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Effect of nutrient fluxes related to rice residue management for small-holder farms in North Vietnam

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In Vietnam, approximately 39 million tons of rice (Oryza sativa) residues are produced every year. While a substantial quantity of these residues is used as animal feed or fuel, or is incorporated into the soils, a large portion is burned on-farm. The burning of crop residues not only causes environmental pollution through greenhouse gas emissions adding to global warming, but may also result in depletion of nutrients like nitrogen (N), phosphorus (P), and potassium (K). With the current trend of increasing cropping intensities, the amounts of residues that are burned on the field are expected to increase dramatically, unless crop residues are managed more sustainably. In this study we quantified soil nutrient balances of paddy rice fields under different crop residue management practices in North Vietnam. Twelve farms were selected for to collecting data on the farm activities, including nutrient inputs and outputs, to calculate nutrient balances for the four following rice residue management practices: (1) incorporation into the soil on the field in Hiep Hoa (HH) district, (2) burning on the field in HH district, (3) applying rice residues compost in HH, and (4) collecting all rice residues for feeding cattle in Mu Cang Chai (MCC) district. For the estimation, the Nutmon model has been adapted to the specific conditions in Asia. The results show that farms applying the three rice residues management practices (1) to (3) in HH have a surplus of P in the range 11-51 kg P ha-1 a-1 and of K in the range 166 – 252 kg K ha-1 a-1. The positive farm nutrient balances indicate that it is likely that soil fertility will be maintained, but that there is a risk of a negative environmental effect, due to nutrient accumulation. Also the concentrations of available P of soils were high (more than 40 mg P 100 g^{-1} soil). The rice residue management system in MCC was the only one, in which the rice residue were removed from the field. It was the only system that resulted in negative N, P, and K balances (- 23 kg N ha-1 a-1, - 2 kg P ha-1 a-1, - 59 kg K ha-1 a-1). Our results of all investigated systems, those resulting in nutrient accumulation, as well as the one resulting in nutrient depletion, demonstrate that nutrient inputs need to be better adapted to the crop needs. Knowledge about the nutrient concentrations in the rice residues and the resulting nutrient cycling corresponding to the different management practices may help improving the crop residue management and to adapt the fertilization practices to the soil nutrient level that results from the applied crop residue management.