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SUMMARY OF DOCTORAL THESIS

Name: DARMAWAN

Title:

Effect of Green Revolution Technology during the Period of 1970 to 2003 on Sawah Soil Properties in Java, Indonesia

Study on the long-term effect of green technology application on the change of sawah soil properties was conducted in Java Island as a pioneer of this new rice cultivation system in Indonesia. The soil samples taken by Kawaguchi and Kyuma in 1970 were used as reference and compare with the new samples taken at 2003 from the same or close to the original sites.

To examine the effect of land management difference on the changing pattern of soil properties, the samples were grouped into seedfarm which cultivated rice in monoculture system throughout the study period and non-seedfarm planted rice and upland crop in some rotation pattern. And in order to check the effect of topographical position difference on the changing rate of available silica, the sampling point were group into upland (≥ 100 meter above sea level) and lowland (≤ 100 meter above sea level).

The results showed, during the period of 1970- 2003 the land use pattern of sawah in seedfarms and non-seedfarms were not changed but cultivation intensity increased. The result showed total carbon (TC) and total nitrogen (TN) contents significantly increased from 31.90 to 40.42 Mg ha^{-1} and from 3.04 to 3.97 Mg ha^{-1}, respectively and mostly found accumulated in the surface soil layer. The difference of land management practices between seedfarm and non-seedfarm affected the change of TC and TN content in 0 – 20 cm soil layer during the period of 1970 to 2003. In seedfarms, where rice had been planted in monoculture system, the TC and TN contents in the soil layer of 0-20 cm increased from 34.50 to 39.24 Mg ha^{-1} and 3.16 to 3.95 Mg ha^{-1}, respectively. In non-seedfarms, the TC and TN increased more than in seedfarms from 29.77 to 41.37 Mg ha^{-1} and 2.94 to 3.98 Mg ha^{-1}, respectively. Within 0 – 100 cm soil layer, the TC and TN increased from 92.68 to 112.83 Mg ha^{-1} and 9.34 to 12.03 Mg ha^{-1} and from 79.60 to 114.86 Mg ha^{-1} and 8.93 to 11.44 Mg ha^{-1} for seedfarms and non-seedfarms, respectively. No significant difference was observed in two main soil types, Inceptisols and Vertisols, in Java. Intensive use of sawah for long time might eliminate the original difference of the properties of these two soil types.

During the study period, mean soil pH and exchangeable sodium (Na) decreased from 6.90 ± 0.77 to 5.84 ± 0.90 and from 3.28 ± 2.76 to 1.67 ± 2.06 $kmol_c$ ha^{-1}, respectively; while the exchangeable acidity and available phosphorus (P) significantly increased

from 9.32 ± 3.09 to 13.23 ± 3.72 $kmol_c$ ha^{-1} and from 136.62 ± 154.72 to 255.75 ± 292.41 kg P_2O_5 ha^{-1}, respectively. There was no significant difference found for the changes of exchangeable calcium (Ca), magnesium (Mg), potassium (K) contents and effective cation exchange capacity (eCEC) within this period. The difference of land management practices might have affected the change trend of soil chemical properties in seedfarms where rice has been planted continuously by using high dose of chemical fertilizers, and non-seedfarm where farmers use rotation patterns with low fertilizer application. The mean values of soil pH, exchangeable acidity, exchangeable Na, and available P in the depth at 0 – 20 cm soil layer seedfarms were changed by -1.25; 4.11 $kmol_c$ ha^{-1}; -1.42 $kmol_c$ ha^{-1} and 194 kg P_2O_5 ha^{-1}, respectively; while in non-seedfarms these soil properties changed by -0.90; 3.26 $kmol_c$ ha^{-1}; -1.77 $kmol_c$ ha^{-1} and 57 kg P_2O_5 ha^{-1}, respectively. The mean value of exchangeable K in seedfarms remained in the same levels at 1970 because of sufficient supply of KCl as a potassium fertilizer during the study period. On the other hand, in non-seedfarms where the K fertilizer was applied infrequently, exchangeable K decreased by -0.30 $kmol_c$ ha^{-1}. In comparison with the results in Bangladesh during the similar period, Bangladesh lost exchangeable base cations more than Java did. For the available P content, in Bangladesh it decreased about 10 %, and in contrast in Java it increased almost two folds.

From 1970 to 2003, the average content of available Si decreased from 1512±634 kg SiO_2 ha^{-1} to 1230±556 kg SiO_2 ha^{-1} and from 6676±3569 kg SiO_2 ha^{-1} to 5894±3372 kg SiO_2 ha^{-1} in the 0-20 cm and 0-100 cm soil layers, respectively. Cultivation intensities' difference between seedfarms planted with rice three times a year and non-seedfarms rotated rice and upland crop seemed affected the changing rates of available Si within the study period. In the 0-20 cm soil layer, the average content of available Si decreased from 1646±581 kg SiO_2 ha^{-1} to 1283±533 kg SiO_2 ha^{-1} (-22%) and from 1440±645 kg SiO_2 ha^{-1} to 1202±563 kg SiO_2 ha^{-1} (-17%) in seedfarms and non-seedfarms, respectively. Topographical position difference also found influence the decreasing rate of available Si in this study. Within the similar management practices and cultivation intensity, sampling sites in upland lost more Si compared with lowland position. Planted rice under rain fed system with no Si addition from rain water in upland may be a reason for higher lost of Si, especially in non-seedfarms. The Si supply from irrigation water might be contributed to slowdown the decreasing rate of available Si in Java sawah soils.