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Crop, Fertilizer and Pesticides Recommendation Model Using Soil, Image and Nutrients Data

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Abstract

Owing to technological improvements, the agriculture sector is undergoing a revolutionary transition towards precision farming practices. An essential component of maximizing crop yield and guaranteeing sustainable farming methods is soil analysis. This study proposes an integrated method for precision farming which brings together methods for soil analysis with intelligent recommendation systems for crops, fertilizers, and pesticides. The initial phase of the study looks at several soil analysis techniques. It looks into how important soil characteristics like pH, moisture, nutrient content, and texture are in selecting crop suitability and yield. Additionally, the study explores machine learning-based intelligent recommendation system creation and implementation. By employing datasets that include soil characteristics, and agronomic expertise, these systems produce tailored suggestions for the best crop choice, fertilizer usage, and pest control. The percentage of accurately predicted outcomes among all of the system's predictions is known as accuracy. After conducting a thorough investigation and verification process, we were able to predict the best crops, fertilizers, and pesticides for different soil types with an astounding 90% accuracy rate. In summary, by offering a thorough framework for soil analysis and intelligent decision support, this research advances precision agriculture.

Keywords

Convolutional Neural Network, Crop Recommendation, Data Pre-Processing, Image Processing, Machine learning, Pesticides and fertilizers recommendation, Soil analysis

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I. Introduction

Modern agriculture has made major advances forward with the integration of soil analysis with a comprehensive recommendation system for crops, pesticides, and fertilizers. Precision farming techniques are more important than ever and environmental sustainability becomes more and more important. This innovative approach combines machine learning capabilities with conventional soil analysis methods to provide a more comprehensive understanding of soil health and how it affects crop growth. The system uses complex algorithms to make use of previous crop data, and information on the use of fertilizer and pesticides. Our approach, which prioritizes efficiency and sustainability, gives farmers the power to make wise choices that improve soil health, and strengthen the agricultural environment.

Our innovative method transforms crop management and soil analysis by utilizing machine learning. Through the processing of large volumes of soil data, such as composition, moisture content, and nutrient content, our system finds complex relationships and patterns that are not obvious to the human eye. We provide accurate fertilizer and pesticide recommendations based on a complex algorithm that is customized for every crop's needs and distinct soil profile.

A revolutionary development in agricultural technology is the integration of Convolutional Neural Networks (CNNs) and Logistic Regression in the fields of crop management and soil analysis. By utilizing logistic regression, we are able to utilize statistical modeling to examine the connections between crop health and soil characteristics, offering suggestions for the best fertilizers and pesticides. Simultaneously, CNN is very good at handling spatial data, which enables us to identify complex patterns in soil photos. Our technology provides farmers with a thorough understanding of soil dynamics through the combination of different approaches, allowing them to make precise and well-informed decisions.

Img.1: Crops

II. Literature Survey

Fahad Kamraan Syed, Agniswar Paul et. Al. introduced a smart farming system. This system combines IoT (Internet of Things) and ML (Machine Learning) technologies to enhance water management and improve irrigation techniques. [1]

Author's suggested a practical system to help farmers manage their crops better. This system takes into account various factors like temperature, humidity, soil type, farm location, and rainfall. It then predicts the best crops to cultivate in that specific environment. [2]

Researchers developed a system for real-time soil analysis using a modified support vector regression, a type of machine learning. This system consists of four main modules: Sensor integration with IoT devices, Agri Cloud, Analysis of Real-time data, and Agri User Interface. By analyzing soil properties in real-time, farmers can receive recommendations on which crops and plants are best suited for their farmland with the help of the modified support vector machine algorithm. [3]

Author's introduces new technologies such as the Internet of Things and Machine Learning. They use an IoT system to gather real-time data from the field area. This data is then fed into a trained model, which makes predictions based on the information. These predictions are very useful for determining which crops are suitable for suitable for planting in that specific field area. [4]

A model is introduced to predict soil types and recommend suitable crops for cultivation in that soil. The model was tested using machine learning algorithm like KNN, SVM, and logistic regression, showing higher accuracy compared to existing models. Aruul Mozhi Varman S proposed a smart agriculture system based on IoT and deep learning. This system uses wireless sensors network to monitor and collect soil parameters from the field, uploading the data to the cloud. Then, it suggests optimal irrigation practices to farmers by predicting the best crops for the next planting cycle. This information is sent to farmers via SMS and includes parameters like soil temperature, atmospheric temperature, and humidity. [5]

This approach proposes to increase efficacy even further by forecasting when pesticides, fertilizer, and manure should be applied. [6]

This paper proposed a system that would help farmers choose the best crop to cultivate by taking into account a variety of geographical and environmental characteristics. Intuitive and inherited expertise will be replaced with far more dependable data-driven machine learning models by the ML and IoT-based recommendations, which will also greatly educate farmers and assist them in cost reduction and strategic decision-making. This makes it possible to provide a scalable, reliable solution to a critical issue impacting an enormous number of people. [7]

III. Methodology

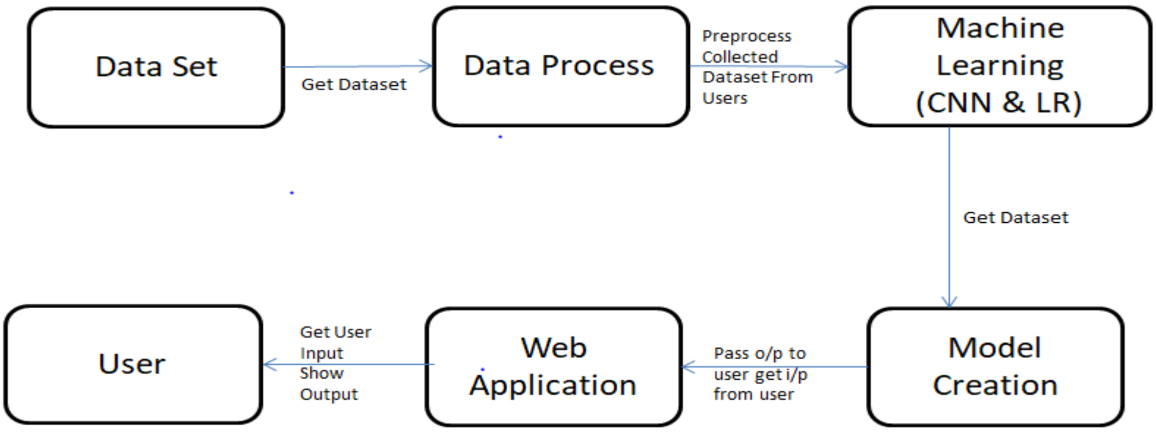


Fig.1 System Diagram

The crop, pesticide, and fertilizer recommendation system and soil analysis methodology use a comprehensive approach that smoothly combines conventional soil analysis techniques with cutting-edge machine learning algorithms. To start, soil samples are taken and thoroughly analyzed in a laboratory to ascertain important factors including pH levels, nutrient composition, and soil texture. Additionally, pertinent information about past crop yields, weather patterns, and fertilizer and pesticide use is gathered. This varied dataset is then used to train machine learning models, which include decision trees, support vector machines, and neural networks. To create complex patterns and linkages, these models make use of historical, environmental, and soil analysis data. The trained algorithms are then used to forecast the best crops to plant and suggest customized fertilizer and pesticide mixes depending on the unique properties of the soil. Real-world data is used to validate the system's efficiency and correctness, guaranteeing its reliability in offering thorough and personalized recommendations for productive and sustainable farming practices.

Collection of Dataset

One of the most important steps in creating a reliable and efficient agricultural decision support tool is gathering data for the soil analysis and crop, pesticide, and fertilizer recommendation systems. The target agriculture areas' soils are systematically sampled to collect soil data, which includes nutrient content and pH levels, as well as soil textures. Comprehensive datasets, such as historical crop yields, climate data, and details on pesticide and fertilizer recommendation systems, are compiled concurrently. These datasets provide the basis for training machine learning models, enabling them to discover and understand complex correlations and patterns in the data.

Pre-processing

Several essential steps are conducted during the pre-processing stage of the dataset for the crop, pesticide, and fertilizer recommendation system as well as the soil analysis to guarantee the accuracy and usefulness of the data for further analysis.

Convolutional Neural Network (CNN)

Convolutional neural networks are feed-forward neural networks that process data using a grid-like architecture, typically for the purpose of analyzing visual images. CNN makes use of special layers, such as filters, to scan input data and extract various attributes. This makes the model better at identifying patterns in objects like photos by supporting it in understanding and organizing features in a step-by-step manner. This architecture is incredibly adept in identifying images, particularly when it comes to identifying patterns and the arrangement of objects. It works well for tasks where the arrangement of elements in a picture is crucial. This specific method is highly effective at image recognition, particularly in terms of identifying patterns and the arrangement of objects. It works well for tasks where the arrangement of elements in a picture is crucial.

Machine Learning

By leveraging the potential of data-driven insights to optimize agricultural operations, machine learning plays a critical role. To identify important factors, soil samples are first subjected to a thorough investigation. This data is part of a complete dataset that also includes information on past crop yields, climate, and fertilizer and pesticide usage. This intricate information is subsequently analyzed using machine learning algorithms, such as decision trees, support vector machines, and neural networks. The computers pick up on complex correlations and patterns between crop results, environmental variables, and soil properties. Subsequently, the trained models are employed to forecast the best crop selections and suggest precise pesticide and fertilizer combinations suited to the particular soil conditions**.**

Decision tree Algorithm

Since it can solve a variety of problems, Decision Tree is regarded as one of the most useful Machine Learning algorithms. The following justifies your use of the Decision Tree: It is thought to be the most understandable machine learning algorithm, and it is simple to interpret. Regression and classification problems can be addressed with it. With DTA, we were able to obtain a 92% accuracy fee.

Random Forest Algorithm

For regression and classification tasks, Random Forest, an ensemble learning technique, is used. In order to do regression or classification, it builds a huge number of decision trees during training and outputs the average prediction of each one of them or the class mode. The selection of a random subset of features at each tree node, which ensures diversity, and the creation of each tree using bootstrapped samples from the dataset are the two main sources of the "random" component. Because of its inherent randomness, the Random Forest model resists overfitting and is resilient to anomalies and noisy data. In contrast to individual decision trees, the combined predictions of all the trees lead to a highly accurate and stable model that is less likely to overfit. Random Forest is a well-liked option in machine learning applications because of its adaptability, ease of use, and capacity for handling big datasets.

Logistic Regression

When dealing with binary classification tasks, where the outcome variable is categorical and represents two classes, usually represented by the numbers 0 and 1, logistic regression is a statistical technique that is employed. Logistic regression models the likelihood that an observation belongs to a specific class, as opposed to linear regression, which forecasts continuous outcomes. A linear combination of input data is transformed into a range between 0 and 1 using the logistic function, often known as the sigmoid function. This converted result can be understood as the likelihood that the specified instance is a member of the positive class. Logistic regression is widely used in various fields, such as medicine and finance, for tasks like predicting the likelihood of a patient having a certain medical condition or a customer defaulting on a loan. It is a basic paradigm in the field of binary classification and is computationally and linguistically efficient.

$$P(y=1|x) = \frac{1}{1+e^{-(\beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_n x_n}}$$ ---eq. (1)

Here in Equation 1,
The probability that an instance belongs to class 1 given the input features x is denoted by P(y=1|x).
e is the base of the natural algorithm.
The intercept term is β_0.
The coefficients for the characteristics x1, x2,..., and xn are β1, β2,... and βn, respectively**.**

IV. Result

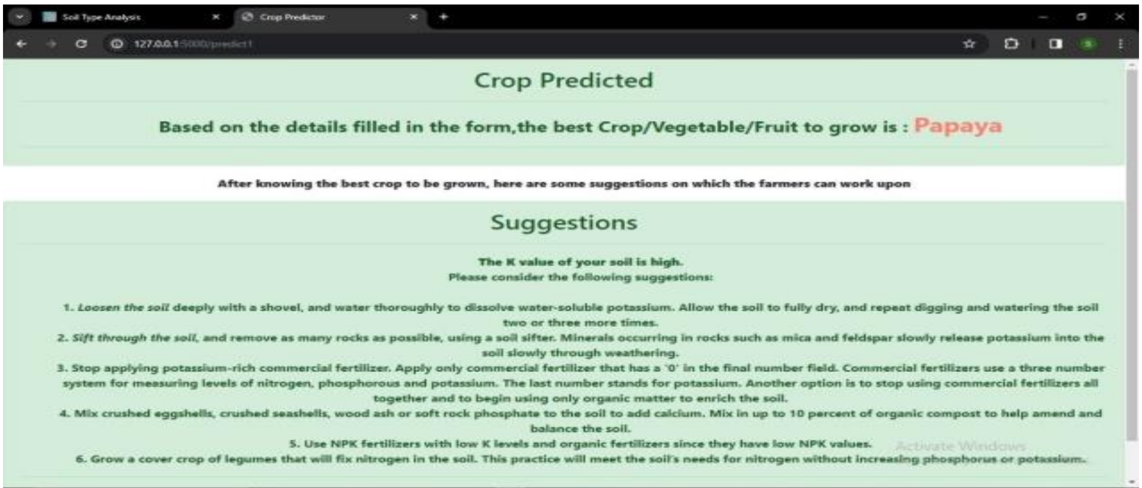
Description of dataset

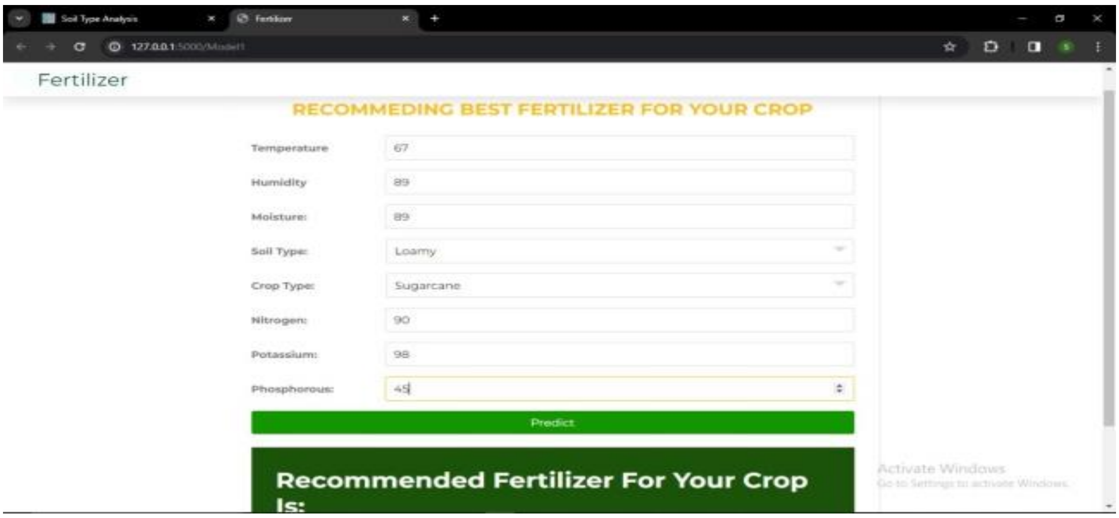
The soil analysis and crop, pesticide, and fertilizer recommendation system use a dataset that is an extensive collection of various agricultural data. It contains information about the soil that is obtained by careful soil sampling and laboratory analysis, including vital characteristics like pH values, nutrient concentrations, and soil texture. Together with comprehensive records of past crop yields, weather patterns, and the use of fertilizers and pesticides in particular agricultural contexts, this fundamental soil data is provided. The dataset serves as the foundation for training machine learning models by capturing the dynamic interaction over time between crop performance and soil variables. The recommendation system seeks to discover complex patterns and correlations by utilizing this extensive and diverse dataset. This will allow it to offer customized and nuanced advice on the best crop selections as well as exact mixtures of fertilizer and pesticides that are suited to the particular needs of the soil. For machine learning algorithms to be accurate and successful in directing sustainable and productive agricultural practices, the dataset's depth and diversity are essential. There are 496 picture datasets in the soil image data. The Fertilizers Dataset has 552 rows in it. The dataset for cropping has 2200 rows.

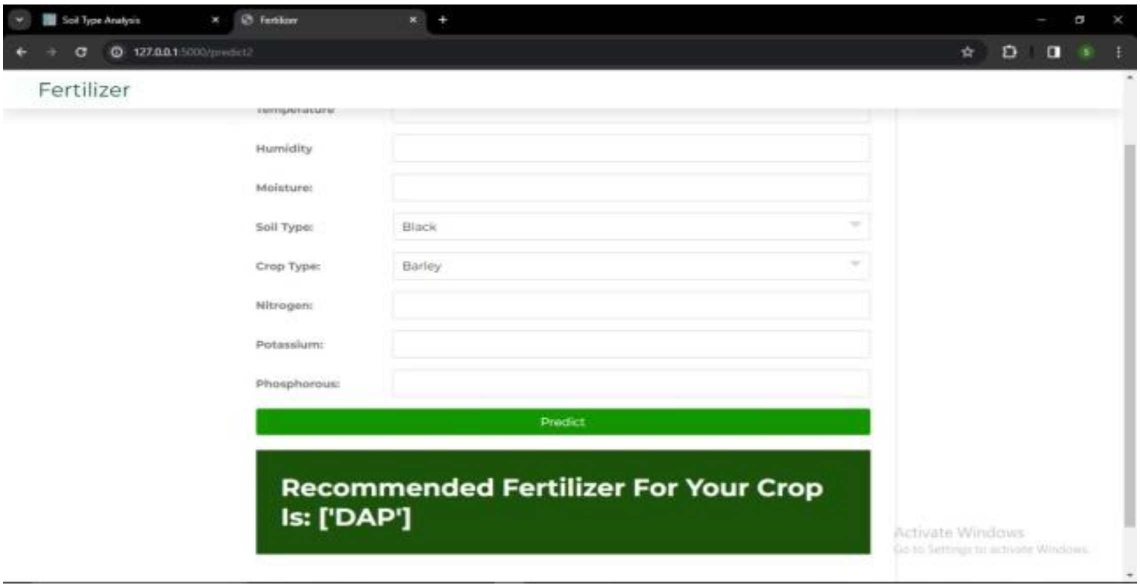
Img.2: Different Types of Soil

Results

This are the screenshots of the output of our project.





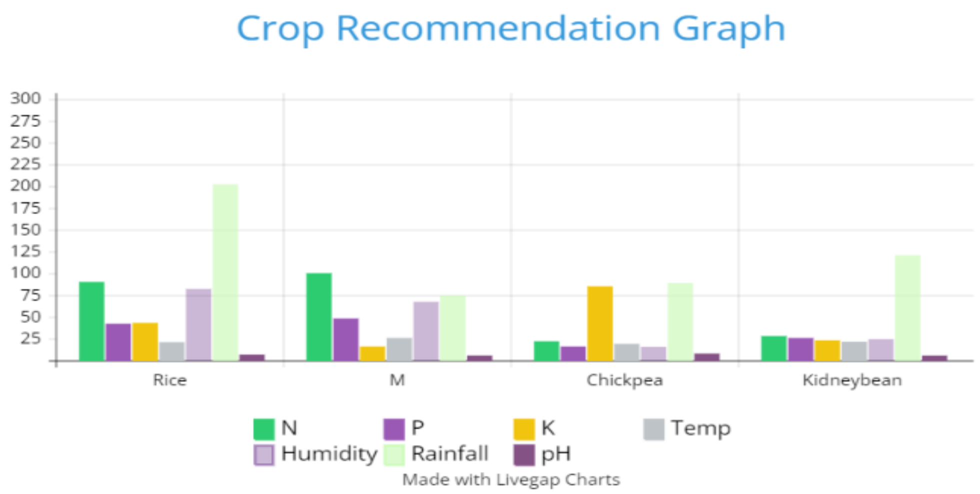


In Table 1, a dataset containing different agricultural parameters and matching crops is contained. With columns denoting variables such as soil pH, temperature, humidity, rainfall, and amounts of nitrogen (N),- phosphorus (P), and potassium (K), each row corresponds to a particular crop. The crop cultivated in those conditions is indicated in the final column. For instance, the first row implies that rice is grown in conditions with specific amounts of pH, temperature, humidity, phosphorus, and potassium

N	P	K	Temperature	Humidity	Rainfall	pH	Crop
90	42	43	20.87	82.00	202	6.50	Rice
100	48	16	25.71	67.22	74.51	5.54	maize
22	72	85	18.86	15.65	88.68	7.78	Chickpea
28	66	23	21.53	24.25	120.69	5.51	Kidneybean

Table 1

The Graph 1 describes the above Table 1.



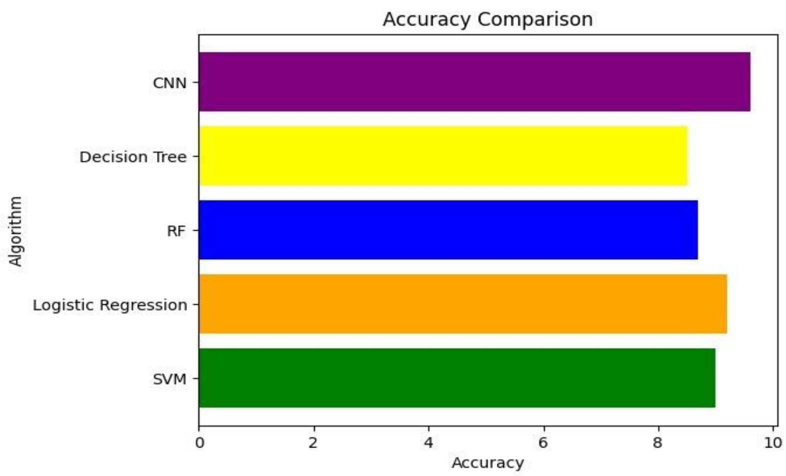
Graph 1

In table 2, it includes agricultural data on a number of variables, including soil type, crop type, temperature, humidity, and moisture. A particular scenario is represented by each row, which includes information on soil type, temperature, humidity, moisture content, and the crop that would be cultivated in that situation. It also specifies the type of fertilizer to be used and the appropriate amounts of potassium (K), phosphorus (P), and nitrogen (N) for maximum growth.

Temp	Humidity	Moisture	SoilType	CropType	N	P	K	Fertilizers
20	83	26	clayey	rice	90	49	36	Urea
25	85	60	Loamy	watermelon	110	10	54	TSP
35	68	33	red	tabacco	11	0	37	DAP
26	78	43	sandy	cotton	22	26	38	Potassium Sulphate

Table 2

Accuracy Comparison Graph of Algorithms
Graph 2 describes the accuracy percentage of several machine learning approaches.



Graph 2

Algorithms	Accuracy Percentage
CNN (Proposed Algorithm for image data)	**96.2%**
Decision Tree	**85.3%**
Random Forest	**86.9%**
Logistic Regression (Proposed Algorithm for various parameters data)	**92.3%**
Support Vector Mechanism	**90.1%**

Table 3

In Table 3, The accuracy percentages of several machine learning approaches are shown. Every row denotes a distinct algorithm, and the accuracy % that corresponds with it shows how well the algorithm performed in classifying evaluation.

V. Conclusion

To sum up, this study has explored the important field of soil analysis and how it affects agricultural decision-making, especially when it comes to crop choice, fertilizer use, and pesticide control. Significant progress has been achieved in improving the accuracy, effectiveness, and sustainability of agricultural operations through the use of cutting-edge technologies and methodologies including Convolutional Neural Networks (CNN), logistic regression, Pandas, and scikit-learn. The information provided here emphasizes how crucial it is to use data-driven methods to improve crop productivity, sustainability, and soil health evaluation. Researchers and practitioners can quickly and accurately characterize soil parameters and diagnose crop illnesses early by utilizing CNNs to extract significant insights from visual data. Moreover, logistic regression provides a strong framework for the analysis of structured data and the forecasting of crop performance under different climatic circumstances. In conclusion, we can ensure food security and prosperity for future generations by using the connections between soil analysis, data analytics, and agricultural expertise. This will pave the way for a more resilient, productive, and environmentally conscious agricultural industry.

References

[1]. S. Athani, C. H. Tejeshwar, M. M. Patil, P. Patil and R. Kulkarni, "Soil moisture monitoring using IoT enabled arduino sensors with neural networks for improving soil management for farmers and predict seasonal rainfall for planning future harvest in North Karnataka — India," 2017

[2]. Mehta, P., Shah, H., Kori, V., Vikani, V., Shukla, S., & Shenoy, M. (2015). Survey of unsupervised machine learning algorithms on precision agricultural data. IEEE Xplore.

[3]. Radhika, Y., & Shashi, M. (2009). Atmospheric Temperature Prediction using Support Vector Machines. International Journal of Computer Theory and Engineering, 55–58.

[4]. Ahmad, S., Kalra, A., & Stephen, H. (2010). Estimating soil moisture using remote sensing data: A machine learning approach. Advances in Water Resources, 33(1), 69–80.

[5]. R. Kumar, M. P. Singh, P. Kumar and J. P. Singh, "Crop Selection Method to maximize crop yield rate using machine learning technique," 2015 International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM), Avadi, India, 2015, pp. 138-145, doi: 10.1109/ICSTM.2015.7225403.

[6]. Thiyaneswaran, B., Anguraj, K., Kumarganesh, S., & Thangaraj, K. (2020). Early detection of melanoma images using gray level co- occurrence matrix features and machine learning techniques for effective clinical diagnosis. International Journal of Imaging Systems and Technology, (ima.22514). doi:10.1002/ima.22514

[7]. Shah, N. P., & Bhatt, P. (2017). Greenhouse Automation And Monitoring System Design And Implementation. International Journal of Advanced Research in Computer Science, 8(9), 468–471. .

[8]. S. Pudumalar, E.Ramanujam, R. H.Rajashree, C.Kavya, T.Kiruthika, & J.Nisha, (2017). Crop recommendation system for precision agriculture. IEEE Xplore.

[9]. Anitha, P., & Chakravarthy, T. (2018). Agricultural Crop Yield Prediction using Artificial Neural Network with Feed Forward Algorithm. International Journal of Computer Sciences and Engineering, 6(11), 178–181. https://doi.org/10.26438/ijcse/v6i11.178181

[10]. P. Rekha, P. Venkat Rangan, Dr. Maneesha V. Ramesh, and Nibi K. V., "High Yield Groundnut Agronomy: An IoT Based Precision Farming Framework", in 2017 IEEE Global Humanitarian Technology Conference (GHTC), 2017.

[11]. Archana Gupta, Dharmil Nagda, Pratiksha Nikhare, Atharva Sandbhor, 2021, Smart Crop Prediction using IoT and Machine Learning, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) NTASU – 2020 (Volume 09 – Issue 03)

[12]. Biradar, H. B., & Shabadi, L. (2017). Review on IOT based multidisciplinary models for smart farming. IEEE Xplore.

[13]. Priya, P. K., & Yuvaraj, N. (2019). An IoT Based Gradient Descent Approach for Precision Crop Suggestion using MLP. Journal of Physics: Conference Series, 1362, 012038.

[14]. A. Patil, M. Beldar, A. Naik and S. Deshpande, "Smart farming using Arduino and data mining," 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom), New Delhi, India, 2016, pp. 1913-1917.