Optimization of Nitrogen Fertilizer Application in Lowland Rice Production System of Agricultural Resource System Research Station Using Tailored Farm-plot Database

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ABSTRACT

The objectives of this study were to monitor the effects of nitrogen and phosphorus from input sources on rice production system by using 3-year-plot database and to optimize application rates of nitrogen fertilizer of 4 rice varieties. Tailored farm-plot database was applied to manipulate crop production data in farming system of Agricultural Resource System Research Station, Chiang Mai University, Thailand during July, 2014 and December, 2016. Nitrogen and phosphorus amount from input sources were quantified by referent nutrient contents in crop residues and fertilizer materials. Stepwise multiple regression was used for selective monitoring input crop nutrients on above ground weight and grain yield. The multiple regression models could explain 77 and 37% of variations on above ground weight and grain yield, respectively. The average harvest indexes and average yield of above 75th percentile of rice yield records of Khao Dowk Mali 105 (KDML), Mali Dang (MD), Sangyod (SY), and Hom Nin (HN) varieties were used to quantify the expected above ground weight. The results from baseline scenario indicated that application of 14.6, 4.0, 0 and 8.9 kg N.ha^{-1} with incorporated green manure were sufficient to supply the expected yield as 5,120.0, 5,597.5, 5,030.0 and 6,735.0 kg.ha^{-1} of KDML, MD, SY and HN, respectively. In case of without incorporated green manure, application of 35.6, 24.3, 16.1 and 22.2 kg N.ha^{-1} were required in comparison with site-usual application rate as 69.8 ± 24.6 kg N.ha^{-1}. The results of this study may guide for site-specific crop nutrient management, which relied on site-database.

Keywords: Farm-plot database, Farming system, Site-specific nutrient management, Lowland rice

INTRODUCTION

Under Thailand 4.0's campaign, collaborative farming has been launched to take advantage form the larger-scale production by gathering of the small farmlands together. Expectedly, operation of the gathering farms could improve cost effective and productivity throughout the cooperative management for production factors and area-base monitoring (Ministry of Agriculture and Cooperatives, 2016; Thailand Broad of Investment, 2017). In this case, modern farm management is needed for upscale monitoring and support decision and policy making by data-driven approach. For instance, plant disease and insect pest outbreak (Birt et al., 2012), and variation of crop growth and yield (Ginaldi et al., 2016; Jiménez et al., 2016) or even the sustainability of farmlands (Esmeijer et al., 2015; Latruffe et al., 2016) were evaluated under data collection of production factors and biophysical factors including socioeconomic and environmental issues from the various scales of the cooperators' network. In traditional data management, those process-mediated data of farm operation were usually structured and stored in the relational database system (Wolfert et al., 2017).

Manipulation of nutrient cycling was crucial reflections of the productivity, stability, and sustainability in the farming system (Conway, 1985; Gliessman, 1988). Insufficient understanding of the optimal nutrient supply and excessive fertilization were the major constraints to improve nutrient-use efficiency in the rice production system (Lafitte, 1998). The concept of site-specific nutrient management was developed to support the decision making to improve crop nutrient-use efficiencies on the variability of soil nutrient supply and crop growth response to nutrients of the individual farms (Dobermann and Witt, 2004). Several techniques were adapted for the site-specific nutrient management, including nutrient omission (Dobermann et al., 2002; Nagarajan et al., 2004), leaf color chart (Liu et al., 2013; Ali et al., 2015), critical crop nitrogen accumulation and nitrogen nutrient index (Ata-Ul-Karim et al., 2017). Soil inherent fertility potential zones (Davatgar et al., 2012).

Alternatively, analysist of variability and determinants in rice growth and development are the alternative approach to optimize fertilizer application rates. Climatic and edaphic condition, and agricultural practices were used in the identification of determinant factors of rice yield (Niang et al., 2017). In the previous studies, identified factors affecting variation of rice yield were analyzed from the particular sets of data collection by several regression techniques. For instance, multiple regression analyses was used to quantify the effects of fertilizer rates, soil test, and temperature on rice grain yield (Carmen, 1968). Regression analysis techniques were used to analyze impact of soil quality index of soil