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Krushi Care: An Integrated Smart Precision Farming App for Enhanced Agricultural Productivity, Profitability and Sustainability

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Abstract: An integrated smart, precise agricultural programme called Krushi Care was created using Java. The purpose of the application is to increase farmers' agricultural output, profitability, and sustainability. Krushi Care offers farmers useful information and tools for effective farm management by utilising cutting-edge technology including Internet of Things (IoT), data analytics, and real-time monitoring. The model provides functions like weather forecasting, study of the health of the soil, crop monitoring, identification of pests and diseases, management of irrigation, and tailored suggestions. Krushi Care enables farmers to take educated decisions, maximise resource use, and embrace sustainable farming practises by seamlessly integrating data from numerous sensors and farm equipment. With its simple interface and extensive capabilities, Krushi Care seeks to transform farming methods and support the expansion and prosperity of the agricultural industry.

Keywords: *Data analytics, real-time monitoring, weather forecasting, soil health analysis, crop monitoring, pest and disease detection, irrigation management, Krushi Care, smart precision farming, agricultural productivity, profitability, and personalised suggestions.*

1. Introduction

To solve the problems that farmers encounter, the "Krushi Care" software integrates cutting-edge technology including IoT, data analytics, and real-time monitoring [1]. The programme provides cognitive insights and predictive analytics to help farmers make data-driven decisions for improved outcomes. This is made possible by the integration of AI-based algorithms. Through the programme, farmers may get weather forecasting services, allowing them to properly plan their activities and adjust to shifting weather conditions. Additionally, the app analyses the health of the soil and uses artificial intelligence to optimise nutrient management practises based on nutrient content, pH levels, and other variables [2].

The model's AI-powered crop monitoring capabilities are one of its primary characteristics. Through picture identification and data analysis, it enables farmers to spot early indications of pest and disease infestation, enabling prompt interventions and reducing crop losses [2].

AI-powered irrigation management capabilities in the model analyse variables including soil moisture levels, weather patterns, and crop water requirements to ensure optimal water consumption. This encourages resource conservation and sustainable practises [3].

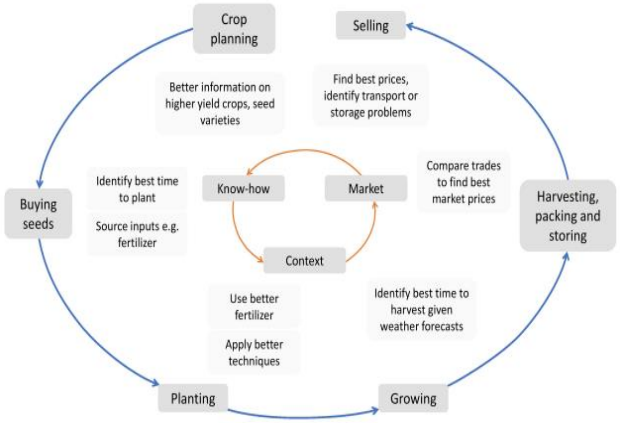

Fig 1. Farmers are required to provide information throughout the agricultural cycle [4].

The model aids farmers in selecting crops, planting methods, pest management tactics, and other decisions by providing personalised recommendations produced by AI algorithms. Overall productivity and profitability are increased as a result [5]. The "Krushi Care" application has the potential to revolutionise contemporary farming methods and contribute to the expansion of the agricultural industry thanks to its user-friendly interface and data-driven methodology. By incorporating AI technologies, farmers may access cutting-edge solutions to improve farm management [6], increase efficiency, and implement sustainable agricultural practises.

2. Methodology

Neural networks are used in agricultural applications to make precise predictions and offer recommendations for

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many elements of crop planning and management by learning patterns and correlations from data [7]. An outline of how neural networks function in farming applications is given below:

1. Data collection: Useful information is gathered from a variety of sources, including soil testing, previous crop yields, weather patterns, crop-specific needs, and agricultural techniques. The neural network is trained using this data as its basis. The process of gathering data can be stated as:

$$D = \{(X\_1, Y\_1), (X\_2, Y\_2), \ldots, (X\_n, Y\_n)\} \ldots (1)$$

2. Data Preprocessing: To ensure that the obtained data is in a format that the neural network can use, the data is preprocessed. Steps like normalisation, scaling, feature extraction, and data partitioning into training and testing sets can be necessary for this.

3. Neural Network Architecture: To fit the particular needs of the agricultural application, the neural network is constructed with the proper layers, neurons, and connections. Depending on the complexity and nature of the problem being handled, the architecture may change.

4. Training: Using the training data, the neural network is trained. To reduce the discrepancy between the expected and actual outputs, the network iteratively modifies its internal parameters (weights and biases) based on an optimisation process, such as gradient descent, throughout training. A loss function that measures the difference between the expected and actual values serves as a guide for this procedure.

5. Forward Propagation: In forward propagation, the neural network's layers of neurons process the incoming data. Each neuron takes in information from the layer above, adds up the weights of those inputs, and then sends the total via an activation function to create an output. Layer by layer, this process is continued until the desired product is produced.

6. Backpropagation: This process is carried out after forward propagation. In order to update the weights and biases, it includes computing the gradients of the loss function with respect to the network's parameters. This stage helps the network to correct its errors and enhance its forecasts.

7. Evaluation and Prediction: After a neural network has been trained, it can make predictions based on brand-new, unexplored data. By contrasting the network's predictions with the actual values from the testing set, its performance is assessed. Depending on the application, other evaluation metrics might be utilised, such as accuracy, precision, recall, or mean squared error.

8. Implementation: To deliver accurate forecasts and suggestions in real-time, the trained neural network is included into the farming application, such as the Farm Calculator. Farmers can provide pertinent data, and the neural network will analyse it and produce recommendations for the best crop management and planning.

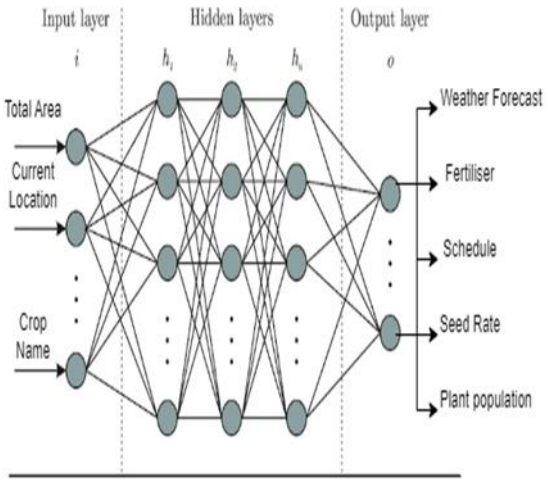


Fig 2. Proposed system neural network output

Neural networks are essential to the planned farm calculator for the Krushi Care application in order to give farmers insightful analysis and suggestions. The neural networks reliably determine the ideal amount of fertilisers (NPK) needed for particular crops by examining aspects such farm acreage, crop-specific nutrient requirements, soil nutrient analyses, fertiliser supply, and environmental conditions. The neural networks also provide recommendations for the ideal plant population by taking into account elements like crop-specific needs, available land space, and spacing. Farmers are able to maximise crop output, optimise resource use, and advance sustainable farming practises thanks to these data-driven projections and recommendations. The farm calculator incorporates neural networks to guarantee that farmers receive accurate and personalised advice, enhancing production and encouraging sustainable agricultural practises.

To assure the "Krushi Care" application's efficacy in resolving the difficulties faced by farmers and promoting sustainable agricultural practises, a methodical approach was used in its development. The proposed Krushi Care application's flowchart (fig. 3) lays out the series of actions and choices that go into running the programme. The logic of the application and user interactions are represented visually. The Krushi Care programme can use neural networks to improve functionality and give farmers precise forecasts and advice.

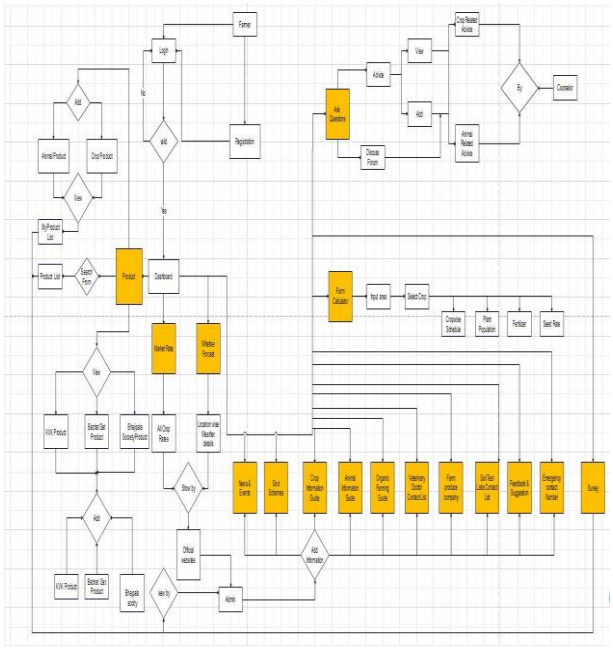


Fig 3. Flowchart of the proposed Krushi care application

1.1 Applications provided by Krushi Care model:

1. Market Rate: By analysing data from numerous sources, this AI-powered technology gives farmers real-time, accurate crop pricing [8]. By analysing market trends, wholesale prices, and data from trading platforms, it enables educated decisions and optimised crop selling tactics. Farmers can better understand market changes and maintain their competitiveness by using this useful resource.
2. Weather Forecast: Accurate, location-specific forecasts for temperature, rainfall, humidity, wind speed, and other variables are made available to farmers via the AI-enhanced weather function on official websites. Informed decisions concerning crop management, irrigation, and pest control may be made by farmers thanks to this. Farmers may reduce hazards and improve their farming techniques to properly safeguard and nurture their crops by keeping up with weather conditions.
3. News and Events: By using, farmers may stay current on information and maintain an edge in their industry. They are able to learn more, obtain new perspectives, and decide intelligently on their farming methods, crop choices, market trends, and other facets of agricultural management.
4. Government Programmes: AI is used in government programmes for farmers to improve productivity and deliver timely updates. These strategies produce insights and suggestions by examining data on crop yields, weather patterns, and market trends. They provide personalised advice on crop choices, planting methods, and pest control as well as real-time weather data.
5. The AI-based Crop Information Guide makes sure that farmers are aware of the most recent developments in farming techniques, market trends, and legal requirements. It enables farmers to make wise decisions, maximise agricultural yield, and increase general productivity.
6. Animal Information Guide: Using AI algorithms, this resource analyses a variety of data, such as animal breeds, dietary needs, health maintenance, and market trends.
7. Organic Farming Guide: By utilising AI technology, this manual improves farmers' knowledge and aids them in making decisions that will improve organic farming practises, boost productivity, and satisfy the rising demand for organic goods.
8. Veterinary Doctor Contact List: It ensures farmers have access to qualified veterinary services whenever necessary and promotes the general health and well-being of livestock.
9. Farm Produce Company: Farm Produce Companies often sell agricultural products to a network of buyers, which includes wholesalers, retailers, and exporters. They give farmers a simple and dependable platform to sell their produce in large quantities, guaranteeing fair prices and prompt payments.
10. Contact information for soil testing laboratories is compiled in this list. These laboratories examine soil samples to determine whether the soil is suitable for particular crops and to prescribe fertilisers. They assess organic matter, pH levels, nutritional content, and other aspects of soil health. The study informs the labs' recommendations for the best fertiliser types and dosages for a given crop. The contact list is a useful tool for farmers since it enables them to manage fertilisers efficiently and understand soil conditions to increase crop productivity and sustainability.
11. Feedback and Suggestions: This mechanism for providing feedback and making suggestions helps farmers continuously improve their farming methods, reduce risks, and increase yields. It promotes communication and cooperation between farmers and counsellors, which improves agricultural productivity and profitability.
12. Emergency contact information: By having access to trustworthy emergency contact information, farmers may respond quickly and efficiently during time-sensitive situations, improving the likelihood that emergencies will be resolved and minimising potential harm.
13. Farm Calculator: A useful tool that helps farmers with numerous elements of crop planning and management,

the "Farm Calculator" is available online. Neural networks can be employed in various applications to improve the tool's functionality. Following are some applications of farm calculator:

a) Prediction of fertiliser needs: Here, neural networks are used to precisely determine the quantity of fertilisers (NPK) needed for certain crops. To optimise fertiliser application and increase crop productivity and sustainability, these take into account parameters including farm area (A), crop-specific nutrient requirements (N), soil nutrient analysis (S), fertiliser availability (F), and environmental factors (E). Let's call the neural network "NN" and the estimated amount of fertiliser "Fertilizer_amount".

A neural network equation for fertiliser prediction looks like this:

$$Fertilizer\ amount = NN(A, N, S, F, E) \ldots\ldots. (1)$$

The predicted amount of fertiliser required for the particular crops is the output that the neural network produces after processing the inputs through its layers of artificial neurons and applying mathematical operations.

b) Plant Population: Based on factors including plant and row spacing, crop-specific requirements, suggested spacing guidelines, and available land area, neural networks calculate the appropriate plant population. These inputs are taken into account when the neural network recommends the best plant population, allowing farmers to efficiently use space and maximise agricultural yields for increased profitability and productivity. Let's refer to the anticipated plant population as "Plant_population" and the neural network as "NN".

The neural network equation for the plant population can be written as:

$$Plant\ Population = NN(R, G, L) \ldots\ldots\ldots\ldots\ldots\ldots\ldots. (2)$$

Based on the processed inputs, the neural network uses mathematical operations to calculate the ideal plant population.

c) In the "Krushi Care" application, neural networks help farmers properly calculate the precise amount of seeds needed for a certain planted area. The neural network predicts the number of seeds required for ideal plant establishment and desired crop density by taking into account variables like crop type (T), recommended seeding rates (SR), and the size of the plantation area (P). This guarantees effective resource use and increases potential yields. Assign the neural network the letters "NN" and the anticipated number of seeds the letters "Seed_amount".

The seed amount neural network equation can be written as:

$$Seed\ Amount = NN(T, SR, P) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The neural network processes the inputs and applies mathematical operations to accurately calculate the precise amount of seeds required for the specific plantation area.

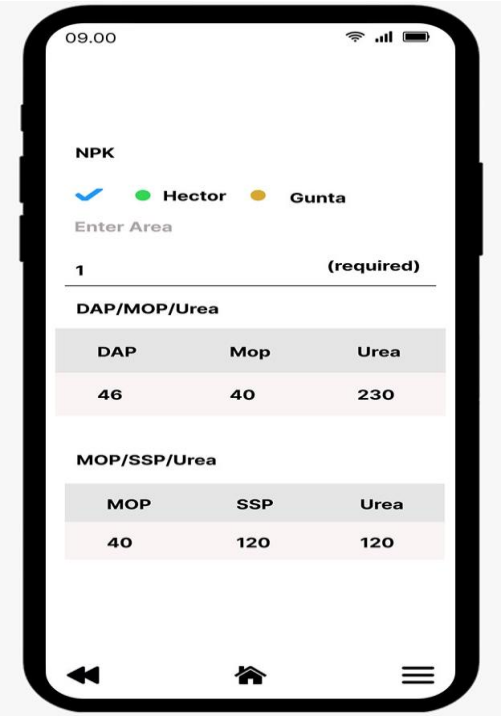
d) Crop-wise schedules: Neural networks provide farmers with tailored crop-specific schedules for optimal fertilizer application in the "Krushi Care" application. By taking into account the crop's growth stages (GS), nutrient requirements (NR), and other relevant factors, the neural network recommends the appropriate timing, type, and quantity of fertilizers to be used. These schedules enable efficient nutrient management, promote healthy plant growth, and maximize crop yields. Let's denote the neural network as "NN" and the predicted crop-wise schedule as "Fertilizer_schedule".

The equation for the crop-wise schedule neural network can be represented as:

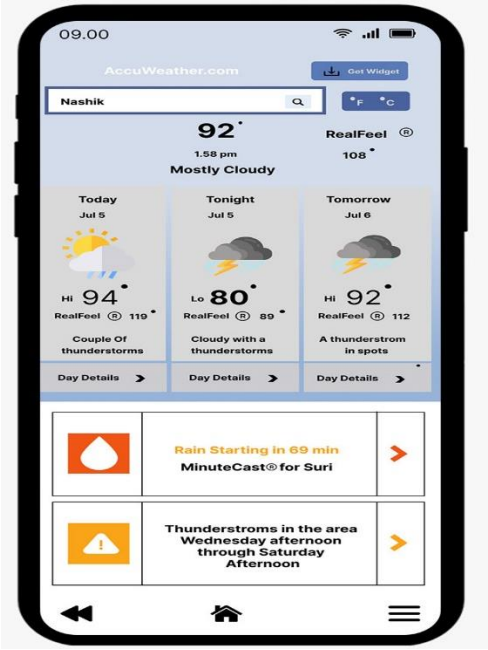
$$Fertilizer\ schedule = NN(T, GS, NR) \ldots\ldots (4)$$

The neural network processes the inputs and applies mathematical operations to provide tailored crop-specific schedules for optimal fertilizer application based on the given inputs.

These equations show how neural networks analyse the data inputs and generate predictions or suggestions for the Farm Calculator features. Depending on the model's complexity and design decisions, the neural network's specific operations and architecture may differ in the Farm Calculator application. Farmers that use the Farm Calculator will get access to precise predictions and recommendations thanks to the integration of neural networks. Through the use of data-driven insights and simplified farming techniques, these intelligent algorithms help farmers make educated decisions and increase the production of their crops. The Farm Calculator uses neural networks to analyse input data, identify patterns, and produce precise forecasts or suggestions. The application expands its capabilities and offers farmers useful knowledge and direction to improve their agricultural methods and increase productivity by utilising neural networks.



(a) NPK claculator



(b) Weather forecasting

Fig 4: Applications provided by “Farm Calculator”

1.2 The "Krushi care" system included several steps for implementation:

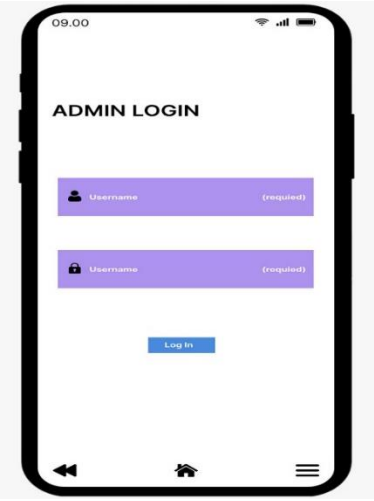
1. Requirement Analysis: To fully grasp the unique demands and difficulties faced by the farming community, the team engaged in comprehensive study and dialogue with farmers, agricultural specialists, and stakeholders during the requirement analysis phase.
2. Technology Selection: Suitable technologies were chosen with an emphasis on the Java programming language, IoT, data analytics, and real-time monitoring based on the defined needs.
3. App Design and Development: To provide a seamless user experience, a heavy emphasis was made on developing an intuitive and user-friendly interface during the "Krushi Care" app design and development phase. The app's architecture was thoughtfully created to allow for the fusion of numerous components, including the use of a MySQL database and APIs for market rates and weather predictions.
4. Testing and Validation are essential for guaranteeing the model's dependability. To find any bugs or performance concerns, its features, such as weather forecasting, soil health analysis, crop monitoring, and personalised advice, go through a thorough examination process. By comparing forecasts and suggestions to actual data, validation aims to ensure their accuracy.
5. Data Integration: These processes bring together data from various sources, including IoT sensors, agricultural machinery, weather databases, and soil analysis reports. Due to this linkage, the app can provide farmers with detailed analyses and suggestions that will help them manage their farms more effectively.
6. User Feedback and Iterative Improvements: The model is continuously improved as a result of user feedback. The functionality and user experience of the app are actively improved with the help of farmers' recommendations and comments. The software is improved through an iterative approach to answer user needs, ensuring that it continues to be a user-centric solution for effective farm management. "Krushi Care" is dedicated to addressing farmers' changing needs by actively engaging users and taking into account their insightful input.

The "Krushi Care" software was created using this concept as a thorough and efficient way to improve agricultural output, profitability, and sustainability.

3. Result and Discussion

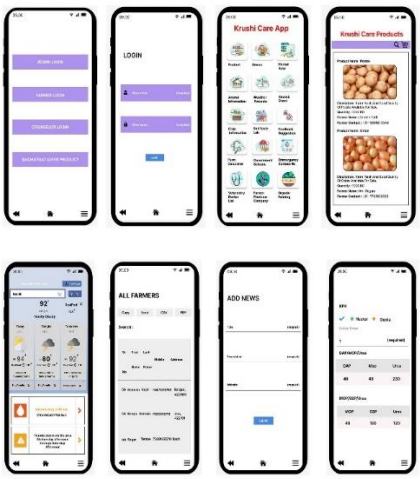
To transform farming practises, the AI-based "Krushi Care" app combines weather forecasts, soil health analysis, crop monitoring, and customised advice. The programme calculates the best plant populations and seed amounts, optimises fertiliser delivery, and delivers customised crop-specific schedules by utilising neural networks. This promotes sustainability, increases crop yields, and improves farming efficiency. In order to deliver precise and trustworthy information, the app's architecture uses technologies like MySQL, government weather APIs, and market rate prediction algorithms. It acts as a holistic remedy, addressing farmers' demands and facilitating educated choices for the expansion of the agricultural

industry.

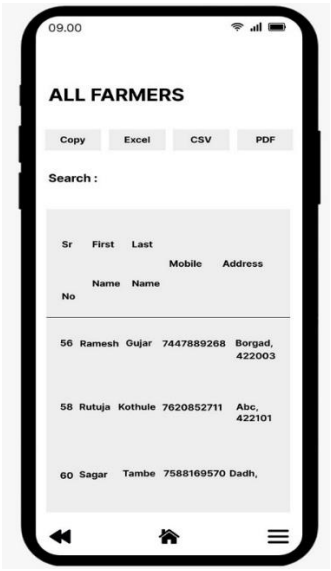


(a) Login window for admin

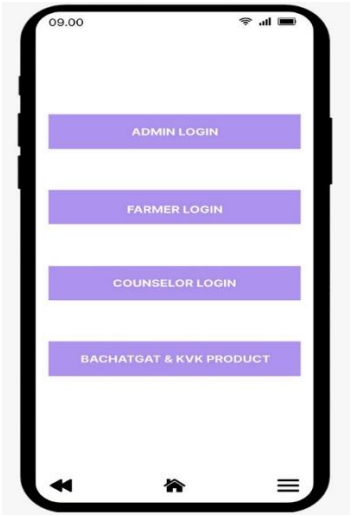
(b) Gallery of Krushi care application



(c) Applications provided by Krushi care App



(d) Window showing details of farmers



(e) Login windows for users of Krushi Care APP

(f) Page for adding news

Fig 5. Products offered by the Krushi Care application

The created Krushi Care app provides a vast array of features and functionality that are tailored to the unique requirements and difficulties faced by the farming community. The focus of the discussion is on the potential advantages and implications of these qualities for farmers, as well as any potential drawbacks and planned advancements. Although the Krushi Care app has many advantages, there can also be some drawbacks. These include the requirement for internet connectivity, the necessity for farmers to be digitally literate, and potential difficulties with data accuracy and reliability. Future upgrades can include upgrading user interfaces, increasing language compatibility, and adding further functionality in response to user feedback.

1.3 Further Products Offered by "Krushi Care":

"Bachat Gat" Product: The suggested approach features the ability to create and oversee Bachat Gat self-help groups. These organisations give farmers the chance to pool their financial resources, encourage saving, get credit, and support a range of agricultural endeavours. The software encourages cooperation and financial empowerment among farmers, enabling them to engage in income-generating activities as a group.

Krushi Vigyan Kendra (KVK): ICAR developed Krushi Vigyan Kendras (KVKs) as agricultural extension centres to offer farmers technical assistance, education, and training [9]. Farmers now have access to helpful information, professional guidance, and resources on a variety of farming topics thanks to Krushi Vigyan Kendra's connection with the Krushi Care app. It improves the app's capacity to offer thorough agricultural support, encouraging farmer production and sustainability.

Bhajipala Society: The Bhajipala Society is an agricultural cooperative society that operates in a certain area and focuses on growing, buying, and marketing fruits and vegetables [10]. Its integration with the Krushi Care app helps farmers by offering direct connection for selling produce, access to real-time market pricing, and decision-making. This partnership encourages an open and effective market, boosting agricultural profitability and supporting farmers' economic viability.

1.4 Research Gap:

1. Farmers must possess a certain level of technical expertise and familiarity with using digital programmes.
2. For some farmers, the cost of implementing and maintaining the necessary technical infrastructure may be prohibitive.
3. The quality of recommendations may vary depending on how well market trends, weather forecasts, and other external data sources are incorporated.

4. Conclusion

The Krushi Care model uses artificial intelligence (AI) and neural networks to boost agricultural output, profitability, and sustainability. The app gives farmers access to a wide range of tools and resources, including the ability to sell their crops, analyze markets, consult with industry professionals, anticipate weather and soil conditions, learn about government programs, and get in touch with medical professionals. With the aid of AI-based data analytics, the app provides farmers with important knowledge and assistance. The Krushi Care app's neural networks analyze current market information, spot patterns, and provide data-driven insights for better decision-making. With the help of this complete strategy, farmers may improve their agricultural methods, boost output, and increase profits.

The app uses AI technology to leverage useful data and recommendations that can benefit the farming community. The welfare and success of farmers will be further aided by the continued development and improvement of the Krushi Care app, while correcting any shortcomings. We have published UK design Petant for Krushi Care app with application number 6295896 on 12 July 2023. Farmers can enhance their overall agricultural performance by making educated decisions thanks to the ongoing improvement and efficacy of the app. The Krushi Care model represents an important step in reforming the agriculture industry and promoting the well-being of farmers.

- **Future scope:**

1. The application can be expanded to reach more farmers and offer those essential resources and agricultural support in a larger geographic area.
2. To offer farmers a wider choice of services and support, the application can form relationships with additional stakeholders including agricultural research institutions, agribusinesses, and governmental organisations.

Declaration: I have developed, tested and deployed Krushi Care app for PIRENS Krishi Vigyan Kendra (KVK) Babhaleshwar, Maharashtra, India in January 2020. Which is a subsidiary venture of The Indian Council of Agricultural Research (ICAR) New Delhi. This has helped PIRENS to intervene more intensively in the field of agriculture.

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