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Go Green Paddy App: A Mobile Application for Rice Cultivation

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***Abstract* - This is crucial to the industry of agriculture that accurate performance projections are made during the growing season. The expected yields can be easily attained through the use of fertilizer on a consistent basis (using fertilizer in a smart way), as well as through the decrease of crop pests. This study's objective is to improve agricultural productivity by providing farmers with the technological tools necessary to do their jobs better. The discussion will focus on four crucial aspects that influence performance. The level of nitrogen in the soil should be evaluated so that a suitable amount of urea may be recommended. The process of forecasting future yield based on historical data collected from a particular area. A disease and four different kinds of agricultural pests were identified. The color of the leaf color indicator is used to calculate the quantity of nitrogen present in the plant. For the purpose of this screening, two grant parameters are considered. To measure this parameter, the colors palette API is used to confirm the color, and the decision tree method is used to confirm the age of the tree. This parameter is determined by the color of the leaves and the age of the tree. A pattern can be obtained that is more accurate than what can be seen with the naked eye, and this is something that is conceivable.**

Keywords: fertilizer, level of nitrogen, forecasting, indicator, the naked eye.

I. INTRODUCTION

One of the world's most vital crops, paddy (Oryza sativa L.) is a staple sustenance for billions of people. Around a third of the world's population relies on it for sustenance. Rice is the most widely consumed staple crop in South Asian countries [1]. Protecting the availability of food for an increasing global population is a major issue today. Improving production and mitigating the factors that contribute to lower yields can help farmers overcome this challenge. When it happens, you can get the best potential harvest. How much of a crop can a farmer hope to reap before having to start again with new seeds? If they have the ability to forecast, they can keep working optimistically from the start to the finish of their cultivation process. Predictions can be made based on information collected from certain areas. We used data spanning many years of history to arrive at this conclusion. Annual precipitation, the amount seeded in the previous season, the harvest from the previous season, and the predicted weather for the next season all have a role in determining the pH value of micronutrients and macronutrients in the soil of that location. The prediction accuracy of this approach is more than 75%. A plant needs both macronutrients and micronutrients to thrive. Yet, macronutrients have a far-reaching impact on crop production. However, nitrogen is a nutrient that has a noticeable effect on rice yield. Even so, macronutrients affect production significantly. Furthermore, nitrogen is a nutrient that has a noticeable bearing on rice output. Fertilizers containing nitrogen and urea are widely used in modern farming. No amount of nitrogen-based fertilizers will produce the intended result. A proper understanding of the nutrients, texture, and content of the soil being farmed is crucial for the efficient application of fertilizer. Cereal plant leaf color (like that of rice) can be used as a proxy for nitrogen concentration [2].

The green color chart is another option. While this may be the case, the farmer really confronts a number of challenges. Distinction from seeing colors, for instance the following elements influence the following ways in which time affects the leaf color chart. Several measures have been taken to lessen the impact of the underlying causes. The leaf color chart will benefit from this award. This area may be seen in six distinct colors. The document's age is estimated using machine learning techniques. The amount of urea fertilizer needed per hectare is then calculated.

The agricultural industry is fraught with difficulties, and rice growers must contend with a number of factors that reduce yield, including insect damage. Insects that are common in this nation and cause damage to rice fields have been the subject of research and presentation by agricultural specialists, but this information has not been put to good use. Many American farmers are still using the same methods that were used decades ago. It's possible that such outmoded

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methods are still widely used, wreaking havoc on their crops and harvests [3].

The ecological balance has been disrupted in the modern day owing to the complexity of some diagnoses, thus it is necessary to seek the guidance of an expert even if these traditional methods have proved useful in some cases. As a result of their own observations, twenty farmers in that area regularly employ the usage of pesticides and infectious diseases to control insect populations. The outcome is the annihilation of the rice crop plants. That's why it's so important to confirm the identification of the pests and get rid of them once and for all. Expert opinion has decided that the key to successfully repelling and controlling these insects is in being able to identify them. Now that every farmer has a smartphone, they may use it to accurately identify insects in the field using an application program, learning more about the insect's biology and the harm it does in the process [4].

II. LITERATURE REVIEW

A) Nitrogen Vacuum Detection

Increases in both rice output and fertilizer use have been seen during the past decade. To meet the needs of Asia's massive population, rice cultivation has become a major issue. Instead of rising to the challenge, the farmer gave up on organic farming in favor of using chemicals. When it comes to growing rice, nitrogen is the single most important nutrient. It's possible that a more conservative approach to nitrogen treatment might have a significant impact on crop production. However, farmers have a hard time estimating how much nitrogen fertilizer paddy fields need. Rice farmers can tell how much nitrogen is in their crops by looking at the leaves. On the other hand, if we look at the Leaf Color Chart (LLC). The amount of self-control needed to pull that off is massive [5].

Nitrogen is an element that is absolutely necessary for the prosperity of rice and wheat crops in South Asia. The desired level of effectiveness could not be accomplished because an excessive amount of nitrogen was used. It is possible to enhance nitrogen efficiency by evaluating the crop's demands and supplying nitrogen in accordance with those needs. That ought to be a reliable indicator overall. As a result of this, a diagnostic tool known as a chlorophyll meter in conjunction with a leaf color chart (LLC) may be utilized.

Throughout the growing season, you may use this apparatus to determine if the crop has a low or high nitrogen level, and it can also assist you in determining the amount of fertilizer that should be provided to the plants. Chlorophyll meters are available for purchase from organizations that focus on agriculture; however it is unreasonable to anticipate that every farmer will do so. In spite of this, the color scheme has been utilized previously in agriculture in South Asia, where it was shown to assist increase nitrogen efficiency [6].

In accordance with the recommendations provided by IRRI, 6,000 different photographs of paddy leaf surfaces were gathered and examined. The information was semantically segmented by utilizing a powerful convolutional neural network (CNN) backbone architecture. In order to do this, we employed the CNN architecture as well as the DT algorithm. A categorization of level 4 was carried out, and a CNN score of 94.2% was accomplished. Just 91.2% of patients were diagnosed with DT throughout this study. It is possible that the plant is ill and should be destroyed if the leaves have become very dark or is almost completely black. The projected production of nitrogen from this experiment is shown in the table, along with the typical yield that was determined by the model. The estimated amount of nitrogen present (per kilogram) falls somewhere in the range of 10 to 20 [7].

B) Insect Classification and Detection

Growing paddy often involves a process that is time-consuming and labor-intensive, beginning with the preparation of the land and ending with the harvesting of the crop. Damage caused by insects is one of the numerous difficulties that farmers face that prevents their rice crop from prospering and generating a harvest. Other difficulties include: Rice fields are susceptible to considerable damage from insects, which is an issue that requires prompt attention. There is clear evidence that insects have caused harm to rice fields in the form of weakening tree trunks, smaller foliage, and withering seeds. As a result of these results, farmers are unable to obtain their customary output. Paddy fields are home to a wide variety of insects; some of the most common of which being brown plant hoppers, paddy bugs, rice leaf filers, and stem borers [8].

According to the findings of the study, this pest caused harm to the rice crop throughout its development. These unwanted organisms need to be recognized and eradicated while they are still in their juvenile stages. The farmers of this country have endured significant monetary loss as a direct result of a scarcity of knowledge and experience in the field of insect identification. Because many farmers in this country continue to use methods that date back centuries. Insect control methods that are harmful to crops are still effective. The primary objective should be to recognize and eradicate these invasive species while they are still in their immature stages. These insects help preserve the natural order of things [9].

Insect identification is challenging and susceptible to interpretation by different professionals. Our work aims to discover insects early in development and provide therapeutic introductions. These studies use the Keras Application

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Programming Interface [4] to define and train high-level APIS neutral networks. Tensor Flow's high-precision prototyping makes new research and production possible. Tensor Flow's API is also simple. Google sells this. Python is the scripting language because of TensorFlow.

It uses CNN to identify flying insects. The recommended investigation examines the accuracy of the Android Studio-built mobile app to detect properly and conveniently. Mended prototyping's easy API allows for new research and product development. Google provides. It identifies photographs using a convolutional neural network (CNN) using Python since it connects with Tensor Flow. CNN and Python find flying insects. The mobile application that uses Android Studio to identify users reliably and simply will assess the correctness of the proposed research [9].

C) Yield Prediction

Achieving Predicted Yield and Improving Yield Components of Mung Bean via Fertilization with Nitrogen, Phosphorous, and Potassium. Mung bean (Vigna radiata L.) is a variety of edible bean that is widely consumed in many regions of the world. Its growth and output might be hindered by insufficient or improper application of fertilizers including nitrogen (N), phosphorus (P), and potassium (K). Despite this, there are few long-term researches on how varying N, P, and K amount in fertilizers influences mung bean yield and quality. With the goal of optimizing fertilization strategies for high yield and improving yield components (pods per plant, seeds per pod, and 100-seed weight) in the Bailv9 mung bean cultivar, 23 treatments were tested in 2013-2015 using a three-factor (N, P, and K fertilizers), five-level quadratic orthogonal rotation combination design. Our findings show that the concentrations of nitrogen, phosphorus, and potassium in the soil significantly influenced both pod production and overall yield [12].

Nitrogen and phosphorus fertilization had significant effects on 100-seed weight, with the former increasing gradually with increasing N fertilizer and the latter reducing dramatically with increasing P fertilizer. When N and K fertilizers were increased, the quantity of seeds produced by a pod decreased considerably, while P fertilizer had little to no effect. There was a substantial effect on yield and pods per plant from the NP interaction at high N levels, but the NK interaction at low N levels. When aiming for yields in excess of 2,141.69 kg ha-1, the optimal fertilization conditions were 34.38-42.62 kg ha-1 N, 17.55-21.70 kg ha-1 P_2O_5, and 53-67.29 kg ha-1 K_2O. In addition, the best intervals for N, P, and K fertilization for pods per plant > 23.41 and 100-seed weight > 6.58 g crossed with the interval for yield, the best time between N fertilization to maximize seed yield in each pod did not change.

The optimum ratio of nitrogen, phosphorus, and potassium fertilizer was found to be 1:0.5:1.59. It took three years of research, but in 2016–2017 scientists validated the best fertilization procedures; the findings indicated a 19.6-percentage-point increase in yield compared to what had been obtained with traditional fertilization. This study provides a theoretical basis and practical advice for optimizing mung bean yields through the use of best-practice fertilization methods [1][4].

The most current research looked at the impacts of nitrogen, phosphorus, and potassium on rice's growth and development. The study was titled "Nitrogen, Phosphorus, and Potassium Functions in Energy Status." Nitrogen (N), phosphorus (P), and potassium (K) are essential nutrients for the growth and development of plants; yet, the functions that these nutrients play in the energy status of plants are not well known [3]. In this investigation, Nippon bare rice seedlings were cultivated in a growth chamber for a period of twenty days at temperatures of 30°C during the day and 24°C at night, with varying amounts of natural sunlight and a number of different fertilizer regimens.

The results revealed that of the three nutrients examined, N had the largest influence on plant development and growth. Plants that were provided with an adequate supply of nitrogen, phosphorus, and potassium had the highest levels of nonstructural carbohydrate content, dry matter weight, net photosynthetic rate (Pn), ATP content, and activities of NADH dehydrogenase, cytochrome oxidase, and ATPase. These plant characteristics were attributed to the plants' ability to produce more ATP. It was discovered that plants with low levels of nitrogen had the lowest values for these characteristics.

While there was no statistically significant difference in the ratio of respiration rate to Pn between the K-deficient and P-deficient treatments, the former showed higher dry matter building than the latter, which may be attributed to variations in the efficiency with which energy is generated. Further evidence in favor of this hypothesis was supplied by the higher levels of ATP and activity of NADH dehydrogenase, cytochrome oxidase, and ATPase in the K-deficient plants. As a result of this, we concluded that the relative effectiveness with which nitrogen, phosphorus, and potassium created energy in rice seedlings was a factor that determined the eventual growth and development of rice plants [13].

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III. METHODOLOGY

A) Urea recommendation

Calculating how much urea fertilizer should be applied to the paddy field is the objective of this component of the grant. The classification of paddy leaves was accomplished by the use of digital pictures of the leaves. Once 14 days had passed since the seedlings were planted, 200 images of the paddy leaves were taken to record the development of the seedlings. Excellent for usage in outdoor spaces like gardens. pointing out the location of the ROI.

In order to correctly assign these semantic labels, a comprehensive description of the artifact's outline is required. Image-level classification has the potential to reliably identify visual items, putting it ahead of other algorithms in terms of performance. The method for resolving this issue is being followed currently. An FCN is the sole source of motivation for the model that is used to recognize and comprehend things. The Deeplabv3+ segmentation model maintains a high level of precision and throughput even when operating on devices with limited processing power [11].

A machine learning decision tree approach was utilized in order to ascertain the amount of time that had elapsed after the paddy leaves had been gathered for harvesting. The decision tree method may be described as having supervised learning. The process of subdividing plant components into distinct groups according to their ages results in the formation of a decision tree. For your convenience, we have listed all seven of the resultant datasets below for you to go at. This is highly dependable, with an accuracy of 84%.

The decision tree method is used to determine the age of the plant, while the Palette API is utilized to determine the RGB value of each leaf. The following is an explanation of the information that may be found in the local database on how much urea should be provided dependent on the leaf's age and color.

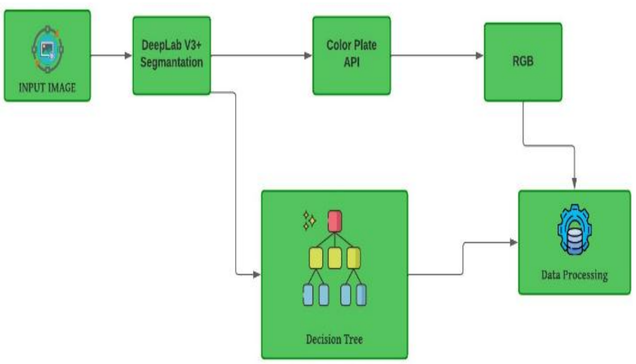

Figure 2: Amount of urea to be applied to the age and color of the leaf

B) Insect Detection

The architecture for image categorization includes a Convolutional Neutral Network, as shown in Figure 1. There are four distinct phases to this procedure, and we'll look at each one in turn below. All the same steps are included in TensorFlow, and the pictures produced are processed by using CNN in a highly accurate and time-efficient manner utilizing open-source software written in the phyton programming language.

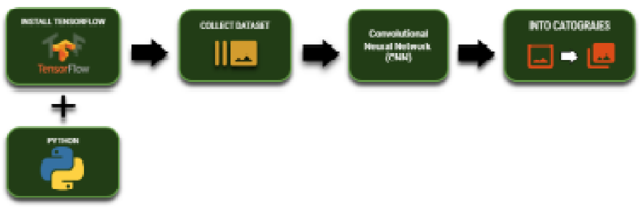

Figure 3: Data Model

This study utilizes hundreds of photos as input. These photos were taken while visiting rice fields and researching insects with a DSLR. Each time these challenging photos are observed in the field. To capture these photos, they spent days in the rice paddies. To distinguish photographs, they are labeled and categorized. This paper used thousands of bug pictures and first-used insect kinds. Our study aims to accurately identify and describe these insects. This dataset comprises 3600 farmers. Table 1 lists the bug numbers.

Table 1: Number of all insects

No	Type of Insect	No of Images
01	Brown Plant Hopper	1080
02	Paddy Bug	1000
03	Rice Leaffolder	850
04	Stem Borer	670
	Total of Insect images	3600

The first 25 photographs from the training set are displayed here, along with the appropriate class labels that are supplied beneath each image. This is done to check that the data set is accurate. The CIFAR-10 dataset contains a total of ten unique categories of color images, with 700 examples drawn from each category. There are 3600 photographs utilized for the purpose of instruction, and another 6000 are utilized for evaluation. There is no overlap or blending of any of the several groups. The input for the CNN is the shape tensor, which includes the dimensions and color channels of the picture. This occurs regardless of the batch size. Those who are not familiar with these measures could benefit from color channels (R, G, B). In this particular instance, the CNN

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will be shut down so that the shape (32, 32) may be applied to the CIFAR photos.

C) Harvest prediction

Phosphorus, potassium, and nitrogen feed paddy. Sri Lanka is initially used to determine the optimal fertilizer level in particular places. You cultivate rice. This software calculates the raw material needed to expand paddy output. Generated using last year soil samples from both sides. Excel data from previous years. Before releasing the data online and in other papers, the agricultural agency and senior farmers checked it. Assuming optimal meat availability. Data is fed into an arima model and trained. Time series forecasting is frequently commercially valuable. It drives business strategy, procurement, and production in most industrial businesses. Forecast inaccuracies will affect the supply chain or any firm. To save money and succeed, precise estimates are crucial [14].

Multi-step prediction intervals for ARIMA(0,0,q) models are relatively easy to calculate. model as yt=εt+q∑i=1θiεt−i. n Statistics 101, taught about a series of independent and identically distributed variables X11, X22, X33 etc... observe multiple, identical experiments i=1,…,n=1,…,where an ωi∈Ω∈Ω is randomly chosen and this allows us to learn about random variable X By the 1n∑ni=1Xi1∑=1 converging almost surely to E[X]E[].

Data analysis and the accompanying manipulation of tabular data stored in Data Frames are the primary purposes for which Pandas is utilized. Importing data into Pandas is possible from a wide variety of file formats, including comma-delimited values, JSON, Parquet, SQL database tables or queries, and Microsoft Excel. In order to accurately forecast the harvest, a learning Arima model will be developed using the data that has been collected. Transmit a server to the input data model so that a comparison can be made between it and the model. And the mobile app serves as the final destination for the data that was found. The information that the farmer needs to know may be quickly accessed thanks to the recommendation that is included in the information provided by the mobile app. As the user enters fresh information, a value will appear indicating that the current quantity is insufficient [17].

From within the program, input the user's information. Placing the other value lab sheet data, setting it to panda, and checking to see how much the value has increased recently are all things that you should do. A flowchart of the classification systems a flowchart of image classification is implemented using TensorFlow. Facilitation Python, the language used in the software produces images of insects, which are then used to train the CNN model. Run for validation or testing and it should restart from CNN If it is not the specific insect image that works as output, The process ends after the output is classified into the correct method type. The flowchart starts by entering the image set as the research input. It has five types of insects. Brown plant hopper, paddy bug, rice leaf folder, and stem borer After that, all these inputs are 'trained' with the convolutional neural network. A convolutional neural network (CNN) must be trained on all these sets. The system continues to check whether each category belongs to one of these five classifications until each of the 3600-image data is identified.

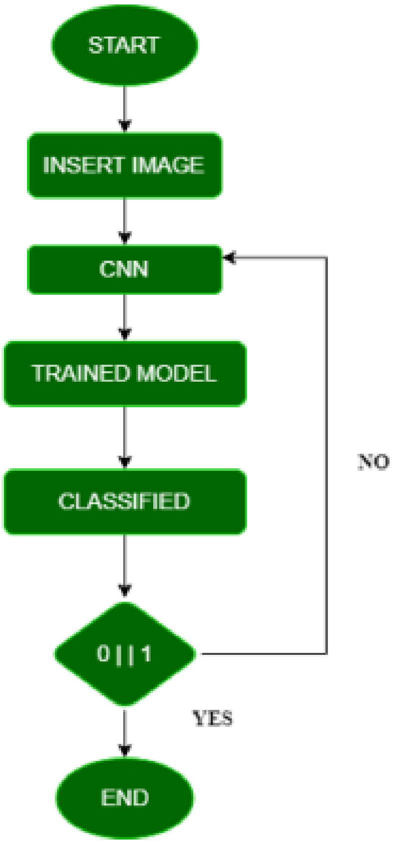

Figure 4: Flowchart of classification system

IV. EXPERIMENTAL ANALYSIS

All of the steps involved in assessing, detecting, and optimizing rice crop production will be automated by the system. For the evaluated rice crop profiles, the user is given the option of carrying out and maintaining activities based on both expert-provided criteria and the outcomes of treatment techniques and specific identification of illnesses. This program uses self-checking features to provide the most accurate and efficient output possible. Several contributions are considered while user feedback is gathered and used to refine the system. Meeting each objective's deadline to ensure that a planned activity is accurate, for instance, it is made available to a subset of users and subjected to testing in both ideal and worst-case conditions. This method was used continuously [14][11].

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The project is evaluated by testing each component individually to guarantee the reliability and correctness of the final product. The intended findings were obtained by measuring the concentration of nitrogen in a randomly selected sample of the pile. Hence, it evaluates the system's output considering the Agricultural Research Institute's leaf color chart, taking into account the characteristics of the paddy tree's leaf. In addition, insect pictures captured at different locations inside the paddy field helped pinpoint the offending plants. This quick, random test validates the reliability of the system. We also confirmed that the system's accuracy is greater than 90% by using a soil sample taken from a rice field to forecast the quantity of manure that should be put to the crop based on the N, P, and K levels of the paddy field and the yield that can be produced by adding it. At last, the output of each module is mixed with the individual contributions [15].

In order to verify the integrity of the system and locate any flaws, an integration test of the modules that have been integrated is carried out. In that case, we should combine the criteria presented in our studies with the criteria presented by the Farmer Research Institute to determine how much nitrogen is present in the paddy field farm through the system, how to prevent insect damage, and how to evaluate the quality of the soil by taking a soil sample. Enhanced with a number of different capabilities, the system's accuracy has been improved, and it can now offer an interpretation of the fertilizer dose [16]. The product has the potential to further increase the system's accuracy by adding machine learning algorithms to dynamically update the system. This will allow the user to establish automatic brief messages that will be sent out while the crop is growing. This transmission has the potential to improve the user experience even further [18].

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