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Design of Expert Decision Support and Learning Console to Assist Farmers in Cultivation

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Abstract: ***Farming is the most significant part of the Indian economy where maximum outcomes rely on the effective functioning of the cultivation. It is not only commercially important but also extends a social responsibility for building a healthy society for future generations. In recent times, many people have shown interest in learning and implementing farming systems for better cultivation patterns but lack relevant expert guidance in completing the problem. The major objective of the research work was to design an expert system capable of portraying complete information on the farming practices in different farmlands and its decision-making process of the right type of crops to be cultivated to yield good production and support. The Intellect Farming Decision Support Framework (IFDSF) assisted budding farmers could learning the art of farming and finding solutions to their problems with technical support from an expert system. The major scope of the research is to build an expert system and implement it with intelligent support for the farmers.***

Keywords: Farmer Support System; Decision Support System; Farming Guidance; Intellect Farming Decision Support Framework; Cultivation Patterns

1. Introduction

Farming, being a significant source of food and materials, was very important in keeping people alive. In India, many people relied on farming for their jobs and income. But it was very important to look again at and improve the ways we update agriculture technology**[1]**. In the next few years, agriculture was expected to change a lot. The old way of farming used strong chemicals to grow crops, but in the future, technology will change how food is grown. Today, mobile devices are a very important part of our everyday lives, even for farmers and people who live in the countryside. Information and Communication Technologies found that mobile devices are very important to farmers in their everyday lives. The old ways that farmers in India used to do things were usually slow and not always dependable. But, using technology **[2]**can help farmers sell their products to people all around the world, making a lot of money. Farming success, no matter where they are, mostly depended on ways to make more land good for growing crops and caring for domesticated animals. With the Android application**[3]**, farmers can use their special username and password to get into the system. Farmers can put in and change information about their products when they log in, making sure the information is correct and current. Alternatively, users have the option to sign up and sign in to the system using their personal information. After signing in, users could see and buy agricultural products using easy online payment options.

This research paper presents an automatic and intelligent Android framework that helps farmers and users communicate and share information. The system lets users do farming research, upload research papers, and get approval from administrators to publish them. The system also worked as a place where people could buy and sell farming goods. It also communicated the problems with the current manual system, explained the benefits of the new proposed system, and described how both the front-end and back-end parts of the system were made. The conclusion stated that the system was implemented successfully and it recommended ways to make it better, like adding web application features and improving data protection.

This computerized Farming Assistant System helps farmers and users easily communicate and share information. The system allowed people to study farming information and share their research. It also lets people buy and sell farming products. This improvement would fix the problems of the current manual system and provide many benefits. The system worked well and showed that it can be improved even more by adding web application features and making the data more secure.

2. Related Works

Plant diseases were a significant remedy to world food security, impacting crop yields and economic growth. exact recognition of plant diseases was tested to reduce crop loss and improve plant health. conventionally, plant organization was performed alternately, depending on the proficiency of the classifier. However, recent advancements in deep-learned techniques have enabled the creation of efficient crop classification systems using computer technology. the ability to find pictures of plants left on a synthetic neural network proposed by an automatic plant recognition process. The trained model efficient net-b3 was utilized to attain a high achievement rate of 98.80% in locating the corresponding exact match of plant and disease. it allowed agronomists and users to easily identify diseases from the left to make the system easy to use, an Android application and website were generated. ***Shah, S. A., et.al. (2023)*[4]** discuss the transfer method for examining a different plant disease, and pictures were captured using a drone or a mobile camera. The ultimate goal was to generate a user-friendly leaf disease product that could work with mobile and drone cameras. The presented technique provides an effective tool for quick and efficient plant disease discovery, which could support farmers of all levels of the incident in making informed conclusions about the utilization of toxicants and optimizing plant health. ***Vignesh, L., et.al. (2023)***[5]aimed to present an agricultural system essentially to reduce the risk and the major problems that were being faced by the farmers to get the maximum yield and help them to take the best decision required during farming to reduce the loss they might face. Implementation of the mechanical irrigation system and displaying the farm conditions like temperature humidity and moisture in the app. The farmers could keep information like how much crop and what type of crop they had grown on their farm. The farmer could predict the yield he could get for a particular crop that had been developed using a casual forest regression design. The farmer could trade his crop by transferring yield details to all the suppliers. If the supplier was interested, he could connect the agronomist and buy from them. Prediction of yield used the erratic forest regression design for farmers to predict their yield.

According to the Department of Agriculture, there are currently 9 different types of pests and 8,000 different types of diseases in the province of Samar. The agronomist didn't know which pests and defect were harming their crops. Currently, local farmers and scientists collect information and reports on crop damage and study them manually to make decisions. The person wanted to do a scientific study and made a special phone app that used GIS technology. The app would help fix the problems in a department. The personalized smartphone app with a mapping system helps keep track of and analyze crop pests and diseases in the province of Samar. ***Durango, D. B. (2022)***[6]used fact-finding methods that gave dependable and precise outcomes by using different approaches. In creating the software, we used the agile model and Hersh's iterative four-stage approaches. In addition, to create the GIS map, the person used thematic mapping and a manifold system. The special computer program with a GIS map was tested for how well it worked, how dependable it was, and what it could do, according to iso 9126 standards. The findings showed that most users liked customized software a lot, with a rating of 94.3%. ***Sreenivasa, N., et.al. (2022)***[7] developed a system that allowed users to access information about what kind of crops were in demand in the market and helped farmers know what to grow to meet those demands. This app had 4 parts. The first part was called pre-production. It helps users grow crops that meet what the market wants. Next was the part of the app where people could buy and sell things. Customers could sign up by giving their information. The admin put yields for trade, and the purchaser could buy them. Farmers could also sell their products online. The third module was called "blogs" and it helps farmers learn how to use fertilizers to grow more crops. The fourth module was about smart farming. It had a sensor to measure climate, a sensor to measure dampness, and a sensor to detect pests.

Farming was one of the first jobs that people had done. Many engineers were trying to find methods to make cultivating robots better because we use them a lot and depend on them. However, most agronomists carry on to use outdated techniques and tools, like wooden ploughs and sickles, to farm their land. Randomly scattering seeds was one way to grow crops, but it requires more materials (seeds, water, fertilizers) and results in higher costs for solving problems in farming. In research, ***Rakhra, M., et.al. (2022)***[8] introduced a robot that could solve this problem by keeping track of the space between seeds to avoid wasting water and by using a soil Ph sensor to determine when plants require fertilization. The hc-05 Bluetooth constituent connects to an Android device and lets you control the robot's movement from far away. The proteus software was used to create the simulation analysis and the Temperature/Humidity graph. The proteus software also imitated the quantity of water in the soil and the acidity level of things in the soil. ***Kumar, B. S., et.al. (2022)***[9]created a robot that used solar power and could do tasks like ploughing, planting seeds, and spraying water. It had been controlled through the internet. This system kept track of the climate, dampness, and sand moisture levels. It then sends this information to an IoT application. It also helps controlled robots use an IoT module automatically. The most important part of this was the AVR at the mega microcontroller that oversees everything. First, the robot prepared the entire field by tilling it. Then, it ploughs the field while also planting seeds next to each other at the same time. The IoT device sends data regularly to the microcontroller. An IoT module was used to control the robot and make it move in different directions. DC geared motors were used to move the plough and release the seeds while a watered sprinkler automatically sprays watered for planting seeds in agriculture. All parts were connected to a tiny computer called Arduino. An Arduino atmega328 microcontroller was a small computer that took in information and did things with it. It did this by using software called Arduino IDE and a type of programming called Embedded C. It needed a special power supply that gave it a steady 5 volts of electricity. ***Bimantio, M. P., et.al. (2023)***[10] developed a computer program that could help farmers figure out at what cost they would be made from selling their fresh fruit. Farmers could use this app to see how much they earn by selling a certain number of crops. This study was done in the Mesuji Regency, Lampung province. We collected our information directly and analyzed it in a way that describes it. The way we chose the farmers for our study was by using a method called proportional random sampling. The author selected 88 farmers who grew oil palm trees. The findings showed that the app made it easier for farmers to figure out what cost they earned. Farmers just had to enter the size of their land, the number of fruits they harvested, and the price of the fruits. This way, they could find out at what cost they were expected to make each month and every year. Farmers could use these calculations to help them predict and plan their farm activities to prevent any losses.

Farming is the foundation of our environment that relies on changes in weather, temperature, and the condition of the soil. Crops in the field were very valuable, like gold in a jewellery shop. They needed to have been taken care of and protected to make sure they stayed safe. To preserve crops from diseases, bad weather, and wild animals that could destroy them quickly without anyone noticing, it was important to monitor them closely. ***Deotale, P., & Lokulwar, P. (2022)***[11] analyzed the problems that farmers had when they were trying to protect their crops as they were growing. They would often wake up with fire in their hands to protect the crops and themselves from wild animals. This system was completely automatic and could be controlled from faraway places at any time. ***Pangestu, A., et.al. (2023)***[12] wanted to create a mobile app for Android that helps people with farming and food businesses. This app lets users make and sell food by themselves. The system was made to motivate people to do things like grow and sell crops, buy food, and keep an eye on the weather.

Spraying pesticides and herbicides on crops and weed control on the field was hard work for people. It was hard to remove certain plants or crops from the field manually. ***Ingle,A.H., et.al. (2022)*** [13]developed a machine that uses solar power and can be controlled from a distance. It is flexible and can move in different directions. It can also spray things and has equipment to cut plants. The machine was made to spray pesticide or insecticide directly onto each sore without wasting or using too much spray. This makes it cheap and good for the environment. It was made to control the start and stop of cutting plants we don't want to use a remote control. Alternatively, it also helped keep grassy lawns and sports fields in good condition. We can use the same system to spray water and cut the grass to the height we want. This helps keep the field well-maintained. ***Santoso, W., et.al. (2023)***[14]analyzed to identify how much farmers knew about managing knowledge when it came to following Indo-Good Agricultural Practices. This was important because it helped make sure that Prima-certified fruits can be grown sustainably in East Java. We used purposive sampling to choose 15 fruit farmers for our study. In total, we had 45 samples. The Guttman Scale measured if knowledge was created, shared, and used, using true or false statements. Then, the amount of knowledge in each dimension was figured out. The mango farmers in Pasuruan Regency knew a lot about creating, sharing, and using knowledge. Kediri Regency pineapple growers had varying results. Some growers had a low level of knowledge-sharing understanding. This happened because Prima-certified producers found it hard to understand the criteria for good agricultural practices. Starfruit farmers have the most advanced level of knowledge, called Knowledge Sharing. This suggests that there is a strong social bond when a farmer knows about Indo-Good agriculture and is willing to share knowledge or help others avoid harmful mistakes.

Farmers invest a significant amount of money in machines to reduce the work needed and improve their crop harvest. Introducing the Agricultural Robot, a new invention engineered to perform the functions of ploughing and seed sowing automatically. ***Kumar, B. S., et.al. (2022)***[15] intended to create a robot that uses solar power and can do things like automatically plough, plant seeds, and spray water by using the Internet of Things. This system kept track of the temperature, humidity, and soil moisture levels and would send the information to a smartphone app. It also had a robot that could be controlled automatically with a module called IOT. The most important part of this was the AVR At the mega microcontroller that oversees the whole process. First, the robot prepared the whole field by digging it up. Then, it started planting seeds while also ploughing the ground at the same time. The device is controlled by the Internet of Things (IoT) technology, which constantly sends data to the microcontroller. The IOT module helps to change the robot's direction. DC-geared motors were used to push the plough into the soil and sow the seeds. Afterwards, the water sprinkler spreads water on its own to help with automatic planting in agriculture.***Kenny, U., et.al. (2021)***[17]This study's objective was to demonstrate how the design thinking methodology may be applied to the creation of a smartphone application for the agricultural sector. The main finding of this study is that each of the first three design thinking stages can help designers and researchers who want to create a smartphone app that satisfies potential target users' needs and incorporates some of the RRI principles concretely. It involves the potential app users in the process of identifying needs as well as the technical solutions that may be used to satisfy those demands.

Paparrizos, S., et.al.(2023)[18]The FarmerSupport app (FSapp) is a service created to help farmers with weather and climate information. It collects forecasts from local farmers and scientific sources and shares this information with users, so they can make better agricultural decisions. The FSapp was used in two rice communities in northern Ghana during the 2020 crop season to test how well it works. Farmers were introduced to the app and received training on how to use it, as well as learned about weather and climate and how to use technology. Farmers found the app fairly accurate and reliable for planning their farming activities. It's important to implement the app in more farming communities to meet the weather and climate information needs of small-scale farmers and help them reach their full agricultural potential.

Chowdary, Y., et.al. (2023) [19]This app helps farmers to sell their crops directly to customers without any middlemen. It also allows farmers to connect through discussion forums. The app was made using real data from agriculture experts, officers, and experienced farmers. It is designed to be easy to use and available in Telugu, so anyone can use it.***Walker, S., et.al (2021).***[20] The Rain for Africa consortium created a mobile app called AgriCloud, which provides daily updated information to extensionists and small-scale farmers. AgriCloud offers location-specific advisories in local languages on Android phones. This app has helped farmers make better use of rainfall by allowing them to plan land preparation and planting based on weather forecasts for their specific farms. One of the benefits is that users eagerly receive daily updates with farming advice in their local language, directly on their phones.

The significant gap associated with the current system was that there was no way for the user to communicate with the farmers. The old system was operated manually with high-cost equipment and time-consuming elements. The system used a lot of paperwork to keep track of information about farmers. It was hard for users to find specific farmers using the manual process. In the current system, the user didn't have information about the details of a farmer's product and where it would be sold. The old system took a long time to find specific information about a farmer. Some problems with the existing works by different authors are: not giving quick answers to questions, needing a lot of paperwork which is expensive and takes a lot of time, not having a good place for everyone to learn, and lacking farming knowledge for beginners.

3. Methodology

The Proposed Framework combines technology with an Android-based application to design an expert system that is compatible with the way to attain the best solution to the problem of assisting farmers in many ways with all the information about agriculture. It included details like new methods of implementing agriculture to increase productivity, finding the right crop for the right land and providing product details to yield productivity. It also acts as a mediator between farmers and Users to assist them not only to cultivate the crop but also to promote their products with automatic contacts to sell them as well. This proposed system is fully computerized thereby reducing the manual work. The proposed Intellect Farming Decision Support Framework (IFDSF) comprised of three phases viz., 1) Learning Phase, 2) Expert Engine Design Phase and 3) Decision Support Prediction Phase.

During the first Phase, Initial Login after registration and training the expert engine with six categories of information including Crop details, soil details, leaf details, fertiliser for specific land details, land details and better weather conditions required for growth of the crop respectively. It is in this phase that the actual learning and training process takes place in the process. The training process is carried out using specific models from data mining and stored in the database at the end of the first phase.

During the second phase, the inputs received from the global database are compared and manipulated with the user input as a query processing engine. The input is then shared as a query to the Intellect Farming Decision Support Engine for analysing the queries and mapping with the intellect expert information from the database. The mapped information is used for learning the different aspects of farming. This training happened for 'N' times until the expert system was normalised.

In the third phase, the decision support system would bring solutions to the user inputs on soil, leaf or any query requests and give decisions based on the best result possible. The final phase studies the inputs from the user maps them with the existing knowledge and brings a solution to the problem of predicting the best crop prescription based on crop, leaf, land and soil along with the fertiliser to be used and the weather conditions suitable for growth. The overall framework with three major phases is depicted in Figure 1.

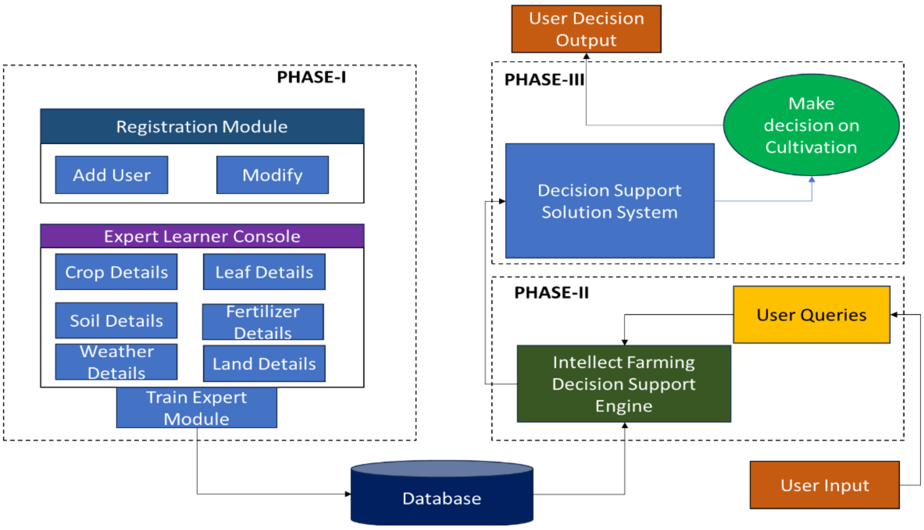

Figure 1: Proposed Intellect Farming Decision Support Framework (IFDSF)

As portrayed in Figure 1, the three phases implemented three major activities of the entire work in a significant manner incorporating the knowledge and decision support system in such a way that it productively assisted the budding farmers.

4. Implementation and Evaluation

The proposed model has been implemented using the Android System Development Kit using the Android Studio platform with three different phases implemented in three levels. Initially, the user has to login to the system using the login form. If the user is new, then registration is compulsory to enter the expert system. The initial login showed different kinds of learning and training possibilities as shown in Figure 2.

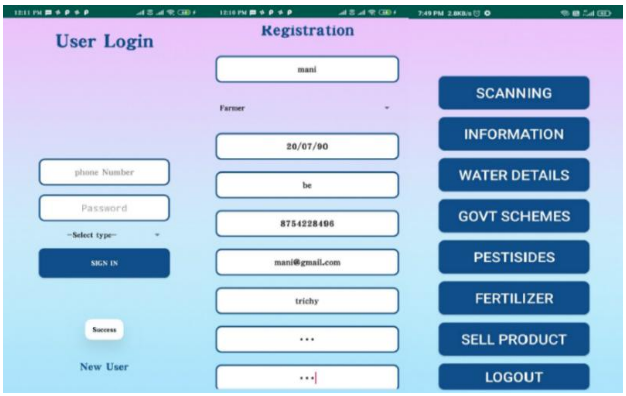

Figure 2: Initial setting for registration and expert learner console

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Based on the information in Figure 2, various details like scanning of images, details of water, pesticides, fertilisers, product sales, government schemes to sell crops etc could be learnt all in one space. The image of the land and soil could be loaded in the learner and trainer console as shown in Figure 3.

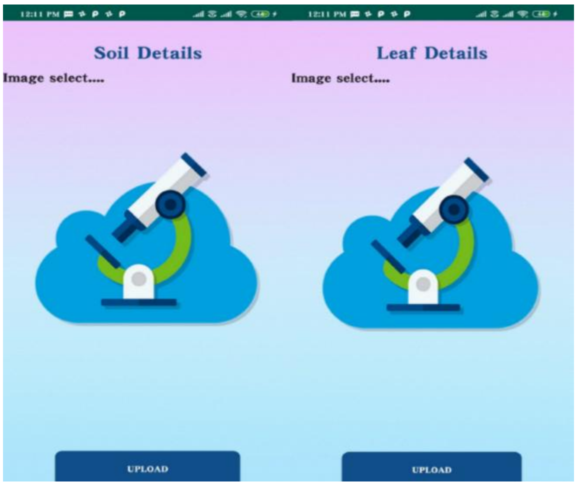

Figure 3: Analysing the quality of soil and leaf in the Engine Design phase

As shown in Figure 3, the Intellect Farming Decision Support Training phase included analysing the quality of images to train the model and bring knowledge into expertise. After continuous training, the model has been trained and implemented as a tester with user input as shown in Figure 4.

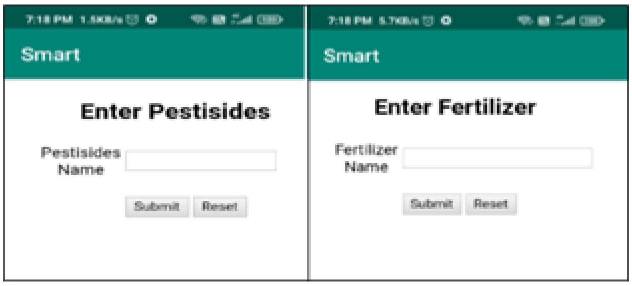

Figure 4: Training model to identify the quality of components in farming using expert engine

As given in Figure 4, the sample data for pesticides and fertilisers were trained and tested using sample inputs from users who were budding farmers and the training was conducted with the knowledge base from the expert's suggestions and opinions. The intellect systems have been trained and implemented in the decision support system at the final phase as shown in Figure 5.

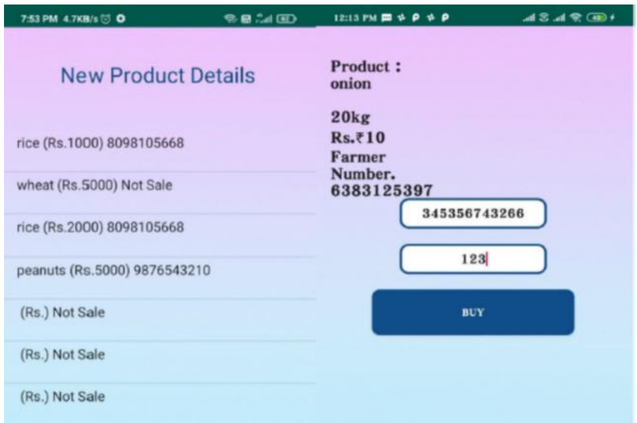

Figure 5: Final Phase Decision Support System for testing the trained model

As indicated in Figure 5., new products like rice and wheat were added and their price, quality and automatic predictions of latitudes and longitudes of availability were tested. It was found that the results were accurate in terms of identifying the right degree of location for selling the products. Same way, the soil level, water level, support of land and weather for the cultivation of a crop have been tested after consistent training. It was significant that these predictions were real and could lead the way to achieve better results in the future. The water level analysis with minimum, maximum or metered levels has been generated after effective training methods. The final results were stored in the database and implemented in the respective Internet Address as given in Figure 6.

Figure 6: Testing the final water level, attaining decision support and storing an IP Address

The outcomes in Figure 6. suggested that the water level was found to be 20% at the minimum level and 50% at the maximum level with a metered level of 1000 m indicating that the water level is at a moderate level. Hence, the inference is that it doesn't suit the development of crops that require more water but could be capable of growing crops with moderate availability of water. The results attained were stored in the cloud-based IP address 192.168.1.4 where further training [16]and predictions are possible. Thus, this framework-based Expert Prediction system has significantly assisted in building a comprehensive platform for farmers to engage themselves in new and innovative forms of farming methods for future perspectives.

5. Conclusion

The research paper highlighted the efficacious execution of the automated expert Farming console that could benefit the life of budding farmers in the current generation and could update its knowledge according to future requirements. It showcased the system's inability to address the limitations of the manual system and provide valuable features for farmers and users. The paper suggests a web-based Android application for future scope and capabilities, which would further improve accessibility and usability. Additionally, the paper recommends the implementation of enhanced secure algorithmic model measures to ensure the confidentiality and integrity of the information stored within the system. These future enhancements would strengthen the system's functionality and make it even more valuable to the farming community. Future enhancements could include the development of a web application or Android-based interface, enabling users to access the system from various devices. Additionally, implementing advanced security measures to protect user and farmer data would enhance the overall system's integrity and trustworthiness for future generations.

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