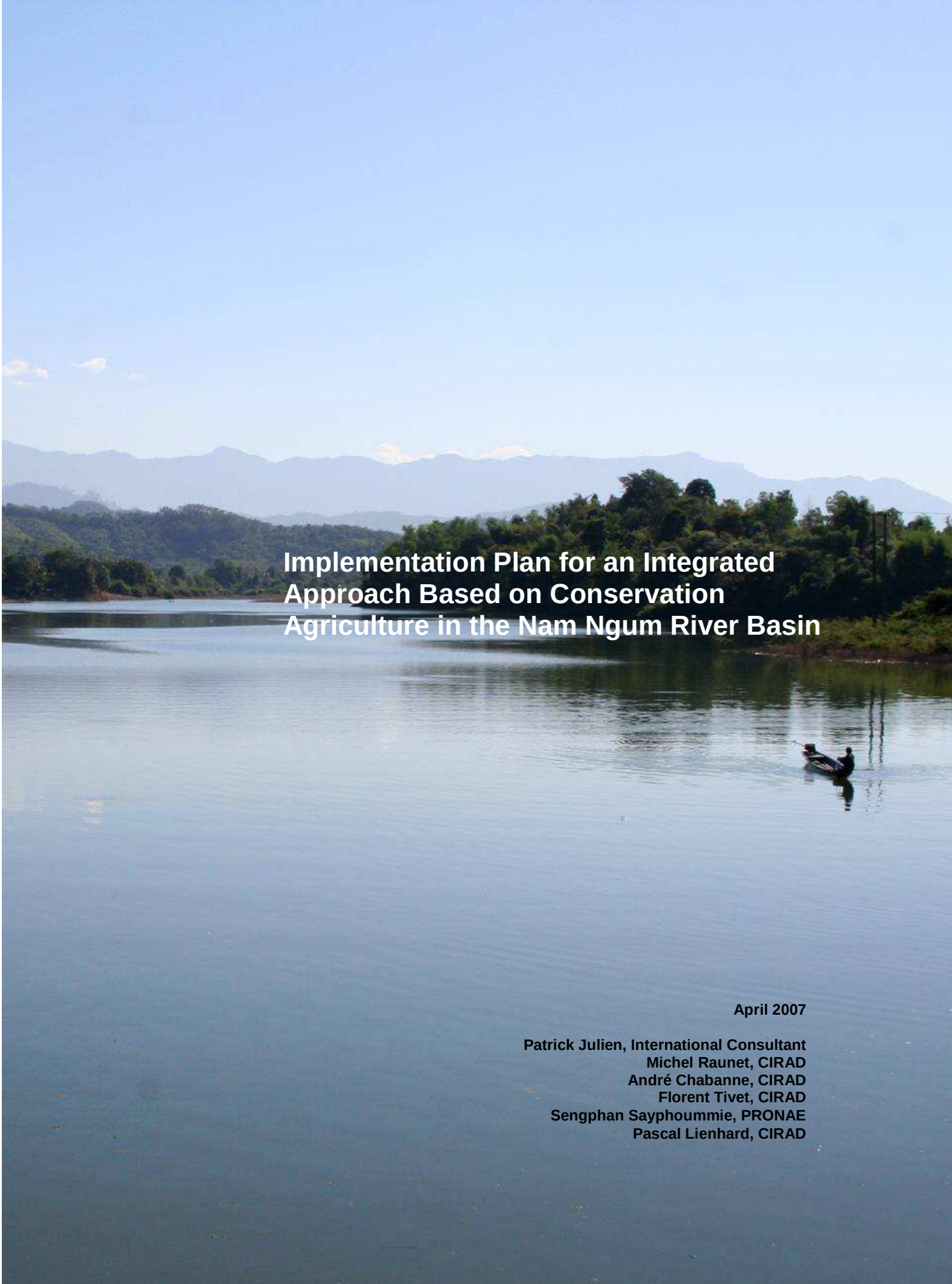

Implementation Plan for an Integrated Approach Based on Conservation Agriculture in the Nam Ngum River Basin

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GENERAL REMARKS ON THE STUDY

The implementation plan presented here is the result of negotiations and discussions conducted by the programme team as they worked with district and provincial authorities to arrange, readjust and approve activities during this mission. This task was undertaken to provide the best possible conditions for the work planned for 2007 in case the Ministry of Agriculture and Forestry (MAF) and the Nam Ngum project approved the 'fast track' proposals (04/01/2007).

A specific programme for every district has been thoroughly discussed with the Nam Ngum project coordinators for each province. The basic premise of agro-ecology and SCV was not new to them, with the suggested production systems having already been in development (training and trial plots were set up during 2006 under PRONAE) in a certain number of project districts.

It is expected that this implementation plan will adjust all Nam Ngum rural development project activities through component 3b around an integrated strategy that takes into account existing human and financial resources. These actions will, moreover, be backstopped by other programmes (PCADR) and projects (PASS, PRONAE) under the MAF, which can already make use of support from the Sectoral Agro-Ecology Programme (PROSA) in coordinating and supervising these activities at national level.

Regarding the actions and strategy for the Nam Ngum project, it would at this stage appear necessary to consider that all decisions on redirecting human and financial resources to optimise these resources will taken by the Ministry of Agriculture and Forestry. This will thus ultimately depend on a political and strategic decision.

In the current context, with no decision having been made so far, activities will be limited to the first plans made in 2006 - the initial training of a team of 20 DAFEO technicians plus support to the establishment of training centres in the provinces of Xieng Khouang and Vientiane. Through this work a more precise diagnosis can be made for each district and then integrated into the training, so that time will not be lost in the long term.

Although the training modules could not be included in this document, the appendices contain some technical files. These will be made available to the DAFEO technicians during the training.

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1. STUDY OBJECTIVES AND PROCESS

1.1. BACKGROUND

NAFES and NAFRI developed a plan and signed a contract to design an integrated development programme for the whole Nam Ngum catchment area. The programme is to be based on the work already undertaken by PRONAE in the provinces of Xayabury and Xieng Khouang.

The contract is divided into three components to be conducted during 2007: i) an implementation plan to define and set up the 2007-2010 technical and financial programme, which will redirect districts towards agro-ecology; ii) foundation training for 20 DAFEO technicians who will be trained within PRONAE (general training on all components of production systems and environmental safeguards); and iii) setting up demonstration sites that will be the basis of an extension programme for 2008-2010.

The original terms of reference for the study (see appendix 1) were adjusted after a meeting held with NAFES on Monday November 27, 2006. In line with the requirements of the Ministry of Agriculture and Forestry (MAF), this realignment mainly specifies the need to:

- To present a full scale agro-ecology development programme that will be integrated into ongoing activities in the two concerned provinces (Xieng Khouang and Vientiane) by the Nam Ngum project, funded by its own financial resources;
- To re-examine the provisional 2007 objectives planned for Xieng Khouang in the areas already assisted by PRONAE in Pek district, and integrating the districts of Phoukhouth and Phaxay;
- To harmonise this programme with the other districts of Xieng Khouang not included in activities financed by the Nam Ngum project, using human and financial resources from PRONAE, which has been working in Nonghet, Pek and Kham districts since 2003.

It has been noted that Nam Ngum River Basin Development Sector Project presented a financial plan for 2006–2007 of US$9,559,888 representing 46.5% of the total budget of the project. This plan was approved by ADB and AFD[1] during the review mission conducted in October 2006 and through this budget 37% was allocated to component 3b (NAFES, Xieng Khouang and Vientiane Provinces). It was therefore difficult for the team to design an implementation plan that followed the updated objectives of NNRBDSP and the expenditure level for 2006–2007. The team decided not make a thorough review of the existing plan but rather to focus on designing a development programme that integrates activities already scheduled by NNRDSP.

1.2. MISSION PROCESS

This mission ran from November 23, 2006 to February 28, 2007 in three distinct phases:

Phase 1, two main themes were treated:

- ✓ Morphopedologic identification across all the sub-catchment areas covered by the Nam Ngum project in the two provinces of Vientiane and Xieng Khouang and the nine districts selected (Pek, Phoukhouth, Paxay, Kasi, Vang Vieng, Hin Heup, Feuang, Hom, and Xaysomboun), encompassing 294 villages and 23,707 families. This identification has made it possible to produce a morphopedologic sketch of all 18,000 km^2 of the Nam Ngum watershed.
- ✓ Identification of the development potential and the agro/socio-economic particularities of these districts.

During this phase the mission comprised four experts, supported by PAFO/DAFO teams and the regional Nam Ngum project coordinators who took part in the study and presented those activities that had already been initiated. Discussions were held with provincial and district authorities, extension agents and farmers. These exchanges and the expectations of all these partners have made it possible to define an outline of the cooperation framework and of implementation.

Following this first phase, a document entitled *Mission Notes, December 2006* was presented to MAF at a meeting on Thursday January 4, 2007. This document lays down a broad outline of the technical intervention framework, the objectives and the financial resources required. It also presented, at the request of the NAFES, the fast track decisions and funds that had to be committed immediately in order to make the 2007 activities possible before the final study was available.

Phase 2

This was used to revisit all the study districts with the DAFEO and PAFO representatives. The villages, intervention zones, demonstration sites and training centres planned for 2007

[1] Asian Development Bank, Agence Française de Développement. AIDE MEMOIRE. Project Review Mission, 6-14 November 2006 for the Nam Ngum River Basin Development Sector Project.

were identified. This ground work continued with detailed technical and financial programming elaborated for each province.

Review workshops were held with the PAFOs and DAFEOs, allowing the re-examination of certain objectives.

The more thorough programming for 2007, integrating the envisaged PRONAE interventions in the financing of this study – the training of 20 DAFEO technicians and set up of the demonstration sites – emphasised certain pre-requisites. These concern the capacity of the Nam Ngum project to mobilise the necessary financial, technical and staffing resources needed for activities over 2007.

Due to the existence of unknown variables, several scenarios were presented. Selection from these could depend on other decisions not yet made and on the resources made available. The factors involved in this extend beyond the Nam Ngum project and must also include events in Xayabury province so that PRONAE can be involved even if the proposed Nam Ngum programme is postponed.

MAF, NAFES and NAFRI, over the course of the talks held during this mission on the subject of the work undertaken by PRONAE, expressed a desire to extend this mode of intervention to all the districts involved with the Nam Ngum project (with financing from the GoL, BAD, AFD, and JFPR) while continuing this technology transfer, at the same pace, in the districts already covered by PRONAE (with financing from AFD, FFEM and MAE) in the provinces of Xayabury (Pak Lai, Botene, Kenthao, and Thongmixay districts) and Xieng Khouang (Pek, Kham and Nonghet). The general objectives will concern:

- Structuring the extension and development agencies around a programme that integrates the agricultural, social and economic environment in a sustainable dynamic.
- Strengthening the organisational, technical, and programme management capacities, and their capitalisation at the provincial, districts and village levels.
- Development of integrated production systems adapted to the initial agricultural situations and the social conditions of the actors concerned (improvement and diversification of income).
- Watershed protection.

While being based on existing structures and the experience gained through PRONAE, this programme, as desired by MAF, would cover 15% of national territory (Xayabury, Vientiane, Xieng Khouang) and it should be possible to later extend the strategy across the whole country in line with the current decentralisation policy. The suggested upscaling is designed to allow realignment of all these activities in phase with the Lao government's five-year plan for 2006-2010.

In this dynamic we have retained a structure of working with local groups at village, district and provincial level to comply with the national policy of decentralisation. Particular focus is placed on the district and village cluster levels through[2]:

- Support to local planning and resources management;
- Data flow and information management on extension;
- Extension delivery (including training and linking production to markets);
- Kumban extension centres (permanent);
- Linkages with NAFRI and other relevant agencies (e.g. banks, services providers).

At the end of this phase final notes on the mission were presented to MAF, then discussed with NAFES and Nam Ngum project management.

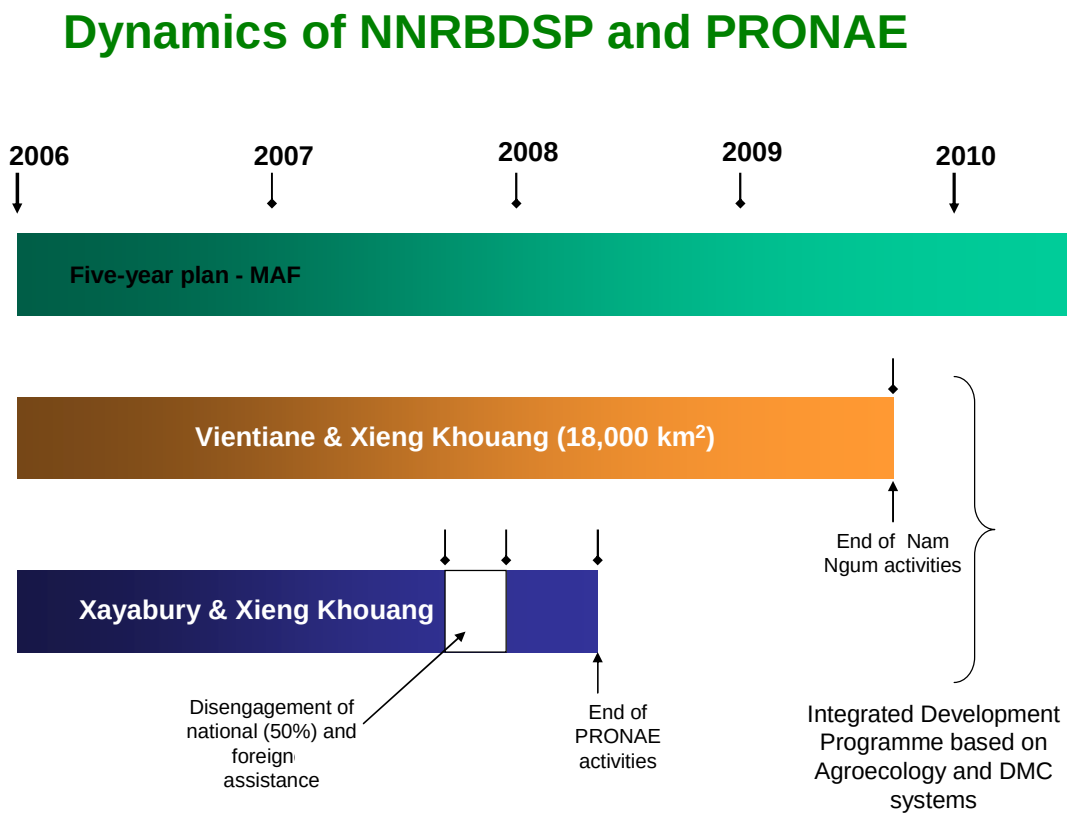
Phase 3: final study report and review workshop

See appendix 2 for mission schedule and a list of people met.

[2] Source: Ministry of Agriculture and Forestry, New Organisational Set-up, 2nd Joint Sectoral Working Group on Agriculture, Rural Development and Natural Resources Management, Vientiane Capital, 22 May 2007.

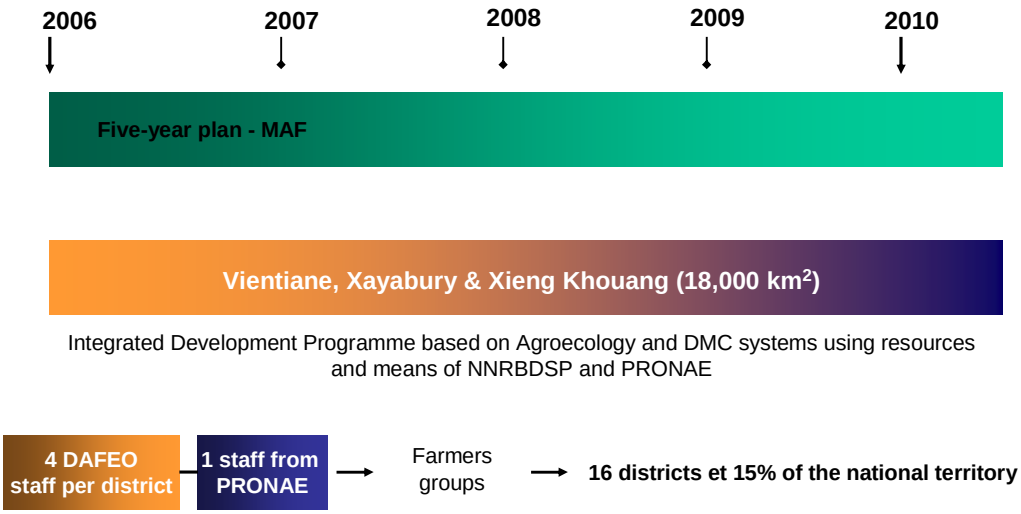
1.3. CURRENT MAF PROJECTS WITH PRONAE & NAM NGUM

The two figures below highlight the need for consistency across donor projects. Indeed, during the meetings held with MAF to realign this mission, it became clear that a technical programme fixed on the current five-year plan was needed.



The suggested dynamic and possible reallocation of funding for these two programmes would make it possible to consolidate development efforts conducted by NAFES, starting with the National Agro-Ecology Programme's existing skills in agro-environmental matters.

Dynamic of the programme



Following redefinition of the objectives and current financial means of PRONAE and the Nam Ngum project (GoL, AFD, FFEM, ADB), and with redeployment of its expertise in agro-ecology, the MAF should have the means of developing this programme.

2. NATURAL CAPITAL AND RURAL DEVELOPMENT

An essential part of this work involves creating awareness - among donors, political decision-makers and project managers - of the importance of including environmental protection measures in rural development policies.

Appendix 3 contains an article on the suggested approach[3] by Pierre-Noël Giraud (Cerna Industrial Economy Research Centre, École Nationale Supérieure des Mines de Paris) and Denis Loyer (AFD). This chapter also provides references from "Millennium Ecosystem Assessment, Rapport de Synthèse de l'Évaluation des Écosystems pour le Millénaire", published by the UN in 2005.

The article provides a good summary of the context which development activities should be conducted in. **Agro-ecology through SCV (the French abbreviation for plant-cover systems) should be regarded as just one of the integral elements of this new approach, already adopted in Laos, rather than as the defining element.**

2.1. GENERAL CONTEXT

*Investments made by **overseas development assistance** (ODA) to encourage pro-poor growth are generally of three different types: (1) infrastructure (**technical capital**), traditionally financed by ODA; (2) health and education funding, often including the building of **human capital** and strongly promoted by the Millennium Development Goals (MDGs); and (3) 'governance' (institutional and social regulation and the rule of law) to build **social capital**.*

*This is why most **Poverty Reduction Strategy Papers** (**PRSP**s), the reference documents for donor assistance, do not take natural resources into account or do so only cursorily. **Natural capital** is still largely regarded as a constraint that must be observed to earn the label 'sustainable development' and not as productive capital like the other elements.*

[3] The following text in italics is taken from "Capital Naturel et Développement Sustainable en Afrique" by Pierre-Noël Giraud, Centre de recherche en économie industrielle (Cerna), École Nationale Supérieure des Mines de Paris, and Denis Loyer, AFD.

However, several positive trials and some very instructive recent exercises to measure the total Wealth of Nations (Hamilton)[4] show that:

- *Natural capital is a directly productive capital or is indirectly essential for a great number of the poor.*
- *Excessive consumption of natural capital can create poverty traps.*

On the other hand, natural capital is central to the question of the ***Global Public Goods****, or* ***Local Environmental Public Goods (GPG*** *and* ***LEPG****). It acts as the second economic axis of justification for certain development assistance policies: those which contribute to the production of GPG (in particular climate and biodiversity) are economically fully justified.*

The Millennium Ecosystem Assessment[5] published on the initiative and under the guidance of the UN in 2005, affirms that the degradation of ecosystems is such that it will hinder countries from attaining the MDGs. As an economic calculation, this report underlines the need to re-examine analysis of the value of ecosystems within their local context, so that the political decision makers can become fully aware of the consequences of their development choices.

From an operational point of view, three types of effect can be distinguished when preserving or increasing natural capital through development:

- Production of ***GPG*** *and* ***LEPG****;*

- Development of a primary export sector, stimulating growth;

- Reduction of poverty trap, particularly in rural areas.

2.2. RELATION BETWEEN NATURAL CAPITAL AND GROWTH/DEVELOPMENT

Some of the characteristics of renewable resources are still not properly accounted for by growth models. Two characteristics are often neglected because of the technical difficulty of building them into models:

- ***The existence of threshold phenomena that cause irreversible change****, e.g. disappearance of key species, no Gulf Stream, or a very long period of time to rebuild the productive capacities of the natural environment: deforestation, desertification, exhaustion of fish stocks, lowering and pollution of water tables.*
- ***The importance of positive and negative externalities on the other types of capital****. These can be considerable, especially when the thresholds mentioned above are being approached. Defining policies without taking these into account can lead to serious failures.*

[4] Available at the sites http://www.worldbank.org/sustainabledevelopment and http://www.worldbank.org/environmentaleconomics
[5] See http://www.greenfacts.org/fr/ecosystemes/index.htm

These two characteristics - externalities, particularly of natural capital on human capital, and the threshold effects on natural resources, are presented in appendix 3 with a graphic illustration of a growth model.

Degradation of natural capital does not evolve in a linear fashion but rather through a succession of critical points that lead to situations of quasi-irreversibility and have very strong negative effects on the other forms of capital.

It is generally considered that in Laos the 'irreversibility' threshold has not yet been reached but that degradation of natural capital is often serious enough to limit the efforts made towards rural development.

2.3. INVESTING IN NATURAL CAPITAL THROUGH AGRICULTURE

Investing in natural capital *obviously involves physical actions to preserve the environment, such as establishing protected areas, restoring forest cover and so forth, but also requires* ***the creation of institutions and regulations*** *to manage resources sensibly. It can also necessitate infrastructure and awareness raising. Thus, this model initiates a framework for sustainable development which rebalances sectoral financing contributions to the four forms of capital.*

Priority should be given to ***renewable capital****: natural resources, water, biodiversity, soil, fish stocks.*

Development must be regarded not simply as dependent on technical (infrastructure) and human (health and education) capital with environmental and social constraints, but rather as relying on the effective management of ***capital with four components****: physical - human - natural - social.*

To take matters beyond the current trials, five types of action must be initiated. They are presented below from the most conceptual to the most political:

1. ***To give natural capital its rightful place within development concepts***
2. ***To improve knowledge of natural resources***
3. ***To subject the results of past and current trials activities to thorough and comprehensive evaluation.***
4. ***To accelerate North-South and South-South (especially from Brazil) technology transfer.***
5. ***To mobilise the relevant decision-makers***

Policies must bear in mind the many functions of conservational agriculture. Good cultivation methods are based on agro-ecology and more specifically on the technique of direct seeding with plant cover, restarting natural ecosystem functions which should be further developed. By supporting the natural regulatory functions of biogeochemical cycles, conservational agriculture provides the following functions:

- Supply of goods to society: food, fresh water, wood, fuel, genetic resources and biochemical products.
- Regulation: regulation of climate, soil erosion and degradation, protection against flooding and disease, purification of water.
- Cultural: aesthetic landscaping, leisure and ecotourism, education, cultural heritage.

At present only goods supply functions are paid for. The other functions, neglected in their financial value, are unaccounted for even though they make a substantial contribution to the overall well-being of society. These agro-environmental measures should thus not be regarded simply as aid assistance, subsidies or donations - ideas that do not hold much value for farmers - but rather as **payment for environmental services (PES)** provided to society. Only agriculture based on the ecosystemic functions of biogeochemical cycle regulation can provide these services. **The agro-ecological management of cultivated ecosystems by direct seeding and plant cover fully satisfies these objectives.**

2.4. SETTING UP AND FINANCING PES

The most important general policy decisions affecting ecosystems are often made by agencies, and in political arenas, that are not directly concerned with protection of ecosystems. For example the PRSPs prepared by the governments of developing countries for the World Bank and other institutions are very effective in developing priorities at the national level, but do not generally take stock of the importance of ecosystems in improving the basic human capacities of the poorest.

Below are various avenues of action to support agro-environmental measures:

- ***Taxes or usage fees for activities that generate 'external' costs*** (compensation not accounted for by the market). These can include taxes levied on destructive farming methods (ploughing or excessive use fertilisers and pesticides) or fees from ecotourism.
- ***Promotion of technologies*** that allow an increase in crop yields without having negative impacts linked to land use, water use, fertiliser or pesticides.
- ***Restoring original ecosystem services***. However, the cost of restoring services is generally extremely high when compared to the cost of preventing degradation of the ecosystem. Not all services can be restored and it can take considerable time to rehabilitate those which have suffered heavy damage.
- ***Promotion of technologies*** that provide an opportunity for underused natural ecosystem services to develop in a reasoned manner that respects the environment: e.g. by giving agricultural value to vast 'empty' spaces such as the Plain of Jars.
- ***Promotion of technologies designed to increase energy efficiency***, by reducing greenhouse gas emissions and increasing carbon sequestration. This will also involve starting up and developing support institutions, plus policies to remove barriers to the

spread of these technologies across markets and to increase public and private funding for research and development and effective transfer of technology.

- ***Mechanisms facilitating response to consumer preferences across markets***. For example, the current profiles for certifying sustainable fishing and efficient forestry practices provide an opportunity to promote sustainability through consumer choices. Certification based on geographical origin alone is not sufficient: the quality of the methods used must also be taken into account.

On a practical level, and for sustainable 'extra-project' financing of activities, taxation of practices with strong environmental impacts will be researched. This could affect:

- Arable practices stimulated by the demands of export markets, as for instance in Xayabury province, where high demand and strong support (credit, mechanisation) for the growing of maize for export to Thailand has resulted in serious social, environmental and health impacts such as soil degradation, water pollution, and heavy use of pesticides. A tax on agro-industrial practices that destroy the environment (as in Xayabury) would make it possible, through PES, to support **the conversion of conventional agriculture into SCV**. Farming practices in both the private or state sector (developments projects) are currently unsatisfactory. Feasibility studies should be conducted on the adoption of the following practices:
    - Monitoring of environmental impacts (pre-project studies and monitoring/evaluation in real time);
    - Funding of a component to support and track the adoption of best practices. To do this, a structure will be needed that **provides specialist services in conservational agriculture through agro-ecology**.
- Taxation of activities exploiting non-renewable natural resources, with strong environmental impacts. Such activities include gold and copper mines and hydroelectric dams (landscape degradation, water pollution, social upheaval). Taxes so collected should be used, through PES, to support projects that opt to promote agro-ecological techniques. This can be done by setting up credit funds, supplying inputs or mechanisation services, providing seeds or technical support, and so on.

3. MORPHO-PEDOLOGICAL SURVEY OF THE NAM NGUM BASIN

3.1. INTRODUCTION

This survey was conducted through ten days of field work in December 2006 by traversing all navigable roads (sometimes only with difficulty). In the absence of reliable geological maps, 1/100.000 scale topographical maps from the National Geographical Service were, in spite of their age, an essential aid in defining the morphopedological cartography.

The Nam Ngum catchment area has a surface area of 18,000 km² (13% of the territory of Laos). Excluding the plain of Vientiane and the plains of Phonsavanh, it is essentially mountainous, with peaks that exceed 2,500 metres above sea level.

The geological structure and nature of the rocks do much to explain the formations and extreme complexity of the hydrographic network. The 'structures' of the natural environment are more differentiated by geomorphological criteria than by pedological criteria. Overall, the nature of the soils does not vary so much. They are, in the majority, 'acrisols' (FAO classification), which are beige, yellow or ochre coloured soils that are very acidic (and sources of aluminium contamination in crops), loamy-clay, not very permeable and thus often waterlogged (in spite of the slopes) in the top stratum (bleached, with a clear grey colour) after rainfall; they are very low in phosphorus and exchangeable cations (except aluminium). The major types differentiated on the map are as follows:

- **High mountains:** significant variations in relative unevenness (500-1,100 metres), very steep slopes, high altitudes, complex hydrographic network.
- **Medium mountains:** relative unevenness ranging from 200-500 metres, steep to average slopes with averages, average altitudes.
- **High hills:** relative unevenness of 40-200 metres, steep to averages slopes. Average to low altitudes.
- **Low hills:** with unevenness of about 10-40 metres, slight to average slopes.
- **High terraces** (old alluvial terraces) with slight slopes, unevenness of 5-20 metres.

- **Low terraces** (recent and current alluvial bottoms on the plains and valleys), slight unevenness (2-5 metres) and very slight to no slope.

Within these major types rocks and formations were differentiated (geomorphological units): granite, sandstone, argillaceous schists (shales), pelites (very fine sandstone), limestone, mudstone, alluvia. These rocks do not all have the same weathering properties or resistance to erosion. The fold strata (primary era) are not all assimilated well and rise at varying levels across the landscape. Formations from sandstone, granite and limestone dominate the landscape. Schists and pelites are at medium level and the mudstones are rather lower down. Elsewhere these same mudstones have been eroded into 'half-orange hills' or 'inverted bowls'.

We have avoided using specialist terms and jargon and, as far as possible, have employed the 'morphopedological' units defined and represented on the map, which are quite easily recognised in the field.

3.2. GEOLOGICAL CONTEXT

Geologically speaking, the Nam Ngum basin is located at the junction of two large orogenic systems: **the Annamese Cordillera**, running NW-SE, and the **upper-western Lao range** running NNE-SSW. The former runs through the upper basin of the Nam Ngum, the latter through the basin of the Nam Lik tributary.

The primary sediments (Cambrian to Permian) were folded into large synclines and anticlines by several orogenies, of which the two largest were the Hercynian Orogeny (end of the primary era), represented by the Annamese Cordillera, followed by the Indonesian orogeny (end of the Jurassic), represented by upper western Lao range (running NNE-SSW).

The cycles and processes of uplift-erosion-levelling have on several occasions 'rejuvenated' the landforms by creating peaks and banked valleys which are next reduced to a plain. At the same time the debris stripped away accumulates at lower levels and is transformed into sandstone and mudstone, either continental or under shallow seas.

The last important phase of uplifting occurred during the tertiary era (as a consequence of the Himalayan movements) and caused faults, fissures and subsidence (plain of Phonsavanh, the Kasi and Vang Vieng basins), plus the activation of a new erosive phase, which is still observable today. These geological processes led to the landforms and strata found in the current landscape.

During this uplifting, the sandstone-mudstone unfolded continental strata of the Jurassic period, aligned in opposition to the primary folded formations, underwent a process of retrograde erosion (large escarpments) and weathering into pseudo-synclines (plain of Vientiane), fractures and subsidence (Hom basin).

These two folded sedimentary systems are composed, in lithological terms, of alternating layers of shale, of coarse or fine sandstones (pelites), of limestone and overlapping mudstone.

As indicated previously, they form a series of **anticlines** and **synclines**, resulting from generations of folding at the end of the primary era and end of the Jurassic period (secondary era). Sandstones, the rocks most resistant to weathering (other than limestone), in the highest areas form long peaks running in line with the major structural formations.

The south of the Nam Ngum basin consists of sandstone and mudstone (terrestrial or from shallow ocean) from the secondary era (Triassic and Jurassic). These sandstones, not folded, intermittently cover the preceding primary formations. They originate from the **major rock escarpments** that resulted from retrograde erosion on soft mudstone. This sedimentary shale cover matches that at the northern end of the vast Khorat Plateau in Thailand.

The preceding formations, in particular the primary rocks are composed of **igneous rocks** of granite character, corresponding to **intrusions** over various periods. These granites form compact and isolated massifs with no dominant orientation.

From a tectonic point of view, two dynamics affected the primary and secondary formations: **subsidence into small or large basins** and vast sub-synclinal **depressions**.

3.3. THE VARIOUS STRUCTURES OF THE NATURAL ENVIRONMENT

- High mountain intrusive granite massifs (structure 1)

These formations cover a relatively low amount of the overall area. Geologists speak of 'batholiths', which are large bodies of rock that intrude across grooved mountain folds. These isolated masses are generally several kilometres wide and are not hard to locate in the landscape because of their 'compactness' (lack of pointed ridges) and their high altitudes. They are grooved by radial hydrographic networks. The slopes are very steep, at up to 70%. The very acidic soils are **acrisols** of a pale yellow to ochre colour, or sometimes red because of ferromagnesium minerals in nearby rocks. They differ from other soils in the area on account of their rather high **quartzose sands** content.

Picture 1. Waterfall in Paxay district (Xieng Khouang) on granite substratum and massifs around.

- High mountain sandstone massifs of primary fold age (structure 2)

These are primary age strata, almost exclusively sandstone, with transversal widths of 0.5-6 kilometres.

These layers, with steep dips, can still be found in the mountains because they erode more slowly than the surrounding shale and mudstone.

In this landscape, sandstone forms solid masses extending over long distances underneath the folded rock structure (vast anticlines or synclines). The relief is always very steep (40-60%) with long rectilinear slopes, marked by water-courses and subparallel thalwegs with no or little branching (in marked contrast to those found in the shale and mudstone).

The soils have developed from slope colluvium amassed through sporadic landslips. Like most of the soils across the basin, they can be classified as **acrisols** (FAO classification): they are of beige to clear yellow colour, **very acidic** (pH 4.6-5.1), and most probably contribute to **aluminium toxicity** for crops. On the surface (top 0-20 cm) the colour is diluted by organic acids.

Once deforested these very steep sandy slopes are very susceptible to sudden erosion events such as subsidence or landslides. These occur because the altered rock and the soils on sandstone are richer in fine quartzose sands than the surrounding shale, enabling them to soak up more water and so become heavier.

-High mountain massifs with predominant shale, of primary fold age (structure 3)

This type of medium to high mountain covers a considerable area (a quarter to a third) of the Nam Ngum basin. The dominant slate is interspersed with layers of sandstone. These protect the peaks of the massifs, underlying **the structural orientation of the folds**. The dominant orientations are NW-SE and NE-SW (Nam Lik basins). Fluvial dissection patterns on the shales and sandstone are 'multi-faceted', as the drainage network shows **extreme branching** and is arranged hierarchically. The slopes, often **convex** in curve, are steep sloped (about 40-60%). Undulation is very significant.

The soils are always **acrisol** types, argillaceous to argillaceous-loam, very acidic (pH 4.5-5) with **aluminium toxicity**. They are of very variable thickness, depending on their degree of colluvial alteration. Areas of weathered shale are generally impermeable and can be subject to waterlogging, even on steep slopes.

- High mountain unfolded sandstone-mudstone massifs from the Jurassic (structure 4)

Unfolded sandstone-mudstone covers the southern half of the basin. The rocks consist of **alternating hard sandstone and levels of 'wine red' mudstone** that is soft and prone to hollowing through geological erosion (retrograde erosion). These slopes are generally dominated by escarpments (unit 5) of **large sandstone bars**. The slopes are long and steep (30-70%).

The soils are **very acidic acrisols** (pH 4.5-5) often a little richer in silts and fine sands than the ground above shales.

- Sandstone escarpments (structure 5)

With a sub-vertical undulation of 50-200 metres, these generally represent the front of a sinkhole caused by retrograde erosion of sandstone-mudstone slopes with a sandstone top, sometimes governed at the beginning by the directions of the cracks in this Jurassic covering.

- Limestone karsts (structure 6)

The primary sedimentary sequences contain limestone layers intercalated with argillaceous shale and sandstone. Like these, the limestone layers were involved in various folding episodes and are very erect, **often with sub-vertical dips**.

Picture 2. Landscape in Vangvieng district with limestone karst and low terraces on alluvial floors (17)

The limestone underwent a karstic evolution, i.e. it was eroded through being dissolved by ground water rich in CO_2 when it was still underground, before it was moved upwards.

The large karsts are generally very jagged in appearance and can be seen from afar, with vertical rock faces (50-300 metres high) topped by specialised forest cover. Within these solid masses can be found pockets of **clay soils from the decalcification** of the limestone. At the foot of the rocks there may be **colluvial limestone soils** with a pH of 6-8.

- Mid-height mountains with a predominance of primary folded shale (structure 7)

These mountainous blocks of average height (200-500 metres) developed on **dominant argillaceous shales**. The peaks are generally convex, the slopes rectilinear to concave with steep slopes (20-40%). Sandstone bars of minor thickness may be present. These can give structural orientation to the peaks. The massifs are drained by a **dense and complex hydrodynamic network**. The soils on the weathered slopes are always **very acidic acrisols** (argillaceous-loam), subject to frequent waterlogging in spite of the slopes.

Picture 3. Landscape in Phoukoun

- Mid-height mountains with argilitic predominance (structure 8)

These characteristic rocks appear as vast multi-convex sheepbacks, constituted of a particular 'red wine' coloured mudstone. Their peaks show no marked orientation – the mudstone is virtually free of traverse sandstone.

The relief consists of very high hills shaped like half oranges, i.e. convex until near the base, where the slopes then become very steep (up to 50-60%). The dense, grooved hydrographic network consists of narrow hollows slightly scored by waterflow.

- High hills on primary folded shale and mudstone (structure 9)

This relief typifies the edges of the plains and alluvial valleys. The high hills have a convexo-concave profile. That is to say that the top consists of a largely convex dome (with slopes of less than 20%), while **the rectilinear slopes become concave at the base** (with slopes of 10-20%) where they meet alluvial terraces at ground level. These extend to the upper Nam Ngum basin in the north of Xieng Khouang.

The soils are again acidic **acrisols** of a beige to bleached ochre and are 'washed' at the summit. The concave downstream areas have been 'thickened' by red colluvial deposits and often display a stone-line at a depth of 100-150 cm. The weathered shale and mudstones are far from permeable and slow down filtration, sometimes leading to waterlogging of the top soil in spite of the slope.

- High hills on mudstone (structure 10)

This environment and structure is marked by **'violet' mudstone** (or wine red coloured) which is especially abundant in the southern half of the basin, but also, though more localised, in the northern half. This mudstone is either of primary age (included in the folded sediments) or of secondary age (Triassic and Jurassic, perhaps Cretaceous), when it is associated with sandstone, with which it alternates.

The erosion and weathering of these mudstones, when they are not alternated too frequently with sandstone, produces the characteristic 'half-orange' shape, of broad convex hills which here are 40-200 metres high, drained by a **complex network of narrow hollows** (less than 100 metres wide). The slopes are steep (20-40%), especially at the base where rupture of the incline by the hollow is abrupt.

The soils are **acrisols**, and therefore very acidic (pH of less than 5), with **aluminium toxicity**. Hydromorphy is frequent (bleached horizon) on the topsoils (perched groundwater) due to the impermeability of the weathered mudstone.

Picture 4. Soil profile of hills on mudrock

- High hills on Jurassic unfolded sandstone (structure 11)

This type of environment is characteristic of the western side of the Vientiane Plain, which lies on **slightly dipping** (less than 15%) sandstone, 'warped' into pseudo-synclines (basins) filled with alluvium (the eastern slope of this vast basin leans, partly due to a fault).

The hills are subtabular, leaning towards the east by an angle of 10-20%, which corresponds to the dip in the sandstone layers.

The soils are often not very deep, with a sandstone substratum (weathered into plinthite) close to the surface or in outcrops. The soils can be classified as **leached acrisols**, acidic and rather sandy on the surface, and very sensitive to erosion. Episodic perched groundwater waterlogs these soils. The **rocky outcrops** tend to be large.

- Low hills on unfolded mudstone (structure 12)

These thick mudstones are only found in proximity to the Jurassic sandstone. They are located either under this sandstone or at its piedmont (Triassic and partly covered by the dam reservoir), or covering it (early Cretaceous), as is the case with the sub-synclinal basin of Vientiane.

The landscape is characterised here by a **repetitive sheepback (half-oranges)** of almost constant altitude, with convex hills 50-300 metres wide, separated by a reticulated network of **narrow anastomosed hollows**. They are not very high (10-40 metres). The lower halves of the slopes are steep, reaching up to 40%.

Neither the peaks nor the hollows show any particular orientation (indicating lack of sandstone layers). The soils are always **very acidic acrisols** prone to temporary surface waterlogging, even on the slopes.

- Banked-slopes on unfolded Jurassic sandstone (structure 13)

These characterise the western side of the Vientiane basin and are very closely associated with structure 11 and structure 14. The slopes are rather regular, broken by hummocks and rocky plateaux with **gentle slopes** (10%), corresponding somewhat to the dip of the sandstone.

The soils are **leached acrisols, sandy** (fine sand and silt) on the surface, then with a sandy-shale beige horizon, followed by weathered mottled sandstone that is rather hard and impermeable. Rock stumps can be also present. These soils are sensitive to groundwater erosion. They are sometimes waterlogged.

- Surbased domes on unfolded mudstone on the plain of Vientiane (structure 14)

These environmental structures are typical of the western and eastern edges of the plain of Vientiane. The underlying mudstone (late Jurassic or early Cretaceous) is covered with alluvia (see below) in the centre of the sub-synclinal basin. The domes, 3-6 kilometres wide, are not high (relative altitude 10-20 metres) in relation to the alluvia and demonstrate **long bank-**

slopes with gentle slopes of about 2-5%. The soils are clayey **acrisols**, very acidic, with slow surface drainage.

- High pluvial lake Pleistocene terraces (late Quaternary period) (structure 15)

These high terraces characterise the subsidence structures influencing the folded primary sediments. The **lake deposits** (horizontal metric layers including pebble strata) can be several dozen metres in thickness.

The largest of these structures is on the plains of Xiang Khouang around Phonsavanh but such terraces can also be found towards Kasi, to the south (Nam Lik), and between Kasi and Vang Vieng (Nam Xong).

The terraces are perched 5-20 metres above the recent and current fluvial alluvia. **Their topography is practically horizontal**.

Pictures 5. Terraces perched above recent fluvial alluvia (line stones), Plain of Jars.

The soils are again **acrisols**, with a surface horizon of 10-20 cm, bleached (clear grey). Next is an argillaceous yellow or beige layer of 50-100 cm, lying on thick mottled clay (marble plinthite).

These soils present two significant constraints: **strong acidity** (pH 4.4-5) and **slow drainage** (surface waterlogging) due to the absence of slope and the low permeability of the material.

- High Pleistocene lake terraces (structure 16)

These structures, which typify the plain of Vientiane, are formed from **surbased domes** comparable to structure 14 (mudstone).

The alluvial material is usually argillaceous with a layer of small pebbles at around 2 metres, **sometimes hardened** into a ferruginous hardcap.

Deeper, the weathered bleached alluvia has been deferruginised by the free groundwater. These are **acid acrisols**.

- Low fluvial terraces (structures 17 and 18)

These are the plains, valleys and valley bottoms that have silted up with **recent (Holocene) to current alluvia**.

The biggest of these is on the plain of Vientiane. Other interesting examples include the valleys and plains of the Nam Xong, the Nam Lik and the upper Nam Ngum. These alluvia are **argillaceous-loams** (fluvisols), often **hydromorphic** (fluctuating free ground water) and deferruginised (cream coloured with bleaching).

3.4. THE AGRONOMIC CONSEQUENCES

Apart from the soils on limestone colluviums, all the other types present fairly similar characteristics. That is to say they are low in organic matter, deficient in phosphorus, show aluminium toxicity (on the Plain of Jars, Xieng Khouang province), have an acidic pH and poor cation exchange capacity.

In the majority of cases, except for in the areas with limestone colluviums, production systems run for no more than three years of cropping after clearance of long-duration fallows. Overall these soils have fragile structures and are very sensitive to erosion.

Given the experience already gained on the soils which present the most serious constraints (Plain of Jars, Xieng Khouang), where in a short period of time the land could be used to grow crops following investment in plant cover systems (SCV) alone, the overall development of these areas need not pose a major constraint. The most important factor is good management of organic matter and the capacity of the systems to strengthen this.

"The rate of carbon sequestration in mulch-based cropping systems can be as rapid and as substantial as the losses made through inadequate management with or without tillage…Changes in the evolution of exchange capacity in the soil strictly follow those of organic matter. Mulch influences the saturation level of the upper horizons of the crop profile. Brachiaria-type forage species grown for fairly long periods (three to four years) act as a 'cation pump' and strongly increase the saturation level of the (useful) surface horizons just as if strong doses of lime-magnesium fertiliser had been applied" (Séguy et al., *Système de culture et dynamique de la matière organique*, 2001).

These soils should therefore be **disturbed as little as possible** in order to conserve their current qualities: no burning of vegetation, no tillage and, in principle, no levelling of the land into terraces. The agronomic practices used should aim at **increasing the organic matter content** (e.g. through forage mulches, crop residues, return of stubble and waste to the soil without burning) through direct sowing, crop rotations, diversification (multipurpose species) and livestock integration.

The selection and development of the land must, of course, take into account physical constraints (steep slopes), the level of environmental degradation, and the farming method to be used (e.g. short fallow) so that the initial systems can begin with management of corrective action such as use of phosphorus, calcium and magnesium. The use of these can be reduced as the soil quality evolves due to the increase in organic matter through the SCV systems.

In all cases careful intensification of fertility must be accomplished by integrating the two possible approaches:

- Organic, through the maximum transfer of fertility possible under animal raising (manure and compost), restoring phosphorus and calco-magnesium, while also balancing the acidity with thermophosphate and introducing forage species with a strong capacity for soil restructuring (high biomass production rate above and within the crop

horizon, leading to improved fertility in the widest sense: chemical, physical and biological);

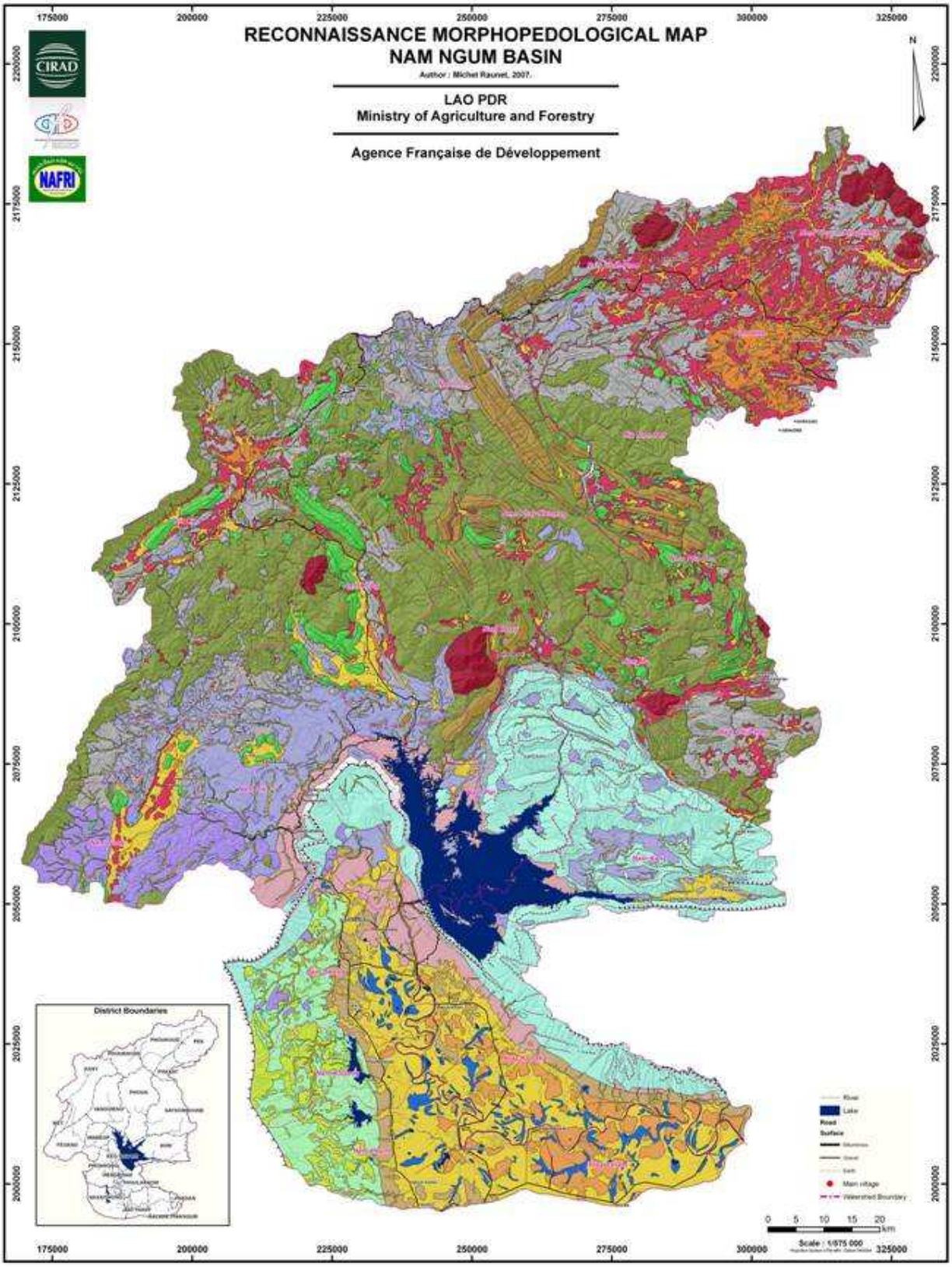
- Chemical: complementing the organic approach through careful application of nitrogen, potassium, phosphorus, oligo-elements and the use of specific inputs in small doses (herbicides, insecticides and fungicides).

Applying mineral fertilisers reduces the regeneration time required through increased biomass production (augmentation of organic matter rates, restoration and balance of soils: improved CEC and diminution of aluminium toxicity), and improves overall fertility (chemical, physical and biological) within a short time frame.

In this dynamic, with effective plant cover systems, it would be advantageous if development projects, the banking sector and aid donors subsidised the mineral and organic fertilisers, such as thermophosphate, in order to accelerate the biological process, so increasing the productivity of systems and leading to greater stability for smallholder farming families. The economic risks associated with these innovations must be assessed before the techniques are transferred to the development structures and to groups of farmers.

This stage of agronomic and socio-economic validation has been integrated within the scope of DAFEO, which works in partnership with NAFRI–PRONAE in the provinces of Xayabury and Xieng Khouang. These teams have effected a gradual launch based on three main principles:

- A good comprehension of ‘conventional’ systems;
- Improvement within this stage of these systems in relation to the starting point with these farmers;
- Monitoring and constant evaluation by the farmers and technical teams.


RECONNAISSANCE MORPHOPEDOLOGICAL MAP
NAM NGUM BASIN
Author : Michel Raunet, 2007.
LAO PDR
Ministry of Agriculture and Forestry
Agence Française de Développement
CIRAD
NAFRI
N
District Boundaries
River
Lake
Road
Surface
Main village
Watershed Boundary
0 5 10 15 20 km
Scale : 1/375 000
175000
200000
225000
250000
275000
300000
325000
2200000
2175000
2150000
2125000
2100000
2075000
2050000
2025000
2000000

BROAD UNITS		GEOLOGICAL MATERIALS	LANDFORM	SOILS
HIGH MOUNTAIN (Variations in height: 500-1100m.)	1	INTRUSIVE GRANITES	Well defined massives in prominent position, without prevailing orientation. Very strong slopes (30-70%)	Silty-clayey to sandy-clayey very acidic soils: acrisols (albic, alumic, or plinthic)
	2	PALAEOZOIC FOLDED SANDSTONES	Dominating orientated massives, with long prevailing crests. Very strong slopes (40-60%)	
	3	PALAEOZOIC FOLDED SHALES AND SANDSTONES	Sharp broken relieves, with multiple crests. Very high slopes(40-60%)	Reworked colluvial materials deriving from acrisols or weathered rocks
	4	JURASSIC UNFOLDED SANDSTONES AND CLAYSTONES	Sharp relieves with long valley-sides. High slopes (30-70%)	
	5	JURASSIC SANDSTONES	Rocky escarpments	Sandstone outcrops Colluvial sandy material
MID MOUNTAIN (Variations in height: 200-500m.)	6	PALAEOZOIC FOLDED LIMESTONES	Sharp stony karstic well defined massives	Limestone outcrops. Pokets of calcaric cambisols
	7	PALAEOZOIC FOLDED SHALES, CLAYSTONES AND SANDSTONES	Intricated sharp reliefs, with convex crests slopes 20-40%	Silty-clayey albic alumic acrisols, very acidic
	8	PALAEOZOIC OR JURASSIC CLAYSTONES	multi convex " half - orange " landform. High Slopes (30-50%)	
HIGH HILLS (Variations in height: 40-200 m.)	9	PALAEOZOIC FOLDED SHALES AND CLAYSTONE	convexo - concaves high hills bordering and dominating main plains and valleys. Moderate slopes (10-30%)	Acrisols (albic, plinthic, ferralic), very acidic
	10	PALAEOZOIC OR JURASSIC CLAYSTONES	Multi convex "half orange" landform. Strong slopes (20-40%)	
	11	JURASSIC UNFOLDED SANDSTONES	Structural valley-sides according to the dip of sandstones. Weak to moderate slopes (10-20%)	Sandstone outcrops Sandy bleached acrisols
LOW HILLS (Variations in height : 10-40 m.)	12	TRIASIC OR JURASSIC UNFOLDED CLAYSTONES	Multi - convex "half orange ' landform. Dense small valley bottoms. slopes 20-40%	Albic, stagnic or plinthic acrisols (very acidic)
	13	JURASSIC UNFOLDED SANDSTONE AND CLAYSTONES	Long " structural " valley-sides conforming to the dips. Weak slopes (5-10%)	Sandy - loamy bleached, ferric or plinthic acrisols (very acidic)
	14	JURASSIC UNFOLDED CLAYSTONES	Low flattened domes (Plain of Vientiane) Weak slopes (2-5%)	
HIGH TERRACES (Variations in height: 5-20m.)	15	PLEISTOCENE FLUVIO-LACUSTRINE DEPOSITS	Sub - horizontal topography (Plain of Phonsavan)	Albic, gleyic, plinthic or alumic acrisols (very acidic)
	16	PLEISTOCENE FLUVIATILE DEPOSITS	Low flattened domed, (Plain of Vientiane) Weak slopes (2-5%)	
LOW TERRACES (Variations in height: 0-5m.)	17	HOLOCENCE AND CONTEMPORARY	Sub-horizontal alluvial floors of valleys and plains	Silty - clayey gleyic or plinthic fluvisols
	18	FLUVIATILE DEPOSITS	Floodable basins (Plain of Vientiane)	Clayey, stagnic gleysols.

4. AGRICULTURAL, SOCIAL AND ECONOMIC ENVIRONMENTS – SITUATIONS, CONSTRAINTS AND OPPORTUNITIES

Four main agro-ecological and socio economic zones were analysed during this study:

- The upper part of the Nam Ngum river basin with Pek, Phoukhouth and Paxay;
- Market based farming systems with high agricultural potential - Kasi and Vang Vieng;
- Hin Heup and Hom, characterised by 'conventional farming' and agro-industrial development mainly based on rubber and 'agarwood' (*Aquilaria crassna*);
- Xaysomboun, where subsistence farming still prevails but rapid change is occurring due to the involvement of the private sector.

The socio-economic data presented hereafter was synthesised from watershed profiles obtained from the Ministry of Agriculture and Forestry IT unit. It has been, however, been difficult to provide a uniform presentation of each district or sub-watershed given the available data. Some districts, such as Xaysomboun, contain different sub-watersheds in which farming systems and socio-economic conditions can differ greatly.

4.1. UPPER PART OF THE NAM NGUM RIVER BASIN (PEK, PHOUKHOUTH AND PAXAY)

Pek, Phoukhouth and Paxay typify the agro-ecological conditions of the elevated plains (800–1,200 m asl). Other than the low lying land, these areas are under used by smallholders due to low soil fertility. Open settlement can be observed on the Plain of Jars where there is lowland access (Picture 6).

Picture 6. Landscape unit on the vicinity of Phonsavanh, Xieng Khouang

4.1.1. Population and ethnicity

In the upper part of the Nam Ngum river basin (113 villages in Pek district, 38 villages in Phoukhouth and 44 in Phaxay), 165 villages have been registered representing 85% of the villages of these three districts. Three main ethnics groups are Phuan (69%), Hmong (25%) and Khamu (6%).

4.1.2. New economic opportunities

New economic opportunities have recently appeared across the high plains of Xieng Khouang province following road construction, increasing urban consumption and relocation closer to roads and trade structures.

New infrastructure

The UNDCP-IFAD Xieng Khouang Agriculture and Development Programme supported improvements to the provincial road and track network from 1991 (Bountong & Boualy, 2002). The tarring of two main communication axes (national roads 7 and 6) was completed in 2002 and these roads are maintained annually, allowing easy transportation of goods and people from Xieng Khouang to the national capital Vientiane, to more northern provinces such as Houapanh, and to Vietnam. Some old tracks have been widened, some new ones created, and funds have been scheduled from international and provincial sources for their maintenance.

Relocation closer to roads and trade structures

Village relocations started in Xieng Khouang in the early 1980s, motivated by several factors (Goudineau, 1997): insecurity related to anti-revolutionary threat; the slash-and-burn eradication policy of relocating excess population from overcrowded areas; and the overall provincial development strategy of defining focal zones where health and education structures are provided to people who settle there. Goudineau (1997) observed that these three provincial policy objectives have generated a variety of relocations that follow two main trends: at provincial level, an east-to-west move from isolated districts (Nonghet and Mok) to more accessible districts (Kham, Paxay, Pek and Phoukout) and, at sub-district level, a general trend to move closer to roads and to combine isolated villages.

Urban development and urban consumption demand

Between 1990 and 2005, the population of Phonsavanh city increased from 15,472 to 34,634 inhabitants (Provincial Department of Statistics, 2005). FAO (1999) evaluated that total per capita meat consumption in Southeast Asia increased from 9.4 to 21 kg/year between 1961 and 1995, with pigs and poultry remaining the main meat sources. In Xieng Khouang, the number of pigs killed for local consumption in official abattoirs (located close to cities) multiplied seven-fold between 1996 and 2003 while during the same period the population multiplied two-fold.

4.1.3. Farming systems

As agreed by many authors (Hacker et al, 1998; Gibson et al, 1999), this area is mainly covered by acidic, infertile savannah grasslands with pine trees. In Pek, only 5% of the total surface is cultivated, with rice paddy land representing 80% of this cultivated area (PAFO, 2004). Surveys conducted by NAFRI (1997) and NGD/JICA (1999) showed a total area of approximately 48,000 ha of savannah grassland. These two studies give an overview of the land use in the three watersheds over a total area of 228,000 ha.

Table 1. Land use in the three watersheds according to NAFRI 1997

Land Use	**Nam Chat-Phae**		**Nam Kho**		**Thoum-Kha-Pieng**		**Total**	
	area (ha)	as %	**area (ha)**	as %	**area (ha)**	as %	**area (ha)**	as %
Dense forest			2,132	2.7%	546	1.7%	2,678	1.2
Open forest	6,873	5.8%	2,153	2.7%	508	1.6%	9,535	4.2%
Forest mosaic	4,577	3.9%	2,977	3.8%	82	0.3%	7,636	3.3%
Regrowth	3,176	2.7%	6,016	7.6%	3,992	12.7%	13,183	5.8%
Rice paddy	1,282	1.1%	4,601	5.8%	2,699	8.6%	8,582	3.8%
Wood & shrubland	81,945	69.6%	21,589	27.4%	14,905	47.5%	118,441	51.9%
Grassland	17,153	14.6%	28,917	36.6%	2,127	6.8%	48,198	21.1%
Crops Mosaic	944	0.8%	3,239	4.1%	5,014	16.0%	9,198	4.0%
Agriculture land	1,606	1.4%	5,025	6.4%	1,536	4.9%	8,168	3.6%
Urban	154	0.1%	2,264	2.9%		0.0%	2,417	1.1%
Total	**117,710**	**100%**	**78,913**	**100%**	**31,410**	**100%**	**228,036**	**100.0%**

Table 2. Land use in the three watersheds according to NGD/JICA, 1999

Land Use	**Nam Chat-Phae**		**Nam Kho**		**Thoum-Kha-Pieng**		**Total**	
	area (ha)	as %	**area (ha)**	as %	**area (ha)**	as %	**area (ha)**	as %
Upper dry evergreen forest	26	0.0%	0.00	0.0%	286	0.9%	311	0.1%
Upper mixed deciduous forest	31,410	26.7%	1,339	1.7%	4,804	15.3%	37,554	16.5%
Coniferous forest	48,415	41.1%	26,068	33.0%	14,210	45.1%	88,694	38.9%
Mixed broad-leaved coniferous	567	0.5%	8	0.0%	565	1.8%	1,140	0.5%
Unstocked forest	14,042	11.9%	10,131	12.8%	4,646	14.8%	28,820	12.6%
Swidden fields	986	0.8%	4,417	5.6%	270	0.9%	5,673	2.5%
Rice paddies	3,637	3.1%	8,970	11.4%	3,271	10.4%	15,878	7.0%
Other agricultural land		0.0%	1,944	2.5%		0.0%	1,944	0.9%
Grass land	17,401	14.8%	25,928	32.9%	3,392	10.8%	46,722	20.5%
Water bodies	543	0.5%	109	0.1%	56	0.2%	707	0.3%
Bamboo	683	0.6%		0.0%		0.0%	683	0.3%
Total	**117,710**	**100%**	**78,913**	**100%**	**31,500**	**100%**	**228,126**	**100%**

Three types of highland household were differentiated according to land access (Lienhard et al, 2004). When the surface of paddy land per worker is more than 2,500 m^2, households tend to conduct two main activities: paddy rice and livestock production. Rice crop residues (bran and broken rice) are used to feed pigs and poultry; cattle and buffalo are raised on natural pastureland and fed with rice straw after the harvest. The manure is collected to fertilise the paddy fields. Surplus rice is sold and the proceeds used to purchase lifestyle commodities like a television, motorcycle, or sewing machine. It may also be reinvested into on-farm equipment such as a cultivator, husking machine, tractor or threshing machine.

The emergence of new economic opportunities has slightly modified this traditional scheme with (i) more fish ponds (surface area increased four-fold between 1996 and 2003) and more animal sales; (ii) intensification of dry-season legume production (especially garlic and chilli) for local markets; (iii) an increase in silk weaving for sale; and (iv) massive investment in means of transport, from cultivators up to big trucks.

4.1.4. Agriculture, livestock and perennial crops

Rice

It should be pointed out that the area of rainfed rice is relatively small in Pek and Paxay districts. For example, during the 2002 season (source: PAFO Xieng Khouang) 6,655 ha was cultivated in Pek, with lowland and upland rice respectively representing 77% and 8% of this area.

Cash crop production

The various commercial or supposedly commercial crops are marginal. For example, the areas under maize and ground nuts are not more than 600 ha and 150 ha for districts of Pek and Paxay respectively (source: DAFO reports for 1996-97).

Livestock

The Lao government considers development of livestock production to be a priority, since cattle are an important export and the main source of monetary income for most farmers. In the three districts, it is estimated that more than 40,000 ha of acidic, infertile savannah grasslands are under-utilised by smallholders (NAFRI, 1997; NGD/JICA, 1999). On these high plains (altitude 800-1,100 m above sea level) farming systems are mainly based on lowland rice and extensive livestock production. As reported by Gibson et al. (1999) this agro-ecological zone is well-known for native cattle and buffalo production. An initial assessment conducted by Lienhard et al. (2004, 2006a) showed that livestock is a major component of farming systems and income generation. Depending on household strategy, land access and financial backing, livestock production accounts from 52-87% of family income generation.

Xieng Khouang is the third biggest cattle producing province (Committee for Planning and Investment, 2005) but the lack of feeding resources (Hacker et al, 1998) and economic incentives, combine with health problems (Gibson et al, 1999) to limit the development of the

livestock sector. Previous attempts to improve pastureland have been hampered by unavailability of fodder seed, limited fodder growth related to poor soil and free grazing, and lack of labour. Hacker et al. (1998) and Gibson et al. (1999) reported that chemical soil characteristics are seriously unfavourable with a pH (1:5 H_2O) of about 5.0, along with deficiencies in nitrogen, phosphorus, potassium, calcium and magnesium. Moreover, these authors also reported that high levels of aluminium saturation are likely to negatively affect the growth of many pasture species and that severe phosphorus deficiency generates animal health problems.

The number of buffalo and cattle increased greatly from 1975-2002, with a slight drop over the last five years (Figure 1). Commercial inks with Vietnam and others Lao provinces (Luang Prabang and Vientiane) have increased.

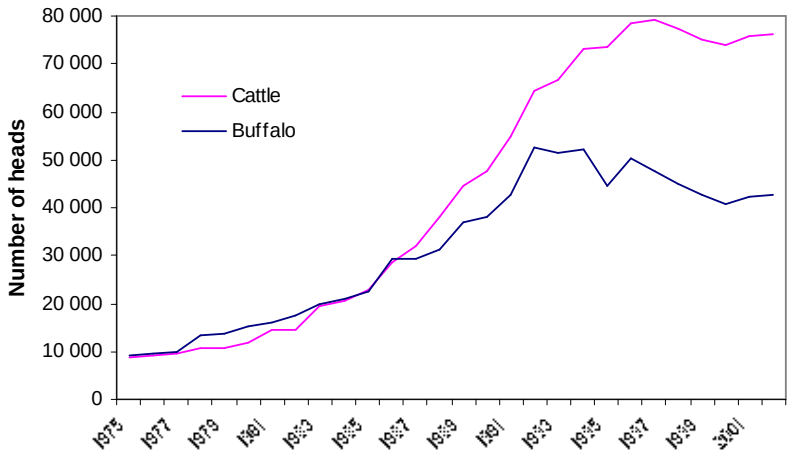


Figure 1. Livestock numbers in Xieng Khouang province 1975-2002

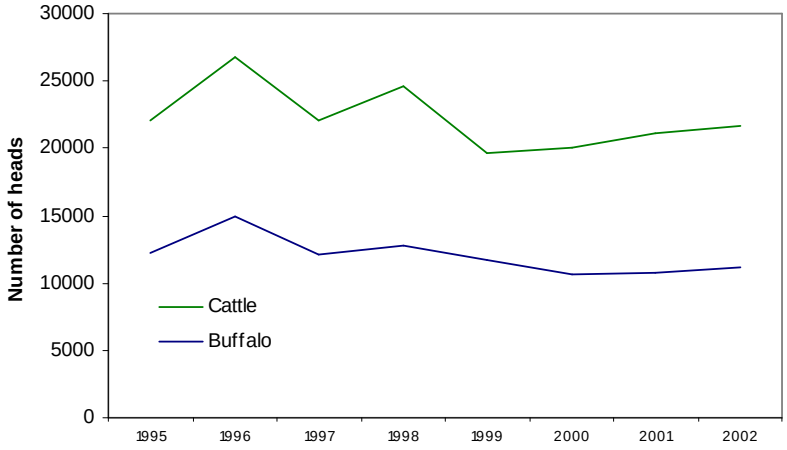


Figure 2. Livestock numbers in Pek 1995-2002.

As shown above, buffalo and cattle represent the main source of income and a form of savings. The former uses of buffalo for ploughing and harrowing wet rice fields have almost disappeared in this region. Most upper watershed cattle are the local yellow 'Asian' breed.

These small cattle showed a high daily growth rate when fattened on improved pastureland. In good conditions mature live animals can exceed 350 kg in weight.

4.1.5. Opportunities

This section summarises the procedures that are indispensable to quality performance in this environment. The principles outlined below are currently being applied by the technical teams (DAFEO and contractors) from PASS and PRONAE. This approach allows extension agents and agronomists to innovate, continuously enhance the process, and support the environmental restructuring through constant analysis of the evolution of production systems and the proposed systems. This method brings the various actors and rural development bodies together around an effective and proven innovative base, founded on agro-ecology and SCV.

As highlighted previously **agro-ecology through SCV should be regarded as just one of the integral elements of this new approach, already adopted in Laos, rather than as the defining element**.

The main principles of this mode of operation are as follows:

- Identification of dominant and emerging systems;
- Helping farmers adjust to these systems in order to anticipate market needs and integrate them into their production systems;
- Frame these interventions within an environmental approach that revolves around preservation of natural resources;
- Create a clear and professional structure across the whole agricultural sector (farmers, extension agents, agronomists, traders, decision makers) with integrated networks (agriculture, livestock, fertility transfer, food and forage resources);
- Immerse the teams in the field so that they work among, with and for the farmers;
- Conduct constant evaluation of innovations and of the evolution of the agricultural, economic and social environment.

Given the experience and the monitoring role of PRONAE, the development initiatives in Pek, Phoukhout and Paxay districts should be focused on production of large ruminants with a fully integrated programme of animal health, forage resources (dry season and rainy season) and genetic improvements in accord with the productivity of this system and the rate of adoption by farmers.

The itinerative techniques of this system are presented in section 6.4.1. Given that the ‘animals’ component, under traditional management techniques, contributes a large part of agricultural revenue, it may be predicted that improved livestock systems will bring substantial economic benefits at the family and provincial level. Daily weight gain fluctuates, in the rainy season, from 100-170 g on natural pasture but can reach 500-600 g/day on improved pasture.

Results obtained over two seasons (Lienhard et al, 2006b) are presented below in an analysis of the economic and technical viabilities of cattle fattening. This used a simple model to

evaluate the daily growth rate of young bulls, which were fattened during the rainy season. This appears to be a very efficient activity with high growth rates recorded.

Higher growth rates were recorded in 2006 (539 g/day, Figure 3) probably related to the fact that the bulls stayed permanently on fields, with earlier and longer daytime fattening that also improved the pasture land through better fertility restitution.

The income generated by this fattening programme in 2006 was equivalent to what could be earned by a paddy rice yield of 1.8 tonnes per hectare, which is unlikely in this ecology. Yields of wet season lowland paddy rice range from 1.5-3.5 t/ha while rainfed rice cropping on the savannah after ploughing reaches 250 kg/ha in the best situations.

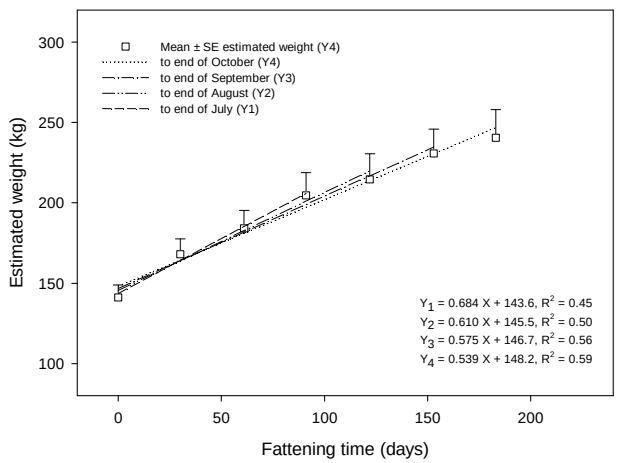


Figure 3. Linear regressions for different fattening periods in 2006. Mean ± SE is given from beginning of the fattening period (May) to the end of October.

During trials in 2005 weight gain and seed production of *B. ruziziensis* earned a gross income of US$879 over 1.5 ha, covering all expenses for fencing, fertiliser, seeds, and bull management for the first year. Fencing (barbed wire) and fertilisers formed the main expenses. A lack of cash income at the end of this first fattening period meant that smallholders could not buy fertiliser for the next season. The cost of fencing could be reduced by using local materials (wood posts and bamboo), growing living fences (hedges) using species such as *Acacia mangium*, *A. auriculiformis*, *Calliandra calothyrsus*, and *Jatropha* sp and shifting from barbed wire to normal wire.

Additional income was provided by the 132 kg of seeds produced on one block (0.3 ha) reserved for seed production. Growing these seeds provides an opportunity to extend the area of improved pasture land or to sell the seeds to others smallholders who wish to generate new income. Sowing *Stylosanthes guianensis* on 5 m contours on the forage fields protects the pasture from wild fires during the dry season and provides protein supplement for the cattle.

In 2006, without taking into account seed production, bull fattening provided a gross income of $804, covering all expenses and generating a net income of $362 per ha and a labour

productivity of $10.4. Seed production earned a gross income of $252 and a labour productivity of $8.4.

Table 3. Economic data recorded for bull fattening on 1.5 ha during two seasons, 2005-2006 around Phonsavanh

Improved pastureland 1.5 ha	Unit	2005			2006		
		Unit cost (US $)	Qty	Total (US $)	Unit cost (US $)	Qty	Total (US $)
COSTS							
Plot fencing							
Wood posts	piece	0.4	440	176			
Barbed wire	piece	5	60	300			
Nails	kg	0.9	20	18			
				494			**0**
Plot designing							
Shelters for animals	piece	5	4	20			
Drinking trough	Oil barrel	8	2	16			
				36			**0**
Land preparation							
				35			**0**
Seeds							
B. ruziziensis	kg	2	23	46			
				46			**0**
Fertilizer							
15-15-15	Ton	340	0.34	116			
Urée (46-0-0)	Ton	300	0.12	36	330	0.34	112
Thermophophate (0-16-0)	Ton	100	0.51	51	100	0.85	85
KCl (0-0-60)	Ton	280	0.09	24	280	0.17	48
				226			**245**
Animals care							
Salt stone	piece	3	2	6	3	2	6
Vaccine and vermifuge	piece	3	3	9	3	3	9
				15			**15**
TOTAL COSTS				**852**			**260**
LABOUR							
Fencing	working.day		20				
Land preparation	working.day		3				
Sowing	working.day		55				
Fertilizer broadcasting	working.day		2			2	
Seeds harvesting	working.day		30			30	
Bulls management	working.day		50			50	
TOTAL LABOUR			**160**			**82**	
BENEFITS							
Bulls added value (difference intial-final value)	US Dollars		6	615		8	804
Seeds production	kg	2	132	264	1.5	168	252
GROSS INCOME	US $			**879**			**1,056**
NET INCOME	US $			**27**			**796**
LABOUR PRODUCTIVITY	US $/day			**0.17**			**9.71**

This bull fattening activity presented four major constraints: First, animal fattening is clearly related to market access and meat demand. Rural areas of Laos have traditionally struggled to find markets for products because of low population density and poor transport links. However, improvement of road and track networks has increased the commercial rate of cattle export to Vietnam (Dalavong et al, 2005; Syphanravong et al, 2005) and the recent

experiences of the Forage for Smallholders Projects (FSLP, CIAT-NAFRI) and the Small Agro-enterprises Development Upland project (SADU, CIAT-NAFRI) show increasing commercial opportunities in places where smallholders are growing forages for cattle feeding. Secondly, it seems difficult for smallholders to carry out this kind of livestock production without technical support for land preparation, pasture growing and cattle management. The local ecologies on schist and granite present good physical properties but low mineral contents (Hacker et al, 1998) with high deficiencies of N, P, K, Ca, Mg and micronutrients (Zn, Bo, Mn). Thermophosphate addition is thus essential, to provide reasonable quantities of Ca, Mg and P and to allow implementation of efficient livestock production and cropping systems. A market channel for such fertiliser is already operational in Xieng Khouang province through Vietnamese traders. Moreover, the soil does not need to be disturbed by mechanical action and land preparation is based on direct sowing of forage species after control of natural pasture land. Direct sowing shows very good results (reducing production costs and land erosion) in the Plain of Jars and could be extended to staple and cash crop production. However, specific equipment adapted to local economic conditions (sowing machine for hand-tractor) must be promoted to decrease labour inputs for land preparation and sowing. The third limiting factor could be that the system was first perceived as requiring an initial cash investment. On these elevated plains, innovative farming systems based on direct mulch-based cropping and better integration of livestock and cropping activities could be stable and profitable if, at the same time, economic incentives (access to market, inputs, credit, agriculture and livestock product processing) are promoted. Fourthly, further work is required to estimate the maximum stocking rate of heifers on improved pasture during the dry season, and in producing additional fodder resources (hay and silage) for this period. A specific programme has to be implemented with farmer groups to evaluate the socio-economic viability of such propositions. Additional fields should be opened for hay (cut-and-carry management) and silage production to feed heifers during the winter and calving periods. Moreover, an accompanied programme based on selected genetic improvement has to be scheduled to increase the number of breeders and their potential.

Seed production does not seem to be problematic in this ecology. Promising results have been observed for the *Brachiaria* species *B. ruziziensis*, *B. decumbens*, *B. brizantha* and for *Stylosanthes guianensis* (cv. CIAT 184). Development of specific market channels for seeds could indirectly improve pasture management, avoid high stocking rates and generate new income that could be invested in fertiliser and animal care. As reported by Hacker et al. (1998), the best option may be to improve small areas through strategies that are specific to smallholders' particular situations, using adapted forage species and thermophosphate.

This programme based on raising large ruminants provides the following benefits:

Bio-physical aspect

- Quantitative and qualitative improvements in cattle;
- Watershed and biodiversity protection through the ceasing of brush fire setting during the dry season, as currently occurs in order to increase the productivity of these areas;

Economic and social aspect

- Augmentation of trade flow at the national and regional level with Vietnam;
- Improvement of living conditions for rural communities;
- Use of land.

Putting these vast areas of land to use constitutes a major challenge for the province; doing so will result in a significant increase in productivity and stability for small-scale farmers while also protecting the watershed and avoiding the further degradation of natural resources (Séguy, 2004). The regeneration of these soils starting from the use of forage species (Picture 7) makes it possible to anticipate fast development of these ecosystems. These species combine a certain number of characteristics that allow them to quickly (two to three years) establish fertility in these soils so they can be used for pastures or, eventually, returned to crops (Séguy and Chabanne, 2004).

These characteristics comprise:

- The biological restructuring of the soil starting from a powerful root system and the constitution of an organic skeleton that improves the physical structure and exchange of gases;,
- Improvement of the biological life essential for the soil structure and plant nutrition;
- The desired mobility and recycling of deep-soil nutrients and water that food and cash crops cannot reach;
- Increase in the organic matter in the upper horizons through a continuous mineralization through vegetation detritus.

Picture 7. *B. ruziziensis + Cajanus cajan*. Plain of Jars

This system of improved pasture must be conceived as a first stage in establishing annual cropping systems. First of all “chemical and organic improvements” from the use of forage species and inputs (thermophosphate) are needed to implant SCV with rice as a base crop. In this dynamic, the farmers will have the opportunity to adapt their production system (livestock and/or crops) according to market trends and their own situation (i.e. financial and human resources, access to specific equipment, food self-sufficiency).

Initial rice systems, established on a cover of *B ruziziensis* (Picture 8) after one or two years of regeneration, produced 1.2 and 1.8 t/ha of rice respectively, with a first investment that is limited in comparison to that of setting up rice terraces in the valley bottoms, the cost of which approaches $1,000 per ha even without counting an irrigation system. Spreading the adoption of this system would make it possible to improve rice production on a provincial scale and to therefore get good use from large areas that are not currently utilised by traditional techniques.

Picture 8. Rice direct seeded on mulch of *B. ruziziensis* + *Cajanus cajan*. Plain of Jars

Table 4. Economic data recorded for upland rice direct seeded on *B. ruziziensis* mulch around Phonsavanh

System	Rice after two years of *B. ruziziensis* no fodder exportation
Sowing	01/06/06
Fertiliser	30N - 45 P_2O_5 - 30K_2O
Yield (kg/ha)	1744 ± 224
Gross income ($US/ha)	401 ± 52
Production cost ($US/ha)	157
Income ($US/ha)	248 ± 52
Labour inputs	47
Labour productivity ($US/day)	5.2 ± 1.1

Various DMC systems are constantly monitored so that the project can in the medium term offer smallholders innovative systems which are productive and profitable, while economic in use of soil, water and nutrients.

In conclusion, a holistic approach involving credit availability through national banks and VDF (Village Development Funds), with technical and political support, should be defined in order to develop productive and efficient systems within this ecology. This poses a great challenge which, if grasped, could yield great benefits in the upper part of the Nam Ngum river basin.

4.2. KASI AND VANGVIENG – MARKET BASED AGRICULTURE

The lower parts of the Nam Ngum river basin are highly diverse in terms of biophysical and socio economic characteristics, and different areas require different strategies and farming systems.

4.2.1. Population and ethnicity

The main ethnics groups in Kasi are the Lao *lum* (51%), the Khamu (45%) and the Hmong (4%). Over 25% of the families classified as poor by the NGPES (according to access to education and healthcare, food self-sufficiency and permanent settlement) live in six villages. A total of 4,452 families and 26,683 people live in the Yot Lik watershed (MAF, 2005).

In the Nam Xong watershed (Vang Vieng), most people live along rivers or streams. There are 72 villages in this area, which in 2005 had a population of 7,987 households, with a total of 40,362 people (MAF, 2005). 67.6 % of the villagers are Lao *lum*, 12.3 % are Khamu and 20.1% are Hmong.

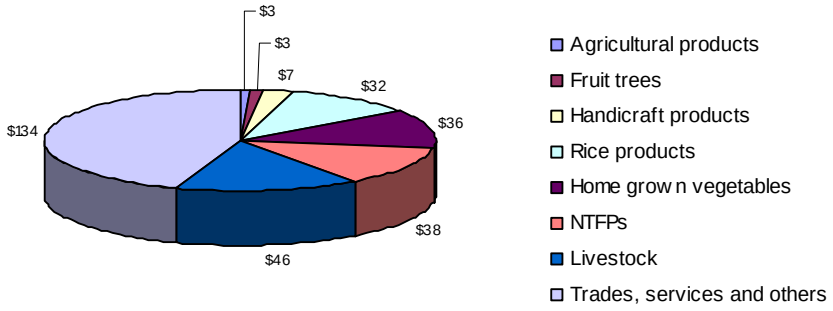
4.2.2. Income and poverty

As shown by Table 5, in the Yot Lik watershed area (Kasi), villagers generate cash income mainly through trade and services (44.7%), NTFPs (12.6%), home grown vegetables (12%), and rice products (20.8%). Yearly income per household is on average $300.

Table 5. Household income (n=4,452) in Yot Lik watershed (kip and %)

Order	Source of income	Kip	%
1	Agricultural products	126,005,600	0,93
2	Fruit trees	152,290,000	1,12
3	Handicrafts	337,550,000	2,48
4	Rice products	1,468,317,000	10,80
5	Home grown vegetables	1,633,926,000	12,02
6	NTFPs	1,718,261,000	12,64
7	Livestock	2,080,951,000	15,30
8	Trades, services and others	6,080,905,000	44,72
	Total	**13,598,205,600**	**100,00**

Figure 4. Sources of household income in Yot Lik watershed (US$)



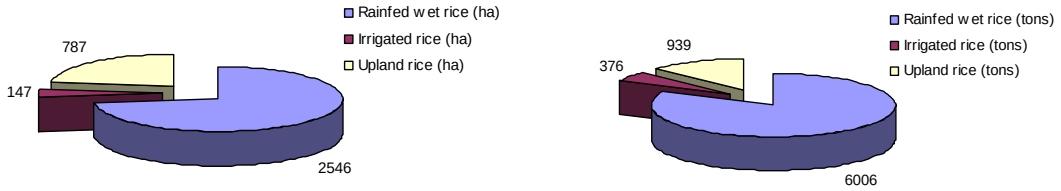
In Vang Vieng, people receive considerable income from tourism and sales of natural substances. The main source of income is from transport services which earn 204.5 million kip. Sales of rice are ranked second, generating 15.5 million kip per year.

4.2.3. Agriculture and livestock

Rice

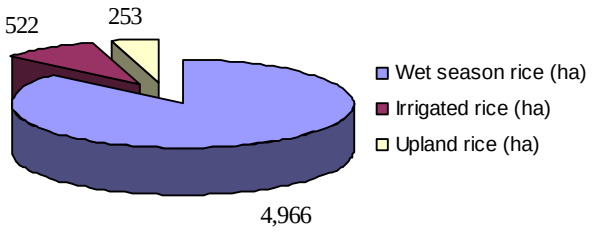
The area under rice production in 2001 in Yot Lik basin was 3,480 ha, yielding 7,321 tonnes or 275 kg per person. This data does not match the population recorded in this basin in 2005.

Figure 5. Rice area (ha) and production (tonnes) in the Yot Lik basin



In Vang Vieng district in 2004-2005, 4,966 ha were under of wet rice (paddy) and total rice production (wet + upland rice) was 16,966 tonnes, or 420 kg of paddy per person.

Figure 6. Rice area (ha) in Vang Vieng district



Cash crop production

In Kasi district, production systems are diversified around annual crops (maize, Job's tears (Coix lacryma Jobi)), fruit (citrus fruits, longan, jack fruit) and off-season vegetables.

Maize production is expanding through the recent introduction of a hybrid, LVN10, and the CP company becoming involved all along the maize production chain (seeds, farming contracts, purchase of production, manufacture of animal feed). There is a danger that this situation could mirror the 'resource mining' (Picture 9) seen in southern Xayabury, where mechanical preparation (ploughing) and increased use of pesticides (weedkiller and insecticide) have been introduced into new production zones. It is vital that preventative work is undertaken with the private sector (companies and service providers) and the farmers to ensure that they integrate in to their cycles soil conservation techniques based on SCV. Given the potential of this area (karst colluviums) and the crops grown, it would be easy to develop such systems building on PRONAE's experience.

Picture 9. Soil erosion in southern Xayabury

Picture 10. Cabbage production in Kasi

The area under off-season vegetables (cabbage, garlic) has also increased since 2001 and now significant areas are dedicated to supplying the national market (Vientiane, Luang Prabang) and exports to Thailand and China. These crops are grown out of season in racks on rice mulch with irrigation (Picture 10). Production of cucumbers under plastic tunnels can also be found now at the end of the dry season and at the beginning of the rainy season before the next rice cycle.

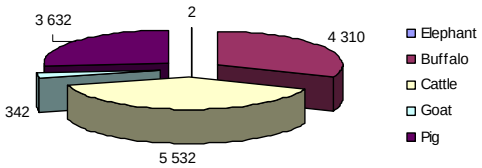
According to the data from Kasi district, the area under perennial crops in this watershed was 254 ha in 2001.

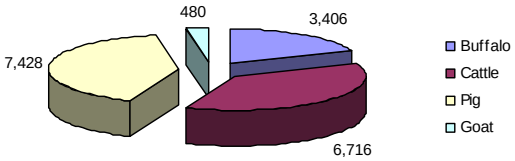
Livestock

According to the Agriculture and Forestry Promotion Office, during the fiscal year 2004-2005, Kasi had a total of 26,436 head of poultry, 5,532 cattle, 4,310 water buffalo, 3,632 pigs, 342 goats and two elephants. This means an average of 2.2 cattle, 0.8 pigs and 5.8 poultry per household.

In Vang Vieng the average was 1.3 head of cattle, 0.9 pigs and 23.3 poultry per household (total of 7,987 households).

Figure 7. Livestock in Kasi and the 72 villages of the Nam Xong watershed, Vang Vieng district.





4.2.4. Opportunities

Farming systems in Kasi and Vang Vieng are characterised by three points:

- High level of diversification (cash crops, horticulture, and market gardening),
- Overall strategies are conditioned by national and regional demand. The tendency is to turn diversified production systems into monocultures, which leads to dependence on markets and risk;
- Private sector involvement in agro-industrial crops (maize, rubber and *Aquilaria crassna)* and a need for environmental impact assessments.

Production is mainly based on cash crop production, with crops varying according to climate, soil potential and market access. DAFEO and NNRBDSP staff should focus their support to farmer groups on:

- Generating DMC systems for annual crops (maize, legumes, rice);
- Supporting existing diversification (e.g. fruit trees, cabbage);
- Improving livestock systems (fodder resources and breeding).

Extension services need to provide technical advice to support the extension of present cropping systems while promoting systems that conserve soil, water and nutrients. These can help avoid the mining development that occurred in southern Xayabury, where traditional systems have collapsed following a transition from subsistence agriculture to intensive cultivation of cash crops, led by the demands of the Thai market. In Xayabury, notable changes in agricultural practices have included the adoption of heavy mechanisation and use of pesticides. To supply traders, maize is now widely sown throughout the region (25,000 ha) and is spreading to more areas every year. With this intensification, rotational cultivation systems and fallow periods are disappearing. The serious social and environmental costs that ensue include increased soil erosion (leading to destruction of roads and paddy fields), loss of soil fertility, and chemical pollution of the environment.

Some agro and economic results recorded on demonstrations sites and with farmer groups in southern Xayabury are presented below.

Generation of a large range of DMC systems

Agro and economic analysis were performed on three annual cropping systems conducted under a conventional system (ploughing) and with no tillage:

- Maize monoculture,
- Two years rotational sequence maize – Rice bean (*Vigna umbellata*),
- Two years rotational sequence maize + *B. ruziziensis – Vigna umbellata*.

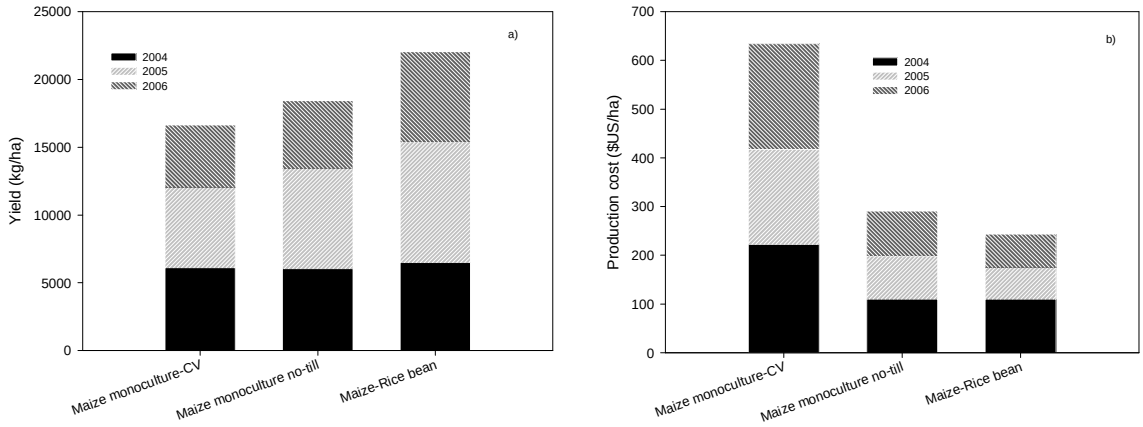
These systems are based on indigenous species and cash crops commonly used by smallholders. Using the local legumes and a rotational sequence to diversify production (grain

production, followed by forages for grazing and/or cut and carry) reduces agronomic, economic and climatic risks while optimising the main functions of the DMC system.

Local species like rice bean and Job's tears are ideal for starting a direct seeding system. With long-cycle durations (seven months), these species produce high amounts of dry matter (>20 t DM ha^{-1} for Job's tears), have low residue degradation due to a high lignin content, and present low levels of animal exportation owing to the unpalatability of both species. They also compete fiercely (especially rice bean) with weeds during the rainy season.

Figure 8. Yield (a) and production (b) costs for different cropping systems – Bouamlao, Pak Lai during three seasons

Maize monoculture-CV: conventional system with maize monoculture under ploughing; Maize monoculture no-till: no-tillage system for maize monoculture without mineral fertilizer; maize – rice bean: two years rotational sequence under direct sowing.



Yield increased under no-tillage systems after the second season but showed a large variability among years even under a two-year rotational sequence. Over three seasons, mean yield was 5,545 kg/ha for maize monoculture under conventional practices, 6,144 kg/ha for maize monoculture under no tillage, and 7,349 kg/ha for a two-year rotational sequence of maize and rice bean.

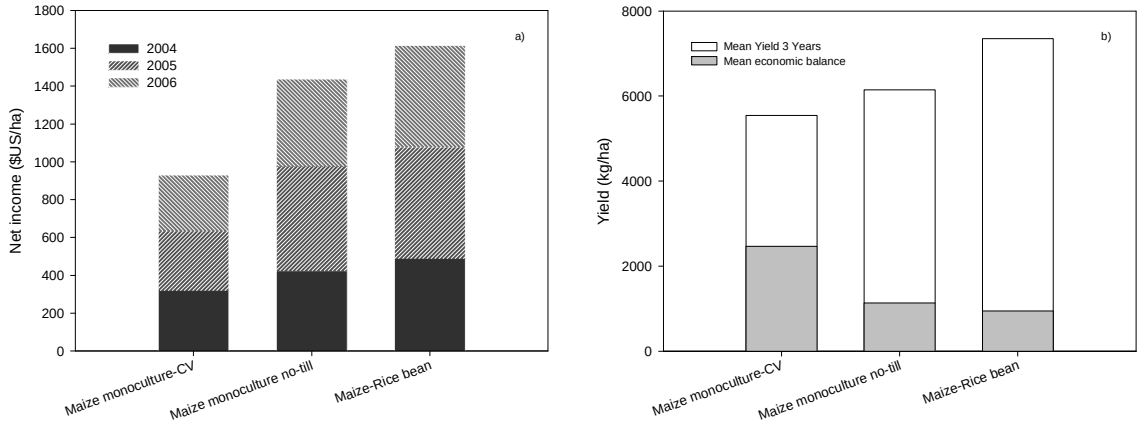
The mean production cost of $97 per ha/y under a no-tillage system for three years represented less than 50% of the $211 per ha/y it cost for conventional ploughing and use of post emergence herbicide. Moreover, this cost was reduced to $81 ha/y under a two-year sequence of maize and rice bean, mainly due to decreased labour for weeding (decreasing weed pressure).

Mean net income per season (Figure 9a) reached $479 per ha and $310 per ha under a no-tillage system and a conventional production system respectively. This drop of net income can be extrapolated at district level and represents a huge loss. It would be interesting to calculate the global cost of this 'mining system' if environmental and social damage (destruction of roads and tracks and lowland paddy fields) were included. Under a two-year rotational sequence (maize – rice bean) net income reached $538 per ha.

The yield required to cover production costs (Figure 9b) was 2,467 kg/ha, 1,131 kg/ha and 948 kg/ha for maize monoculture under conventional practices, maize monoculture under no tillage, and a two-year rotational sequence with maize and rice bean respectively.

The Nam Ngum River Basin Development Sector Project will need to take advantage of this knowledge to create innovative systems for smallholders for market-based production.

Figure 9. Net income (a) and economic balance (b) per ha for three cropping systems in Bouamlao, Pak Lai, 2004- 2006



Extension of no-tillage systems with farmer groups

Under no-tillage systems with residue management, yield levels were generally close to or even higher than those obtained in conventional systems (Table 6). In degraded areas (Paktom–Kenthao and Nongpakbong–Boten) mean yield recorded with no-tillage oscillated between 3.1 and 3.7 t ha^{-1} with maize hybrids, while mean yield with conventional tillage was 3.3 $t.ha^{-1}$. In Nongphakbong, lower soil fertility plus poor soil structure due to compaction and crusting seem to be the main yield limiting factor for both DMC and conventional systems. Erenstein (2003) reports that short-term yields often depend on the mulch, crop and site characteristics, and therefore a number of seasons are necessary to stabilise the system.

With time the production costs for conventional practices rise considerably due to increased use of herbicides for chemical weeding, applied mainly after crop emergence. In southern Pak Lai (Kengsao and Bouamlao) and northern Kenthao (Houay Lod), mean net income per ha was $415 per ha for no tillage systems and $276 per ha for conventional tillage systems in 2005. In these areas, lower production costs combined with high yields resulted in high net incomes under DMC systems. It was also interesting to observe that in degraded areas such as Paktom and Nongphakbong, net income per hectare could be improved rapidly after two or three years of practicing no tillage. Overall, net income increased over three seasons under DMC systems, although with great variability among sites. This variability is mainly due to low soil improvement and increased weed pressure under maize monoculture.

Since the first season in 2005, labour productivity increased to highly significant rates in Bouamlao, Kengsao and Houaylod (Table 6), ranging from $7.1-7.8 per day with DMC and

from $3.2-5.8 with conventional practices. In 2005 on sandstone land in Nongpakbong, mean labour productivity among survey respondents reached $5.7 under DMC systems, thanks to very low production costs and good management of crop residues. Net income and labour productivity increased greatly over the years with relative increases of 83% and more than 200% in Houay Lod and Paktom respectively. However, results showed that in most cases of no tillage maize monocropping, weed pressure could not be controlled efficiently because of the short duration of maize and rapid mineralization of maize straw. Indeed, after harvest and during intercropping (six months), weed proliferation and seeding occurred.

Mean yield over three seasons and economic balance (yield required to cover production costs) is presented in Figure 10 for Bouamlao village in Pak Lai district). Yield under conventional system was higher than under the no-tillage system, mainly due to a drop under no-tillage in 2004. However, the economic balance under the no-tillage system is 1,011 kg/ha meaning in this system requires only 53% of the yield needed by the conventional system to cover production costs. Thus mean net income per year is $283 per ha under DMC and $224 per ha under conventional practices (Figure 11).

Figure 10. Mean yield (a) and Economic balance (b) per ha between 2003 and 2005 for one group of farmer (Bouamlao, Pak Lai)

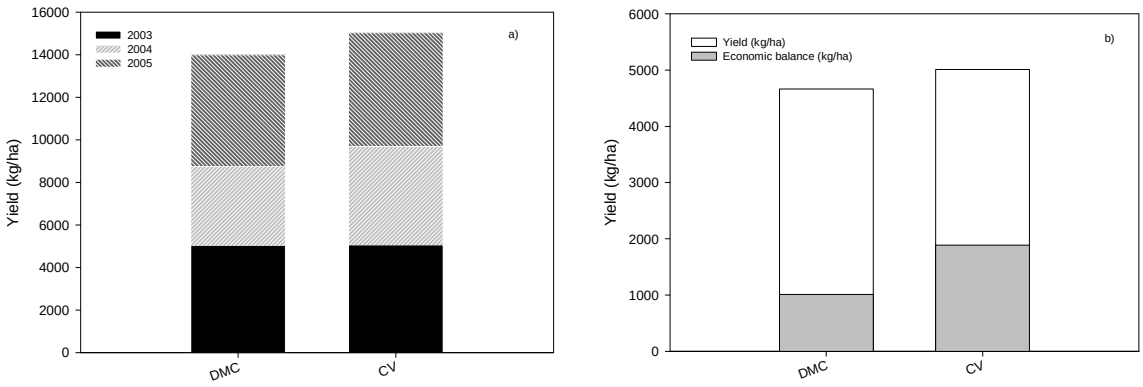
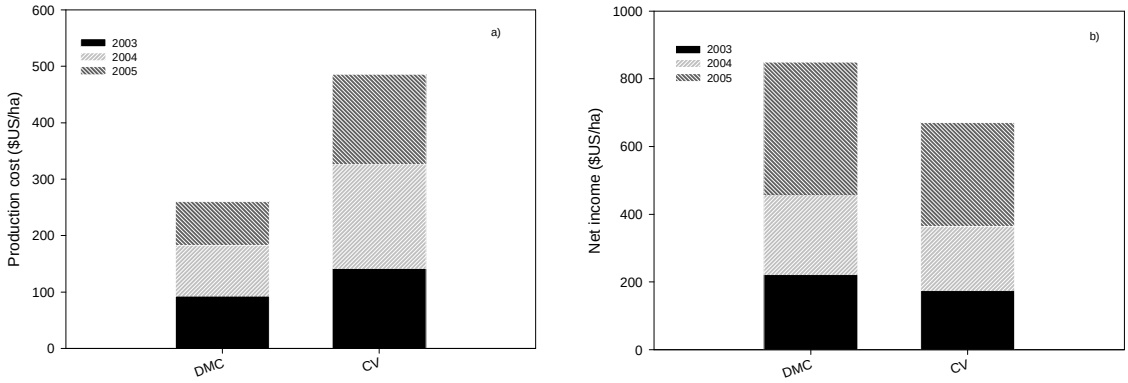


Figure 11. a) Production costs and b) Net income per ha over three seasons for one group of farmers (Bouamlao, Pak Lai)



The degree of dissemination of DMC systems differed greatly among the villages according to their biophysical and socio-economic environments. Surveys carried-out in 2005 and 2006 showed a rapid adoption of these technologies in Houaylod, Nongphakbong and Paktom (Tables 7 and 8), with percentages of smallholder farms practising DMC ranging from 66% to 76%. In 2006 a survey carried out with stratified sampling suggested spontaneous dissemination from farmers to farmers. The adoption process in Paktom stands out, where the cultivated area under DMC was relatively low at less than 15% (Table 7), but by contrast, the percentage of smallholders practising such systems was high (68% in 2006, Table 8). Recently, new maize production areas in northern Kenthao district (Houaylod), which have access to the Thai market, have contributed to a dramatic increase in total cultivated area per labourer in the last three years. Common land preparation is based on slash-and-burn and DMC systems are spreading rapidly as farmers attempt to increase the area cultivated.

Adoption processes in southern Pak Lai (Kengsao and Bouamlao) differed greatly from the areas described previously. Although the economic superiority of the no-tillage system over conventional tillage was demonstrated every year, both the adoption of DMC systems by smallholders and the area managed with residues remained extremely low (Tables 7 and 8) before this cropping season. In these two villages, where the cultivated area of maize per labourer can easily exceed 2 ha, land preparation through large-scale herbicide application entailed considerable labour drudgery (Tran Quoc et al, 2006). Introduction of specialised equipment (seeder and sprayer) and the involvement of DAFEO and the PASS–PCADR project in extension activities have enhanced the dissemination of such technologies. After one season, 13% of smallholders started DMC systems in Bouamlao (Table 8) on 8% of the total dry land area. Surveys conducted by PASS (Julien & Rattanatray, 2006) showed that larger areas of 42 ha and 54 ha were mechanically sown in southern Pak Lai and Kenthao respectively. PASS gave technical support to 385 families faming 401 ha of crops under DMC systems (spontaneous dissemination was not included in this record).

Positive results were evident for direct seeding systems based on residues in southern Xayabury, where a growing interest and potential for widespread adoption were observed. After one season of the PASS-PCADR project in southern Xayabury following this approach of supporting farmer groups and structuring the environment, great impact became apparent in the promotion of no-tillage systems and their transfer to smallholder farms and the private sector. Despite rapid adoption of DMC systems (based on residue management) in some areas, these no-tillage systems will still need to be progressively improved with rational crop rotations, relay crops and cover crops in order to achieve all their potential biophysical and economical advantages. The present system of mono-cropping under no-tillage is an incomplete system in which diseases, weeds and pests will tend to increase and labour productivity and profits will decrease.

Table 6. Data ± SE from on-farm experiments conducted between 2003 and 2005 in southern Xayabury. Mean value, yield, production cost, net income, labour inputs and labour productivity are presented for five situations. Data is from two to eleven on-farm trials of 1,000 m^2 per treatment.

Components	Treatment	Villages												
		Kengsao			Bouamlao			Houay Lod		Paktom			Nongphakbong	
	Year	2003	2004	**2005**	2003	2004	**2005**	2004	**2005**	2003	2004	**2005**	2004	**2005***
	(Replications)	(3)	(6)	**(5)**	(5)	(4)	**(4)**	(6)	**(6)**	(8)	(11)	**(11)**	(4)	**(2)**
Yield (kg/ha)	**DMC**	5481 ± 167	4583 ± 325	**6355 ± 735**	5044 ± 379	3727 ± 379	**5220 ± 1045**	4976 ± 435	**5965 ± 440**	2563 ± 329	3383 ± 714	**3150 ± 945**	2270 ± 434	**3725**
	CV	4332 ± 691	5215 ± 588	**5190 ± 660**	5073 ± 281	4629 ± 394	**5330 ± 1105**	4726 ± 518	**5950**	2787 ± 316	3477 ± 42	**3310 ± 850**	3305 ± 811	**-**
Production cost (US$/ha)	**DMC**	116 ± 13	100 ± 12	**90 ± 13**	93 ± 3	90 ± 3	**77 ± 12**	94 ± 0.5	**95 ± 4**	52 ± 5	89 ± 9	**95 ± 10**	59 ± 14	**64**
	CV	169 ± 39	201 ± 40	**201 ± 52**	142 ± 23	185 ± 46	**159 ± 59**	194 ± 61	**226**	88 ± 8	111 ± 16	**135 ± 32**	86 ± 28	**-**
Net income (US$/ha)	**DMC**	227 ± 19	243 ± 53	**423 ± 71**	222 ± 23	236 ± 67	**392 ± 78**	280 ± 73	**429 ± 28**	82 ± 17	123 ± 8	**161 ± 64**	33 ± 41	**215**
	CV	102 ± 53	190 ± 84	**234 ± 93**	175 ± 39	190 ± 86	**306 ± 138**	100 ± 41	**288**	57 ± 19	107 ± 16	**146 ± 75**	52 ± 66	**-**
Labour inputs (days/ha)	**DMC**	62 ± 5	51 ± 8	**60 ± 8**	55 ± 9	49 ± 13	**51 ± 6**	65 ± 10	**56 ± 3**	61 ± 4	40 ± 12	**40 ± 9**	31 ± 1	**38**
	CV	75 ± 7	93 ± 32	**94 ± 42**	70 ± 6	64 ± 18	**50 ± 11**	78 ± 24	**51**	74 ± 7	41 ± 7	**35 ± 6**	64 ± 4	**-**
Labor productivity (US$/day)	**DMC**	3,7 ± 0.1	4,8 ± 0.9	**7,1 ± 1.5**	4 ± 0.8	4,9 ± 1.0	**7,8 ± 2.1**	4,2 ± 0.9	**7,7 ± 0.6**	1,3 ± 0.2	3,2 ± 1.4	**4 ± 1.4**	1 ± 0.8	**5,7**
	CV	1,4 ± 0.7	2,2 ± 1.3	**3,2 ± 2.6**	2,5 ± 0.7	3 ± 1.5	**5,8 ± 1.6**	1,3 ± 0.1	**5,7**	0,8 ± 0.3	2,6 ± 0.5	**3,9 ± 2.0**	0,8 ± 0.6	**-**

Key: DMC: direct seeding with residue management; CV: conventional – ploughing. Nongphakbong 2005*: all conventional plots were managed with crop residues

Table 7. Dissemination of DMC systems by area 2003-2006 in 5 villages

Villages	**Houaylod**				**Paktom**				**Nongphakbong**				**Kengsao**			**Bouamlao**		
Total Smallholders	169				131				101				134			383		
(Replications)	(90-103)				(90-124)				(74-80)				(90)			(155-137)		
Land preparation	**2003**	**2004**	**2005**	**2006**	**2003**	**2004**	**2005**	**2006**	**2003**	**2004**	**2005**	**2006**	**2003**	**2004**	**2005**	**2003**	**2004**	**2005**
Slash & burn	72,2	54,5	17,6	**18,5**	16,6	13,7	6,8	**13,4**	35,1	33,3	38,1	**40,9**	16,4	5,6	**1,5**	7,6	2,5	0,1
Ploughing	19,7	21,7	26,8	**38,8**	78,4	81,1	83,1	**71,7**	57,2	56,1	42,3	**17,1**	79,3	67,4	**37**	81,6	68,8	31,6
Ploughing & Herbicide	2,3	1,7	11,7		1,7	0,8	0,9		1,1	0,8	0,8		4,3	26,5	**58**	10,8	28,7	68,3
DMC	5,8	22,1	43,9	**42,6**	3,3	4,4	9,2	**14,9**	6,6	9,8	18,8	**42**	0	0,5	**3,5**	0	0	0

Key: DMC =direct seeding with residues management; Ploughing & Herbicide: Herbicides (Paraquat or Atrazine) are applied after sowing and maize emergence. Source: data from a survey carried out by the PASS Project in 2005. Replications differed between surveys conducted in 2005 and 2006. Data was not recorded in 2006 in Kengsao.

Table 8. Dissemination of DMC systems according to percentage of smallholders between 2003 and 2006 in 5 villages

Villages	**Houaylod**			**Paktom**			**Nongphakbong**			**Kengsao**		**Bouamlao**		
Total Smallholders	169			131			101			134		383		
(Replications)	(90-103)			(90-124)			(74-80)			(90)		(155-137)		
Year	2003	2005	**2006**	2003	2005	**2006**	2003	2005	**2006**	2003	**2005**	2003	2005	**2006**
% of smallholders	4	50	**66**	8	50	**68**	5	22	**76**	0	**2**	0	2,5	**13**

Use of specific equipment overcame constraints previously identified in Bouamlao and Paktom villages, where large areas of maize are sowed every year and where the main constraint was the labour drudgery involved with land preparation and sowing (Tran Quoc et al, 2006). Farmers adopt DMC systems firstly because of socio-economical advantages and not for their environmentally positive effects, and secondly when conventional cropping systems are no longer productive or economically efficient. For example, in the most fragile area (Nongphakbong), where soil fertility had decreased rapidly because of the nature of the soil (sandstone in Boten district) and erosion induced by former ploughing techniques, crops tend to be diversified (maize, peanuts, rice bean) in order to limit risks due to soil and climatic factors. Furthermore, in order to increase cash income, most small and medium households are shifting to DMC systems to cultivate wastelands infested by the *Imperata cylindrica* weed with rice bean cropping systems. Such areas cannot be farmed through conventional tillage systems because of the high labour requirements for weeding.

The next main challenge is to transfer knowledge, systems, and equipment to smallholders and the private sector through rental-selling processes. Many smallholders say that a major limitation to the dissemination of DMC systems is the lack of any credit system for inputs. For many smallholders, even when extremely high interest rates are given for ploughing on credit (50% over eight months), this option still represents a good opportunity to avoid investing any cash at the beginning of the season, when money is needed for other agricultural activities (livestock, farm equipment) or the household requirements (health, school, etc).

Two main work themes will be pursued by DAFEO with the support of NNRBDSP:

- Generation of a large range of DMC systems and technologies at Training Centres (e.g. pigsties, improved pastureland, mechanisation, use of inputs);
- Validation of DMC systems with farmer groups.

The team will follow an iterative approach, advising incremental changes to the conventional systems in use. This is likely to be more acceptable to farmers than risky and drastic modification. Scaling up this approach and DMC systems in Kasi and Vang Vieng will be relatively simple given the experience and knowledge within NAFRI–PRONAE. Advice must be based on an understanding of the agro-ecological and socio-economic conditions under which alternatives are adopted and implemented at the local level. Farmer groups will be constituted in different villages to ensure localised conditions and farmer strategies are taken into account.

This programme will bring the following bio-physical and socio-economic benefits:

Bio-physical

- Soil protection and improvement of soil fertility and potential through DMC systems;
- Watershed protection.

Economic and social components

- Increased diversification;
- Stabilisation of smallholder farms;
- Generation of income and improved well-being in rural communities.

4.3. XAYSOMBOUN – SUBSISTENCE FARMING AND AGRO-INDUSTRIAL CROPS

4.3.1. Population and ethnicity

Pha-Yen sub-watershed

In 2004 there were eight villages in the Pha-Yen sub-watershed with a total population of 2,259. Of these, 1,085 people or 48% were Lao *lum*, 909 or 40% Khamu, and 266 persons or 12% Hmong.

Based on statistics from the Xaysomboun Special Zone Investment and Planning Office, between 2004 and 2005, the population declined by 149 people to 2,110, with an increasing number of young people moving to Vientiane for study and work. Migration to Xieng Khouang province and other neighbouring districts also occurred.

This district will accept some of the families from Phoon district who will be displaced by construction of the Nam Ngum 2 hydro-electric dam. Most of the 1,200 families from this district will be resettled in Feuang district from 2007.

Table 9. Population in Pha-Yen watershed, 2004-2005

No	Village	Population		Household	
		2004	2005	2004	2005
1	Pha-Yen	188	157	35	36
2	Longcheng	667	514	188	88
3	Phoukongkhao	121	147	21	25
4	Louangphanxay	387	400	75	70
5	Phanxay	229	197	37	33
6	Namxan	260	273	46	46
7	Namxome	171	175	33	32
8	Namnguao	236	247	46	49
Total		**2,259**	**2,110**	**481**	**379**

Source: Statistics Sector, DIPO, Xaysomboun Special Zone.

Ja-Nam Hao sub-watershed

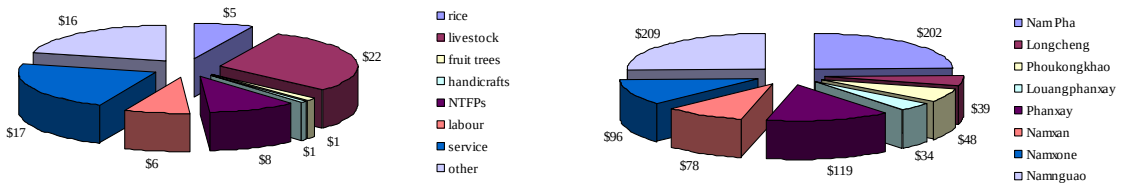
Eleven villages are situated in the Ja-Nam Hao watershed. In 2005, according to the population survey department, there were 1,374 families and 9,339 people. 80.4% of the villagers are Hmong, 14.9% Lao *lum*, and 3.7% Khamu.

4.3.2. Poverty and income generation activities

Pha-Yen sub-watershed

Seven of the eight Pha-Yen villages are considered poor, with more than 51% of their households poor. In 2004 villagers in Pha-Yen had a total cash income of 357,294,700 kip or an average of 742,816 kip per household per year. There was great large variability among the villages.

Figure 12. a) Mean income generation per household and year (US$) in Pha-Yen villages. b) Variability of cash income between the eight villages



4.3.3. Agriculture, livestock and NTFPs

Rice

During the fiscal year 2003-2004, the DAFEO reported that the eight villages in Pha Yen watershed cropped about 276 ha of wet rice fields, and 82 ha of upland fields, at an average of 0.74 ha of rice field (lowland and upland) per household. Cash crops were grown on about 216 ha of garden fields.

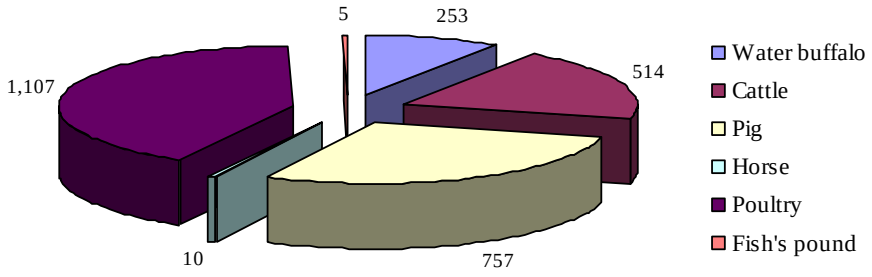
In 2003 to 2004, the total agricultural area in Nam Ja-Nam Hao was 1,822 ha, of which 1,347 ha was paddy fields which can only produce rice during the rainy season.

Livestock and fisheries sector

According to DAFEO data, livestock production is very low in Pha Yen watershed with less than one head of cattle, buffalo and pig per household. Villagers suffer high rates of disease among their animals including foot and mouth, hepatitis, diarrhoea, hookworm and other diseases. This is due to the lack of a veterinary network or epidemic prevention programmes in the area.

With a large area of grassland available in Pha Yen and Nam Ja-Nam Hao watersheds, a specific livestock programme could be implemented based on the experience in Xieng Khouang province.

Figure 13. Livestock in Pha Yen watershed, Xaysomboun district. Data from Phoukongkhao village not recorded



Non-timber forest products (NTFPs)

NTFPs found in these watersheds include palm seeds, cardamom, dammar resin, *Arenga pinnata* (sugar palm), rattan canes for handicrafts, rattan shoots for food, mushrooms and a wide variety of medicinal plants. NTFPs provide a significant source of household subsistence and cash income and represent 10% of total cash income per year (75,226 kip/household/year) in Pha-Yen.

4.4. HOM AND NAM XAN SUB WATERSHED – SUBSISTENCE FARMING AND AGRO-INDUSTRIAL CROPS

4.4.1. Population and ethnicity

Nam Xan sub-watershed

The population in Nam Xan sub-watershed (32 villages) is 17,852 people in 2,615 households. These villages are mostly located along the Nam Ngum reservoir and the rivers of the Nam Xan valley. These areas are the most accessible and suitable for agriculture production and fisheries.

The Hmong are the largest ethnic group with 11,246 people (62.9% of the watershed population) settled all over the area. The next largest segment of the population is Lao Phuan with 3,800 people (21.3 %). This group is concentrated mainly along the Nam Xan river and the Nam Ngum reservoir. The smallest group is the Khamu with 2,383 people (12.8%) who in the southeast of the watershed where the central administration of Hom district is located.

4.4.2. Poverty and Income Generation Activities

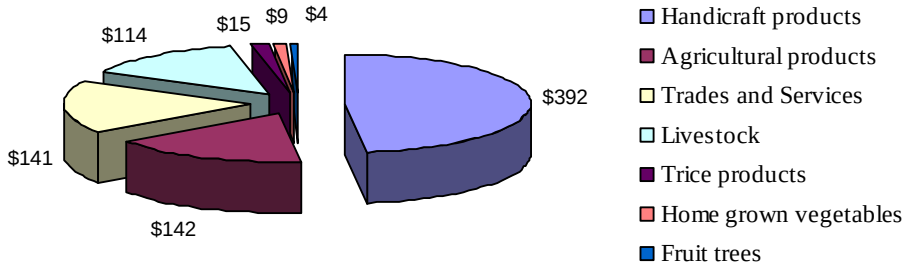
Nam Xan sub-watershed

One way of measuring poverty in the Nam Xan watershed is use of household rice insufficiency information from the Planning and Cooperation Office of Hom district. Based on fiscal year 2003-2004, there are four villages in Nam Xan in which more than 51% of

households are poor: Sam Khone with 76.3%, Houai Yang (71.9%), Vang Loaung (59.2%), and Phon Lao (51.4%).

Villagers in Nam Xan watershed generate cash income mainly by selling handicraft products (47.9%), agriculture products (17.4%), trades and services (17.3%) and livestock (14%). Tham Din village earns the highest cash income in the area with a total of about 3,746 million kip, followed by Khon Vat, with a total income of about 2,652 million kip. Ban Houay Siath has the lowest cash income at about 33.7 million kip.

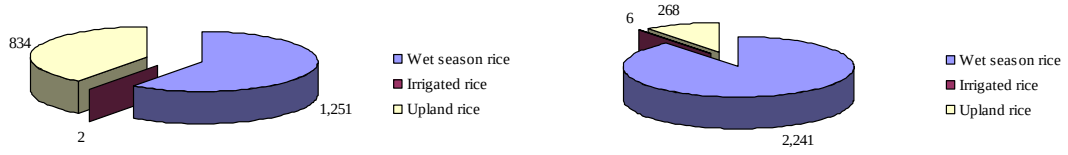
Figure 14. Mean income generation per household and per year (US$) in the Nam Xan sub-watershed



4.4.3. Agriculture, livestock and NTFPs

Rice

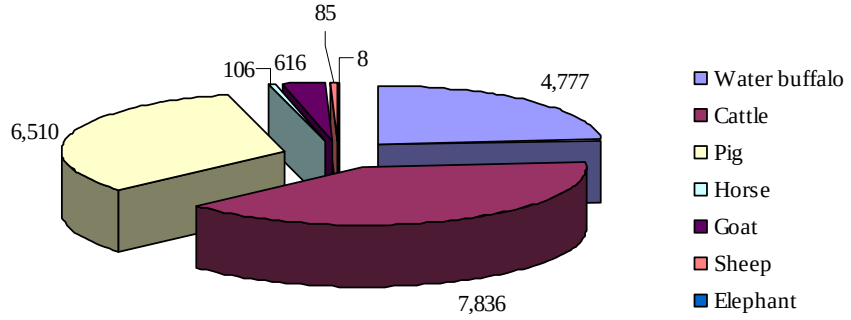
Figure 15. Rice area (ha) and production (tonnes) in the Nam Xan sub-watershed



Livestock and fisheries sector

In comparison with Pha-Yen watershed, livestock rearing is reasonably developed in Nam Xan, with a mean of 1.8 buffalo, 3.0 cattle and 2.5 pigs per household.

Figure 16. Livestock in Nam Xan sub-watershed (data not shown for poultry)



4.5. HIN HEUP AND NAM LIK SUB WATERSHED – SUBSISTENCE FARMING AND AGRO-INDUSTRIAL CROPS

4.5.1. Population and ethnicity

The population in the Hin Heup and Nam Lik sub-watershed is 2,658 households, with 14,832 people. The population is composed of two main ethnic groups: Lao *lum* at 8,466 people and 6,327 Khamu. There is a small Hmong community of 39 persons. According to the district office, the total population of Hin Heup in 2006 was 26,236 people in 5,285 households.

4.5.2. Agriculture, livestock and NTFPs

Rice

During the 2005-2006 fiscal year, the DAFEO reported that 49 villages in Hin Heup cropped about 2,169 ha of wet rice fields at an average of 0.41 ha per household, plus 175 ha of upland fields.

Table 10. Populations and rice area (ha) in Hin Heup

Year	Households	Persons	Rice area (ha)		
			Wet season paddy	Upland	Dry season paddy
1998	5125	25300	2967	1631	46
1999	5223	25436	2229	1673	41
2000	5236	25700	2279	679	50
2001	5242	25840	2575	695	75
2002	5263	26117	2618	696	87
2003	5273	26124	2587	539	99
2004	5282	26234	2326	528	123
2005	5284	26236	2220	193	45
2006	5285	26236	2169	175	93

Livestock sector

According to the Agriculture and Forestry Promotion Office, during the fiscal year 2005-2006, Hin Heup had a total of 4,412 cattle, 2,824 water buffalo, 2,858 pigs, and 51,666 head of poultry. This worked out at an average of 1.3 head of cattle/buffalo, 0.5 pigs and 9.8 poultry per household.

4.6. OPPORTUNITIES (XAYSOMBOUN, HOM AND HIN HEUP)

It has been noted over the last year or two that with the opening up of certain districts (Hin Heup, Xaysomboun, Hom) agro-industrial crops - mainly rubber, teak, *mai khetsana* (*Aquilaria crassna*: agarwood for essential oil), and *jatropha* (biofuel) have started to proliferate (Pictures 11). The techniques needed to start these crops growing (clearance, burning, ploughing, and mini-terraces) are very expensive and are detrimental to these fragile soils and to natural resources in general. Loss of fertility, erosion, and pollution of rivers is already perceptible. Private loans from outside sources with high interest rates are accompanying these agricultural developments.

Pictures 11. a) rubber plantation on mini terraces in Hin Heup, b) maize and c) cassava production in Phoukhouth (LTACO Company)

Environmental assessment has to be carried-out to evaluate the impacts of this development of perennial plantations (rubber and *Aquilaria crassna*) and to analyse the socio-economic viability of such systems for households. In Hin Heup a low level of diversification has also been noted, with hills under-utilised by farmers.

Agricultural production in Hom and Xaysomboun is mainly based on upland rice, livestock production (cattle and pig raising), and diversification through fruit trees and multipurpose species such as cassava. Until recently these two districts had limited access to market. They are characterised by:

- High socio-economic diversity related to ethnic groupings, farmer strategies, and land access;
- Farming systems mainly based on lowland and upland rice, livestock production (cattle and pigs, 30% of cash income sources), NTFPs (10% of cash income sources) and home gardens (cassava, cana, fruit trees, pineapple). Labour and services account for 30% of cash income sources,
- Large grassland areas in Xaysomboun, suitable for livestock grazing.

DAFEO and NNRBDSP staff should focus their support to farmer groups on:

- Improving livestock systems (fodder resources and breeding);

- Supporting existing diversification (e.g. fruit trees, cabbage);
- Generating DMC systems for annual crops (maize, legumes, rice).

5. OBJECTIVES AND METHODOLOGICAL APPROACH

5.1. GENERAL OBJECTIVES AND SYSTEMIC APPROACH

5.1.1. Conservation agriculture

Taking the capital natural into consideration is the first priority fixed by the project within the plan to protect the watersheds. The main environmental and socio-economic objective will thus be to develop technical alternatives that shall enable the preservation of renewable but not inexhaustible natural resources such as soil and water, and to promote sustainable agriculture that is socially acceptable, economically profitable and environmentally sound.

First of all the project should move to restore and preserve the physical, chemical and biological fertility of the soils used in agriculture, which constitute much of the natural heritage of the area. Given the fragile condition of the soils described above, and the degradation that has already been observed, this work is essential.

Soil management is the principal integrating topic for all development activities linked to agriculture, livestock, forestry, fishing, preservation of infrastructure, water quality and the quality of life. Conservation agriculture based on the simple techniques of direct seeding and plant covers is thus proposed (appendix 4).

Centring the approach on soil capital also makes it possible to maintain enough diversity to allow interesting ecosystemic properties to emerge, notably with regards to the natural functions of bio-geochemical regulatory cycles. It thus enables the project to meet the environmental issues described above through:

- *Promotion of technologies* that can increase the productivity and socio-economic capacities of farming systems without negative affects related to land use, water use, inputs or pesticides;
- *Promotion of technologies* that can assist the careful and environmentally responsible development of the ecosystemic services of natural systems whose primary production functions are not fully exploited. This can increase incomes by giving agricultural value to vast ‘empty’ spaces (e.g. the Plain of Jars);

- *Promotion of technologies that increase energy efficiency*, reducing greenhouse gas emissions and increasing carbon sequestration.

In addition to the promotion of sustainable agriculture, this approach also allows the creation of global and local ***environmental public goods*** (GPG and LEPG), which for the moment have no monetary value. The concept of ***Payment for Environmental Services (PES)*** provided to society is appropriate here.

These systems, which have already proved their worth in Laos, among other places, were the subject of a circular of the Cabinet of the Council of Ministers (Ref 554/CCM.DC, 21/4/2005) and a ministerial decree from the Ministry of Agriculture and Forestry (Ref: 0372/DF.05, 11/05/2005) and can thus be applied in all provinces of the Lao PDR (see appendix 5).

Production systems will be designed around the broadest possible technological improvement at various levels of intensification as befits the situation in each place, the knowledge levels of the farmers, and the economic risk identified. In this work emphasising mixed agro-sylvo-pastoral production models would appear essential:

- Food and cash crops, fruit trees and market gardening;
- Animal husbandry with large ruminants, and small animals, tightly integrated into current production systems;
- Exploitation of forestry and NTFPs.

These components are structured around rainfed rice farming, which is the crux of all production systems in Laos (food self-sufficiency). From these structures, other cash crop and small livestock systems of varying levels of intensity will be developed to optimise the natural resources.

Current slash-and-burn practices, which through long fallow periods of 10-15 years allow the soils to recover, are no longer feasible due to the diminishing amount of land available. They will be replaced with SCV, in which forage crops - thanks to their above- and below-ground biomass with strong, deep roots - reproduce the natural regulatory functions of the forest's bio-geochemical cycles over a shorter time frame (two to three years). This constitutes a preliminary phase before the development of more diversified systems.

Moreover, these species contribute to improved incomes not only through their value as forages but also through sale of the seeds they produce, which offer revenue from the very start, even as the systems begin to develop. Such forage species can, in addition, be grown in association with perennial crops such as fruit trees, rapid-growth multi-usage trees, firewood and construction species, and annual cash crops such as rubber and coffee.

5.1.2. A global systemic approach

This systemic approach, designed to progressively transfer skills to the local authorities, development agencies and private operators, is organised around two principles:

<u>To develop a repeatable global solution</u> to the constant need for information from all development practitioners, in order to improve and update in 'real time' the technological, methodological and organisational methodology to keep it in line with the evolving biophysical, socio-economic and political context, and with demand. Constant evaluation at each stage will allow real time adjustment of activities and reorientation of programmes, and so optimise the use of all resources.

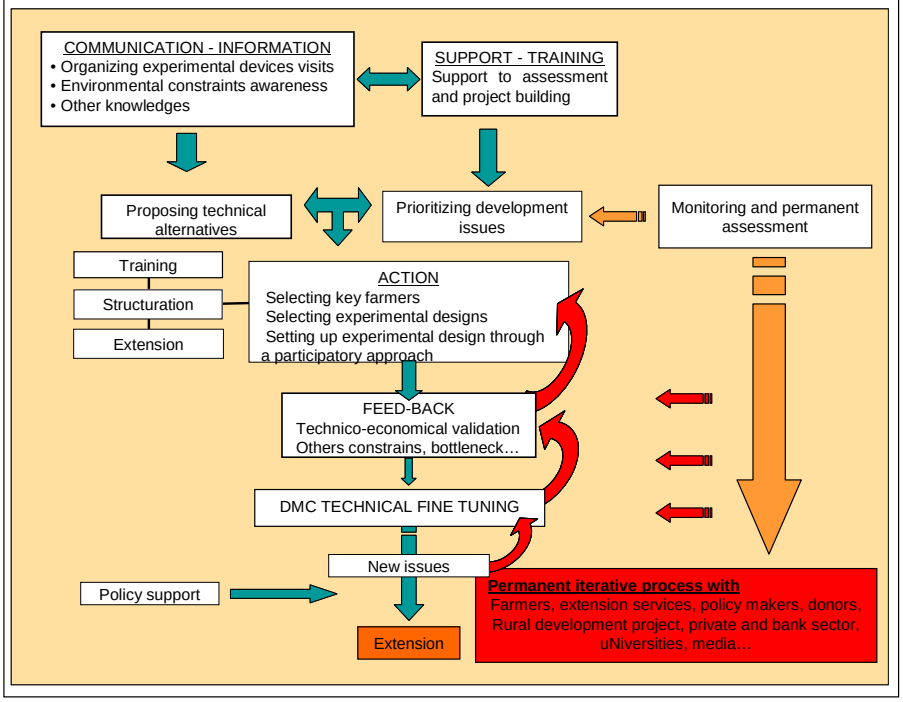
<u>To develop an integrating approach</u> that unites research, extension, training and all processes involved with creating a structure and taking policy and financial decisions from the very start of the project and throughout its cycle. This will require links with all actors in rural development: farmers, extension agents, trainers, researchers, the private and banking sectors, and political and financial decision makers.

The solution lies in an integrating and iterative process based on components designed to fulfil activities of Diagnosis, Set-up & Trials, Training, Monitoring & Evaluation, Creating Structures and Diffusion. Each participant will thus be somehow involved in every project activity. Such involvement is essential to the success of this global systemic solution.

The single most important objective in each component is the constant safeguarding of the human, economic, cultural, technical and natural environment.

For this reason the division of responsibilities between partners (PAFO, DAFEOs, the Nam Ngum project and PRONAE) is not based on different activity themes but rather on integration of these interdependent activities. Within each activity the division of tasks is based on scale. With regards to training for example, PRONAE will train a first group of extension agents who will then themselves train new extension agents (training of trainers) and farmers, thus ensuring up-scaling through a multiplication effect.

The iterative process of assessment – creation- Training - Extension



5.2. SPECIFIC OBJECTIVES

This activity plan involves four specific objectives:

- Structuring extension and development agencies, private operators, the banking sector and farmers through a programme to integrate the agricultural, social and economic environments in a sustainable dynamic;
- Capacity building to increase the independence of local institutions;
- Diffusion of production systems integrated and adapted to the agricultural situation and social conditions of every participant (improvement and diversification of revenue);
- Policy aid for programme adjustment.

5.3. GEOGRAPHIC DIMENSIONING

Selection of the areas for the development programme is governed by the current dynamics of the Nam Ngum project. The districts already selected are:

- Phoukhouth, Pek and Phaxay in Xieng Khouang province;
- Kasi, Vang Vieng, Hin Heup, Xaysomboun, Hom and Feuang in Vientiane province.

The terrain in these various districts includes contrasting situations of elevated plains (Xieng Khouang), areas of average height, high mountains and valleys. All the ethnic minorities present in the Nam Ngum basin will be involved.

Production systems on the whole show little diversity. In the mountains and on the high plains rainfed rice growing remains the basis of production systems. Household income also comes from raising cows, buffalo, small ruminants, pigs and poultry, together with gathering of NTPFs, which to many people are vital to income and food self-sufficiency.

However, following new market accessibility (along the Kasi-Vang Vieng-Hin Heup axis), new crops have appeared over the last five or six years. These are mainly horticultural - citrus fruit, pineapple and market gardening at the end of the rainy season, with cabbages, cucumber, garlic, and water melon on rice fields during the dry season. Overall they show little diversity and are conditioned by national and regional (Thailand) demand. The tendency is to turn diversified production systems into monocultures, which leads to dependence on markets and risk.

The four-year programme developed for 2007-2010 will be executed in two phases:

- Work in 2007 will enable seven of the nine districts (Phoukhouth, Pek, Phaxay, Kasi, Hin Heup, Xaysomboun, and Hom) to map out a full-scale extension programme beginning with the development of production systems adapted to the various ecologies and socio-economic situations encountered.

- From 2008-2010 such programmes will be operated in all nine districts.

5.4. CREATING AN ENABLING ENVIRONMENT

5.4.1. Institutional structuring

Building partnerships

This programming should make it possible to integrate the whole agro-ecology and SCV component within the programmes underway in these nine districts within the Nam Ngum project. NAFRI and PRONAE were requested to propose a partnership agreement for each province in order to strengthen capacity within district teams (DAFEO) as a continuation of actions in progress since 2003 in Xieng Khouang and Xayabury.

A partnership agreement already exists between PRONAE and the provincial departments of Agriculture and Forestry for Xieng Khouang and Xayabury and should soon be extended to the Vientiane province department. Within this framework the capacity should be present to mobilise the necessary funds from the Nam Ngum project to develop this support programme around agro-ecology and SCV.

Supporting programme coordination and execution teams with the DAFEOs

In 2007 this component is supposed to include the training of four DAFEO technicians from each district, to be supported by a technician trained within PRONAE over the last three years. They will undergo uninterrupted general training on the creation and development of these production systems (general agronomy, feasibility and know-how). They will be also be taught basic diagnosis, plus annual technical and financial programming methods for district and village level in order to assist with management of these programmes.

For the year 2007 PRONAE is committed to placing seven technicians, one for each district, to support these DAFEO agents. From 2008 and the integration of all the selected watersheds over ten districts, 16 PRONAE technicians could be placed in the two provinces of Xieng Khouang and Vientiane, or ten technicians could give direct support at the DAFO level.

In addition, a support team of six technicians (three per province) will be established to coordinate with the PAFOs on tasks such as supplies, credit and sales. This will be backstopped by provincial managers and the PRONAE technical assistants.

This programme will also be supported by the ***Sectoral Programme for Agro-Ecology (PROSA)*** in its work to strengthen the structure for training and communications in 2007 financed at ministry level by the French Development Agency.

5.4.2. Structuring farmers

The 'territory' approach helps village institutions with space management: land, infrastructure, area designation.

The territory approach focuses on the creation of farmers' groups for the following purposes:

- Analysing the short- and medium-term village strategy;
- Analysing needs relating to the chosen strategy;
- Defining a development programme within the community;
- Defining activities to be implemented within the community.
- Encouraging, from the beginning, the continuation of this development process with farmers, village heads, district and provincial agricultural services, and the banking and private sector after the end of the programme.

This framework seems essential to understanding the effects and impacts of the activities, and particularly to understanding the whole *problematique* at the village level. The provisional objectives and the technical dimensioning for the period 2007–2010 are as follows:

Table 11. Dimensioning of activities in Xieng Khouang and Vientiane, 2007–2010

Districts	2007				2008			
	Villages	Familles	Surfaces (ha)	Techniciens DAFEO	Villages	Familles	Surfaces (ha)	Techniciens DAFEO
Pek	12	260	260	7	30	1160	1160	7
Poukhouth	8	200	200	6	20	600	600	6
Paxay	5	100	100	4	15	400	400	6
Total Xieng Khouang	**25**	**560**	**560**	**17**	**65**	**2160**	**2160**	**19**
Kasi	4	32	32	4	15	300	300	6
Hinheup	5	40	40	4	15	300	300	6
Feuang	4	32	32	4	15	300	300	6
Xaysomboun	4	32	32	4	12	240	240	6
Hom	5	40	40	4	15	300	300	6
Phoukoun	0	0	0	0	5	100	100	4
Vangvieng	0	0	0	0	5	100	100	4
Total Vientiane	**22**	**176**	**176**	**20**	**82**	**1540**	**1540**	**38**
TOTAL	**47**	**736**	**736**	**37**	**147**	**3700**	**3700**	**57**

Districts	2009				2010			
	Villages	Familles	Surfaces (ha)	Techniciens DAFEO	Villages	Familles	Surfaces (ha)	Techniciens DAFEO
Pek	60	2960	2960	7	60	4760	4760	7
Poukhouth	35	1300	1300	6	35	2000	2000	6
Paxay	30	1000	1000	6	30	1600	1600	6
Total Xieng Khouang	**125**	**5260**	**5260**	**19**	**125**	**8360**	**8360**	**19**
Kasi	32	800	800	6	32	960	960	6
Hinheup	22	550	550	6	22	660	660	6
Feuang	35	875	875	6	35	1050	1050	6
Xaysomboun	22	550	550	6	22	660	660	6
Hom	25	625	625	6	25	750	750	6
Phoukoun	10	250	250	4	10	300	300	4
Vangvieng	10	250	250	4	10	300	300	4
Total Vientiane	**156**	**3650**	**3650**	**38**	**156**	**4380**	**4380**	**38**
TOTAL	**281**	**8910**	**8910**	**57**	**281**	**12740**	**12740**	**57**

According to plans, over the period 2007-2010 nearly 60% of the villages will be covered by Nam Ngum project financing, with an area of approximately 12,000 ha (Table 11). In 2007, 25 target villages in the three districts of Pek, Phoukhouth and Paxay (Xieng Khouang) will be covered (400-560 families). In the province of Vientiane 22 villages, or 176 families, are earmarked.

2007 is regarded as a probationary period in which the effects of the programme should go beyond the immediate earmarked areas and set up activities according to the specificities of the production major zones in each district. This will entail the technical teams immersing themselves in diagnosis work in order to focus efforts well, and to identify the constraints and potential for each following campaign.

Setting up farmer groups (production, credit, collection, supply)

The farmer groups approach will be used to facilitate regular technical support and exchange with families (creation of structures) concerning the production systems that will be developed. The approach must be flexible, evolving according to results and indicators, and able to structure and adapt groups of producers towards service activities (e.g. supply, credit, and collection).

Assisting management of subsidies

Support will be provided to help with management of subsidies as well as with the diversification of activities within village institutions and credit, collection and supply groups.

5.4.3. Structuring the banking sector

Support to setting up a savings and credit policy

Village Development Funds were included in the plans for the current Nam Ngum project. These consist of two components: a subsidy granted for village infrastructure and a micro-credit component to finance crop investments, current consumption and goods and equipment.

Rural credit services adapted to encourage sustainable production systems will unquestionably be a factor in determining the success of all activities proposed in this programme. On this subject, as of 2007 a number of uncertainties remain regarding the current project's capacity to attain the envisaged objectives. On the basis that these problems cannot be solved without definitive action, it is suggested that, if possible, a Nam Ngum project revolving fund should be set up and managed at PAFO level as a pilot programme. This would reveal the constraints and potential of credit operations and make it possible to outline a reorganisation of credit schemes in each province to work with the new VDFs and the national banking system.

Study should be made of how to involve the national banking system, together with farmer groups and private operators, in order to encourage development on a broad, equitable and sustainable scale. Such a move would also combat the high-interest loans with which private lenders are currently exploiting farmers and hindering rural development as a whole. Specific measures will be required; as discussed in the later section on *Assisting national debate and decision-making to support the planning of agro-environmental policies in relation to the banking sector and private operators.*

5.4.4. Structuring private operators and services

Support to credit operations

As with the approach developed in southern Xayabury province by PASS and PRONAE, private sector credit operations used in supplying inputs and collecting produce could be integrated into this programme if interest rates of not more than 1.5% per month are agreed.

Supporting supply, collection and processing operations

Market channels can be stimulated by building connections between private entrepreneurs at the local level and farmer groups. The production systems that will be proposed are all centred on broader diversification and better integration of the various system components. The role of private operators in the structuring and the consolidation of market channels will be crucial to extending the proposed systems on a broad scale. Of particular importance will be the development of multi-use species used in the construction of these systems. Research will also be required on the national and regional marketing of inputs (fertiliser, pesticides, and seeds) and specialised equipment (low-level mechanisation). This will entail complementary marketing studies.

The programme should be able to identify stable operators and to promote mutually fair contractual agreements for production and supply.

5.5. DESIGNING A RURAL DEVELOPMENT SCHEME BASED ON MANAGEMENT OF NATURAL CAPITAL

5.5.1. Assisting national debate and decision-making to support the planning of agro-environmental policies in relation to the banking sector and private operators

Consideration of agro-environmental measures

It is now essential that a structure within MAF, such as PROSA, is able to present to the decision-making authorities documented results from analyses of the impact and diagnosis of the agro-ecology/SCV programme. This would encourage redirection of funding towards development activities which best integrate environmental management in improving family incomes.

The most urgent measures to be adopted are:

- Introducing a taxation system for agro-industrial and mining projects to compensate for environmental damage. Funds raised through this would be reinjected into development activities through the PES scheme;
- Support to the conversion of conventional systems to systems based on agro-ecology and SCV by:

- Creating specific lines of credit which can be accessed by farmers (cropping and equipment credit), by private entrepreneurs and farmer groups through short-term loans for supply and collection, and through medium-term loans for produce storage and processing facilities;
- The establishment, according to the resources of the provinces and of the state, of PES schemes to encourage production systems which use agro-ecology and SCV at household level.

The agro-ecology and SCV programme could, through such credit schemes, guarantee its part in farming plans from the identification of needs through to the justifying results, and it will accompany private operators and farmer groups in these actions.

Designing credit schemes (identifying demand and developing procedures accordingly)

The support team and provincial services will need to take part, with PROSA support, in designing these credit schemes.

5.5.2. Agro-industrial projects, the mining sector and services

Identifying the environmental impacts of projects, the private sector, and the banking sector

With the development of agro industries, and the establishment of industrial projects and copper and gold mines in the provinces of Xieng Khouang and Vientiane (Phu Bia Mining Company), the environmental impacts of these innovations should be analysed so that MAF and local institutions (PAFO/DAFO) can design and position activities within these projects to prevent degradation of the natural environment (Picture 12).

Picture 12. Mining activities in Xaysomboun

Future mining activities around the provincial capital of Xieng Khouang (Phonsavanh) raise the problem, as in Xaysomboun, of environmental pollution of the hydrographic network of the city. It is to be hoped that all suitable environmental assessments have been conducted and mitigation measures integrated into mining activities.

Regarding the concessions granted to agro-industrial entities, it is essential that the agro-ecological and SCV approach is included within these projects right at the start in order to preserve the productivity of the environment, increase diversification and improve the incomes of farmers. It is recommended that in each district the already-identified programmes are discussed and that agro-ecology and SCV development methods are proposed, as this approach would enormously reduce the costs of introducing these crops for both entrepreneurs and farmers.

This agro-industrial development is likely to cause land problems but it is possible to work from the beginning to avoid environmental degradation, reduce investment costs, and

optimise income from the crops. With regards to the mines and hydroelectric dams, the irreversible damage which will result should be evaluated accurately. The current compensatory measures offered by NT2, NTPC, NN2 and Phu Bia appear derisory. These companies profit from international assistance agencies (World Bank, ADB, AFD, JICA, etc.), which paradoxically also finance sustainable development and environmental initiatives.

Positioning and building the agro-ecology-SCV approach in these projects and within village institutions

Starting with impact analyses and a baseline diagnosis to be conducted during 2007, the programme should quickly move to design cropping development systems for all these operators.

5.5.3. Complementary studies (land reallocation and displacement of villages and families from the Nam Ngum 2 reservoir)

For this specific programme it will be possible to create an operations diagram for the land, the production systems and the accompanying measurements required to ensure stable and sufficient incomes.

An environmental and social impact study will be required on the displacement of the villages and the 1,200 families of Feuang district who will have to make way for the Nam Ngum 2 reservoir.

5.5.4. Transfer of programmes to the public sector

Experience from the programmes in Xayabury and Xieng Khouang has shown that this integrated development approach takes at least three to four years to train the personnel of the PAFO/DAFO system in these dynamics until they can operate independently.

With this in mind, PRONAE team support to the provinces and the Nam Ngum project has been planned for four years, 2007-2010, in order to achieve an optimal programme transfer.

5.6. CAPACITY BUILDING THROUGH TRAINING

General context: it is suggested that an environment favourable to the diffusion of agro-ecological techniques be created by capacity building, through the training of rural development actors.

Objectives:

- Raising awareness, among all development actors, of the negative environmental impacts of conventional agriculture, the limitations it imposes on rural development, and the need for alternative techniques based on direct seeding and plant cover;

- Training for extension agents and farmers on the implementation of these agro-ecological techniques;
- Helping local institutions become independent in technical and financial programme management.

These involve six activities:

- ***Awareness*** (visits, field days, conferences, media) of environmental impacts and the need for alternative techniques.
- ***Short thematic training courses:*** These revolve around reinforcing basic knowledge on general agronomy for all technicians and extension agents working with development partner projects at previous PRONAE sites and in connection with PROSA. This stage is essential before long practical training courses on agro-ecology/SCV can be considered.
- ***Long practical training courses:*** Practical training will be arranged for all DAFEO technicians and extension agents with development partner projects. This practical training will take place at the district training and demonstration centres. Courses will run for a whole cropping season (at least seven months).
- ***Continuous training*** of all agents involved with these activities. This is combined with a permanent process of self-evaluation that allows real-time adjustment of the overall approach (technical, methodological and institutional).
- ***Capacity building on training methods for DAFEO technical teams.*** This involves the introduction of complementary knowledge, methodologies and tools (training supports) so that DAFEO technicians can build comprehensive and sustainable training courses for other extension agents and the farmers (diffusion of knowledge).
- ***Training in project management,*** on technical and financial planning, building relationships with development partners, and on monitoring-evaluation. This requires the transfer not only of technical results to local institutions but also of the methodology of establishing and managing an integrated project.

The short thematic training programmes will be designed to suit the general agronomy levels of the participants. This will entail offering a range of themes according to the knowledge levels of the participants. These themes will correspond to two levels of training:

- Practical training at each level: choice and use of seed material, cover crop management, careful use of inputs;
- Theoretical training on the foundations of general agronomy: various soil functions, plant nutrition, animal nutrition and health, the effects of farming, etc.

Particular emphasis will be laid on the need to develop the capacity for systematic analysis among participants, beginning with various concrete study subjects on diversified production systems and different development factors.

More theoretical subject matter, in particular soil functions dependent on physical, chemical and biological properties will be specially illustrated by field activities to learn about soil permeability and density, structural stability, root density, macrofauna, organic matter and so on. These field activities will be based on a series of simple experiments that each participant (including the farmers) will be able to reproduce within their host organisation (farmer groups, DAFO, development projects).

Various multi-media supports will be placed at the disposal of the agents at the end of training. They will thus be able to use both modern new information communications technologies (internet, CD-Roms etc.) and traditional supports accessible in the most isolated areas (illustrated technical cards, gazettes, illustrated guides etc). To accomplish this, existing capacities within NAFRI and NAFES will be fully exploited. For example, trainers will be able to use the richly illustrated documents published by NAFRI, NAFES and NUOL in 2005: *Improving Livelihoods in the Uplands of the Lao PDR*, *Volume 1: Initiatives and Approaches*, and *Volume 2: Options and Opportunities*.

The practical long-term training runs over an entire agricultural season, i.e. six to seven months. As far as possible, participants will follow the course through continuous application in the field. If agents are not always available for this, participation will be limited to the key agricultural phases: choice of cropping systems, field preparation, sowing, care of plants, harvest, establishment and management of cover crops.

These thematic and practical training courses, together with awareness-raising visits, could take place on three types of site:

- Previous PRONAE sites in Xayabury and Xieng Khouang, which already have all the technical and institutional assets of that project (four to six years of experience);
- The district training centres currently being set up. In these, practical training would also serve to set up useful trial plots;
- Existing facilities/centres of partners, in particular NAFRI and NAFES, but also the agricultural schools. For example, the complementarity of the NAFRI and NAFES facilities at Nabong (Vientiane) could be used by a nearby training centre which would benefit from their experimental devices for mechanisation, seed multiplication and post-harvest treatments, plus dormitories, meeting and teaching rooms, and simple laboratories.

Table 12. Training

	Beneficiaries	Sites	2007 (trial)	2008-2010	TOTAL
Short thematic training courses	Extension agents and farmers	Previous PRONAE and PROSA sites	20 agents per year + farmers	20 agents per year = 60 over the period + farmers	80 agents
Long practical training courses	Extension agents	District demonstration and training centres	4 agents for each of the 7 districts = 28 in total	2 agents per district each year = 60 over the period	88 agents
Training of trainers	Extension agents	District demonstration and training centres	3 per district = 21 in total	3 per district = 30 over the period	51 agents
Training in project management	Local officials at districts and village levels	Local institutions	Continuous autonomisation process		
Awareness raising	All actors	* Previous PRONAE and PROSA sites * District demonstration and training centres	Continuous awareness process		

6. DEVELOPMENT OF INTEGRATED PRODUCTION SYSTEMS

Agro-ecology and plant cover systems (SCV) are the unifying elements of this integrated and systemic approach, which essentially allows the regeneration of soil fertility that is indispensable for developing diversified systems that integrate annual and perennial crops with livestock systems: **conservation of the environment is the main objective**.

These two elements entail a range of activities that can be grouped into seven main themes:

- Institutional: planning, initiation, coordination and monitoring-evaluation of programmes;
- Accompanying research:
  - ✓ Improvement of production systems: transfer of appropriate technologies;
- Extension – technical support:
  - ✓ Improvement of forage resources and regeneration of degraded pastureland;
  - ✓ Diversification of systems production in mountainous agriculture areas integrating rainfed rice, maize, cassava and perennial crops in rotation with animal raising (agro-sylvo-pastoral systems);
  - ✓ Integration of crop and animal production systems (setting up fattening units for cattle, pigs and goats);
  - ✓ Agro-sylvo-pastoral systems: reforestation and introduction of trees into livestock and cropping systems;
  - ✓ Mechanisation of seeding and crop management (manual, mechanised and semi-mechanised),
- Continuous training of technicians and farmers;
- Environmental structures:
  - ✓ Development of credit procedures adapted to production systems;
  - ✓ Strengthening of seed and plant production systems;
  - ✓ Support to marketing of produce supply of inputs;
  - ✓ Building of relations between farmers and the private sector (traders, service providers);
- Communication and capitalisation,

- Planning (villages, districts, provinces) according to outside operators, development activities, and defining of local development policies.

6.1. METHODS OF INTERVENTION

The planning, management and coordination of the programmes based on agro-ecology and SCV will be conducted with backstopping from the Department of Agriculture and Forestry and the Nam Ngum project teams, with support from PROSA and PRONAE at national and provincial levels. The main objective is managerial independence for these programmes on a provincial scale (decentralisation).

The year 2007 will be regarded as a trial phase and a time to gauge the dimensions of interventions and means (target villages, pilot zones, identification of the production systems to be developed, organisation of credit, access to markets, independence of provincial services, PAFOs and DAFEOs etc).

An integrated approach will be developed; which can be separated as follows:

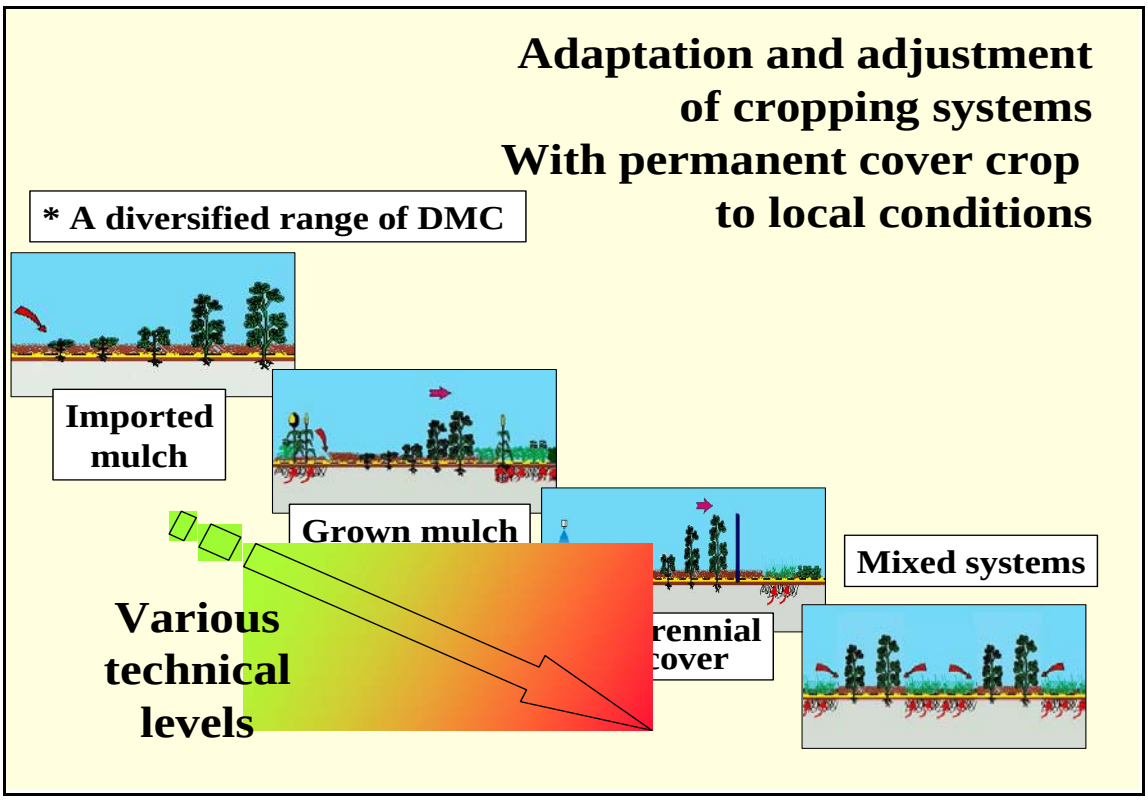
- Knowledge of the agricultural, economic and social environment;
- Accompanying research: demonstration centres - training covering a broad range of systems and simple technologies;
- Methodology of extension and development activities:
  - ✓ Setting up farmer groups;
  - ✓ Technical support to farmer groups to check new systems before transfer and extension
  - ✓ Territory approach, whereby the Nam Ngum project provides overall support to the community as a whole while paying special attention to the collective management of space and to all components of the production system (annual and perennial crops, livestock and management of space);
  - ✓ Farmer groups for extension of successful systems on a wider scale;
- Continuous training of various actors (farmers, extension agents, agronomists, traders and donors);
- Building on project success, starting with the production of various supports (technical files, articles, reports, posters, videos);
- Monitoring and evaluation of all programmes and budgets;
- Permanent assessment.

6.2. BASIC PRINCIPLES FOR ESTABLISHING DMC

The cover crops to be planted should be selected based on the ecological situation, with reference to the tests already carried out for each Variety. They must enhance and correct chemical soil functions.

The different types of DMC systems that can be developed in the Nam Ngum watershed are as follows:

- **Imported biomass**: soil mulching for intensive vegetable crop systems (dead mulch) grown in irrigated areas;
- **Biomass produced in crop rotations** and left to provide dead mulch for food cropping systems comprising cereals (rice and maize) or legumes (soybeans, beans);
- **Permanent living plant cover** for agro-forestry, fruits, perennial industrial crops, etc. The living plant cover can be used as animal feed after two or three years;
- **Contour strips of living cover** providing mulch for cultivated strips **for all types of crop.**



A. Chabanne

6.3. ESTABLISHING SYSTEMS: ACCOMPANYING RESEARCH (SET UP AND VALIDATION – TRAINING CENTRES)

It is envisaged that within each district, and in conjunction with the already identified Training Centres, teams will be established to focus on the set-up, training and validation of production systems and simple technologies (sowing density, variety choice, use of mineral and organic fertilisers and pesticides etc).

At these Training Centres a broad range of systems will be proposed to farmers to integrate annual and perennial crops, forestry, NTFPs and livestock. This broad range of options will allow farmers to adjust their systems in line with changing market demands (continual diversification and adjustment of systems).

One of the proposed district training centres should offer the broadest possible range of options in light of the fact that these centres will have to be meet all conditions right from the start, and in order to avoid expensive initial investment that would not be possible in all the districts. These centres will serve as a base for creating knowledge and for training, but they should also generate revenue by selling genetic materials (plant and animal) and/or through training people from outside the province.

These bases are essential within a dynamic of constant support to diffusion, where systems are designed to evolve alongside the market, and in line with agricultural constraints and developments. The extension of this research unit should be explored to provide development within each district backed up by technical support from NAFRI (decentralisation of research activities to local level). In this dynamic, based around agro-ecology and SCV, building relationships between the promoters and participants of the approach is essential due to the innovative and evolutionary character of the systems, and the need to unite and structure the activities as a whole: research and development; extension; financial support and credit; private operators; farmer groups; provincial planning; and support to decision-making regarding development assistance.

The systems and technologies on offer will be adjusted according to the situation in each district. The broadest range of systems should include the following basic proposals:

- Fruit crops (US$350 per hectare, 1 ha);
- Agro-sylvo-pastoral systems:
  - Improved pasture land with different forage species (4 ha at $255/ha);
  - DMC systems for annual crops (2 ha at $175/ha);
- Organic systems: (1 ha at $150/ha);
- Show room for species and varieties: (0.5 ha at $200/ha);
- Livestock (pigsty and breeders): ($3,570)
- Operating costs (materials, electricity): ($1,300).

It is suggested that an additional annual budget of $3,000 be provided to cover training and field days. From the PRONAE experience, such a budget would allow organisation of field days for 3,000 farmers.

An additional budget of $12,000 per province has also been envisaged for the "Seed Production and Nurseries" component.

6.3.1. Agro-sylvo-pastoral systems: improved pasture land with forage species and DMC systems for annual crops

Two main activities have been proposed:

- Evaluation of different forage species, seed and cuttings production;
- An animal fattening unit based on a complete programme (improved pasture, rationed in the dry season: tedding and ensilage, disease prevention, livestock buildings, etc).

Fodder range

The adaptability of various forage species has already been evaluated by PRONAE and other projects (CIAT-NAFRI, FSLP), and the most suitable of these will be promoted within the training centres. Priorities will include ensuring production of seeds for diffusion and allowing farmers to visualise how these species can be used (pasture, foddering, cover etc).

The forage species range will be made up of the following species: *Brachiaria ruziziensis, B decumbens, B brizantha, B hybrid* ('Mullato'), *Stylosanthes guianensis, Panicum maximum* and cane forages (e.g. *Saccharum, Pennisetum purpureum*). This collection will receive two or three different levels of mineral fertiliser treatment according to the morphopedological conditions. The ecological situation on the Plain of the Jars means that two levels will required (F1 and F2), as it is already known that it is not possible for these species to develop in this environment without mineral and/or organic fertilisers.

Table 13. Factors and variations for the forage species collection

Factors	Variations
Forage species	*Brachiaria ruziziensis, B. decumbens, B. brizantha, B. hybrid* ('Mullato'), *Stylosanthes guianensis, Panicum maximum* (1.2 ha) and cane forage (0.6 ha)
Fertiliser	F0 = without fertiliser F1 = 30N – 80 P_2O_5 – 60 K_2O (on seeds) + 30 N through two applications during the rainy season F2 = 30N – 160 P_2O_5 – 120 K_2O (on seeds) + 90 N through three applications during the rainy season

The phosphorous required by these species will be supplied through thermophosphate, the chemical composition of which is given in the table below.

Table 14. Mineral content of thermophosphate ($80-$100 per tonne). Analysis performed at CIRAD, France.

Element	Content	
	%	mg/kg^{-1}
SiO_2	27.76	
CaO	28.05	
MgO	21.43	
K_2O	0.63	
P_2O_5	15.45	
Mn		3744.60
S		1225.00
Zn		30.00
Cu		10.50
Mo		2.22
B		0.02

Fattening units (pasture with fodder complement); Improvement of manure (cattle pen dung) and transfer of fertility

A complete programme, including the following components, is planned:

- Improvement of animal health (prevention);
- Rotated pasture (management of load per hectare) and rationed feeding by season (tedding, ensilage);
- Supplementary feeds (salt and phosphate blocks) according to the environment (e.g. phosphorus deficiency on the Plain of the Jars);
- Improvement of stabling;
- Genetic improvement for careful intensification.

These components will begin with a fattening unit for young bull calves on rotated pastures (1.5 ha) in the rainy season with foddering in the dry season (tedding, ensilage). The procedure is based on agronomic and economic references tested by PRONAE over the last two years (Pictures 13, Appendix 6). *B ruziziensis* will be used to constitute this improved pasture. These plots will be direct seeded and receive the following mineral fertilisation: 60N - 80 P2O5 - 60 K2O. Six bull calves will be fattened over one complete year and their growth curves recorded.

Pictures 13. Improved pasture land, cattle fattening and seed production on the Plain of Jars – Xieng Khouang province

Production of additional fodder for the dry season will be accomplished by tedding of *Brachiaria* sp. plots at the end of the rainy season (September-October) and by ensilage of cane fodder (0.4 ha) grown in association with *S. guianensis* (a system featuring alternate strips of cane and *S. guianensis*). Specific equipment will have to be bought for this, such as haymakers for the ensilage, which will be carried out on flat ground without digging of pits. This 'foddering-ensilage' component will require an adaptive research stage to evaluate constraints and obtain the necessary agronomic and economic references before diffusion.

Improvement of animal housing follows the techniques developed PASS-PCADR for pigs. Local building materials are used with improved litter, based on a Korean technique composed of nine parts earth and ten parts rice husk filling 70-cm deep pits. The use of this type of natural litter improves animal comfort, and prevents excreta from leaking, thus ensuring maximum transfer of fertility when litter is renewed and transferred to crop fields.

This first stage (herd management, disease prevention, foddering, development of livestock housing) should be used as a vehicle for preliminary training of technicians and the stockbreeder farmers groups that will be established.

At the same time research should be continued into the use of certain species within the production systems (*Cajanus cajan*, *E coracana*, *Sorghum* sp.) that could be introduced into the dry season feed.

Small livestock

It is suggested that an improved pigsty (Pictures 14) be set up in one centre per district, based on the model developed by PASS-PCADR. The following components will form the approach:

- Animal health improvements (disease prevention);
- Balanced diet with vitamin and mineral supplements;
- Improved livestock housing using local materials and improved litter (mixture of rice husk + earth for better transfer of fertility) and a feed distribution system that limits losses;
- Genetic improvement for careful intensification.

The progenitors (Duroc, Landrace, Large white) will be introduced, with each unit (training centre) to receive one male and ten females. These animals and the required material (pipes for water supply) will be bought in Vientiane or Thailand. The centres will also need a hammer mill and the raw ingredients to make the feed (corn, protein, mineral and vitamin supplements), which will have to be organised before these units operating.

Pictures 14. Improved pigsty (animal health, feeding, housing, and genetic improvement)

In light of the agronomic and economic analyses conducted by PASS, it will be necessary to find a substitute for the protein source (bought in Thailand) using production residues or secondary species (e.g. *C. cajan*). Accordingly, the multi-functional species used to set up the

annual cropping systems will have to be integrated into the daily diet in order to get the most from the *in situ* production. The conditions for use of these species must nevertheless be subject to a trial stage that is set, as far as possible, according to the results from previous trials at regional and international level.

Picture 15. Association between Cassava and *Stylosanthes guianensis*

In many production zones cassava is an essential food crop for human and animal consumption. The conventional method of growing this crop will be improved by planting it in association with *S. guianensis* (Picture 15); it is suggested that stockbreeders start this at the same time as the fattening units. This simple system makes it possible to use the resources of each locality as needed. In addition to providing the food supplement (protein source + glucids), associating these activities also protects the soil throughout the cassava-growing cycle, thus reducing the time needed for field maintenance and fallow before rice can be grown on the plot again.

These breeding centres will be used as training bases for farmer groups that will be set up in 2007 on the following modules: animal housing, feed regimes, disease prevention and distribution systems. Piglets bred on these sites will be sold to the stockbreeders (credit in kind); the number of improved hogs is another essential matter to be addressed from the start of this activity, depending on the number of breeding units to be launched in 2007. A technical/economic assessment will be required on these breeding-fattening units in order to confirm the viability of this whole component.

6.3.2. DMC systems for annual crops

Experimental units representative of the bio-physical (integrating soil, slope and climate) and farming system diversities will be set up in order to test a large range of cropping systems and technologies. Soil and crop management, cultivars, other inputs (fertiliser and/or pesticide) and natural conditions are cross-linked to obtain a set of highly varied conditions (Séguy et al, 1998). Throughout the trials, permanent comparisons are made among traditional cropping systems, which remain the reference, and different levels of DMC system optimisation. In different experimental units, soil and crop management sets are conducted under varying levels of fertiliser in order to assess the evolution of the different systems under time.

Modification of land preparation and crop management

Iterative generation of DMC systems should be followed. The first step is based on modification of land preparation with crop and weed residue management. Cash crops like Job's tears and rice bean (*Vigna umbellata*) can be considered key crops for implementing this first level of DMC systems. These crops, with long-cycle durations, produce a large amount

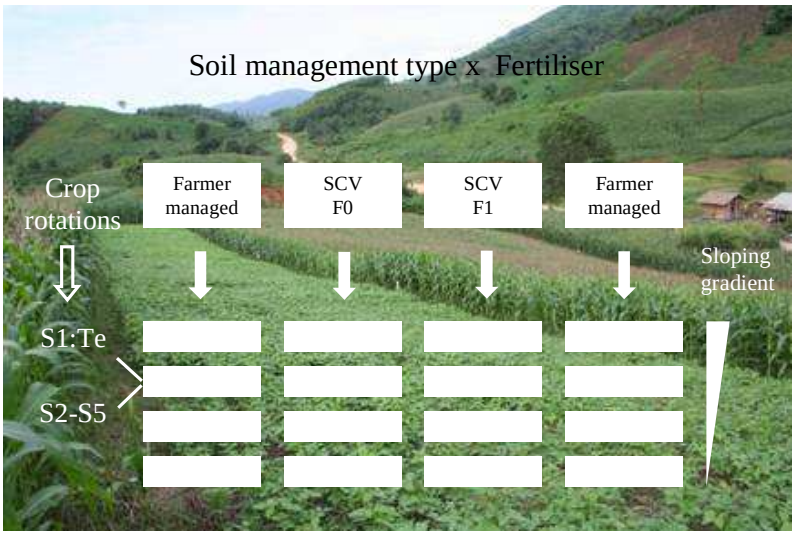
of dry matter (over 20 t.ha^{-1} for Job's tears) and degradation of these residues is relatively slow due to a high rate of lignin. This provides good soil protection, reducing evaporation, soil erosion and weed pressure. Moreover, the strong root system of Job's tears improves soil structure, making it a useful secondary crop. The second step integrates soil and crop management (association, rotation and/or annual crop sequence) in order to diversify production (grain production, rational use of forages by grazing and/or cut and carry), and so reduces agronomic, economic and climatic risks while optimising the main functions of DMC systems through adequate use of main and relay crops.

Use of cover crops

Many options are available when using additional crops (cover crops) but in the case of smallholders, who usually lack market access, an integrated cropping and livestock production system is more suitable. Many systems could be tested:

- Rotations with direct-seeded grain crops (maize, Job's tears) followed by forage production for grazing. Species like *Brachiaria ruziziensis* are sown at the first weeding stage by seed broadcasting in order to limit labour input. After two or three years, depending on the farmer's strategy, crops can be direct seeded on forage mulch.
- Grain production based on two crop sequences: a main short-cycle crop (e.g. peanuts, sesame, soybeans) followed by a relay crop for small animal feeding (sorghum, finger millet, winter oats in mountainous areas). The aim of this system is to use annual species which can produce grain and a large amount of dry matter at the end of the rainy season.

These annual cropping systems will be adjusted according to each major production area. The overall planning 'cropping systems' matrix is presented below (Picture 16):



Picture 16. Overall presentation of a 'cropping systems' matrix

The matrix is designed to show the agronomic potential of the cropping systems:

- Seed treatment (fungicides, insecticides);
- Risk management;
- Protection against

Kasi and Vang Vieng districts

For the districts where commercial agriculture is already well developed (Kasi and Vang Vieng) the first systems for 2007 will be based on the commercial crops already being grown

(corn, Job's tears) in association with multi-use species. It will then be necessary to develop alternative systems to increase diversity (crops and or integrated with livestock), enhance labour efficiency and reduce production costs.

For the Kasi and Vang Vieng district training centre a simple 'cropping systems' matrix will be proposed integrating various factors: i) Soil management method, ii) Crop management method, and ii) Fertiliser option.

Table 15. Factors and variations for a 'Cropping Systems' matrix

Factors	Variations
Method of soil management	1. Conventional (slash-and-burn, labour) 2. Direct seeding: - on crop residue - on dead cover crop (e.g. *Brachiaria ruziziensis*)
Rotation	1. Maize monoculture (comparison system) 2. Biennial rotation: maize – *Vigna umbellata* 3. Biennial rotation: maze in association with *B. ruziziensis–V. umbellata* 4. Biennial rotation: maze in association with *B. ruziziensis*–Soya/*Eleusine coracana* 5. Biennial rotation: Job's tears in association with *B. ruziziensis–V. umbellata*
Fertiliser	F0: control – no fertiliser F1: ▪ *For cereals*: F1 = 60 N – 60 P_2O_5 – 60 K_2O (on seeds) or 400 kg/ha of 15-15-15 ▪ *For legumes*: F1 = 22.5 N – 60 P_2O_5 – 60 K_2O or 250 kg of 9-24-24

Note:

- *Brachiaria ruziziensi*s associated with maize and Job's tears is planted according to the growth of the main crop. For example:
  - Association with maize: Ten days after seeding (DAS) with fertiliser and 15 DAS without fertiliser,
  - Association with Job's tears: 25-30 DAS with fertiliser and 35 DAS without fertiliser.
- *Eleusine coracana* will be planted in succession with soya to produce biomass at the end of the cycle, control weeds and yield grain for small livestock during the dry season.
- Mineral fertiliser use will adjusted according to soil conditions.

Pek, Phoukhouth and Phaxay districts – the Plain of Jars ecosystem

These ecosystems of peneplains at altitude are regarded as uncultivable with traditional agricultural means: these vast areas currently yield small amounts of arable crops and

livestock. Developing these areas constitutes a major challenge on a provincial scale; a significant increase in productivity and stability is required among the smallholder farmers while at the same time avoiding degradation of the natural resources (Séguy, 2004).

Establishing annual cropping systems for this ecology will require a first stage of soil regeneration starting from the use of plants that can tolerate the acidity, current low fertility and dryness of the land.

Regeneration of these soils through use of forage species would improve the physical (apparent density, permeability and aggregation) and biological parameters of the soils and quickly (within two to three years) improve fertility so that the land can be used for pasture or, in the medium term, returned to crops (Séguy and Chabanne, 2004). For these sites it is therefore suggested that in association with the livestock systems (raising large ruminants and other small animals), multi-use species be established in 2007 in order to create annual cropping systems from 2008 on. Development of these systems will require several initiatives, notably:

- The addition of phosphorous fertilisers (thermophosphate and/or dolomitic limestone).
- Balancing of micro elements, particularly zinc, manganese and boron.

It will thus be necessary to conduct sets of tests (dolomitic limestone + simple source of phosphorus, and various micro elements) and to evaluate the agronomic and economic results. This evaluation will be undertaken by PRONAE over the next few seasons: a continued relationship with this organisation is essential to developing viable long-term systems for the extension services.

Pictures 17. Direct seeding of rice on different cover crops (a: *B. ruziziensis*, b: *C. cajan* + *B. ruziziensis*, c: *Stylosanthes guianensis*). Plain of Jars, Xieng Khouang

Table 16. Factors and variations from a 'Cropping Systems' matrix –Plain of Jars ecology

Factors	Variations
Soil management method	1. Direct seeding on natural pasture (*Themeda* sp., *Cymbopogon nardus*, *Hypparenhia* sp.)
	Year 2007: S1 = Seeding an association of *E. coracana* + *Cajanus cajan* S2 = Seeding *S. guianensis* S3 = Simultaneous seeding of rice + *B. ruziziensis* Year 2008: S1.1 = Direct seeding of rice in association with *B. ruziziensis* S1.2 = Direct seeding of rice in association with *S. guianensis* S2 = Plot of S. guianensis (regeneration phase) S3 = Pasture of *B. ruziziensis* (integration with livestock)
Rotation	Year 2009: S1.1 = Direct seeding of soya on *B. ruziziensis* mulch S1.2 = Direct seeding of soya on *S. guianensis* mulch S2 = Direct seeding of rice on *S. guianensis* + *B. ruziziensis* mulch S3 = Direct seeding of rice on *B. ruziziensis* Year 2010: S1.1 = Direct seeding of maize + [*B. ruziziensis* + *C. cajan*] S1.2 = Direct seeding of maize + *B. ruziziensis* S2 = Direct seeding of soya on *B. ruziziensis* mulch S3 = Direct seeding of soya
Fertiliser	▪ F1:*For rice and cereals*: F1 = 60 N – 80 P_2O_5 – 60 K_2O ▪ *For legumes*: F1 = 25 N – 80 P_2O_5 – 60 K_2O F2: ▪ *For cereals*: F1 = 90 N – 160 P_2O_5 – 120 K_2O *For legumes*: F1 = 25 N – 160 P_2O_5 – 120 K_2O

6.3.3. Perennial crops

Fruit trees

The introduction of fruit trees has already been partly carried out by the Nam Ngum project. This should be continued with planting of a range of fruit trees at the training centres so that the adaptability of different species can be evaluated and so that there are nurseries for distributing seedlings to farmers.

Before the start of this activity tests should be conducted on various local Xieng Khouang species (e.g. peach, apricot) and introduced species (from Vietnam by the Horticulture division of NAFRI at Haddokeo over the last few years).

Various details will have to be developed and this process can serve as training for DAFEO technicians and farmers. These details include:

- Planting and grafting techniques;
- Fertilisation plans (mineral, organic);
- Size.

The following species will be introduced, in accordance with variations in ecology and area:

Table 17. Species and planting density

Species	Planting density	
	plants/ha	Spacing (m x m)
Peach	420	8x3
Plum		
Nashi pear		
Guava		
Mango	210	8x6
Avocado	125	8x10
Sweet chestnut*	125	8x10

*The Plain of Jars is an excellent environment for chestnuts, which could be developed for human and animal food.

Trees - perennial multi-usage species

Restoring the fertility of the highlands on the Plain of Jars through planting of improved pastures and SCV will render the land valuable once more and make land allocation possible. This will result in increased land and labour productivity and will have positive economic, social and environmental consequences. In this context there will be potential for land management and reforestation programmes, which would enable diversification (firewood, fruit trees and so on) and protection (natural filtration) of the agricultural environment.

Picture 18. Living fence with *Acacia mangium*

There is thus a need to look at introducing perennial multi-usage species (*Acacia mangium*, *A. auriculiformis*, *Calliandra calothyrsus*, *Erythrine* sp., *Jatropha curcas*) as 'living fences' (Picture 18) around fields (improved pastures and annual crops). Seedbeds will be established in the Training Centres and in villages where farmer and/or stockbreeder groups have been set up. The seedlings will be given to the farmers (PES) to plant around their fields.

With the forage species production units already established on the Plain of Jars, it can be noted that common management of the land is in full swing. The discontinuation of using fire in these areas has allowed native species to regenerate, so that trees can now be protected and integrated into these systems. This was previously impossible.

6.3.4. Species range (showroom)

As mentioned in the introduction to this chapter, these Training Centres should present the broadest possible range of systems and thematic adjustments.

Evaluation of varieties is carried out annually by PRONAE, and this work does not need duplicating but the Training Centres should grow a diversified range of annual food species:

- Cereals: rice, maize, Job's tears, sorghum, finger millet, millet;
- Beans: soya, rice bean, mung bean (*V. radiata*), cowpea (*V. unguiculata*).

In time, these centres will have to manage seed-supply contracts with farmers to ensure sufficient seed production over the first stages of diffusion.

6.4. DIFFUSION OF INTEGRATED PRODUCTION SYSTEMS: ARABLE CROPS-LIVESTOCK-PERENNIAL CROPS

The main integrating element during the first season will be the introduction of forage species (e.g. *Brachiaria* sp., *S. guianensis*) which allow:

- Low-cost restoration of the physical, chemical and biological fertility of the soil;
- Cessation of fire-setting (protection of soils and watersheds), which allows development of reforestation schemes integrated with cropping and livestock systems;
- Land development, starting from use of forage species (concession and development of authorised investment: perennial crops, improved pastures etc.);
- Provision of simple systems that can be used by as many people as possible. The introduction of these systems will itself constitute a stage of SCV initiation and training for farmers and extension agents;
- Broad scope for diversification in the second phase through integration of annual and perennial cropping systems with direct seeding on these multi-use species;
- Land security and improved incomes;
- Production of forage seeds with a view to expansion of these systems.

6.4.1. Livestock systems – general principles

A major part of household incomes is derived, in all the production areas, from livestock breeding (large ruminants, pigs and poultry). It will be thus necessary, through the livestock units that will be set up in the training centres (fattening units for large ruminants and pigs, reproduction centres), to set up a programme that can help farmers develop these activities. Accompanying measures such as animal houses, water distribution, veterinary care and feed regime must be considered.

On top of these traditional systems and a baseline needs assessment, more intensive systems could be set up in line with the strategies and means of farmers (labour force, income, land resources, etc.). These systems will require substantial intensification and technical input. They will be integrated into family farming through:

- Transfer of fertility to fields;
- Development of arable production (fodder and grains);
- Development of by-products (e.g. rice bran);
- Work power (draught animals);
- Improved savings and assets (immediate sources of income);
- Diversification of diet (source of protein, calcium and vitamins).

6.4.2. Large ruminants

General context

The 'raising of large ruminants' component should receive as much emphasis as possible on account of the beneficial effects of fertility transfer, draught power and savings capacity. However, this will require intensification of fodder production, which will take time given the general strategy of conservative use of resources. It should nevertheless be stressed that national and regional demand for meat is growing rapidly, with Xieng Khouang province enjoying regular sales to Vietnam. The strategy developed by the FSLP project in Xieng Khouang (NAFRI-CIAT) has enabled stockbreeders to move towards short-term fattening systems with a fast and profitable return on investment.

The financing of these new systems (rotational pasture and seasonally-controlled feed) could to some extent be initially covered by the sale of those cows and animals which will not be productive on improved pastures. To this end, analysis and advice should be carried out and given as fast as possible by DAFEO technicians in each district, in order to build a clear idea of the following:

- A detailed inventory of the cattle;
- Sanitation situation;
- Impact of herd reduction on family economies;
- Strategies for cattle farmers in their new conditions.

Objectives

Two main objectives have been defined:

- To develop activities vital to the regeneration of soil fertility (physical, chemical and biological), which is a prerequisite for the development of annual cropping systems;
- To intensify this component and develop local strategies to meet national and regional market demand, in order to generate regular income.

Intensification of this component is desirable, in particular for:

- Planting method and management of improved pastures;
- Veterinary care, vaccinations;
- Herd control;
- Genetic improvement;
- Feed supplements;
- Improvement of livestock sheds and buildings;
- Quality and distribution of water;
- Transfer of fertility.

Procedure by production zone

This component will need developing according to the specific resources available in each production zone. These resources include credit from the Nam Ngum project or banking sector, the financial capacities of the farmers, and the morphopedologic characteristics of the zones.

Case study: the Plain of Jars ecology

On the Plain of Jars, the establishment of improved pastures and fattening units will require the completion of many steps, notably:

- Credit support to farmer groups and farmer investment to build fences with local materials;
- Use of specialised equipment for sowing (seeder for direct seeding with cultivator or tractor) in light of the initial level of soil compaction;
- Access to inputs, particularly fertiliser (thermophosphate and mineral fertilisers) and weedkillers;
- Purchase of seed production from farmers, essential for repayment of loans;
- Technical support provided for herd and pasture management (load per hectare, fertility management);
- Prevention of grazing on plots during the first year in order to ensure optimal establishment of forage crops and seed production.

The establishment of improved pastures (inputs, farming operations) will require credit support (Table 19) plus an initial contribution from the farmers. For the first year in-kind credit should be granted by the Nam Ngum project, pending the creation of credit schemes and management procedures. Loans should not be granted to finance the erection of metal fences, as these induce crippling costs and do not provide a fast return on investment.

If the various points presented above are all fulfilled it will be possible to ensure income for farmers from 2007 on, through the production of forage seeds. These will be repurchased by the projects or private operators to be planted from 2008.

Fattening units will be open from 2008 and will use the fodder grown on the newly-established pieces. Depending on the resources that become available , it should be possible to start development of these systems on 1.0 ha per family in 2007 in all three project districts (Pek, Phoukhouth and Phaxay) in Xieng Khouang, that is to say on 400-560 ha.

Various alternatives have been described based on use of seeding and pulverising equipment for reparation of the plots. Details of these options are given in the following table.

Table 18. Details of technical options for improved pastureland

Option	Seeder	Pulveriser	Cost (US$/ha)
1	7 lines - Vence Tudo brand	300 l carried	45
2	2 lines for Fitarelli motocultivator	200 l drawn	30
3	1 line for motocultivator	20 l pulled	15

The maximum overall cost for planting a hectare of improved pasture is $340, including the cost of using specialised equipment for preparation and seeding, and assuming the farmer has

agreed to some investment (Table 19, option 1). These costs could be readjusted according to the actual price of supplying inputs (thermophosphate + mineral fertiliser) and according to the price of the forage seeds that will be given to the farmers.

Table 19. Funding plan for planting one hectare of improved pasture

Heading	With use of equipments		
	N°1	N°2	N°3
1- Farmers			
Fencing	60	60	60
Living fence	15	15	15
Sub total farmers	***75***	***75***	***75***
2- VDF			
Inputs	210	210	210
Sub total Credit	***210***	***210***	***210***
3- Grant of GoL			
Cultural operations	45	30	15
Reforestation	10	10	10
Sub total Grant	***55***	***40***	***25***
TOTAL (per ha)	**340**	**325**	**310**

Family labour to put up the fences ($60/ha) and plant trees ($15/ha) is included in this calculation and is regarded as an agreed investment on behalf of the farmers. Repayment of loans will from the first year be underwritten by the production and sale of forage seeds (*B ruziziensis*). The minimum yield of *B ruziziensis* will be 120 kg/ha in the first year.

Other districts

In the other districts the costs of planting improved pastures could be reduced according to the use of sowing and land preparation equipment and the application of fertilisers. These will depend on the initial condition of the land.

It should nevertheless be underlined, in view of the evaluation carried out during the mission, that the improvement of soil fertility achieved by PRONAE in Xieng Khouang (in terms of acidity, and phosphorus, calcium and magnesium deficiency) should be reachable in the various zones visited, in the districts of Xaysomboun, Hom and in parts of Hin Heup and Feuang. Judging from this experience, and from the systems developed so far by PRONAE on these morphopedologic units, it will this year be necessary to use mineral fertilisers, especially thermophosphates, on many of the plots. This would make it possible to adapt carefully planned fertiliser regimes according to the various different ecosystems.

General remarks

In the various areas, seed production contracts will have to be drawn up between the farmers, the Nam Ngum project and any private entrepreneurs who commit to purchasing the seeds at the rate of $1.5/kg. At village level, local institutions will need to approve procedures for setting up credit facilities and for engaging the community and farmers in reforestation operations. With national banking interest rates at 18% per annum, or 1.5% per month, it is recommended that a rate of 12% per annum be set; the 6% difference can be regarded as the GoL contribution to Payment for Environmental Services (PES). Based on a repayment

schedule of nine months, the PES on a loan for the establishment of one hectare of improved pasture would be $9.45.

The introduction of wood species to coppice the plots can be supplied by village nurseries. These will be started this year so that they can begin supplying the materials for this activity in 2008.

It will be necessary to work on the logistical organisation for this year, in particular:

- The supply of inputs from Vietnam and Vientiane;
- Stocking of inputs in villages and distribution;
- Management and geographical distribution of equipment across the zones.

The total amount needed to set up these groups in Xieng Khouang and Vientiane provinces can be broken down as follows:

- Seasonal loans in kind, at a maximum of $149,100 (710 ha) for the two provinces
- Assumption of responsibility for farming operations by the Nam Ngum project as PES: $14,200 or $20/ha;
- Assumption of responsibility for reforestation (CBIF of the VDF) as PES: $7,100 or $10/ha.

The total PES contribution of the Lao government will be $39.45/ha.

6.4.3. Small livestock – pigs

General context

Semi-intensive breeding tends to be concentrated around the main district and provincial towns but in some districts local supply lags far behind market demand. For example, improved breeds of pig (Duroc or Large White) are regularly bought in Vientiane (in batches of 20) and sold at Xaysomboun market.

General livestock conditions need improving (buildings, water supply, litter, etc) as a precondition to the technical support that will be offered.

Objective

The first objective is intensification of production and the creation of specialist groups of breeders and breeder-fatteners. This intensification will run through the following stages:

- Veterinary care, vaccinations;
- Genetic improvement;
- Feed supplementation;
- Improvement of livestock sheds and buildings;
- Quality and distribution of water;
- Control of the animals.

Procedure

It is suggested that two groups be set up in each province in 2007 (ten stockbreeders per group) and that credit be made available to provide:

- Four piglets per stockbreeder, supplied by the reproduction centres set up at training centre level;
- A hammer mill for each group plus other specific equipment (pipette for water supply);
- Vitamin and mineral supplements and drugs necessary for preventative health care.

Supply and distribution of the protein and vitamin-mineral supplements will first have to be organised by the Nam Ngum project and then transferred to traders and farmers. On the basis of the initial survey, support to these groups will initially be concentrated around the main towns, markets and areas where pig breeding is already widespread. Vitamin-mineral supply will have to be sourced from Vietnam.

It is suggested, as has been proposed for the training centres, that a certain number of forage species (e.g. *E. coracana*, forage canes, *C. cajan*) be made available to the stockbreeders. These could be introduced into the feed regiment as a partial or total substitution for imported protein sources or in addition to the feed used in conventional systems. The conventional cassava system could also be enriched by the addition of *S. guianensis*.

An economic assessment will have to be carried out for all these fattening units. Such an assessment would provide evaluation and cross-checking of the technical and economic performance of this programme before it is expanded to a large scale.

A study will be required on the possibilities of marketing of improved pig breeds by seeking better prices for higher quality (carcass weight and fat percentage).

The budget required for this activity for 2007 totals $12,000 for Xieng Khouang and Vientiane provinces.

These activities could be extended to poultry and goat raising during 2008.

6.4.4. Annual cropping systems

General principles

Irrespective of the production area, the first stage of setting up these systems must be based on protection of the soil and improvement of fertility in the broadest sense. The methods for establishing these systems can vary according to the initial situation. Three main situations that are representative of all the areas can be identified:

- The Plain of Jars ecosystem;
- Commercial agriculture with strong production potential in the karstic districts of Vang Vieng and Kasi, and in the ‘fragile’ district of Hin Heup (mudstone and shale);
- ‘Mountain’ agriculture where the traditional rotational slash-and-burn and fallow system prevails.

The following systems were designed with reference to the morphopedologic conditions and specific current dynamics of each area.

Ecology of the Plain of Jars

This peneplain has considerable potential for growing rainfed rice and for livestock breeding in the three districts of Pek, Phaxay and Phoukhout. Many rice fields have been set up but the costs of creating and maintaining them are often very high, while at the same time poor water control and substrata with low fertility mean that yields are limited. Using a multi-purpose rice from existing genetic resources (a selection programme by Séguy, Bouzinac, Taillebois & Vales) and techniques of sowing on top of plant cover, it is now possible to develop rainfed rice growing systems that are just as productive as those used in the lowlands, but more economical in terms of water and labour use and are more diversified. It remains a major challenge to demonstrate that such rice production can evolve from the costly systems currently in use and take off in this vast area devoid of any grain crops (Séguy, 2004).

Objective

In addition to the establishment of forage species, which constitutes an essential stage in the regeneration of these plots, fields will be planted with multi-use species such as *E. coracana* + *C. cajan* and *S. guianensis*. These species allow soil regeneration at low costs within an SCV dynamic. It is anticipated that these direct seeding systems can begin for rainfed rice crops in 2008, and conventional rice fields will not be used.

Procedure

This activity is planned for an area of 5 ha per village, to be financed by the Nam Ngum project in 2007 as PSE, at a total of $36,250 for Xieng Khouang and Vientiane provinces.

In 2008 farmers should benefit from technical support and credit in initiating these systems.

Table 20. Annual cropping systems with use of multipurpose species – Plain of Jars ecology

Factors	Variations
Plot preparation – 2007	Direct seeding on natural pasture (*Themeda* sp., *Cymbopogon nardus*, *Hypparenhia* sp.)
Rotation	Year 2007: S1 = Seeding of *E. coracana* + *Cajanus cajan* in association S2 = Seeding of *S. guianensis* Year 2008: S1.1 = Direct seeding of rice in association with *B. ruziziensis* S1.2 = Direct seeding of rice in association with *S. guianensis* S2 = *S. guianensis* plot (regeneration phase) Year 2009: S1.1 = Direct seeding of soya on *B. ruziziensis* mulch S1.2 = Direct seeding of soya on *S. guianensis* mulch S2 = Direct seeding of rice on *S. guianensis* + *B. ruziziensis* mulch Year 2010: S1.1 = Direct seeding of maize + [*B. ruziziensis* + *C. cajan*] S1.2 = Direct seeding of maize + *B. ruziziensis* S2 = Direct seeding of soya on *B. ruziziensis* mulch
Fertiliser	▪ *For rice and cereals:* F1 = 60 N – 80 P_2O_5 – 60 K_2O ▪ *For legumes*: F1 = 25 N – 80 P_2O_5 – 60 K_2O

Commercial agriculture – Kasi, Vang Vieng and Hin Heup districts

Simple first systems can be proposed based on the commercial crops present in these areas and the experience developed in southern Xayabury province by PRONAE and PASS (see appendix 7). Farmer groups should be set up with a minimum of six families per group. This method encourages exchanges between farmers and between groups and enables group farming operations.

Objective

To develop productive systems on diversified plant cover crops that also preserve soil resources.

Procedure

These groups will need access to credit to finance these crops ($80/ha) and the Nam Ngum project should provide access to inputs (seeds, pesticides, fertiliser) and arrange this with traders at the local level. Agricultural equipment - seeders and pulverisers - will be made available to the farmer groups, which should be fully responsible for its management and use. This equipment therefore needs to be purchased and can then be rented to other farmers.

An iterative process should be retained with these groups, with a first stage based on modifying the method of plot preparation, in particular with regard to dealing with the residues of the previous crop. Job's tears, common in Vang Vieng district, is an interesting crop for starting this type of system due to its high production of biomass above and within the ground.

Judging from the experience in Xayabury, it is essential from the start to integrate these systems in rotation with legumes and other species that will strengthen production of biomass and limit weed growth. The following systems will be proposed to the groups:

2007: Maize + *B. ruziziensis* (soil protection and diversification) - 2008: Soya + *E. coracana* or long-cycle *Vigna* sp;

2007: Job's tears + *B. ruziziensis* (soil protection and diversification) - 2008: Soya + *E. coracana* or long-cycle *Vigna* sp.

F	M	A	M	J	J	A	S	O	N	D	J

2007 Maize + [*B. ruziziensis* + *C. cajan*] ⟶ Pasture – Rationale use of forages

2008 *Vigna* sp. direct seeding on [*B. ruziziensis* + *C. cajan*] mulch

In Hin Heup district, where the soils on mudstone and shale are more susceptible to erosion, systems with strong biomass production should be found to maximise the benefits of these crop rotations and cover plants from the beginning (soil protection, weed control, overall improvement of fertility).

Assuming six groups per district, the total credit required to conduct this type of activity amounts to $8,640 ($80/ha for 18 groups of six farmers).

Mountain agriculture

General context - principle of selective and conservational clearance for rainfed rice cultivation

In mountain fields the traditional system is based on slash-and-burn farming in rotation with forest fallows of varying duration. These environments are now under pressure from increasing population, from land allocation that is often restrictive, and from resultant stress caused by reduction in fallow times to levels that do not allow the renewal of natural fertility.

The proposals given hereafter refer to various components of the production system and are thus much broader than for a single annual crop system.

Objective

To stabilise and diversify the traditional slash-and-burn system and to gradually develop SCV with integrated annual and perennial crops and livestock.

Procedure

The first priority is to stabilise this system, diversify it and retain the productive potential of these environments. Thus any plot to be used for crops should be cleared according to the following procedure:

- Exploitation of valuable wood species;
- Clearance of vegetation while preserving the young trees of valuable species;
- Creation of contour hedgerows with material from the clearance (the largest pieces can be used either for fuelwood or fence posts to enclose the plots);
- Control of regrowth and weeds either through a controlled fire (after clearance and hedge-making with preservation of certain species) or by use of herbicide just before sowing of the crops;
- Application of mineral and organic fertilisers immediately after the simultaneous sowing of the crop species (rice and fodder);
- Progressive coppicing along the hedge-rows and fences using versatile species that can be used for feeding small animals or large ruminants.

The second issue concerns decreasing the fallow cycle while at the same time improving the fallow content by planting fallow species in crop fields (rainfed rice) at the end of the cycle (return to fallow). Short duration forest fallows, which are not very productive, can thus be replaced by species with direct value (for feeding large and small animals) and which also restore fertility in a very short time (three years) while providing optimal control of weeds. These improved fallows will be mainly composed of *Brachiaria* sp. and *S. guianensis*, which are sown in rainfed rice plots at the end of cycle (at the time of the last clearance) in order to ensure a return to cropping after two or three years. *S. guianensis* has the advantage of being controllable just by cutting, without the use of herbicides (organic system).

In view of the importance of the large ruminant breeding system (transfer of fertility, asset savings, draught power), the first activities should be focused on this component, which can be quickly improved by integrating the various points already described in the “Large

Ruminants" section above. The communities in these areas often possess common pasturelands that can facilitate and help optimise this component.

SCV will be also proposed for the other annual crops found in these areas, especially maize and soya. As presented in the "Small Livestock" section, it can also be used to enrich conventional cassava systems with *S. guianensis* in order to increase diversification and generate additional resources.

Perennial cropping systems

General context

Particular attention must be paid to the perennial crops being encouraged by agri-business in many districts of these two provinces, notably rubber (Pictures 19), *Jatropha curcas* (for biofuel) and *mai khetsana* or agarwood (for essential oil).

Pictures 19. Rubber plantations in Hom and Hinheup districts (Vientiane province)

Objective

This activity should focus on two main objectives:

- Preserving the production potential of the environment;
- Developing SCV to integrate these crops and promote diversity.

Procedure

Regarding rubber, various points should be borne in mind:

- Plot preparation must use soil conservation techniques without the mechanical preparation and/or creation of mini terraces observed in Hin Heup and Hom districts. This plantation method is very expensive and the results do not justify it;
- Certification of plants which are sold or made available to farmers;
- Diversification of this system in order to limit the length of the unproductive period (six to seven years) before the first tapping can occur;
- Protection of soil and reduction of weeding time while inter-planting lines of tropical forage legumes that can generate additional income through sale of seeds and use as pig feed. Growing forage seeds in these plantations will make it possible to pay off the establishment costs and generate additional income within the first five years, will add

to the diffusion process (local and national), and will leave the soil intact so that if these plantations fail the land can be reconverted to annual cropping systems.

For the field hedgerows and coppices (for annual crops and improved pastures) *Jatropha curcas* or many others species presented in the section on "Trees and Multi-Usage Species" can be used. The Nam Ngum project needs to carry out a rapid assessment of this topic and work with the private sector and farmer groups to obtain plant material with the necessary characteristics. The introduction of fruit-bearing species could initially be made in gardens around and in the villages.

6.5. CREATING A SUPPORTING ENVIRONMENT FOR SUPPLY AND SALES NETWORKS (FOR INPUTS AND AGRICULTURAL MACHINERY)

This component is essential to ensuring effective development structured around existing supply and demand at the national and regional level. The Nam Ngum project should create a team that can initially ensure the supply of inputs and specialised equipment. It will later need to build relationships with the banking sector, private companies and rural communities in order to find an outlet for production and to transfer supply and collection activities to the private sector.

Significant support must be provided to introduce agricultural equipment, inputs and plant materials to the farmer groups. These will specifically include:

- Hay makers, a cassava rasper, and a hammer mill for feed making
- Seeders and pulverisers
- Vitamin-mineral supplements, vaccines and other drugs, and a protein source for pigs
- Genetic materials:
  - Animal: breeding pigs;
  - Vegetable: *Jatropha curcas*, *Acacia* sp. *Calliandra* sp., *Flemingia* and other timber species as well as annual multi-use species: sorghum, finger millet, *Cajanus cajan*, *Vigna* sp., soya etc.

This team will work with the Nam Ngum project coordination unit at the provincial level and with PAFO and DAFO. It will be made up of DAFEO technicians and PRONAE contract employees. The team will also work with the farmer groups to design and organise credit procedures.

7. MONITORING & EVALUATION

The creation of a monitoring and evaluation unit is envisaged for each province, attached to the coordination-support unit. This team will be led by a PAFO agent who will work closely with the coordination-support team.

The objectives will be:

- Monitoring of the running of development and programme structures;
- Budget monitoring;
- Monitoring of the agro-socio-economic and environmental impacts of the proposed production systems;
- Development of monitoring and evaluation supports;
- Participation in the identification of specific studies;
- Recruitment of students to undertake complementary research;
- Submission of monitoring and evaluation reports and contribution to periodic management reports.

This should allow the PAFO services to:

- Set up real-time technical and financial management of the programmes;
- Supervise activities and check innovations;
- Capitalise on lessons learned;
- Communicate with all development partners: farmers, village organisations, technical development agents, project management, donors and the government.

The logical framework matrix below provides indicators for all activities. From the beginning of activities in 2007, and in line with any adjustments that may be necessary, the Monitoring & Evaluation unit will provide indicators of results from the support documents in each district.

Results related to the diffusion objective have already been presented in Table 11, section 5.4.2. These constitute a part of the anticipated quantitative result indicators. They are to be supplemented by qualitative indicators which must be wholly identified during the set-up phase of the programme.

8. PROGRAMME LOGFRAME

GENERAL OBJECTIVES	SPECIFIC OBJECTIVES	ACTIVITIES
Sustainable Agriculture: • Social • Economy • Environment • Ethic Protection of watersheds	Structuring extension and development agencies, des private operators, the banking sector and farmers through a programme integrating environmental, social and economic farming in a sustainable dynamic	**<u>1. Creating an Enabling Environment</u>** ***Institutional Environment*** • Build a partnership with Nam Ngum, PAFO, DAFO, and village authorities and structures, • Support to the pilot team within PAFOs (programme management). ***Farmer Environment*** • 'Territory' approach, helping village institutions with spatial management (land, infrastructure, etc), • Creating farmer groups (production, credit, collection, supply), • Support to PES management. ***The Banking Sector*** • Support to setting up a credit and savings policy. ***Private Operators and Services*** • Support to credit operations, • Support to supply, collection and processing operations **<u>2. Designing a rural development scheme focused on the management of natural capital</u>** 2007: • Assisting national debate and decision-making to support the planning of agro-environmental policies in relation to the banking sector and private operators ➢ Consideration of agro-environmental measures ➢ Conceptualising credit operations (identification of demand, elaboration of procedures). • Agro-industrial projects and the mining sector

		➢ Identification of environmental impacts by projects, the private sector, and the banking sector, ➢ Position and establish the proposal in these project and within village institutions, ➢ Draft contracts between partners and private operators, • Complementary studies (reallocation of land and displacement of villages and families by the Nam Ngum 2 reservoir), • Transfer to public and private operators.
	Strengthening capacity and independence within local institutions	**3. Training** • Information and awareness raising with projects, the private sector and farmers (visits, meetings), • Short-term thematic training for DAFEO technicians on PRONAE sites together with PROSA, • Long-term technical training • Continuous training of agents within all activities. • Strengthening the technical capacity of DAFEO technicians in training matters • Training in management of the project cycle.
	Diffusion of integrated production systems adapted to all the initial situations of these farmers and the social conditions of the relevant actors (improvement and diversification of revenues)	**4. Development of integrated production systems** • Methodology • Basic principles for building SCV • Construction of accompanying research systems (Set up and Validation –Training Centres). • Diffusion of production systems: integrated agriculture–livestock– perennial crops. • Creating an enabling environment and support for sales and supply
	Aid to decision-making for programme adjustment	**5. Monitoring-evaluation of programmes** • Following the coordination and management of programmes, • Analysis of economic, social and environmental impacts.

8.1. CREATING AN ENABLING ENVIRONMENT

Institutional environment

Actions		Operations/Activities Indicators
Building partnerships with Nam Ngum, PAFO, DAFO, and village authorities and structures	Structuring technical teams	Negotiation with all partners Preparation of partnership agreement with DAFO/PAFO Workshop: Formalising the agreement Set up a coordination unit at PAFO level Redistribution of PAFO/DAFEOs/PRONAE technical teams
	Intervention methodology for village structures	Assessment of current functioning of village structures Define tasks of technical teams in their support to village structures Joint evaluation of actions Supervision
Support to PAFO coordination unit (management of programmes)	Technical and financial programming	Assessment of technical and financial programmes underway; Analysis of constraints and synergies in relation to CA objectives Support to programming by operational unit Validation of annual technical and financial programmes Coordination and set up of technical and financial programmes
	Reports on and review of activities	Validation and consistency of data Building on results Support to publishing of periodic reports (quarterly and annual) of operational units Publishing of weekly synthesis reports Review workshop with all technical, financial and political partners
	External and internal communication	Development of all communication supports to meet needs of coordination unit Publishing of periodical

Farmer environment

Actions		Operations/Activities Indicators
'Territory' approach, helping village institutions with spatial management (land, infrastructure, etc)	Analysing the short- and medium-term strategy of the village	Rapid analysis of production systems Evaluation of environmental and socio-economic impacts Evaluation of potential and constraints
	Analysing needs relating to the relevant strategy	Proposal of possible development axes Analysis of needs arising from these axes
	Definition of a development programme with the community	Elaboration of an integrated development programme Validation of the partnership with DAFEOs and the technical programme with the village authorities
Creating farmer groups (production, credit, collection, supply)		Supervision along the proposed development themes Supervision of constitution de groups Constitution of groups
Support to PES management		Evaluation of relevance of programmes linked to existing PES Needs evaluation Assessment of capacity of village institutions to implement aid programmes Support to decision-making and creation of management tools

Banking sector

Actions		Operations/Activities Indicators
Support to setting up a credit and savings policy	Urgent Programme 2007	Pilot credit programme for 2007 Creation of revolving fund in each province from funds allocated by NNRBDSP (VDF) Details of set-up and loan repayment
	Programme 2007-2010	Evaluation of needs and necessary structures Support to setting up credit and savings operations with banks

Private Operators and Services

Actions	Operations/Activities Indicators
Support to credit operations	Assessment of private sector capacity to finance and set up rural credit facility Build connections between private sector and farmer groups
Support to supply, distribution and processing	Market studies Evaluation of capacity to organise supply, collection and processing among private operators and farmer groups Build connections between private sector and farmer groups Formalise contracts for activities

8.2. ELABORATION OF A RURAL DEVELOPMENT SCHEME

Actions		Operations/Activities Indicators
Assisting national debate and decision-making to support the planning of agro-environmental policies in relation to the banking sector and private operators	Discussion of agro-environmental measures	Define partnership with PROSA Contribution of NNRBDSP project to national debate National workshop on the NNRBDSP experience
	Conceptualisation of credit operations (identification of demand, laying down of procedures)	Contribution of NNRBDSP project to national debate
Agro-industrial and mining projects	Identification of environmental impacts by projects, the private sector, and the banking sector	Analysis of environmental impacts Propose compensation funds and PES
	Position and establish the proposal in these project and within village institutions	Contractualise partnerships with projects and private operators Set up management mechanisms for compensation funds and PES
Complementary studies (reallocation of land and displacement of villages and families by the Nam Ngum 2 reservoir)		Special study on the environmental impact of resettlement Support to designing development actions
Transfer to public and private operators		Gradual and continuous transfer of all activities through joint evaluation

8.3. TRAINING ACTIVITIES TO STRENGTHEN CAPACITY

Actions	Operations/Activities Indicators
Information and awareness raising with projects, the private sector and farmers	Organising visits, meetings Set up signs and visits Create materials adapted to the various audiences Disseminate
Short-term thematic training for DAFEO technicians on PRONAE sites together with PROSA	Evaluation of training needs and teaching materials Identification of partners and resource persons Choice of subjects - elaboration of programmes Programming sessions Create teaching materials Readjust themes Set up thematic workshops
Long-term technical training	Open training centres Evaluation of training needs and teaching materials Identification of partners and resource persons Choice of subjects Adjust sites and themes Enact

Continuous training of agents within all activities	Permanent evaluation
Strengthening the technical capacity of DAFEO technicians in training matters	Evaluation of training needs and teaching materials Identification of partners and resource persons Choice and ranking of subjects Programming sessions Enact
Training in management of the project cycle	Support to completion of technical and financial programmes at district level Elaboration of management and monitoring tools Training in use of management and monitoring tools

8.4. DEVELOPMENT OF INTEGRATED PRODUCTION SYSTEMS

Actions	Operations/Activities Indicators
Methodology	Knowledge of agricultural, economic and social environment Identification of demonstration-training centres Methodology of extension and development actions: ✓ Identification and set up of farmer groups ✓ Define technical support to farmer groups ✓ Territory approach – the Nam Ngum project provides overall support to the whole community ✓ Farmer groups for upscaling of validated systems Identification of continuous training for the different actors (cf. Activity 3) Monitoring-evaluation and building on lessons learned (cf. Activity 5)
Basic principles for building SCV	Communication and information on basic principles
Construction of accompanying research systems (Set up and Validation –Training Centres)	Choice of sites Build agro-sylvo-pastoral systems Permanent evaluation
Diffusion of production systems: integrated agriculture–livestock– perennial crops	Adaptation of innovations according to identified production systems
Creating an enabling environment and support for sales and supply	Scale according to demand and put on market

8.5. MONITORING AND EVALUATION

Actions	Operations/Activities Indicators
Monitoring-evaluation unit	Set up monitoring-evaluation unit in each province Create tools Develop work schedule Identify specific studies Recruit students to conduct extra research Monitoring-evaluation reports and contribution to periodic activity reports Review workshop Adjustment of programmes

8.6. ACTIVITY SCHEDULE 2007

ACTIVITE 1: CREATING AN ENABLING ENVIRONMENT	2007											
Institutional environment	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Building partnerships with Nam Ngum, PAFO, DAFO, and village authorities and structures												
Structuring technical teams												
Negotiation with all partners												
Preparation of partnership agreement with DAFO/PAFO												
Workshop: Formalising the agreement												
Set up a coordination unit at PAFO level												
Redistribution of PAFO/DAFEOs/PRONAE technical teams												
Intervention methodology for village structures												
Assessment of current functioning of village structures												
Define tasks of technical teams in their support to village structures												
Joint evaluation of actions												
Supervision												
Support to PAFO coordination unit (management of programmes)												
Technical and financial programming												
Assessment of technical and financial programmes underway; Analysis of constraints and synergies in relation to CA												
Support to programming by operational unit												
Validation of annual technical and financial programmes												
Coordination and set up of technical and financial programmes												
Reports on and review of activities												
Validation and consistency of data												
Building on results												
Support to publishing of periodic reports (quarterly and annual) of operational units												
Publishing of weekly synthesis reports												
Review workshop with all technical, financial and political partners												
External and internal communication												
Development of all communication supports to meet needs of coordination unit												
Publishing of periodical												
Farmers environment	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
'Territory' approach, helping village institutions with spatial management (land, infrastructure, etc),												
Analysing the short- and medium-term strategy of the village												
Rapid analysis of production systems												
Evaluation of environmental and socio-economic impacts												
Evaluation of potential and constraints												
Analysing needs relating to the relevant strategy												
Proposal of possible development axes												
Analysis of needs arising from these axes												
Definition of a development programme with the community												
Elaboration of an integrated development programme												
Validation of the partnership with DAFEOs and the technical programme with the village authorities												
Creating farmers groups (production, credit, collection, supply)												
Supervision along the proposed development themes												
Supervision of constitution de groups												
Constitution of groups												
Support to PES management												
Evaluation of relevance of programmes linked to existing PES												
Needs evaluation												
Assessment of capacity of village institutions to implement aid programmes												
Support to decision-making and creation of management tools												
Banking sectore	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Support to setting up a credit and savings policy												
Urgent Programme 2007												
Pilot credit programme for 2007												
Creation of revolving fund in each province from funds allocated by NNRBDSP (VDF)												
Details of set-up and loan repayment												
Programme 2007-2010												
Evaluation of needs and necessary structures												

ACTIVITE 2: ELABORATION OF A RURAL DEVELOPMENT SCHEME	2007											
Aide à la décision, réflexion nationale pour l'appui à la définition de politiques agri-environnementales	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Assisting national debate and decision-making to support the planning of agro-environmental policies in relation to the banking sector and private operators												
Define partnership with PROSA												
Contribution of NNRBDSP project to national debate												
National workshop on the NNRBDSP experience												
Conceptualisation of credit operations (identification of demand, laying												
Contribution of NNRBDSP project to national debate												
Agro-industrial and mining projects	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Identification of environmental impacts by projects, the private sector, and the banking sector												
Analysis of environmental impacts												
Propose compensation funds and PES												
Contractualisation des partenariats avec les projets et les opérateurs privés												
Mise en œuvre des mécanismes de gestion des fonds de compensation et PSE												
Complementary studies (reallocation of land and displacement of villages and families by the Nam Ngum 2 rese	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Special study on the environmental impact of resettlement												
Support to designing development actions												
Transfer to public and private operators	**Jn**	**Fv**	**Mr**	**Ap**	**Ma**	**Ju**	**Jl**	**Au**	**St**	**Oc**	**Nv**	**Dc**
Gradual and continuous transfer of all activities through joint evaluation												

ACTIVITE 3: TRAINING ACTIVITIES TO STRENGTHEN CAPACITY	2007											
Information and awareness raising with projects, the private sector and farmers	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Organising visits, meetings												
Set up signs and visits												
Create materials adapted to the various audiences												
Disseminate												
Short-term thematic training for DAFEO technicians on PRONAE sites together with PROSA	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Evaluation of training needs and teaching materials												
Identification of partners and resource persons												
Choice of subjects - elaboration of programmes												
Programming sessions												
Create teaching materials												
Readjust themes												
Set up thematic workshops												
Long-term technical training	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Open training centres												
Evaluation of training needs and teaching materials												
Identification of partners and resource persons												
Choice of subjects												
Adjust sites and themes												
Enact												
Continuous training of agents within all activities	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Permanent evaluation												
Strengthening the technical capacity of DAFEO technicians in training matters	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Evaluation of training needs and teaching materials												
Identification of partners and resource persons												
Choice and ranking of subjects												
Programming sessions												
Enact												
Training in management of the project cyclet	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Support to completion of technical and financial programmes at district level												

ACTIVITE 4: DEVELOPMENT OF INTEGRATED PRODUCTION SYSTEMS	2007											
Monitoring-evaluation unit	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Knowledge of agricultural, economic and social environment												
Identification of demonstration-training centres												
Methodology of extension and development actions												
Identification of continuous training for the different actors												
Monitoring-evaluation and building on lessons learned												
Basic principles for building SCV	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Communication and information on basic principles												
Construction of accompanying research systems (Set up and Validation -Training C	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Choice of sites												
Build agro-sylvo-pastoral systems												
Permanent evaluation												
Diffusion of production systems: integrated agriculture- livestock- perennial crops	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Identification of farmers groups												
Identification of agro-sylvo-pastoral systems												
Adaptation of innovations according to identified production systems												
Creating an enabling environment and support for sales and supply	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Scale according to demand and put on market												

ACTIVITE 5: MONITORING AND EVALUATION	2007											
Monitoring-evaluation unit	Jn	Fv	Mr	Ap	Ma	Ju	Jl	Au	St	Oc	Nv	Dc
Set up monitoring-evaluation unit in each province												
Create tools												
Develop work schedule												
Identify specific studies												
Recruit students to conduct extra research												
Monitoring-evaluation reports and contribution to periodic activity reports												
Review workshop												
Adjustment of programmes												

9. BUDGETS 2007-2010

The budget presented here, for a sum of US$7,570,000 over the period 2007-2010, was made in consideration of the technical objectives presented above. Of this sum, it should be specified that $6,230,000 has already been budgeted by the NNRBSDP for activities planned in the two provinces. Consequently, a supplementary budget of $1,340,000 is required over the period 2007-2010 in order to finance the accompanying technical support required for these programmes from NAFRI and PRONAE.

To complement this budgetary programming, a revolving fund worth an estimated $2,970,000 should be established within the framework of the VDF to promote credit operations.

This financial plan also presents the government's contribution to the PES (Payment for Environmental Services) scheme, worth $691,500.

It should be noted that from the total amount of $7,570,000, it will be necessary to subtract $535,000 at the end of the exercise, which will be repaid as the floating capital of the revolving fund.

The provisional 2007 budget is below.

thousand $US - Nam Ngum Xieng Khouang & Vientiane	2007	
	Actual	Additional Costs
1 Investments	**578 100,00**	**0,00**
2 Personnel	**41 280,00**	**337 060,00**
2,1 National technical assistance		
Technical assistance		48 060,00
DAFEO Staff	35 520,00	
Logistic, Tractor driver	5 760,00	
2,2 External technical assistance		289 000,00
3 Activities	**452 450,00**	***0,00***
4 Fonctionnement	**159 960,00**	***0,00***
TOTAL	**1 231 790,00**	**337 060,00**

It should be noted that a document on ordering the inputs required for the 2007 "Fast Track" campaign has already been provided (January 4, 2007) during the mission to assist with decision-making.

Budgets 2007-2010

Plan de Financement - Nam Ngum Xieng Khouang & Vientiane

thousand $US - Nam Ngum Xieng Khouang & Vientiane	2007	2008	2009	2010	Total 2007-2010	Actual	Additional Costs
1 Investments							
1,1 Vehicles 4*4	120000,00	0,00	0,00	0,00	120000,00		
1,2 Motorbikes	120600,00	0,00	0,00	0,00	120600,00		
1,3 Office materials	25000,00	0,00	0,00	0,00	25000,00		
1,4 Training materials	67500,00	0,00	0,00	0,00	67500,00		
1,5 Equipments (seeders, sprayers…)	125000,00	125000,00	0,00	0,00	250000,00		
1,6 Infrastructures (seed processing, pigsty...)	120000,00	0,00	0,00	0,00	120000,00		
Sous- total 1	***578 100,00***	***125 000,00***	***0,00***	***0,00***	***703 100,00***	***703 100,00***	***0,00***
2 Personnel							
2,1 National technical assistance	89 340,00	116 980,00	118 260,00	118 260,00	442 840,00		
Technical assistance	*48 060,00*	*56 820,00*	*56 820,00*	*56 820,00*	*218 520,00*		218 520,00
DAFEO Staff	*35 520,00*	*53 760,00*	*53 760,00*	*53 760,00*	*196 800,00*	196 800,00	
Logistic, Tractor driver	*5 760,00*	*6 400,00*	*7 680,00*	*7 680,00*	*27 520,00*	27 520,00	
2,2 External technical assistance	289 000,00	289 000,00	289 000,00	254 000,00	1 121 000,00		1 121 000,00
Technical assistance	*234 000,00*	*234 000,00*	*234 000,00*	*234 000,00*	*936 000,00*		
External missions	*55 000,00*	*55 000,00*	*55 000,00*	*20 000,00*	*185 000,00*		
Sous- total 2	***378 340,00***	***405 980,00***	***407 260,00***	***372 260,00***	***1 563 840,00***	***224 320,00***	***1 339 520,00***
3 Activities							
3,1 Monitoring, Evaluation and Coordination	7 000,00	7 000,00	7 000,00	7 000,00	28 000,00		
3,2 Demonstrations fields, Creation - Training and Diffusion	60 000,00	60 000,00	60 000,00	60 000,00	240 000,00		
3,3 Extension through VDF	195 100,00	591 250,00	1 122 000,00	1 062 000,00	2 970 350,00		
Livestock systems	161 100,00	501 000,00	973 000,00	838 000,00	2 473 100,00		
Annual cropping systems (SCV), maket gardening	0,00	36 250,00	125 000,00	200 000,00	361 250,00		
Nursery fruit crops and vegetables	24 000,00	24 000,00	24 000,00	24 000,00	96 000,00		
Processing and storage of products	10 000,00	30 000,00	0,00	0,00	40 000,00		
3,4 Grant GoL (reforestation and operating costs for sowing)	57 550,00	188 000,00	323 000,00	123 000,00	691 550,00		
3,5 Structuring environment (revolving funds)	127 800,00	378 000,00	20 000,00	10 000,00	535 800,00		
3,6 Communication capital	5 000,00	8 000,00	8 000,00	8 000,00	29 000,00		
Sous- total 3	***452 450,00***	***1 232 250,00***	***1 540 000,00***	***1 270 000,00***	***4 494 700,00***	***4 494 700,00***	***0,00***
4 Fonctionnement							
4,1 Vehicles	119 960,00	166 960,00	166 960,00	166 960,00	620 840,00		
4,2 Offices	40 000,00	48 000,00	48 000,00	48 000,00	184 000,00		
Sous- total 4	***159 960,00***	***214 960,00***	***214 960,00***	***214 960,00***	***804 840,00***	***804 840,00***	***0,00***
TOTAL	**1 568 850,00**	**1 978 190,00**	**2 162 220,00**	**1 857 220,00**	**7 566 480,00 #**	**6 226 960,00**	**1 339 520,00**
Village Developping Funds					**2 970 350,00**		
Paiment pour Services Environnementaux					**691 550,00**		

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11. APPENDIX

Appendix 1: Terms of Reference

Appendix 2: Mission Schedule and List of People Met

Appendix 3: Natural Capital and Rural Development

Appendix 4: Main Principles of Conservation Agriculture, Direct Seeding and Plant Cover

Appendix 5: Circular of the Cabinet of the Council of Ministers and a Ministerial Decree from the Ministry of Agriculture and Forestry on Conservation Agriculture

Appendix 6: Cattle Fattening Opportunities in Xieng Khouang Province

Appendix 7: Validation of Direct Seeding Mulch-Based Cropping Systems with Farmer Groups in Southern Xayabury Province

Appendix 8: List of Providers

Appendix 9: Management of Fruit Trees

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