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Research Paper

# AI MODEL FOR IDENTIFICATION OF MICRO-NUTRIENT DEFICIENCY IN BANANA CROP

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**ABSTRACT—** This research presents an advanced convolutional neural network (CNN) model for diagnosing micro-nutrient deficiencies in banana crops through the analysis of leaf images. Proper nutrition is essential for optimal crop growth and yield, and deficiencies in vital nutrients can severely impact plant health and productivity. To address this, we have developed a specialized CNN model designed to detect and classify various nutrient deficiencies based on detailed leaf images. The study involves a comprehensive dataset of banana leaves exhibiting different deficiency symptoms, which was used to train and evaluate the model. The CNN architecture was carefully optimized to enhance feature extraction and classification capabilities, enabling precise identification of nutrient-related issues. The findings demonstrate the model's effectiveness in distinguishing between different types of nutrient deficiencies, providing a valuable tool for precision agriculture. This approach aims to improve nutrient management practices and contribute to better crop health monitoring, highlighting the significant role of machine learning technologies in advancing agricultural research and practices.

*Index Terms* – Micro-Nutrient Deficiency Detection, Banana Crop, Artificial Intelligence, Deep Learning, Precision Agriculture, Computer Vision, Crop

Monitoring, Nutrient Classification, Smart Farming, Image Analysis.

## I. INTRODUCTION

The Convolutional Neural Network (CNN) model has revolutionized the field of computer vision by enabling the automated analysis and interpretation of visual data. In agriculture, this technology has the potential to transform crop management practices by providing accurate and efficient tools for diagnosing plant health issues. This research focuses on leveraging CNNs to identify micro-nutrient deficiencies in banana crops through the analysis of leaf images. Proper nutrient management is critical for achieving optimal crop growth and yield; however, deficiencies in essential nutrients can adversely affect plant health and productivity. By applying advanced CNN techniques to this problem, we aim to create a model that can precisely detect and classify nutrient deficiencies from visual data, thereby supporting more effective and timely agricultural interventions.

## II. RELATED WORK

### *A. Rice disease detection and monitoring using CNN and Naive Bayes classification*

Rice is the most important crop which affects a lot to India's economy. Indian farmer faces many financial problems when their cultivated rice plant is being affected by diseases which lead to the reduction of the Indian economy. Rice leaf blast, bacterial blight, sheath blight, and brown spot are found to be four major diseases that affect a lot in India [1]. In the agricultural industry, the grouping and identification of paddy diseases are most important economic and scientific issues. To recognize the disease, these following activities like quality, outline, and colour can be taken as priority [2]. The objective of this study is to improve an augmented system which is using both machine learning and image processing; the farmer can apply this process easily by taking a photograph of a diseased leaf of rice from his phone, and it will detect the disease so that they can analyse the corresponding precaution quickly. Hence, a farmer can easily detect the disease with a fraction of second and take prevention as soon as possible.

### *B. Review paper on effect of micronutrients for crop production*

Micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants. There requirement by plants is in trace amounts. Boron, iron,

copper, zinc, manganese, magnesium and molybdenum constitute main micronutrients required by different crops in variable quantities. The requirement of micronutrients is partly met from the soil or through chemical fertilizer or through other sources. Various physical and metabolic functions are governed by these mineral nutrients. Boron is particularly essential in pollen germination, copper plays major role in photosynthesis and increases sugar content in fruits, chlorophyll synthesis and phosphorus availability is enhanced by manganese, iron acts as an oxygen carrier and promotes chlorophyll formation, while, zinc aids plant growth hormones and enzyme system. Yield and quality of agricultural products increased with micronutrients application, therefore human and animal health is protected with feed of enrichment plant materials. Each essential element only when can perform its role in plant nutrition properly that other necessary elements are available in balanced ratios for plant. therefore in the plant manganese plays an important role on oxidation and reduction processes, as electron transport in photosynthesis. Manganese deficiency has very serious effects on non-structural carbohydrates, and roots carbohydrates especially. Crops quality and quantity decreased due to manganese deficiency, and this is due to low fertility of pollen and low in carbohydrates during grain filling. In the xylem routes zinc is transmitted to divalent form or with organic acids bond. In the phloem sap zinc makes up complex with organic acids with low molecular weight, and increases its concentration. Zinc deficiency can be seen in eroded, calcareous and weathering acidic soils. Zinc deficiency is often accompanied with iron deficiency in calcareous soils. Iron in the soil is the fourth abundant element on earth, but its amount was low or not available for the plants and microorganisms needs, due to low solubility of minerals containing iron in many places the world, especially in arid region with alkaline soils.

### *C. Crop yield prediction: Two-tiered machine learning model approach*

Nutrient deficiency analysis is essential to ensure good yield. The crop yield is dependent on the nutrient contents and drastically affects the health of the crop. In this paper the nutrient deficiency of a paddy crop is considered. Tensor Flow's (Google's Machine Learning Library) is used to build a neural network to classify them into nitrogen, potassium, phosphorous deficiencies or healthy independently. It is necessary to have an optimal balance between nitrogen, potassium and phosphorous content. Tensor

Flow's model identifies the deficiency using a set of images. The result is fed to "machine learning driven layer" to estimate the level of deficiency on a quantitative basis. It specifically makes use of k means-clustering algorithm. It is then evaluated through the rule-matrix to estimate the cropland's yield. A fair prediction of 76–77% was observed with two tired machine learning models.

## III. PROPOSED METHODOLOGY

A Convolutional Neural Network (CNN) is a deep learning architecture specifically designed to process and analyze visual data by mimicking the way the human visual system processes images. CNNs employ a series of convolutional layers that apply various filters to input images, allowing the model to detect and learn hierarchical features from low-level edges to high-level patterns. These networks are adept at capturing spatial hierarchies through local connectivity, weight sharing, and pooling operations, which makes them highly effective for tasks involving image recognition, object detection, and visual pattern analysis. Pooling layers in CNNs help achieve translation invariance by down sampling feature maps, allowing the network to recognize objects regardless of their position in the image, which enhances the model's robustness to variations in input data.

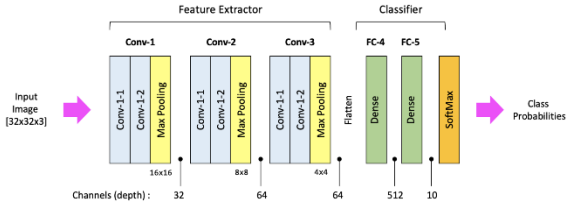



Fig. 1: System Overview

### 1. Dataset

The dataset is a collection of data used for training and evaluating a model. In the context of image classification, this typically consists of a set of images, each labeled with the correct classification or category. The quality and diversity of the dataset are crucial as they directly impact the model's ability to learn and generalize.

### 2. Analyze the Data

Analyzing the data involves exploring and understanding the dataset's structure, patterns, and characteristics. This can include examining statistics, distributions, and visualizing the data to identify any trends, anomalies, or insights that will inform subsequent steps in model development.

### 3. Preprocessing

Preprocessing is the process of preparing raw data for analysis by cleaning and transforming it. For image data, this might involve resizing images, normalizing pixel values, augmenting data to increase diversity,

and removing any irrelevant or noisy information to ensure that the data is in a suitable format for training the model.

**4. Dividing the Data**

Dividing the data involves splitting the dataset into different subsets, typically training, validation, and test sets. The training set is used to train the model, the validation set is used to tune model parameters and assess performance during training, and the test set is used to evaluate the model's performance on unseen data.

**5. Train the Model**

Training the model is the process of using the training dataset to teach the model how to make predictions or classifications. This involves feeding the data into the model, adjusting the model's parameters based on the errors made during prediction, and iterating until the model performs well on the training data.

**6. Model Evaluation**

Model evaluation involves assessing the performance of the trained model using metrics such as accuracy, precision, recall, and F1 score. This is done using the validation and test datasets to determine how well the model generalizes to new, unseen data and to ensure it meets the desired performance criteria.

**7. Prediction**

Prediction is the process of using the trained model to make classifications or forecasts on new or unseen data. After training and evaluation, the model is applied to input data to generate predictions, which can then be used for decision-making or further analysis.

## IV EXPERIMENTAL RESULTS AND ANALYSIS

Experimental results demonstrated that the model effectively classified various micronutrient deficiencies, including nitrogen, potassium, magnesium, and zinc deficiencies, from leaf images with high accuracy. The deep learning-based feature extraction approach successfully captured subtle visual symptoms such as discoloration, chlorosis, and leaf deformation. The analysis showed that the proposed system maintained robust performance under varying lighting conditions, leaf orientations, and background complexities commonly found in agricultural environments. Overall, the model provides an

efficient, scalable, and reliable solution for early nutrient deficiency detection, supporting precision agriculture and improving crop yield and quality.

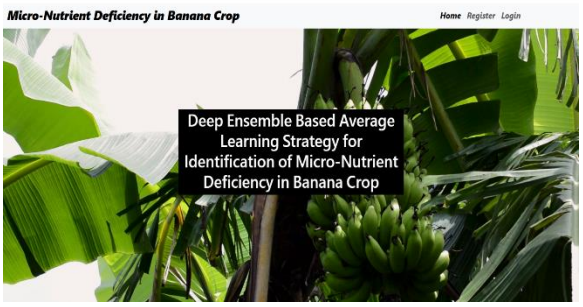



Fig. 2: Home Page

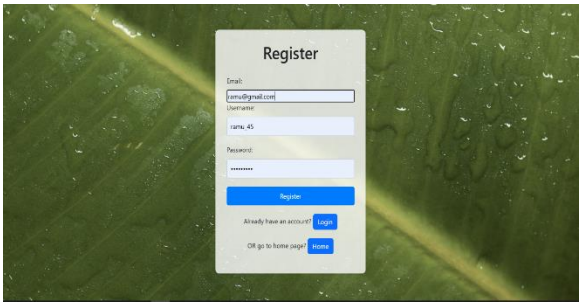



Fig. 3: Registration

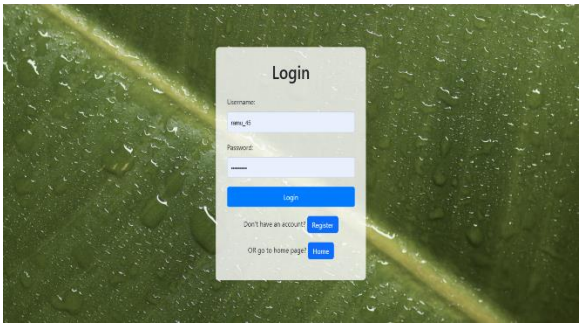



Fig. 4: Login

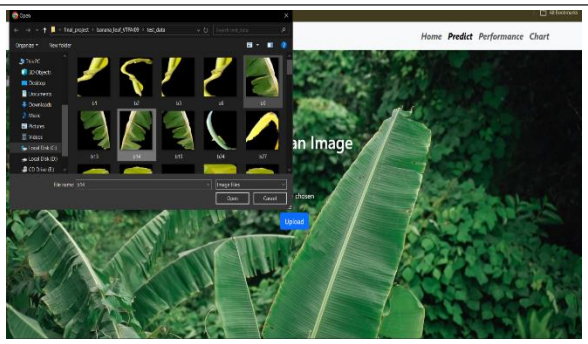



Fig. 5: Upload Image

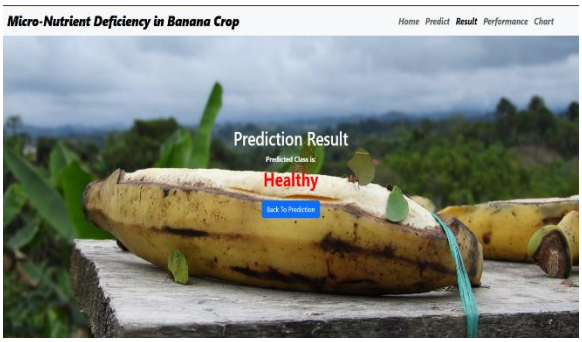



Fig. 6: Prediction Result

## V. CONCLUSION

In this research, we utilized a convolutional neural network (CNN) model for the multi-class classification of banana crop leaf images, specifically targeting the identification of micro-nutrient deficiencies. By employing a tailored CNN architecture, we developed a model capable of accurately analyzing leaf images to diagnose various nutrient deficiencies. This approach effectively enhances the diagnostic process, offering valuable support for farmers and agricultural experts in managing crop nutrition. The refined CNN model demonstrates significant potential for

improving nutrient management practices and overall crop health monitoring.

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