SUSTAINABLE FERTLIZATION

A PROJECT REPORT

Submitted by

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BONAFIDE CERTIFICATE

Certified that this project report titled **"SUSTAINABLE FERTILIZATION"** is the bonafide work of **"YOGITA BHARDWAJ(19BCE10187), NAMAN JAIN(19BCE10185), ROHIT VANWANI(19BCE10127)"** who carried out the project work under my supervision. Certified further that to the best of my knowledge the work reported at this time does not form part of any other project/research work based on which a degree or award was conferred on an earlier occasion on this or any other candidate.

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I would like to thank all the technical and teaching staff of the School of Computer Science & Engineering, who extended directly or indirectly all support.

Last, but not least, I am deeply indebted to my parents who have been the greatest support while I worked day and night for the project to make it a success.

LIST OF ABBREVIATIONS

NPK - Nitrogen Phosphorous Potassium

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ABSTRACT

Fertilizer use is typically under the limited control of farmers. For the farmers to achieve higher yields and reduce fertilizer loss, competent guidance is required for the best use of these fertilizers. Additionally, there is a connection between rainfall volume and nutrient loss for various fertilizer applications after each rainfall event. Rainfall that is moderate and falls at the right moment can help nutrients penetrate the soil's rooting zone and dissolve dry fertilizer. However, too much rain can increase the possibility of runoff and the pace at which nutrients like nitrogen (N) which is quintessential, phosphorus (P), and potassium (K) which are crucial, manganese (Mn), and boron (B) that are present in the soil. This research presents nutrient recommendations using an updated iteration of the random forest algorithm which is based on time-series data to forecast the required quantity of nutrients for various crops by examining rainfall patterns and crop fertility. The method suggested in this study, comes in handy for improving soil fertility by providing nutrients recommendations for optimum conditions for crop growth and reducing leaching and runoff potential.

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INTRODUCTION:

- Unbalanced Progress in rural areas.
- Analysis of farmers problems at the ground level.
- The problem statements are analyzed and determined based on what is in our study area.

LITERATURE REVIEW:

Ref No.	Year	Title	Author's Name	Journal	Description
1.	2018	Prediction of Crop Fertilizer Consumption	Krutika Hampannavar, Vijay Bhajantri Shashikumar G. Totad	IEEE, DOI:10.1109/ICCUB EA.2018.8697827	Prediction of fertilizer consumption can prevent the toxicity and deficiency in plants to certain extent and this can help farmers to get proper yield without much wastage.
2.	2018	Fuzzy decision support system for improving the crop productivity and efficient use of fertilizers	G. Prabakaran,D. Vaithiyanathan, Madhavi Ganesan	Computers and Electronics in Agriculture ,ISSN : 0168-1699 (Elsevier)	This paper explores the process of using fuzzy logic systems to reduce fertilizer consumption and improve crop productivity.
3.	2018	Data Mining Techniques for Crop Yield Prediction	Shital Bhojani Nirav Bhatt	Computers and Electronics in Agriculture, ISSN: 0168-1699 (Elsevier)	It's a difficult task to predict crop yield due to stochastic rain fall pattern and also variation in temperature. So we can apply different data mining techniques for crop yield predication and can produce an efficient algorithm for crop classification for better.

Ref No.	Year	Title	Author's Name	Journal	Description
4.	2019	Estimation of NPK requirements for rice production in diverse Chinese environments under optimal fertilization rates	Yulong Yin, Hao Ying Huifang Zheng ,Qingsong Zhang ,Yanfang Xue, Zhenling Cui	Agricultural and Forest Meteorology, ISSN : 0168-1923 (Elsevier)	Objectives of this study were to evaluate the relationship between nutrient requirements and climates or soil chemical properties.
5.	2020	Rainfall intensification increases nitrate leaching from tilled but not no-till cropping systems in the U.S. Midwest	Laura J.T. Hess Eve-Lyn S. Hinckley G. Philip Robertson Pamela A. Matson	Agriculture, Ecosystems & Environment, ISSN : 0167-8809 (Elsevier)	Rainfall intensification may exacerbate leaching losses of reactive N from cropping systems, and that no-till management may buffer against these losses.
6.	2020	Crop Yield Prediction Based on Indian Agriculture using Machine Learning	Potnuru Sai Nishant Pinapa Sai Venkat Bollu Lakshmi Avinash B. Jabber	2020 International Conference for Emerging Technology (INCET)	This paper predicts the yield of almost all kinds of crops in India. This script makes novel by usage of simple parameters like state, district, season, area and the user can predict the yield of the crop in which year he or she wants to.

Ref No.	Year	Title	Author's Name	Journal	Description
7.	2020	Cropping systems in agriculture and their impact on soil health	TonyYang, Kadambot H.M. Siddique, Kui Liu	Global Ecology and Conservation, ISSN: 2351-9894 (Elsevier)	Significant achievements, including refine content of soil health and the development of new evaluation standards for 'soil health and quality'.
8.	2020	Would fertilization history render the soil microbial communities and their activities more resistant to rainfall fluctuations?	János Kátai Ágnes Oláh Zsuposné Magdolna Tállai Tarek Alshaal	Ecotoxicology and Environmental Safety, ISSN: 0147-6513 (Elsevier)	This paper aims to study the intrinsic changes in the composition of soil populations and their functions due to the interaction between long-term fertilization and rainfall fluctuations, seeing whether fertilization history would render the soil microbial communities and their activities more resistant to water stress or not.
9.	2021	A nutrient recommendation system for soil fertilization based on Evolutionary Computation.	Usman Ahmed Jerry Chun-Wei Lin Gautam Srivastava Youcef Djenouri	Computers and Electronics in Agriculture, ISSN: 0168-1699 (Elsevier))	This paper develops a model that enables efficient exploration of correct usage of nutrients (such as N, P and K) for developing a knowledge-based system for the ICT (Information and Communication Technology) environment.

Ref No.	Year	Title	Author's Name	Journal	Description
10.	2021	Controlled traffic farming effects on productivity of grain sorghum, rainfall and fertiliser nitrogen use efficiency	A.Hussein Diogenes L. Antille Shreevatsa Kodur GuangnanChen Jeff N.Tullberg	Journal of Agriculture and Food Research	Enhanced efficiency fertilizers cannot compensate for other stresses caused by compaction.
11.	2021	Optimized fertilizer recommendation method for nitrate residue control in a wheat–maize double cropping system in dryland farming	Zujiao Shi, Donghua Liu, Miao Liu, Muhammad Bilal Hafeez, Pengfei Wen, Xiaoli Wang, Rui Wang, Xudong Zhang, Jun Li	Field Crops Research ISSN: 0378-4290 (Elsevier)	To optimize the fertilizer recommendation method and reduce nitrate residue levels, this paper establishes the relationships between crop yield, nitrogen requirement, and nitrate residue level under combined N and P fertilizer application.
12.	2021	Analysis of agricultural crop yield prediction using statistical techniques of machine learning	Janmejay Pant, R.P. Pant, Manoj Kumar Singh, Devesh Pratap Singh, Himanshu Pant	Materials Today: Proceedings, ISSN: 2214-7853 (Elsevier)	This paper suggests the use of Machine Learning techniques to create a trained model for detecting patterns in data, which we then used to predict crop yields. The application of machine learning to the prediction of four of India's most cultivated yields is considered in this study. Maize, potatoes, rice (paddy), and wheat are among these crops.

Ref No.	Year	Title	Author's Name	Journal	Description
13.	2021	Prediction of the production of crops with respect to rainfall.	Benny Antony	Environmental Research, ISSN: 0013-9351 (Elsevier)	This paper predicts the production of crops as a function of rainfall. This is implemented by generating a rough overview of how the production is based on rainfall and how much can a specific crop production for the amount of rainfall it receives. The proposed method of evaluation is better than other existing methods of evaluation as it evaluates all the regression techniques.
14.	2021	Factors affecting agriculture and estimation of crop yield using supervised learning algorithms	Akash Manish Lad, K. Mani Bharathi, B. Akash Saravanan, R. Karthik	Materials Today: Proceedings, ISSN: 2214-7853 (Elsevier)	Comprehensive method developed to estimate crop sustainability using supervised algorithms that increase crop yields, reduce manual labor, time spent on various agricultural activities and plant recommendations based on certain soil parameters.
15.	2021	Precision agriculture using IoT data analytics and machine learning	Raves Akhtar, Shabbir Ahmad Sofi	Journal of King Saud University - Computer and Information Sciences,ISSN: 1319-1578(Elsevier)	This paper proposes an apple disease prediction model in apple orchards in Kashmir Valley using data analysis and machine learning in an IoT system. The paper discusses the challenges faced when integrating these technologies into traditional agricultural approaches.
16.	2021	Farmers' risk preference and fertilizer use	Fang-binQIAOJi-kunHUA NG	Journal of Integrative Agriculture	This study examines the role of farmers' risk attitudes toward fertilizer use in cotton production.
17.	2022	Untangling the effect of soil quality on rice productivity under a 16-years long-term fertilizer experiment using conditional random forest	Saheed Garnaik, Prasanna Kumar Samant, Mitali Mandal, Tushar Ranjan Mohanty, Sanat Kumar Dwibedi, Ranjan Kumar Patra, Kiran Kumar Mohapatra, R.H. Wanjari, Debadatta Sethi, Dipaka Ranjan Sena, Tek Bahadur Sapkota, Jagmohan Nayak, Sridhar Patra, Chiter Mal Parihar, Hari Sankar Nayak.	Computers and Electronics in Agriculture, ISSN: 0168-1699(Elsevi er)	The study demonstrated how interpretable machine learning techniques can be used in long-term fertilizer experiments to produce the most meaningful information, and that these techniques can be used in other similar long-term experiments.
18.	2022	Agricultural decision system based on advanced machine learning models for yield prediction: Case of East African countries	Rubby Aworka, Lontsi Saadio Cedric, Wilfried Yves Hamilton Adoni, Jérémie Thouakesseh Zoueu, Franck Kalala Mutombo, Charles Lebon Mberi Kimpolo, Tarik Nahhal, Moez Krichen	Smart Agricultural Technology, ISSN: 2772-3755 (Elsevier)	Crop Random Forest, Crop Gradient Boosting Machine, and Crop Support Vector Machine are three crop prediction models proposed in this paper. The paper makes use of advanced machine learning models to develop a decision system based on climate data, crop production data, and pesticide data.

Ref No.	Year	Title	Author's Name	Journal	Description
19.	2022	Smart farming using Machine Learning and Deep Learning techniques	Senthil Kumar Swami Durai, Mary Divya Shamili	Decision Analytics Journal, ISSN: 2772-6622(Elsevier)	The purpose of this paper is to help an individual farm be efficient and thus achieve high yield at a low cost. It also helps to predict the total costs required for growth. It will help one to plan ahead Pre-cultivation activities lead to an integrated solution in agriculture.
20.	2022	Improving the prediction accuracy of soil nutrient classification by optimizing extreme learning machine parameters	M.S. Suchithra, Maya L. Pai	Information Processing in Agriculture, ISSN: 2214-3173 (Elsevier)	This paper suggests solutions to the classification problems of soil nutrient which are solved using the fast learning classification technique known as Extreme Learning Machine (ELM) with different activation functions.

OBJECTIVES:

- To provide useful information for fertilizer use in terms of nutrients (NPK) by considering weather forecasts.
- To reduce water pollution by slowing down the process of leaching.

TOOLS & TECHNOLOGIES:

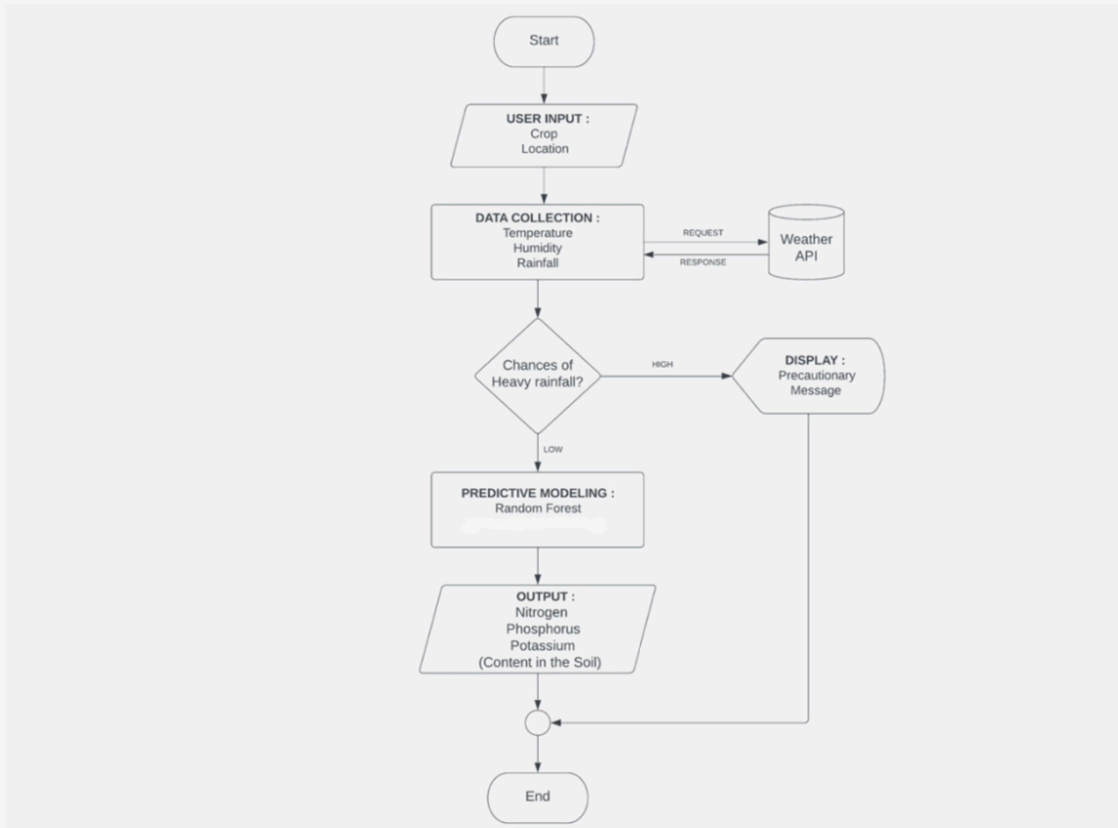
- Jupyter Notebook
- Python
- Matplotlib
- HTML/CSS
- Flask
- VS Code

METHODOLOGY:

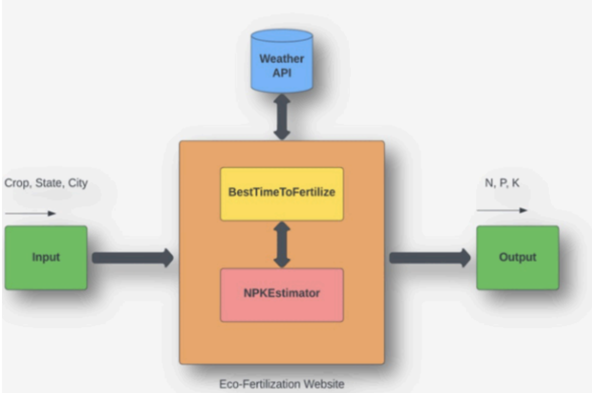
- In this study, a predictive model for the nutrients required for crops was obtained using random forest. Random Forest Regression represents the model with K-Fold Cross Validation technique and the model with acceptable accuracy for the prediction is then obtained. A total of 7 features have been used to evaluate the algorithm.
- The algorithm requires input from the user (such as location and cropping). The location is fed to the Weather API which will return certain characteristics (e.g. temperature, humidity, rainfall) and if there is a possibility of heavy rainfall, a precautionary message is displayed to the user, otherwise the proposed algorithm is followed.

IMPLEMENTATION MODEL:

Flowchart :



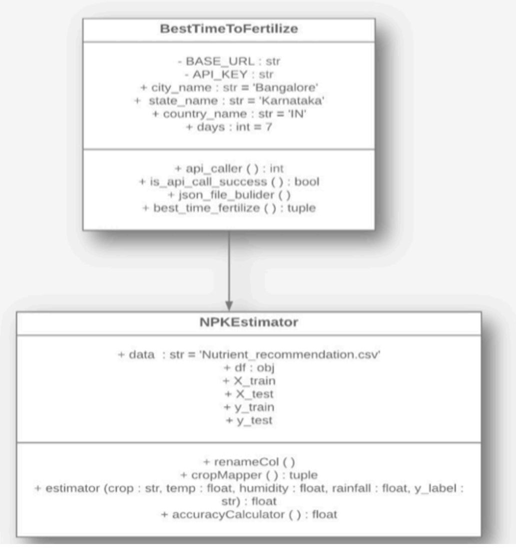
Block Diagram :



- System architecture is a conceptual model that defines the structure and behavior of the system. It comprises of the system components and the relationships describing how they work together to implement the overall system. The Figure shows the system's architecture and the various components added to them.
- The description of each component from the block diagram and their major functionalities with respect to the Eco-Fertilization as a complete unit is described in the table below.

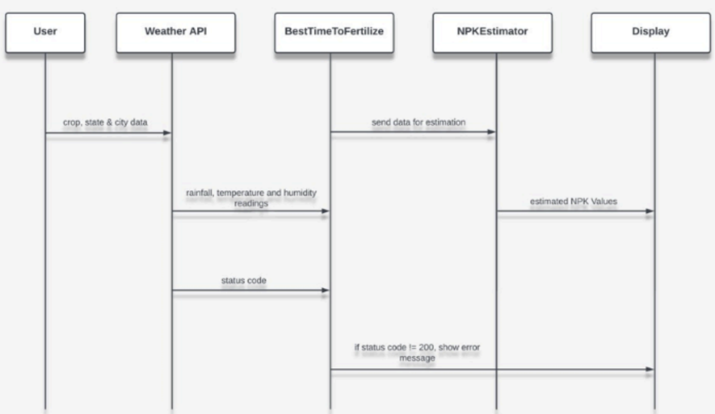
S. no.	Block Name	Functions
1	Input	User provides data such as crop , state and city using drop down menu
2	Weather API	Weather details like temperature, rainfall etc is fetched from the weather API
3	BestTimeToFertilize	This module provides the functionality to determine the best time to fertilize using fetched weather data and provides warming for heavy rain.
4	NPKEstimator	This module estimates the required ratio of NPK contents in the soil.
5	Output	Nitrogen, Phosphorus and Potassium content displayed on the website

Class Diagram :



- Class diagram is a static diagram. It represents the static view of an application.
- Class diagram is not only used for visualizing, describing, and documenting different aspects of a system but also for constructing executable code of the software application.
- Class diagram shows a collection of classes, interfaces, associations, collaborations, and constraints.
- It is also known as a structural diagram.

Sequence Diagram :



- A sequence diagram shows object interactions arranged in time sequence.
- It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario.
- Sequence diagrams are typically associated with use case realizations in the Logical View of the system under development.
- Sequence diagrams are sometimes called event diagrams or event scenarios.
- A sequence diagram consists of parallel vertical lines (lifelines) which shows different processes or objects that live simultaneously, and horizontal arrows that depicts the messages exchanged between them, in the order in which they occur.
- This allows the specification of simple runtime scenarios in a graphical manner.

DATA PREPARATION:

Actual Dataset :

	N	P	K	temperature	humidity	ph	rainfall	label
2	90	42	43	20.8797437	82.0027442	6.50298529	202.935536	rice
3	85	58	41	21.7704617	80.3196441	7.03809636	226.655537	rice
4	60	55	44	23.0044592	82.3207629	7.84020714	263.964248	rice
5	74	35	40	26.4910964	80.1583626	6.98040091	242.864034	rice
6	78	42	42	20.1301748	81.6048729	7.62847289	262.717341	rice
7	69	37	42	23.0580487	83.3701177	7.0734535	251.055	rice
8	69	55	38	22.708838	82.6394139	5.70080568	271.32486	rice
9	94	53	40	20.2777436	82.8940862	5.71862718	241.974195	rice
10	89	54	38	24.5158807	83.5352163	6.68534642	230.446236	rice
11	68	58	38	23.2239739	83.0332269	6.33625353	221.209196	rice
12	91	53	40	26.5272351	81.4175385	5.38616779	264.61487	rice
13	90	46	42	23.9789822	81.450616	7.50283396	250.083234	rice
14	78	58	44	26.800796	80.8868482	5.10868179	284.436457	rice
15	93	56	36	24.0149762	82.0568718	6.98435366	185.277339	rice
16	94	50	37	25.6658521	80.6638505	6.94801983	209.586971	rice
17	60	48	39	24.2820942	80.3002559	7.04229907	231.086335	rice
18	85	38	41	21.5871178	82.7883708	6.24905066	276.655246	rice
19	91	35	39	23.7939196	80.4181796	6.97085975	206.261186	rice
20	77	38	36	21.8652524	80.1923008	5.95393328	224.555017	rice
21	88	35	40	23.5794363	83.5876032	5.85393208	291.298662	rice
22	89	45	36	21.3250416	80.474764	6.44247538	185.497473	rice
23	76	40	43	25.1574553	83.1171348	5.07017567	231.384316	rice
24	67	59	41	21.9476674	80.973842	6.01263259	213.356092	rice
25	83	41	43	21.0525355	82.6783952	6.25402845	233.107582	rice
26	98	47	37	23.4838134	81.3326507	7.37548285	224.058116	rice
27	66	53	41	25.0756354	80.5238915	7.77891515	257.003887	rice
28	97	59	43	26.3592716	84.0440359	6.28650018	271.358614	rice
29	97	50	41	24.5292268	80.5449858	7.07096	260.263403	rice
30	60	49	44	20.7757615	84.497744	6.24484149	240.081065	rice

Crop Recommendation Dataset [23]

Actual Dataset contains 8 features. All of the features are not useful for proposed model. Therefore, a dimension reduction technique called feature selection is applied and seven features, then selected for evaluation

	Crop	Temperature	Humidity	Rainfall	Label_N	Label_P	Label_K
2	rice	20.87974371	82.00274423	202.9355362	90	42	43
3	rice	21.77046169	80.31964408	226.6555374	85	58	41
4	rice	23.00445915	82.3207629	263.9642476	60	55	44
5	rice	26.49109635	80.15836264	242.8640342	74	35	40
6	rice	20.13017482	81.60487287	262.7173405	78	42	42
7	rice	23.05804872	83.37011772	251.0549998	69	37	42
8	rice	22.70883798	82.63941394	271.3248604	69	55	38
9	rice	20.27774362	82.89408619	241.9741949	94	53	40
10	rice	24.51588066	83.5352163	230.4462359	89	54	38
11	rice	23.22397386	83.03322691	221.2091958	68	58	38
12	rice	26.52723513	81.41753846	264.6148697	91	53	40
13	rice	23.97898217	81.45061596	250.0832336	90	46	42
14	rice	26.80079604	80.88684822	284.4364567	78	58	44
15	rice	24.01497622	82.05687182	185.2773389	93	56	36
16	rice	25.66585205	80.66385045	209.5869708	94	50	37
17	rice	24.28209415	80.30025587	231.0863347	60	48	39
18	rice	21.58711777	82.7883708	276.6552459	85	38	41
19	rice	23.79391957	80.41817957	206.2611855	91	35	39
20	rice	21.8652524	80.1923008	224.5550169	77	38	36
21	rice	23.57943626	83.58760316	291.2986618	88	35	40
22	rice	21.32504158	80.47476396	185.4974732	89	45	36
23	rice	25.15745531	83.11713476	231.3843163	76	40	43
24	rice	21.94766735	80.97384195	213.3560921	67	59	41
25	rice	21.0525355	82.67839517	233.1075816	83	41	43
26	rice	23.48381344	81.33265073	224.0581164	98	47	37
27	rice	25.0756354	80.52389148	257.0038865	66	53	41
28	rice	26.35927159	84.04403589	271.3586137	97	59	43
29	rice	24.52922681	80.54498576	260.2634026	97	50	41
30	rice	20.77576147	84.49774397	240.0810647	60	49	44

Customized Dataset

DATA DESCRIPTION:

Input Features:

- Crop: Rice, Cotton, etc.
- Temperature: Temperature in degree celsius
- Humidity: Relative humidity in percentage
- Rainfall: Rainfall in mm

Output Features:

- Label_N: Ratio of Nitrogen content in soil
- Label_P: Ratio of Phosphorous content in soil
- Label_K: Ratio of Potassium content in soil

DEMO VIDEO:

Paste the below link in your browser for the demo video.
https://youtu.be/aJEpP8-5k_k

FUTURE SCOPE:

The proposed system provides a helping hand to our farmers. It gives information about the use and quantity of nutrients required by the crops. There is scope for improvement in the system by providing user interface in the native language, so that the user can operate the system easily if he or she is unfamiliar with the English language. In addition, speech recognition systems can be added to handle illiterate users.

CONCLUSION:

The proposed system is able to achieve 92% of accuracy, which is quite good for any predictive model. It provides information about the use and the amount of nutrients required by the crops for satisfactory crop growth and production with respect to weather conditions. It provides weather alerts and messages. Alerts are displayed in the output of this application in case of bad weather conditions. The accuracy can be improved further with development in technologies.

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