A MACHINE LEARNING METHOD FOR CROP RECOMMENDATION

RAHAMTULLAH MOHAMMAD
PG Scholar, Student Miracle Educational Society Group of Institutions, Vizianagaram, Andhra Pradesh, India.

Ch. KODANDARAMU
Associate Professor, Miracle Educational Society Group of Institutions, Vizianagaram, Andhra Pradesh, India.

A.ACHYUTA RAO
Associate Professor, Miracle Educational Society Group of Institutions, Vizianagaram, Andhra Pradesh, India.

ABSTRACT

In rural India, the majority of people make a living in agriculture or a related industry. The agricultural industry has a major economic impact on the country's GDP (GDP). The nation is fortunate to have a sizable agriculture industry. In contrast to worldwide norms, the agricultural output per acre is disappointing. Because of this, the suicide rate among poor farmers in India may be greater than it otherwise would be. In order to help farmers plan ahead, this research suggests a practical and straightforward method of yield prediction. The suggested technology allows farmers to stay connected using a smartphone app. With the use of GPS, it is possible to track down precisely where the user is. Extent and soil type are user-supplied variables.

Pick the most beneficial harvest list or foresee the yield of a client chose crop with the assistance of AI calculations. Support Vector Machine (SVM), Artificial Neural Network (ANN), Random Forest (RF), Multivariate Linear Regression (MLR), and K-Nearest Neighbor (KNN) are some of the Machine Learning methods used to make predictions about crop productivity. The Random Forest method outperformed the others with 95% accuracy. Moreover, the algorithm recommends when to apply fertilisers for maximum yield.

1. INTRODUCTION

India has a long tradition of farming. India has just moved up to second place in global agriculture production [15]. The agribusiness business, which incorporates subordinate enterprises like ranger service and fisheries, contributed 16.6 percent to Gross domestic product in 2009 and utilized about portion of the absolute labor force. Agriculture's formerly dominant position in

India's gross domestic product is now in steady decline. [1]. The economic value of agriculture is heavily dependent on the success of the harvest. The success of a harvest is affected by a wide range of variables [6]. Farmers have a hard time deciding when and what crops to produce because to the instability of the market [7]. According to Wikipedia, the suicide rate in India has averaged 1.48 per 100,000 people during the last decade [15]. The unpredictability of weather prevents farmers from knowing which crops will thrive in their area and when to begin planting. Seasonal shifts in weather and the availability of resources like soil, water, and air further complicate decisions on which fertilisers to use. The rate of agricultural output is falling continuously in this scenario [2]. The problem can be solved by giving farmers access to a smart, easy-to-use recommender system.

Endeavoring to precisely gauge crop yield is a critical trouble for the farming area [3]. Each rancher wants to find out whether their collect will meet or surpass their expectations. [4]. This curiosity may be satisfied by looking at the farmer's historical performance with the crop in question and extrapolating the yield [3]. Weather, pests, and harvesting preparation are the three most important factors influencing agricultural output. For effective agricultural risk management, accurate crop history data is essential [5].

This study proposes a model to solve these problems. The suggested system's innovation lies in its ability to advise farmers on how to get the most possible yield from their crops, as well as which crops would be the most financially beneficial to grow in a given area. Crops may be chosen according to economic and environmental factors in the suggested approach, which has the added bonus of raising yields to assist the country's food supply keep up with rising demand [8]. The suggested approach analyses variables including precipitation, temperature, land size, growing season, soil type, and more to estimate crop output. The device also aids in selecting optimal fertiliser application times. Current methods of estimating agricultural production rely on costly and difficult-to-obtain gear that is only reliable in the short term. According to the suggested technique, a mobile-based software can accurately forecast which crop would provide the most return. The user's position may be determined with the use of GPS. The inputs from the user are the cultivated area and soil

type. In response to a need, the model estimates potential harvest yield for a certain crop. To maximise profits, the programme also indicates when to apply fertiliser.

We highlight the paper's most important contributions below.

1. Using several Machine Learning algorithms to make region-specific crop production predictions and then comparing their accuracy and error rates.
2. it's a smartphone app that's easy to use and figures out which crop will make the most money and then suggests that one.
3. A GPS-based coordinate that may be used to find out when and how much rain is expected to fall where you are.
4. A recommender system that can advise when to apply fertilisers. The rest of the paper will be coordinated thusly. In this way, in Segment II, we discuss the pioneering research that opened the way for our present-day capability to forecast agricultural output. Our suggestions regarding where to plant, as well as an introduction to the yield prediction methodology we propose, may be found in Section III. Best times to apply fertilisers are also recommended by the model. Segment IV examines the outcomes, and Area V closes the piece.

2. LITERATURE STUDY

[1] Umamaheswari S, Sreeram S, Kritika N, Prasanth DJ, "BIoT: Blockchain-based IoT for Agriculture", 11th International Conference on Advanced Computing (ICoAC), 2019 Dec 18 (pp. 324-327). IEEE.

Blockchain technology has the potential to revolutionise several industries, including agriculture, by addressing issues including Agri-product fraud, traceability, pricing manipulation, and a general lack of consumer confidence in the product. By reviewing previous research and looking at how blockchain-based startups have dealt with similar problems, this article hopes to show how the technology may be used in the agricultural sector. To encourage a future that is safer, better, more sustainable, and more reliable in the agri-foods system, blockchain technology offers promise. Despite the fact that the deployment of blockchain in agriculture is still in its infancy and confronts challenges such as the aforementioned, it has the potential to revolutionise the agricultural business.

[2] Jain A. "Analysis of growth and instability in the area, production, yield, and price of rice in India", Journal of Social Change and Development,

2018;2:46-66

Most of India's GDP comes from agriculture and associated businesses. Gross domestic product also benefits greatly from the agriculture sector (GDP). It's a boon for the country that there are still large swaths of wilderness to explore. No of the reason, the reap yield per hectare is exceptionally low contrasted with global principles. There may be a correlation between this and the high suicide incidence among ranchers on India's rural fringe. The results of this study may help ranchers set realistic and understandable goals for production. The proposed framework is a versatile application that connects ranchers together. Global Positioning System technology is used to pinpoint the precise position of the client. The customer supplies the location and soil type. With the use of AI algorithms, customers may choose the best crop to harvest or have their crop's harvest yield predicted. Support Vector Machines, Artificial Neural Networks, Random Forests, Multivariate Linear Regressions, and K-Nearest Neighbors are just few of the Machine Learning algorithms that may be used to forecast agricultural outputs. When compared to the other methods, Random Forest had the highest accuracy (95%). Additionally, the framework recommends when composts should be used to maximise their effect on output.

[3] Manjula E, Djodiltachoumy S, "A model for prediction of crop yield" International Journal of Computational Intelligence and Informatics, 2017 Mar;6(4):2349-6363.

The use of data mining techniques to analyse agricultural yields is a relatively new area of study. Predicting agricultural yields is a critical topic. Any farmer worth his salt wants to know what kind of harvest he may anticipate. On the past, output forecasts included in farmers' familiarity with a certain field and crop. Predicting yields with the information we have now is still a major undertaking. Instead, you should use data mining methods for this job. For the purpose of forecasting the next year's harvest, farmers utilise and compare a variety of Data Mining methods. This study suggests and executes a methodology for extrapolating future crop yields using historical records. In order to do this, we use association rule mining on agricultural databases. Future agricultural yields are the focus of this investigation, which aims to construct a model for doing so. For the chosen location, a district in Tamil Nadu, India, this study provides a short

investigation of agricultural production prediction utilising data mining approach based on association rules. The empirical evidence supports the accuracy of the suggested study in predicting future crop yields.

[4] Sagar BM, Cauvery NK., "Agriculture Data Analytics in Crop Yield Estimation: A Critical Review", Indonesian Journal of Electrical Engineering and Computer Science, 2018 Dec;12(3):1087-93.

Agriculture is crucial to human life because it satisfies a necessary but fundamental requirement. It's common knowledge that almost half of India's population works in agriculture. Limitations to expanding India's agricultural output come as a result of the country's very variable climate. Achieving yield goals in agricultural production has become a difficult challenge. The yield and productivity of the crops depend on a number of variables. Estimating future crop yields is a crucial part of farming. Before planting seeds, farmers need data on expected crop yields to make informed decisions. Data analytics is one example of a technological development that has spread into the agricultural sector in recent years. The biggest obstacle to integrating big data in farming is figuring out which big data analytic techniques really work. Research is being conducted to learn how big data analytics might boost agricultural output. This research not only fills in the gaps on the different data analytics approaches now being used for agricultural yield prediction, but also highlights the most pressing areas where further investigation is needed.

[5] Wolfert S, Ge L, Verdouw C, Bogaardt MJ, "Big data in smart farming– a review. Agricultural Systems", 2017 May 1;153:69-80.

The increasing global population raises foreboding forecasts that may be linked to a wide range of difficulties. In the case of food production, for instance, a large increase in population might have a negative impact. Due to this, the present UN directives foresee a worldwide need to increase agricultural productivity and expand food production. Such efforts are predicted to provide limitless food for the projected population until the year 2050. (Wolfert et al., 2017). Smart farming is one of the few technologies that will help make these changes possible. It is founded on AI, which has the potential to improve the efficiency of many farming procedures by making it simpler to adopt technological fixes and gather higher-quality harvests. Farmers everywhere now have the

opportunity to incorporate digital technology into their everyday operations and use artificial intelligence to help some of the most critical agricultural tasks thanks to the rise of the smart farming concept and precision agriculture. There has been a significant reduction in the use of hand tools in agriculture, making way for the next industrial revolution that will advance the field and cause a sea change in farmers' attitudes about their work (Wolfert et al., 2017). This study offers an in-depth analysis of previous research on the advantages of "smart farming" and the potential uses of cutting-edge agricultural technology for assisting farmers. Future developments in AI-driven agriculture are outlined, along with the ramifications of adopting a smart farming approach and potential avenues for further study.

[6] Jones JW, Antle JM, Basso B, Boote KJ, Conant RT, Foster I, Godfray HC, Herrero M, Howitt RE, Janssen S, Keating BA, "Toward a new generation of agricultural system data, models, and knowledge products: State of agricultural systems science. Agricultural systems", 2017 Jul 1;155:269-88.

When applied to research, the findings from agricultural systems science provide a framework for analysing and solving difficult agricultural issues and making well-informed policy choices. The lengthy and successful history of this area of research demonstrates its applicability to a broad variety of systems and sizes. For more than 60 years, researchers from a broad variety of fields have collaborated to develop and refine the conceptual frameworks and computational tools necessary for modelling, a necessary instrument for the study of agricultural systems. As agrarian researchers consider the "future" models, information, and information items expected to meet the undeniably mind boggling frameworks issues looked by society, it is essential to think about this past and its illustrations to stay away from re-development and to endeavor to consider all elements of the related difficulties. In this paper, we present a high-level review of the development of agricultural systems modelling and emphasise critical insights that might help shape the future generation of agricultural system tools and methodologies. Several historical events and the overall improvement in technology in other sectors have had significant impacts on the development of agricultural system modelling. These turns of events and events remember the streamlining and displaying of economies for the neighborhood, public, and

global levels, as well as factual models in light of verifiable perceptions of yields and creatures. Different scholars in different domains have been motivated to construct and use models of agricultural systems for a wide range of reasons, each of which has resulted to a distinct set of model features. Recent improvements in public-private sector collaborations and cross-institutional collaboration promise well for the development of innovative models, databases, knowledge products, and decision support systems in the agricultural systems research community. When designing the next generation of agricultural systems models, it's crucial to keep the lessons of the past in mind so that we can avoid making the same errors and falling into the same traps.

[7] Johnson LK, Bloom JD, Dunning RD, Gunter CC, Boyette MD, Creamer NG, "Farmer harvest decisions and vegetable loss in primary production. Agricultural Systems", 2019 Nov 1;176:102672.

This paper's aims are to (1) undertake a thorough literature evaluation of the numerous ways in which imperfect, ugly, or suboptimal food products contribute to food waste; (2) identify existing improvements to these problems; and (3) propose new solutions for achieving more sustainable food production and consumption.

[8] Kumar R, Singh MP, Kumar P, Singh JP, "Crop Selection Method to maximize crop yield rate using a machine learning technique", International conference on smart technologies and management for computing, communication, controls, energy, and materials (ICSTM), 2015 May 6 (pp. 138-145). IEEE.

The prosperity and food safety of an agricultural nation depend heavily on the nation's agricultural policy. The problem of crop selection is crucial in agricultural planning. The production rate, market price, and government policy are all factors. Using statistical approaches and machine learning techniques, several academics have explored the problem of predicting crop output rate, weather, soil, and crop categorization for agricultural planning. Crop selection becomes a conundrum when many crops may be planted at once on a finite plot of land. Crop Choices Method (CSM) is a strategy put out in this research with the aim of optimising crop selection in order to boost national GDP. This strategy has the potential to increase agricultural yields.

3. PROBLEM STATEMENT

The reason for this study is to survey the

effect of weather conditions factors on farming creation in the assigned areas of Madhya Pradesh, one of the primary examinations made a specific site [10]. The districts were chosen according to the area that will be planted with the crop. The five districts with the highest potential agricultural area were selected based on these factors. Crops were chosen for the research based on what was already being grown in the targeted regions. Maize, soybeans, wheat, and paddy were the selected crops, the yields of which were calculated over a 20-year time span. For the specified crops, the constructed model had an accuracy of between 76% and 90%, with an average of 82%. Important work has also been done to analyse soil quality, forecast crop production, and select the best fertilisers to use [11]. This model uses the user's Ph value and location data as inputs. The current location's weather and temperature forecasts were generated using an API. The system uses both supervised and unsupervised ML algorithms and evaluates the differences between the two types of models. In [12], a greedy classifier was presented for estimating future harvests. Results are improved when using an attribute-based decision tree classifier. Typically, better results may be obtained by combining the predictions of many models into a single "ensemble model," which is what has been suggested. Multi-decision tree models are used in the random forests ensemble classification to provide predictions about the crop production. Mean and standard deviation figures are computed after dividing the data into two groups, say, divided between training and test data (67% to 33%). To get the most precise outcomes, our effort also uses clustering of crops with comparable characteristics.

Disadvantages

The data sets from this area are not well represented in any current model, making it impossible to estimate crop production. 2) There is no prior processing or cleaning of the data sets. None of the missing data points are averaged in.

4. PROPOSED SYSTEM

The system has suggested a model that deals with these problems in the proposed system. The suggested system's innovation lies in its ability to advise farmers on how to get the most possible yield from their crops, as well as which crops would be the most financially beneficial to grow in a given area. Crops may be chosen according to

economic and environmental factors in the suggested approach, which has the added bonus of raising yields to assist the country's food supply keep up with rising demand [8]. The suggested approach analyses variables including precipitation, temperature, land size, growing season, soil type, and more to estimate crop output. The device also aids in selecting optimal fertiliser application times. The current framework that suggests crop creation is either equipment based and consequently expensive to run, or it isn't uninhibitedly open. The proposed technique expresses that a versatile based programming can precisely gauge which yield would give the most return. The user's position may be determined with the use of GPS. The inputs from the user are the cultivated area and soil type. In response to a need, the model estimates potential harvest yield for a certain crop. In addition to deciding which crop would provide the most return, the model will also advise when to apply fertiliser.

Advantages

Utilization of a suite of Machine Learning techniques to forecast regional crop yields; an evaluation of their relative accuracy and precision is provided. An accessible smartphone app that advises on the most lucrative harvest. An ID that may be used to pinpoint your precise position using GPS and then receive an accurate forecast of precipitation for that region. The use of a recommender system to provide guidance on when to apply fertilisers would be very useful.

5. IMPLEMENTATION

5.1 Service Provider

The Service Provider must provide a valid user name and password to access this section. If his login is successful, he'll have access to features like "Browse Agriculture Data Sets" and "Train & Test." You may see the results of the trained and tested accuracy in a bar chart, download the predicted data sets, check out the roster of remote users, and find out what your crop yield prediction per acre was.

5.2 Explore Authorized Users

A complete roster of registered users is available to the administrator here. The administrator is granted access to the user's information (username, email, and physical address) and is responsible for authorising the users.

5.3 Remote User

There are exactly n users present in this module. It is required that the user register before any actions may be taken. Upon successful registration, a user's information will be added to our database. If his

registration goes smoothly, he'll be able to access the site after providing his valid user ID and password. After a successful login, the user may do actions such as predicting crop yield and production, generating crop recommendations, and seeing their own profile.

6. ARCHITECTURE

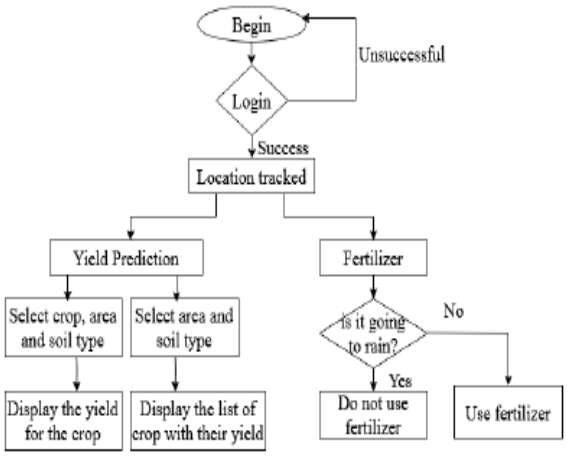


Fig. 2 Flow Chart

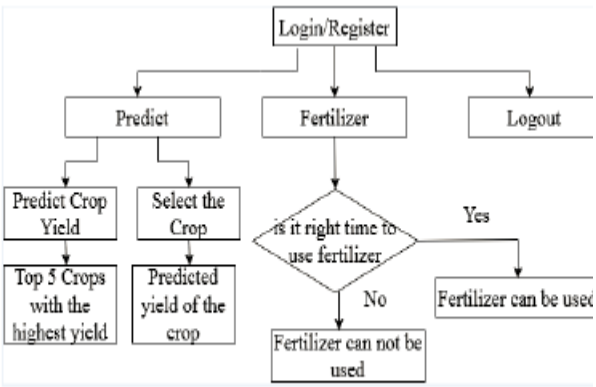
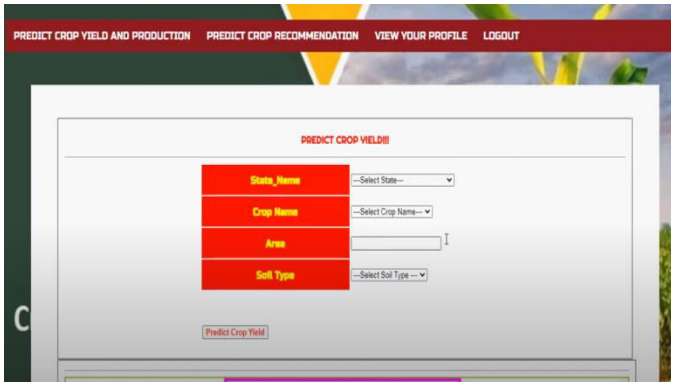


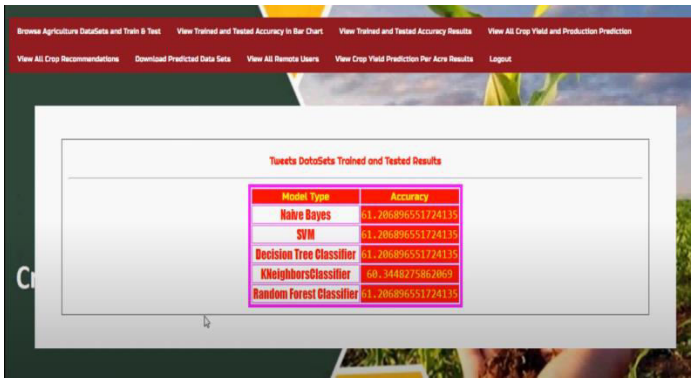
Fig. 1 System Architecture

Figure: 6.1: Architecture

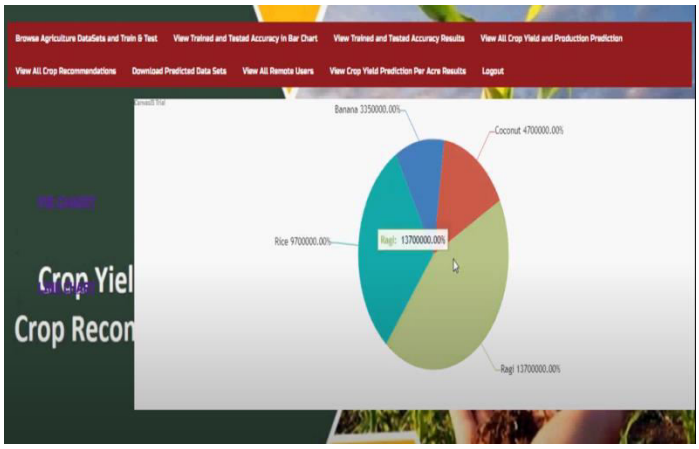
7. SCREENSHOTS

Send this application on DJANGO employee and then thereafter run in programme get in LINK as 'http://localhost:8000/index.html' to obtain beneath screen

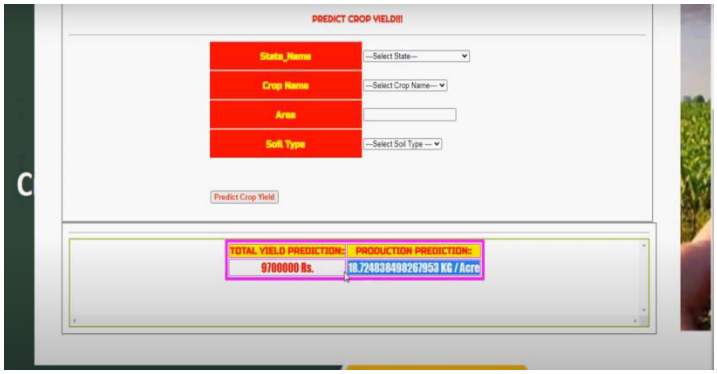


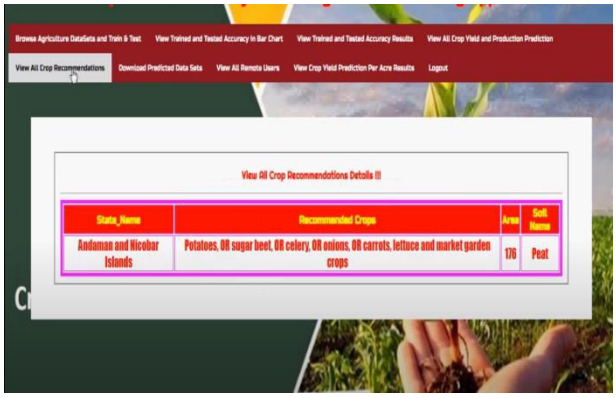


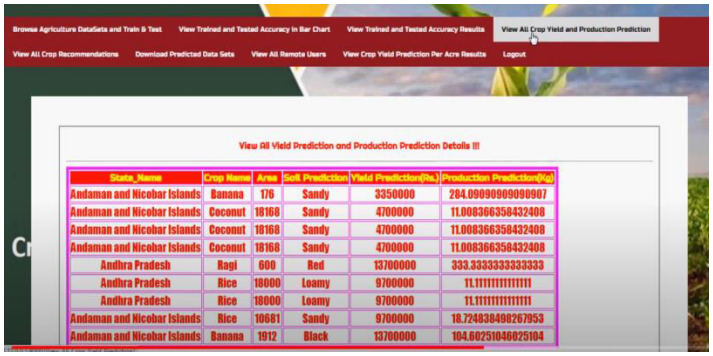

Naive Bayes 61.21%
SVM 61.21%
Decision Tree Classifier 61.21%
Random Forest Classifier: 61.21%
KNeighborsClassifier 60.34%
Naive Bayes
SVM
Decision Tree Classifier
KNeighborsClassifier
Random Forest Classifier


Banana 3350000.00%
Coconut 4700000.00%
Rice 9700000.00%
Ragi: 13700000.00%
Ragi 13700000.00%

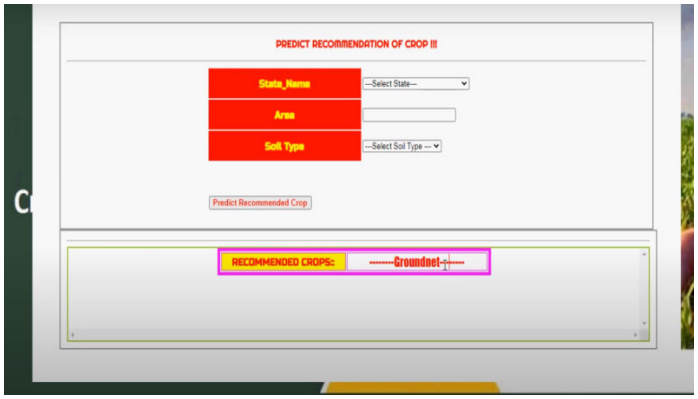

Naive Bayes 61.21%
Random Forest Classifier 61.21%
SVM 61.21%
KNeighborsClassifier: 60.34%
KNeighborsClassifier 60.34%
Decision Tree Classifier 61.21%


PREDICT CROP YIELD!!!
State_Name
Crop Name
Area
Soil Type
Predict Crop Yield
TOTAL YIELD PREDICTION:
9700000 Rs.
PRODUCTION PREDICTION:
18.724838498267953 KG / Acre


View All Crop Recommendations Details !!!
State_Name
Recommended Crops
Area
Soil Name
Andaman and Nicobar Islands
Potatoes, OR sugar beet, OR celery, OR onions, OR carrots, lettuce and market garden crops
176
Peat


View All Yield Prediction and Production Prediction Details !!!
State_Name | Crop Name | Area | Soil Prediction | Yield Prediction(Rs.) | Production Prediction(Kg)
Andaman and Nicobar Islands | Banana | 176 | Sandy | 3350000 | 204.09090909090907
Andaman and Nicobar Islands | Coconut | 18168 | Sandy | 4700000 | 11.008366358432408
Andaman and Nicobar Islands | Coconut | 18168 | Sandy | 4700000 | 11.008366358432408
Andaman and Nicobar Islands | Coconut | 18168 | Sandy | 4700000 | 11.008366358432408
Andhra Pradesh | Ragi | 600 | Red | 13700000 | 333.33333333333333
Andhra Pradesh | Rice | 18000 | Loamy | 9700000 | 11.111111111111111
Andhra Pradesh | Rice | 18000 | Loamy | 9700000 | 11.111111111111111
Andaman and Nicobar Islands | Rice | 10681 | Sandy | 9700000 | 18.724838498267953
Andaman and Nicobar Islands | Banana | 1912 | Black | 13700000 | 104.60251046025104


Ragi 13700000.00%
Rice 9700000.00%
Coconut 4700000.00%
Banana 3350000.00%
Banana
Coconut
Ragi
Rice


PREDICT RECOMMENDATION OF CROP !!!
State_Name
Area
Soil Type
Predict Recommended Crop
RECOMMENDED CROPS:
--------Groundnut--------

8. CONCLUSION

In this research, we looked at the strengths and weaknesses of existing yield prediction methods. A practical yield forecast system is then shown to the farmers, and a system that connects farmers via a mobile app is offered. There are a number of tools available inside the smartphone app that may assist with crop choosing. The integrated harvest prediction system helps farmers plan ahead. The built-in recommender system may help users learn more about the available crop varieties and their yield. Random Forest, ANN, SVM, MLR, and KNN were among the several machine learning algorithms tested on the given Maharashtra and Karnataka datasets to see which produced the highest rate of accuracy. Comparisons are made between the performance of various algorithms. Based on the evaluation of the several conventional methods employed on the provided datasets, the findings obtained highlight Random Forest Regression as the most effective. The suggested model also analysed when to apply fertilisers and made suggestions for how long each application should last.

In the future, we may automate these procedures to save time and effort while still regularly updating the datasets for more precise forecasts. Correctly supplying the sort of fertiliser required for a 1070given crop and location is another feature that has to be accomplished. To put this into action, we need to investigate the available fertilisers and how they interact with the soil and weather. There must be a thorough examination of all relevant statistical data.

9. REFERENCES

[1] Umamaheswari S, Sreeram S, Kritika N, Prasanth DJ, “BIoT: Blockchain-based IoT for Agriculture”, 11th International Conference on Advanced Computing (ICoAC), 2019 Dec 18 (pp. 324-327). IEEE.

[2] Jain A. “Analysis of growth and instability in the area, production, yield, and price of rice in India”, Journal of Social Change and Development, 2018;2:46-66

[3] Manjula E, Djodiltachoumy S, “A model for prediction of crop yield” International Journal of Computational Intelligence and Informatics, 2017 Mar;6(4):2349-6363.

[4] Sagar BM, Cauvery NK., “Agriculture Data Analytics in Crop Yield Estimation: A Critical Review”, Indonesian Journal of Electrical Engineering and Computer Science, 2018 Dec;12(3):1087-93.

[5] Wolfert S, Ge L, Verdouw C, Bogaardt MJ, “Big data in smart farming– a review. Agricultural Systems”, 2017 May 1;153:69-80.

[6] Jones JW, Antle JM, Basso B, Boote KJ, Conant RT, Foster I, Godfray HC, Herrero M, Howitt RE, Janssen S, Keating BA, "Toward a new generation of agricultural system data, models, and knowledge products: State of agricultural systems science. Agricultural systems", 2017 Jul 1;155:269-88.

[7] Johnson LK, Bloom JD, Dunning RD, Gunter CC, Boyette MD, Creamer NG, "Farmer harvest decisions and vegetable loss in primary production. Agricultural Systems", 2019 Nov 1;176:102672.

[8] Kumar R, Singh MP, Kumar P, Singh JP, "Crop Selection Method to maximize crop yield rate using a machine learning technique", International conference on smart technologies and management for computing, communication, controls, energy, and materials (ICSTM), 2015 May 6 (pp. 138-145). IEEE.

[9] Sriram Rakshith.K, Dr.Deepak.G, Rajesh M, Sudharshan K S, Vasanth S, Harish Kumar N, "A Survey on Crop Prediction using Machine Learning Approach", In International Journal for Research in Applied Science & Engineering Technology (IJRASET), April 2019, pp(3231-3234)

[10] Veenadhari S, Misra B, Singh CD, "Machine learning approach for forecasting crop yield based on climatic parameters", In 2014 International Conference on Computer Communication and Informatics, 2014 Jan 3 (pp. 1-5). IEEE.

[11] Ghadge R, Kulkarni J, More P, Nene S, Priya RL, "Prediction of crop yield using machine learning", Int. Res. J. Eng. Technol. (IRJET), 2018 Feb;5.

[12] Priya P, Muthaiah U, Balamurugan M, "Predicting yield of the crop using machine learning algorithm", International Journal of Engineering Sciences & Research Technology, 2018 Apr;7(1):1-7.

[13] S. Pavani, Augusta Sophy Beulet P., "Heuristic Prediction of Crop Yield Using Machine Learning Technique", International Journal of Engineering and Advanced Technology (IJEAT), December 2019, pp (135-138)

[14] https://web.dev/progressive-web-apps/

[15] https://www.wikipedia.org/

[16] Plewis I, "Analyzing Indian farmer suicide rates", Proceedings of the National Academy of Sciences, 2018 Jan 9;115(2): E117.

[17] Nishant, Potnuru Sai, Pinapa Sai Venkat, Bollu Lakshmi Avinash, and B. Jabber. "Crop Yield Prediction based on Indian Agriculture using Machine Learning." In *2020 International Conference for Emerging Technology (INCET)*, pp. 1-4.

IEEE, 2020.

[18] Kale, Shivani S., and Preeti S. Patil. "A Machine Learning Approach to Predict Crop Yield and Success Rate." In 2019 IEEE Pune Section International Conference (PuneCon), pp. 1-5. IEEE, 2019.

[19] Kumar, Y. Jeevan Nagendra, V. Spandana, V. S. Vaishnavi, K. Neha, and V. G. R. R. Devi. "Supervised Machine learning Approach for Crop Yield Prediction in Agriculture Sector." In 2020 5th International Conference on Communication and Electronics Systems (ICCES), pp. 736-741. IEEE, 2020.

[20] Nigam, Aruvansh, Saksham Garg, Archit Agrawal, and Parul Agrawal. "Crop yield prediction using machine learning algorithms." In 2019 Fifth International Conference on Image Information Processing (ICIIP), pp. 125-130. IEEE, 2019.

[21] Bang, Shivam, Rajat Bishnoi, Ankit Singh Chauhan, Akshay Kumar Dixit, and Indu Chawla. "Fuzzy logic based crop yield prediction using temperature and rainfall parameters predicted through ARMA, SARIMA, and ARMAX models." In *2019 Twelfth International Conference on Contemporary Computing (IC3)*, pp. 1-6. IEEE, 2019.