Use of a common spatial graphic representation model as a tool to discuss integrated crop livestock alternatives in the uplands of Northern Vietnam

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Introduction In the mountainous area of Northern Vietnam many households depend on buffaloes for their draught power. Conflicting situations are increasing between large ruminant husbandry, agriculture and forest management, particularly during the resource scarce winter period. Underfed animals damage crops and systematically overgraze natural resources. Restricted access to traditional meadows due to increasing land pressure pushes the animals into the shrubs and forests, limiting the forest regeneration. Field studies in the mountainous Bac Kan Province, Vietnam, (Sadoulet *et al*., 2001; Castella *et al*., 2001a, Eguienta *et al*.., 2002) led to converging conclusions about the key role of crop-livestock interactions in understanding and promoting renewed land use systems and defining intervention points for development.

Therefore, any new land use system proposal for poverty stricken households, has to be compatible with the shifting agriculture practices on the hillside and the current extensive management of numerous household with few livestock, in order to evolve to better integrated and improved crop-livestock systems (Castella *et al.*, 2001). In Bac Kan Province, a range of technical innovations are tested, to overcome some of the crop/livestock issues previously identified, and as alternatives to slash-and-burn practices (Husson *et al*., 2001a). While contributing to soil restructuring, erosion control and improved crop management, these innovations can also provide important quantities of good quality forage for the livestock (Eguienta *et al*, 2002). They are components of cropping systems that farmers can combine according to their specific needs and objectives (e.g. priority to rice sufficiency, crop/livestock association, fodder intensification for livestock or perennial crops establishment). The specific constraints of the mountainous environment have to be considered in designing dissemination strategies. In most cases very low-income farmers cannot adopt a complete package; a 'stepwise adoption' should be preferred. Innovation should be proposed in a 'systemic perspective', as changes in the cropping patterns of small upland farms inevitably affect livestock and forest resource management. Facing the local diversity of situations and systems, (Eguienta *et al*., 2002) a diversity of solution has to be offered to the farmers who will choose according to their own circumstances and needs. There is need for integrated approaches of farmers' livelihood systems and, more specifically, of crop/livestock management systems. To understand individual farmers' needs and promote an evolutionary scheme in a time effective manner, methodology tools would be particularly useful.

Toward a common representation of the livestock system The challenge was to engage both scientists and local stakeholders in a mutual learning process. The scientists would facilitate innovation dissemination by providing all the necessary elements to help individuals in diagnosing their own crop/livestock issues, to collectively consider potential solutions and adapt them to the defined issues. To initiate such an interactive communication process a common graphic language between scientists and local stakeholders was developed through models, incorporating two major assumptions derived from previous studies in the same area: (i) the village entity is the relevant spatial and social unit for community-based management of natural resources (Castella *et al*., 1999a); and (ii) the spatio-temporal dimension of crop/livestock interactions is a key factor to take into account when designing or introducing technical innovations (Eguienta *et al*., 2002). Graphic models were discussed to verify that a "common spatial representation" had effectively been established between researchers, developers and farmers. It was intended to provide a concrete support for: (i) the participatory validation of local information related to spatial management of natural resources; and (ii) the introduction of technical innovations to improve large ruminant feeding systems.

Models are the result of a whole process involving both, scientists from different disciplines and local stakeholders. At each step different ones were mobilized, such as a 3-dimensional (D) model to capture local land representation, and Multi-Agent Systems to identify farmers' strategies, experiments, surveys, etc. For a village, the spatial compartmental modeling is based on the administrative boundaries (corresponding to natural relief limits), and on the land resources repartition. Specific activity areas correspond to landscape units and land use resources: (i) bottom valleys for lowland 1-2 cycle irrigated rice production (hot rainy season) and vegetables (cold dry season); (ii) piedmont for settlement and garden areas; (iii) nearby slopes for rain-fed rice, maize, cassava and plantations in upland crop area corresponding to; (iv) distant slopes with animal husbandry areas relying on meadows and secondary forest re-growth. Natural or artificial fences, mostly to keep animals out of the cultivated areas, separate each land unit. Each land unit is a partially closed compartment and the

village appears as a gathering of these compartments. Each compartment provide a specific potential animal feeding and, or, crop resource. The model is then designed by gathering squares that represent each compartment.
There are two simulation inputs: (i) innovation adopted: each innovation has an associated yield and period (winter or summer); (ii) surface area, the local unit is the *bung* (1000m^2) with 2 *bungs* being the area of an average plot.
The output is expressed by the number of buffalo equivalents (eq.bu) per unit surface. The average weight of a buffalo is 300 kg and its daily food requirement is 6,25 kg DM. Four parameters are considered: (i) potential yield (**PY**, kg/ ha); (ii) productive period, (**Pprod**, days); (iii) intake rate for a given fodder, ranging from 0 to 1 (**CR**),; (iv) maintenance needs, (**MN**, kg DM/eq.bu/day). For each innovation and a 2 *bungs* unit surface: PY*CR / (PProd*MN**) = n eq.bu.**

Five types of innovations have been presented to the farmers, each one specific to an agroecological compartment, a type of plant and a given transformation level: (i) Food-forage, 3 years *Brachiara sp*/maize crop rotation (1 eq bu fed on 2 bungs from March to November); (ii) Food-forage crop associations, *Brachiara sp./* interlined-maize (0,5 eq.bu fed on 2 bungs from August to November), *Stylosanthes guyanensis/*cassava perennial system, (1 year settlement and weeding required, 1 eq.bu fed on 2 bungs from March to November); (iii) Orchard tree /*Arachis pintoï* soil cover (1 eq. Bu fed on 2 bungs from March to November); (iv) winter oats intercropping in the irrigated rice fields 1 eq. bu December to March); (v) Urea treated straw (1 for maize to 2 for rice eq. Bu fed on 2 bungs from December to March;
After the presentation of the model components (compartment, innovations potential) printed copies were distributed as support for a participatory simulation exercise of innovation and dissemination at the community level. Then, potential collective/individual solutions to feed the village herd within the village territory limits were introduced and discussed:
1) closing the access to other village territories; 2) increasing the meadow area in the collective area 3) individually combining throughout the year the five types of innovations, based primarily on direct sowing under cover crop techniques (CSC) (this solution being accepted by the farmers who agreed to simulate the results of such systems). With the assistance of the team, each farmer was invited to choose innovations they would adopt, to locate them and to evaluate, the feeding potential to cover the needs his own herd. It enabled the farmer to visualize if the total herd can be fed or not and to enter into discussion. Many farmers are concerned about shortage of labour; few were interested in rotations between forage and food crops and preferred mixing these crops; some think that urea treated straw, especially from maize, can be dangerous for livestock; only a few are interested in growing winter oats because the lack of fences on paddy fields. The animal husbandry objectives differ according to circumstances, which consist in owning a couple of buffaloes, for draught requirements, having live capital, producing meat or developing diversified husbandry activities. All of these objectives condition the interest of the farmers, their involvement in the simulation, their choice of innovations and, moreover, their will to actually implement these innovations. Farmers who owned no animals also took part, either because they plan to buy an animal or are interested by the soil fertility improvement function of the techniques, or in the feeding value of the cover plants for fish farming.

A stage in the continuum from research to action The method presented here does not aim at substituting, but rather to complement conventional participatory approaches. A big step towards problem solving is to formulate development questions from both the scientific and local stakeholders point of view, in a way understandable by all partners. Farmers' reactions and interest for the simulation are very encouraging. They provided many new diagnostic elements and helped to improve the proposed model. Farmers were unquestionably sensitized to local issues related to crop/livestock interactions and were ready to take concrete action, as they did during the simulation. However, most of them are still reluctant to develop concerted or community-based livestock management rules. Although they were conscious of the benefits for the whole village, the dissemination process has to go through a first stage of individual adoption, taking into account the particular circumstances of each household. The approach needs to be tested in different natural and human environments for further validation. In designing of feeding systems, important work is still to be done, such as adapting to specific constraints and labour situations to enable farmers to confidently implement the innovations (seeds, environment-friendly herbicides, fences etc.). In this perspective, socio-economic components have also to be closely considered.

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