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Small Holders Farming Predictive Analysis Using Peer-To-Peer Approach

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Abstract: ***Farmers cultivating crops without permission from agriculture centres and farmers might choose some crops to Grow without complete knowledge of climatic and soil conditions, resulting in crop failures and further losses due to low rates set by middlemen for selling the yield, leading to an increase in farmer suicides and a data scalability problem (i.e., every time details are updated). To address the aforementioned issues, the major focus is on establishing a suggested system that would provide farmers with crop recommendations and yield predictions based on soil and meteorological parameters such as pH, N, P, and K levels; temperature; rainfall; and humidity. With these circumstances, farmers can determine which crops are the most suited as well as profitable and how much yield can be created. Farmers may also sell their agricultural harvest directly to purchasers without the need for a third party. We may make the farmer register to start the crop, obtain acknowledgement from village centres, and then, after farming, re-enter the crop specifics and amount of crop grade to accomplish data scalability. The transaction has now been accomplished, from receiving the crop at this address to sending the harvest to a certain warehouse. In this, we can use supervised machine learning approaches like classification and regression to help farmers decide the best crop to grow to avoid crop failures due to climate change, as well as to eliminate the need for a third party to sell to buyers, resulting in direct profits to farmers and lowering farmer suicide rates.***

Keywords: Predictive Analysis, Machine Learning, Peer-To-Peer, Smallholder Farmers.

1. INTRODUCTION

Agriculture is critical to a country's economy and GDP. It is the principal source of income for around 58 percent of India's population. The vast majority of them are smallholder farmers. Tiny Holder Farmers farm a small plot of land and a limited number of crop kinds. A large

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proportion of these farmers adhere to ancient and traditional agricultural techniques, such as manual crop prediction, which may result in crop failure.

Farmers generally choose a crop and continue to so the same crop every time. Overall agricultural production may decrease year after year due to changing climatic and soil conditions. Many farmers are dealing with crop failures and lower yield rates as a result of unpredicted weather circumstances. Furthermore, soil parameters such as pH, N, P, and K levels are continually changing owing to activities that occur on the land. They also rely on brokers/middlemen to sell their yield. These brokers frequently acquire additional output from farmers at low rates and then sell it at high rates to the actual customers. Farmers suffer significant losses as a result, and suicide rates have risen. This necessitates the development of a trusted small-holder agricultural system that suggests crops and predicts yields bridges between farmers and buyers with the assistance of a government or private authority.

It is critical in agriculture to build an accurate system since inaccurate forecasts may result in huge losses and crop failures. Supervised learning algorithms that can perform classification can be useful for making crop selection decisions. Crops may be chosen by taking into account factors such as soil type, temperature, humidity, rainfall, and season. Crop recommendation makes use of a variety of coding methods.

Crop recommendation utilising multiple categorization approaches and crop yield prediction using regression based on numerous aspects such as soil, climatic, and geographic attributes are also provided by the proposed system. These machine learning algorithms produce precise findings, allowing farmers to pick which crop to select for the fourth crop cycle while the government estimates overall production per area. Farmers that use this approach will be able to significantly reduce crop failures while also profiting from peer-to-peer connections with purchasers.

Literature Survey

Many algorithms for crop selection and crop yield prediction models have been suggested. Nishant, Potnuru, Saiet.al (2020) [1] used Kernel Ridge, Lasso and ENetalgorithmforcropyieldprediction. They used criteria such as state, district, season, and area to forecast the crop. We utilised the most accurate algorithm based on the same parameters.

Bang, S. et al. (2019) [2] employed fuzzy logic classification to forecast crop production to distinct classifications such as "excellent yield" and "very good yield" using statistical time series models. They use characteristics like rainfall and temperature to forecast the

Sujatha, R., and P. Isakki (2016) [3] used classification techniques such as ANN, Random Forest, j48, NaveBayes, and Support Vector Machines. In their modeling, they incorporate crop name, land area, soil type, soil pH, insect data, weather, water level, and seed type.

Shastry, A. et al. (2015) [4] employed Fuzzy logic, the Adaptive Neuro Fuzzy Inference System, and Multiple Linear Regression models to estimate wheat yield. As input factors, they evaluated biomass, extractable soil water (esw), radiation, and rain.

Using climate characteristics such as rainfall, maximum and minimum temperatures, potential evapotranspiration, cloud cover, and wetday frequency, Veenadhari et al. (2014) [5] projected agricultural yield range.

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Kumar, Avinashet, et al. (2019) [6] employed the SVM classification algorithm, Decision Tree algorithm, and Logistic Regression algorithm for crop recommendation and discovered that the SVM classification model provides better accuracy than the other techniques.
Verma, A. et al. (2015) [7] employed classification approaches such as Nave Bayes and the K-NN algorithm to propose crops for a soil type that contains nutrients such as zinc, copper, manganese, pH, iron, sulfur, phosphorous, potassium, nitrogen, and organic carbon.
Y. Jeevan Nagendra et al. (2020) [8] employed soil condition and yield prediction using a random forest classifier.
Manjula, A. et al. (2015) [9] utilised metrics such as Temperature Condition Index (TCI), Vegetation Condition Index (VCI), and Normalised Difference Vegetation Index (NDVI) to propose a unique framework called the Extendable Crop Yield Prediction Framework (XCYPF) that is both adaptable and extensible.
It allows for crop selection, dependent and independent factors, and datasets for agricultural production prediction in the direction of precision agriculture. The available indices are combined with rainfall data and surface temperature to forecast crop yields for rice and sugarcane crops.
Gandge, y(2017) [10] usedvariousmachinelearningalgorithmslike K-means, NeuralNetworks, SupportvectorRegression, Decisiontree, Bee-HiveClustering, etc., considering factors like soilnutrientssuchas N, K, Pandsoilph. Pranay Malik et al. (2021) [11] employed a variety of machine learning methods such as KNearestNeighbor, NaveBayes, and Decision Tree classifiers. They took into account variables such as temperature, humidity, pH, rainfall, and crop type.
ElavarasanDhivya and others (2020) [12] forecasted agricultural yield using the Deep Recurrent Q-Network model, which is an RNN deeplearning algorithm over the Q-Learning reinforcement learning method.
Shreya V. Bhosale and colleagues (2019) [13]Crop data and details enter the era of big data, and crop production is projected using big data and various machine learning techniques.

Problem Statement

Farmers cannot simply and properly select the appropriate crop depending on climatic and soil conditions. Furthermore, crop production cannot be easily calculated prior to crop harvest, so farmers cannot estimate their investment. Crop failure is caused by incorrect crop choices and unexpected weather conditions. Farmers sell their crop to brokers, who buy it at a cheap rate and sell it to clients at a premium rate, allowing them to profit. Profit is not reaching the farmers in this manner. All of this contributes to an increase in farmer suicide rates. Crop registration necessitates the use of an end-to-end system. Crop advice, crop production projections, and an interface allowing farmers to sell their crops directly to the government. For crop recommendation and agricultural yield prediction, accurate machine learning models must be deployed. The removal of third-party harvest sellers is essential. For providing real-time traffic, high throughput and short reaction times are essential.

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2. METHODOLOGY

The system takes data consisting of several details like the soil characteristics and weather conditions from a webpage form and this data is used to determine the best crop type and predict yield.

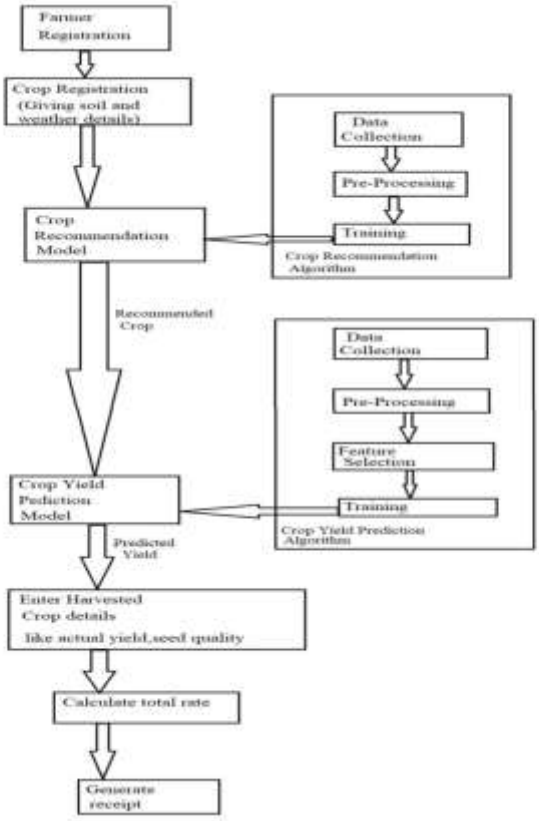

Figure: Workflow

A) Steps:

Farmer Registration: Farmers visit neigh bouring government locations to register for the portal. Farmer details like name, district, state, Aadhar Number, and bank account number are used for registration.

Crop Registration: Before receiving crop suggestions and estimated yield, the farmer's land information such as pH, N, P, and K values; total area; and meteorological parameters such as temperature, humidity, rainfall, and crop cycle season are provided for crop registration.

Crop Recommendation: Soil and climatic details like soil pH, N, P, K, temperature, humidity, rain fall from crop registration data are used as input for crop recommendation algorithm. Preprocessing: Input data is preprocessed to fit he input format of the crop recommendation algorithm. This information is then forwarded to a crop recommendation system based on gradient boosting, which is used to categories certain suggested crop types.

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B) Gradient Boosting:

Gradient Boosting is an iterative gradient algorithm. It is an ensemble strategy that employs weak predictors such as decision trees. It works by merging weak predictors into a strong model and improves model performance repeatedly. Gradient Boosting has three major components: a loss function, a weak learner, and an additive model. Loss function issued to know how accurately the model is performing. Weak learner is a model that classifier switch high error rate. Eg: Decision Trees. Additive modeling is an iterative approach for adding weak learners. It uses log loss as the cost function elog (odds)/(1+elog (odds)) In every state, are sidualis calculated using the below formula: Residual=Observed-Predicted. The series dual are used to get then extreme.

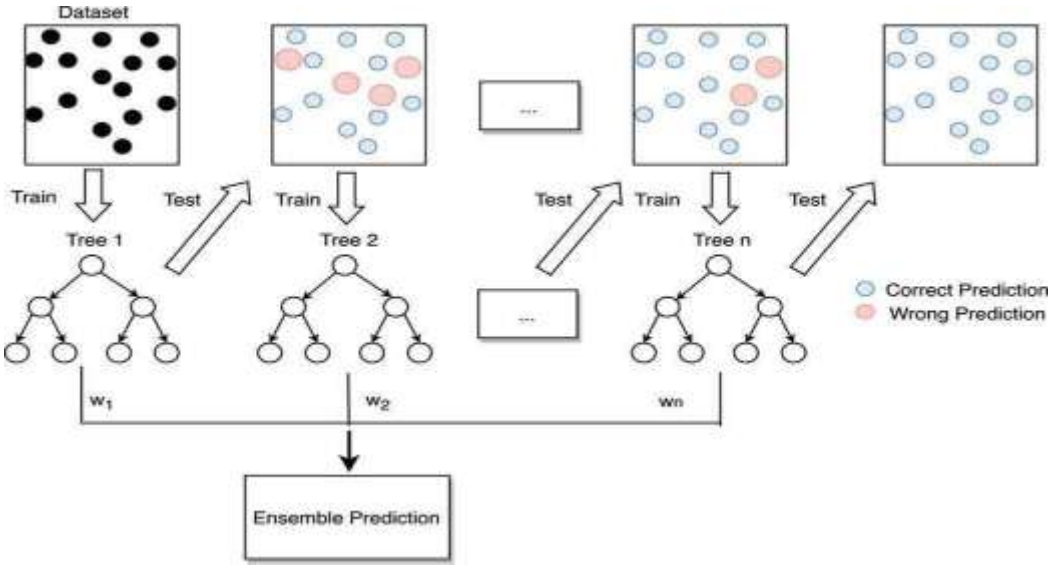

Figure: Gradient Boosting

C) Crop Yield Prediction:

Crop yield prediction system uses the crop recommendation stage's recommended crop name, as well as crop registration stage's geographical characteristics such as region, district, and season.

Preprocessing:

Input data is preprocessed to fit the input format of the crop yield prediction algorithm. This data is then passed to Random Forest Regression based crop yield prediction system (a supervised, ensemble algorithm for regression and prediction), which issued to predict yield of crop.

Random Forest Regression: A Random Forest is an ensemble technique which uses multiple decision trees and bagging. It is a supervised algorithm which can be used for both classification and regression. Random Forest Regressor is used for regression.

Bagging/Bootstrap

Aggregation is a method of randomly sampling a dataset and averaging its results.
Number of decision trees required can be set using then estimate or sparameter.

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Loss function like MSE can be selected using the criteria on parameter. It fit s a number of classifying decision tree son various sub-samples of the dataset.
Averaging all of the outputs enhances prediction accuracy and control over fit.

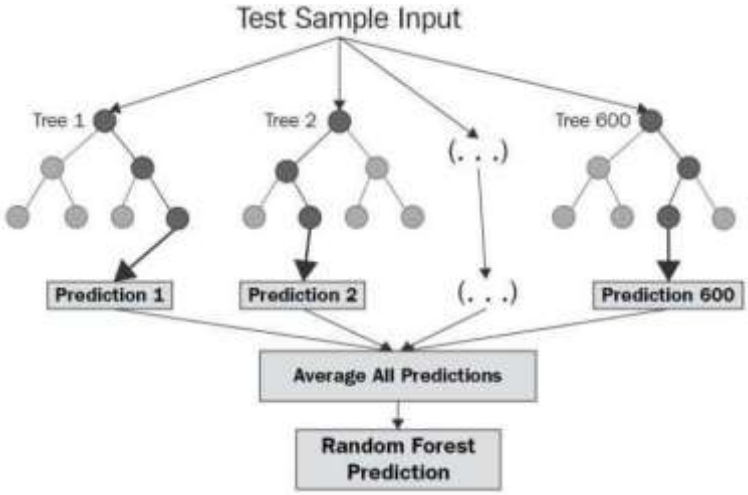

Figure: Random Forest Regressor

Get Harvest Details: After examining the proposed crop name and expected yield, the farmer intends to sow, cultivate, and harvest accordingly. Seed quality is evaluated, and yield is calculated. CalculatetotalRate: Rate is fixed based on crop name and seed quality. Totalproduction and amount is calculated using the below formula:
Totalproduction = totalarea * actualyieldperarea
Totalamount=Totalproduction*rate
GenerateReceipt:
areceiptisgeneratedwithallthesedetailsandharvestissenttogodownsaftertransaction.
Comparative Analysis
CropRecommendationSystem: To determine the best classifier for the proposed crop, classification algorithms such as Nave Bayes, Decision Tree, Random Forest, KNN, and GradientBoosting are utilised. GradientBoosting had the highest accuracy of 98 percent, followed by Random Forest (98%), KNN (97.45%), NaveBayes (97.09%), and DecisionTree (98%) (96.73%).

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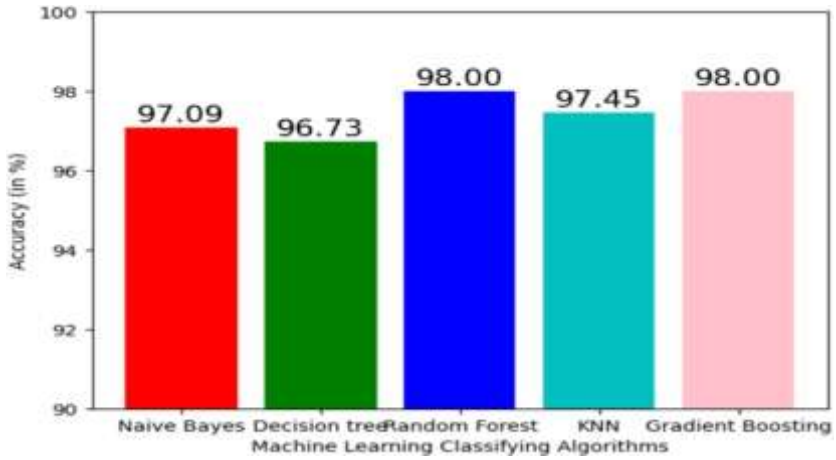

Figure: Machine Learning Classifying Algorithms

To discover the optimum model for predicting crop yield, regression algorithms such as Decision Trees and Random Forest Regressors are employed. Following DecisionTree, the Random Forest Regressor had a higher accuracy of 83.17 percent (70.14 percent).

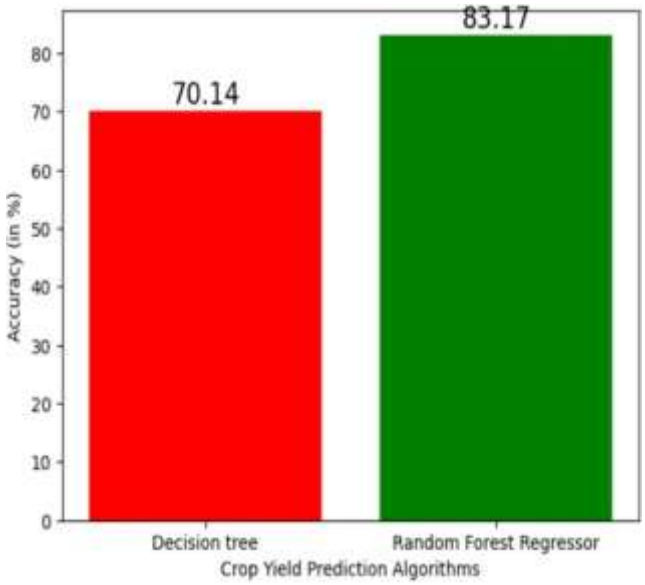

Figure: Crop Yield Prediction Algorithms

Implementation

Data: Data is collected from GitHub. It consists of crop details like crop name, season, area, N,P,K, temperature, humidity, pH,rainfall,production,district,state. The dataset consists of 22 unique crop names. Tools, Used: Jupiter Notebook (for machine learning model), Stream lit(forwebdesign), mySQL Work Bench(for database) Database connection: Using mysql. Connector, a database connection is established from stream lit to MySQL Work Bench.

Modules: There are 5 modules in this system.

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Farmer Registration: On clicking the Register Farmer button, farmer details such as farmer name, city, state, aadhar no, and bank account no are collected and put to the farmers table.
Crop Registration: Details such as farmer name, season, area, N, P, K, temperature, humidity, pH, and rainfall are gathered.
Crop Recommendation: Crop Recommendation module has 2 sub modules for web interface and crop recommendation model
Web Interface:
Details such as farmer name and crop registration id are chosen to load related N,P,K, temperature, humidity, pH, rainfall data. On clicking Recommend Crop, Crop Recommendation model is called.
Crop Recommendation model:
Data preprocessing is done to remove NaN values. Required features are selected for crop recommendation like crop name,N,P,K, temperature, humidity, pH, rainfall. Crop name is encoded using pd.get dummies(). Data is split in to train and test data using train test split(). Gradient Boosting Classifier is called using Gradient Boosting Classifier (). This classifier is used for building the modela long with Multi Output Classifier () for getting encoded output. Train data is fed to the model for training using model. fit(x train,y train). Crop is predicted using model. predict(x test). Accuracy is measured using accuracy score(). Crop name is sent back to the Web Interface was predicted.
Crop Yield Prediction:
Crop Yield Prediction module has 2 sub modules for web interface and crop yield prediction model.
Web Interface:
Details like farmer name and crop registration id are selected to load corresponding recommended crop name, area, season, district. On clicking the predict crop yield button, Crop yield prediction model is called.
Crop Yield Projection Model:
Data preprocessing is done to remove NaN values. Required features are selected for crop yield prediction like crop name, district, season, area. Crop name, district, season are encoded using pd. get dummies(). Data is split in to train and test data using train test split(). Random Forest Regressor is called using Random Forest Regressor() Train data is fed to the model for training using model. Fit (x train,y train). Yield is predicted using model. Predict (x test). Accuracy is measured using accuracy score(). The predicted yield is returned to the WebInterface.
Harvest Details and Rate:
After Harvest and seed quality testing, details like actual yield and seed quality are given
Crop Rate is set based on crop name and seed quality. Total Rate, Amount are displayed.

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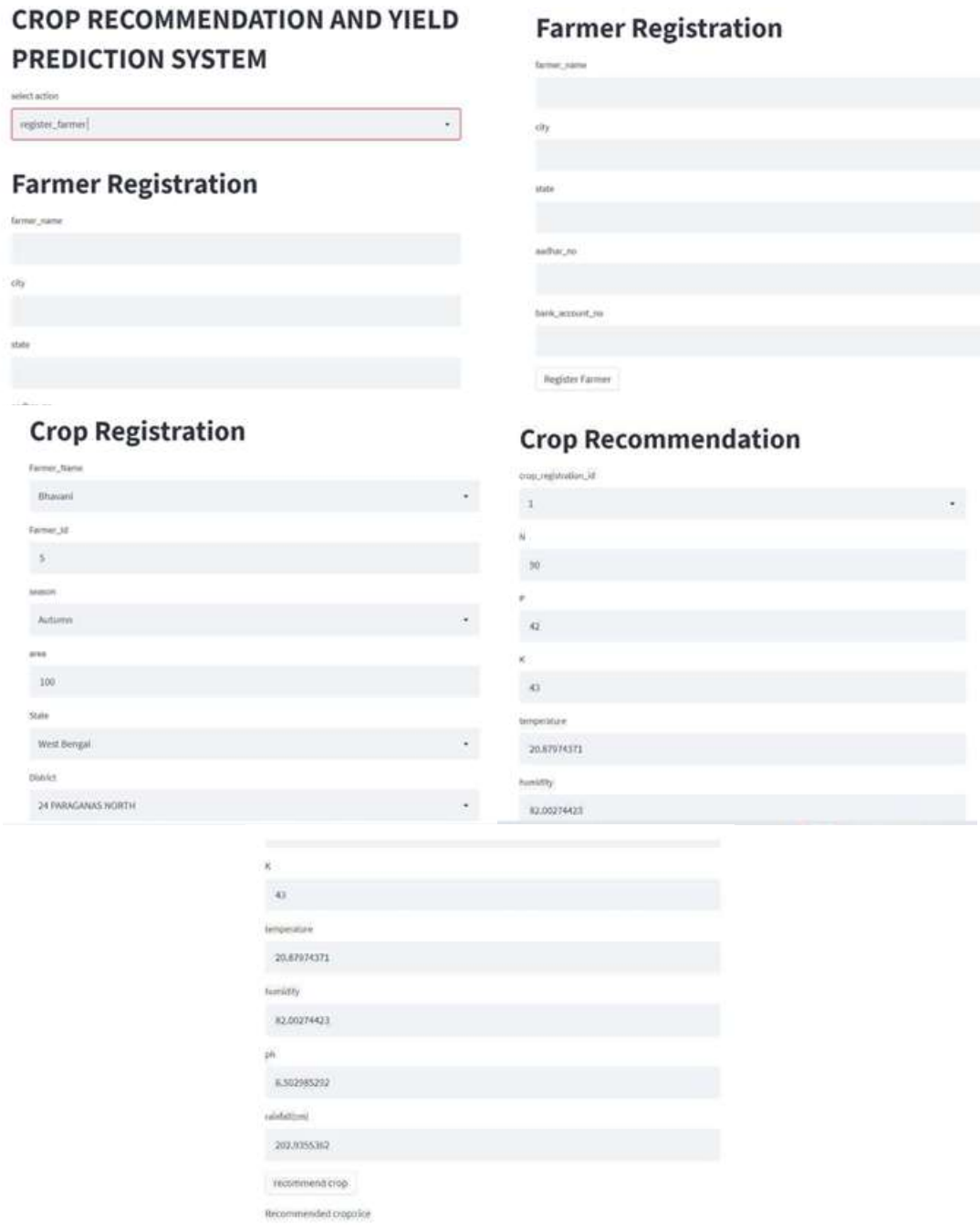

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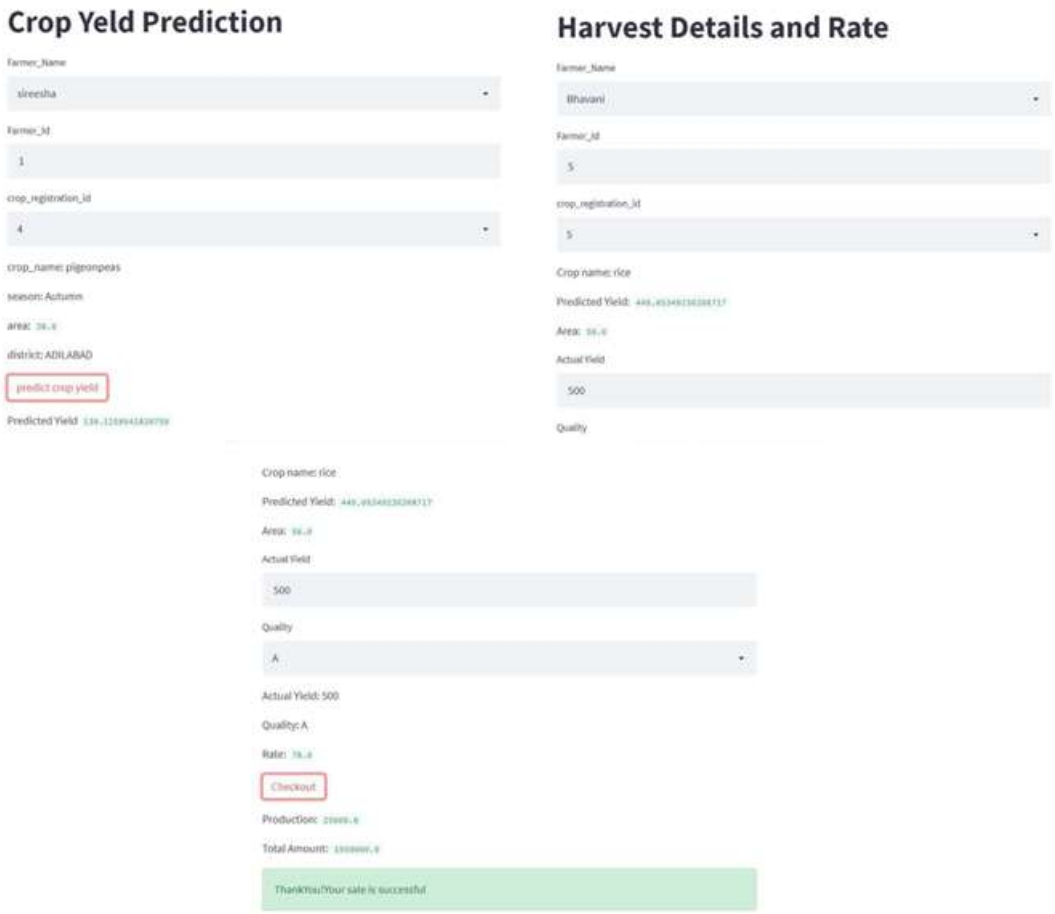

3. CONCLUSIONS

The suggested approach assists farmers with improved crop estimation by proposing which crop to harvest depending on seasons, meteorological conditions, and crop demand at that time. Because there is a high demand for certain crops during certain seasons, this is based on farmer information such as state and district, as soils differ in different places and some soils are exceptionally well suited to the growth of certain crops while others are not. The system advises which crop to harvest based on this data, and based on this data and the farmer's region, the system also estimates their yield. Knowing these facts allows the farmer to harvest the crop according to the rules and obtain a decent yield and profit.

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