Maize expansion in Xieng Khouang province, Laos: what prospects for conservation agriculture?

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Background

During the 2000s, the rapid expansion of maize cultivation engendered substantial landscape transformations in the Laotian province of Xieng Khouang. Maize not only replaced existing upland crops, including gardens and fruit tree plantations, but also expanded at the expense of forests and fallow lands. This impressive agricultural intensification has occurred as a corollary to the introduction of hybrid cultivars in the region (Jobard et al. 2011). With farmers' greater agricultural income and investment capacity, mechanical ploughing has become the main technique for land preparation, and herbicides are now commonly used in the cropping sequences (Lestrelin et al. 2012).

With the exception of a few villages with limited potential for paddy rice production, intensive maize cropping has replaced traditional rice-based slash-and-burn techniques in the uplands (Kongay et al. 2010). From 2003 to 2009, the Lao National Agro-Ecology Programme (PRONAE) was implemented in the province to mitigate the potential harms of intensive maize monocropping. The project offered technical support to target villages through agricultural extension of direct mulch-seeding cropping (DMC) systems, equipment lending and training on the safe and sustainable use of pesticides.

Objectives

This abstract addresses the impacts of maize expansion on the household economy by comparing 2 series of household surveys conducted in 2003 and 2009 in Kham and Nonghet districts (600 households in 20 villages). We analysed the contribution of maize to local incomes over time by comparing observed household income changes with simulated household incomes under the hypothesis of no maize expansion. Despite low adoption rates in the target zone of PRONAE, we also explored the potential impacts of DMC systems on the household economy.

Methods

Village selection. In 2003, 73 households in Xieng Khouang province were surveyed by PRONAE. The same households were surveyed again in 2009 so livelihood changes could be detected.

Village census. All 1463 households in 20 target villages were surveyed to gather basic information on the structure of the households and farms. The data were used to build a typology of households and to select stratified samples for more surveys.

Rapid household surveys were then undertaken in 600 households (30 random samples in each target village). These rapid surveys gathered data on changes to farming system (crops and livestock) and livelihood (assets and housing) and the extent of adoption of DMC systems since 2005.

Detailed socioeconomic surveys of 10 households per target village addressed the decision-making processes of the farmers in relation to the transition from subsistence to commercial agriculture and to the adoption of DMC techniques. Qualitative data were also collected through focus groups on the drivers of change (e.g. access to technical information, markets and credit) and perceived changes in the environment and security of land tenure.

Data management and analysis. All data were entered in a database, and statistical analyses and socioeconomic modelling were performed. Olympe software was used to explore the future of maize productivity under intensive versus conservation agriculture (CA) practices.

Results

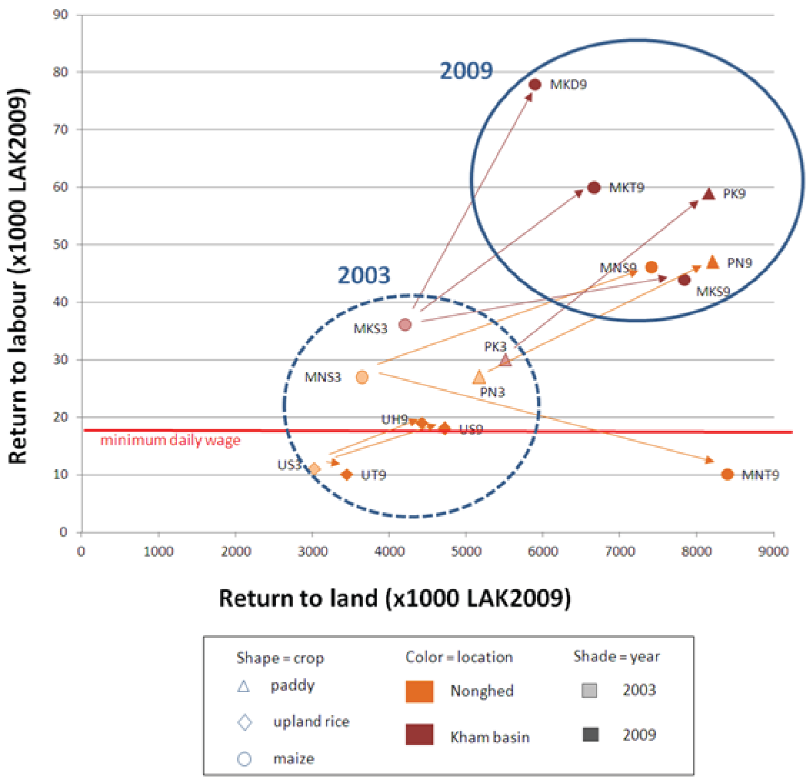
Five main household types were identified in 2009 (Table 1) and compared with their 2003 situation. Better-off households in 2003 had kept their economic advantage in 2009 through early investment in maize cultivation. The replacement of upland crops by maize led to a general improvement of economic situation (Fig. 1).

More generally, the local patterns of household differentiation during the maize boom appeared to be directly related to the availability of upland area and capital (Fig. 2a).

As a result of PRONAE extension activities, DMC systems covered a small proportion of the total upland areas cultivated in the target area in 2009. The highest DMC adoption rates were encountered among medium-range household types, reflecting a strategy of lessening the investment risks while optimising the returns on labour (Fig. 2b).

However, the cropping model that really imposed itself is the one based on soil tillage (Nanthavong et al. 2011). DMC had more success on the hillsides, where the steep slopes prevented heavy mechanisation. Thus, while the status of CA appears rather unsettled in the area, farmers with sufficient capital tended to shift from slash-and-burn or DMC systems to ploughing-based systems (Lestrelin et al. 2012).

Figure 1. Changes in return on land and return on labour of the main cropping systems.



Cropping system codes: P, paddy; U, upland rice; M, maize. N, Nonghet; K, Kham. S, slash and burn; H, slash and burn + herbicide; T, till; D, DMC. 3, 2003; 9, 2009.

Figure 2. Principal component analysis linking household types with (a) increasing capital availability and (b) the percentage of maize under DMC.

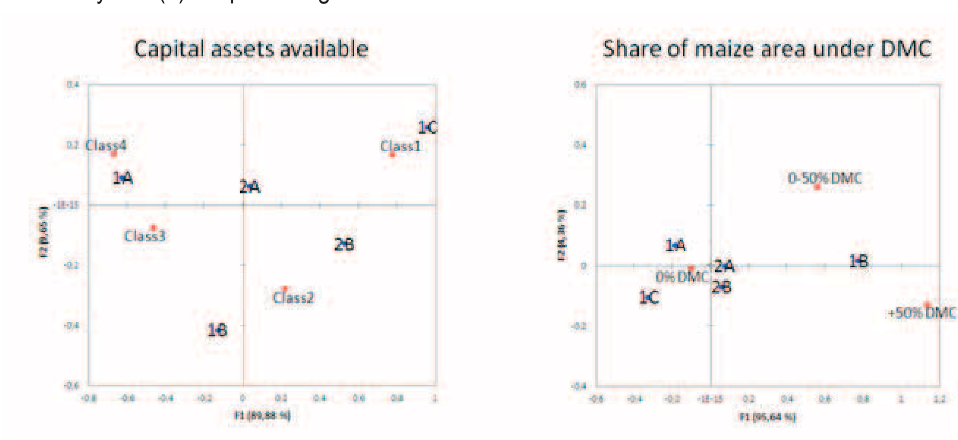


Table 1. Household typology in 2009.

Household type	Main characteristics
Type 1A	Rice needs covered by lowland paddies. Rice surpluses invested in livestock and off-farm activities Upland areas all cropped with maize—labour force availability limits maize expansion; use of mechanised tillage contractors
Type 1B	Limited lowland areas. Upland rice cropped to reach rice sufficiency All remaining upland areas (besides upland rice slash-and-burn system) are cropped with intensive maize
Type 1C	No paddy land. Rice sufficiency reached with upland rice only Family labour force fully occupied with upland crops. Herbicides used to expand area under maize cultivation
Type 2A	Maize production on 100% of the farm land; sold to buy rice for household consumption Intensification of cropping practices (mechanical tillage + herbicide) because of lack of labour to expand upland agriculture
Type 2B	No paddy land. Upland rice cultivation is a risk management strategy in case of bad maize harvest Maize on hillsides is not mechanised. Limits economic risks but places high demand on family labour

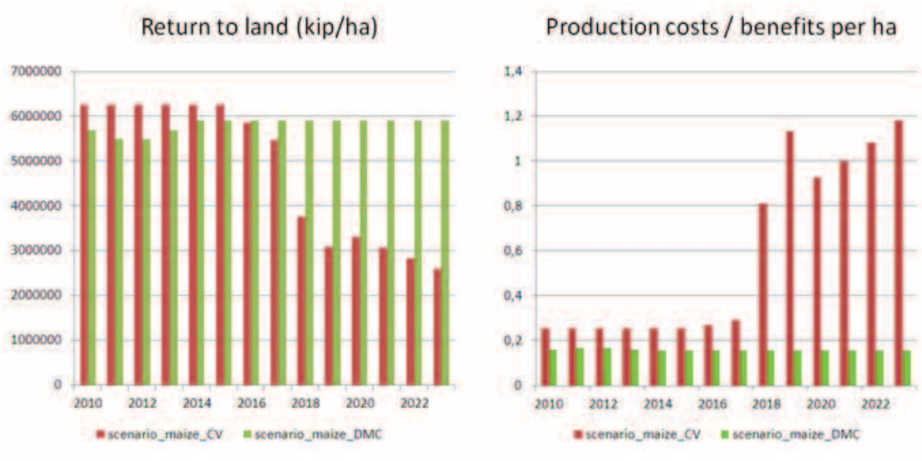
Discussion

With tillage, herbicides, pesticides and hybrid seeds, farmers have significantly reduced the time spent in their fields, which seems to be a key consideration for all household types. Yet with the gradual homogenisation of landscapes and production, farmers have also become more vulnerable to land degradation, agrobiodiversity loss and price fluctuations. Although DMC systems provide possible ways to solve long-term drawbacks resulting from the dynamics of land use intensification in the study area, they may be associated with higher requirements for labour (e.g. sowing and management of legume cover crops) and finance (e.g. fencing to protect cover crops and residues from communal grazing).

It is difficult to encourage local farmers to take a long-term perspective, even though most are aware of the potential drawbacks of their practices on the environment and on their future agricultural production (Keophosay et al. 2011).

To date, they have not experienced any environmental degradation. Therefore, they do not perceive any need to change their current cropping practices. Farmers are reluctant to experience an immediate loss in their income or in their return on labour despite the recognition of the potential loss in the long term (Fig. 3).

Figure 3. Simulations with Olympe software comparing economic scenarios: maize under DMC versus soil fertility decrease after the 7th year of maize monocropping compensated by the use of chemical fertilisers.



Conclusions

Without experience or knowledge of the potential downsides of intensive maize monocropping, farmers do not feel the need to invest time and capital in alternative cropping systems. Indeed, all environmental costs of prevailing cropping systems are currently externalised, and the environmental benefits of DMC systems are not accounted for in economic evaluations.

Prospective analyses and simulations are required to explore scenarios with multiple stakeholder groups and to design support policies for more sustainable agricultural practices. As long as the environmental drawbacks of intensive agriculture are not perceptible by local farmers, only strong policy incentives and regulations (e.g. bans on mechanical ploughing on steeply sloping lands), combined with extension activities conducted in close collaboration with research agencies, can prevent the rapid expansion of unsustainable practices.

Keywords

Farming systems, innovation adoption, risk management, prospective simulations, Lao PDR

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