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Smart Farming Through Machine Learning: - A Review

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ABSTRACT:

Agriculture plays a key role in Indian economy. But nowadays, agriculture in India is undergoing a structural change leading to a crisis situation. The only remedy to the crisis is to do all that is possible to make agriculture a profitable and attract the farmers continue to the crop production activities. As an effort towards this direction, this research paper would help the farmers in making appropriate decisions regarding the cultivations with the help of machine learning. The works analysed were categorized in crop management, livestock management water management. Random forests (RF) is a versatile machine-learning method for crop yield predictions at regional and global scales for its high accuracy and precision, ease of use, and utility in data analysis and the other algorithms are ANN, SVM. etc. The paper concludes that the ML techniques will provide cost-effective and comprehensive solutions for better crop and environment state estimation and decision making.

Keywords: **- crop management, livestock management, Random forests, data analysis, machine learning technologies.**

INTRODUCTION: -

Agriculture is the backbone of Indian economy. But the average contribution of agriculture into the GDP has been declining steadily. It is alarming that India is going to become an importer of food. One of the way to resolve this problem is smart farming . It makes agriculture more efficient and effective with the help of high-precision algorithms. The mechanism that drives it is Machine Learning. Machine learning is everywhere throughout the whole growing and harvesting cycle. It begins with a seed being planted in the soil and it ends when robots pick up the harvest determining the ripeness. The algorithms used in smart farming through machine learning are artificial, deep neural networks(ANN,DL)and support vector machine(SVM) With the increase of population, frequent changes in climatic conditions and limited resources, it becomes a challenging task to fulfil the food requirement of the present population. Precision agriculture also known as smart farming have emerged as an innovative tool to address current challenges in agricultural sustainability.

LITERATURE SURVEY

Following research papers are studied in details to understands the proposed recommendation technique and experimental result for predicting the output

2.1 R. Alfred, J. H. Obit, C. P. -Y. Chin, H. Haviluddin and Y. Lim, "Towards Paddy Rice Smart Farming: A Review on Big Data, Machine Learning, and Rice Production Tasks," in IEEE Access, vol. 9, pp. 50358-50380, 2021.

- In this paper, we perform a survey of the latest research on intelligent data processing technology applied in agriculture, particularly in rice production.
- This paper also presents a framework that maps the activities defined in rice smart farming, data used in data modelling and machine learning algorithms used for each activity defined in the production and post-production phases of paddy rice
- We describe the data captured and elaborate role of machine learning algorithms in paddy rice smart agriculture, by analyzing the applications of machine learning in various scenarios, smart irrigation for paddy rice, predicting paddy rice yield estimation, monitoring paddy rice growth, monitoring paddy rice disease, assessing quality of paddy rice and paddy rice sample classification

2.2. Gupta, M. Abdelsalam, S. Korando and S. Mittal, "Security and Privacy in Smart Farming:

Challenges and Opportunities," in IEEE Access, vol. 8, pp. 34564-34584, 2020.

- Smart devices are widely used by a range of people from farmers to entrepreneurs. These technologies are used in a variety of ways, from finding real-time status of crops and soil moisture content to deploying drones to assist with tasks such as applying pesticide spray

- In this paper, we present a holistic study on security and privacy in a smart farming ecosystem.
- The paper outlines a multi layered architecture relevant to the precision agriculture domain and discusses the security and privacy issues in this dynamic and distributed cyber physical environment.

2.3. Z. Ünal, "Smart Farming Becomes Even Smarter with Machine Learning A Bibliographical

Analysis," in IEEE Access, vol. 8, pp. 105587-105609, 2020

- The papers are classified into the following categories as disease detection, plant classification, land cover identification, precision livestock farming, pest recognition, object recognition, smart irrigation, phenotyping, and weed detection
- The latest advancements in connectivity, automation, and artificial intelligence enable farmers better to monitor all procedures and apply precise treatments determined by machines with superhuman accuracy. Farmers, data scientists and, engineers continue to work on techniques that allow optimizing the human labor required in farming.
- Smart farming technologies and precision agriculture are gaining more attraction for their potential to fulfill such an increasing demand and meet global food supply needs. Smart farming technologies involve integration of technology and data driven agriculture applications to increase crop yield and quality of food products.

2.4**. A. Sharma, A. Jain, P. Gupta and V. Chowdary, "Machine Learning Applications for Precision**

Agriculture: A Comprehensive Review," in IEEE Access, vol. 9, pp. 4843-4873, 2021.

- In this article, authors present a systematic review of ML applications in the field of agriculture.
- The areas that are focused are prediction of soil parameters such as organic carbon and moisture content, crop yield prediction, disease and weed detection in crops and species detection. ML with computer vision are reviewed for the classification of a different set of crop images in order to monitor the crop quality and yield assessment
- This approach can be integrated for enhanced livestock production by predicting fertility patterns, diagnosing eating disorders, cattle behaviour based on ML models using data collected by collar sensors, etc. Intelligent irrigation which includes drip irrigation and intelligent harvesting techniques are also reviewed that reduces human labour to a great extent.

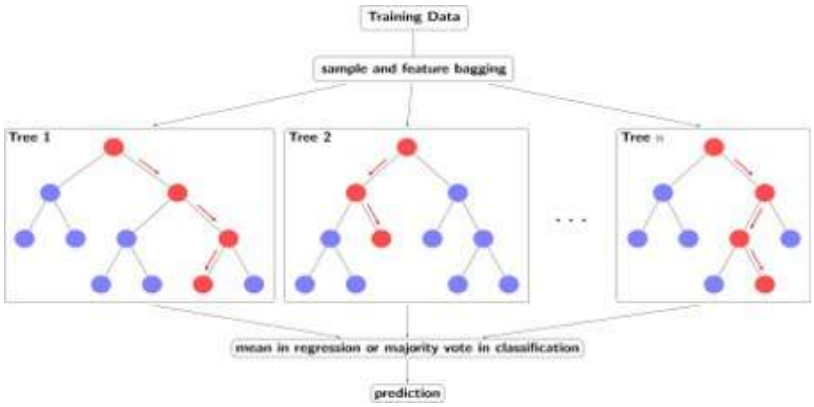
2.5 S. I. Hassan, M. M. Alam, U. Illahi, M. A. Al Ghamdi, S. H. Almotiri and M. M. Su'ud, "A Systematic Review on Monitoring and Advanced Control Strategies in Smart Agriculture," in IEEE Access, vol. 9, pp. 32517-32548, 2021.

- This research paper presents different control strategies used to automate agriculture such as: IoT, aerial imagery, multispectral, hyperspectral, NIR, thermal camera, RGB camera, machine learning, and artificial intelligence techniques
- Problems in agriculture like plant diseases, pesticide control, weed management, irrigation and water management can easily be solved by different automated and control techniques
- Automation by advance control strategies of agricultural methods have verified to increase the crops yield and also the soil fertility become strong. This research paper reviews and observe the work of different researchers to present a brief summary about the trends in smart agriculture

METHODOLOGY

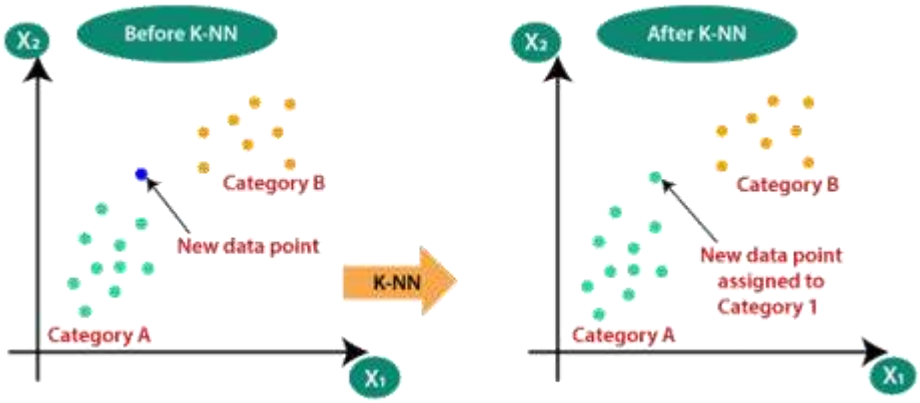
1.1 Random Forest:

Random Forest is a popular machine learning algorithm that belongs to the supervised learning technique. It can be used for both Classification and Regression problems in ML. As the name suggests, "Random Forest is a classifier that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset". Random forests(RF) is a versatile machine-learning method for crop yield predictions at regional and global scales for its high accuracy and precision, ease of use, and utility in data analysis.



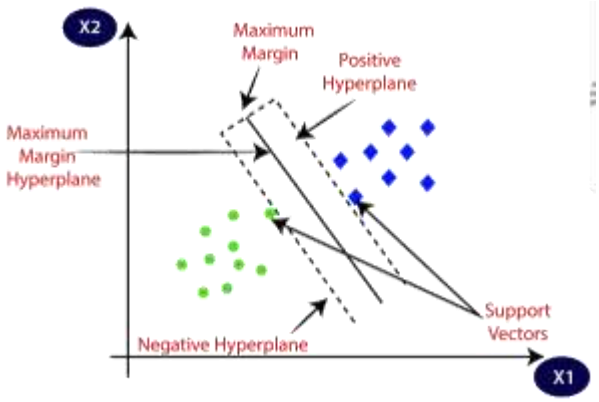
1.2 K-Nearest Neighbor (KNN):

K-Nearest Neighbour is one of the simplest Machine Learning algorithms based on Supervised Learning technique.K-NN algorithm assumes the similarity between the new case/data and available cases and put the new case into the category that is most similar to the available categories. K-NN algorithm stores all the available data and classifies a new data point based on the similarity. This means when new data appears then it can be easily classified into a well suite category by using K- NN algorithm. K-NN algorithm can be used for Regression as well as for Classification but mostly it is used for the Classification problems.



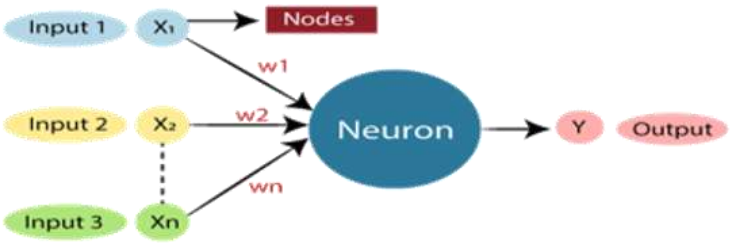
1.3 Support Vector Machine:

Support Vector Machine or SVM is one of the most popular Supervised Learning algorithms, which is used for Classification as well as Regression problems. The goal of the SVM algorithm is to create the best line or decision boundary that can segregate n-dimensional space into classes so that we can easily put the new data point in the correct category in the future. This best decision boundary is called a hyperplane. SVM chooses the extreme points/vectors that help in creating the hyperplane. These extreme cases are called as support vectors, and hence algorithm is termed as Support Vector Machine. Consider the below diagram in which there are two different categories that are classified using a decision boundary or hyperplane:



3.4. **Artificial Neural Network:**

The term "Artificial neural network" refers to a biologically inspired sub-field of artificial intelligence modeled after the brain. An Artificial neural network is usually a computational network based on biological neural networks that construct the structure of the human brain. Similar to a human brain has neurons interconnected to each other, artificial neural networks also have neurons that are linked to each other in various layers of the networks. These neurons are known as nodes.



3.5. Bayes Theorem:

Machine Learning is one of the most emerging technology of Artificial Intelligence. We are living in the 21st century which is completely driven by new technologies and gadgets in which some are yet to be used and few are on its full potential. Similarly, Machine Learning is also a technology that is still in its developing phase. There are lots of concepts that make machine learning a better technology such as supervised learning, unsupervised learning, reinforcement learning, perceptron models, Neural networks, etc. In this article "Bayes Theorem in Machine Learning", we will discuss another most important concept of Machine Learning theorem

$$P(X|Y) = \frac{P(Y|X).P(X)}{P(Y)}$$

RESULTS

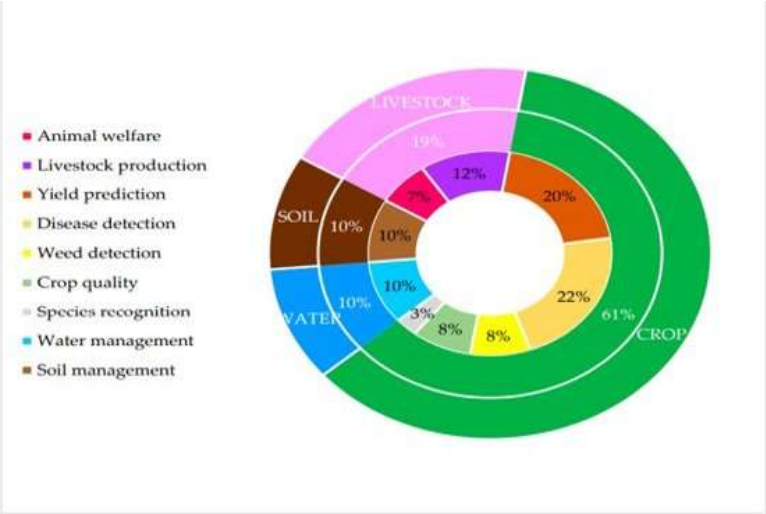


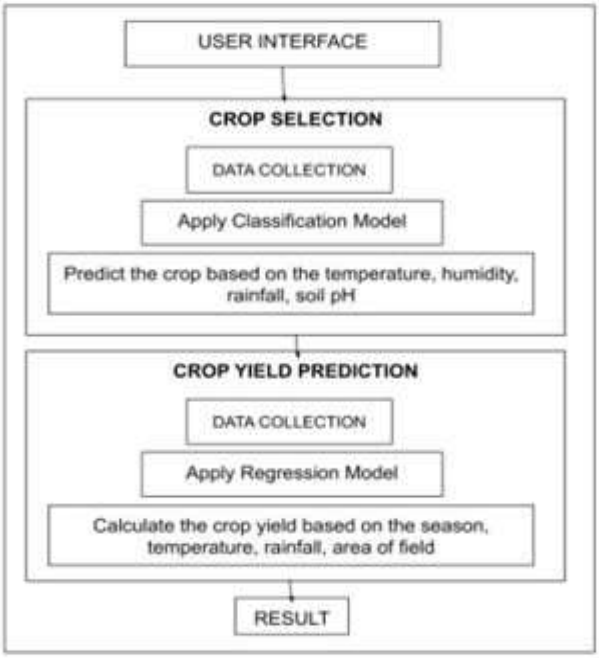
Fig: Pie chart presenting the papers according to the application domains

From the analysis of these articles, it was found that eight ML models have been implemented in total. More specifically, five ML models were implemented in the approaches on crop management, where the most popular models were ANNs (with most frequent crop at hand—wheat). In livestock management category, four ML models were implemented, with most popular models being SVMs (most frequent livestock type at hand—cattle).

Regression Model	R-Squared Value	MSE
Random Forest Regressor	0.9179	0.1011
Support Vector Regressor	0.0119	1.2166
Multiple Linear Regressor	0.2351	0.9418
KNN Regressor	0.8340	0.2043

Table: Comparison between various regressors

Random Forest Regression Model gives the highest R-Squared value and least MSE among all the regressors. Hence the Random Forest Regressor has been selected in the project.



Above fig shows the proposed approach to this problem. There are basically two modules: the first one is the Crop prediction module which predicts the most appropriate crop based on temperature, humidity, soil pH and rainfall values and second one is the Crop yield prediction module which predicts the production of the crop based on area, season and location.

CONCLUSION

Random Forest Regression Model gives the highest R-Squared value and least MSE among all the regressors. Hence the Random Forest Regressor has been selected in the project. To develop an user-friendly web application we used Flask. Flask is an API of Python and it is based on the WSGI toolkit and Jinja2 template engine. User selects the location, puts the soil ph value, gets from ph meter and then puts the area which is in acres. The result shows the appropriate crop based on the climatic conditions as well as the production in tonnes. Web page also displays the data that user inputs and the weather data.

REFERNCES: -

[1]. R. Alfred, J. H. Obit, C. P. -Y. Chin, H. Haviluddin and Y. Lim, "Towards Paddy Rice Smart Farming: A Review on Big Data, Machine Learning, and Rice Production Tasks," in IEEE Access, vol. 9, pp. 50358-50380, 2021

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