AGRICULTURAL CROP RECOMMENDATION BASED ON PRODUCTIVITY AND SEASON

A Project Report Submitted

in the Partial fulfilment for the award of Degree of

Bachelor of Technology

In

Computer Science and Engineering

By

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DECLARATION

We declare that this project report titled **AGRICULTURAL CROP RECOMMENDATION BASED ON PRODUCTIVITY AND SEASON** submitted in partial fulfillment of the degree of **B. Tech in (Computer Science and Engineering)** is record of original work carried out by us under the supervision of **Dr.P.Vasuki** and has not formed the basis for the award of any other degree or diploma, in this or any other Institution or University. In keeping with the ethical practice in reporting scientific information, dueacknowledgements have been made wherever the findings of others have been cited.

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ABSTRACT

Agriculture is an essential sector that provides food and raw materials for various industries. In recent times, the use of technology has become increasingly important in the agricultural sector. One of the areas where technology is playing a significant role is in crop recommendation. With the help of machine learning algorithms, farmers could receive the recommendations for crops that are best suited to their region and season. The aim of this project is to develop a machine learning model that can recommend agricultural crops based on productivity and season. This project proposed the random forest algorithm, which is an ensemble learning technique that combines multiple decision trees to make predictions.

The dataset used for this project contains information about various crops and their yield for different seasons in a particular region. The dataset also includes information about soil type, rainfall, groundwater level, temperature, season and other factors that can influence crop productivity. The first step in the project is data preprocessing, which involves cleaning the data and transforming the data to make it suitable for analysis. Next, the data is split into training and testing sets, with the majority of the data used for training the model and the remaining data used for testing.

The random forest algorithm is then applied to the training data to develop the model. The algorithm creates multiple decision trees, each trained on a subset of the data. The algorithm then combines the predictions of each decision tree to make a final prediction. Once the model is developed, it is evaluated using the testing data. The evaluation metrics used include accuracy, precision, recall, and F1 score.

The results of the model show that it is highly accurate in recommending crops based on productivity and season. The model can accurately predict the yield of various crops based on the climate, soil, and other factors. The model can be used by farmers to make informed decisions about which crops to plant based on their region and season. This can help farmers increase their yield and reduce their losses.

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ABBREVIATION

SL.NO.	ABBREVIATION	DESCRIPTION
1.	ACRBPSML	Agricultural Crop Recommendation Based on Productivity and Season using Machine Learning
2.	RF	Random Forest (algorithm)
3.	ML	Machine Learning
4.	CPS	Crop Productivity Score
5.	CSS	Crop Suitability Score
6.	GIS	Geographic Information System
7.	NPK	Nitrogen-Phosphorus-Potassium (fertilizer components)
8.	SVM	Support Vector Machines (algorithm)
9.	KNN	K-Nearest Neighbors (algorithm)
10.	ANN	Artificial Neural Network (algorithm)
11.	ROI	Return on Investment
12.	MSA	Mean Squared Error
13.	R^2	Coefficient of Determination
14.	RMSE	Root Mean Squared Error
15.	MAE	Mean Absolute Error

CHAPTER 1

INTRODUCTION

Agriculture has an extensive history in India. Recently, India is ranked second in the farm output worldwide. Agriculture-related industries such as forestry and fisheries contributed for 16.6% of 2009 GDP and around 50% of the total workforce. Agriculture's monetary contribution to India's GDP is decreasing. The crop yield is the significant factor contributing in agricultural monetary. The crop yield depends on multiple factors such as climatic, geographic, organic, and financial elements. It is difficult for farmers to decide when and which crops to plant because of fluctuating market prices. Citing to Wikipedia figures India's suicide rate ranges from 1.4-1.8% per 100,000 populations, over the last 10 years. Farmers are unaware of which crop to grow, and what is the right time and place to start due to uncertainty in climatic conditions. The usage of various fertilizers is also uncertain due to changes in seasonal climatic conditions and basic assets such as soil, water, and air. In this scenario, the crop yield rate is steadily declining. The solution to the problem is to provide a smart user-friendly recommender system to the farmers. The crop yield prediction is a significant problem in the agriculture sector. Every farmer tries to know crop yield and whether it meets their expectations, thereby evaluating the previous experience of the farmer on the specific crop predict the yield. Agriculture yields rely primarily on weather conditions, pests, and preparation of harvesting operations. Accurate information on crop history is critical for making decisions on agriculture risk management.

Agriculture is a crucial sector that provides food and raw materials for various industries. With the world population projected to reach 9.7 billion by 2050, there is a growing need to increase agricultural productivity to meet the demands of the growing population. One of the ways to increase agricultural productivity is through the use of technology.

One of the areas where technology is playing an increasingly significant role in agriculture is in crop recommendation. Crop recommendation involves identifying the best crops to plant in a particular region based on various factors, including soil type, climate, and other environmental factors. The use of technology in crop recommendation can help farmers increase their yield and reduce their losses. Machine learning is a subfield of artificial intelligence that involves developing algorithms that can learn from data. Machine learning algorithms have been applied in various fields, including finance, healthcare, and marketing. In recent years, machine learning has also been applied in agriculture to solve various problems, including crop recommendation.

The aim of this project is to develop a machine learning model that can recommend agricultural crops based on productivity and season. The model uses the random forest algorithm, which is an ensemble learning technique that combines multiple decision trees to make predictions. The project aims to demonstrate the effectiveness of the random forest algorithm in recommending agricultural crops and its potential to revolutionize the agricultural sector.

The agricultural sector has undergone significant changes over the years, with new technologies and practices being adopted to improve productivity. In recent years, precision agriculture has emerged as a new approach to farming, which involves the use of technology to optimize crop production. Precision agriculture involves using sensors, drones, and other technologies to collect data on soil, weather, and crop health. This data is then used to make informed decisions about planting, irrigation, and fertilization.

One of the areas where technology is playing an increasingly significant role in agriculture is in crop recommendation. Crop recommendation involves identifying the best crops to plant in a particular region based on various factors, including soil type, climate, and other environmental factors. Traditionally, crop recommendation has been done through field trials and expert knowledge. However, this approach is time-consuming and may not be accurate.

In this paper, we have proposed a model that addresses these issues. The novelty of the proposed system is to guide the farmers to maximize the crop yield as well as suggest the most profitable crop for the specific region. The proposed model provides crop selection based on economic and environmental conditions, and benefit to maximize the crop yield that will subsequently help to meet the increasing demand for the country's food supplies. The proposed model predicts the crop yield by studying factors such as rainfall, temperature, area, season, soil type etc. The system also helps to determine the best time to use fertilizers.

CHAPTER 2

LITERATURE REVIEW

2.1 Crop Recommendation using Machine Learning Techniques, Shafiulla Shariff [1]

To compute the profitability of a crop, per hectare production is derived from the number of hectares planted and the yield for that year. Profitability is also influenced by the price of the crop and the costs incurred for agriculture and irrigation.Machine learning algorithms such as decision trees, random forests, and gradient boosting are used to build the predictive models. The models are trained on the historical data to predict the profitability of the crop based on various factors such as weather forecast, market demand, production costs, and government subsidies. The models can also identify which factors are most significant in determining the profitability of the crop.The project's results have a significant impact on the Indian agricultural sector as it helps farmers make informed decisions about which crops to plant, how much to produce, and at what price to sell their produce. It also helps policymakers to design policies that support the growth of the agricultural sector and ensure farmers' economic welfare. The use of machine learning in agriculture has enormous potential, and as more data is collected, and more sophisticated algorithms are developed, the accuracy and usefulness of these predictive models will only improve.In conclusion, the Indian agricultural sector plays a crucial role in the country's overall economic development, and promoting the economic welfare of farmers is pivotal to progress the sector further. Predictive models based on machine learning can help predict the profitability of crops in advance and enable farmers to make informed decisions. These models have a significant impact on the agricultural sector and have enormous potential to transform the way agriculture is practiced in India.

2.2 Computer vision and artificial intelligence in precision agriculture for grain crops, Patrico [2]

Machine learning is a field of artificial intelligence that enables machines to learn from data without explicit programming. When combined with IoT, machine learning has opened up new possibilities for real-time monitoring and prediction in various fields. The use of machine learning in emerging fields has created many new applications and challenges for future prediction. The advent of data science and probabilistic models in big data, IoT, image processing, and high-performance computing has helped to overcome several complexities and provided solutions for complex problems. In agriculture, machine learning and computer vision have introduced a new trend of monitoring and predictions, reducing equipment costs, increasing computational power, and saving time in the production process. Computer vision employs "seeing" to learn and make predictions. Computational learning theories have also evolved in the field of machine learning, which has led to a better learning experience and improved future prediction analysis. Computer vision has reduced equipment costs, increased computational power, and saved time for agricultural production. With continued advancements in technology, machine learning and computer vision will undoubtedly bring new applications and challenges for future prediction and analysis in various fields. The potential of machine learning and computer vision is enormous, and their integration with other emerging technologies such as blockchain, quantum computing, and augmented reality will unlock further possibilities.

2.3 A Review on Data Mining Techniques for Fertilizer Recommendation, Jignasha[3]

To keep up nutrition levels in the soil in case of deficiency, fertilizers are added to soil. The standard issue existing among the Indian agriculturists choose approximate amount of fertilizers and add them manually. Excess or deficient extension of fertilizers can harm the plants life and reduce the yield. This paper gives overview of various data mining frameworks used on cultivating soil dataset for fertilizer recommendation.

2.4 An Overview of Internet of Things and Data Analytics in Agriculture: Benefits and Challenges, Abdul Rahaman [4]

A blueprint of Iot and DA in agriculture has been shown in this paper. A couple of zones related to the association of Iot in agribusiness have been discussed in detail. The investigation of composing exhibits that there are clusters of work advancing being produced of Iot development that can be used to increase operational efficiency and gainfulness of plant and creatures. The benefits of Iot and DA, and open troubles have been identified and inspected in this paper. Iot is depended upon to offer a couple of benefits to the agribusiness division. Regardless, there are up 'til now different issues to be steered to make it moderate for close to nothing and medium-scale farmers. The key issues are security and cost. It is typical that as contention increases in the cultivating part

2.5 Machine Learning in Agriculture,Konstantinos G.Liakos [5]

Machine learning is a powerful tool that can automatically learn and solve large non-linear problems from datasets of different natures, often obtained from multiple real-time sources. It is a multi-disciplinary field that involves the application of various techniques on real-time data to improve data quantification and probabilistic fusion of information. Multiple data regression, classification, and cluster analysis are some of the major methods used for data analysis in machine learning.Classification is a property of supervised machine learning models, in which class labels are predicted for input data in the form of two output classes, i.e., Yes or No. In classification, input values are divided when the output attribute consists of finite and discrete values. This predictive model approach is useful in various applications, including sentiment analysis, fraud detection, and spam filtering.Regression analysis, on the other hand, is used for predicting continuous numerical values, such as temperature, stock prices, or sales figures. It is widely used in finance, economics, and engineering to predict future trends based on historical data.Cluster analysis is a technique used for grouping similar data points based on their attributes. It is useful for identifying patterns and relationships in large datasets and is widely used in marketing, customer segmentation, and image analysis.Machine learning models have vast potential in various fields, including healthcare, finance, transportation, and many others. The ability to automatically learn from data and make predictions without explicit programming has opened up new possibilities for real-time monitoring and prediction. As technology continues to advance, the potential of machine learning models will undoubtedly grow, and their integration with other emerging technologies such as blockchain, quantum computing, and augmented reality will unlock further possibilities.

2.6 A Survey on Data Mining Techniques in Agriculture, R.S.Kodeeshwari [6]

Agriculture is the most critical application area especially in the developing nations like India.Use of information technology in agriculture can change the situation of decision making and farmers can yield in better way. Data mining plays a important role in decision making on several aspects with agriculture field. It examines about role of data mining in the farming field and their related work by a few authors in related to agriculture domain. It additionally talks about on various data mining applications in taking care of the several agriculture problems. This paper integrates the work of several authors in a single place so it is valuable for specialists to get data of current situation of data mining systems and applications in context to farming field.

2.7 Circulation Mode Selection Based on Cost Analysis, Chenglin Wang [7]

If every farmer and each average production base will join their optimal conditions in making cooperatives, it will accomplish economies of scale. Furthermore, producers will have an all the more favourable position in the plans with downstream firms (shipper or retailer). Second, the main customers of wholesale market are not inhabitants nearby who buy small quantities products but lower distributors or retailers. More redesigned transportation mode respects intensive attempt of new agrarian things, which prompts bolster the movement of new chain joint logistics and strengthen resource utilize and made logistics advantage quality. Refresh everything considered agrarian things spread. By then, regard the examination of gigantic worth control of standard things and achieve the mind-blowing control to stream process.

2.8 An Analysis of Agricultural Soils by using Data Mining Techniques, Ramesh Babu [8]

The author discussed the importance of soil analysis in agriculture and how data mining techniques can be used to extract useful information from soil datasets. The article focused on three data mining techniques: decision trees, association rules, and clustering.The author applied these techniques to a dataset of agricultural soils from India and analyzed the results. The analysis revealed several useful insights, such as the identification of important soil parameters for crop growth, the relationship between soil parameters, and the identification of patterns in the soil data.Overall, the article highlights the potential of data mining techniques in analyzing agricultural soils and provides a useful framework for future research in this area. It is a valuable resource for researchers and practitioners in the field of agriculture and data mining.

2.9 Smart farming system using data mining, P.Chandak Priyanka [9]

There are various traditional techniques available for irrigation, exp. Traditional sprinkler system and Rotary system for irrigation. All these are the manual techniques but we need dynamic control over the residential irrigation system, as in previous system more water is wasted so, various hardware/software-based irrigation system as well as mobile based system introduced.

2.10 AgroNutri Android Application, Khaimar Ghanshyam [10]

This paper communicates the idea regarding the making of AgroNutri an android application that helps in conveying the harvest particular fertilizer amount to be applied. The idea is to calculate the measure of NPK composts to be applied depend on the blanked proposal of the crop of interest. This application works depends on the product chosen by the farmer and that is taken as input, thus providing the farmers. The future scope of the AgroNutri is that GPRS can be included so that according to location nutrients are suggested. Further this application would be incorporated as a piece of the accuracy agriculture wherein sensors can be utilized to discover the measure of NPK present in the dirt and that sum can be deducted from the suggestion and giving us the exact measure of supplements to be added.

2.11 Machine Learning: Applications in Indian Agriculture, Subhadra Mishra [11]

Agriculture is a field that has been lacking from adaption of technologies and their advancements. Indian agriculturists should be up to the mark with the universal procedures. Machine learning is a native concept that can be applied to every field on all inputs and outputs. It has effectively settled its ability over ordinary calculations of software engineering and measurements. Machine learning calculations have improved the exactness of artificial intelligence machines including sensor based frameworks utilized in accuracy farming. This paper has evaluated the different uses of machine learning in the farming area. It additionally gives a knowledge into the inconveniences looked by Indian farmers and how they can be resolved using these procedures.

2.12 Brief history of agricultural systems modelling, James.W.Jones [12]

Rural frameworks science creates information that enables analysts to consider complex issues or take educated farming choices. The rich history of this science represents the decent variety of frameworks and scales over which they work and have been contemplated. As agrarian researchers currently consider the "people to come" models, information, and learning items expected to meet the inexorably mind-boggling frameworks issues looked by society, it is vital to check out this history and its exercises to guarantee that we stay away from re-innovation and endeavor to think about all elements of related difficulties. To this end, we outline here the historical backdrop of rural frameworks demonstrating and distinguish exercises discovered that can help control the structure and advancement of up-and-coming age of farming framework apparatuses and techniques. Various past occasions joined with generally innovative advancement in different fields have unequivocally added to the development of farming framework demonstrating, including improvement of process-based bio-physical models of yields and domesticated animals, factual models dependent on verifiable perceptions, and financial streamlining and reproduction models at family unit and local to worldwide scales. Attributes of rural frameworks models have changed broadly relying upon the frameworks included, their scales, and the extensive variety of purposes that spurred their advancement and use by specialists in various controls. Late patterns in more extensive joint effort crosswise over establishments, crosswise over orders, and between people in general and private segments recommend that the stage is set for the significant advances in rural frameworks science that are required for the up-and-coming age of models, databases, learning items and choice emotionally supportive networks. The exercises from history ought to be considered to help stay away from barricades and entanglements as the network builds up this up-and-coming age of horticultural frameworks models.

2.13 Crop and Yield Prediction Model, S.Bhanose Shreya [13]

The agricultural sector is a vital component of the world's economy. With the increasing demand for food, it is essential to develop a systematic approach for predicting crops and their yield. Predicting the best crops can be a challenging task due to the unavailability of a crop knowledge base. Therefore, crop prediction is an efficient approach for better quality farming and increased revenue. Machine learning techniques can be applied to crop prediction using data clustering algorithms to extract useful information and provide accurate predictions.Various approaches have been implemented so far, but they have not worked efficiently for crop prediction. Crop prediction models can help farmers make the right decisions and improve the quality of farming. This, in turn, generates better revenue for farmers. Traditional clustering algorithms such as k-Means, improved rough k-Means, and K-means++ make the tasks complicated due to the random selection of initial cluster centers and the decision of the number of clusters.To overcome these challenges, modified K-Means algorithms have been used to improve the accuracy of the system as they achieve high- quality clusters due to initial cluster-centric selection. These algorithms use a systematic approach to predict crop yield and suggest the best crops to be grown based on historical data. This approach can significantly impact the agricultural sector by providing valuable insights for farmers to improve their yield and increase revenue. In conclusion, the use of data clustering algorithms and machine learning techniques for crop prediction can significantly benefit the agricultural sector, improve the quality of farming, and increase revenue for farmers.

2.14 A Survey on Data Mining Techniques for Crop Yield Prediction, Ramesh A.Medar [14]

The article discusses the use of data mining techniques for crop yield prediction, which is a significant area of research in agriculture. The author begins by introducing the concept of data mining and its importance in agriculture. He then discusses various data mining techniques that are used for crop yield prediction, including decision trees, neural networks, support vector machines, and clustering.The author also discusses the challenges faced in crop yield prediction, such as the availability of reliable and accurate data, the complexity of crop yield data, and the need for effective data preprocessing techniques. He then reviews various studies that have been conducted on crop yield prediction using data mining techniques and summarizes their findings.Overall, the article provides a useful overview of data mining techniques for crop yield prediction and highlights the potential of these techniques in improving agricultural productivity. It can be a valuable resource for researchers and practitioners in the field of agriculture and data mining

2.15 KrishiMantra: agricultural recommendation system, Vikas Kumar [15]

With the evolution of Web 2.0, ICT has become the primary need of human beings. There is a gap between the farmers and the knowledge of agricultural experts. ICT can fill the gap between farmers and the experts. In this paper, we have proposed a semantic web-based architecture to generate agricultural recommendations, using spatial data and agricultural knowledge bases. Our knowledge base acts as a domain expert and will send recommendations to the farmers based on climate conditions and geographic data. We have shown experimental results as a part of implementation of our proposed architecture. A farmer sends a query to the query engine, in order to get information for a specific crop. Query may be related to GIS data, crop knowledge base or both. The result of the query is displayed on a mobile device.

2.16 Impacts of population growth, economic development, and technical change on global food production and consumption, Steffen Fritz [16]

Throughout the following decades humanity will request more food from less land and water assets. This investigation evaluates the food production effects of four elective advancement situations from the Millennium Ecosystem Assessment and the Special Report on Emission Scenarios. partialy and jointly considered are land and water supply impacts from population development, and specialized change, and forests and agriculture demand request shifts from population development and economic improvement. The income impacts on nourishment request are registered with dynamic flexibilities. Worldwide farming area increments by up to 14% somewhere in the range of 2010 and 2030.Deforestation restrictions strongly impact the price of land and water resources but have little consequences for the global level of food production and food prices. While projected income changes have the highest partial impact on per capita food consumption levels, population growth leads to the highest increase in total food production. The impact of technical change is amplified or mitigated by adaptations of land management intensities

CHAPTER 3

3.1 EXISTING SYSTEM

1. A Survey of Crop Recommendation Systems for Precision Agriculture reviews various crop recommendation systems that use precision agriculture techniques such as sensor-based technologies, machine learning, and data analytics. The study provides an overview of the systems and compares their effectiveness in terms of crop yield and resource utilization.

2. Crop recommendation systems based on soil data; this survey focuses on crop recommendation systems that use soil data to predict the best crops for a given soil type. The study discusses various machine learning algorithms used in these systems, such as decision trees, support vector machines, and artificial neural networks.

3. Crop Recommendation Systems Based on Weather Data, focuses on crop recommendation systems that use weather data to predict the best crops for a given climate. The study reviews various machine learning algorithms used in these systems, such as k-Nearest Neighbors, Decision Trees, and Support Vector Machines.

4. Crop Recommendation Systems Based on Data Mining Techniques, provides an overview of various crop recommendation systems that use data mining techniques to predict the best crops for a given location. The study discusses different data mining algorithms used in these systems, such as Association Rule Mining, Clustering, and Decision Trees.

5. Crop Recommendation Systems Based on Yield Prediction, focuses on crop recommendation systems that use yield prediction models to predict the best crops for a given location. The study reviews various machine learning algorithms used in these systems, such as Random Forests, Artificial Neural Networks, and Support Vector Machines.

3.1.1 DISADVANTAGES OF EXISTING SYSTEM

1. Limited availability of data: One major disadvantage of the existing systems is that they rely heavily on data, such as weather data, soil data, and historical crop yield data. However, in some regions, this data may be limited or unreliable, which can limit the accuracy of the crop recommendation system.

2. Lack of personalized recommendations: Many existing systems provide crop recommendations based on average yields and soil conditions, but they may not take into account the unique needs and preferences of individual farmers. This can lead to suboptimal recommendations and lower crop yields.

3. High computational requirements: Some of the machine learning algorithms used in crop recommendation systems, such as Random Forests, can be computationally expensive and require large amounts of processing power and memory. This can be a challenge for small-scale farmers or in regions with limited computing infrastructure.

4. Limited generalization capability: The existing crop recommendation systems may be trained on data from specific regions and may not generalize well to other regions with different soil and weather conditions. This can limit the usefulness of the system in new regions or for farmers who want to grow crops outside of their region.

5. Lack of transparency and interpretability: Many machine learning algorithms used in crop recommendation systems are black box models, meaning it can be difficult to understand how they arrived at their recommendations. This lack of transparency and interpretability can make it difficult for farmers to trust the recommendations and make informed decisions.

3.2 PROPOSED SYSTEM

1. This research paper proposes recommending the crop based on various input parameters such as such as soil type, Rainfall, Groundwater level, Temperature and season. This paper considers the geographical characteristics from all the states of India.

2. Crop production depends on many agricultural parameters. Proposed work is based on the production of crops in previous years, crops can be recommended to the farmers.

3. This kind of suggestions will make farmer to know that whether that particular crop type is yielding a good production in recent years. Production of crops may become less due to any crop disease, water problem and many other factors. While considering about the production, farmers may get knowledge about which crop is in high volume in the market in that year. Based on this farmer can take decision of trend on crops in recent years. Farmers will be given recommendation by considering the season of crop production.

4. We have used a large dataset to develop and designed the recommendation model to generate recommendations for crops based on geographical and climatic parameters using Random Forest Machine Learning algorithms.

5. The basic process of this project is that we will preprocess the data provided to us, then it is used to prepare the model for the backed and using flask to connect it to the UI interface to show the full and final output.

6. This recommender model that recommends the most suitable crop for the given inputs. The performance of the model is validated on various parameters and it is found that model is effective in recommending the crops to the user.

3.2.1 ADVANTAGES OF PROPOSED SYSTEM

1. It takes into account various important input parameters such as soil type, rainfall, groundwater level, temperature, and season to provide recommendations for crop production. This ensures that the recommendations are tailored to the specific geographical and climatic conditions of the region.

2. The system uses a large dataset and a Random Forest Machine Learning algorithm to generate recommendations. This ensures that the recommendations are based on accurate and reliable data, and are not simply based on guesswork or assumptions.

3. The system is validated on various parameters, indicating that it is effective in recommending the most suitable crops for a given set of inputs. This helps farmers make more informed decisions about crop selection, which can lead to higher yields and greater profitability.

4. The system is designed to be user-friendly and easy to use, with a simple and intuitive user interface that is connected to a powerful backend.

5. This ensures that farmers can quickly and easily access the information they need to make informed decisions about crop production.

6. Computationally less expensive.

CHAPTER 4

SYSTEM REQUIREMENTS

4.1 HARDWARE REQUIREMENTS:

System	-	Pentium-IV
Speed	-	2.4GHZ
Hard disk	-	40GB
Monitor	-	15VGA color
RAM	-	512MB

4.2 SOFTWARE REQUIREMENTS:

Operating System	-	Windows XP
Coding language	-	Python

CHAPTER 5

VISUALIZING SYSTEM DESIGN

5.1 SYSTEM ARCHITECTURE

The system architecture of such a recommendation system may involve several components, including data collection and pre-processing, data analysis and modelling, and user interface for displaying recommendations to farmers.

The data collection and pre-processing component may involve collecting data from various sources such as satellite imagery, weather stations, and soil sensors. This data is then pre-processed to remove noise and inconsistencies, and prepared for analysis.

The data analysis and modelling component involve the use of machine learning algorithms to analyze the pre-processed data and build models that can predict the productivity of different crops based on various environmental factors. These models can then be used to provide recommendations on what crops to plant during different seasons and under different environmental conditions.

Finally, the user interface component of the system may involve developing a user-friendly dashboard or mobile application that displays the recommendations to farmers in a simple and easily understandable format.

Overall, the Agricultural Crop Recommendation system based on productivity and season is a promising application of modern technologies that can help farmers optimize their crop yields, reduce costs, and improve their livelihoods.

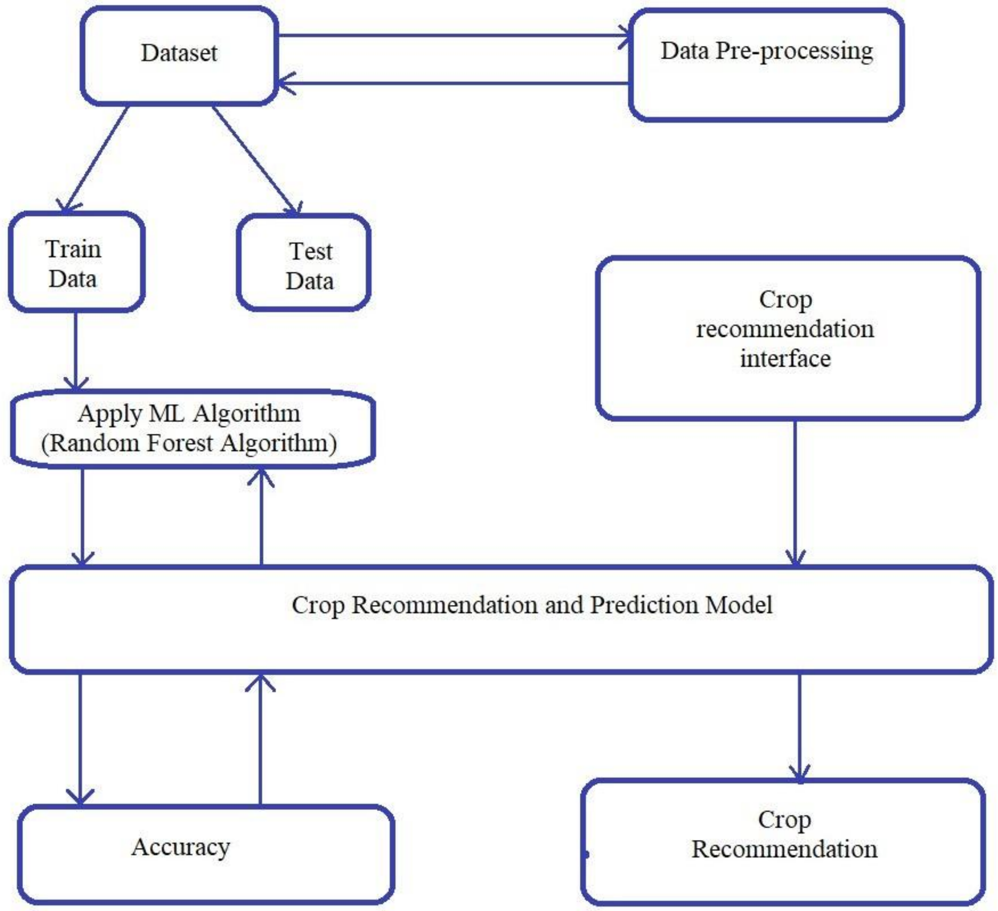

Fig:5.1 System architecture

5.2 DATA FLOW DIAGRAM:

1. The DFD is also called as bubble chart. It is a simple graphical formalism that can be used to represent a system in terms of input data to the system, various processing carried out on this data, and the output data is generated by this system.

2. The data flow diagram (DFD) is one of the most important modeling tools. It is used to model the system components. These components are the system process, the data used by the process, an external entity that interacts with the system and the information flows in the system.

3. DFD shows how the information moves through the system and how it is modified by a series of transformations. It is a graphical technique that depicts information flow and the transformations that are applied as data moves from input to output.

4. DFD is also known as bubble chart. A DFD may be used to represent a system at any level of abstraction. DFD may be partitioned into levels that represent increasing information flow and functional detail.

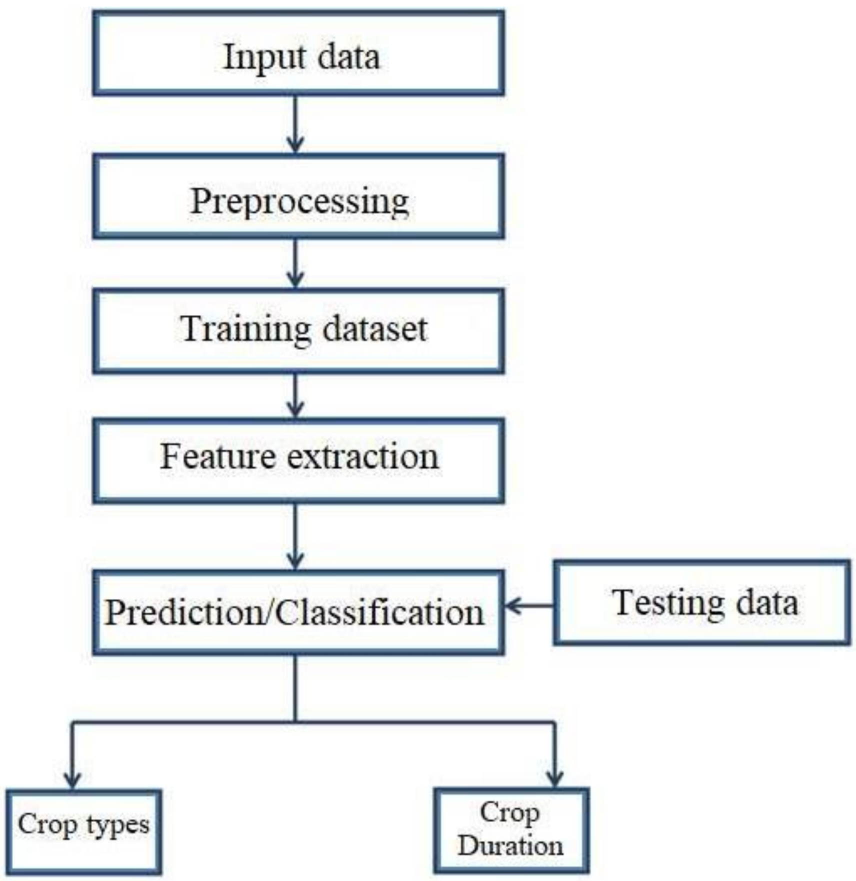

Fig:5.2 Dataflow diagram

5.3 UML DIAGRAM:

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group.

The goal is for UML to become a common language for creating models of object-oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems.

The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems.

The UML is a very important part of developing objects-oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

5.3.1 GOALS:

The Primary goals in the design of the UML are as follows:

1. Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models.
2. Provide extendibility and specialization mechanisms to extend the core concepts.
3. Be independent of particular programming languages and development process.
4. Provide a formal basis for understanding the modeling language.
5. Encourage the growth of OO tools market.
6. Support higher level development concepts such as collaborations, frameworks, patterns and components.
7. Integrate best practices.

5.4 USE CASE DIAGRAM:

A use case diagram in the Unified Modeling Language (UML) is a type of behavioral diagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.

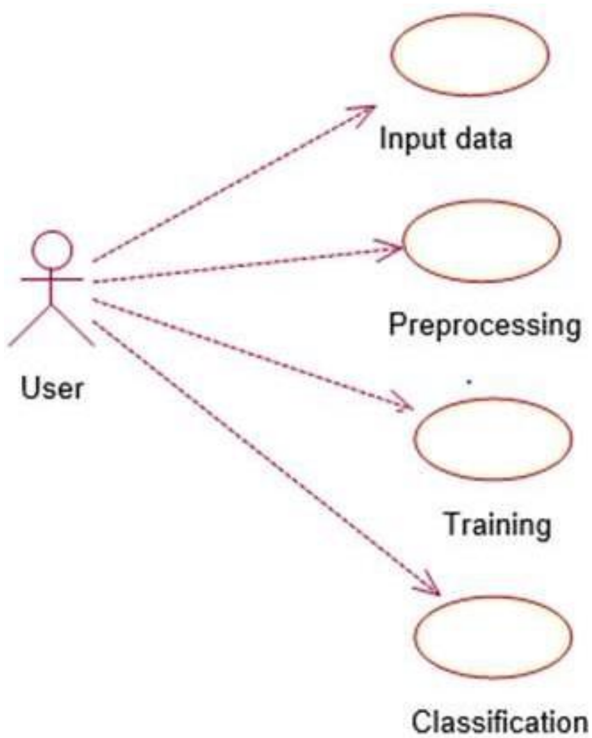

Fig:5.4 Use case diagram

5.5 SEQUENCE DIAGRAM:

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagram.

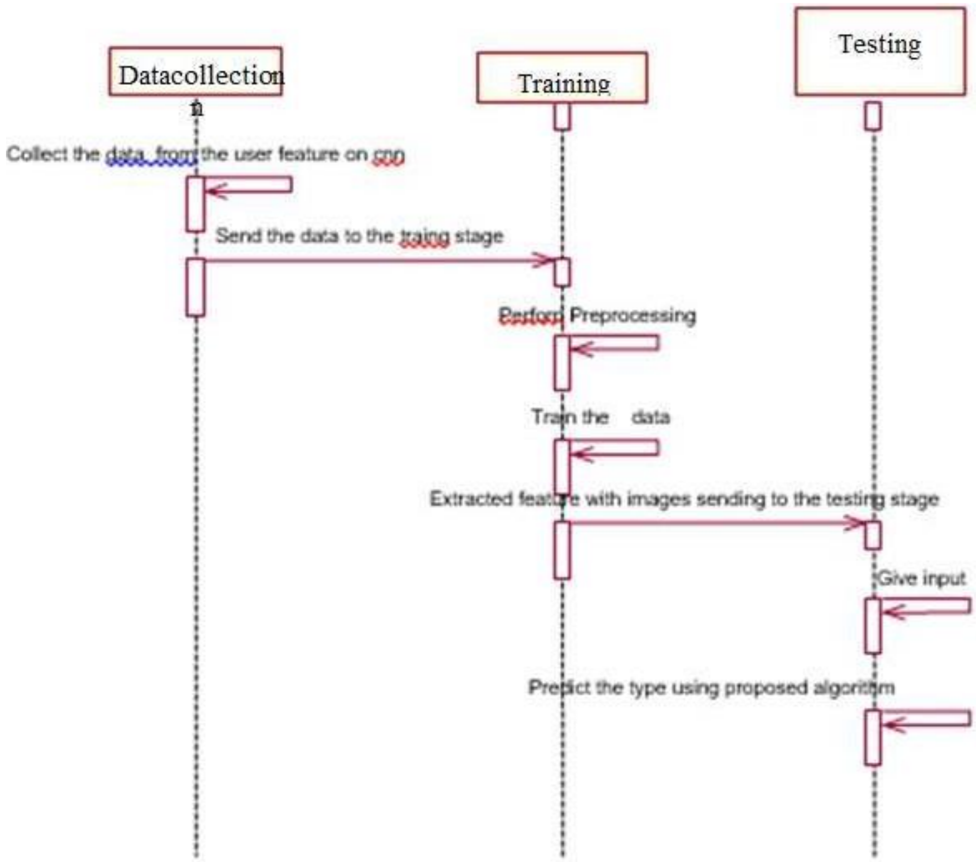

Fig:5.5 Sequence diagram

5.6 ACTIVITY DIAGRAM:

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams can be used to describe the business and operational step-by-step workflows of components in a system. An activity diagram shows the overall flow of control.

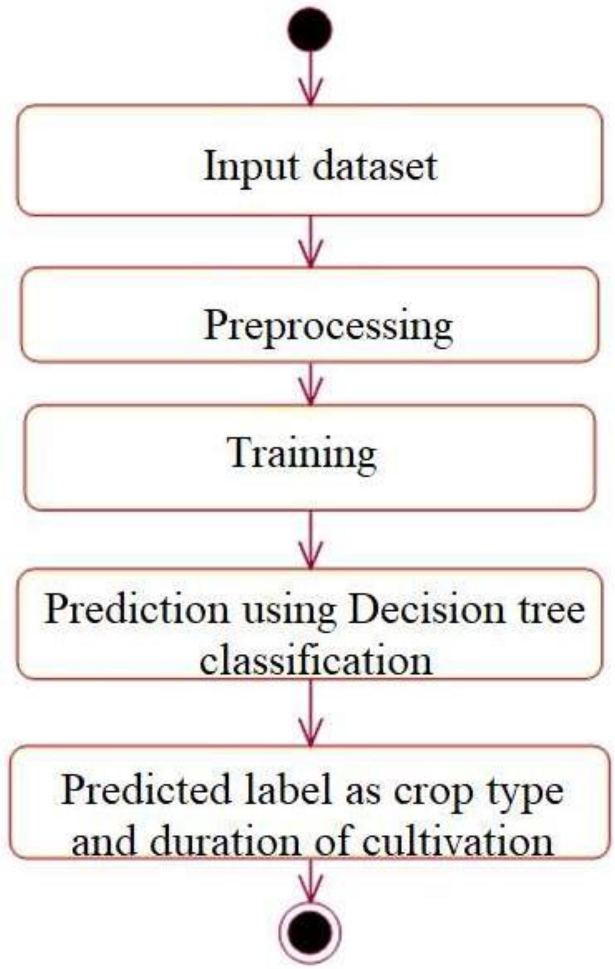

Fig:5.6 Activity diagram

CHAPTER 6

MODULES:

- **Admin Login**
- **Metadata**
- **Data Pre-processing**
- **Crop Prediction Model**

6.1 Admin Login:

In today's digital age, websites have become an integral part of our lives. They are not just a source of information, but also provide various services and products online. However, to access these services and products, users need to register themselves on these websites. During the registration process, users are required to provide their personal information, such as name, contact number, email address, and a password. This information is stored in a database table for future reference.

Once a user has registered on a website, they can login using their registered contact number and password. This process ensures that only authorized users can access the website's services and products. However, it is important to note that the login process is only successful if the contact number and password entered by the user match the data in the database table. If the data entered is incorrect, the user is prompted to re-enter the correct information.

The first activity of any website is to ensure that the login process is secure and robust. This involves implementing various security measures, such as encryption and authentication, to protect the user's data. Encryption ensures that the data transmitted between the user's browser and the server is secure and cannot be intercepted by unauthorized users. Authentication ensures that only authorized users can access the website's services and products.

In addition to security measures, websites also implement various user experience (UX) design principles to enhance the user's experience while logging in. This includes providing clear and concise instructions on how to login, ensuring that the login form is easy to navigate, and providing feedback to users when they enter incorrect information.

One of the key challenges faced by websites during the login process is preventing unauthorized access. Hackers and cyber criminals are constantly looking for ways to breach the website's security and gain access to user data. To prevent such attacks, websites implement various security measures, such as two-factor authentication, captcha codes, and IP blocking.

Two-factor authentication is a security measure that requires users to enter a code sent to their registered mobile number or email address in addition to their password. This ensures that even if a hacker has access to the user's password, they cannot login without the code. Captcha codes are used to prevent automated attacks by ensuring that the user is a human and not a bot. IP blocking is used to block access from IP addresses that are known to be associated with malicious activities.

In conclusion, the login process is a critical activity for any website. It ensures that only authorized users can access the website's services and products. To ensure that the login process is secure and robust, websites implement various security measures, such as encryption, authentication, two-factor authentication, captcha codes, and IP blocking. They also implement UX design principles to enhance the user's experience while logging in. However, it is important for users to be vigilant and protect their personal information by using strong passwords and not sharing them with anyone.

6.2 Metadata:

The login process is a critical activity for any website, as it ensures that only authorized users can access the website's services and products. The first step in the login process is for the user to enter their registered contact number and password. This information is then verified by the website's server to ensure that it matches the data stored in the database table.

The administrator of the website plays a key role in this process, as they are responsible for providing the correct contact number and password to the user. If the information provided by the administrator matches the data stored in the database table, the user is successfully logged in to the website. However, if the information provided is incorrect, the user is notified that their login has failed and they are prompted to re-enter the correct information.

It is important to note that the login process is only successful if the user enters the correct contact number and password. This is because the website's server compares the information entered by the user with the data stored in the database table. If there is a mismatch between the two, the user is not allowed to access the website's services and products.

To ensure that the login process is secure and robust, websites implement various security measures, such as encryption and authentication. Encryption ensures that the data transmitted between the user's browser and the server is secure and cannot be intercepted by unauthorized users. Authentication ensures that only authorized users can access the website's services and products.

Websites also implement various UX design principles to enhance the user's experience while logging in. This includes providing clear and concise instructions on how to login, ensuring that the login form is easy to navigate, and providing feedback to users when they enter incorrect information. For example, if a user enters an incorrect password, the website may display a message indicating that the password is incorrect and provide instructions on how to reset it.

One of the key challenges faced by websites during the login process is preventing unauthorized access. Hackers and cybercriminals are constantly looking for ways to breach the website's security and gain access to user data. To prevent such attacks, websites implement various security measures, such as two-factor authentication, captcha codes, and IP blocking.

Two-factor authentication is a security measure that requires users to enter a code sent to their registered mobile number or email address in addition to their password. This ensures that even if a hacker has access to the user's password, they cannot login without the code. Captcha codes are used to prevent automated attacks by ensuring that the user is a human and not a bot. IP blocking is used to block access from IP addresses that are known to be associated with malicious activities.

In conclusion, the login process is a critical activity for any website. It ensures that only authorized users can access the website's services and products. To ensure that the login process is secure and robust, websites implement various security measures, such as encryption, authentication, two-factor authentication, captcha codes, and IP blocking. They also implement UX design principles to enhance the user's experience while logging in. However, it is important for users to be vigilant and protect their personal information by using strong passwords and not sharing them with anyone.

6.3 Data Pre-processing:

In machine learning, data pre-processing is a critical step that involves cleaning and transforming raw data into a format that can be easily understood and used by machine learning algorithms. The pre-processing step involves several sub-steps, such as data cleaning, data normalization, feature extraction, and data splitting. One of the key pre-processing steps is cleaning the data by removing any inconsistencies or errors in the data.

In the context of crop data, the raw data needs to be cleaned and the metadata needs to be appended to it. This is done by removing the things that are converted to integers, making the data easier to train. The metadata provides additional information about the data, such as the date, location, and crop type, which is important for machine learning algorithms to understand and make accurate predictions.

To pre-process the crop data, the first step is to load the metadata into the dataset. This metadata is then attached to the data and replaces the converted data with the corresponding metadata. This step ensures that the data is consistent and can be easily interpreted by machine learning algorithms.

After the metadata has been appended to the data, the next step is to remove any unwanted data in the list. This includes removing any missing values, duplicates, or irrelevant features that may not contribute to the accuracy of the machine learning model. Once the unwanted data has been removed, the data is divided into the train and test datasets.

The train dataset is used to train the machine learning model, while the test dataset is used to evaluate the performance of the model. It is important to ensure that the train and test datasets are representative of the data as a whole and that the model is trained on a diverse range of data to ensure that it can generalize well to new data.

In addition to cleaning the data, other pre-processing steps may also be necessary, such as data normalization, which involves scaling the data to a specific range to ensure that all features have equal importance. Feature extraction is another important pre-processing step that involves selecting the most relevant features that contribute to the accuracy of the machine learning model.

In conclusion, pre-processing is a critical step in machine learning that involves cleaning and transforming raw data into a format that can be easily understood and used by machine learning algorithms. In the context of crop data, pre-processing involves appending metadata to the data, removing unwanted data, and dividing the data into the train and test datasets. Other pre-processing steps may also be necessary, such as data normalization and feature extraction, to ensure that the machine learning model can make accurate predictions.

6.4 Crop Prediction Model:

The use of machine learning algorithms to predict crop yield can provide significant benefits to farmers and the agriculture industry as a whole. By accurately predicting crop yield, farmers can make more informed decisions about which crops to plant and when to plant them, leading to higher yields and more efficient use of agricultural resources.

In addition to helping farmers make better decisions about crop selection and resource management, crop yield prediction can also help reduce food waste and ensure food security. By predicting crop yields with greater accuracy, farmers can better plan for harvests and minimize the risk of overproduction or underproduction, which can lead to food waste and shortages.

Furthermore, crop yield prediction can also help in sustainable farming practices by reducing the use of chemicals and fertilizers. By accurately predicting crop yield, farmers can reduce the amount of chemicals and fertilizers they use, leading to lower costs and reduced environmental impact.

Overall, the use of machine learning algorithms to predict crop yield has significant potential to improve agricultural productivity, reduce waste, and promote sustainable farming practices. With continued research and development in this area, it is possible to unlock even greater benefits for farmers and the agriculture industry as a whole.

CHAPTER 7

RESULTS AND DISCUSSIONS

7.1 Webpage:

The user interface for the project plays a critical role in enabling users to easily interact with the system and access its features.

The user interface is designed to provide an intuitive and user-friendly experience, allowing users to input their requirements for crop selection based on productivity and season. The UI should also enable users to visualize the recommendations made by the machine learning model in an understandable and easily digestible format.

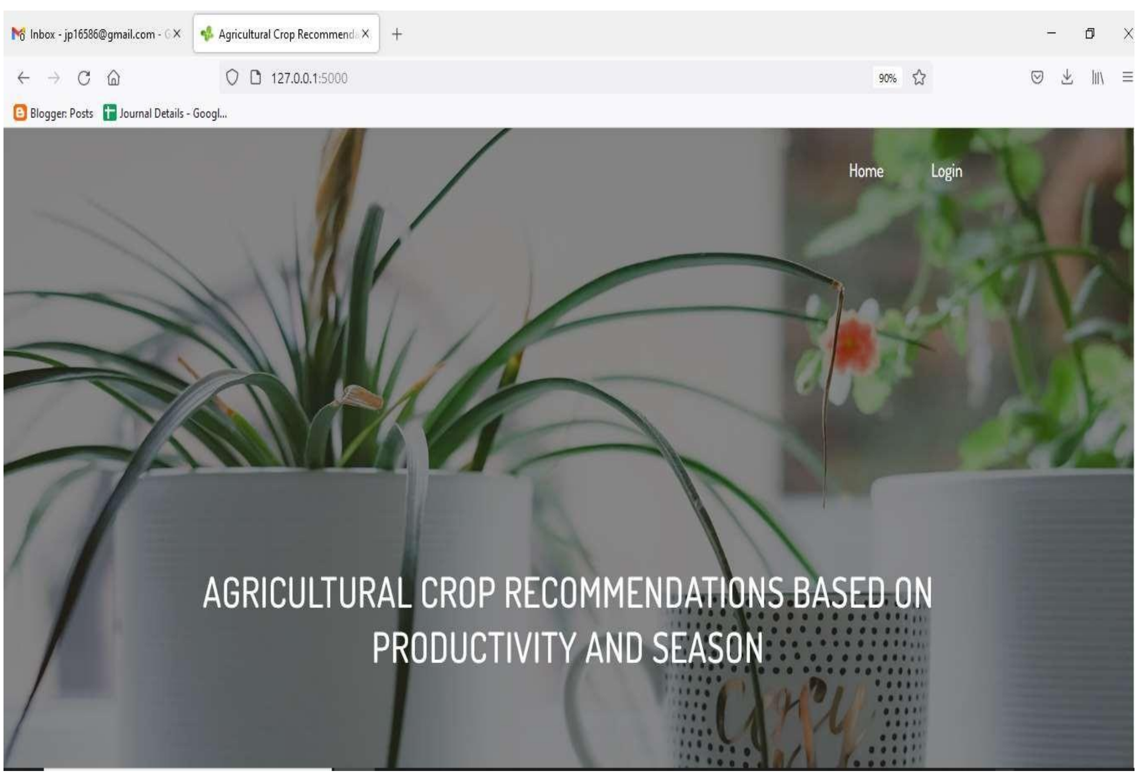

Fig:7.1 Webpage

7.2 Admin Login:

This is the first activity. Admin needs to provide a correct contact number and a password, which the user enters while registering, to login to the webpage.

If information provided by the admin matches with the data in the database table then user successfully logins into the website, otherwise a message of login failed is displayed and user needs to re-enter correct information.

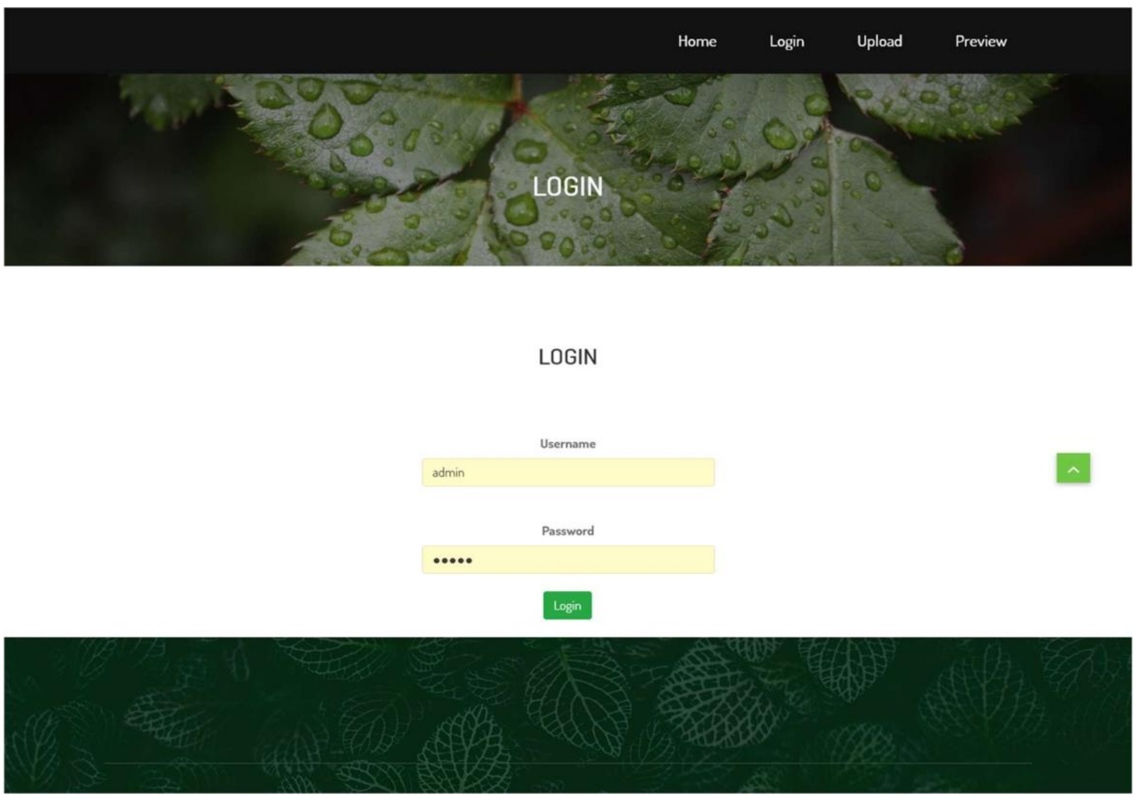

Fig:7.2 Admin login

7.3 DATA PRE-PROCESSING:

To pre-process the crop data, the first step is to load the metadata into the dataset. This metadata is then attached to the data and replaces the converted data with the corresponding metadata. This step ensures that the data is consistent and can be easily interpreted by machine learning algorithms.

After the metadata has been appended to the data, the next step is to remove any unwanted data in the list. This includes removing any missing values, duplicates, or irrelevant features that may not contribute to the accuracy of the machine learning model.

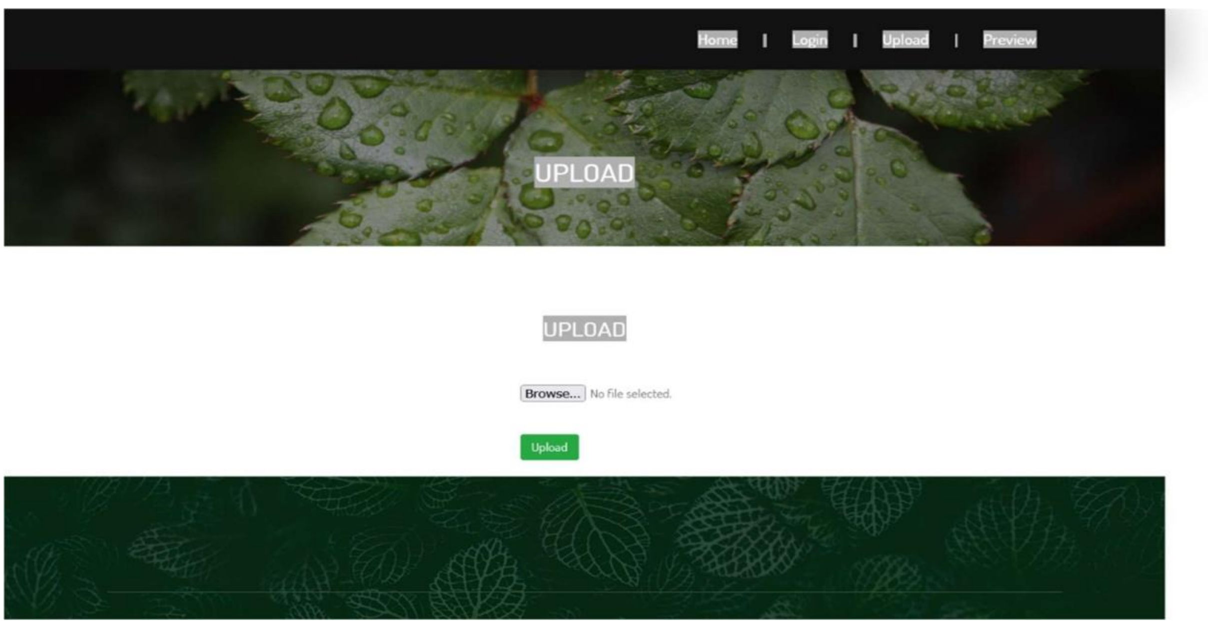

Fig:7.3.1 Uploading dataset

PREVIEW

States	Rainfall	Ground Water	Temperature	Soil type	Season	Crops	Fertilisers required	Cost of cultivation	Expected revenues	Quantity of seeds per hectare
Andhra Pradesh	110.75	9.74	31.5	Clayey	Kharif	Paddy IGKVR-2 (IET 19795)	Potassium,Urea	22810	63851.8391	25kg
Andhra Pradesh	110.75	9.74	31.5	Alluvial	Kharif	Paddy IGKVR-2 (IET 19795)	Potassium,Urea	22810	63851.8391	25kg

Fig:7.3.2 Preview the dataset

Manipur	148.80	4.00	30.5	Black	Kharif	Bajra	Nitrogen,Phosphorus,Potash	8000	70414.47817	4.5kg
Odisha	215.00	5.00	30.0	Latterite	Kharif	Bajra	Nitrogen,Phosphorus,Potash	8000	70414.47817	4.5kg
Odisha	215.00	5.00	30.5	Black	Kharif	Bajra	Nitrogen,Phosphorus,Potash	8000	70414.47817	4.5kg
Punjab	60.00	8.90	30.0	Latterite	Kharif	Bajra	Nitrogen,Phosphorus,Potash	8000	70414.47817	4.5kg
Punjab	60.00	8.90	30.5	Black	Kharif	Bajra	Nitrogen,Phosphorus,Potash	8000	70414.47817	4.5kg

Fig:7.3.3 End of the dataset

7.4 Training and Testing the dataset:

Once the data has been pre-processed, the data is divided into the train and test datasets. The train dataset is used to train the machine learning model, while the test dataset is used to evaluate the performance of the model. It is important to ensure that the train and test datasets are representative of the data as a whole and that the model is trained on a diverse range of data to ensure that it can generalize well to new data.

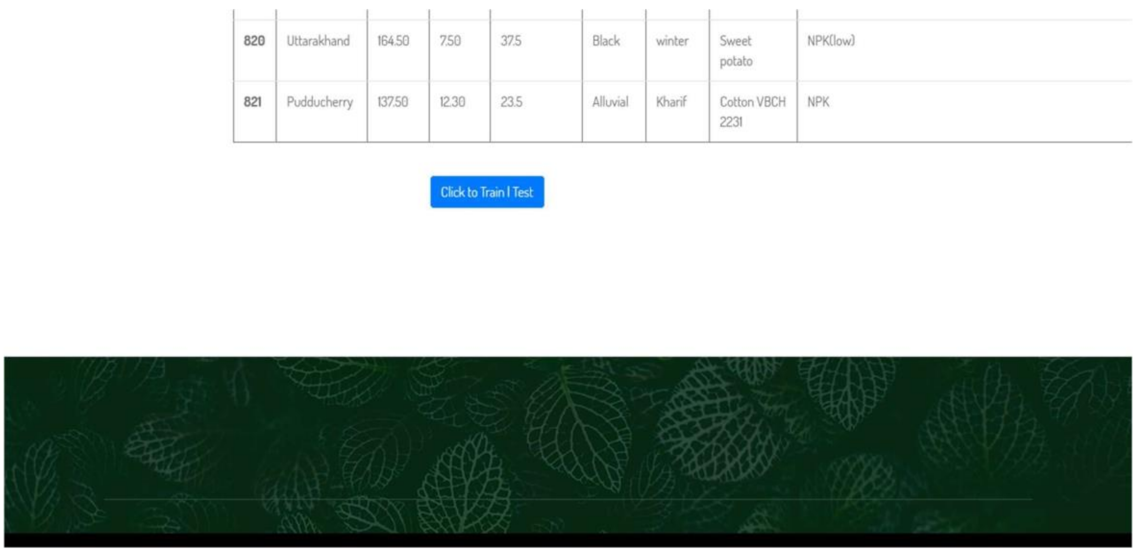

Fig:7.4 Training & Testing the dataset

7.5 OUTPUT:

Crop Recommendation System for agriculture is based on various input parameters. This paper proposes a hybrid model for recommending crops to Indian states by considering various attributes such as soil type, Rainfall, Groundwater level, Temperature and season. The model is built by using the classifier machine learning algorithm. Based on the appropriate parameters, the system will recommend the crop. Technology based crop recommendation system for agriculture helps the farmers to increase the crop yield by recommending a suitable crop for their land with the help of geographic and the climatic parameters. The proposed hybrid recommender model is found to be effective in recommending a suitable crop.

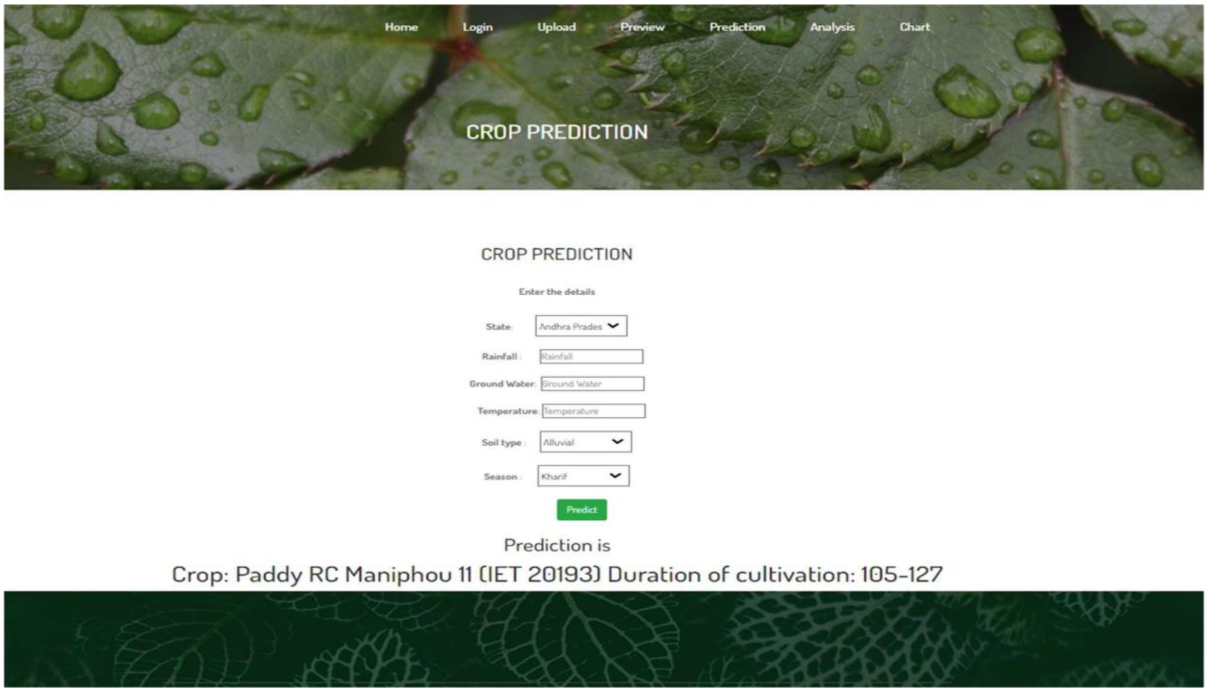

Fig:7.5 Result

CONCLUSION

In conclusion, the declining crop yield rate in the agriculture sector is a significant concern for farmers, which can be addressed by providing them with a smart and user-friendly crop recommendation system. This paper proposed a novel hybrid model that considers various factors such as soil type, rainfall, temperature, groundwater level, and season to recommend the most profitable crop for a specific region. The model uses machine learning algorithms to predict crop yield and determine the best time to use fertilizers. Such a technology-based system can help farmers maximize crop yield and meet the increasing demand for food supplies in India. With the effective implementation of this proposed model, farmers can make informed decisions about crop selection, which will result in significant economic benefits and reduce the risk of financial loss.

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APPENDIX

SOURCE CODE:

```
import numpy as np
import pandas as pd
from flask import Flask, request, jsonify, render_template, redirect, flash, send_file
from sklearn.preprocessing import MinMaxScaler
from werkzeug.utils import secure_filename
import pickle

import numpy as np
import pandas as pd
from flask import Flask, request, jsonify, render_template, redirect, flash, send_file
from sklearn.preprocessing import MinMaxScaler
from werkzeug.utils import secure_filename
import pickle
import numpy as np
import pandas as pd
from sklearn.tree import DecisionTreeClassifier
from sklearn.ensemble import RandomForestClassifier, BaggingClassifier, AdaBoostClassifier,
VotingClassifier

app = Flask(__name__) #Initialize the flask App

#forest = pickle.load(open('boosting.pkl','rb'))
crop = pickle.load(open('crop.pkl','rb'))
@app.route('/')

@app.route('/index')
def index():
    return render_template('index.html')
```

```
@app.route('/analysis')
def analysis():
    return render_template('analysis.html')

@app.route('/chart')
def chart():
    return render_template('chart.html')

#@app.route('/future')
#def future():
#    return render_template('future.html')

@app.route('/login')
def login():
    return render_template('login.html')
@app.route('/upload')
def upload():
  return render_template('upload.html')
@app.route('/preview',methods=["POST"])
def preview():
  if request.method == 'POST':
    dataset = request.files['datasetfile']
    df = pd.read_csv(dataset,encoding = 'unicode_escape')
    df.set_index('Id', inplace=True)
    return render_template("preview.html",df_view = df)



#@app.route('/home')
#def home():
 #  return render_template('home.html')

@app.route('/prediction', methods = ['GET', 'POST'])
def prediction():
  return render_template('prediction.html')
```

```
#@app.route('/upload')
#def upload_file():
#    return render_template('BatchPredict.html')



@app.route('/predict',methods=['POST'])
def predict():
    int_feature = [x for x in request.form.values()]

    final_features = [np.array(int_feature)]

    y_pred=crop.predict(final_features)

    if y_pred[0] == 'Paddy IGKVR-2 (IET 19795)':
        label="Crop: Paddy IGKVR-2 (IET 19795) Duration of cultivation: 105-123"
    elif y_pred[0] == 'Paddy CR Dhan 501 (IET 19189)':
        label="Crop: Paddy CR Dhan 501 (IET 19189) Duration of cultivation: 105-126"
    elif y_pred[0] == 'Wheat VL Gehun 907 (VL 907)':
        label="Crop: Wheat VL Gehun 907 (VL 907)) Duration of cultivation: 60-154"
    elif y_pred[0] == 'Wheat WHD 943':
        label="Crop: Wheat WHD 943 Duration of cultivation: 60-157"
    elif y_pred[0] == 'Millet Nandi-65 (MH-1549)':
        label="Crop: Millet Nandi-65 (MH-1549) Duration of cultivation: 65-70"
    elif y_pred[0] == 'Lentil Pant Lentil-8(Pant L-063)':
        label="Crop: Lentil Pant Lentil-8(Pant L-063) Duration of cultivation: 45-60"
    elif y_pred[0] == 'Bajra':
        label="Crop: Bajra Duration of cultivation: 45-50"
    elif y_pred[0] == 'Cardamom':
        label="Crop: Cardamom Duration of cultivation: 730-735"
    elif y_pred[0] == 'Urad':
        label="Crop: Urad Duration of cultivation: 70-85"
    elif y_pred[0] == 'Jowar':
        label="Crop: Jowar Duration of cultivation: 65-75"
    elif y_pred[0] == 'Paddy CR Dhan 401 (REETA)':
        label="Crop: Paddy CR Dhan 401 (REETA) Duration of cultivation: 105-124        "
```

```
elif y_pred[0] == 'Millet MH 1540 (86M64) (Hybrid)':
    label="Crop: Millet MH 1540 (86M64) (Hybrid) Duration of cultivation: 65-73"
elif y_pred[0] == 'Sugarcane Karan 5 (Co 0124)':
    label="Crop: Sugarcane Karan 5 (Co 0124) Duration of cultivation: 300-451"
elif y_pred[0] == 'Banana':
    label="Crop: Banana Duration of cultivation: 365-370"
elif y_pred[0] == 'Arhar':
    label="Crop: Arhar Duration of cultivation: 120-200"
elif y_pred[0] == 'Clove':
    label="Crop: Clove Duration of cultivation: 120-180"
elif y_pred[0] == 'Oilseed':
    label="Crop: Oilseed Duration of cultivation: 110-115"
elif y_pred[0] == 'Tea':
    label="Crop: Tea Duration of cultivation: 60-65"
elif y_pred[0] == 'Coffee':
    label="Crop: Coffee Duration of cultivation: 240-270"
elif y_pred[0] == 'Turmeric':
    label="Crop: Turmeric Duration of cultivation: 210-270"
elif y_pred[0] == 'Cashewnut':
    label="Crop: Cashewnut Duration of cultivation: 1030-1035"
elif y_pred[0] == 'Ragi':
    label="Crop: Ragi Duration of cultivation: 5.0-7.0"
elif y_pred[0] == 'Soyabean':
    label="Crop: Soyabean Duration of cultivation: 45-65"
elif y_pred[0] == 'Black Gram':
    label="Crop: Black Gram Duration of cultivation: 70-85"
elif y_pred[0] == 'Khesari':
    label="Crop: Khesari Duration of cultivation: 125-130"
elif y_pred[0] == 'Wheat MACS 6222':
    label="Crop: Wheat MACS 6222 Duration of cultivation: 60-151"
elif y_pred[0] == 'Black Pepper':
    label="Crop: Black Pepper Duration of cultivation: 120-150"
elif y_pred[0] == 'Chillies':
    label="Crop: Chillies Duration of cultivation: 40-45"
elif y_pred[0] == 'Garlic':
    label="Crop: Garlic Duration of cultivation: 120-150"
```

```
elif y_pred[0] == 'Wheat MPO(JW) 1215 (MPO 1215)':
        label="Crop: Wheat MPO(JW) 1215 (MPO 1215) Duration of cultivation: 60-150"
elif y_pred[0] == 'Maize PMH 5 (JH 3110)':
        label="Crop: Maize PMH 5 (JH 3110) Duration of cultivation: 95-105"
elif y_pred[0] == 'Groundnut Kadiri Harithandhra (K 1319)':
        label="Crop: Groundnut Kadiri Harithandhra (K 1319) Duration of cultivation: 110-
121"
elif y_pred[0] == 'Groundnut GPBD 5':
        label="Crop: Groundnut GPBD 5 Duration of cultivation: 110-122"
elif y_pred[0] == 'Lentil Pant Lentil-7(Pant L-024)':
        label="Crop: Lentil Pant Lentil-7(Pant L-024) Duration of cultivation: 45-61"
elif y_pred[0] == 'Tobacco':
        label="Crop: Tobacco Duration of cultivation: 90-120"
elif y_pred[0] == 'Tomato':
        label="Crop: Tomato Duration of cultivation: 50-60"
elif y_pred[0] == 'Cocoa':
        label="Crop: Cocoa Duration of cultivation: 150-180"
elif y_pred[0] == 'Rubber':
        label="Crop: Rubber Duration of cultivation: 120-130"
elif y_pred[0] == 'Masoor':
        label="Crop: Masoor Duration of cultivation: 120-130"
elif y_pred[0] == 'Sunhemp':
        label="Crop: Sunhemp Duration of cultivation: 60-90"
elif y_pred[0] == 'Varagu':
        label="Crop: Varagu Duration of cultivation: 160-165"
elif y_pred[0] == 'Paddy CR Dhan 601 (IET 18558)':
        label="Crop: Paddy CR Dhan 601 (IET 18558) Duration of cultivation: 105-125"
elif y_pred[0] == 'Wheat Netravati (NIAW 1415)':
        label="Crop: Wheat Netravati (NIAW 1415) Duration of cultivation: 95-100"
elif y_pred[0] == 'Maize HSC1':
        label="Crop: Maize HSC1 Duration of cultivation: 95-100"
elif y_pred[0] == 'Millet Nandi-61 (MH-1548)':
        label="Crop: Millet Nandi-61 (MH-1548) Duration of cultivation: 65-71"
elif y_pred[0] == 'Millet 86M64 (MSH 203) (Hybrid)':
        label="Crop: Millet 86M64 (MSH 203) (Hybrid) Duration of cultivation: 65-72"
elif y_pred[0] == 'Barley Pusa Losar (BH- 380)':
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        label="Crop: Barley Pusa Losar (BH- 380) Duration of cultivation: 60-72"
    elif y_pred[0] == 'Maize DHM 119 (BH 4062)':
        label="Crop: Maize DHM 119 (BH 4062) Duration of cultivation: 95-103"
    elif y_pred[0] == 'Millet HHB 226 (MH 1479)':
        label="Crop: Millet HHB 226 (MH 1479) Duration of cultivation: 65-76"
    elif y_pred[0] == 'Jute':
        label="Crop: Jute Duration of cultivation: 120-150"
    elif y_pred[0] == 'Paddy Chinsurah Rice (IET 19140)':
        label="Crop: Paddy Chinsurah Rice (IET 19140) Duration of cultivation: 105-120"
    elif y_pred[0] == 'Paddy (CNI 383-5-11)':
        label="Crop: Paddy (CNI 383-5-11) Duration of cultivation: 105-121"
    elif y_pred[0] == 'Paddy IGKVR-1 (IET 19569)':
        label="Crop: Paddy IGKVR-1 (IET 19569) Duration of cultivation: 105-122"
    elif y_pred[0] == 'Onion':
        label="Crop: Onion Duration of cultivation: 80-150"
    elif y_pred[0] == 'Cotton CNH012':
        label="Crop: Cotton CNH012 Duration of cultivation: 80-150"
    elif y_pred[0] == 'Cotton CICR-3 (CISA 614)':
        label="Crop: Cotton CICR-3 (CISA 614) Duration of cultivation: 105-120"
    elif y_pred[0] == 'Rice':
        label="Crop: Rice Duration of cultivation: 105-120"
    elif y_pred[0] == 'Flax':
        label="Crop: Flax Duration of cultivation: 120-140"
    elif y_pred[0] == 'Barley BH-902':
        label="Crop: Barley BH-902 Duration of cultivation: 60-70"
    elif y_pred[0] == 'Sunflower':
        label="Crop: Sunflower Duration of cultivation: 90-100"
    elif y_pred[0] == 'Maize HQPM-4':
        label="Crop: Maize HQPM-4 Duration of cultivation: 95-101"
    elif y_pred[0] == 'Groundnut Girnar - 3 (PBS 12160)':
        label="Crop: Groundnut Girnar - 3 (PBS 12160) Duration of cultivation: 175-180"
    elif y_pred[0] == 'Dry Ginger':
        label="Crop: Dry Ginger Duration of cultivation: 175-180"
    elif y_pred[0] == 'Horse Gram':
        label="Crop: Horse Gram Duration of cultivation: 120-180"
    elif y_pred[0] == 'Castor Seed':
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            label="Crop: Castor Seed Duration of cultivation: 7.0-10"
    elif y_pred[0] == 'Sesame':
            label="Crop: Sesame Duration of cultivation: 40-45"
    elif y_pred[0] == 'Sugarcane Karan 6 (Co 0239)':
            label="Crop: Sugarcane Karan 6 (Co 0239) Duration of cultivation: 300-450"
    elif y_pred[0] == 'Peas':
            label="Crop: Peas Duration of cultivation: 50-100"
    elif y_pred[0] == 'Paddy RC Maniphou 11 (IET 20193)':
            label="Crop: Paddy RC Maniphou 11 (IET 20193) Duration of cultivation: 105-127"
    elif y_pred[0] == 'Cowpea':
            label="Crop: Cowpea Duration of cultivation: 45-90"
    elif y_pred[0] == 'Maize MCH 36 (Hybrid) (DKC 9099)':
            label="Crop: Maize MCH 36 (Hybrid) (DKC 9099) Duration of cultivation: 95-102"
    elif y_pred[0] == 'Pulses':
            label="Crop: Pulses Duration of cultivation: 95-102"
    elif y_pred[0] == 'Sugarcane Co-0218':
            label="Crop: Sugarcane Co-0218 Duration of cultivation: 300-452"
    elif y_pred[0] == 'Wheat PDW 314':
            label="Crop: Wheat PDW 314 Duration of cultivation: 60-152"
    elif y_pred[0] == 'Sweet potato':
            label="Crop: Sweet potato Duration of cultivation: 120-125"
    elif y_pred[0] == 'Cotton VBCH 2231':
            label="Crop: Cotton VBCH 2231 Duration of cultivation: 150-180"

    return render_template('prediction.html', prediction_text=label)
#@app.route('/performance')
#def performance():
    return render_template('performance.html')

if __name___== "__main_":
  app.run(debug=True)
```

PUBLICATION

CONFIRMATION LETTER:

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Ref No : IJRTI / Vol 8 / Issue 4 / 036

To,
Bhukya Ganesh Naik
Published in : Volume 8 | Issue 4 | April-2023

Subject: Publication of paper at International Journal for Research Trends and Innovation - IJRTI.

Dear Author,

With Greetings we are informing you that your paper has been successfully published in the International Journal for Research Trends and Innovation (ISSN: 2456-3315). Thank you very much for your patience and cooperation during the submission of paper to final publication Process. It gives me immense pleasure to send the certificate of publication in our Journal. Following are the details regarding the published paper.

Registration ID	:	IJRTI_ 185848
Paper ID	:	IJRTI2304036
Title of Paper	:	Agricultural Crop Recommendation Based on Productivity and Season
Impact Factor	:	8.14 (Calculate by Google Scholar)
DOI	:	
Published in	:	Volume 8 | Issue 4 | April-2023
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Published URL	:	http://www.ijrti.org/viewpaperforall.php?paper=IJRTI2304036
Authors	:	Bhukya Ganesh Naik, Biyyala Venkata Bharath, Keetha Deepak, Venukupati Mohan

Thank you very much for publishing your article in IJRTI. We would appreciate if you continue your support and keep sharing your knowledge by writing for our journal IJRTI.

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