Nitrogen Deficiency Detection in Paddy for Urea Fertilizer Management

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***Abstract*—** Plants need nutrients to survive and thrive. It is essential that they receive the right type and quantity of nutrients at the right time. Nitrogen is the major nutrient involved in growth of paddy crops and is the most common nutrient in commercial fertilizers. These fertilizers are added based on predefined values which are based on land size, age of the crop, and is usually recommended by the fertilizer seller. This approach is not sustainable as it does not account for the soil fertility level. This results in mismanagement and over fertilization which has detrimental effects to the environment. Soil fertility, and understanding the various nutrient levels is key in proper plant growth, as too much of a particular kind can have detrimental effects on plant growth, by preventing uptake of other essential nutrients. Lack of nutrients is also problematic as it can stunt plant growth. Currently soil testing by sending samples to labs is the well-established practice, which is time consuming and generally not followed for every growing season. Paddy is one of the staple cereal crops in India, and largely consumed in south India. It is nutrient demanding crop, which need good levels of major nutrients, especially nitrogen for high yield. In this paper we review the recent technologies used to estimate and identify nitrogen deficiency levels in paddy crops. Computer models are capable of classifying plants as healthy and not healthy, and identify nitrogen deficiencies, using image processing, machine learning, and deep learning techniques.

***Keywords*—** Nitrogen, Urea, Fertilizer, Management.

I. INTRODUCTION

Almost 70% of India's population depends on agriculture, with 78% of them are small holder farmers. These farmers take loans to buy the requirements like fertilizers, pesticides, etc. for cultivation of their crops. When they notice some issue in their crops like leaf yellowing, leaf dropping, stunted growth, lack of flowering, etc. they ask their local fertilizer/pesticide shop for advice, and follow that.

This method does not focus on identifying the specific cause of the problem, but rather treats the symptoms in a general manner. This can and has led to over-fertilization of soil which leads the chemicals to runoff along with the water, polluting the water bodies, causing eutrophication, etc. The nutrient deficiency in plants can disrupt their growth and food formation and result in poor flowering and fruiting. It can also lead to unwanted developments in the plant, where there is a large accumulation of one kind of nutrient, which prevents/blocks the intake of other nutrients. All this leads to loss in crop productivity, quality and eventually the income of the farmer due to low quality and poor yield, even though the farmer has spent money in buying the required fertilizers, leading them to debt and suicide.

A plant needs almost twelve nutrients for its efficient growth. To achieve their life cycle and physiological functions, plant need chemicals such as Nitrogen, Potassium, Phosphorus, Calcium, Magnesium and Sulphur called the macronutrients and Zinc, Copper, Boron, Chlorine, Manganese, Iron called the micronutrients.

These kinds of nutrient deficiencies are generally identified in laboratories and through research. This can be a time consuming and costly process for the farmer to perform regularly. The accurate determination of nutritional status can prevent losses and also serve as a basis for the rational use of nutritional supplements. As a result, waste of resources is avoided and environmental impacts are also reduced. Moreover, computational tools for nutrition monitoring can be made available as part of decision support and farm management tools, which can be particularly valuable for farmers that do not have access to expert advice.

After the green revolution, there has been a huge rise in consumption of fertilizers and pesticide, as the hybrid crops require more resources like water and nutrients, as it lacks the qualities of normal indigenous plants. This leads the farmers to take loans to buy the chemicals, and are faced with debt when prices go low or harvest is poor. Additionally, the chemicals in fertilizers are carried along with the water, when applied in excess and end up polluting water bodies and causing eutrophication. Moreover, when there is excess of one kind of nutrient in the soil that is taken up by the plant it blocks other essential nutrients from being taken up by the plant, leading to a deficiency. These excess chemicals end up in our food, leading to various health issues. So, there is a need to apply the right kind and

quantity of fertilizers to plants, whenever required. To tackle this issue, we propose a method of identifying the nutrient deficiencies in plants from its leaf images, to allow the farmer to make a more informed decision. During the last decade, the combination of digital images with artificial intelligence and image processing techniques for tackling agricultural problems has proven to boost the field of digital farming. A considerable effort in the development of new methods for detection of nutritional problems in plants can help in eliminating the problems and ensures to take the necessary measures for safe and sound growth of plants.

We are using the leaf of the plant for identifying the nutrient deficiency in plants, to provide information on any nutrient deficiencies if present.

A. Advances

B. S. Anami et.al, proposed a method that uses deep learning approach for recognition and classification of yield affecting paddy crop stresses using field images [1]. P. K. Sethy et.al, used convolutional neural networks for nitrogen deficiency prediction of rice crop [2]. Md. A. D. Siddik et.al, developed LCC-based device for measuring urea consumption in major food crops [3]. Torikul Islam et.al developed a nitrogen fertilizer recommendation for paddies by automating the leaf color chart [4]. Latte et.al used rule based approach to determine nutrient deficiency in paddy leaf images [5].

B. Drawback

The existing methods largely focus on feature extraction and image processing techniques. This method is time consuming, requires expert guidance and has to be specialized for each variety of crop, which is not scalable. The datasets collected for this purpose uses plants grown in controlled environment, for a short period of time. Most nutrient deficiency models are trained on severe deficiency symptoms, which is not the case in real time. Additional work is required to make use of technology in this field.

C. Future Work

Recently there has been an increase in usage of CNN and ANN for building classification models, this approach requires large number of datasets. The focus is mostly on crops grown in controlled environments, which is different from the conditions encountered in fields. The models developed are specific to a particular crop, and nutrient. Different crops require different models. So, there is a need for the proposed solution, to be scalable, and relevant to the actual symptoms encountered in the field.

D. Proposed Methodology

We propose to build a machine learning model that is capable of identifying the nutrient deficiencies in paddy crops through leaf images. The farmer will just have to take a photo of the affected leaf, and provide some details like, age of plant, etc. and get predicted nitrogen levels for that plant. This knowledge in the hands of farmers will help them make a more informed decision when purchasing and applying fertilizers. The model can be deployed in the form of a mobile application, for easy use. Based on the literature survey, we plan to identify a few techniques in image processing that can be used to highlight the region of interest (nutrient deficiency affected part). Then we have to manually collect/create a dataset on which these techniques can be applied. Then using the pre-processed images, we train a multiclass classification model to identify the nutrient deficiencies present.

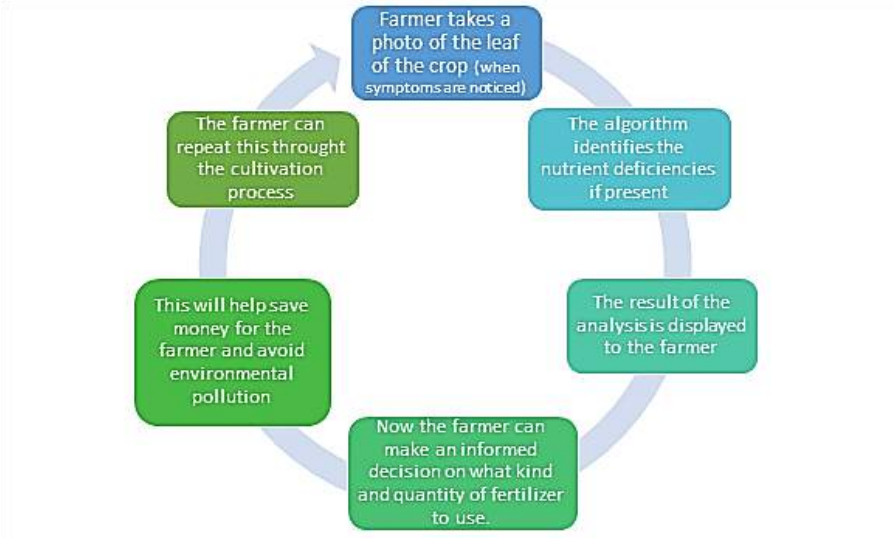

Fig 1: Multiclass classification model for identifying the nutrient deficiencies.

E. Summary

Today, the majority of the farmers depend on their local fertilizer and pesticides shop, when they face some issues in their crops like leaf yellowing, leaf dropping, lack of blooms, etc. They blindly follow the recommendation given in the shop, without probing deeper to find the root cause of the problem and the reason for the symptoms. Various methods and extensive work have been conducted to identify nutrient deficiencies in plants. The nutrient deficiencies are identified in the leaves of the crop plants with the help of their symptoms like reduction in leaf size, changes in the color of the leaves, distorted edges, necrosis and black spots. In order for recognizing the deficient nutrients the tester may need to uproot the entire plant and carry out the manual work required. However, with the advancement of technology several scientists and researchers have come up with the techniques to unload the heaps of work required for the identification. These include using the techniques from Machine Learning, Artificial Intelligence, Deep Learning, and Image Processing, where the color and texture features of leaves and fruits are used to identify deficiencies.

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