

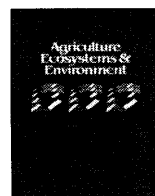


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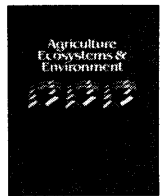
Analysis of the sustainability within the composite swidden agroecosystem in northern Vietnam

1. Partial nutrient balances and recovery times of upland fields

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ABSTRACT

Composite swiddening is defined as an agroecosystem that integrates upland rotating crop/fallow plots and downstream permanent wet rice fields into a single household resource system. Analyses of partial N, P, K nutrient balances in upland fields were followed over a 5-year period in northern Vietnam comparing two shifting cultivation intensities (4-year rice (*Oryza sativa*)-rice-cassava-cassava (*Manihot esculenta* Crantz), and 2-year rice-cassava cropping cycles) and a secondary forest. Nutrient inputs by forest burning, seeds, atmospheric deposition and output by erosion, runoff, leaching, rice straw burning and off-take in crop produce were determined. Burning of a 12-year fallow plot resulted in only moderate nutrient recycling via ashes and unburned plant materials (12.5, 2.8 and 29.8 kg ha⁻¹ of N, P, and K, respectively) but losses (off-take and atmospheric) from the field of 91, 82 and 70% of N, P, and K, respectively of nutrients contained in plant biomass. Economic yields of rice and cassava declined rapidly with successive cropping cycles. Average yearly atmospheric depositions amounted to 29, 7, and 37 kg ha⁻¹ of total N, P, and K, respectively. Yearly runoff and erosion (7–23 Mg ha⁻¹ year⁻¹) were significantly higher from cropping systems than from secondary forest plots (0–3 Mg ha⁻¹ year⁻¹). Yearly nutrient balances in the experimental upland fields were negative for total N, P, and K during the cropping period but on average positive for N (7 kg ha⁻¹ year⁻¹) and P (4.1 kg ha⁻¹ year⁻¹) in the secondary forest. In the more intensively managed upland fields about 139, 11, and 1600 kg ha⁻¹ of N, P, K, respectively were lost during 4 years of cropping, with less losses occurring in the 2-year cropping cycle. If nutrient losses from forest burning were also taken into account, the cumulative nutrient losses over 5 years were 247 N ha⁻¹ and 23 kg P ha⁻¹ in the 4-year cropping system. The main pathway of total nutrient losses was erosion during cropping cycles but runoff during fallow periods. Soil analysis confirmed declining organic matter and N contents with increasing cropping cycles and partial recovery during fallow phases. It was estimated that fallows lasting up to 37 (incl. recovery of N losses from burning) years would be needed to restore N, and up to 6 years to restore P balances. With current fallow periods being mostly substantially shorter (about 4–6 years) the negative nutrient balances and soil erosion pose a serious threat to long-term sustainability of these upland fields.

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1. Introduction

Composite swiddening is defined as an agroecosystem that integrates upland rotating crop/fallow cycles (shifting cultivation, swiddening) and downstream permanent wet rice (*Oryza sativa*) fields into a single household resource system (Fig. 1). In such a system there exist several interdependencies between the upland

and lowland farming system, e.g. economic and labour investments, nutrient transfers via sediment translocation, source of construction material, firewood, medicinal plants, etc. The swiddening component (shifting cultivation) is neither a survival from an earlier shifting cultivation-based system nor is it a recent innovation adopted in response to increased population density and consequent shortage of paddy land. Instead, it is a stable adaptation that has persisted for generations, perhaps even centuries, in the mountain and valley zone of the highlands of northwestern Vietnam (Rambo and Vien, 2001) and other areas in Asia (Prill-Brett, 1986).

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