Co-design of forage production scenarios with mixed crop-livestock farming systems in North West Vietnam

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Abstract

In the North-western mountains of Vietnam, erosion and loss of fertility of agricultural slopes land, and dry season forage deficit are the main constraints to the development of livestock production system. Forage production options seem relevant to jointly address these two constraints and promote an agroecological transition of mixed crop-livestock systems in the region. Forage production scenarios were designed with farmers and local authorities through interviews and their impacts on the farm sustainability evaluated using *Tìm ra mô hình*, a simulation tool adapted to the farms of the region. Data describing the structure and practices of farms were collected by farm surveys. The results show that co-designed scenarios can represent options for agroecological transition of farms. To be effective and implemented, these scenarios must be adapted to the farms types and accompanied by support actions.

Keywords: forage, cattle, buffalo, agroecology, Vietnam

Introduction

In the mountains of northwestern Vietnam, conservation agriculture has been proposed to face slope erosion, but remains poorly adopted by farmers (Hauswirth *et al.*, 2015). The feeding of cattle and buffaloes in this region remains largely grassland based. Forage deficit occurs in the cold and dry winter when vegetative growth is limited (Horne and Stür, 1997). The protection of slope lands and the improvement of animal feeding are two issues for an agroecological transition of the mixed crop-livestock systems of the region. In this region, mixed crop-livestock farms are dominant with the conduct of two joint activities on the farm (Herrero *et al.*, 2010). Forage production are part of the agroecological options that can be used to jointly address these two issues. The integration of crop and livestock activities on farms is conducive to greater farm sustainability, and forage production is one of the pillars of this integration (Landais and Lhoste, 1990). There is an infinity of possible forage production options, both for the species and varieties potentially used, and for the production model (monocrop, association, intercrop, etc.), or their position on the farm (garden, lowland, sloping land, uplands; Ngoc and Blanchard, 2019). The choice of desirable options among those possible is improved by the involvement of the actors (Vall *et al.*, 2016) and the

considerations of farms specificities (Hauswirth *et al.*, 2015). We propose to define options for an agroecological transition of mixed farming systems, allowing a change of agricultural model to implement the principles of agroecology (diversification, natural processes, mobilization of knowledge). For this, a participatory approach can be used with a diversity of farmers in order to define forage production scenarios adapted to their context and their specific problems (interviews with farmers), and to evaluate the impacts of these scenarios on the sustainability of the diversity of farms (farms surveys and simulation).

Materials and Methods

The study was done in Thanh Yên commune (Điện Bien Province) in North-West Vietnam. An agropastoral diagnosis has highlighted 4 types of crop-livestock farms according to the degree of intensification and integration of production systems (Blanchard *et al*., 2018): intensive farms (A) strongly integrate crop and livestock, produce forage, stable their animals all year round, and provide feed to trough (crop residues, forage and concentrates); farms in the process of intensification (B1) produce forage, their animals are partly in the stable, receive supplement and graze in the valley and the slope (free grazing on fallow, under forest); low crop-livestock integration farms (B2) keep their animals at night, and graze during the day in nearby pasture and receive a poor feed at the end of the day (rice straws, natural herbs), without forage; and extensive farms (C) drive their animals to mountain pastures, with very little supplementary feeding. We use this diversity to define forage production options adapted to the diversity of crop-livestock farms in the region.

The design of forage production scenarios was carried out based on the survey elements of the diversity of farms and local authority. The surveys allowed (i) to discuss perceived changes in crop and livestock activities; (ii) to reformulate the problem of soil fertility and animal feeding deficit according to actors opinions; (iii) to consider potential solutions to these problems and discuss the research proposals; (iv) and to discuss the impacts of the proposed solutions (Vall *et al.*, 2016).

A modeling tool *Tìm ra mô hình* (find the good practice in Vietnamese) adapted from the tool *Cikeda* (Andrieu *et al.*, 2009) makes it possible to establish balance sheets for forage, cereal for human consumption, soil fertility, and economic at mixed crop-livestock farms levels. The model was adapted to the context of northwester Vietnam, to the structures of the farm types studied and to evaluate the impacts of the different co-designed scenarios. Balance sheets, and inter-monthly variations of forage availability (Figure 1) taken out of the model, were used as an intermediary object to discuss with the farms the feasibility of implementing these scenarios and the implications in terms of organization of work (Andrieu *et al.*, 2009).

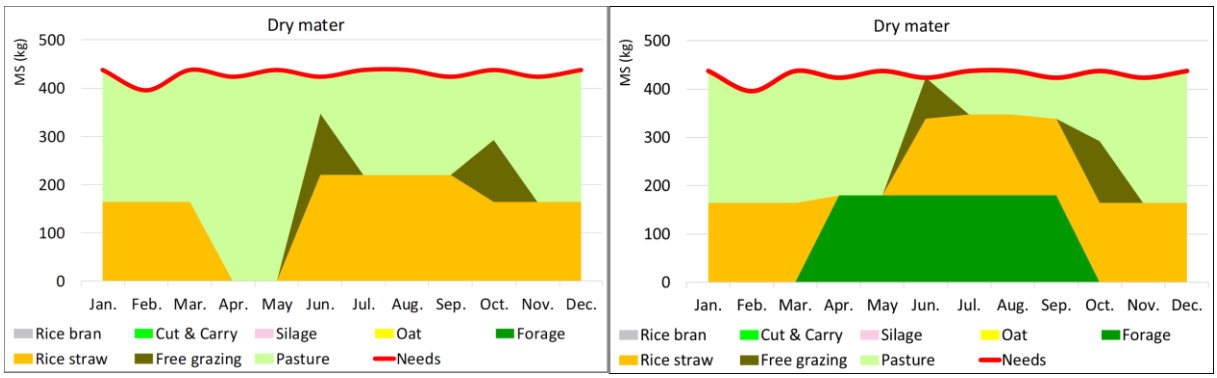

Figure 1. Coverage of monthly animal feed requirements by crop residues, forages, supplements and pasture (a) without any scenario and (b) with forage production

Results

Diversity of forage production scenarios co-designed by farmers

The co-construction approach leads to the formulation of four scenarios. The three scenarios co-designed by the farmers are: (S1) establishment of a crop of *Pennisetum purpureum* (Elephant grass); (S2) establishment of *Panicum maximum* (Guinea grass) or replacement; (S3) establishment of a maize forage crop and silage production. A last scenario was proposed by the research with (S4) the establishment of an oat crop in the lowlands, after the 2nd cycle of irrigated rice.

Possible impacts of forage production scenarios on the sustainability of farm diversity

The establishment of a crop of *Pennisetum purpureum* (Elephant grass S1) seems to best respond to the rainy season forage deficit for farmers with no current forage production (B2 and C), with an improvement in the forage unit balance of 8% and 60%, respectively (Figure 2). The establishment of *Panicum maximum* (Guinea grass, S2) also improves the forage balance of farms without forage. The yields remain more limited. Yet Guinea grass is more resistant to drought and cold temperatures. Its production can be maintained in winter with a better monthly distribution. Its forage value is also better. Forage maize with silage (scenario S3) allows farmers to use silage to fill the forage deficit at the end of the dry season. This scenario improves the animal feeding for all farmers and particularly suitable for extensive and intensive farmers. Finally, oat production in winter after the second cycle of rice (S4) improves availability for dry season feeding and seems particularly suitable for intensive and semi-intensive farmers. All of these scenarios would help to increase the animals' housing time, favourable to the sanitary control, but also to collect the faeces and produce manure.

The obstacles to the adoption of these options by farms are the lack of knowledge of farmers for new crops (oat and Guinea grass; Horne and Stür, 1997), the technical mastery level for silage and crop management (cutting height, cutting period, etc.), poor access to seeds and available farmland near barns for forage production.

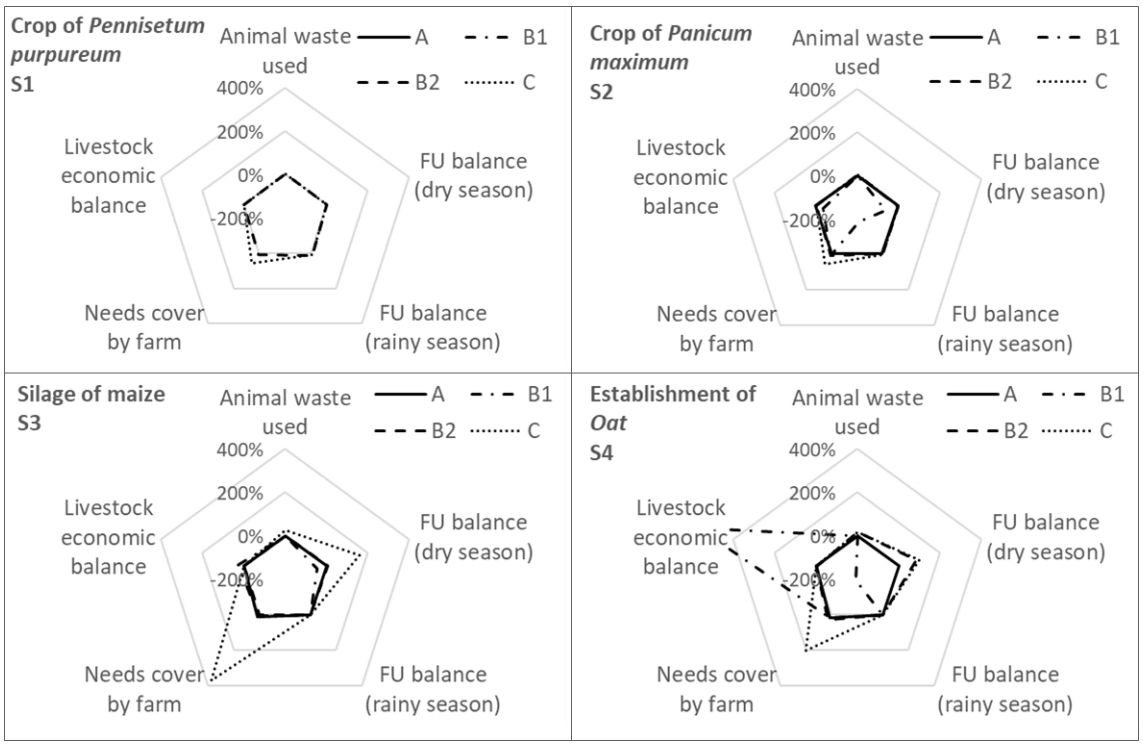

Figure 2. Economic and socio-technical impacts of forage production scenarios for farm types.

Conclusion

The different forage production options meet the different needs of the diversity of farms (forage deficit during the rainy or dry season, independence for grazing). The forage produced help farmers to intensify animal production in the future.

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