CASE STUDY **Nutrient flows and intensification options for smallholder farmers of the Lao uplands**

Sabine Douxchamps,
Forage Based Crop-Livestock Systems Specialist/The Alliance of Bioversity and CIAT

The transition from subsistence to intensive and market-oriented agricultural production is often at the cost of soil fertility. This is especially a problem for the poorest farmers in the Lao uplands that rely solely on natural resources. In this study sustainable intensification options were explored with farmers with different degrees of diversification and market orientation. A modelling exercise was done to identify trade-offs between increasing income or land productivity and enhancing nutrient balances. Despite the positive effects of sustainable intensification, nutrient depletion is a risk and additional nutrient inputs are necessary.

Important Details

time (or time period)	2017
country & region	Laos, Southeast Asia
context & agro-eco landscape type	Uplands, diverse and/or market-oriented farms
key actors, stakeholders & beneficiaries	smallholder farmers
model and/or tools used	FarmDESIGN, participatory nutrient flow maps, and simple excel-based scenario analysis (radar graphs)

Overview

South East Asia's agricultural landscape is rapidly transitioning from subsistence to intensive and market-oriented production, often with negative impacts on soil fertility. Ensuring that this transition is conducted in a sustainable way is critical, especially for the poorest who rely exclusively on natural resources that are of limited quality and quantity.

We aimed to evaluate sustainable intensification options for smallholder ethnic minority farmers of the Lao uplands. Following a systematic selection of case study crop-livestock farms with different degrees of diversification and market orientation, we adopted a detailed nutrient flow approach to quantify nitrogen (N) and phosphorus (P) balances at farm level using a whole farm modelling tool (FarmDESIGN). A feedback meeting with each farmer allowed discussing management options and drawing resource flow diagrams to get a better understanding of biomass allocation as well as labour availability. This was then used to simulate alternative and realistic sustainable intensification options relative to the baseline and identify trade-offs between increasing income or land productivity vs. increasing nutrient recycling and

nutrient balances. Irrespective of the intensification level, nutrient balances were negative on all farms, with net nutrient removal between -34 and -130 kg N $ha^{-1}y^{-1}$ and between -9 and -20 kg P $ha^{-1}y^{-1}$.

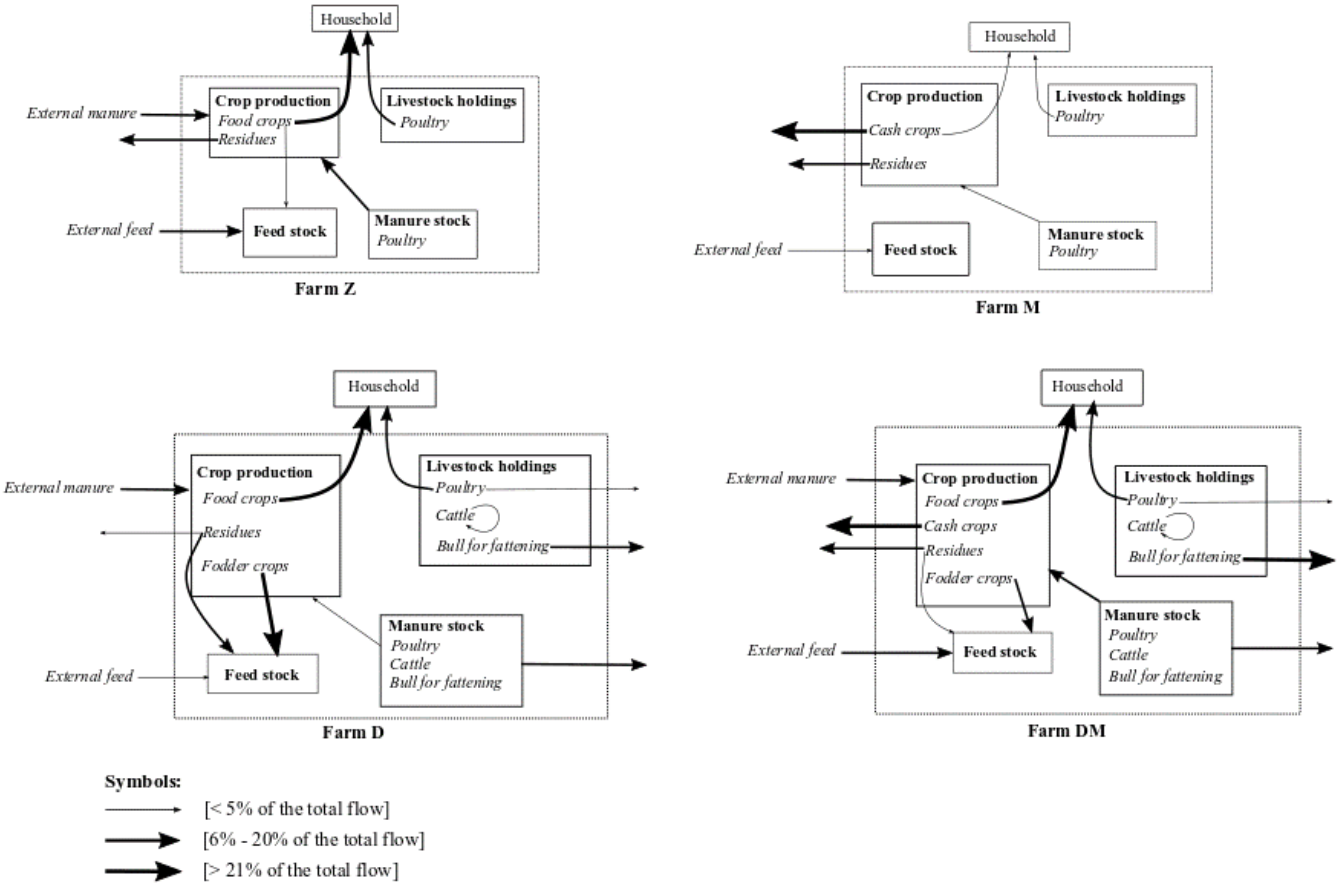

Figure 1. *Nutrients flows diagrams for four selected farms. The weight of the arrows indicates the relative importance of the total flows that they symbolise with respect to the other flows. Z=non diverse, not market-oriented; M=market-oriented; D=diverse; DM=diverse and market-oriented.*

The positive effect of the sustainable intensification options on selected system performance variables (income and land productivity) was up to 15 times higher when its baseline value was low, i.e. when potential for improvement was high. Compared to the baseline (rice and maize monocropping systems), fallow plots during the dry season and low level of residues recycling, all intensification options increased land productivity and N balance by at least 12% on each farm, whereas the P balances were negatively impacted. The positive effects on the N balances might not be sufficient to reverse nutrient depletion, and additional nutrient inputs would be necessary.

Lessons Learned & Recommendations

The system which will have more chance to go through the transition smoothly was based on four principles: 1) no residue burning, 2) stay diverse, 3) integrate livestock, and 4) use small amounts of P mineral fertilizer. Livestock integration provided more options to close nutrient cycles while at the same time increasing farm productivity and income.

Successful sustainable development in this context depends a lot on efficient and integrative agricultural extension, seed systems and market development.

When modelling case study farms, it is critical to include feedback meetings at different stages of the scenario formulation to stay realistic and relevant.

Key references

C. A. Epper, B. Paul, D. Burra, P. Phengsavanh, R. Ritzema, C. Syfongxay, J.C.J. Groot, J. Six, E. Frossard, A. Oberson, and S. Douxchamps (2020). Nutrient flows and intensification options for smallholder farmers of the Lao uplands. Agricultural Systems, 177 (DOI 10.1016/j.agsy.2019.102694). https://research.wur.nl/en/publications/nutrient-flows-and-intensification-options-for-smallholder-farmer