A Novel Approach to Estimate Nitrogen Content of Paddy

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Nitrogen (N) is an essential element in photosynthesis which makes it critically important that cultivations are provided with sufficient amounts of N to gain a fertile yield. Majority of this requirement is fulfilled through N based fertilizer. Paddy farmers in Sri Lanka rely on information given by Agricultural Instructors to decide fertilizer requirement for their paddy fields. However, due to insufficient number of officials, currently they are in a dire situation of not being able to get timely information. As a result farmers have opted to use their previous experience in applying fertilizer. This has resulted in either over application or under application of N fertilizer, which causes significant impacts both to the farmer as well as the environment. While over application of N fertilizer lead to critical issues for bio-diversity, contamination of water, contamination of soil and health issues under application of fertilizer will result in a reduced harvest to the farmer. Therefore, the objective of this work in progress research is to suggest a novel approach to estimate N content of paddy in Sri Lanka

The literature review phase was carried out to study existing methods available to measure the N content in paddy cultivation. According to this study the most widely used methods were identified as, tissue analysis, leaf color chart, SPAD chlorophyll meter and image processing techniques. Tissue Analysis methods are laboratory procedures used to estimate plants' N content. Although these methods are highly accurate, specialized knowledge and laboratory equipment are needed. Furthermore, the results will not be available to the farmer in real time. Leaf color chart is the most popular method currently used in Sri Lanka. In this approach measurements are highly biased as a reader, compares the color of a paddy leaf against the color card by visually observing it. SPAD meter is a chlorophyll content meter which uses visible light and infrared waves. High cost associated with the device makes it impractical to be used by farmers. Under image processing techniques two major types of image capturing devices are used, they are visible light camera and near infrared cameras. Proposed methods that use digital cameras operate in fixed camera angles and illumination conditions and the data taken needs to be processed separately. Agricultural Digital Camera operates using near infrared and visible light bands and is ranged at a high price. Moreover, they can only be used at certain phases of the growth stage and are affected by the humidity and temperature of the surrounding.

This put forward a requirement of cost effective and straight forward technique that would generate real time outputs to the farmer. Thus, an attempt was made to investigate the suitability of images taken from mobile phone camera with on location reference to estimate the N content in paddy cultivation.

Since this research associates with creation of new knowledge through the design of novel artifacts and analysis of the performance of the designed artifact along with reflections, this research follows design science research, methodology.

In the requirement analysis phase a survey was carried out in Kurunegala district among the farmer community to gather details regarding farmer issues and assess the feasibility of a mobile based application. Subsequently, data analysis phase was conducted to gather data from five test plots with varying N levels containing 66 days old Bg450 rice variety at Batalagoda Rice Research and Development Institute. Images of the youngest fully expanded leaf of 30 randomly selected rice plants were taken using a mobile phone equipped with 8MP Exmor RS sensor together with a white card reference. Furthermore, relevant LCC and SPAD meter readings for each of the rice plants were also taken at the same time. Moreover, a kjeldahl wet digestion procedure was conducted to analyse the total N content in selected paddy plants. After initial pre-processing mean color values for RGB components were extracted and several combinations were tried out to find the best correlation with SPAD meter, LCC readings and total N content.

Initial results showed satisfactory outcomes and the highest correlation coefficient was shown by mean value of Green component for both SPAD and LCC readings. Taking the results from requirement and data analysis into consideration mobile application will be developed in the artifact design and implementation stages. Finally, the developed artifact will be evaluated under two methods. Initially the accuracy of the predictions made by the artifact will be compared against existing N estimation methods and subsequently a usability analysis will be carried out for the application among targeted users.