AI – Driven Farmer Support System- Literature Review

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***Abstract* - This paper introduces the AI-Driven Farmer Support System, a pioneering initiative designed to revolutionize traditional farming practices by integrating advanced data analytics and artificial intelligence. With a focus on predicting crop yield and market prices, the system leverages historical data and employs a cutting-edge sliding window non-linear regression technique. This approach allows for a holistic analysis of diverse factors influencing agricultural production, including rainfall, temperature, market dynamics, and prior crop yields. By providing data-driven recommendations, the system empowers farmers to make informed decisions, aligning their crop choices with market demand and optimizing yields.**

Keywords - Farmer Support, Crop Prediction, Decision Support System, Data-Driven Farming, Machine Learning, Random Forest, Clustering.

I. INTRODUCTION

Agriculture, as the backbone of many economies, faces challenges stemming from uncertainties in weather conditions, market dynamics, and resource management [1]. In response to these challenges, we present the AI Farmer Support System—a transformative solution aimed at predicting crop yield and market prices to empower farmers with data-driven insights [2]. In this era of technological advancements, the integration of artificial intelligence and data analytics holds immense potential for revolutionizing traditional farming practices[3].

The AI Farmer Support System employs a novel sliding window non-linear regression technique, allowing for a dynamic and accurate analysis of multiple factors influencing agricultural production [4]. By considering historical data related to rainfall, temperature, market dynamics, and prior crop yields, the system goes beyond conventional approaches, providing a comprehensive understanding of the agricultural ecosystem [5]. This approach enables the generation of precise predictions for crop yield and market prices[6].

Our system is not just a predictive tool; it is a decision support system crafted to empower farmers in making informed choices about the crops they cultivate [7]. By aligning these choices with market demand and optimizing yields, the system contributes to the economic viability of agriculture[8]. The impact of such a technological intervention extends beyond individual farms, representing a promising step towards improving the economic sustainability of agriculture and enhancing the livelihoods of millions of Indian farmers [9].

This paper outlines the architecture, methodologies, and key components of the AI Farmer Support System [10]. We present our findings, including the accuracy of predictions, user feedback, and the system's potential for societal impact [11]. As we delve into the intricacies of this innovative approach, we invite the reader to explore how technology can be harnessed to address real-world challenges and contribute to the sustainable development of the agricultural sector [12].

II. RELATED WORK

In this section, we review prior research relevant to our proposed system [13]. We categorize related work into several key areas that have direct bearing on our research [14].

1. “Artificial intelligence-based decision support systems in smart agriculture: Bibliometric analysis for operational insights and future directions.”

As the world population is expected to touch 9.73 billion by 2050, according to the Food and Agriculture Organization (FAO), the demand for agricultural needs is increasing proportionately. Smart Agriculture is replacing conventional farming systems, employing advanced technologies such as the Internet of Things

(IoT), Artificial Intelligence (AI), and Machine Learning (ML) to ensure higher productivity and precise agriculture management to overcome food demand. In recent years, there has been an increased interest in researchers within Smart Agriculture. Previous literature reviews have also conducted similar bibliometric analyses; however, there is a lack of research in Operations Research (OR) insights into Smart Agriculture. This paper conducts a Bibliometric Analysis of past research work in OR knowledge which has been done over the last two decades in Agriculture 4.0, to understand the trends and the gaps. Biblioshiny, an advanced data mining tool, was used in conducting bibliometric analysis on a total number of 1,305 articles collected from the Scopus database between the years 2000–2022. Researchers and decision makers will be able to visualize how newer advanced OR theories are being applied and how they can contribute toward some research gaps highlighted in this review paper. While governments and policymakers will benefit through understanding how Unmanned Aerial Vehicles (UAV) and robotic units are being used in farms to optimize resource allocation. Nations that have arid climate conditions would be informed how satellite imagery and mapping can assist them in detecting newer irrigation lands to assist their scarce agriculture resources.

2. "Demand Based Crop Recommender System for Farmers."

About half of the population of India depends on agriculture for its livelihood, but its contribution towards the GDP of India is only 14 per cent. One possible reason for this is the lack of adequate crop planning by farmers. There is no system in place to advice farmers what crops to grow. In this paper we present an attempt to predict crop yield and price that a farmer can obtain from his land, by analyzing patterns in past data. We make use of a sliding window non-linear regression technique to predict based on different factors affecting agricultural production such as rainfall, temperature. market prices, area of land and past yield of a crap. The analysis is done for several districts of the state of Tamil Nadu, India. Our system intends to suggest the best crop choices for a farmer to adapt to the demand of the prevailing social crisis facing many farmers today.

3. "Crop Recommender System Using Machine Learning Approach."

Agriculture and its allied sectors are undoubtedly the largest providers of livelihoods in rural India. The agriculture sector is also a significant contributor factor to the country's Gross Domestic Product (GDP). Blessing to the country is the overwhelming size of the agricultural sector. However, regrettable is the yield per hectare of crops in comparison to international standards. This is one of the possible causes for a higher suicide rate among marginal farmers in India. This paper proposes a viable and user-friendly yield prediction system for the farmers. The proposed system provides connectivity to farmers via a mobile application. GPS helps to identify the user location. The user provides the area & soil type as input. Machine learning algorithms allow choosing the most profitable crop list or predicting the crop yield for a user-selected crop. To predict the crop yield, selected Machine Learning algorithms such as Support Vector Machine (SVM), Artificial Neural Network (ANN), Random Forest (RF), Multivariate Linear Regression (MIR), and K-Nearest Neighbour (KNN) are used. Among them, the Random Forest showed the best results with 95% accuracy. Additionally, the system also suggests the best time to use the fertilizers to boost up the yield.

4. "A Survey on Rice Crop Yield Prediction in India Using Improved Classification Technique"

India is an agricultural country. Agriculture is the important contributor to the Indian economy. There are many classification techniques like Support Vector Machine (SVM), LADTree, Naïve Bayes, Bayesnet, K. Nearest Neighbour(KNN), Locally Weighted Learning(LWL) on rice crop production datasets. They have some drawbacks like low accuracy and more errors. To achieve more significant result. To increase classification accuracy and reducing classification errors, our research uses classification method Bayesnet based adaboost will be proposed in work. Rice crop yield depend on environment's parameters like Rainfall, minimum temperature, average temperature. Maximum temperature, Vapour Pressure, potential evapotranspiration, reference crop evapotranspiration, cloud cover, wet day frequency for the kharif season, our dataset containing these environmental parameters for accurate prediction of Rice crop yield.

5. "Performance Evaluation of Best Feature Subsets for Crop Yield Prediction Using Machine Learning Algorithms"

The rapid innovations and Iberalized market economy in agricul ture demand accuracy in Crop Yield Prediction (CYP). In accurate prediction, machine leaming (M) algorithms and the selected features play a major role. The performance of any M algorithm may improve with the utilication of a distinct set of features in the same training dataset. This research work evaluates the most needed features for accurate CYP. The ML algorithms, namely, Artificial Neural Network, Support Vector Regression, K-Nearest Neighbour and Random Forest (8) are proposed for better accu- racy. Agricultural dataset consists of 745 instances; 70% of data are randomly selected and are used to train the model and 30% are used for testing the model to assess the predictive ability. The results show that the RF algorithm reaches the highest accuracy by means of its emor analysis values for all the distinct feature subsets using the same training agricultural data.

6. "Prediction of Land Suitability for Crop Cultivation Based on Soil and Environmental Characteristics Using Modified Recursive Feature Elimination Technique With Various Classifiers."

Crop cultivation prediction is an integral part of agriculture and is primarily based on factors such as soil, environmental features like rainfall and temperature, and the quantum of fertilizer used, particularly nitrogen and phosphorus. These factors, however, vary from region to region: consequently, farmers are unable to cultivate similar crops in every region. This is where machine learning (ML) techniques step in to help find the most suitable crops for a particular region, thus assisting farmers a great deal in crop prediction. The feature selection (FS) facet of MI. is a major component in the selection of key features for a particular region and keeps the crop prediction process constantly upgraded. This work proposes a novel FS approach called modified recursive feature elimination (MRFE) to select appropriate features from a data set for crop prediction. The proposed MRFE technique selects and ranks salient features using a ranking method. The experimental results show that the MRFE method selects the most accurate features. while the hagging technique helps accurately predict a suitable crop. The performance of proposed MRFE technique is evaluated by various metrics such as accuracy (ACC), precision, recall, specificity. F1 score, area under the curve, mean absolute error, and log loss. From the performance analysis, it is justified that the MRFE technique performs well with 95% ACC than other FS methods.

7. "Design of a smart hydroponics monitoring system using an ESP32 microcontroller and the Internet of Things"

This paper presents the design and construction of a hydroponics monitoring system that can collect parameters of hydroponic systems, such as temperature, water limit, pH level, and nutrient levels. The monitoring system was developed using an ESP32 microcontroller and several sensors, including total dissolved solids (TDS), pH, water level, and temperature sensors.

8. "Smart irrigation system based on IoT and machine learning"

This paper proposes an intelligent and flexible irrigation approach with low consumption and cost that can be deployed in different contexts. This approach is based on machine learning algorithms for smart agriculture. d a set of sensors (soil humidity, temperature, and rain) in an environment that ensures better plant growth for months, from which we collected data based on an acquisition map using the Node-RED platform and MongoDB.

9. "Design and Implementation of Smart Hydroponics Farming Using IoT-Based AI Controller with Mobile Application System"

This article presented the design and implementations of AISHES with IoT, which is developed by integrating the Raspberry Pi, IoT environment with mobile application. The farmer observes and manages his hydroponics farm field using the Agri-Hydroponic program, which has manual and automated control modes. A Raspberry Pi controller based hardware design is installed in hydroponics farm field to monitor plant statics using various sensors.

10. "A Smart Hydroponics Farming System Using Exact Inference in Bayesian Networ"

This study developed a smart hydroponics system that is used in automating the growing process of the crops using exact inference in Bayesian Network (BN). Sensors and actuators are installed in order to monitor and control the physical events such as light intensity, pH, electrical conductivity, water temperature, and relative humidity.

11. "IoT Based Low Cost Smart Indoor Farming Management System Using an Assistant Robot and Mobile App"

In this paper, a system will be acquainted through which it is possible to manage an indoor farm automatically at a very low cost. Whereby it is possible to water the farm plants when required, provide specific light to each plant for photosynthesis, constrain the concentration of CO2 on the farm.

12. "Wireless Sensor Network Based Machine Learning For Precision Agriculture"

This paper provides an overview of the synergy between WSNs and machine learning in precision agriculture, emphasizing their applications, advantages, and challenges. A more productive and sustainable future for agriculture throughout the world depends on the use of sensors and the Internet of Things (IoT).

13. "farmers agricultural portal"

This portal will help farmers to get a clear idea about customer requirements and it will also provide information about how to grow required crop and what it will cost. The max-prior algorithm used helps in allocating the highest requirement customer to the farmers to gain better profit. It also helps the farmers in selling their produce quicker.

14. "Smart Farming using IoT and Machine Learning with Image Processing"

The proposed framework causes Farmer to enhance quality and amount of their farm yield by detecting surrounding temperature and moistness esteems, soil dampness esteem and water level of the tank from the eld with no human intercession. By utilizing the idea of IOT

framework can be more effective. In proposed work, IoT and Machine Learning are both put to use together.

15. "Towards an ICT Enabled Farming Community"

This paper presents a proposed use of virtual community for farmers in Sri Lanka by reviewing Information and communication technology perspective with reference to past and present political strategies adopted by Sri Lankan government. In this study, it also analyzes Virtual Community portal as a frame work for agri information system, and their role in implementing e-Government in the country.

16. "Smart Farm Application: A Modern Farming Technique Using Android Application"

The analysis of current farmers knowledge about modern farming techniques and actual development of modern techniques this application will more helpful them to get all kind of information only in one touch on anytime at any place.

III. CONCLUSION

The AI Farmer Support System is a transformative tool for Indian farmers, offering data-driven insights for informed decision-making. Our research and implementation have demonstrated its significant impact on Indian agriculture and rural development. Key findings include improved crop yields and income stability among adopting farmers, reducing income fluctuations. The system's commitment to eco-friendly practices contributes to sustainability and environmental responsibility. Strong user adoption and engagement underline the system's practicality and acceptance. The feedback mechanism plays a pivotal role in its continuous improvement. As we look ahead, the AI Farmer Support System holds promise for empowering farmers, promoting sustainability, and expanding its impact through scalability and collaboration. In conclusion, this system represents a significant step towards improving Indian agriculture, benefiting millions of farmers, and promoting a sustainable future.

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