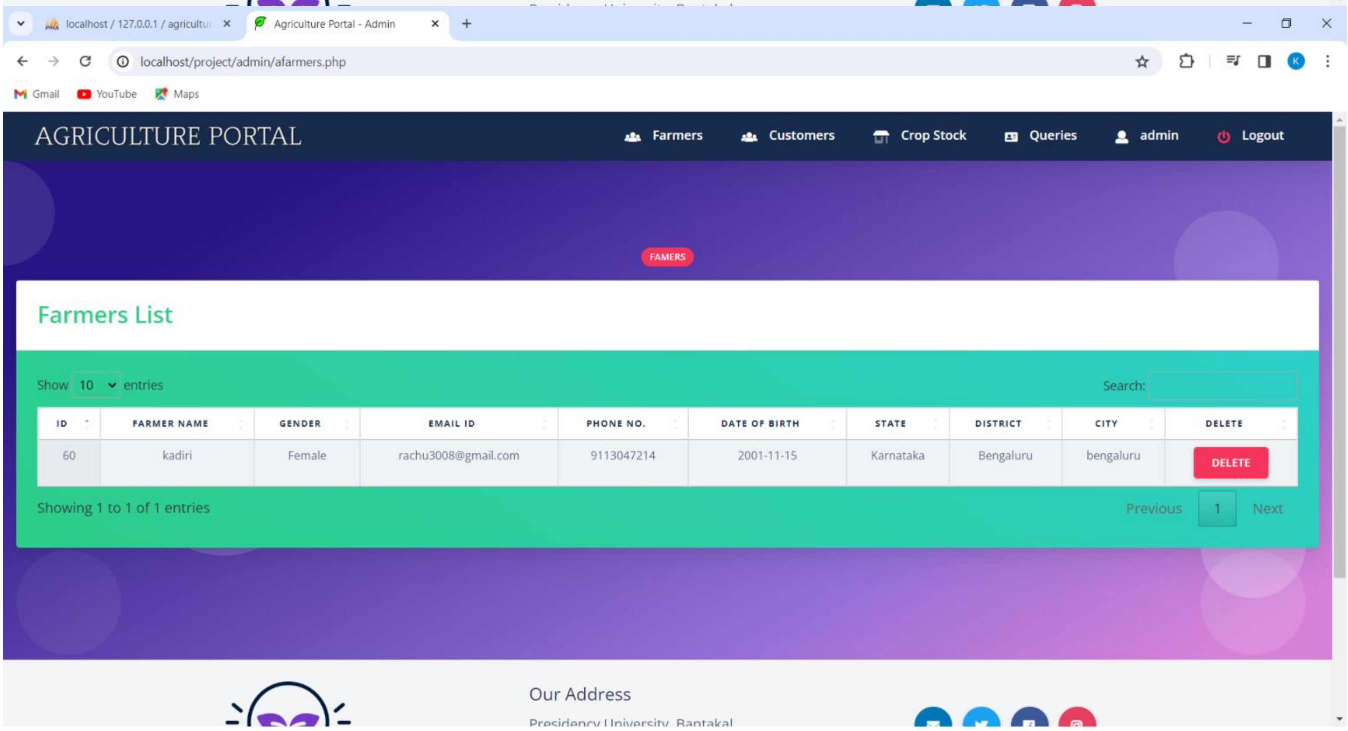

localhost / 127.0.0.1 / agricultu
Agriculture Portal - Customer
localhost/project/customer/cprofile.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Buy Crops
Crop Stocks
kad
Logout
PROFILE
Welcome kad
EDIT PROFILE
Customer ID 19
Customer Name kad
Email Address abc@gmail.com
Mobile No 1234567890
State Kerala
City Thrissur
Address abc,qwe
Pincode 560013
Password ********
Our Address


localhost / 127.0.0.1 / agricultu
Agriculture Portal - Customer
localhost/project/customer/cbuy_crops.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Buy Crops
Crop Stocks
kad
Logout
SHOPPING
Buy Crops
CROP NAME
QUANTITY (IN KG)
PRICE (IN RS)
ADD ITEM
Select Crop
Available Quantity
0
ADD TO CART
Select Crop
arhar
bajra
barley
lentil
soyabean
Quantity (in KG)
Price (in Rs.)
Action


localhost / 127.0.0.1 / agricultu
Agriculture Portal - Admin
localhost/project/admin/aproducedcrop.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Farmers
Customers
Crop Stock
Queries
admin
Logout
CROPS
Produced Crops
Show 10 entries
Search:
CROP NAME
QUANTITY (IN KG)
arhar
10
bajra
2
barley
8
lentil
20
soyabean
5
Showing 1 to 5 of 5 entries
Previous
1
Next


localhost / 127.0.0.1 / agricultu
Agriculture Portal - Admin
localhost/project/admin/acustomers.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Farmers
Customers
Crop Stock
Queries
admin
Logout
CUSTOMER
Customers List
Show 10 entries
Search:
ID
FARMER NAME
EMAIL ID
PHONE NO.
STATE
CITY
ADDRESS
PINCODE
DELETE
19
kad
abc@gmail.com
1234567890
Kerala
Thrissur
abc,qwe
560013
DELETE
Showing 1 to 1 of 1 entries
Previous
1
Next
Our Address


localhost / 127.0.0.1 / agricultu
Agriculture Portal - Admin
localhost/project/admin/aprofile.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Farmers
Customers
Crop Stock
Queries
admin
Logout
ADMIN
Welcome admin
Admin ID: 1
Admin has access to all the data in the Agriculture Portal.
Admin can modify and view all the Customer's details when necessary.
Admin can manage the farmer's details who provide supplies to the store.
Admin also has access to the sales report and can sort them as required.
Our Address


localhost / 127.0.0.1 / agricultu
Agriculture Portal - Admin
localhost/project/admin/afarmers.php
Gmail
YouTube
Maps
AGRICULTURE PORTAL
Farmers
Customers
Crop Stock
Queries
admin
Logout
FAMERS
Farmers List
Show 10 entries
Search:
ID
FARMER NAME
GENDER
EMAIL ID
PHONE NO.
DATE OF BIRTH
STATE
DISTRICT
CITY
DELETE
60
kadiri
Female
rachu3008@gmail.com
9113047214
2001-11-15
Karnataka
Bengaluru
bengaluru
DELETE
Showing 1 to 1 of 1 entries
Previous
1
Next
Our Address
Presidency University, Bantakal

APPENDIX-C
ENCLOSURES

1. Conference Paper Presented Certificates of all students.
2. Include certificate(s) of any Achievement/Award won in any project related event.
3. Similarity Index / Plagiarism Check report

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Sustainable Development Goals

The project work carried out here is mapped to SDG – 15 Sustainable life on land.

Sustainable life on land is a paramount challenge facing humanity as we navigate the complexities of environmental conservation, biodiversity preservation, and responsible land management. As our planet contends with deforestation, soil degradation, and the loss of critical ecosystems, the need for sustainable practices has become more urgent than ever. This endeavor seeks to strike a harmonious balance between human activities and the health of terrestrial ecosystems. Through innovative approaches such as reforestation, agroecological farming, and habitat restoration, we aim to not only mitigate the adverse impacts of human actions on land but also foster thriving ecosystems that support diverse flora and fauna. This project is a testament to our commitment to achieving Sustainable Development Goal 15, as we work towards ensuring life on land is sustained for present and future generations. By promoting responsible land use, conservation efforts, and community engagement, our initiative endeavors to create a blueprint for a sustainable coexistence between humanity and the land upon which our well-being depends.