SOIL NUTRIENT MANAGER: A MOBILE APP FOR SOIL FERTILITY CHECK AND PREDICTION OF CROP YIELD

Abstract

The purpose of the study is to create an application in order to establish a solution for Soil Fertility Checks and Crop Prediction Using Machine Learning. In India, traditional farming practices are used without knowledge of the soil's quality or com- position. The suggested application will assist farmers and garden- ers in determining the soil's fertility using only common house- hold items and no special equipment. Using pH drops or litmus paper, we may calculate the pH value based on the colour inten- sity. Then, we may assess the quantities of nitrogen (N), potassium (K), and phosphorus (P) in the soil using the pH of the soil. To estimate pH value, we are utilising a classification system, a clus- tering method, and suitable techniques based on sustainable crops.

Keywords: pH value, classification algorithm, soil fertility and clustering algorithm.

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I. INTRODUCTION

One of the key sources of revenue for the Indian economy is agri- culture. India is rated second globally in terms of agriculture output. We continue to have the lowest per capita production and farmer income due to the use of traditional techniques. We continue to have the lowest per capita production and farmers' income while using conventional methods. Food insecurity is brought on by seasonal climate changes that are harmful to basic resources including soil, water, and air.

A smart system that can address the issue of declining agricultural output is required in a scenario where crop yield rates are continue- ally falling short of fulfilling demand. When there are several crops to be grown, it can be challenging for farmers, especially if they are unaware of market values. In this scenario, we want to employ a certain plant to carry out our research, which entails soil study and crop production projection.

A farmer's prior expertise with a particular crop was previously used to compute yield prediction. But nowadays, machine learning is used by the suggested system to produce the predictions. It has a significant impact on farmers' ability to select the best crops for their region. The NPK and pH values of the soil are provided through soil analysis, which is a crucial methodology.

The list of crops that are suitable is anticipated and the processes are shown depending on the values we obtain from the suggested sys- tem. India has seen significant economic and social upheaval due to rising suicide rates among small and marginal farmers. Our goal is to provide support and resources to such farmers and communities in order to overcome these problems.

There is currently no software available that suggests crops depend- ing on several variables including soil type and meteorological con- ditions like temperature and rainfall. Additionally, the systems that are now in use are hardware-based, which makes them costly and challenging to maintain. The suggested solution suggests a mobile application that, by forecasting yield, can accurately tell a farmer which crop will be the most profitable.

The proposed system will help the farmers to check the fertility of soil without any kit & using only household products (i.e., Vinegar & Baking soda). We can find the pH value whether it is alkaline or acidic and we use litmus paper or pH drops, based on intensity ofcolour we can determine the pH value & we can estimate Nitro- gen(N), potassium(K) and phosphorous(P) from the pH of the soil. So, with the help of the NPK values and the pH of the soil we can predict the suitable crops for particular.

For greater agricultural yields, farmers must be knowledgeable about soil fertility. To maximise the production of a given crop and to choose the appropriate fertiliser, The macronutrients and micro- nutrients in the soil must be known to farmers. Soil testing is a cru- cial component of farming. Currently, it takes a few weeks for a government lab to evaluate a specific soil sample. There is a danger that farmers could receive inaccurate information and that soil sam- ples will go missing. Therefore, we are recommending an applica- tion to automate the manual procedure of soil testing and nutrient estimation.

II. LITERATURE SURVEY

In [1] the authors have proposed that the project will help the farm- ers by predicting the crops that need to be cultivated before they cultivate crops in their agriculture land. So, by this system predic- tion the farmer can take a proper decision where he can select a high yielding crop to be cultivated in his farm. For this prediction method Deep reinforcement learning will provide the way a by building a proper framework in order to predict the crop yield. This method will usually collect all the raw data of the soil, land, climate, humid- ity etc. that are needed to be mapped to give the prediction. This project constructs a Deep Recurrent Q-Network model which is an algorithm that determines the crop yield. This algorithm is stacked with a layer of Networks that have data parameters passed to con- structs a crop yield prediction by taking the input parameters given by the user. A linear layer from the network algorithm will map the Recurrent Network output values to the Q-values. Finally, the algo- rithm provides the output values that have minimal error and have forecast accuracy.

In [2] the authors have proposed that this paper aims to help to pre- dict the crop that helps the Indian agriculture sector if provided with the proper set of data on rainfall and humidity. The parameters also require the data on potassium, nitrogen, phosphorus and the pH value of the soil in-order to provide the required output [10]. This research uses different types of machine learning algorithms that will help to predict the type of crop required for plantation if pro- vided with the climatic conditions as the input data. This work also helps in analysing the role and impact of the soil and it conditionsto predict the suitable crop. We got to know from the output that by humidity and rainfall data parameters we can predict specific crop for the land to be planted. The potassium and nitrogen content ratio present in the soil will help the selection of the crop. By using the feature selecting algorithm rainfall acts as important attribute to pro- vide the output data. Different ML algorithms like k-NN, RF and GB trees were taken into consideration to compare the provided in- put data values [11]. These methods gave the best output accuracy to build a proper prediction system. However, we can still improve this system using different set of data to predict the crops.

Crop yield prediction, which is a key topic in the agricultural Indus- try, is the focus of [3], and it may be accomplished utilizing statisti- cal and machine learning techniques. In this model, mainly we use statistical model MLR and machine learning models such as BPNN, SVM, and GRNN models, are used for taking wide area data param- eters of agriculture land. Compared to the statistical model, the ML models give the results more accurately as predicted by the model when it is validated with the real time result analysis. GRNN model plays significant role to provide more variance and higher prediction than the other ML models [12]. So, by the analysis we can conclude that GRNN model is more suitable for the prediction of wide area spectrum to make the accurate prediction of the crop to be yield.

In [4] the authors focused on the farmers with two different ap- proaches. Along with the parameters of present data inputs, historic data sets are also taken by the government websites in-order to pre- dict the crop more accurately. The historic data sets consist follow- ing parameters temperature, humidity and rainfall. These datasets are gathered and kept in storage. The effort will examine the param- eters utilising the DHT-22 sensor and historical data gathered from the government website in order to provide reliable crop predictions [14].

The type of soil is determined by using the supervised and non- supervised algorithms. Using the learning network algorithms da- taset is trained. The most accurate forecast is delivered to the end users after being compared to the others. It will forecast the crop as well as the necessary and appropriate fertilisers for the crop. The accuracy of the result is improved by using both current and histor- ical data sets [15]. Thus, this technique will lessen the challenges experienced by the farmers and improve the calibre of their job.

According to [5], the key factors influencing crop forecast are soil vegetation and local humidity. This paper use the Deep Recurrent Q-Networks vector technique to forecast it. This algorithm will pro- vide detailed predictions about the functionality that plants must have in order to be predictive. A appropriate yield prediction frame- work is created by deep reinforcing function, which will plan the unmapped facts in crop prediction rates. According to [5], the key factors influencing crop forecast are soil vegetation and local hu- midity. This paper use the Deep Recurrent Q-Networks vector tech- nique to forecast it. This algorithm will provide detailed predictions about the functionality that plants must have in order to be predic- tive. A appropriate yield prediction framework is created by deep reinforcing function, which will plan the unmapped facts in crop prediction rates.

The work in [6] is mainly used to forecast the market prices of the crop yield. In addition, it also provides economic plans and suitable agricultural products. Here we use the different ML algorithms such as Deep Yield, CNN-LSTM that predicts the suitable crop, prices and agricultural products. However, in this study there are mainly two architectures that have been considered. The first architecture includes 2D-CNN, skip connections, and LSTM-Attentions. The second architecture includes 3D-CNN, skip connections, and Conv LSTM Attention. The second proposed architecture provides the more accurate predictions compared to the first architecture predic- tions [10]. Finally, this project provides us the prediction of the crops along with plans to get a proper market price for the crop to sustain the needs of the farmers.

In [6] the farmers do farming by traditional method, without know- ing the soil type, humidity and data sets that are required to give a good crop. Because of this farmer will not get profits from the farm- ing. Thus, we need an automated process from the existing soil methods that will predict the yield more accurately rather than hav- ing human errors and thus crop prediction can be done. So, we pro- vide a hand device that determines the pH of soil and provides data on phosphorous, potassium and nitrogen based on the pH of the soil [8]. Based on the information we receive from our device, we utilise a classification system to anticipate appropriate crops, and we also supply the appropriate fertilisers needed for that field [16].

III. PROPOSED METHODOLOGY

Our system's primary goal is to automate the manual process of soil testing and nutrient estimate. In our approach, we check the soil fer- tility using common household items like litmus paper. The fertility level of the soil will be determined by our system's analysis of the soil's characteristics and nutrients, such as NPK. Our system will analyse the soil and forecast the crops as well. According on NPK values, the system will also recommend a list of fertilisers for that crop [9]. During the cultivation phase, farmers can test the soil sev- eral times and take the required precautions to produce good yield. Reports will be produced at

the conclusion so farmers may track their fertility.

The system use machine learning to estimate the harvest, and Python is used as the programming language because it is well-known for usage in machine learning experiments. In order to learn from past events and create a trained model, machine learning employs histor- ical data and knowledge. The model then predicts the outcome. The classifier's accuracy will increase with the quality of the dataset gathering. Regression and classification techniques used in machine learning have been found to outperform a number of statistical mod- els.

`The production of crops is entirely reliant on geographical elements such as soil chemistry, rainfall, topography, soil type, temperature, etc. These elements significantly contribute to an increase in crop output. Additionally, market factors impact the crop(s) that should be planted for optimal profit. To anticipate the yield, we must take into account every aspect individually. As a result, we develop an application that employs machine learning to anticipate crop yield utilizing methodologies from the area of agriculture.

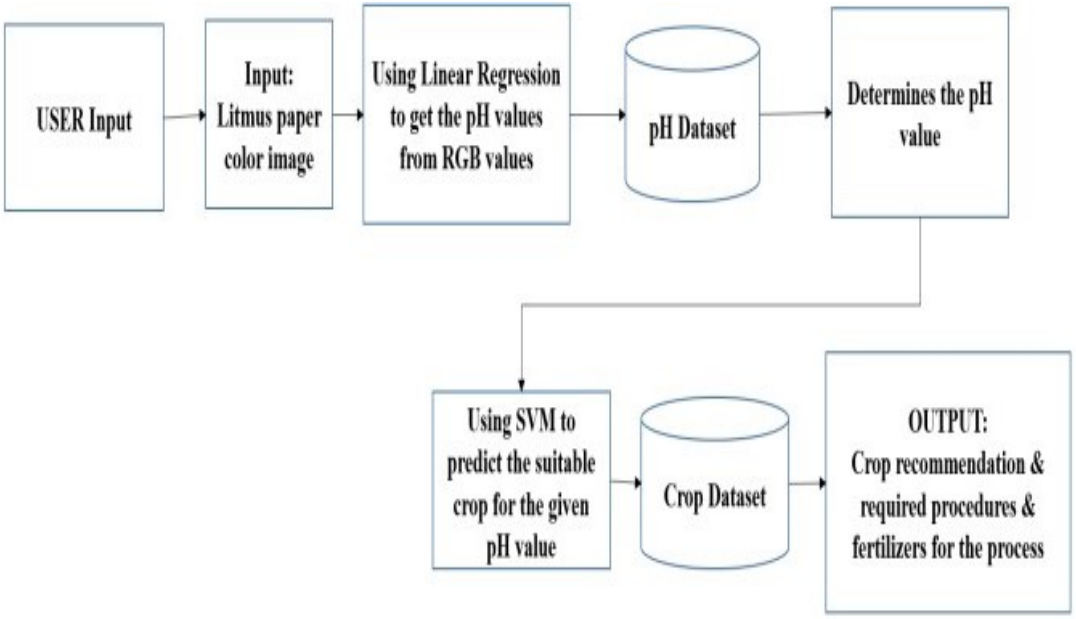


Figure 1: System Architecture

A high-level overview of the functions and duties of the system is provided by the system architecture. It outlines how the system is divided into several subsystems and the varied roles that each one plays.

Farmer’s input: After litmus paper test, the user can upload the im- age of the litmus paper for the colour classification to determine the pH value from the colour dataset. The user can directly input the pH value.

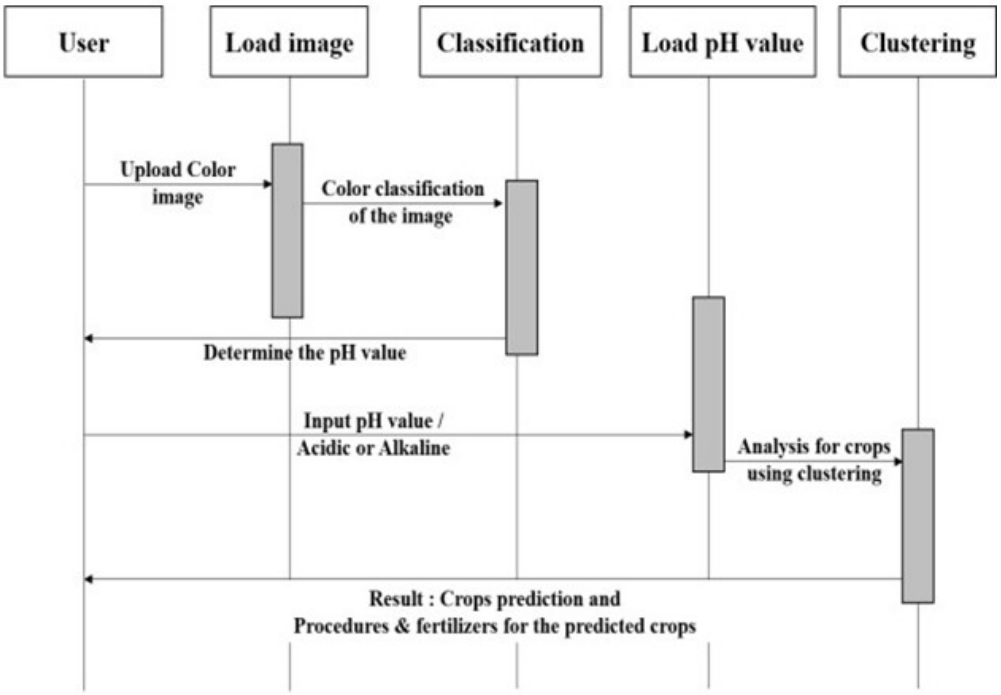


Figure 2: Sequence Diagram

An interaction diagram that demonstrates how processes interact with one another and in what order is known as a sequence diagram in the Unified Modelling Language (UML). It is a Mes-sage Se- quence Chart construct. Event diagrams and event scenarios are other names for sequence diagrams. Sequence diagrams aid in plan- ning and comprehending a scenario's intricate operation, whether it be present or hypothetical. They might be helpful resources for com- panies and other institutions. Fig. 2 above displays the sequence di- agram for the suggested system.

Incise the pH value is unknown, the User will upload the litmus col- our image to the system to determine the pH value.

Using KNN model the image is classified and the pH value is deter- mined. If the pH value is known, the user will load the value as the input to analyse the NPK values.

Using the Keans model the crops are predicted with the analysis of NPK values. As a result, the predicted crops and the fertilizers & procedures for the crops are given to the user.

Figure 3: Litmus Paper**.**

Litmus paper is a filter paper that has been treated with a lichen- provided natural-soluble dye. Litmus paper is a piece of paper that produces a result which can be used as a pH indicator. Wood cellu- lose, lichens, and adjunct compounds are the primary raw materials used to produce litmus paper. Litmus paper is made mainly of paper, as the name suggests. Litmus paper must be free of pollutants that could influence the pH of the system being tested.

Figure 4: Distilled Water

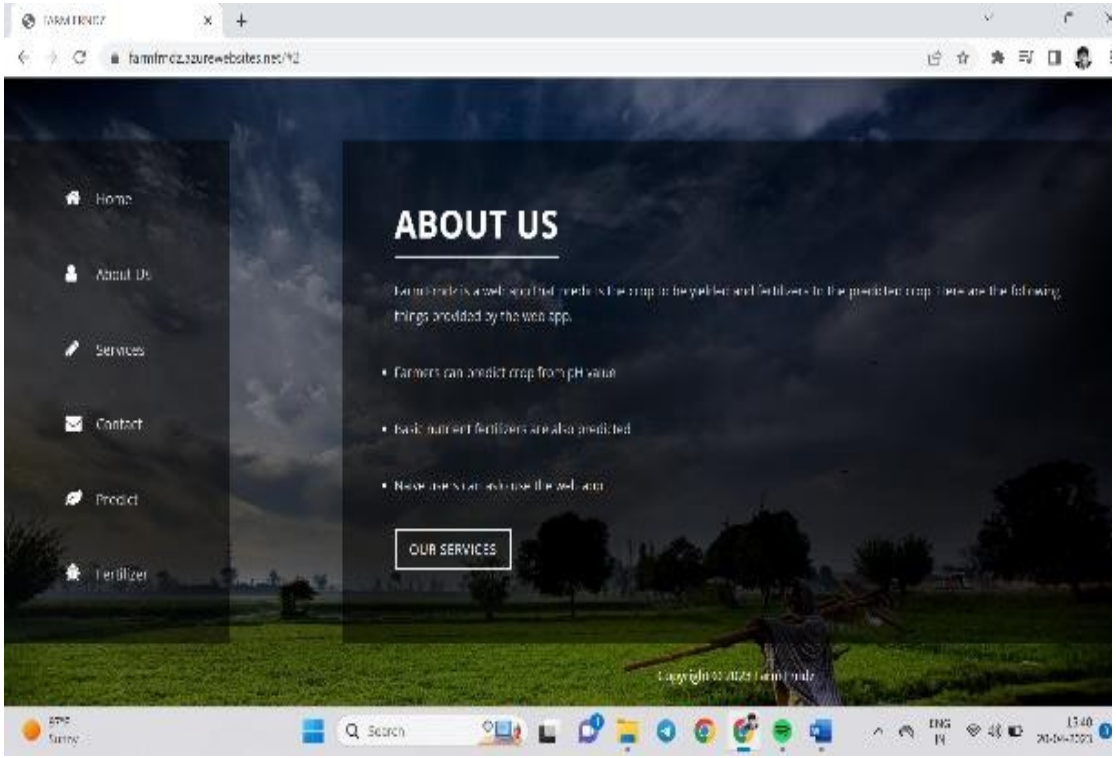
The definition of distilled water is water that has been cooked into a vapor and then condensed back into liquid in a different container. Water contaminants from the original container still exist since they do not boil at or below the water's boiling point. As a result, distilled water is one kind of refined water.

IV. RESULTS

Firstly, the farmer must perform the manual test using litmus paper and distilled water. Upload the image of the litmus paper in the web application. After the image is uploaded, the linear regression takes place to predict the pH value using the color of the litmus paper. After the pH values is determined, it predicts the crops for the ob- tained pH value using Keans clustering algorithm.

Secondly, it also predicts the cost and amount of basic nutrient fer- tilizers to be used for the land. To predict the NPK values, it uses Gradient boosting algorithm. The user interface figures are shown below:

Figure 5: Interface Design



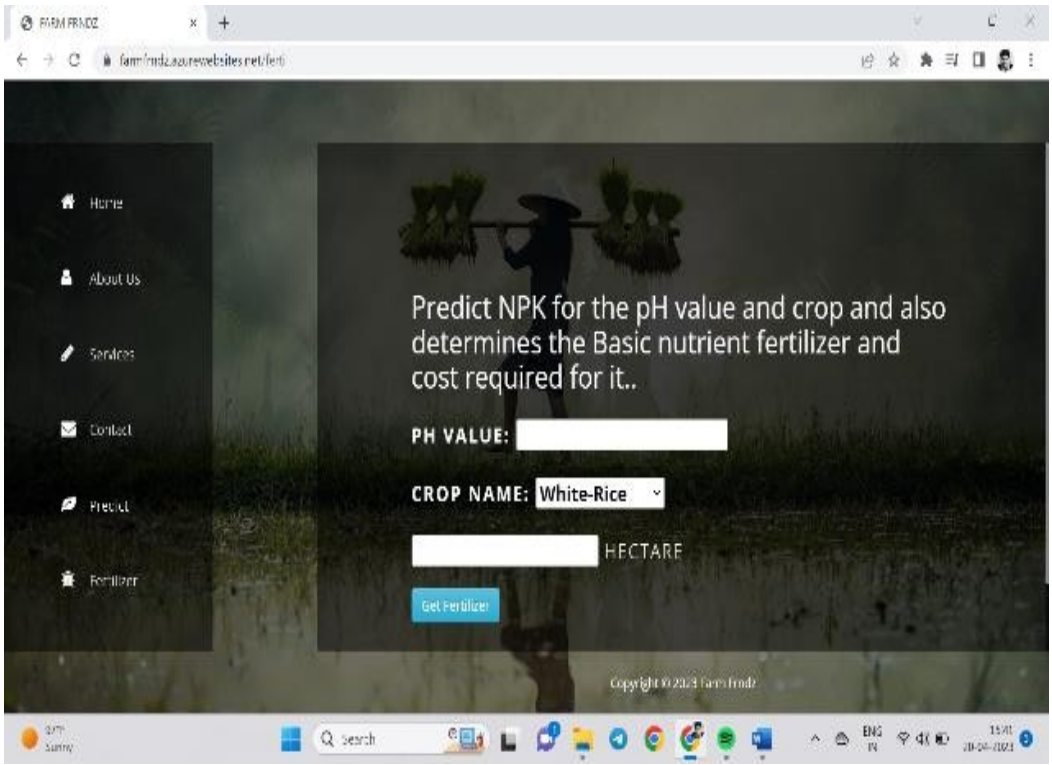


Figure 6: Interface Design Showing About Us

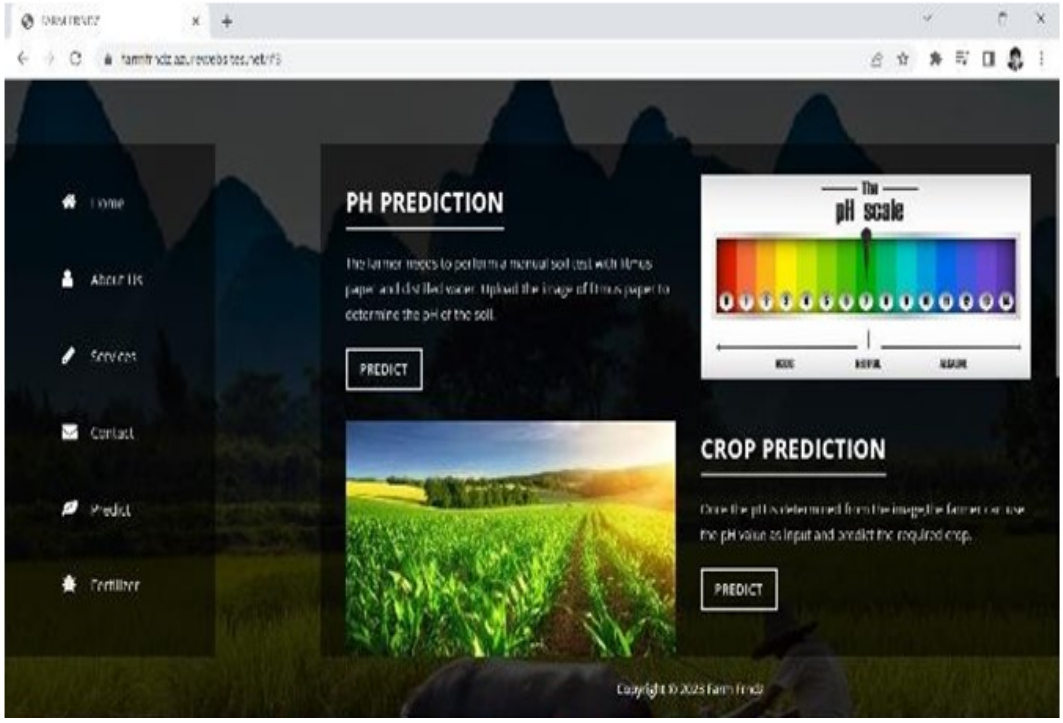


Figure 7: Interface Design Showing PH Prediction

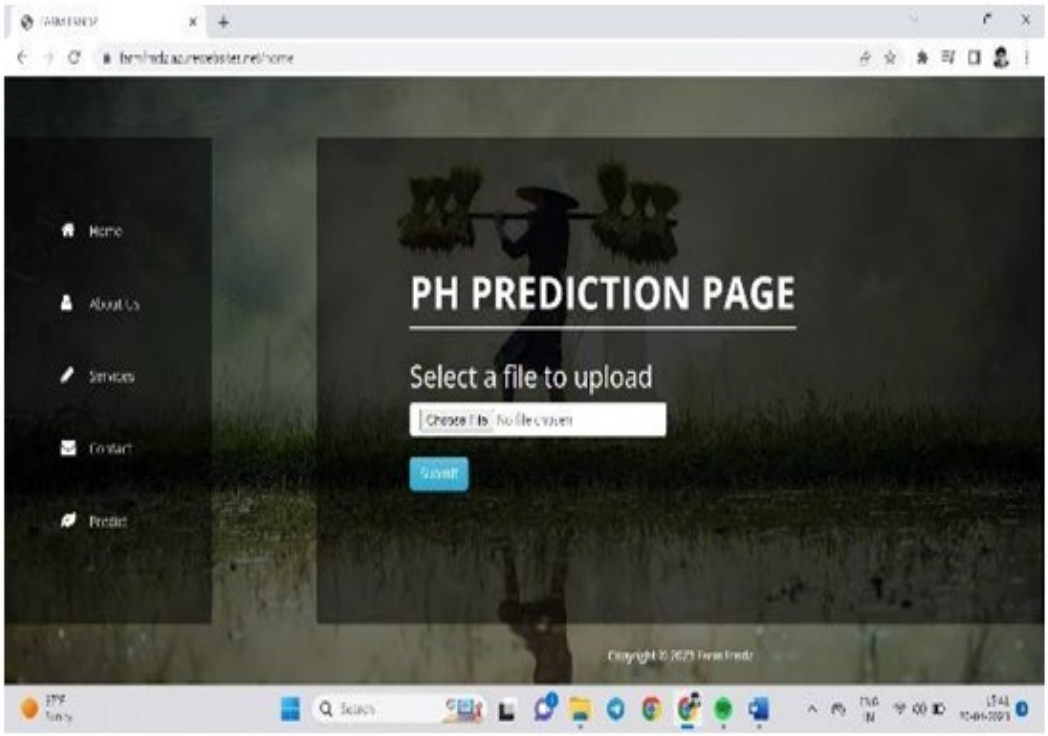


Figure 8: Interface Design Showing PH Prediction Page

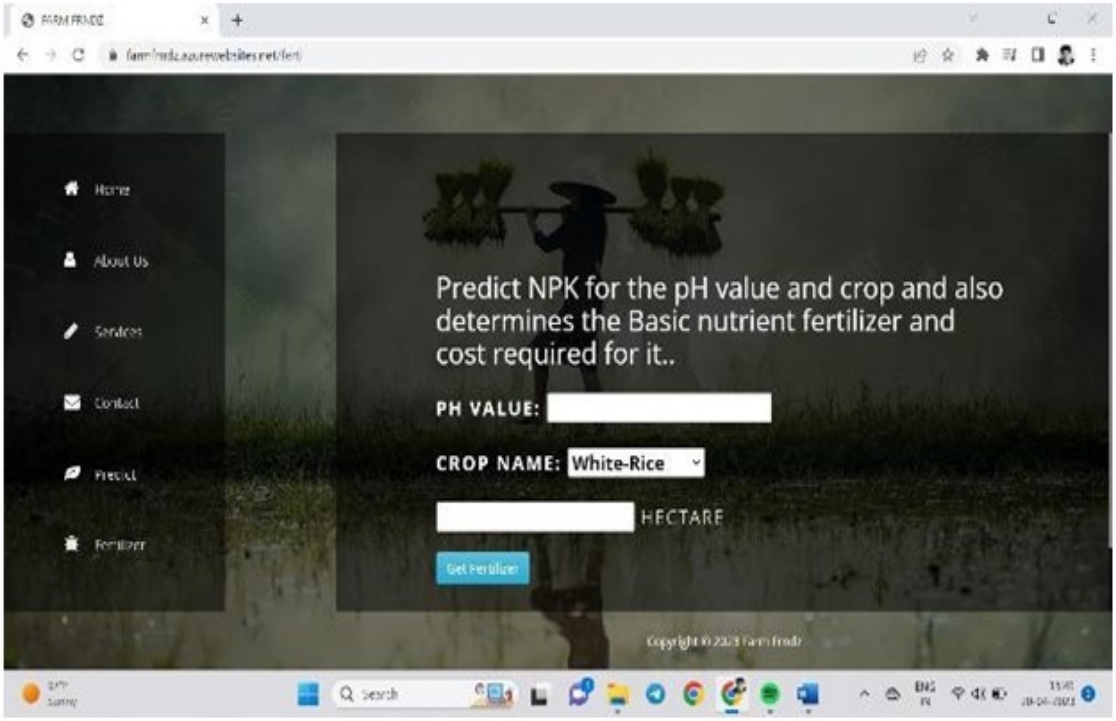


Figure 9: Interface Design showing PH prediction

V. CONCLUSION

In the strategy we propose, we employ a soil testing technique that uses Litmus paper to ascertain the pH of the soil. Then, based on pH, we forecast a list of appropriate crops and fertilisers. By substi- tuting our model, which produces results in real time, for the manual soil testing process, we will be able to overcome its shortcomings. The suggested approach is quite effective.

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