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Nitrogen content estimation of rice crop based on Near Infrared (NIR) reflectance using Artificial Neural Network (ANN)

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Abstract

Nitrogen content is an important indicator used for monitoring and management of plant due to its role in photosynthesis, productivity as well as its effect on carbon and oxygen cycle. The research aimed at estimation of nitrogen content of rice crop based on Near Infrared (NIR) reflectance using Artificial Neural Network (ANN). ANN is a non-linear modeling tools based on statistical data. Nitrogen content was measured by laboratory analysis, meanwhile, its spectral reflectance of NIR (700 – 1075 nm) in the field was measured by using hand held spectroradiometer. Data were divided into 33 data training and 15 data testing using 3-fold cross validation. We found that organic molecules (nitrogen, water, etc) have specific absorption pattern in the NIR region. The experimental result shows that the comparison between measured and model estimation of Nitrogen content have RMSE of about 0.32. We conclude that NIR reflectance values can be used to predict nitrogen content using ANN method.

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Keywords: ANN; NIR; nitrogen; reflectance; rice plant

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1. Introduction

Rice (*Oryza sativa*) is one of the major food commodities from Indonesia. Indonesia as an agrarian country has 8 million hectares of rice fields, or 8% of the total land area of Indonesia [1]. But, the yields are not as good as expected. It was caused by various factors such as plant diseases, pests, bad management and monitoring, as well as natural disaster. In rice cultivation, monitoring activity is a very important aspect to maintain the quality of the rice plant. Rice plants that have good conditions are expected to provide a good yield.

Monitoring and management process of plant is closely associated with monitoring of biochemical processes, such as photosynthesis, respiration, evapotranspiration, and the decomposition of the existing biochemical concentrations in leaves, like chlorophyll, water, nitrogen, lignin and cellulose [2]. These processes provide an indicator of crop productivity, crop diseases and the availability of nutrients in plants [3]. Nitrogen content is a very interesting thing to be used as an indicator in the monitoring and management of the plant. This is because nitrogen has a very important role in photosynthesis process, plant productivity, and it affects the carbon and oxygen cycle [4]. Besides, over-fertilization of N is a common problem in rice production, which not only results in low N use efficiency, but also poses environmental pollution, reduced economic returns, increased susceptibility to crop lodging and diseases, and poor eating and cooking quality of rice grains [5, 6, 7, 8, 9].

NIR is closely associated with the structure of the molecule in plants [10]. All organic matter is composed of atoms such as Carbon, Oxygen, Hydrogen, Nitrogen, Phosphorus, Sulfur, and small amounts of other elements. These atoms will combine through covalent and electro covalent bond that form molecules. Due to the nature of the bond, the atoms and the molecules are moving constantly. The molecules will vibrate in NIR channel and absorb it[11]. The more organic molecules exist in an object, the more NIR will be absorbed. And, its reflectance value gets smaller.

Previous research had been done on rice plant using regressive linier with helicopter mounted NIR camera. In this research, the author tried to find a relationship between NIR reflectance with nitrogen content using regressive linier [12]. Besides, nitrogen estimation had been done on the other objects such as in sugarcane using spectroscopic image [13], nitrogen estimation on mixed canopy [3], and protein estimation using NDVI data [12]. In this research, we will estimate nitrogen content of rice plant using NIR reflectance based on ANN.

2. Method

This research consists of several steps: Data Acquisition, Data Preprocessing, ANN Modeling and Evaluation. The flow of this research can be seen in Figure 1

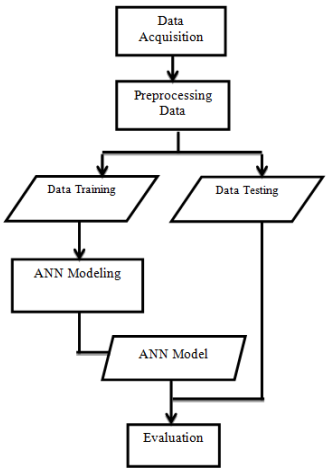

Fig. 1. Research flow