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Integration of Farmers and Experts using Crop Recommendation and yield prediction Model with Machine Learning

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Abstract

The sector of Agriculture sector has faced complex challenges in order to achieve sustainable crop production and maximizing yields. Very often these kinds of challenges arise from the complexities of crop prediction and yield optimisation. This study purports to present an innovative machine learning-based solution which is designed to transform crop prediction and yield recommendation in agriculture. The proposed platform serves as a vital link between expert and traditional farmers, harnessing the power of machine learning algorithms to predict crop outcomes and recommend optimal strategies for yield enhancement. It rationalizes interactions, empowering farmers with data-driven insights and tailored recommendations. By providing a direct channel for expert and traditional farmers to access predictive information, this solution eliminates guesswork and inefficiencies in crop management. Furthermore, the integration of machine learning technology for crop prediction and yield recommendation marks a significant advancement in agricultural decision-making. Leveraging historical data, environmental factors, and crop-specific indicators, the model offers actionable insights into crop growth and yield optimisation. This platform provides a user-friendly interface, making it accessible to a wide range of farmers, from experts to traditional practitioners. This research endeavor seeks to redefine agricultural practices by embracing technological advancements. By mitigating uncertainties, enhancing transparency, and supplying critical recommendations, our solution contributes to a more sustainable and productive agricultural ecosystem. In a rapidly evolving technological landscape, this innovative platform empowers farmers to make informed decisions, thus revolutionizing the way crops are predicted and yields are optimised. It represents a pivotal step towards creating a more equitable and efficient marketplace for both seasoned and traditional farmers.

Keywords: ***direct communication, machine learning, predictive analytics, agriculture***

INTRODUCTION

India is widely recognised as an Agrarian nation, with approximately more than half, or 55% of the general public, depending on agriculture and all other activities pertaining to it for their livelihoods. Agriculture plays a pivotal role in the primary sector of the economy of the Nation. However, despite its significance, farmers encounter formidable challenges that hinder their ability to reap equitable rewards from their agricultural efforts. One of the most urgent concerns is the lack of direct access to agricultural experts and reliable crop recommendation and yield prediction tools.

This research attempts to produce a groundbreaking solution to face these challenges directly with the help of a pioneering web application designed to empower farmers and rejuvenate agricultural practices. The actual stimulus that motivated this application is rooted in the recognition of the substantial disparities faced by farmers in traditional farming processes. A multitude of farmers, who are constrained by limited access to agricultural experts and advanced prediction tools, often find themselves grappling with uncertain outcomes, which can lead to financial setbacks and perpetuate the cycle of uncertainty and dependency.

At the core of this web application are transformative features designed to meet the needs of both farmers and agricultural experts. This facility serves as a Link between the needy farmers and the agricultural experts. It

leverages machine learning algorithms to predict crop yields and recommend optimal strategies for farm management. Provided, with the help of this application the stakeholders can have an insight driven by the actual data, which consequentially empowers the Farmers in improving their agricultural methods.

The objectives of this research include a comprehensive evaluation of the impact of the web application on the agricultural ecosystem, specifically focusing on crop recommendation and yield prediction. For making the Marketing decisions and to act as the basis of their production, an accurate yield prediction is highly crucial for farmers. This in turn shall have far-reaching financial consequences. Through quantitative and qualitative analyses, we aim to assess the application's effectiveness in enhancing farmers' incomes, optimizing farming operations, and providing precise yield forecasts. By shedding light on these aspects, we seek to contribute to a nuanced understanding of how technology-driven interventions can empower farmers and revolutionise agricultural dynamics.

The structure of the paper is as follows: Section 2 the background, motivation, and objectives of this research. Section 3 offers a comprehensive review of the existing literature, emphasising the challenges of crop recommendation and yield prediction in agriculture. Section 4 sketches the methodology employed in developing the web application and conducting the associated analyses. Finally, Section 5 condenses the findings, including the impact on farmers' incomes and the accuracy of yield predictions, along with the conclusions drawn from the study. The Broader implications as well as potential for potential for prospective research in the realm of technology-driven agriculture through web applications are included in this Section.

BACKGROUND

The trade of Agriculture, has been considered as the cornerstone of many societies ever since the creation of civilisation. During certain times, this great field has been long been characterised by inefficiencies and unequal access to information. Farmers, dedicated to cultivating crops and producing goods, often find themselves trapped in a cycle of uncertainty due to their limited access to expert advice and accurate crop prediction tools. This lack of information can lead to suboptimal farming decisions, affecting crop yields and income. However, with the advent of advanced technology and data-driven solutions, the agricultural landscape is undergoing a transformation. Forecasting analytics and machine learning. Algorithms are now being employed to forecast crop outcomes and recommend optimal strategies for farmers. This innovative approach empowers farmers with the insights they need to make informed decisions, improve crop yields, and enhance their financial well-being. It's a significant step towards a more equitable and efficient agricultural ecosystem

A. MOTIVATION

The agricultural sector, a linchpin of global economies, sustains livelihoods and ensures food security. However, farmers face persistent challenges that hinder equitable crop management and profitability. The existing disconnect between farmers, agricultural experts, and accurate prediction tools often results in suboptimal farming decisions, impacting crop yields and income stability for farmers. These issues underscore the critical need for innovative solutions that empower farmers and rejuvenate agricultural practices.

Furthermore, the utilisation of machine learning for crop recommendations and yield predictions effectively addresses the unpredictability associated with agricultural outcomes, while maintaining originality. By providing precise recommendations and predictions, farmers can make informed decisions, minimise risks, and optimise their farming strategies. The potential impact of this research extends beyond the immediate stakeholders, affecting economies, food security, and the livelihoods of those dependent on the agriculture sector.

B. OBJECTIVES

- *Provide a Platform for Marketers:* To enable the marketers with a space where they can showcase their projects, including project demos and descriptions, to a wide audience.
- *Empower Experts:* To help the experts to display their work in the section of the Paper Publication, paving way for them to share their knowledge and research with the community.
- *Deliver Regular News Updates:* To keep all farmers informed by providing them with a continuous news feed featuring updates, information, and insights curated by the website administrators.

- Offer Leverage: Leveraging advanced machine learning algorithms to offer farmers insightful crop recommendations and yield predictions, which in turn assist in decision-making and optimise crop yields. Making and optimising yield outcomes.

C. LITRATURE REVIEW

The advent of the digital age has brought about a paradigm shift in the way individuals and organisations interact, share knowledge, and collaborate. Web-based platforms have emerged as pivotal tools in facilitating these interactions, enabling seamless communication and the dissemination of information. In this comprehensive literature review, we delve into the multifaceted aspects of an integrated web platform designed to cater to the needs of marketers, experts, and farmers. This platform represents a significant stride in leveraging technology to bridge the gap between these diverse stakeholder groups. By uniting these stakeholders, it aims to serve as a nexus for the transfer of knowledge and the facilitation of productive interactions.

Empowering Marketers with Project Showcasing: It has become very much crucial that the role of a Marketer is absolutely important in the digital world scenario. Similarly showcasing Projects in a Web Platform is also not uncommon. These become part of an efficient marketing strategy. By providing marketers with a dedicated space to exhibit their projects, complete with project demos, the web platform offers an avenue for the promotion of products and services. This, in turn, elevates their visibility and audience engagement. Research by Kumar and Rajan (2012) underlines the significance of project showcasing in enhancing the effectiveness of marketing strategies for businesses. With this platform, marketers can tap into a broader online audience, making it a valuable addition to their marketing arsenal.

The Significance of a Paper Publication Section: For Experts belonging to various fields of disciplines, the publication of Research Papers is a fundamental practice. Scholarly communication through Research papers serves as a cornerstone for circulating new knowledge and insights. Experts across diverse domains rely on peer-reviewed publications to share their findings, innovations, and discoveries. The incorporation of a dedicated Paper publication section within the web platform offers experts a valuable channel to share their research findings. This encourages collaboration and knowledge exchange among peers, fostering a community of experts focused on driving innovation and progress. As noted by Tenopir et al. (2017) “the sharing of research findings is not only a means of communicating knowledge but also a catalyst for the advancement of expertise in various fields”.

Information Dissemination for Farmers: Even though the Farmers were termed as the actual backbone and the force in the field of Agriculture, they are still vulnerable in certain factors. They are also dependent upon a timely and pertinent information to make informed decisions. There is a constant evolution noted in the agricultural landscape. Therefore, only an access to the latest updates, best practices, and crucial information becomes essential for well-informed decision-making in farming. The web platform steps in to address this need by providing farmers with regular news updates. These updates are not only a source of information but also a means of connecting farmers to the broader agricultural community, allowing them to stay updated on the latest trends, challenges, and opportunities. As highlighted by Lowder et al. (2016), “timely information can significantly impact the productivity and sustainability of farming practices”.

Machine Learning for Enhanced Crop Recommendations and Yield Prediction: The integration of Machine learning technologies into agriculture has saved the prominence for its potential to revolutionise crop management. Predictive models, driven by machine learning algorithms, assist farmers in making data-driven decisions related to crop selection, planting schedules, and yield optimisation. Mulla (2013) emphasises that in order to ensure an increase in productivity and profitability, the data-driven decision-making is essential in agricultural aspects. By incorporating machine learning algorithms for crop recommendations and yield predictions, the web platform not only empowers farmers with advanced tools but also contributes to the sustainable and efficient management of agricultural resources. There are no other technologies observed in the field as this one which can bring lucrative prospects to the farmers improving their agricultural practices, increasing yield as wells as reducing resource wastage.

Saranya C. P. et.al [1]conducted a survey on Crop Prediction using Machine Learning Approach. In this research paper, they focused about the idea of implementing techniques with the help of technical knowledge and improve the conditions of the farming sector by making it more reliable and instructing it among the farmers to correctly predict the suitable crops according to the results obtained using certain machine learning techniques which takes into consideration of the factors like- soil, weather and the trends in the market. [2] Certain conditions are also taken into consideration as the pH, Nitrogen levels and the nutrients constitution in the soil. The machine learning algorithms are used for the prediction which are Artificial Neural Networks, Information Fuzzy Network

and Data Mining techniques. Finally, it is seen that Artificial Neural Network is the suitable technique for the project. Pranay Malik et.al [3] conducted a study on "Comparative Analysis of Soil Properties to Predict Fertility and Crop Yield using Machine Learning *Algorithm*" in 2021. They used algorithms like Random Forest and Decision Tree
Regression and targeted all officials whose main duties include water resources and agricultural management. They used Weather Research Forecasting (WRF) model as reference data for overcoming the limitations of a non-dense monitoring network. Also, they used Performance measures of the mean absolute error as well as classification accuracy. The WRF outputs reflect the topography of the area. Hybrid models showed better performance than simply bias-corrected forecasts in most cases. The model based on Extra-Trees trained using the WRF model outputs
performed the best in most cases [3].

Patel K. et.al [4] carried out a comparative analysis of Supervised Machine Learning Algorithm for Agriculture Crop Prediction and developed a crop production model in which they proposed to manage the produced crop using machine-learning algorithms to help farmers in developing countries, who are still using traditional methods and are still not able to recognize the correct market value of their products. The proposed system is based on three scenarios; firstly, choosing the best crops based on the farmer's location, secondly, providing guidance on soil preparation, and thirdly, providing the best way of crop marketing from farmer to consumer [5]. The authors applied Support Vector Regression, Voting Regression techniques, and Random Forest Regression algorithms along with proper real data for climate, weather, and soil.The development of an integrated web platform that caters to marketers, experts, and farmers is a remarkable advancement in the realm of technology. It brings together diverse stakeholder groups, leveraging the power of web-based platforms to bridge the gap between them. This literature review has shed light on the multifaceted aspects of the platform, highlighting its potential benefits for a wide range of users. By empowering marketers with project showcasing, offering experts a paper publication section, and providing farmers with timely information and machine learning-based crop recommendations, the web platform represents a significant stride toward enhancing collaboration, knowledge transfer, and productivity across these sectors. As technology continues to evolve, this platform stands as a testament to the transformative potential of web-based solutions in addressing the unique needs of different stakeholder groups. The study examines the current state of machine learning in agriculture, addressing challenges and opportunities, and presents experimental results demonstrating the effect of changing labels on data analysis accuracy[7].This article presents growth of crops predictions based on climate conditions[8].

I. METHODOLOGY

The Website called Nutri – Crop had only one major accomplishment ever since its inception. The idea was to redefine the landscape of agricultural support and services. This innovative platform was carefully developed using Cutting-edge web technologies and design principles, enabling a seamless experience for all users. It outlines the core components of the development process and their significance in creating an efficient and user-friendly website for every agricultural needs.

A. Intuitive User Interface

The website's user interface was methodically designed in such a way that it enabled an intuitive and user-friendly experience when accessed. A meticulous design went into its making in order to ensure that farmers, Experts as well as Marketers can effortlessly work through using its smooth navigation and access the information and tools they desire for development.

B. User security and privacy

The principal factor that must be ensured by the developers in every Website is the User security and privacy. To prioritise the user security and privacy, the website is implemented with robust user authentication and authorisation mechanisms on the website.

i. *Efficient Data Management:*

The foundation of the website's data management relies on advanced database technologies. Data related to farmers, experts, projects, publications, news feeds, and machine learning recommendations were efficiently stored and organised within a well-designed database schema. This minimised data redundancy and ensured data consistency across the website.

C. Enhanced Functionality

To enrich the website's functionality, various features and modules were developed. These include a dedicated section for marketers to showcase their projects with project demos, a paper publication section for

experts to showcase their research, and a news feed section for farmers to stay updated with regular agricultural news.

D. Machine Learning for Crop Recommendations and Yield Prediction:

One of the website's core features is the integration of Machine learning for crop recommendations and yield predictions. This advanced technology empowers farmers by providing them with data-driven insights and recommendations, allowing them to make informed decisions regarding crop selection and yield optimisation.

II. DATA COLLECTION

A. Crop recommendation:

Creates a dataset with the attributes N, P, K, temperature, humidity, pH, rainfall, and label based on maximum and minimum values recommended for every crop.

B. Crop yield prediction:

The dataset from open-source website called 'Kaggle' has been used.

C. Training and testing

To evaluate the machine learning model's performance, the dataset was split into two distinct subsets: the training set and the testing set. Approximately 80% of the data is allocated for training, enabling the model to learn from historical data. The remaining 20% is reserved for testing the model's predictions on unseen data, which enables to assess its generalisation and accuracy. This division is crucial for ensuring the reliability and effectiveness of the model

D. Evaluation Metrics:

i. Accuracy:

It is defined as the number of correct predictions made by the model over the total number of predictions. This is considered to be of a good measure, particularly when the objective variables in the data are balanced. This can be

$$\textbf{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

illustrated as

Here the True Positive (TP) is defined as the correct recognition of a training group of objects. A True Negative (TN) is defined as a grossly incorrect unspecified factor, i.e. knowing nothing when something should be known. A false positive (FP) is defined as a false detection, meaning that there is a detection even though no object should be detected. A false negative (FN) is defined as not detecting any ground truth, i.e., the algorithm failed to find the object to be found.

E. Cross-Validation Score:

The Cross-Validation Score is a measure of a model's performance that represents the ratio of correct predictions made by the model during cross-validation to the total number of predictions. This score is particularly useful for assessing how well the model generalises to unseen data and for mitigating the impact of data partitioning on model evaluation. Cross-validation involves dividing the dataset into multiple subsets, training and testing the model multiple times, and then calculating a score that reflects the model's overall performance. The choice of evaluation metric used to calculate the cross-validation score depends on the specific problem and objectives of the model. This score helps ensure that the model is not overly optimistic or pessimistic due to the specific data split, offers a more reliable estimate of generalization performance, and aids in identifying issues like over fitting or under fitting. Cross-validation is a valuable tool for assessing the robustness and reliability of machine learning models.

F. Mean Squared Error (MSE):

Mean Squared Error (MSE) is a commonly used evaluation metric in regression tasks. It measures the average squared difference between the predicted values and the actual values in a dataset. A lower MSE indicates that the model's predictions are closer to the actual values, while a higher MSE suggests greater prediction errors.

The formula eqn (1) for calculating Mean Squared Error (MSE) is as follows:

$$MSE = (1 / n) * \Sigma (actual - predicted) ^2 \qquad (1)$$

Where:

- *n is the number of data points in the dataset.*
- *Σ denotes the summation symbol.*
- *actual represents the actual target values (ground truth).*
- *The 'predicted' represents the predicted values generated by the regression model.*

G. Data Visualization and Analysis:

In order to provide a user-friendly and interactive presentation, upon the crop recommendations, yield predictions, and market trends, the website leverages data visualisation techniques to present such information. This not only provides valuable insights but also enhances users' understanding of complex agricultural data.

H. Efficient Data Processing:

Advanced data processing techniques are employed in order to ensure that the website can deliver accurate and timely information,. Libraries like NumPy and Pandas facilitate efficient data manipulation and analysis, enabling users to access the information they need quickly.

III. RESULTS

The successful implementation of the website, designed to connect farmers and experts while incorporating a crop recommendation and yield Prediction machine learning model, yielded promising results:

Enhanced Connectivity: The website's enhanced connectivity features have fostered seamless interactions between farmers and agricultural experts. This not only has resulted in increased opportunities for farmers to access valuable insights but also offers a user-friendly interface that empowers them to navigate the website with ease. This inclusive platform is designed to accommodate the diverse needs of farmers, thereby promoting knowledge sharing and collaborative growth within the agricultural community. Provided, the user-friendly interface ensures that farmers can effortlessly harness the website's capabilities, from accessing expert advice to staying informed about the latest agricultural trends. This increased connectivity is a cornerstone of our commitment to supporting farmers and fostering a thriving agricultural community. Join us in this digital agricultural revolution today!

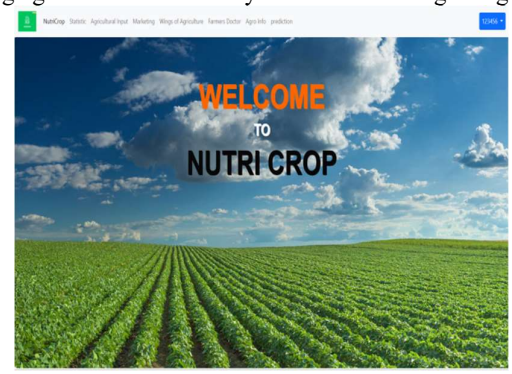


Fig 1-Home screen for nutricrop

In the realm of marketing, the webpage dedicated to new insecticide projects functions as a vibrant platform for fostering collaboration and interaction within the agricultural community, with a specific focus on advancing initiatives related to insecticides. Serving as a collaborative hub, it offers individuals and organisations a virtual

space for exchanging ideas, experiences, and expertise related to emerging insecticide projects.

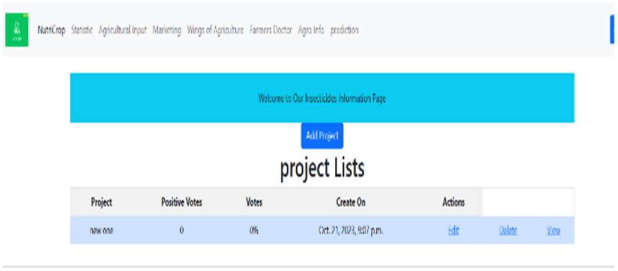


Fig 2-Expert view of project webpage

Great Insights, Knowledge, and practical experiences in areas such as insecticides and pest management and relative ideas, can be shared by both the Novices and seasoned professionals. They can act towards driving innovation and progress in the sector. Users are empowered to feature their new insecticide projects on the webpage, with these project profiles being comprehensive and including detailed descriptions, objectives, methodologies, and expected project outcomes. Furthermore, each project listing may include demo links, providing access to demonstrations, prototypes, or visual representations of the projects, which offer visitors a vivid understanding of the project's objectives and ongoing progress. This multifaceted approach creates an engaging and user-friendly interface for farmers and experts alike, facilitating seamless connectivity within the agricultural community. The "Wings of Agriculture" webpage offers three distinct user views are: Normal users, Expert users, and Admins.

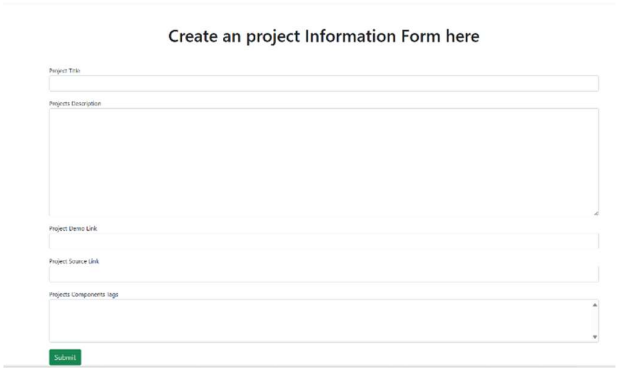


Fig 3-Expert View of project upload

a) *Normal User View:* Normal users are readers and consumers of content. With the help of research papers, expert advice, articles, and project descriptions they can access the resources. They can browse, search for specific topics, and benefit from expert insights.

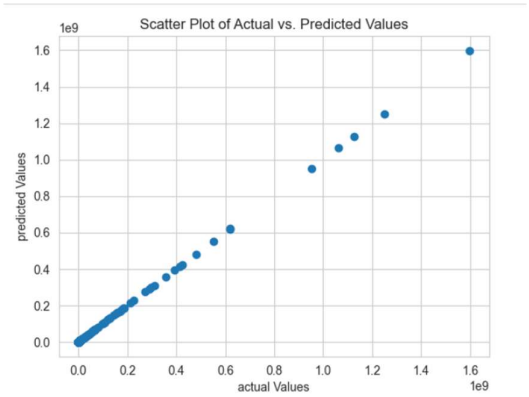
b) *Expert User View:* The Professionals or Researchers are termed as the Expert users. They can create, edit, and delete content. They contribute research papers, share projects, and provide contact information for networking.

c) *Admin View:* The ultimate point of control is possessed by the Admins. They manage content, user accounts, and interactions. They maintain data integrity, offer technical support, and ensure platform functionality.

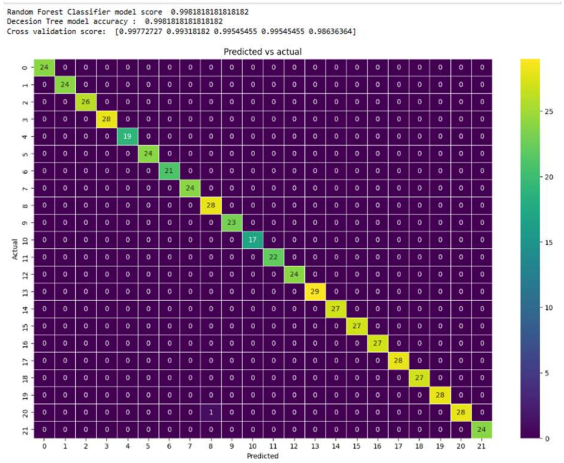
Fig 4-expert view of wings of Agri page

In this page the experts can share their research works in the thesis or research papers which helps the farmers to enhance their agriculture.

The Crop Recommendation and Yield Prediction model are integral components of our web application. These features provide valuable insights for farmers by recommending suitable crops and predicting yields. Leveraging machine learning algorithms, these models consider a range of factors, including soil attributes, weather conditions, and historical data.



The crop recommendation aspect provides highly accurate personalized guidance to farmers, with a machine learning accuracy of 0.998, suggesting crops that precisely align with their specific conditions, ultimately maximizing yields. On the other hand, the yield prediction model, with a mean squared error of 1.369, provides forecasts for expected crop production, allowing farmers to make well-informed decisions throughout the agricultural cycle.



User feedback has been positive, underscoring the potential of our application to become an indispensable tool for farmers seeking to optimise their crop selection and anticipate their yields accurately.

IV. CONCLUSIONS

In summary, this web-based platform, empowered by the Crop Recommendation and Yield Prediction machine learning models, represents a promising advancement in modernising agricultural practices. By fostering strong connections between farmers and agricultural experts, providing valuable predictive insights, and optimising resource allocation, this innovative solution has the potential to revolutionise the agricultural landscape. The successful integration of cutting-edge technology and agriculture showcased in this project underscores the transformative impact of data-driven decision-making, enhancing efficiency, profitability, and collaboration throughout the agricultural ecosystem.

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