Nutrient Balance for Agricultural Sustainability in Undulating Terrain of Northeast Thailand

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1. Introduction and justification

The word of "nutrient budget or nutrient balance" is meant an "account" of nutrient inputs and outputs in a certain, clearly defined, or is the difference between the sum of nutrient inputs (flow in or applied) and nutrient outputs (out of or removed). Agricultural systems of Northeast Thailand, cover 1/3 of the land area in the whole country, have been developed on rather marginal poor sandy soils of the undulating terrain which is a main factor to determining type of agricultural land use in this region. However, during the last 4 decades, land use in the region has dramatically changed in such a way that the forest cover was reduced for production of rice and commercial upland crops. The gently undulating terrain topography dominates the region's landscape and forming a "mini-watershed" agroecosystem in which paddy rice occupies the lower lying areas and various field crops in the higher grounds as well as remnants of dipterocarp forest are in the uppermost areas. The dominant field crop has changed from monoculture of kenaf to cassava, and most recently to sugarcane.

Continuous upland field crops cultivation of these crops in this fashion for many years has resulted in a substantial decline in land productivity as indicated by declining crop yields and an increasing dependency on chemical fertilizers to obtain satisfactory yield levels which were indicated as soil degradation. The objectives of this study are as follows:

(1) to evaluate the nutrient balances in cassava, sugarcane, and paddy fields at the research site.

(2) to evaluate the sustainable land use systems among cassava, sugarcane and paddy fields.

(3) to better perception in upland-lowland interaction and development of sound technique to define soil degradation in different land use systems.

(4) to propose or suggest optimum amounts of fertilizer s from a view point of nutrient balances.

2. Materials and Methods

A survey was conducted to identify sites representing the prevailing topography and cropping patterns in the undulating terrains of Northeast Thailand in 1998-1999. A mini-watershed area in undulating terrain was selected for this

research namely Kham Muang village, Khao Suan Kwang district, Khon Kaen province. The study procedure involved a field survey, interviewing with key informant and nutrient input and output variables were determined. Fields in the different subsystems were identified for crop cut study to obtain more accurate figures of the identified variables. Plant samples were also taken and analyzed for their chemical compositions. Quantitative data on crop yields and rates of fertilizer application for the different land types were also obtained from farmer interview. Based on the quantitative data obtained, amounts of nutrient elements (N, P and K) coming in and going out each subsystem based on cultural practices were estimated in each land use system. The balance of each nutrient element was then determined for each subsystem. The sediment tanks were installed on-farm trial at the bottom slope of each land use unit for study on nutrient losses through soil erosion and runoff water.

3. Results and discussions

Main results was

(1) The results of nutrient balances analysis in this dissertation revealed that all N, P and K balance in both cassava subsystems were negative but P balance was slightly negative. In addition to, K balance was highly negative in the early rainy season of cassava subsystems. Farm-out water was seriously occurred at the early rainy season subsystem.

(2) Nutrient balances analysis for sugarcane fields, N balances were positive but P and K balances were negative for both subsystems. Positive balance of N was higher at the high fertilizer rate subsystem and then was slightly declined at the low fertilizer rate. Negative P and K balances was higher as high rate of fertilizer while the negative balances of P and K were highly increasing (less minus) at the low rate application of fertilizer.

(3) For nutrient balances analysis of rainfed paddy fields, All nutrients (N, P and K) balances were positive due to its location topographically where was destination of transported nutrients flow from the higher fields and storing function of flooded water in paddy field. N, easily mobile nutrient, balance was higher positive balance than K and P balances.

(4) Total N from the fertilizer was the highest input, N balance was slightly positive with input flow from upper fields. While P balance was, due to input flow

from easily fixed by clay particles and colloid clay (suspended solids). And K balance, there were two input factors which were farm-in water and chemical fertilizer. But applied fertilizers were most important factor in nutrient input.

(5) High fertilizer application in rainy season is caused in high nutrient output, cost loss, and effective environment. Rotation of legume cover crops with cassava and sugarcane fields, multiple cropping systems or left the upland fields 1-2 years to be fallow after cassava and sugarcane harvesting are able to improve nutrient balances, soil fertility thus ensuring greater agricultural sustainability.

(6) Field maintenance from erosion is effective in nutrient imbalance from erosion. From the recent researches, 1) applying organic matter, 2) no tillage farming, 3) taking earth worm, 4) mulching, and 5) crop rotating are useful.

(7) In the end, sustainable land use for cropping systems in cassava and sugarcane is offered. For example, cassava field “late rainy season (traditional variety)” and “low fertilizer rate” is useful in land use sustainability with their smallest outflow.