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Smart Agriculture Using Machine Learning

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Abstract

Agriculture is a vital source of income in India, but farmers often face challenges in selecting the right crop and fertilizer, leading to reduced productivity. Smart agriculture helps address this by leveraging soil data, crop yield statistics, and environmental factors to provide accurate recommendations. This project proposes a machine learning-based recommendation system using majority voting (Random Forest, Naive Bayes, SVM, and Logistic Regression) to suggest the most suitable crop based on site-specific parameters. Additionally, a fertilizer recommendation system compares user-inputted soil nutrient levels with optimal values, identifying deficiencies and providing targeted suggestions to enhance soil fertility. The project also integrates a disease prediction model that detects potential crop diseases early, enabling timely intervention and reducing crop loss. By combining crop selection, fertilizer recommendation, and disease prediction, this system empowers farmers with data-driven insights, ultimately improving agricultural productivity, resource efficiency, and sustainability.

Introduction

A farmer's decision about which crop to grow is generally clouded by his intuition and other irrelevant factors like making instant profits, lack of awareness about market demand, overestimating a soil's potential to support a particular crop, and so on. A very misguided decision on the part of the farmer could place a significant strain on his family's financial condition. Perhaps this could be one of the many reasons contributing to the countless suicide cases of farmers that we hear from media on a daily basis. In a country like India, where agriculture and related sector contributes to approximately 20.4 per cent of its Gross Value Added (GVA) , such an erroneous judgment would have negative implications on not just the farmer's family, but the entire economy of a region. For this reason, we have identified a farmer's dilemma about which crop to grow during a particular season, as a very grave one. The need of the hour is to design a system that could provide predictive insights to the Indian farmers, thereby helping them make an informed decision about which crop to grow. With this in mind, we propose a system, an intelligent system that would consider environmental parameters (temperature, rainfall, geographical location in terms of state) and soil characteristics (N, P, K, pH value, soil type and nutrients concentration) before recommending the most suitable crop to the user. In addition to that a fertilizer suggestion is also made which is based on the optimum nutrients of the crops grown.

Architecture

Project architecture represents number of components we are using as a part of our project and the flow of request processing i.e. what components in processing the request and in which order. An architecture description is a formal description and representation of a system organized in a way that supports reasoning about the structure of the system. Architecture is of two

types. They are

(1) Software Architecture

(2) Technical Architecture

Software Architecture

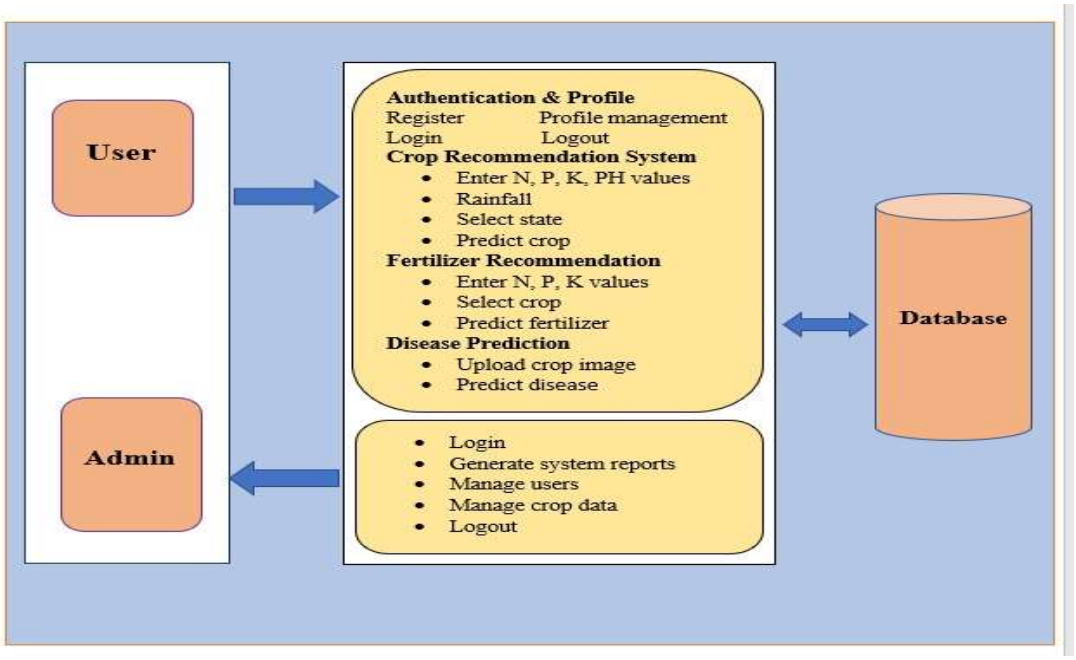

Fig3.1 Software architecture

Technical Architecture:

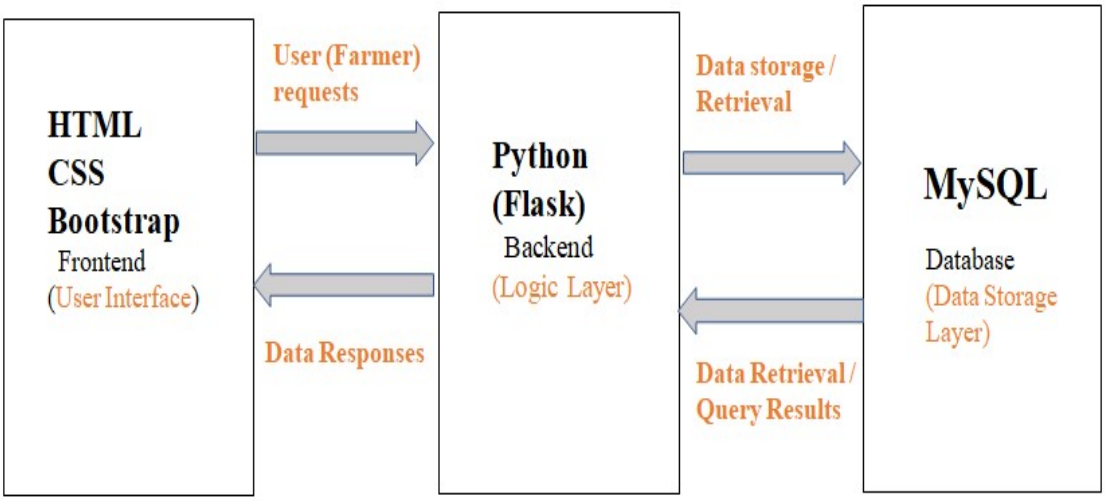

Fig3.1.2 Technical architecture

Testing Methodologies

The program comprises of several algorithms which are tested individually for the accuracy.

we check for the correctness of the program as a whole and how it performs.

Unit Testing

Unit tests focus on ensuring that the correct changes to the world state take place when a

transaction is processed. The business login transaction processor functions should have unit

tests, ideally with 100 percent code coverage. This will ensure that you do not have typos or

logic errors in the business logic. The various modules can be individually run from a

command line and tested for correctness. The tester can pass various values, to check the

answer returned and verify it with the values given to him/her. The other work around is to

write a script, and run all the tests using it and write the output to a log _le and using that to

verify the results. We tested each of the algorithms individually and made changes in

preprocessing accordingly to increase the accuracy.

System Testing

System Testing is a level of software testing where a complete and integrated software is tested. The purpose of this test is to evaluate the systems compliance with the specified

requirements. System Testing is the testing of a complete and fully integrated software

product and White Box Testing. System test falls under the black box testing category of

software testing. Different Types of System Testing:

- Usability Testing - Usability Testing mainly focuses on the users ease to use the application, exibility in handling controls and ability of the system to meet itsobjectives.
- Load Testing - Load Testing is necessary to know that a software solution will perform under real-life loads.
- Regression Testing- - Regression Testing involves testing done to make sure none ofthe changes made over the course of the development process have caused new bugs.
- Recovery Testing - Recovery testing is done to demonstrate a software solution isreliable, trustworthy and can successfully recoup from possible crashes.
- Migration Testing - Migration testing is done to ensure that the software can bemoved from older system infrastructures to current system infrastructures without anyissues.

Test Cases

Table 5.3.1 Crop Recommendation Module

TCID	TestCaseDescription	Input	ExpectedOutput	ActualOutput	Status
1	Pass:ValidinputforWheat	N=90,P=40,K=40,Temp=25, Humidity=70%,pH=6.5,Rainfall=100	wheat	Wheat	Pass
2	Pass:ValidinputforRice	N=100,P=42,K=43,Temp=28,	Rice	Rice	Pass

		Humidity=85%,pH=6.0,Rainfall=200			
3	Pass:ValidinputforCotton	N=75,P=55,K=60,Temp=30, Humidity=65%,pH=7.2,Rainfall=250	Cotton	Cotton	Pass

Table 5.3.2 Fertilizer Recommendation Module

TCID	TestCaseDescription	Input	ExpectedOutput	ActualOutput	Status
1	Fail:Typoincrop name	Crop= 'Tomato ' N=70,P=40,K=40	Error:Cropnotfound	Error:Cropnotfound	Fail
2	Pass:Correctedcropname	Crop='Tomato',N=70,P=40,K=40	ApplyNitrogen-basedfertilizer	ApplyNitrogen-basedfertilizer	Pass
3	Pass:BalancedNPKforWheat	Crop='Wheat',N=60,P=40,K=40	ApplyPhosphorus-based fertilizer	ApplyPhosphorus-based fertilizer	Pass

Table 5.3.3Disease Prediction Module

TCID	TestCaseDescription	Input	ExpectedOutput	ActualOutput	Status
1	Pass:Validtomatoleafimage	Tomatoleafwithdisease	TomatoLeafCurlVirus	TomatoLeafCurlVirus	Pass
2	Pass:Healthyleafimage	Tomatoleaf(nosymptoms)	Nodiseasedetected	Nodiseasedetected	Pass
3	Pass:Chillileafwithspots	Infectedchillileaf	ChilliLeafSpotDisease	ChilliLeafSpotDisease	Pass

Results

nshots:

Fig 6.1 Home page

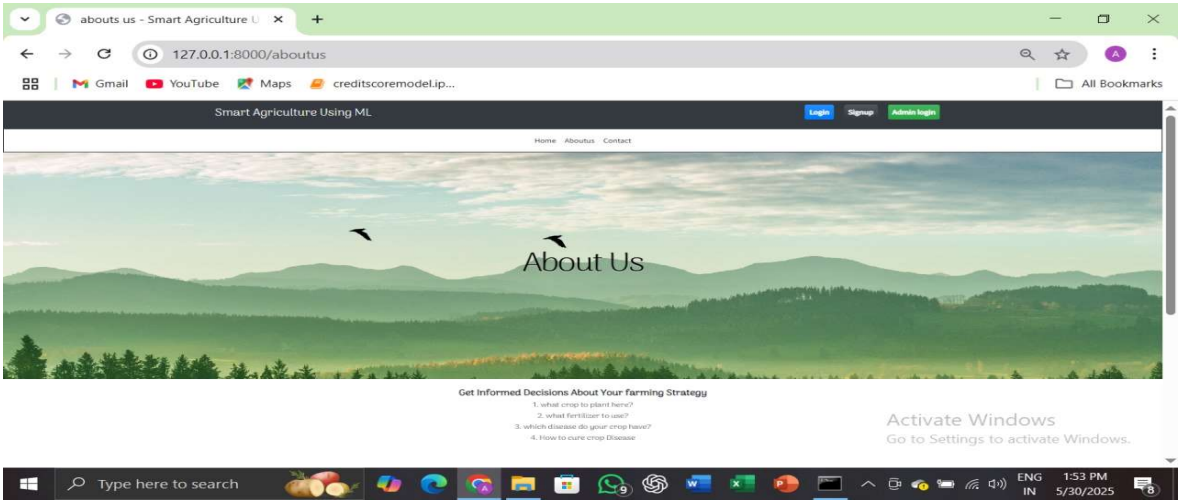

Fig 6.2 Our Services

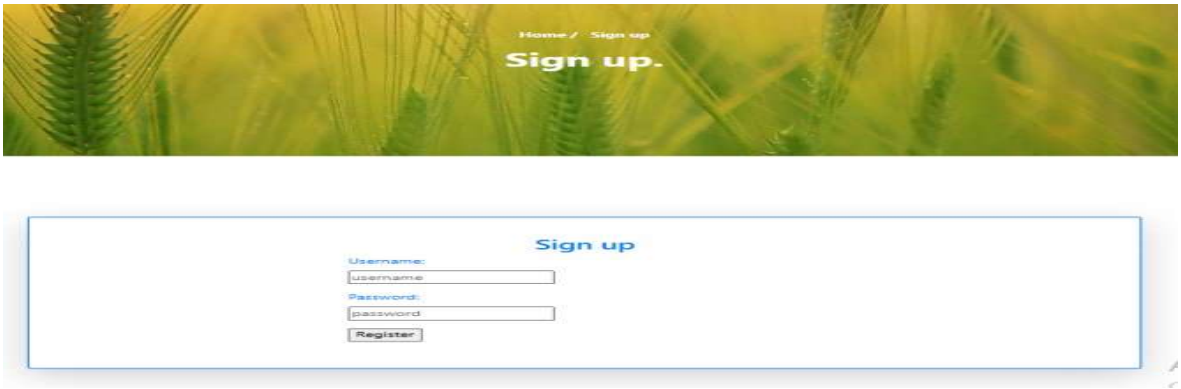

Fig 6.3 Sign in page

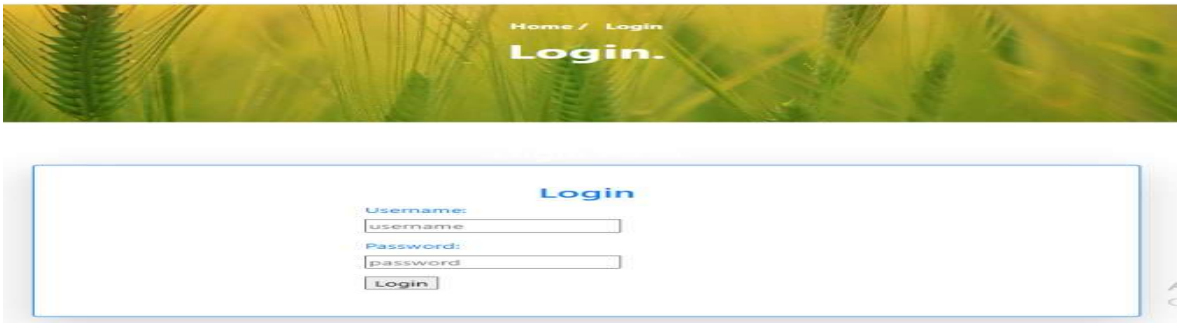

Fig 6.4 Login page

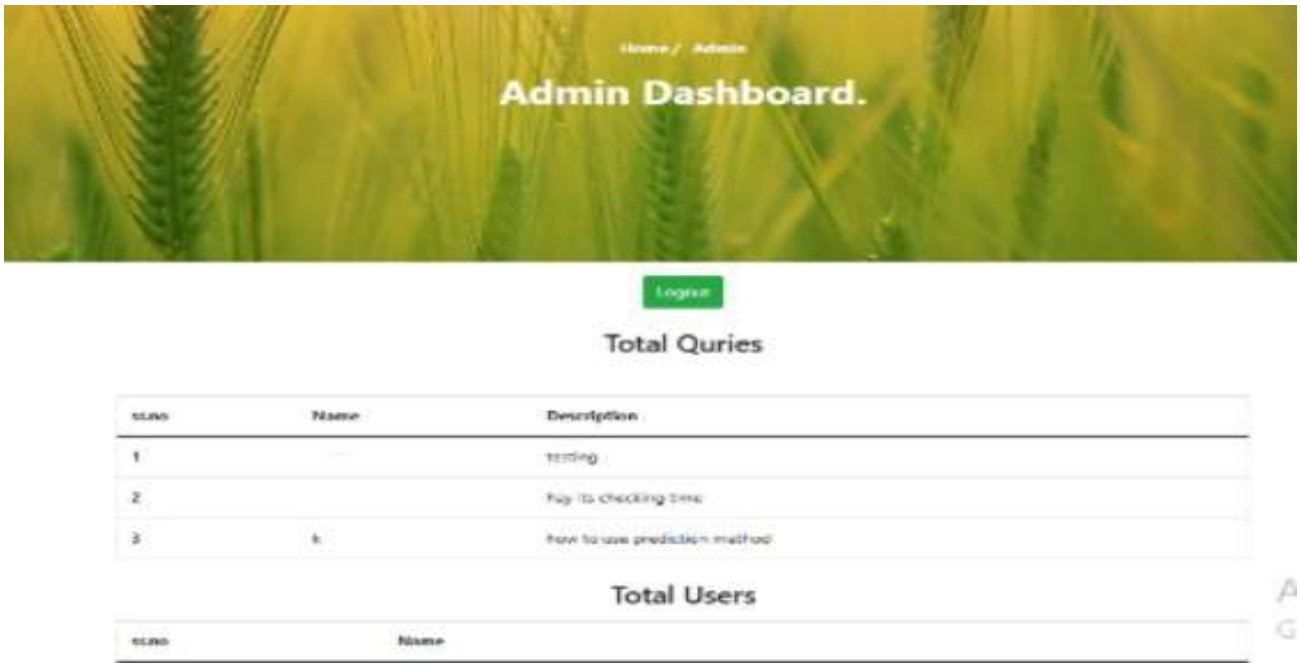

Fig 6.5 Admin Dashboard

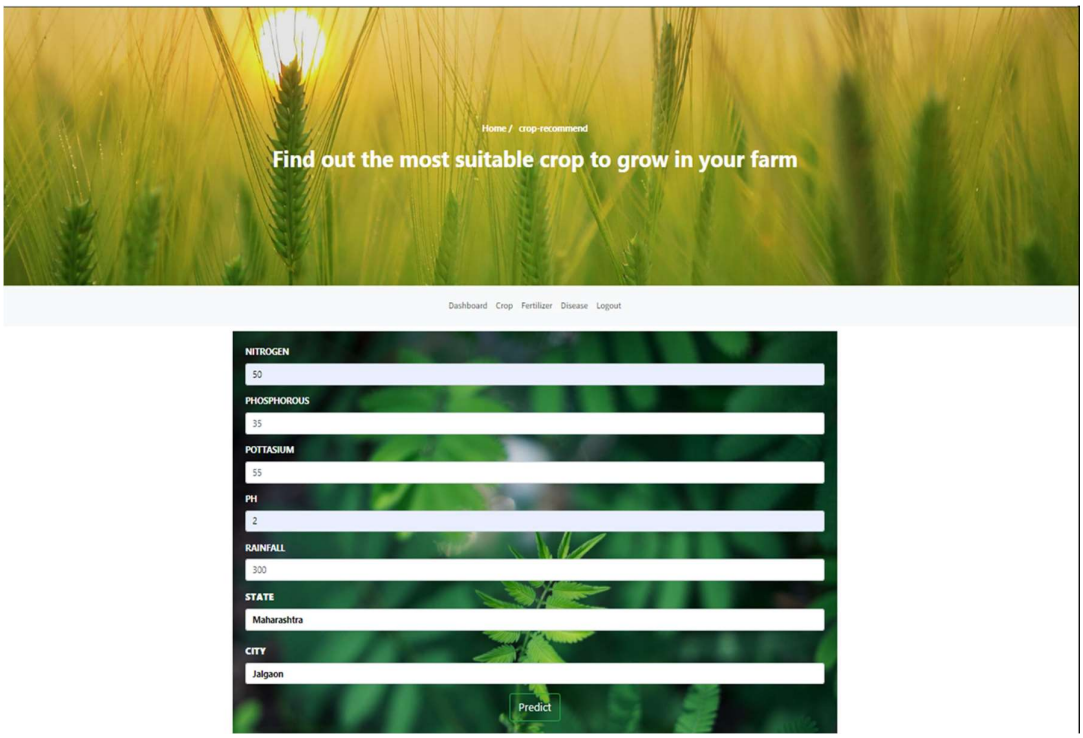

Fig 6.6 (a) Crop Recommendation

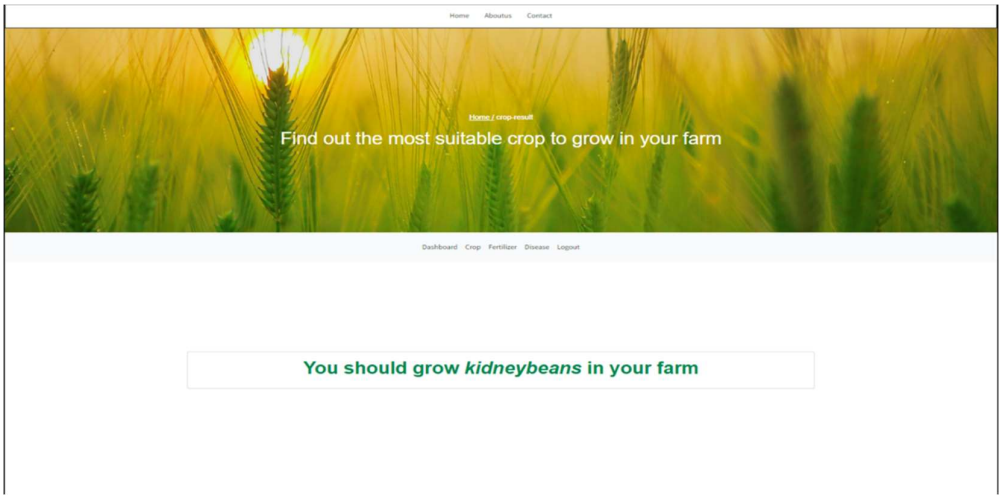

Fig 6.6 (b) Crop Recommendation

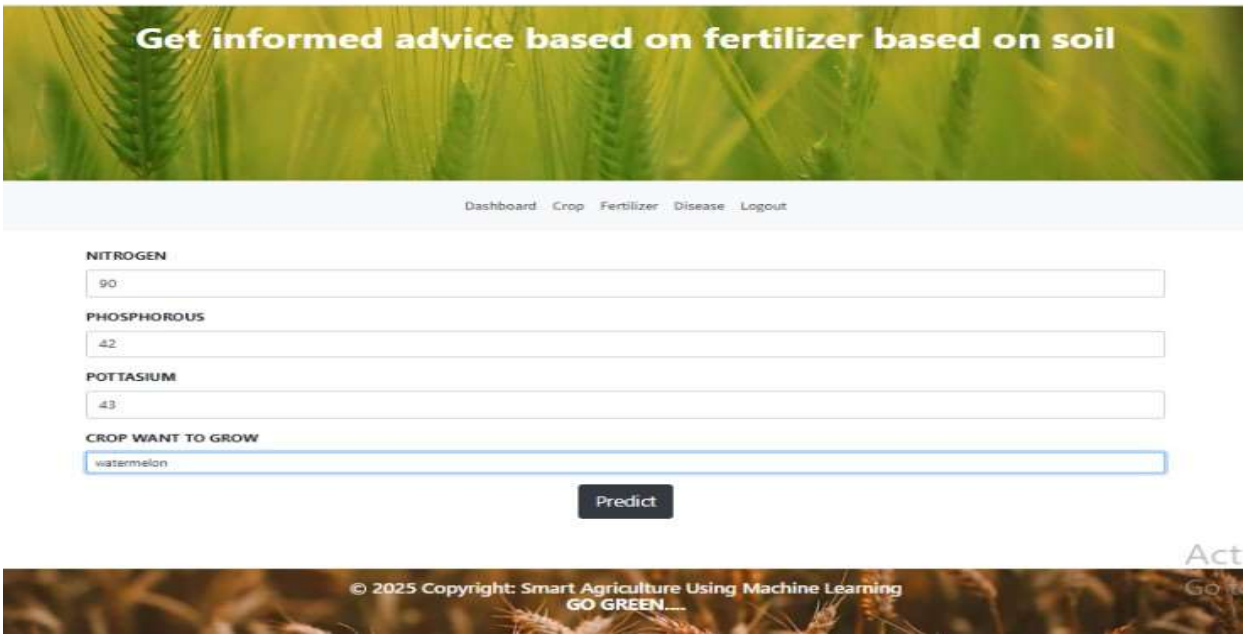

Fig 6.7 (a) Fertilizer Recommendation

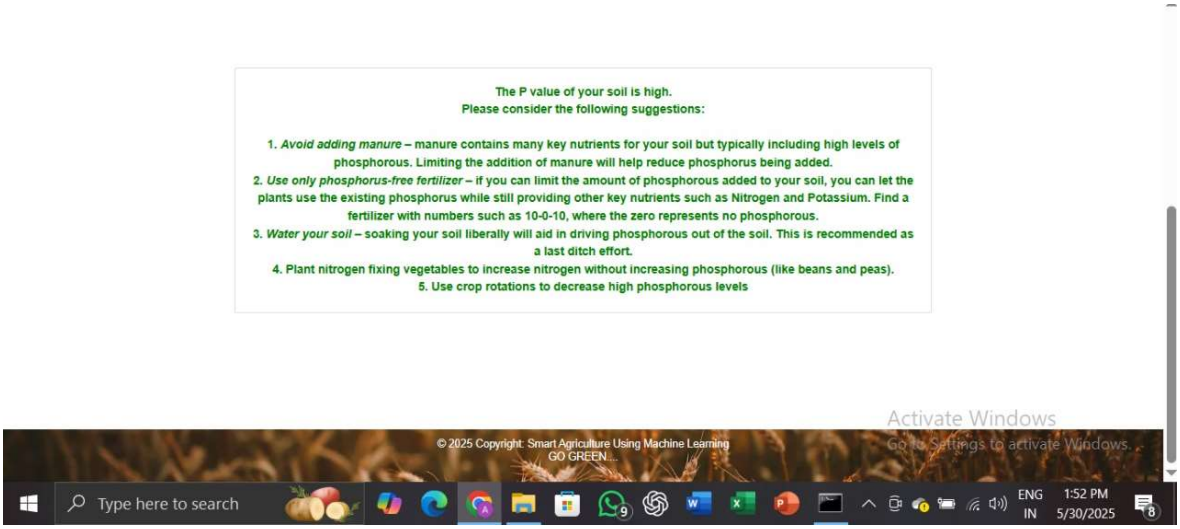

Fig 6.7 (b) Fertilizer Recommendation

Fig 6.8 (a) Disease Prediction

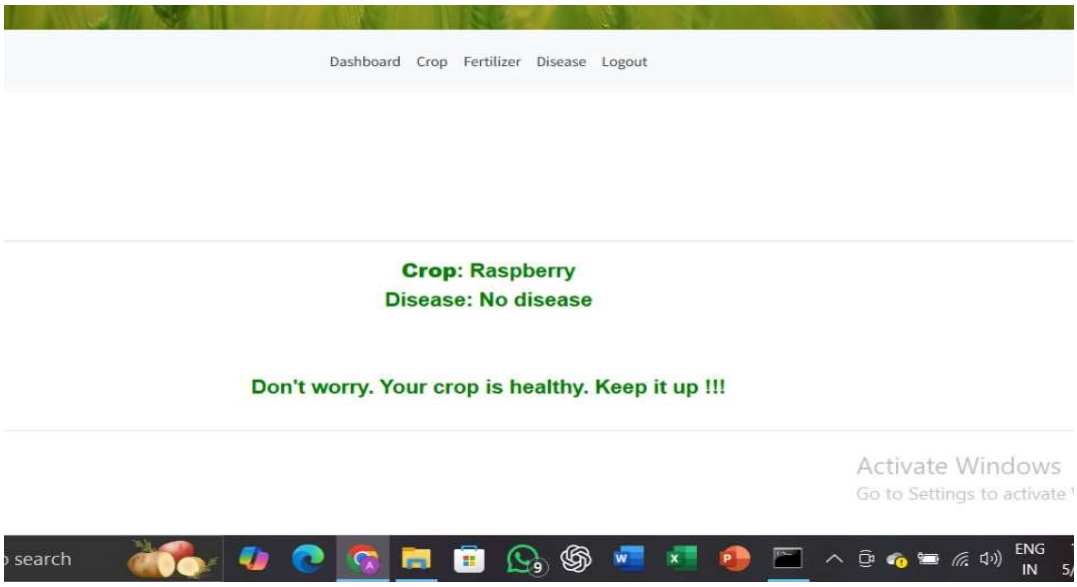

Fig 6.8 (b) Disease Prediction

Fig 6.8 (c) Disease Prediction

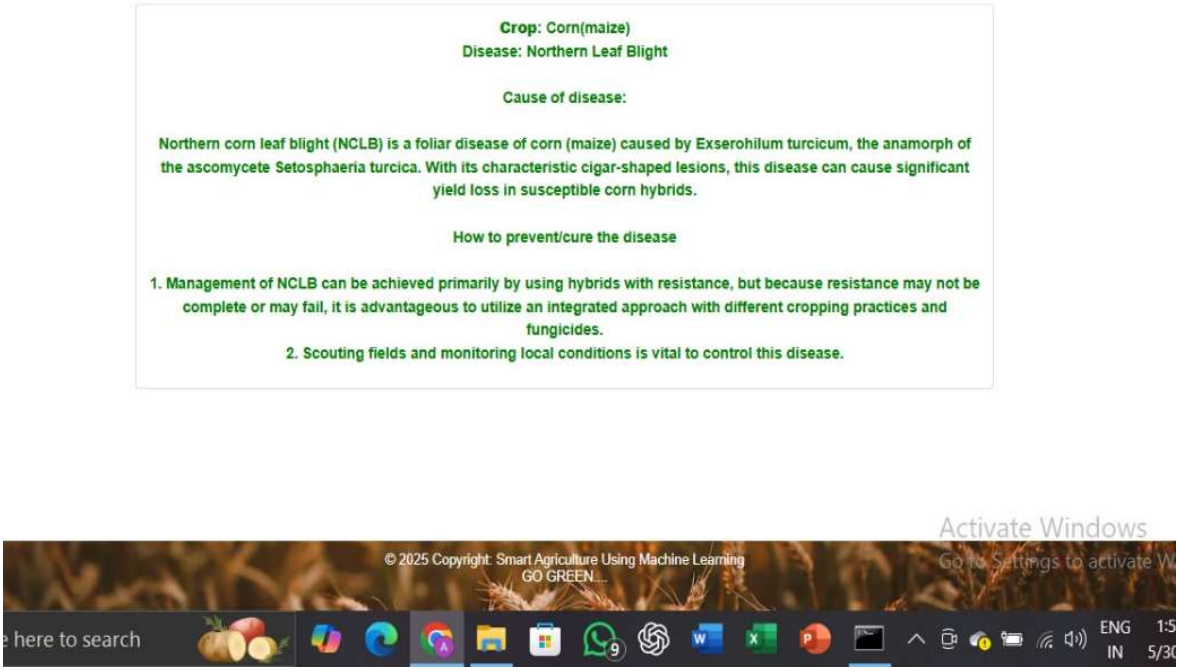

Fig 6.8 (d) Disease Prediction

Conclusion

All This system helps the farmer to choose the right crop by providing insights that ordinary farmers don't keep track of thereby decreasing the chances of crop failure and increasing productivity. It also prevents them from incurring losses. The system can be extended to the web and can be accessed by millions of farmers across the country. We could achieve an accuracy of 90 percent from the Decision Trees, an accuracy of 70.6 percent from the Support Vector Machine, an accuracy of 94.30 percent from the Logistic Regression and an accuracy of 99.09 percent from the Random Forest model. Thus, our work would help farmers in sowing the right seed based on soil requirements to increase productivity and acquire profit out of such a technique's.

- Can be developed as a mobile app for easier access by farmers.
- Voice support in Telugu and other local languages for better usability.
- Real-time weather and soil data using IoT sensors to improve accuracy.
- Use of images to detect crop diseases and give instant suggestions.
- Suggest best crops based on market demand and prices.
- Link with government schemes to help farmers get support easily.
- Provide alerts for climate changes to avoid crop damage.
- Build a community platform where farmers can share knowledge.

7.1.1 Future Scope

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