Assessing the socio-economic impacts of conservation agriculture adoption in Xieng Khouang Province, Lao PDR.

Etienne Jobard

August 2010

Citation

Jobard E., 2010. Assessing the socio-economic impacts of conservation agriculture adoption in Xieng Khouang province, Lao PDR. MSc Dissertation, IRD-AgroParisTech, Vientiane.

Acknowledgments

I would like to thank many people for their help. Particular thanks go to Jean-Christophe Castella and Guillaume Lestrelin, who not only gave me constant support during my research but also provided me with the best possible working conditions. My thanks also go to Pascal Lienhard for sharing his experience of the study area. I would like to thank my Lao colleagues Anousith Keophosay, Khamla Nanthavong and Chansay Khamvanseuang, for their hard work in the field and in the office. I am also grateful to the staff of the IRD Representative Office in Vientiane for their support.

This internship was conducted within the framework of the Multi-country Support Programme for Agro-ecology (PAMPA) and funded by the French Agency for Development (AFD), the French Ministry of Foreign and European Affairs (MAEE) and the French Fund for World Environment (FFEM). I thank the Agriculture and Forestry Offices of Xieng Khouang Province, and the districts of Pek, Kham and Nonghet for their support during the fieldwork. Finally, I would like to acknowledge the generosity of local farmers who spent a great deal of time in answering our questions and welcomed us into their homes.

List of Abbreviations

Institutions

AFD: French Agency for Development (Agence Française du Développement)

FFEM: French Fund for Global Environment (Fond Français pour l'Environnement Mondial)

MAEE: French Ministry for European and Foreign Affairs (Ministère des Affaires Etrangères et Européennes)

CIRAD: International Cooperation Research Center for Agronomy and Development (Centre de coopération Internationale en recherche Agronomique pour le Développement).

PAMPA: Multiple Countries' Action Program for Agro-ecology (Programme d'Actions Multi Pays en Agro écologie)

PAA: Global Action Program on Agro-ecology (Plan d'Action global en Agro-écologie)

PRONAE: Lao National Agro-Ecology Programme

DAFO: District Agriculture and Forestry Office

PAFO: Provincial Agriculture and Forestry Office

NAFRI: National Agricultural and Forestry Research Institute

AFPRC: Agriculture and Forestry Policy Research Center of NAFRI

Technical terms

CA: Conservation Agriculture

DMC: Direct Mulch Cropping

Sommaire

Introduction

In the early 1990s, the Lao PDR emerged from a position of relative isolation that had preserved many of its natural resources, e.g. the forests and water. The low population density means that the country is often considered as having abundant arable land. However, the recent opening-up of the national economy to the global market has brought significant changes to the agricultural sector. Within a few years of this opening-up, the shift from traditional subsistence agriculture to intensive cropping practices for cash crop production has led to an increased dependency on chemical inputs, e.g. fertilizers and pesticides. In some areas of Lao PDR, this rapid expansion of cash-crops is even threatening both food security and the environment as the speed at which these changes are occurring is surpassing the capacity of the adaptation of local communities. Most areas affected by these recent changes now face land scarcity, as well as an increase in agro-production demand —due to demographic growth and changes in dietary behaviors — i.e. the increase in domestic meat consumption and the booming export market. In this context, conservation agriculture has been promoted by the Government of the Lao PDR as a sustainable alternative to current production practices and to prevent land degradation.

Conservation agriculture (CA) is based on three principles which are: minimum soil disturbance — direct sowing, no tillage practices— permanent soil cover —either with a mulch or with vegetal cover— and crop rotations. The main objectives of CA are soil erosion protection and fertility maintenance. CA was first introduced to curb degradation and soil erosion phenomena observed in the United States of America in the 1940's and in Brazil in the 1970's. It was first based on no-tillage practices and direct mulch cropping. Vegetal cover based cropping practices were then developed in order to adapt CA to tropical climates. CA became more successful with the advent of herbicides in the late 1940's; and even more successful after the oil shocks, as the absence of soil tillage enabled a significant decrease in fuel consumption.

This one-year study (from September 2009 to August 2010) aims at assessing the socio-economic impacts of the adoption of CA and is based on household surveys in the target zone of an action-research project which developed CA techniques from 2004 to 2009.

The first part of the report introduces the research approach from the selection of the study sites, the successive steps of the field works to the dissemination of research results. The second part distils the main results and achievements of the study with reference to the final products attached as appendixes.

Institutional context and research approach

Conservation agriculture in Lao PDR - the institutional context

The PAMPA network

In the early 1980's CIRAD (International Research Center on Agronomy and Development) was involved in developing innovative cropping systems based on the principles of conservation agriculture (CA). The direct mulch cropping (DMC) system was adapted to tropical areas, by developing direct seeding under vegetal cover. Various experiments were carried out leading to technical recommendations which were disseminated in tropical countries such as Brazil and Madagascar thanks to the support of the French Agency for Development (AFD) and to the French Fund for the Global Environment (FFEM)

In 2000, the Global Action Program on Agro ecology (PAA) was launched with the objective of promoting CA techniques in 5 pilot countries (Madagascar, Tunisia, Cameroon, Mali and Lao PDR), through the transfer of technologies between pilot countries.

The results of these projects led to the launch of the Multiple Countries' Action Program for Agro-ecology (PAMPA) in 2007 with joint financing from the French Ministry of Foreign and European Affairs (MAEE), the French Development Agency (AFD) and the French Fund for the Global Environment (FFEM). The targeted countries were:

- Cameroon, Mali, Burkina, Madagascar in Africa
- Brazil in South-America
- Cambodia, Viet Nam, Lao PDR in South-east Asia

The objectives of PAMPA are to support the adoption of agro-ecological cropping techniques through networking activities between agro-ecology projects, capitalizing on knowledge across multiple countries and assessing the impacts of agro-ecology.

Conservation agriculture in Lao PDR

From 2003 to 2009, the National Agriculture and Forestry Research Institute (NAFRI) with the support of the International Cooperation Research Center for Agronomy and Development (CIRAD) implemented the Lao National Agro-Ecology Programme (PRONAE) in the provinces of Sayabouri and Xieng Khouang. Alternative systems to slash and burn practices were designed with the objectives of environmental sustainability, economic performances and replicability. The different production systems proposed by the PRONAE (for both crop production and animal production) are presented below.

Direct mulch cropping (DMC)

Direct mulch cropping (DMC), the first step towards conservation agriculture, consists of the management of crop residues on which the new crop is directly seeded. The soil is kept protected

with the residues of the previous crop, the decomposition of which also enriches the soil organic matter. DMC was mostly applied to maize cropping.

Crop rotations and crop associations

Different rotation sequences were developed. These included the introduction of one year of soil improvement by a forage species (mainly Stylosanthes sp.). The forage crop was then alternated with one year of rice production by direct seeding. The introduction of crop rotation is the second step of integration towards CA. The rotation sequence can be intensified, by replacing one year of forage crop by the introduction of a legume cash crop, for example soybean. To create the mulch necessary for this new crop under DMC, a cover plant is sown before the harvest of the main crop of rice or soybean.

Fattening livestock on improved pastures

The cultivation of certain forage species (e.g. Brachiaria sp. and Stylosanthes sp.) which are well adapted to poor and acidic soils can improve soil quality and can also be used for grazing livestock, thus helping to generate income through livestock sales. Further improvement of soil fertility can be achieved by rotation between pastures and crops.

Improved pasture is considered here as another step towards CA as it improves soil characteristics by creating a vegetal cover that can be further integrated into a crop rotation e.g. with rice production.

Research design in the three PRONAE target districts in Xieng Khouang Province

The objectives of the study were to:

- Understand agricultural dynamics and the influence of CA on the current changes,
- Analyze CA adoption and dissemination conditions in different production contexts
- Design new tools and approaches to assess the long-term socio-environmental impacts of CA adoption.

The province of Xieng Khouang holds particular interest as a study zone since its agro-ecological diversity is apparent at a provincial scale. Furthermore, the ecological and ethnic diversity encountered is representative of the natural and human environments of north-eastern Lao PDR. This range of local situations is concentrated in the three PRONAE target districts: Pek, Kham and Nonghet. These districts where chosen in 2003 also because they include a large diversity of farming systems and agricultural practices.

Selection and description of the sites in Xieng Khouang Province

The preliminary diagnostic study performed by PRONAE in 2003, identified four agro-ecological zones in the study area in the three districts of Pek, Kham and Nonghet. This zoning was based on biophysical criteria, e.g. climate, soil qualities, and vegetation cover.

Pek District (the Plain of Jars)

This zone lies on a plateau at an altitude of 800 to 1,200m and is characterized by non-fertile soils: compact acidic soils with phosphorus deficiency and aluminum toxicity. The vegetation consists of savanna and pine forests. Agriculture comprises paddy rice cultivation in limited lowland areas and extensive cattle ranching on open grasslands.

The Kham Basin

This zone of Kham basin consists of a graben at an altitude ranging from 500 to 700m. These lower altitudes mean that the climate is warmer than that of the rest of the province. The soil substrata are diverse comprising alluvia, limestone and sandstone, and is mostly characterized by good fertility. Agriculture comprises paddy rice cultivation in the lowlands and commercial crops (maize, chili and fruit) in gardens and uplands.

Northern Kham

The geography of this zone of northern Kham is characterized by high mountains (from 1,200 to 1,600m). The lateritic and acid soils have crystalline substrata (granites and schist). Rain-fed upland rice is dominant with the presence of extensive cattle and pig breeding.

Nonghet District

Nonghet District lies in a highly karstic region (at altitudes from 1,000 to 1,200m) and where the Hmong is the dominant ethnic minority. Rice production dominates in both the low and high lands. Other agricultural products such as sugarcane and cassava can also be found. The production of both large and small livestock is important.

Sampling of Villages

In 2003, 73 households the three districts of the study zone were included in the PRONAE project. These villages were included in our sampling procedure so that the households surveyed in 2003 could be surveyed again in 2009 and any changes in the households could be described.

In our study, the sample in each agricultural zone comprised 4-6 villages. The first factor considered in the village selection was the villagers' participation or non-participation in the 2003 PRONAE project. At least one village, to serve as a control, in each sample had not participated in this project. These control villages were to enable a better understanding of the dissemination of CA and its impacts.

The table below presents the background information of the total of 20 villages selected. For some surveyed villages PRONAE was the only development project taking place in the village.

Zone	Village	In-depth surveys 2003	PRONAE intervention	Farmer groups[1] and years of implementation
Pek district	Nahoy	Yes	No	
	My	No	Yes	Yes (2006)
	Xoy Nafa	Yes	Yes	Yes (2006)
	Dong	Yes	No	
	Khay	Yes	Yes	Yes (2006)
Kham north	Nong Oln	No	No	
	Keoleuk	Yes	Yes	Yes (2007)
	Tenetho-Tenelod	Yes	Yes (only in Tenetho)	Yes (in Tenetho in 2005)
	Suanmone	No	Yes	Yes (2008)
	Gnod Lieng	No	Yes	Yes (2006)
Kham basin	Houat	Yes	Yes	Yes
	Phonekham	Yes	No	
	Dochkham	Yes	No	
	Le	Yes	Yes	Creation site (2004-2006)
	Leng	No	Yes	Yes (2006)
Nonghet	Pakhae Tay	Yes	Yes	Yes (2006)
	Nammen	Yes	Yes	Yes (2006)
	Keopathou	Yes	No	
	Komone	Yes	No	

Methodology

Various teams were responsible for the implementation of different tasks: one team performed the detailed socioeconomic surveys and focus group discussions while the other teams of 2 project members and 2 local staff performed the village census and rapid household surveys.

Village census

An exhaustive survey was undertaken of every household (a total of 1,463 households) of the target villages to gather basic information on the structure of the household — family members, the age of the household head and function in the village — and on the basic farming structure — areas under crops, number of cattle, buffaloes, pigs — and equipment — hand tractors, motorbikes. This data was used to do a classification of households, and then sampling in each household class, for the detailed surveys.

Rapid household survey

A rapid household survey was undertaken of 30 randomly selected households in addition to a survey of those 4-5 households already surveyed in 2003, and the 4-5 households selected for the

[1] Farmer groups were promoted by the PRONAE in order to facilitate the diffusion of conservation agriculture (technical and equipment support)

detailed socio-economic survey; making a total of about forty households per village. These 'rapid surveys' gathered data on the changes in farming systems since 2005 (in terms of crops and livestock), in the livelihoods (in terms of equipment and housing), and also the extent of the adoption of CA on the farm. A total of 600 households were surveyed.

Detailed socio-economic survey

The detailed socio-economic survey included both quantitative and qualitative assessments. The results of this were not included in statistical analyses since the sample was restricted to 10 households per village. The aim of the detailed survey was to study the decision-making processes of the farmers in relation to the agrarian transition (from subsistence to commercial agriculture) including the process of CA adoption and dissemination. The detailed survey collected technical-economic information on crops and livestock. Twenty five households of the 180 surveyed in 2009 had been already surveyed in 2003, which made a longitudinal analysis of changes in household economics possible. More qualitative data were collected during a semi-directed interview on the drivers of change (such as access to technical information, markets, and credit) at the farm scale.

Focus groups

Focus group discussions were organized in each village to better understand the current situation and the possible developments at the community level. Any issues raised during the individual household interviews were brought to a panel of village representatives for further discussion. Issues included: perceived changes in the environment, markets and market access, credit, access to technical information and changes in land use and security of land tenure, at a village scale. Although the moderator of the focus group discussions tried to ensure that all participants were given equal time and opportunity to speak, this proved almost impossible in practice due to the natural or culturally acceptable shyness (particularly of women and young farmers); often priority in speaking was accorded to the village authorities.

The same four surveys were undertaken in each village with the exception of the villages of Nahoy and Nong Oln, where the detailed socio-economic surveys were not carried out.

Data management and analysis

All the information collected during the field work was entered into computers and saved in a digital format. The data from the random surveys were entered in a Microsoft Access database. The in-depth survey and village census were entered in Microsoft Excel files. Information from the focus groups were also digitized. Different types of statistical analyses and socio-economic modeling were then performed.

In parallel with the household survey, a chronological series of remote sensing data (Landsat) was analyzed by a team of GIS consultants to generate maps of land use and of land use change. A ground truth survey was conducted in April 2010. The areas including target villages of this study were analyzed in more detail by GIS specialists.

The outputs of this land use change analysis were combined with those from household surveys for cross validation and interpretation of the results.

Main products and the strategy for the dissemination of knowledge

Different outputs of the field research carried out between September 2009 and April 2010 are presented in the appendices to this report. The preliminary research results were presented during a stakeholder workshop organized on the 15 July 2010, at the Provincial Agriculture and Forestry Office (PAFO) of Xieng Khouang Province. Posters, policy briefs and oral presentations were used to present the main results of the study. The purpose of this workshop was to validate our preliminary results with local staff and villagers. The workshop participants were: village chiefs, DAFO staff members, heads of PAFO sections (Forestry, Crops, Livestock, Irrigation, Planning), Vice director of the NAFRI, and representatives of development projects (TABI project, PRONAE, etc.).

The morning was dedicated to the presentation of the preliminary results in a plenary session while the afternoon was organized around group discussions on the different agro-ecological zones.

The content and recommendations of the three policy briefs (one for each agro-ecological zone – see appendices) were reviewed collectively. The results of the land use change analysis from remote sensing data were also discussed in groups. Finally, each group made a presentation of the main outcomes of their discussion to the whole audience.

The workshop permitted the validation of the first conclusions drawn from the data analysis. We were also able to correct some elements of the policy briefs and to incorporate comments received during the workshop in a revised version of the documents. Also, the land use change maps were validated and interpreted thanks to the comments from the village chiefs and district staff members.

Policy briefs

The target audience for the policy briefs was the local administration staff and national decision makers. The briefs summarized the changes in the study area over the past decades. Since the same dynamics are at work in the agro-ecological zones of both Nonghet and Kham basin it was decided to put these together in a single policy brief. In contrast, since Pek and Kham north typify the dynamics of different land use changes they each deserved their own policy brief.

- *Improved pastures and DMC-based upland rice cultivation: Two solutions for the intensification of land-use in Pek District*
- *Enhancing land productivity while preserving natural resources in northern Kham District*
- *Accompanying the 'maize boom' in the Kham basin and Nonghet district*

Scientific publications

This study led to the drafting of three scientific publications targeted at both the national and international scientific communities, namely:

- *Understanding the diversity of the local development pathways in relation to the commercial agricultural boom in Xieng Khouang Province (2000-2010).*
- *Impact of maize expansion on household economy in Xieng Khouang Province.*
- *"To till or not to till?" Opportunities and constraints to the diffusion of Conservation Agriculture in Xieng Khouang Province, Lao PDR*

Abstracts of these are attached to this report.

Results and achievements

This section aims to present a synthesis of the main results. More detailed results are given in the appendices (i.e. policy briefs and scientific publications).

Firstly, the dynamics of agriculture at global, national, local and individual levels are presented together with an explanation of the factors related to their emergence. A discussion of the dynamics at a global level is possible because this study in Xieng Khouang Province formed part of a world-wide study on the socio-economic impact of conservation agriculture. A discussion at the national level is possible since the results of this study are comparable with similar work conducted in Sayabouri Province to draw lessons and provide advice to policy makers. A discussion of the dynamics at the local level are also possible, because the environment (i.e. climate, soil quality, traditional production practices) is both a constraint to and an asset of the farming systems. Finally a discussion at the level of an individual is possible since the farmer is the ultimate decision marker on whether or not to adopt CA technologies depending on his/her specific objectives and production strategies.

Secondly, stemming from this the point of view of an individual, we will try to understand the opposing forces at work within the recent agricultural dynamics taking place in Xieng Khouang Province. These can be represented as trade-offs between short-term benefits, long-term objectives within a developing global economic framework.

Finally, adopting the same bottom-up approach, we will explain what conditions are necessary for creating a context that is conducive to the successful dissemination of sustainable agricultural practices.

Understanding recent agricultural dynamics

Despite the significant diversity in agricultural production systems present in the study zone, there are two main factors involved in the main land use changes in the agricultural intensification in the uplands. These are the intensification of maize production in Kham basin and Nonghet, and the development of cattle breeding and fattening in Pek and Kham north.

Prevailing production systems and their limits

Two main types of traditional agricultural systems are present in Xieng Khouang Province, namely, rice production in the lowlands and that in the highlands. This distinction can be seen from a geographical point of view i.e. the differences in rice production related to the agro-ecological zones. However, there is also a distinction apparent between those farming households with good access to highly productive lowlands and those with poor lowland access who are forced to cultivate the less productive uplands to meet their needs.

The topography of the area is such that any further expansion of the productive potential of the lowlands in terms of the cultivation of paddy rice is severely limited. For example, no expansion is possible in Nonghet, Northern Kham or Pek since all possible areas for the creation of paddy fields have already been explored. Moreover, the construction of major irrigation infrastructure would be

needed. This is unlikely considering the uncertainty about crop productivity because of the poor soil characteristics. Only a minor amount of intensification is possible through the addition of a cropping cycle because of climatic constraints — it is too cold in the dry season. In Kham basin although two annual crops are possible, this was only rarely observed because of the irregular water supply during the dry season.

In contrast, all the agro-ecological zones include important upland areas which vary in terms of their production potential, with, for example, highly fertile soils in Kham and Nonghet but only poor production potential in northern Kham and Pek. Farmers benefit from the upland resources through:

- extensive cattle breeding in Pek
- extensive cattle breeding and upland rice cultivation in northern Kham
- upland rice and maize cultivation, and cattle breeding in Nonghet
- cultivation of fruit trees, vegetables chili, and upland rice in Kham basin

As there appears to be no realistic possibility of any increase in lowland agricultural production, either because of limitations in suitable areas of land or the need for significant investments in irrigation infrastructure, the only way to increase agricultural production in the area is to intensify upland production systems.

New production opportunities

New market outlets are being created with the integration of Xieng Khouang Province in the regional market economy mainly through its proximity to Viet Nam. There has been an increase in the demand for meat products resulting from the increased standards of living and from the increase in the urban population. The direct consequence has been an increase in the price of maize bought by feed mills in Viet Nam. This has doubled during the previous 6 years (from 800 LAK in 2003 to 1,700 LAK in 2009 - prices are expressed in constant LAK 2003). This is also a reflection of the improvements in the national roads which have improved market access even for those really remote areas (such as Kham north) and now provide direct access to Viet Nam.

In addition, various agricultural development projects have recently been introduced to the study area. In terms of lowland production, the general use of mechanization (hand tractors and motorized rice threshers) has resulted in an increase in labor productivity. In terms of upland production, the main technological breakthrough has been through the introduction hybrid varieties of maize resulting in better yields — especially when its cultivation is accompanied by the use of herbicides and/or mechanical soil tillage. There have also been other improvements in livestock production through the introduction of improved pastures.

Access to credit has improved thanks to local bank branches: e.g. the Agriculture Development Bank and the Policy Bank. A prerequisite for the intensification of agricultural production is the possession of the capacity to invest.

All these changes in the context of production are generating new production possibilities for farmers who have yet to explore and adopt them. What decision making processes are at work?

Households adoption dynamics

The new market opportunities are removing some of the previous constraints to production. However these changes are not only generated by external factors; they are also in response to internal changes in household strategies. A major challenge is to reach an understanding of these adoption strategies and so be able to explain the on-going changes at the regional scale. The main drivers of adoption strategies are a lessening of the investment risks and a maximization of the returns to labor. Therefore decisions are made on a short-term basis and no account is taken of any long-term impacts of the production practices. For example, maize production is mostly based on mechanized tillage. This enables good weed management and a reduction of the workload for the most time consuming activities of plot preparation and weeding. The same reasoning can be applied to the use of herbicides with part of the family workload being reduced through the using of chemical products, even though the general use of herbicides on a broader scale may eventually lead to soil and water pollution, and weed resistance.

Reducing the time spent in the field seems to be an important consideration for farmers. Time saved on agricultural activities can be used for off-farm activities, which may be more profitable, but are certainly less hard work. It is also true that the desire to engage in farming is declining; farmers are now encouraging their children to pursue courses of study in order to go in for careers in the second or ternary sectors. As a result, farmers must increase their productivity, because they need to maintain the same or even higher levels of production with a smaller labor force.

Conclusions

Although what we describe here is a general framework of the agricultural changes in the study zone., it should be borne in mind that under certain conditions, some farmers are able to escape from the general development path to follow an alternative. This was the case in the village of Keopatou where the farmers still follow traditional cropping systems. The explanation for the exclusive nature of this village is the presence of many development projects and the significant remittances from expatriate family members (representatives of the Hmong diasporas) to the villagers.

The rising demand for agricultural products — driven by the demographic changes in general — entails the need to increase not only land productivity but also to expand the production areas. The dynamics currently at work in the study zone illustrate the interdependence of both agricultural and demographic transitions which are at work on the broader scale of South East Asia.

Impacts of upland intensification

Economic impacts

The intensification of agriculture in the uplands is leading to an overall increase in both wealth and the living standards. The evidence of this is the improved quality of the housing, more access to electricity, common ownership of means of transportation even if only the sharing of a motorcycle.

But there are drawbacks to be mentioned. Let us consider the different impacts on the households' economics.

Maize

Maize has become a very profitable upland crop because of the significant increases in the productivity of both land and labor, partly due to the changes in cropping practices and in the outlets. This has led to the expansion of the areas under maize at the expense of other less profitable upland crops, mainly those of upland rice and chili, and of fallows and shrubs. This increase in maize production has resulted in significant increases in incomes for households in Kham and Nonghet. The production strategies of some farmers are entirely dedicated to maize, leading to a specialization in maize cropping.

Although this specialization in maize mono-cropping increases the farmers' annual incomes, it is also increases their vulnerability. Some farmers are now completely reliant on a single crop, with their incomes indexed to the price of maize. A single poor harvest or a fall in prices could lead to severe indebtedness. Several such cases were observed in 2008, when the harvests were characterized by a low maize prices and poor yields. The vulnerability of such production systems is also accentuated by the genetic uniformity of the crops. This lack of diversity linked to the lack of pest control could be really damaging to the household economics in case of a pest invasion or disease. Farmers, as yet, have no means of fighting these because the production systems are still in a transition stage, where new techniques are only just penetrating into traditional cropping systems.

Upland rice in Pek

The development of upland rice production in Pek District presents a real opportunity for increasing the rice supply in the villages which often suffer from rice shortages. This was made possible thanks to the innovative techniques introduced by PRONAE.

Fattening of cattle

In the past, cattle were rarely thought as being a source of cash income, but rather as a means of saving or a provider of manure. Cattle were only sold in cases of extreme necessity such as in rice shortages when cash was needed to purchase rice, and in droughts or epizootic disease incidents when it was necessary to find a safer way of saving capital rather than saving it in the form of livestock which were likely to die. The introduction, by different agricultural development projects, of self-regenerating pastures enabled a better forage production in terms of quantity and quality. This improvement in forage made possible an intensification of cattle management through the fattening of cattle with the potential of bringing new sources of annual incomes and so transforming a former savings activity into a cash providing activity.

Environmental impacts

The rate at which mechanical tillage is becoming popular in Kham basin and in Nonghet is alarming. The similarities, between the dynamics currently at work in these zones and those previously observed in Sayaburi province allow us to predict the appearance of erosion problems in the coming years. This erosion will lead to a loss in fertile soil horizons, a decrease in soil fertility and a loss of those incomes reliant on maize production.

There is a rapid intensification in the use of herbicides accompanied by the rapid spread of the use of motor-driven pumps. This intensification is likely to lead to water and soil pollution: there is no real support or training from extension agents in spraying techniques, doses or the potential impacts. The salesmen are often the only advisers. The first signs of water pollution have been detected in Kham basin.

The intensification of cropping practices, and in particular that of the uniformity of those areas under maize, is changing the landscape with the disappearance of forests and trees. Maize is spreading in accessible zones at the expense of forest cover, shrubs and fruit trees however forest re-growth is evident in the less accessible lands — probably where upland rice plots were abandoned when they were found to be not profitable enough.

Social impacts

In the past, the main social discriminating factor was traditionally possession of access to lowlands and thus the ability to cultivate lowland rice in paddy fields. But now, with the introduction of maize cultivation, upland productivity is comparable to that of the paddy fields. This has meant that access to uplands is becoming a new social discriminating factor; some families who were forced to develop their uplands because they had no access to lowlands have now been able to get out while the going is good.

The fattening of cattle is also bringing about new social discriminations: households able to invest in improved pastures are those households which are already well-off, and are able to invest and mobilize cash during the fattening period. Thus not every household can engage in cattle fattening.

In the rural areas, the diversification of economic activities is occurring. This is linked to the re-structuring of agricultural sector through inputs and service providers, middle men and primary processing factories. Secondary and service sectors are emerging accentuating the diversification of the portfolio of household activities towards more off-farm activities. Here again, there is a social differentiation in the kind of off-farm activity in which farmers can engage. A distinction has to be made between those activities requiring capital (e.g. trading and the provision of services) and those activities requiring no capital (e.g. working for a daily wage).

Conclusion

During our interviews, the farmers often failed to appreciate the likelihood of any long-term negative impacts occurring because they have never before lived through such recent changes in agricultural production practices and so have no experience of any results of such changes. The role of the institutions is to prevent the occurrence of such negative impacts by proposing alternatives, and sharing the global experience together with the example of other provinces in Lao PDR that already have already gone through these changes. How then can we reconcile the desire for short-term benefits with the sustainable exploitation and management of natural resources?

Building a supportive environment to conservation agriculture

Although conservation agriculture does provide possible alternatives to solve the long-term drawbacks resulting from the dynamics of intensification at work in the study area, it results in a reduction in the short-term benefits. Are farmers ready to accept lower immediate incomes in order to secure future ones? What are the institutional conditions and incentives which could be implemented in order to support more sustainable farming systems?

Farmers' needs

It seems to be very difficult to encourage the local farmers to take a long-term perspective, even though most are aware of the potential drawbacks of their practices on their environment and on their future agricultural production. The farmers are reluctant to experience an immediate loss in their income despite the recognition of the potential loss in the long-term.

Another characteristic of the farmers' behavior is the fragmentation of investments, leading to a loss in the efficiency of those investments made. This is due to the difficulties inherent to gathering together at one time the entire amount needed for a large (and often risky) investment. The consequence is a latent underinvestment in farming activities which could be overcome by better access to credit.

To date, the farmers have not seen any environmental degradation. Therefore, they do not perceive any need to change their current cropping practices to more sustainable methods. However, the force driving changes in cropping practices is the farmers' need to reduce the time spent working on their plots, and especially that spent on those labor-intensive activities during the preparation of the plots —this may explain the relative success of mechanical plowing. In contrast, CA techniques to a certain extent are labor intensive —herbicide spraying needs water to be carried up to the plots— and these herbicides are often considered as being dangerous.

The foregoing information demonstrates that, in general, the solutions proposed do not match with the farmers' needs; however, solutions can be proposed in order to make CA more attractive to farmers. These solutions are related to the institutional context of agriculture; the modification of which relies on political decisions.

Institutional context

Although farmers have access to bank credits, the terms are not attractive enough. Firstly, the interest rates are too high, and secondly repayment times are inappropriate and too rigid. Banks should offer longer repayment terms recognizing those investments which need a longer time to be paid off —for example building fences or building roads.

Farmers are in need of more technical support and more agricultural information. Most farmers are left to their own devices in terms of the choice and use of different inputs. In general, the only technical support available for farmers is provided that by traders.

This technical support could be linked to a monitoring of changes in both the environment and agricultural production. As the negative impacts of the current cropping practices have not yet

appeared, the detection of the first signs of any environmental degradation is important, as is the need to try to increase the farmers' awareness of this degradation.

Finally, it is important to enable the creation of farmer groups, in order to share productive capacity, but also investment capacities. Farmer groups are also able to share risks taken when investing in new activities, and could be a good solution to overcome the farmers' aversion to risk-taking.

Conclusions

Limits of the research

The research was limited by several factors. The first of these was the use of the data collected by the 2003 PRONAE diagnostic study which intended to form an important input for the assessment of changes in our study zone. Thus the selection of villages and households for our study was based on the inclusion of the same villages and households included in the PRONAE study. However the difficulties in identifying the households, and the differences in the 2003 and 2009 sample sizes, made comparisons between the 2003 and the 2009 data difficult.

In addition, the dissemination of Conservation Agriculture was limited mostly because the PRONAE objectives were not to do agricultural extension, but rather to develop innovative cropping techniques through on-farm experiments.

Furthermore, the potential impacts of CA adoption in the study zone were diluted by other unrelated major changes taking place there. Therefore, it was very challenging to analyze only the impacts of CA adoption.

Main lessons

The dynamics currently at work in agriculture in the province of Xieng Khouang are directly linked to the recent technical and economic changes there. These have resulted in a rapid intensification of upland agriculture. A positive impact of this intensification has been an increase in the farmers' wealth, but, as predictable, other impacts have negative such as the general degradation of the environment. It is important to find solutions that can provide a balance between, on the one hand, the intensification of agricultural production and future productive capacity and, on the other hand, the protection of the environment. Conservation agriculture seems to offer a good solution for the creation of conditions suitable for sustainable agriculture in the study zone. However, our work leads us to the conclusion that the major restraints to the dissemination and adoption of conservation agriculture could be overcome if the correct political decisions, enabling farmers to take more risk in the short term, were made in order to ensure their future agricultural activities in the province.

Policy Brief 1

Improved pastures and DMC-based upland rice cultivation:
Two solutions for the intensification of land-use in Pek District

The agroecology of Pek district is characterised by a vast altitude plain (The Plain of Jars) with particularly acid and infertile soils. The farming systems of this region are essentially based on extensive livestock production and lowland rice cultivation with yearly manure application[2]. With limited opportunities for agricultural expansion in the lowlands (i.e. most of the lowland areas have already been converted into paddy fields), increasing rice production represents a key challenge for the subsistence farmers of the plain of Jars. Yet, in the quasi-absence of chemical fertilization, the productivity of lowland agriculture is strongly linked to upland cattle breeding and the availability of manure. For many years, farmers have thus been raising increasingly larger cattle herds primarily as a means of savings and, to a lesser extent, as a way to sustain manure production and paddy fertilization. However, the increase in the number of cattle is constrained by forage supply during the dry season. In order to overcome these constraints and to improve local production systems, two main alternatives have been introduced and supported by PRONAE.

Improved pasture and upland rice production: Patterns of diffusion and constraints to adoption

- *Improved pasture*

In line with provincial policy and the activities of other projects in the province, a first alternative has involved establishing and/or regenerating pasturelands – through initial mineral fertilization and introduction of more productive grass species (e.g. *Bracharia ruziziensis*) – in order to increase quantity and quality of forage supply. From there, with the development of cattle fattening, traditional saving activities are transformed into cash generating activities enabling further investments to settle improved pastures and raise larger cattle herds. The regeneration of the pasture after three years of grazing is financed by one cycle of commercial crop (upland rice or soybean) under DMC. As shown in Figure 1, improved pasture has been widely adopted in Xoy Nafa where village authorities have long supported the intensification of livestock production. Adoption has been less important in My and Pouhoum. Finally, although PRONAE did not intervene in Nahoy, Dong and Khay, a significant number of farmers from Dong and Khay have developed improved pastures with the support of other development projects and following different techniques (e.g. ploughing, absence of fertilization).

As reported by the villagers, the main constraint to adoption is linked to the important financial investment that is required for establishing improved pastures and fattening activities (see Table 1). This initial investment can be either self-financed through the sale of cattle or provided through credit contracted with a bank. The sale of cattle heads, however, tends to be seen by farmers as mortgaging the future fattening activities. With limited guarantees to support their demand (e.g.

[2] Lienhard, P., F. Thivet, B. Bounkhampone, T. Sosomphou, S. Sayphoummie, I. Phanthavivong, and L. Séguy. 2008. *Direct Seeding Mulch-Based Cropping systems for Rice-Beef Production in the Plain of Jars, Xieng Khouang Province, Laos PDR: an Example of the "Creation – Validation" Research & Development Methodological Approach*. PRONAE, Vientiane.

land titles), farmers also encounter difficulties in gaining access to bank loans that are, in any case, subject to high interest rates (i.e. from 10% to 14% per year). In addition, the refund period is generally not adapted to the time frame of fattening activities. Indeed, fattening periods can be relatively long depending on forage supply and can vary importantly as a function of the age, sex and growth capacities of the animals raised. If the refund date of the loan comes before the cattle reaches its highest weight, the profitability of the fattening activities is not optimal.

Figure 1: Adoption of improved pasture (% of households per village, 1999-2009)

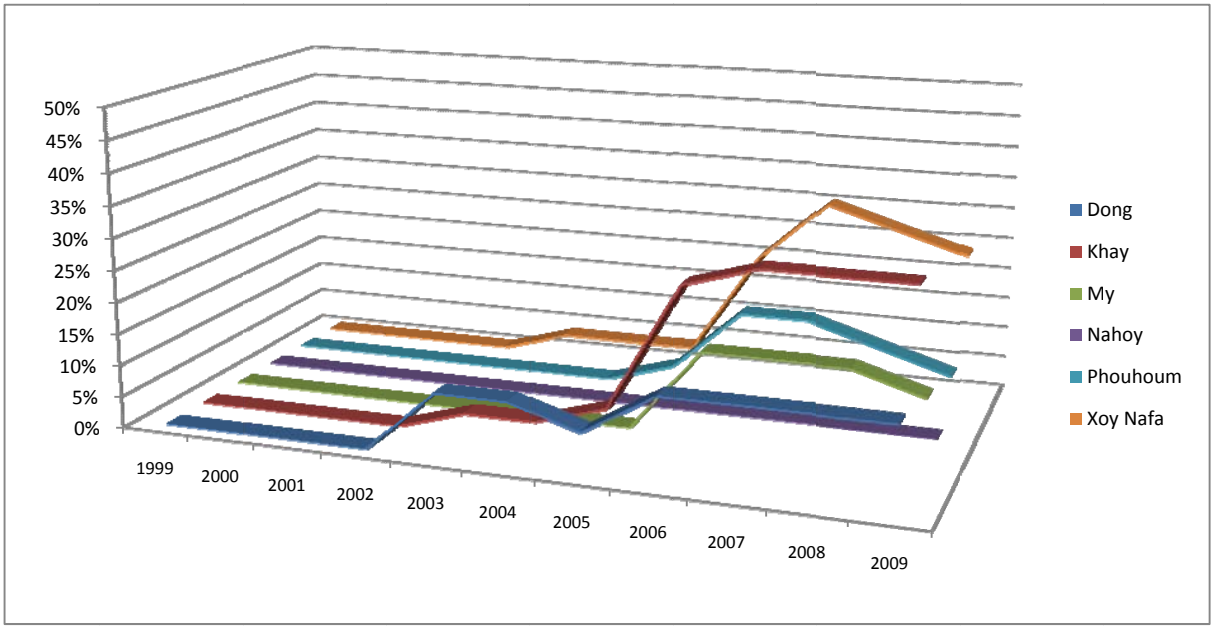


Table 1: Motivations underlying local disinterest in and disengagement from improved pasture

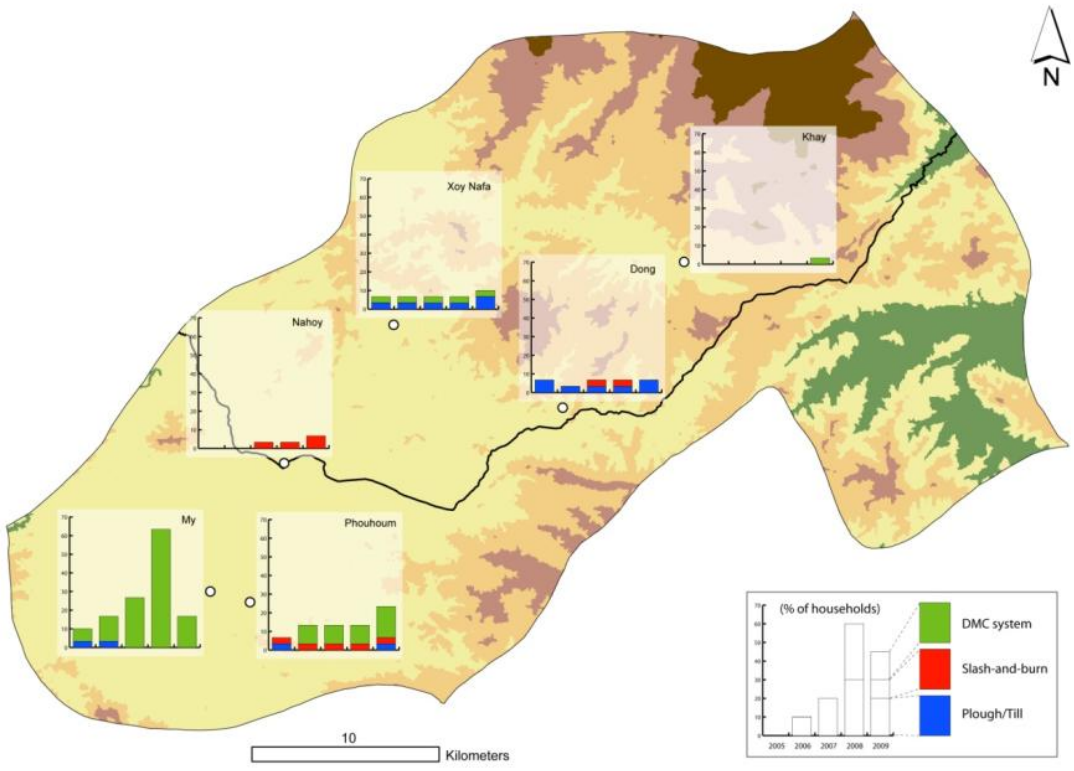
Reasons (disinterest)	**Frequency of answer (157 respondants)**	**Reasons (disengagement)**	**Frequency of answer (12 respondants)**
Not enough capital	26,2%	Not enough capital	31,6%
Not enough labour	20,7%	Not enough labour	15,8%
No cow	18,7%	Not successful in production	15,8%
Not enough land	18,4%	Wants to grow rice	5,3%
Wants to have less cattle	5,4%	Herbicides are inefficient	5,3%
Enough natural pasture	3,4%	No cow	5,3%
No technical knowledge	2,4%	No seeds	5,3%
No seeds	2,0%	Risk of low production	5,3%
No project support	0,7%	Water-soaked area	5,3%
Unsuccessful experience of neighbour	0,7%	No market for selling grass seeds (to recover initial investment)	5,3%
Never heard before	0,3%		
New family	0,3%		
No equipment	0,3%		
Risk of low production	0,3%		

- *Upland rice production*

A second alternative proposed by PRONAE has involved upland rice cultivation through Direct Mulch-seeding Cropping (DMC) systems (also considered as an important stage in the regeneration of improved pasture every three years). DMC systems involve no tillage and the maintenance of a permanent plant cover on the soil. The latter plant cover can be dead mulch (crop residue or dead cover plants) or live mulch associated with the main crop. As developed in the study area, this system involves the use of chemical fertilizers to compensate for nutriments deficiencies of the soil along with two types of herbicides (i.e. total herbicides sprayed on the natural grass to establish the mulch and selective herbicides for post-emergence application).

As illustrated by Figure 2, DMC systems were introduced with variable success in the study villages. Without project intervention like in Nahoy and Dong villages, upland rice is generally cultivated through slash-and-burn (on grass and shrub lands) and tillage-based systems. Furthermore, while DMC systems had become very popular in My, the end of PRONAE's financial and technical support, combined with the reluctance of banks to support farmers groups with their innovative system, has resulted into a neat withdraw of the villagers. As in Pouhoum, 17% of the villagers were involved in DMC-based upland rice production in 2009. In Xoy Nafa and Khay, despite the economic incentives associated with rising rice prices[3], adoption of PRONAE's alternative rice production system has remained very limited.

Figure 2: Adoption of upland rice production techniques (2005-2009)



[3] 3,000 LAK/kg in Nov. 2010 against 2,300 LAK/kg in Nov. 2007 (Source: Provincial Trade Department).

As for improved pasture, the financial investment required to establish DMC-based upland rice production represents an important constraint for adoption. The purchase of chemical fertilizers and herbicides is indeed considered as an important investment by farmers — it constitutes an economic risk even if it is compensated by higher net incomes (Table 2).

Table 2: Compared agro-economic results for DMC-based and tillage-based upland rice production

	DMC	Tillage (hand-tractor)
Crop yields (T/ha)	2.0	0.97
Gross profit (LAK/ha)	5 200 000	2 522 000
Net Profit=Net Income	3 119 000	2 203 000
Productivity	134 000	95 000

Data derived from six household surveys conducted in 2009 in My (three farmers using DMC techniques with mechanised seeders), Pouhoum (two farmers using tillage) and Xoy Nafa (one farmer using tillage)

$Gross\ profit = Production \times Mean\ price$

- Mean yields: DMC: 2000 kg/ha; Tillage: 970kg/ha
- Rice selling price: 2600 LAK/kg

$Net\ profit = Gross\ profit - Inputs$

- Sowing density: DMC: 110 kg/ha; Tillage: 104 kg/ha
- Seedling price = 2600 LAK/kg
- Herbicides DMC: Glyphosate = 5L/ha ; 65,000 LAK/L
- Fertilizer DMC: 300kg/ha ; 4900 LAK/kg
- Petroleum Tillage 6.6L/ha ; 7020 LAK/L

$Net\ income = Gross\ income - Taxes$

- We consider that $Gross\ income = Net\ profit$ (Depreciation is not accounted)
- Pek upland taxes = 0 LAK/ha/year

$Productivity = {}^{Net\ Income}/_{Time\ of\ work}$

- Time of work (in MD/ha) DMC: 23.3 ; Tillage: 73.5

In addition to these economic considerations, the development of upland rice production is constrained by an important competition for access to land. Upland rice and improved pasture are indeed competing with common land-uses (e.g. cattle roaming) and, more importantly, with a growing demand for large private concessions by influent urban-dwellers and foreign investors[4]. Local demand for tree plantation and reforestation represents also another source of competition as many villagers expressed the need to increase forest cover in order to sustain water and fuel/construction wood supply.

Village authorities can play an important role in arbitrating this competition. In Xoy Nafa for instance, village leaders tend to promote cattle breeding activities over rice production. In village like Khay, with relatively good availability of lowlands, there is probably less incentive to turn to upland rice production.

[4] E.g. Cow farm and Korean cassava concession in Ban Phouhoum, Vietnamese cow farm in Ban My, Chinese potato farm project in Ban Xoy Nafa.

Conclusion and recommendations

In general, the households of the study area seem to limit the investments made to improve their farming system to a relatively low level. Farm investments usually come from incomes that are generated by the farm itself (e.g. hand tractors bought with the sale of buffaloes) and farming activities tend to be considered as a basis for food self-subsistence rather than as a source of revenue and accumulation. Hence, while the proximity to the district capital allows for generating important off-farm incomes (e.g. construction work, handicraft, petty business), these are rarely reinvested into the farm. Rather, they fund the studies of children or are spent to improve the standard of living (e.g. purchase of transportation means and household equipment, payment for housing improvement and access to the electric grid, etc.). In turn, this chronic underinvestment into the farm, especially for required fencing and chemical inputs, does not play in favour of the development of new techniques and the adoption of new farming systems.

Measures could nevertheless be taken in order to provide higher incentives to farmers and facilitate agricultural innovation:

- In relation to the improvement of livestock farming activities, agricultural banks should facilitate local access to credit, provide more attractive interest rates and ensure that the refund periods are better adapted to the time frame of these activities (i.e. adequate support to fencing, pasture establishment and early production would require 3 to 5-year refund periods),

- A dedicated livestock extension system – operated by the provincial and/or district agricultural services with the support of the numerous livestock promotion projects active in the area – could promote a stepwise adoption of the proposed alternatives while encouraging livestock farmers to establish production groups that would reduce pasture protection costs and facilitate the development of hedged pasturelands,

- In relation to DMC-based upland rice production, reducing the surfaces cultivated and/or providing adapted credit may assist in reducing the risks taken by smallholders and, thus, in making the cropping system more attractive.

- In relation to DMC-based upland rice production, improved pasture and the labour required for establishing these alternatives, facilitating access to small equipment (e.g. hand-job and mechanised seeders, manual sprayers) through the establishment of rental service providers and associated credit for equipment purchase/rental could also provide higher incentives to farmers.

Policy Brief 2

Enhancing land productivity while preserving natural resources in the mountains of northern Kham district

Constrained by a hilly topography, i.e. absence of valley bottom suitable for paddy, and long distances to the main economic centres of the province, agriculture in the northern part of Kham district has long been dominated by traditional (slash-and-burn) shifting cultivation of upland rice. In general, the plots are cropped with glutinous rice during one year, sometimes planted with traditional maize varieties the following year, and left fallowed for 3 to 15-years (depending on the distance of the plot to the road/village and the associated land pressure)[5]. In these forested environments, NTFPs are traditionally an important source of food, and with a growing market demand the contribution of NTFP collection to the households' annual income is increasing.

Over the recent years, a large majority of the villages in the area have resettled, either spontaneously or under the pressure of the district authorities, along the national road no. 6 linking the district capital to Huaphan province. Soil fertility, however, is relatively low along the extensively cultivated crest line and farmers have to walk long distances in order to find more productive plots (usually located near their former settlements). In some villages, 'upland roads' are thus being developed – with private capital or external support[6] – in order to make remote lands more accessible and facilitate cultivation and transportation of commercial crops (e.g. hybrid maize in Nong Oln village). Beyond these local investments in infrastructures, two main innovations have been developed and supported by the National Agro-Ecology Programme (PRONAE) to enhance the productivity of existing agricultural land.

Improved pasture and DMC systems: patterns of diffusion and constraints to adoption

- *Improved pasture*

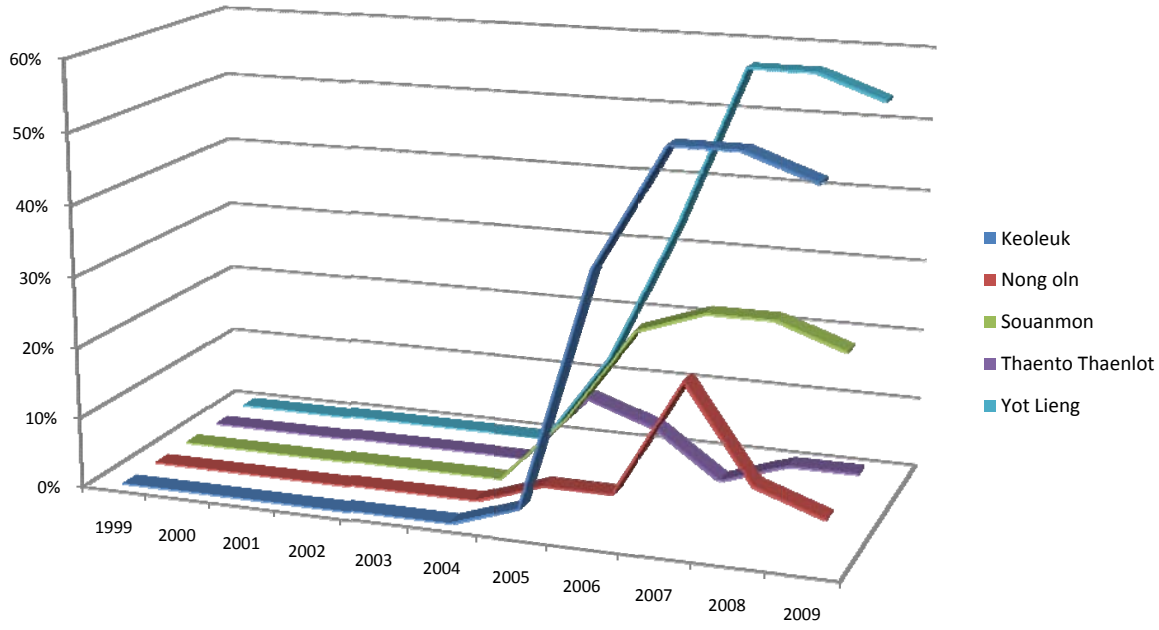
In northern Kham area, PRONAE has focused its activities on improved pastures and livestock fattening. From 2004 to 2008, the project established on-farm demonstration plots in Suanmone village. Grass seeds and technical support were provided to farmers of Suanmone, Gnod Lieng, Keoleuk and Thaentho Thaenlot villages who volunteered to participate in the project. As a further incentive to pasture improvement, PRONAE proposed to buy the grass seeds that the farmer would harvest from their plots – an option which would allow farmers to cover their initial costs, especially for fencing. As a result, improved pasture and cow fattening have rapidly developed. In the villages of Keoleuk and Gnod Lieng, half of the population has established improved pastures over the past decade (Figure 1). In Ban Suanmone, 25% of the villagers have done so.

[5] PRONAE. 2003. *Diagnostic agro-socio-économique de la zone d'intervention du projet : Districts de Pek, Kham et Nonghet*. CIRAD and NAFRI, Vientiane.

[6] Nong Oln villagers have contracted credits in order to finance the development of a road section within the village land. Supported by a Food for Work program, Thaentho Thanlot villagers have been able to exchange road construction labour with rice.

In general, livestock related activities appear to be well adapted to mountainous villages where suitable areas for cropping remain limited. A number of issues have emerged however. The artificial market for grass seedlings established by PRONAE had a number of drawbacks. Some farmers have cultivated grass seeds as an annual crop without developing fattening activities. In Keoleuk village, some farmers are even protecting their grass plots from their own cattle. In Thaentho Thanlot village, some farmers also complained that they could not sell their grass seed production after the initial stage of improved pasture establishment.

Figure 1: Adoption of improved pasture (% of households per village, 1999-2009)



By engaging in the project activities, many farmers had in mind that establishing improved pastures would provide them with sufficient guarantee to gain access to bank loans. In turn, they would have the possibility to purchase cattle heads for fattening and develop their herds. Most of them, however, could not get access to credit and, as a result, abandoned their pastures – leaving only those farmers who already had an important cattle herd or who had enough capital to self-finance the acquisition of cattle.

An important constraint also reported by farmers relates to labour requirements. Improved pastures cannot maintain themselves naturally and, without a yearly weeding, become invaded with weeds and ligneous plants. Weeding operations, however, require important labour inputs at the same time as the upland rice plots are slashed. Many farmers prefer thus to leave their pasture invaded by weeds and focus on a key subsistence activity. Some villagers of Gnod Lieng have nevertheless been able to limit these labour requirements by introducing '*nya oysan*' in their improved pastures. Originating from Nonghet district (where it constitutes the traditional feed for fighting bulls), this cane can indeed be more easily hoed than the grass species that were initially proposed by PRONAE.

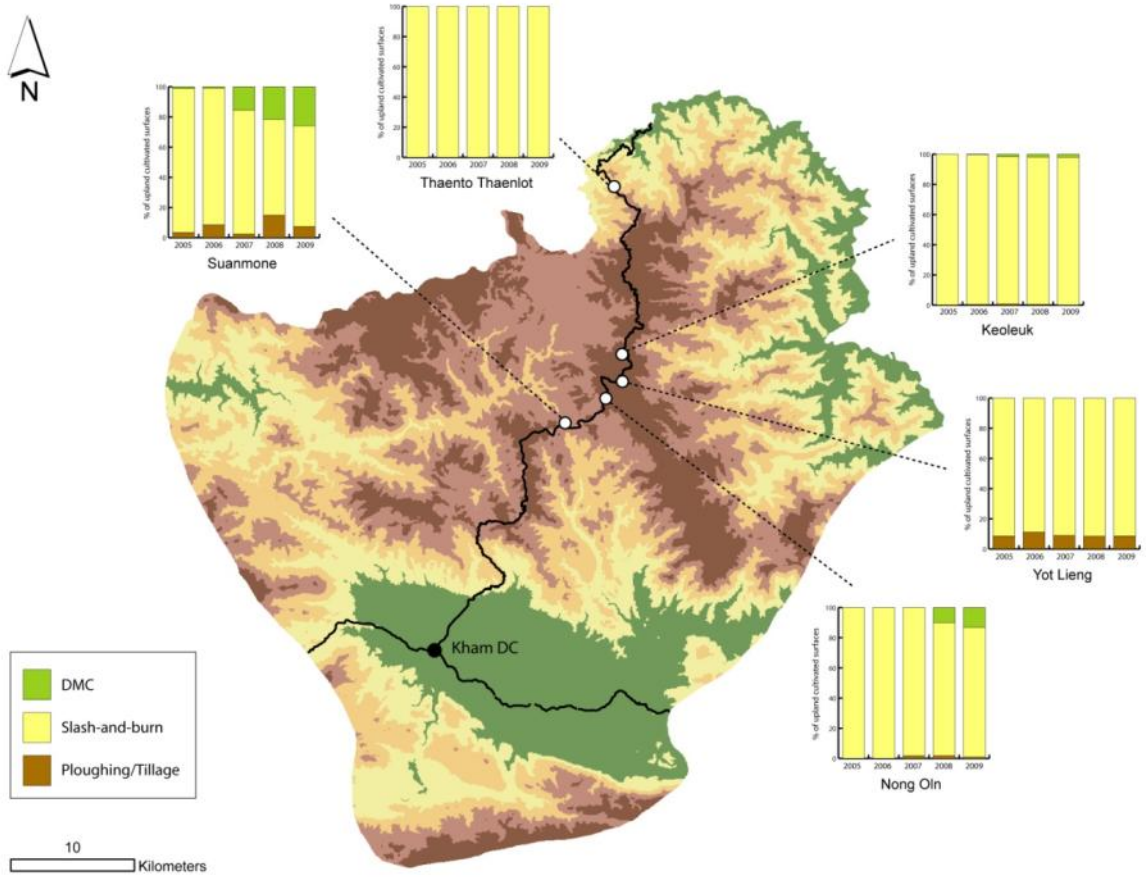
Photo 1: An improved pasture invaded by weeds in Gnod Lieng village (March 2010)

Photo 2: A pasture planted with 'nya oysan' in Keopatou village (March 2010)

- *Promotion of DMC techniques*

Along with improved pastures, the PRONAE established a number of demonstration plots in Suanmone village where different techniques (i.e. slash-and-burn and DMC) and different crops (i.e. rice, maize, cassava and sorghum) were tested and compared. DMC systems experimented in these plots appeared to gain some popularity among Suanmone farmers and the share of DMC systems in the uplands increased significantly from 2007 to 2009 (Figure 2). Furthermore, while the PRONAE demonstration plots had all been returned to villagers in 2008, most of the conservation techniques developed by the programme were still applied by the plot owners the next year. This contributes to maintain a momentum that could be valorised by future extension programs. Finally and more surprisingly, some farmers of Nong Oln village have also developed DMC maize monoculture on plots made accessible through the construction of an upland road in 2009. In fact, although PRONAE did not have specific activities in this village, DMC adoption was subsequent to the participation of village leaders to study tours organized in Suanmone village and in southern Sayaboury province (where the programme has been active since the early 2000s).

Figure 2: Distribution of ploughing, slash-and-burn and DMC systems within upland crop areas (2005-2009)



As expected from PRONAE activities being exclusively focused on Suanmone village, farmers' adoption of DMC systems remained very limited in the other villages surveyed in the area. A main constraint to the dissemination of these innovative systems in the study area lies into the limited extent of commercial agriculture. The requirements of DMC systems in terms of inputs and

associated financial capital provide limited incentives to farmers in areas where subsistence agriculture is predominant. As a corollary, the case of Nong Oln village illustrates that, with the emergence of commercial productions like maize, DMC systems can represent an attractive option for remote villagers – even with limited external support.

Conclusion & Recommendations

Livestock fattening is a highly capital-intensive activity and its development raises questions with respect to local investment capacities for the acquisition of both cattle and improved pastures. Some villagers of Gnod Lieng, Keoleuk and Suanmone have successfully established improved pastures and started cattle fattening activities. However, those who have been able to do so are generally among the better-offs. They could sell cattle to finance their pasture improvement and/or they had other assets (e.g. small shops, regular salaries or remittances) to serve as guarantee for requesting bank credits. In that sense, while improved pasture and cow fattening have the potential to enhance land productivity in the northern part of Kham district, financial options should be sought to facilitate the engagement of poor households in these activities. Similarly, if conservation agriculture has gained some popularity among the farmers of Suanmone and Nong Oln villages, the adoption of DMC systems has been largely contingent on the simultaneous expansion of commercial maize production – allowing for sufficient cash flow and investment in farm inputs.

On the basis of these observations, measures could be taken that would facilitate the engagement of poor households into livestock fattening activities and provide higher incentives for upland subsistence farmers to shift towards more productive and profitable land-uses:

- The agricultural promotion bank should provide specific, low interest credit for cattle acquisition. Indeed, although Kham is not included in the 47 priority districts of Laos for poverty alleviation, the establishment of a branch of the Nayobay Bank, for instance, could certainly benefit upland dwellers whose poverty level is in fact much higher than the one generally encountered in the Kham basin area and in Nonghet district (a district which is classified among the 47 poorest districts of the country)

- Facilitated access to low interest loans could also help the development of ‘upland roads’ and open up remote upland areas to commercial agriculture. As observed in Nong Oln village, the productivity of the newly accessible and fertile lands could then be enhanced through DMC systems and the development of commercial crops like maize,

- In line with the growing contribution of forest products to the incomes of upland dwellers and with the objective to ensure the regeneration of NTFP resources, agricultural and forestry services could also provide support for the sustainable management and domestication of NTFPs (e.g. cardamom, bamboo shoots and broom grass). Through the development of multi-usage living hedges (e.g. composed of bamboo, paper mulberry, jatropha, etc.), NTFP domestication could in turn facilitate the management and protection of improved pastures and DMC plots.

Policy Brief 3

Accompanying the 'maize boom' in Kham basin and Nonghet district

Characterized by a warm micro-climate, fertile soils and a good accessibility, the Kham basin allows for an important diversity of upland commercial productions (e.g. fruits trees, vegetables, chilli, maize). Located at the eastern part of the basin, the limestone soils of the mountainous Nonghet district remain quite productive despite the steeper slopes. Beside livestock raising, local upland agriculture can be characterized by the relative share of subsistence-oriented upland rice and commercially oriented maize production.

Hybrid maize as main driver of agricultural intensification

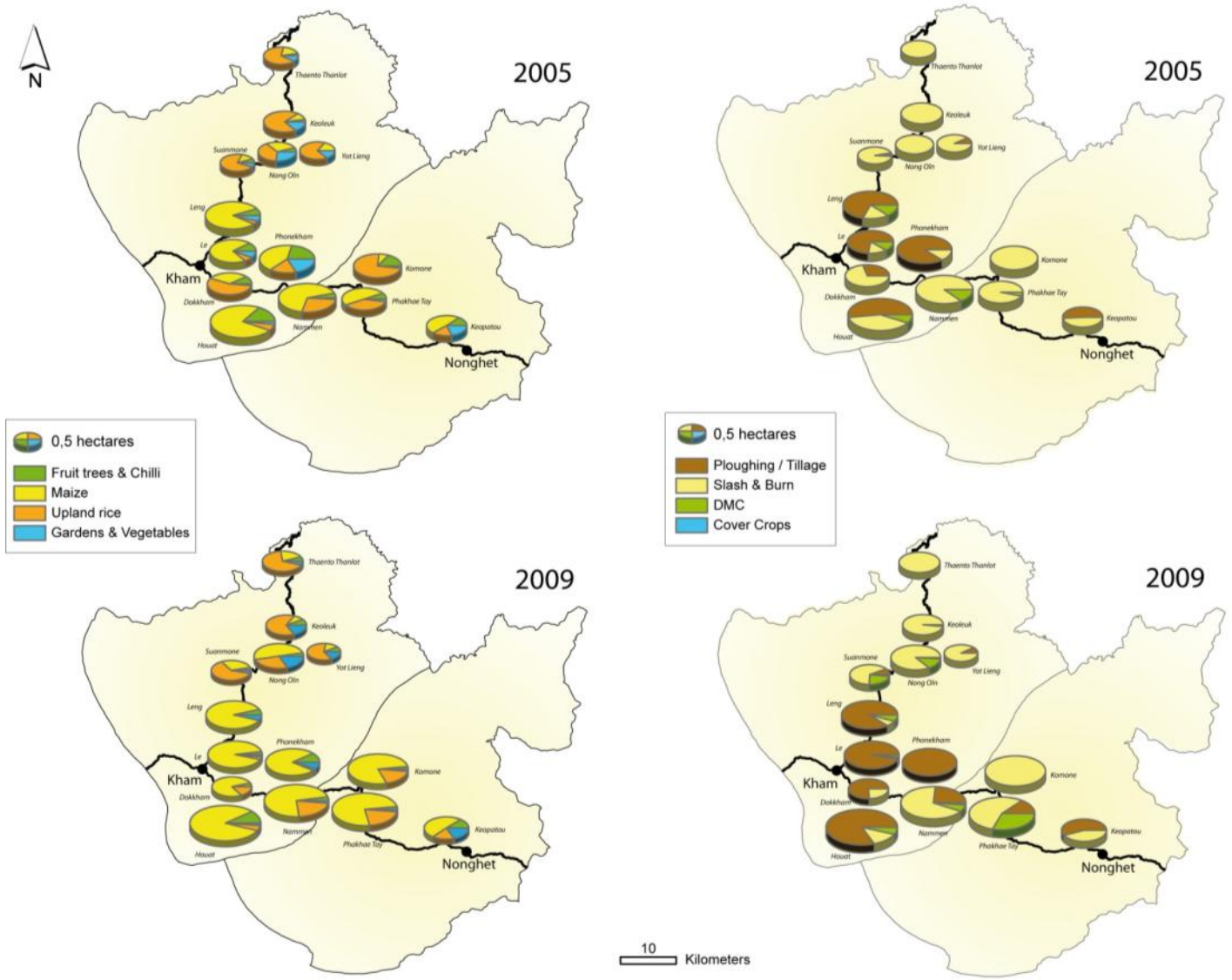
Since the mid-2000s, land-use in Kham basin and Nonghet hillsides has come to be dominated by hybrid maize mono-cropping (Figure 1). The rapid expansion of this commercial crop – along the national road no. 7 linking Phonsavanh, the provincial capital, to Vietnam – has a tremendous impact on both the local economy and the environment. Maize has not only replaced existing gardens, chilli and fruit tree plantations but it has also expanded at the expense of forests and former fallowed areas. At the exception of a few villages with limited access to the lowlands for paddy rice production, upland rice areas have decreased significantly. The success of this cash crop can be explained by (i) the important incomes and labour productivity gains that it generates, (ii) the ease of production and hardiness of the plant that require no specific technical knowledge, (iii) low input and low investment limiting economic risk, (iv) the proximity of the main outlet —Vietnam— from where hybrid seeds are imported, and where maize production is exported for animal feed.

This impressive agricultural intensification process has occurred as a corollary to the introduction of hybrid cultivars in the region. Improved maize seeds are planted at higher density and they are generally more productive than traditional varieties. With greater agricultural income and investment capacity, mechanical ploughing has then become the main technique for preparing the agricultural plots (Figure 2). Thus, many farmers of the Kham basin have recourse to service providers for their ploughing operations with tractors and ploughs[7]. Along the national road, mechanical ploughing has rapidly expanded towards Nonghet district, where it is (partly) replacing traditional slash-and-burn techniques and competing with conservation techniques developed by the National Agro-Ecology Programme (PRONAE). Herbicides such as atrazine, gramoxone and glyphosate are commonly used during the cropping sequence[8].

[7] Some of these service providers come from provinces that engaged earlier in a similar 'maize boom' (e.g. Sayaboury, Udomxay).

[8] As reported during interviews, farmers consider that, as long as they follow application protocols, the use of herbicides does not raise concerns relative to their negative impact on health and the environment.

Figure 1: Distribution of land-use types and soil preparation techniques in the uplands of Kham and Nonghet districts in 2005 and 2009



Komone village provides a good example of the rapid expansion of hybrid maize and the intensification of cropping practices. In this village, farmers have clearly engaged in the transition from traditional to commercial agriculture. Maize mono-cropping has developed very rapidly over the past three years and, in 2010, a large majority of farmers started spraying herbicides with motor-pumps. Traders have played a key role in fostering this transition — pushing farmers to plant hybrid maize seedlings in 2008, introducing herbicides in 2009 and motor-pumps in 2010. Informal information exchange with other villages and direct observation also played a key role in these land-use transformations. In contrast with more accessible areas, however, mechanical ploughing has not yet reached the village.

Although the transition towards intensive hybrid maize mono-cropping is occurring on a very large scale, some villages appear to oppose some resistance to the process. In Keopathou village for instance, despite proximity with the district capital, villagers have maintained a traditional Hmong agriculture based on the cultivation of upland rice and traditional maize varieties (with plots slashed and burned and ploughed by hand). Dedicated to the fattening of fighting bulls, improved pastures (based on elephant grass or *nia oysan*) are also common in the village. While some attempts were made to introduce hybrid maize in 2008, low production and low prices pushed the villagers to revert back to their traditional varieties in 2009.

Photo 1: Tractor ploughing on a burnt plot (Pakhae Tay, Feb. 2010)

Conservation Agriculture

In this context, the activities promoted by PRONAE have focused on accompanying the 'maize boom' and, in particular, mitigating its potentially negative environmental impacts by developing DMC-based maize cropping systems. For that purpose, the project offered technical support through agricultural extension equipment lending and training on the safe and sustainable use of pesticides. Improved pasture systems were also proposed by the project but, as the area has long been focused on crop production, pasture-related innovations had less success than in other agro-ecological zones where animal production represents a key livelihood component (e.g. Pek and Kham north).

As a result of these efforts, DMC systems effectively covered a small proportion of the total upland areas cultivated in Kham basin in 2009. However, the cropping model that really imposed itself is the one based on soil tillage (see Figure 2). DMC had more success in Nonghet hillsides as the steep slopes prevented tractor access. However mechanical ploughing expanded quite significantly in the area. In 2010, many farmers who were previously engaged in conservation agriculture started to till their maize plots— when ploughing service providers started prospecting upstream of the Kham basin. The status of conservation agriculture appears thus rather unsettled in the area and farmers with sufficient capital tend to shift from slash-and-burn or DMC systems to ploughing-based systems.

Constraints to adoption

Intensive, tillage-based maize mono-cropping is just emerging in Xieng Khouang province. Therefore, in contrast with what has been reported in other regions of Laos (e.g. southern Sayaboury province), the system has not yet reached nor shown its limits in terms of soil erosion, soil fertility depletion, weed resistance to herbicides and water pollution. None of the interviewed farmers reported soil erosion issues, neither in the gently sloping lands of the Kham basin nor in the hilly areas of Nonghet district. Soil fertility depletion did not appear as an issue (i.e. organic manure or chemical fertilizers have not been used so far). Instead, at this initial stage of 'conventional agriculture' introduction, soil tillage and herbicides are perceived by local people as having very positive impacts on local livelihoods – improving agricultural productivity and incomes while reducing agricultural workload.

Thus, without experience (or knowledge) of the potential downsides of the current agricultural transition, farmers do not feel the need to invest time and capital in alternative cropping systems. As a matter of fact, while most of the interviewed farmers who took part in the PRONAE activities reported that they understood the logic and functioning of the proposed conservation techniques, they also considered that there was no pressing need to apply them as the soil quality was still fairly good and as they would still have the capacity to do so in the future. Similar to what had been observed in southern Sayaboury province[9], this latter perspective was made particularly explicit by the farmers of Phakhae Tay village. They suggested that, in the future, they would probably alternate ploughing with DMC systems as a way to manage soil fertility.

[9] Slaats, J., and G. Lestrelin. 2009. *Improving cropping systems by introducing Conservation Agriculture: Taking stock of the results and methodology of research-development in southern Sayaboury province, Lao PDR.* Programme de Capitalisation en Appui à la Politique de Développement Rural, Vientiane.

Conclusion & Recommendations

For different reasons, the recent and rapid development of ploughing-based maize monoculture in the districts of Kham and Nonghet is alarming. As already observed in Sayaboury province, agricultural intensification and heavy mechanisation can have rather negative ecological impacts, including increased soil erosion, siltation of the lowlands, gradual soil exhaustion, weed invasion and water pollution. Without proper technical guidance from extension agents, farmers rely on traders to select and use agricultural inputs like pesticides and cultivars – with serious associated risks not only in terms of economic dependency but also, in case of misuses[10], in terms of farm indebtness, human and animal intoxication and environmental degradation. DMC systems can represent a viable alternative, allowing farmers to benefit from improved farm productivity and greater incomes while mitigating the environmental impacts of the transition. Yet, in a context where farmers have no experience of the potential negative impact of the 'conventional' agricultural practices, they perceive it as the best option both in term of economic risk management and in term of family labor management. Incentives appear rather limited to maintain or to adopt alternative, more sustainable cropping systems.

On the basis of these observations, recommendations can be made that could help anticipating and mitigating the negative impacts of the current 'maize boom':

- In order to limit the risks associated with the current agricultural transition, further technical support (e.g. cultivar selection, sowing techniques and crop associations/rotations, pesticide dosage and safety precautions) should be provided by agricultural extension services in order to maintain DMC systems as a possible option for the farmers of the area,

- In order to provide greater incentives for farmers to shift towards more sustainable cropping systems, awareness-raising campaigns should be conducted to inform farmers of the medium and long-term impacts of current agricultural practices. In line with the latter, monitoring systems (e.g. crop and sediment yields, water quality) could also be established at the village level,

- As long as the environmental drawbacks of 'conventional agriculture' are not perceptible by local farmers, only strong policy incentives and regulations (e.g. ban on mechanical ploughing on steeply sloping lands), combined with extension activities conducted in close collaboration with research agencies can prevent the rapid expansion of non sustainable practices associated with the boom crops such as maize.

[10] A first case of water pollution by pesticides was reported by Ban Houat interviewees, apparently without consequences for the use of herbicides in the village.

Paper 1

Understanding the diversity of the local development pathways in relation to the commercial agricultural boom in Xieng Khouang Province (2000-2010)

Jean-Christophe Castella[1,2], Guillaume Lestrelin[1], Khamla Nanthavong[3], Etienne Jobard[4], Anousith Keophoxay[5], Sonnasack Phaipasith[6], Chanxay Khamvanseuang[5], Linkham Douangsavanh[5]

1. IRD, Vientiane
2. CIFOR, Vientiane
3. Provincial Agriculture and Forestry Office, Xieng Khouang Province
4. AgroParisTech, Paris
5. NAFRI Policy Research Centre, Vientiane
6. Department of Geography, Faculty of Social Sciences, National University of Laos

Abstract

At the end of the 1990s, the opening of the country to market economy led to a shift from subsistence to commercial agriculture and a massive conversion of land use in relation to the expansion of cash crops such as rubber or maize and livestock. Many on-going debates about the expected impact of this land conversion at the national level on food security (rice sufficiency), poverty, economic differentiation, land grabbing, land degradation, are rather pessimistic.

However, the impact of these megatrends - pull and push factors of economic changes, i.e. market forces and GoL policies - and local trajectories of change are variable from place to place all over the country based on a few influencing factors: history, local leadership and social capital as well as physical factors (soils, relief, climate, etc) distribution and access to natural resources (accessibility).

The province of Xieng Khouang encapsulates a diversity of physical environments in a relatively limited area. We have studied there the agrarian changes that have occurred in relation with the opening to the market economy during the 1st decade of the new millennium (i.e., agricultural expansion, diversification, etc.) and their socioeconomic impact.

Paper 2

Impact of maize expansion on household economy in Xieng Khouang province

Jean-Christophe Castella[1,2], Etienne Jobard[3], Anousith Keophoxay[4], Guillaume Lestrelin[1], Khamla Nanthavong[5], Chanxay Khamvanseuang[4]

1. IRD, Vientiane
2. CIFOR, Vientiane
3. AgroParisTech, Paris
4. NAFRI Policy Research Centre, Vientiane
5. Provincial Agriculture and Forestry Office, Xieng Khouang Province

Abstract

Like in many other upland areas of Laos, the rapid expansion of maize crop is one of the main drivers of the profound agricultural changes that occurred in Xieng Khouang province during the 2000s. In this paper, we study the impact of these changes on the household economy by comparing two series of households surveys conducted in 2003 and 2009 in Kham and Nonghet districts. The patterns of household differentiation during the maize boom are related to their capacity to cover their rice needs in the early 2000s. We analyze the contribution of maize to the general increase in household income by comparing the observed changes in household income with the simulated income under the hypothesis of no maize expansion over the same period. The trajectories of change in household strategies show that the replacement of most former upland crops by maize has led to a general improvement of the economic situation but is also responsible for an increased vulnerability both environmentally (i.e. land degradation to extensive tillage, agrobiodiversity loss in relation with gradual landscape homogenization) and economically (i.e. price fluctuations for both inputs and outputs). Better diffusion of conservation agriculture may help buffering the negative impacts of the current cropping practices while preserving a diversity of agricultural products and income sources.

Paper 3

"To till or not to till?" Opportunities and constraints to the diffusion of Conservation Agriculture in Xieng Khouang Province, Lao PDR

Guillaume Lestrelin[1*], Khamla Nanthavong[2], Etienne Jobard[3], Anousith Keophoxay[4], Chanxay Khambanseuang[4], and Jean-Christophe Castella[1,5]

1. IRD, Vientiane
2. Provincial Agriculture and Forestry Office, Xieng Khouang Province
3. AgroParisTech, Paris
4. NAFRI Policy Research Centre, Vientiane
5. CIFOR, Vientiane

Abstract

Over the past decade, efforts have been made to promote Conservation Agriculture as an ecologically-sound alternative to tillage-based agriculture in Lao PDR. This paper assesses some of the outcomes of a 5-year research-development project aimed at developing sustainable no-till cropping and pasture systems, and promoting their adoption by smallholders in Xieng Khouang Province. Based on extensive household surveys in 20 villages, the study highlights some of the key environmental and socio-economic factors influencing the adoption and diffusion of Conservation Agriculture. It provides a number of policy recommendations aimed at facilitating agricultural innovation and providing greater incentives for farmers to shift towards more sustainable farming practices.