Section A-Research paper
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Precision Agriculture using Machine Learning Techniques for Strengthening Industry

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Abstract

As Global population is increasing very rapidly, the demand of food and employment also increases. The traditional methods of farming are not sufficient to fulfill the increasing demand of food and employment. In India agriculture contributes 18% - 23% GDP of the country as well as provides near about 60% employment. To overcome the problem precision agriculture is necessary. The researchers are finding various techniques to analyzed large amount of agricultural data for sustainability in agriculture. Machine learning is one of best technique. The knowledge extracted using machine learning technique is useful in decision making. In agriculture Machine learning techniques are use to monitor crops and detect various diseases of plants, to develop smart irrigation system, weed detection, suggest the best suitable crop for plantation according to the soil type and climatic condition, predict the crop yield, supply chain management, suggest pesticides to protect yield from diseases, as well as fertilizer to increase the production of the crop, predict commodity price and the crop yield etc. Implementation of machine learning techniques in agriculture used to improves the quality and increase the quantity of the crop production. This paper studies various applications of Machine Learning Techniques in Agriculture field Strengthening Industry.

Keywords: Machine Learning, Unsupervised learning, Clustering

Introduction

Agriculture plays significant role in economic growth of the country as well as produce employment. In India agriculture is depends on various parameters such as soil type, pH value, soil fertility, climate, weather, land under irrigation. To ensure the food safety, food security

creating employment. Traditional farming methods are not enough to bring sustainability in agriculture.

Machine Learning is a sub set of Artificial Intelligence. Machine learning techniques are use for data analysis and prediction purpose. Machine learning methods broadly classified into five categories such as supervised learning, unsupervised learning, semi supervised learning, analytical learning and reinforcement learning. Labeled data has to be given as input to the machine in case of supersized learning. In case of unsupervised learning input given to the machine has no label. In reinforcement/ feedback based learning. The learning agent get penalty for each wrong action and reward for right action. Various Machines learning Techniques are used for analysis and forecasting agricultural data.

Literature Review

The purpose of the literature review titled "Precision Agriculture Using Machine Learning Techniques to Strengthen Industry" is to investigate the existing corpus of knowledge concerning the incorporation of machine learning techniques into precision agriculture practises. Precision agriculture has emerged as a promising strategy for optimising resource utilisation, boosting agricultural productivity, and reducing environmental impacts in the agricultural sector. This review endeavours to examine the key applications, challenges, and potential benefits of employing machine learning techniques in precision agriculture using machine learning algorithms and advanced data analytics. This review's findings will contribute to a comprehensive comprehension of the current state of research and provide insight into future directions for bolstering the industry through the use of machine learning.

[1] The proposed work focused on developing automated disease detecting system using remote sensing images and identifying the disease using Canny's edge detection algorithm. The model helps to the framer to take proper decision regarding diseases and also suggest pesticides to control the diseases.

[2] The proposed work has developed model for smart irrigation system which predicts the requirement of water for a crop, using machine learning Techniques. The quantity of water required for irrigation is depends on humidity, Moisture and temperature. The sensor deployed in agriculture field sense data. IoT, Cloud computing and supervise machine learning decision tree algorithm has used for developing smart irrigation system.

[3] The Proposed system developed for predicting best time for irrigation. Wireless sensors network techniques spread in field are used for collecting data of weather and soil. Machine learning algorithms were tested included Random Forest, Neural Network, XGBoost, Decision Trees and Support Vector Machine. It is found that XGBoos has highest accuracy i.e. 87%.

[4] Agriculture planning plays a vital role in food security and economic growth of agro-based country. Selection of best suitable crop(s) for cultivation is an important for agriculture planning. It depends on various parameters such, weather and soil classification, rainfall, soil fertility,

cultivation area. The study gives a Crop Selection Method (CSM) to maximize net yield rate of crop over season and achieves maximum economic growth of the country.

[5**]** To increase the crop production the proposed work has developed a crop section system based on various soil and weather parameter. By using seasonal weather forecasting it also suggests suitable crop and proper time for sowing. To select suitable crops Random forest classification algorithm and for weather prediction recurrent neural network are used.

[6] The prediction of the crop yield may help the farmer for taking the decision about which crop to be grown. In this research Multilayer artificial neural network regression model has developed for the prediction of various crops yield. The data of crop cycle for summer, kharif, Rabi, autumn and whole year of Maharashtra state is used. The parameters considered for study are cultivation area, crop, state, district, season, year and production. The model suggest best possible crop with highest success rate as per input given by the farmer.

[**7**] In order to tackle the ever-increasing problems in agricultural production systems, advancements in smart farming and precision agriculture provides important tools to face agricultural sustainability challenges. Data analytics is one of the best tools to ensure future food safety, food security, and ecological sustainability. The current study presents a systematic review of machine learning (ML) applications in agricultural supply chains (ASCs).

[8] Now a days the technology like IoT and machine learning emerging in agriculture. The IoT device installed in the farm collects data about various soil parameters, weed and diseases, monitor crop etc, the machine learning gives ability to the machine to learn without being explicitly programmed. The various Machine learning techniques draw meaning full insights from data collected by IoT devices installed in farm and helps farmer in developing intelligent harvesting and irrigation system.

[9] The time series data with non normality, nonlinearity and highly chaotic in nature cannot be forecast efficiently by using conventional statistic tools. Now a day to process such type data wavelet of transformation is getting so popular. This study focused on forecasting of tomato prices in three different markets i.e. Ahmadabad, Burdwan and Madanapalli. ML techniques and combination of wavelet have been applied on price series. The Haar, D4, D6 and LA8 filters are used. D4 filter performs better among all filters.

[10] To avoid wastage of water due to scheduled irrigation, smart irrigation system is developed at Jojoba Israel's orchard. Sensors are used for collecting soil moisture data and monitoring the plants. Various classification and regression algorithms are applied on data of irrigation, weather, soil collected from various recourses and predict plan for weekly irrigation. It is found that the model developed by Gradient Boosted Regression Trees, has 93% accuracy. While best classification mode has developed with Boosted Regression Tree has 95% accuracy.

Applications of Machine Learning Technique in Agriculture

Machine learning plays significant role in Agriculture, for sustainable future precision agriculture is necessary. The large amount of agricultural historical data can be analyzed using various machine learning techniques such as classification, clustering, association rule,

reinforcement and combinations of various parameters are used for study. ML techniques are applied on various agricultural datasets and meaningful insights can be drawn which are useful to government, the people involved in agribusiness, policy makers and farmers. Using the extracted knowledge farmer can make future planning about farming, selecting best crop for cultivation, avoid wastage of water, monitoring crop and detect disease of plant in early stage.

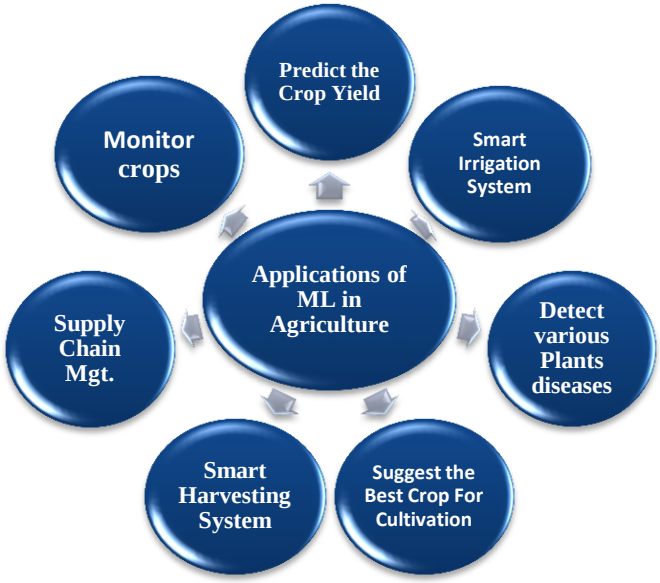

Figure 1 Machine Learning Applications

Monitor crops and detect various diseases of plants:

As farmers are facing loss due to various crop diseases and it becomes very tedious to monitor the crops regularly because of large cultivated area. Generally pathogens, insects, pests are the causes of plant diseases, which decreases the productivity and quantity of crop. Remote sensing techniques help in early detection and spread of disease on leaves. The cultivated field is continuously monitored by automated remote sensing system and intimate farmers so that further action can be taken. The system can also suggest the proper pesticide to control the disease. [1]

Develop Smart Irrigation System:

As the population of the entire globe is increasing need of food and water is also in demand. In India more than 80% water resources are used for agriculture. **[2]** Scheduled irrigation always leads to wastage of water. Smart Irrigation management system plays a critical role in improving the quality and quantity of the crops. Irrigation scheduling and management informs when, where, and how much to irrigate. Smart irrigation system makes use of use precipitation data, soil moisture data, evaporation data, and weather forecasts for better decision-making. Efficient irrigation system plays significant role in maintaining balance between hydrological, climatological and agronomical cycle for long term agricultural sustainability. The ML algorithms used for developing efficient irrigation management systems are based on simulation

and optimization techniques[Rohit Sharma] ML algorithms such as Support Vector has Machine (SVM), Neural Networks (NN), Decision Trees (DT) , Random Forest (RF) and XGBoost used to predict the ideal irrigation hours. According to recent research studies it is found that XGboost algorithm achieve highest accuracy for developing smart irrigation system. It predicts best time of day for irrigation and save wastage of water [3]. The smart irrigation system conserves water resources, maintain quality of crops and increase crop production.

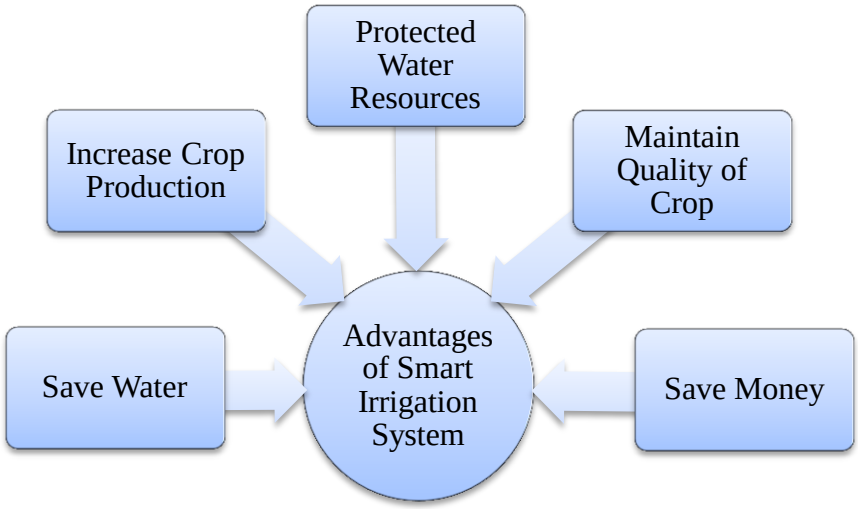

Figure 2 Advantages of Smart Irrigation System

Suggest the Best Crop For Cultivation:

Economic growth of agro-based country depends on agriculture planning. Achieving maximum yield rate of crop using limited land resource is a goal of agricultural planning. The yield rate of crop is influenced by two factors such as seed quality and selection of crop based on favorable season [4]. For suggesting the best suitable crop various soil parameters like pH value, fertility, water holding capacity and weather parameter like wind speed, humidity, sun hours, wind direction, temperature, market price, production rate, and yield rate of crop etc. can be processed by applying machine learning techniques **[5**]. The model Crop Selection Method (CSM) has been developed to suggest suitable crop and proper time for sowing. The CSM classifies crops into various categories like seasonal, whole year, short time and long time plantation crops. A combination of crops can be selected in a sequence based on yield rate per day. CSM method improve net yield rate of crops over season using limited land resource and also increases re-usability of the land and achieves maximum economic growth of the country[4]. The rotation of crop restores soil nutrients, enriched soil quality, prevents soil erosion and mitigates pathogens.

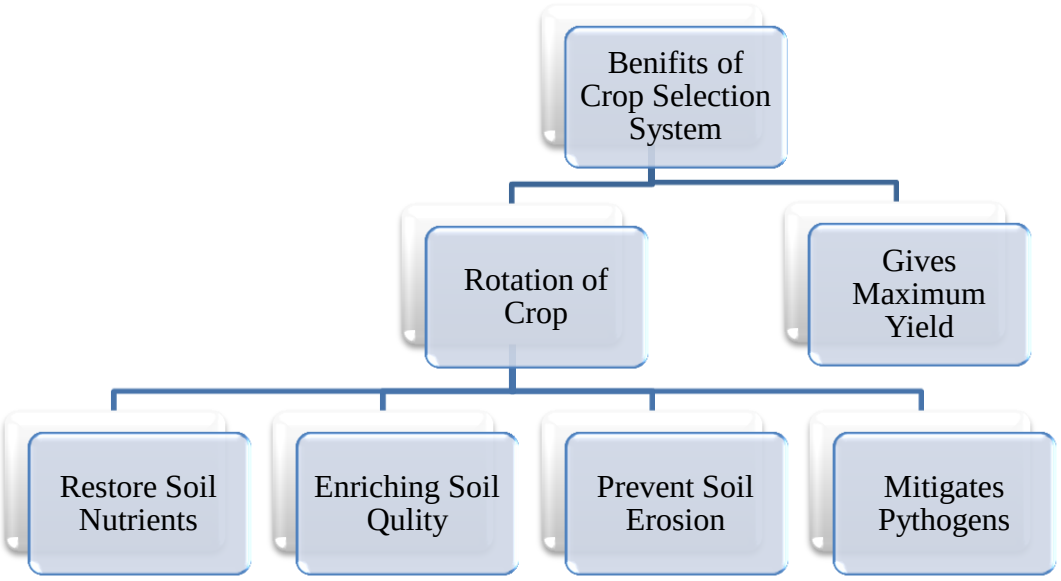

Figure 3 Advantages of Crop Selection System

Predict the Crop Yield:

Agriculture sustainability focused on improving agricultural productivity and reducing environmental impact better decision about growing the crop. Impact of various parameters like weather, Soil types, nutrients, pH value, area of cultivation, fertilizer on crop production can be analyzed. Machine learning is found to be a very appealing field that can contribute to the agriculture field, forecasting yield of crops will surely help the farmer [6]. The farmer can make a decision about the best suitable crop according to the climatic conditions, and season. It helps government to makes different polices, agribusiness industries to plan supply chain management. It is found that Machine Learning Techniques like SVM, Random Forest, Decision Tree, KNN, ANN, K means, DBSCAN, CLARA etc. are use for agricultural data analysis purpose. Linear Regression, Multivariate linear regression, Random Forest Regression are used for crop yield prediction purpose.

Supply Chain Management:

For ever growing global population demands food requirements is increased, it is estimated that global food production must be increased by 60–110% to feed 9–10 billion of the population by 2050. The precision agriculture is the only key to hunger eradication and food security. Machine learning techniques are used to develop Agriculture Supply Chains (ASCs). ASC is performs several operations such as pre-production, production, storage, processing, retail, and distribution before the final product reaches the end consumers. ASC are based on technologies, skills, information and attributes of supply chain patterns. The ASC includes many stakeholders like producers, farmers, traders, certification agencies, distributors, retailers and final consumers.

As compare to the other supply chains an ASC is complex due to high supply-demand fluctuations due to seasonality of the produce, the perish ability of the product, and increasing consumer awareness towards produce provenance, quality and safety. The recent advances in information and communication technology, more people are becoming aware and concerned about social, economic, and environmental aspects of the ASCs. This has led to growing pressure from various stakeholders such as NGOs, consumer organizations, agro-based organizations, government institutions, and policymakers for developing sustainable food production and consumption strategies. Most of the practitioners and researchers agree to the fact that current ASCs need a drastic shift towards sustainability to comply with the United Nation's 2030 agenda of Sustainable Development Goals **[7]**. Supply chain management system has following Social, Environmental and Economic benefits.

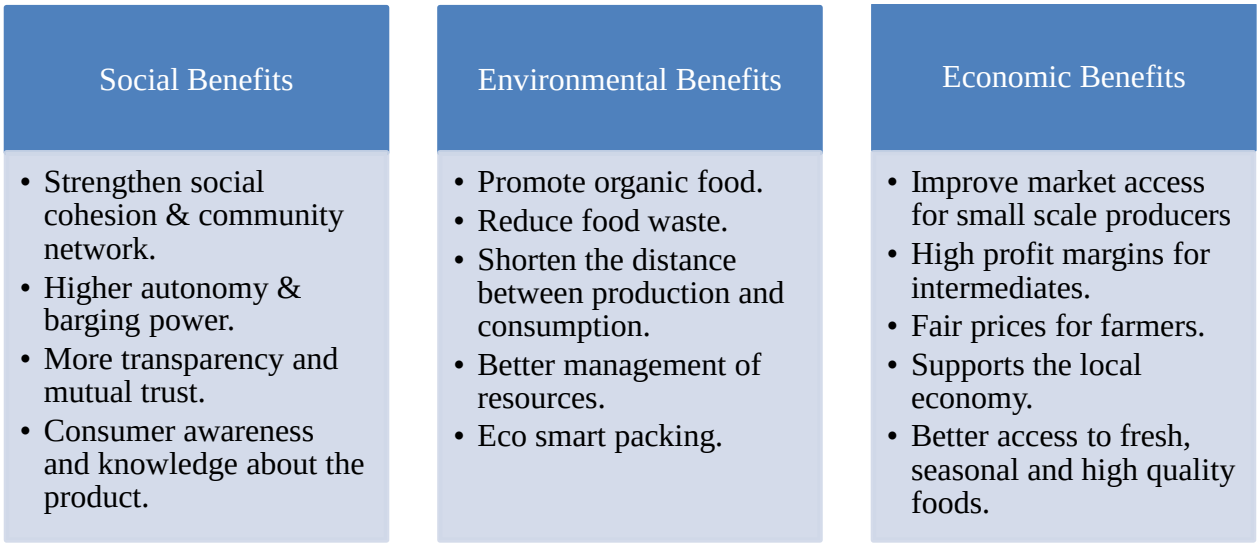

Figure 4 Advantages of Supply Chain Management System

Smart Harvesting System:

IoT devices can be employed in field to collect data of various parameters regarding soil, weather. For automated harvesting image processing algorithm can be used. The AI harvesting techniques largely depend on image recognition methods; hence CNNs can easily be deployed for implementing intelligent harvesting techniques [8].

Predict Commodity Price:

Agricultural time series datasets are mostly nonstationary, nonlinear, heteroscedastic and non-normal in nature. Forecasting commodity price of agricultural produce helps farmers, government and policy makers, beneficial for policy making, investment modeling, and corporate planning. The machine Learning Artificial Neural Network and wavelet with four different filters (W-ANN), is applied on price series dataset. It is found that combination of ANN and wavelet with D4 filter gives more Accurate Result [9].

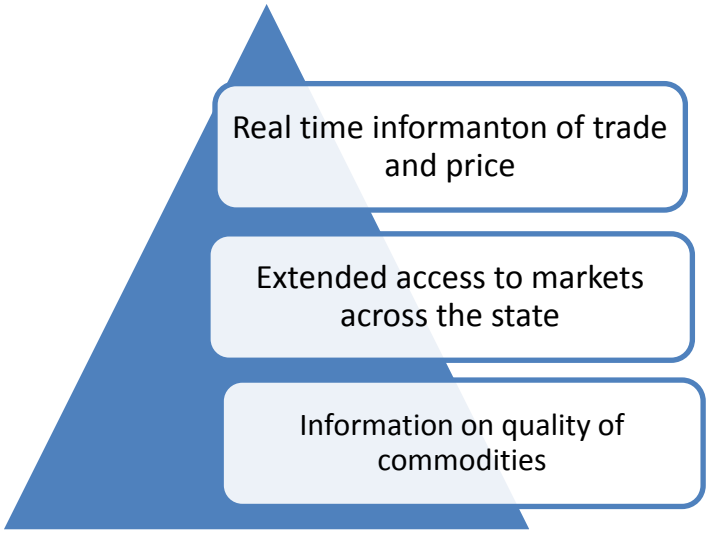

Figure 5 Benefits of Prediction of commodity price

Conclusion

As agriculture is a primary source of food and plays major role for the Indian economy and employment. To fulfill the increasing food requirement as well as accelerate economic growth of the country, it is necessary to improve the crop production by doing precision agriculture. Sustainable agriculture focused on reducing harmful environmental impact and enhancing agricultural productivity. Machine Learning is one of the best techniques which provide many methods to predict and analyze agricultural data.

ML techniques are applied on soil crop and weather datasets and find meaningful insights. These is useful in predicting commodity price of crop, developing smart irrigation system and avoid wastage of water, developing agricultural product supply chain to fulfill the need of end user, predict crop production, monitor crop and detect plant diseases to improve crop quality and increase the productivity.

According to recent research studies it is found that XGboost algorithm achieve highest accuracy for developing smart irrigation system. It predicts best time of day for irrigation and save wastage of water. The combination of ANN and wavelet with D4 filter gives more Accurate Result for forecasting tomato price in different market. For Predicting crop yield Decision Tree, Random Forest and polynomial regression algorithm are used; the performance Random Forest algorithm is more accurate than other methods

Challenges of Precision Agriculture

Technology plays significant role in precision agriculture and helps in meeting food requirements. However, there are many challenges in adopting them are as follows:-

- Digital divide is challenge task.

- Implementation of sensor for collecting data in ruler area is challenging task without unreliable internet connectivity.
- In initial stage smart farming requires huge investment for setting up hardware and software.

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