Agro-Ecosystem Analysis

Agro-ecosystem analysis (AEA) is a methodology for zoning and analysing agricultural systems in order to plan and prioritise research and development activities in the fields of agriculture and natural resource management. It uses a holistic or systems approach to gather bio-physical and socio-economic information and, within the ecosystem, to identify key issues or problems that will be useful for rural development, extension and research programmes.

AEA can be conducted at any level, province, district or zone depending on particular needs. In the Lao PDR the preference is for district or development area levels because these are the key levels for rural development planning. AEA is undertaken by multi-disciplinary teams which bring to the exercise a range of different skills. For example in the exercise carried out by the Lao Swedish Upland Agriculture and Forestry Research Programme (LSUAFRP), the teams included land use planning, farming systems, forestry, socio-economic, and geographic information systems specialists.

The analysis relies heavily on secondary data, both bio-physical and socio-economic information. Examples of bio-physical data are topography, climate, water resources, geology, soils, communications, infrastructure, and land use. Examples of socio-economic data are agriculture systems, agro-forestry systems, ethnicity, markets, poverty status, and opium addiction. Information is gathered during workshops and using Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) tools.

A manual has been prepared to assist field staff with AEA and agro-ecological zoning with a focus on upland areas in northern Laos. It is based on field experience from pilot AEAs conducted by LSUAFRP in 2004 in Phonxay District, Luangprabang Province, and Namor District in Oudomxay Province. Copies are available from the Information Management Division of NAFRI (info@nafri.org.la).

Reasons for conducting AEA

The main reasons for conducting AEA are to:

- Describe upland land-use systems of selected study areas.
- Identify, demarcate and map agro-ecological zones of selected study areas.
- Describe the physical and socio-economic characteristics and conditions of agro-ecological or forestry zones identified.
- Identify agricultural, forestry and socio-economic issues and problems existing in the zones so that they can be addressed by extension or research programmes.
- Provide district authorities with information that can be used to plan development activities to address poverty.

The purpose of defining agro-ecological zones is to define areas with fairly homogenous biophysical and socio-economic conditions or characteristics. A description and analysis of each zone can then be undertaken. The analysis reveals key agricultural, forestry and socio-economic issues and problems for each zone, for which solutions can be proposed, some through research and others by extension and development.

- Strengthen district skills and capacities in agro-ecological zoning and rural development planning.
- Match available agricultural and forestry technology options with identified agricultural sub-systems or recommendation domains.
- Promote co-operation and linkages between research and development.

Options for implementing AEA

AEA may be conducted for agro-ecosystems at different levels, such as province, district, district development area or development zone. The LSUAFRP experience indicates that the district and development area levels are preferable because the analyses are most useful to district planning authorities in setting development and extension priorities within the zones of a district. The analyses at this level also provide useful information on key research issues and problems that can be addressed by farming system researchers working at district, development area or village levels, as explained below and in Table 1.

Agro-ecosystem analysis procedures

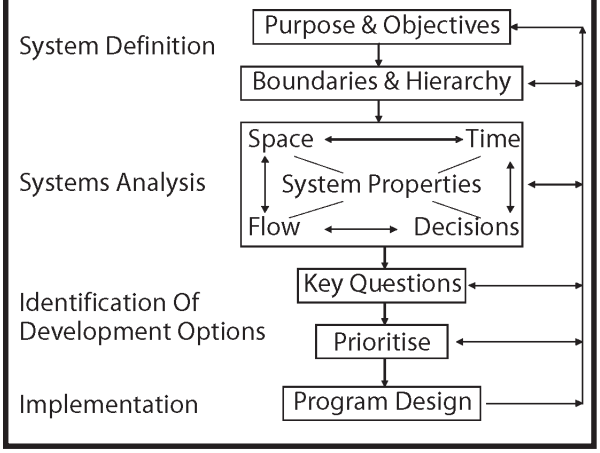
AEA is based on the concepts of systems, hierarchies, agro-ecosystem zones, and the system properties of productivity, stability, sustainability and equitability.

As shown in Figure 1 and Table 1, AEA follows a step-by-step procedure to decide on the purpose of the analysis, to define precisely the system(s) of study, identify its boundaries, its position in the hierarchy of other systems and its major components and their key interactions. As an understanding of the system is developed, a limited number of key issues begin to emerge which are then used to guide later analysis and to plan further follow-up studies in the field. As these issues are clarified and understood, key questions and hypotheses are proposed, elaborated and used to identify research and extension priorities.

Table 1: Brief explanation of AEA procedures

Stage	Description
Systems definition	Agree on the purpose and objectives of the analysis. Precisely define the system(s) to be studied . Clearly identify and delineate the systems boundaries (physic al, social, administrative, etc). Describe its position in the hierarchy of other systems.
System analysis	Identify and describe the major agro-ecological zones (agro-ecosystems) within the system and the important interactions among them. Analyse each zone in regard to: 1. Space: spatial diversity, sub-systems and key relationships 2. Time: long-term (trends) and short-term (cyclical) changes in the system over time. 3. Flow: the movement of materials, money, information, etc. within, into and out of the system. 4. Decisions: the decision-making process and choices/options for key decision makers (farmers, government, projects, etc.) . Identify the key attributes of the system that contribute either positively or negatively to the productivity, stability, equitability and sustainab ility of each agro-ecosystem. Identify the key processes determining the overall performance of each agro-ecosystem.
Identification of development options	As an understanding of the system is developed, a number of key issues, problems and development opportunities begin to emerge. These are further developed and elaborated into hypotheses or key questions for further analysis. System properties analysis is used to identify those attributes of each agro -ecosystem that impact positively and negatively on productivity, stability, equitability and sustainability. The results of this are used to further develop the key questions. The key questions are interfaced with available technologies to identify appropriate solutions or development options for each question.
Research, design and implementation	Proposed development options are assessed using innovation assessment techniques. This provides a rating for each which is then used to set development priorities. High priority development options will include proposals for research, extension and management (district planning) interventions. These are used by the appropriate agency (NAFRI, NAFES or district authority) to develop appropriate implementation plans. Once these activities have been implemented, their results should be re -assessed in the context of AEA and any new lessons used to modify plans.

Figure 1: AEA steps



Agro-ecosystem analysis outputs

The most important and useful outputs that AEA provides are:

- The delineation and description (bio-physical and socio-economic) of distinct agro-ecological zones at the agro-ecosystem level chosen, i.e. District or Development Area.
- An improved, holistic understanding of the major farming and livelihood systems of each zone.
- A prioritised list of important problems and opportunities for each zone.
- A prioritised set of research, extension and development proposals to solve the problems.
- Enhanced interdisciplinary cooperation and improved research and extension linkages.

Agro-ecosystems analysis tools

AEA uses a variety of tools to assist with the analysis of space, time, flow and decision-making. Many are similar to PRA tools and all emphasise simplicity, participation and objectivity.

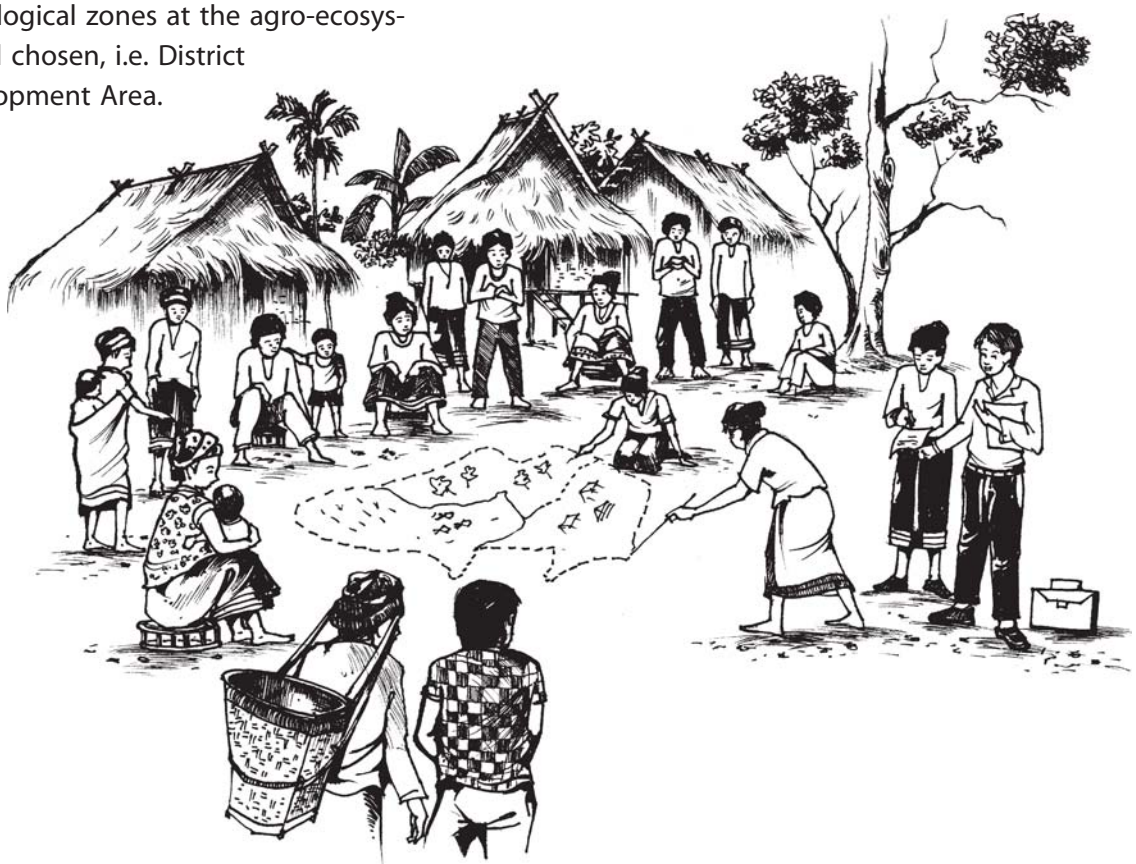


Table 2: Explanation of AEA implementation stages		
Stage	**Main activities**	**Location and duration**
Stage 1: Planning and preparation	• AEA team formation and organisation. • Inform and brief partner institutions (district authorities, development area leaders, research institutions, etc). • Arrange logistics for meeting rooms, materials, supplies, transport, etc. • Prepare spatial data at central level: digital maps on topography, elevation, slope, geology, soils, climate, land use, watersheds, rivers, administration boundaries, village locations, roads, and so on. • Explain secondary data collection needs and request district staff to prepare preliminary numeric data.	Vientiane (NAFRI GIS unit) Intermittently over three weeks by core AEA staff
Stage 2: Staff orientation and agro-ecosystem definition	• Staff orientation on AEA: procedures, methods and expected outputs. • System definition; defining AEA study area and boundaries. • Explanation of agro-ecosystem hierarchies. • Definition of AEA purpose and objectives. • Forming work groups and designating responsibilities for data collection.	District or development area 1-2 days
Stage 3: Secondary data collection and organisation.	• Explanation of secondary data needs (using prepared data list). • Collating initial secondary data including socio-economic and biophysical information for the study area. • Preparation of secondary data spread sheets using Excel program.	District or development area 2-3 days
Stage 4: Agro-ecological zoning	• Explanation of digital maps used in agro-ecological zoning. • Explanation of zoning methods and tools. • Identification of initial boundaries in the agro-ecosystem zones.	District or development area 2-3 days
Stage 5: Preliminary system analysis	• Identify key issues/problems regarding land use and livelihoods for each zone. • Identify important missing information and data for each zone. • Assign responsibilities and prepare for follow-up fieldwork.	District or development area 1 day
Stage 6. Fieldwork in the study area	• Organise sub-group responsibilities for each agro-ecosystem zone. • Prepare tools for field activities: i.e. historical profiles, agro-ecosystem base maps, transects, seasonal calendars, flow diagrams, Venn diagrams etc. • Gather additional data to complete zone descriptions. • Verify and explore key issues with farmers and local stakeholders. • Identify key problems and opportunities with farmers and local stakeholders using problem census meetings.	District or development area 1-2 days
Stage 7. Completion of systems analysis	• Explain tools for describing agro-ecological zones. • Prepare a general description of district agro-ecosystems using a transect table. • Prepare the information on time, flow, space and decision-making for each agro-ecological zone. • Prepare detailed description of each agro-ecological zone. • Present and analyse the information in plenary sessions. • Analyse the system properties for each zone (system properties table). • Key issues and problem formulation and recording. • Key issue and problem solution analysis. • Key issue prioritisation and problem solution ranking (innovation assessment).	District or development area 2-3 days
Stage 8. Reporting and write-up	• Draft report for presentation to key stakeholders. • Presentation of findings to key stakeholders. • Incorporation of feedback from presentation into an AEA report. • Finalise and translate report.	Vientiane 3-4 weeks
Stage 9. Use of the outputs	• District implementation of priority programmes with help from LSUAFRP. • Use of adapted AEA methodology elsewhere in Laos (AEA user manual). • Hold dissemination workshop on AEA methodology for potential users. • Plan replication of AEA methodology for other areas.	District On-going

Major analysis tools

Transect diagrams (space analysis tool):
Transect diagrams are used to describe and compare each agro-ecological zone according to a number of key agro-ecological and socio-economic parameters. Transects help to ensure that all relevant information is collected and clearly organised for each agro-ecological zone; they also assist in the analysis by facilitating comparisons and identifying important relationships among the zones.

Historical profiles (time analysis tool):
Historical profiles or 'timelines' are used to identify key events and analyse changes and trends over the longer term. They review major occurrences over a number of decades and usually rely heavily on local knowledge. Their purpose is twofold: firstly, to try to identify longer-term trends, for example changes in forest cover, trends in rice yields, changes in livelihood systems, etc. Secondly, they are used to assess the robustness of the agro-ecosystem to major perturbations such as flood/drought, pest outbreaks, market-price fluctuations, etc.

Seasonal calendars (time analysis tool):
Seasonal calendars are also used to analyse time related changes for each agro-ecosystem, but over the shorter term (within-year). Climate, cropping patterns, major agricultural operations, labour use, price movements, social activities, etc. are presented by month so that comparisons can be made and key periods identified.

Flow diagrams (flow analysis tool):
Flow diagrams are used to analyse the flow of materials, money, information, labour, etc. both from outside and within the system. Flows occur both up and down the hierarchy, i.e. from village to district to province, and from one agro-ecosystem zone to another, e.g. grazing-cattle migration from zone to zone in different seasons. Various schematic means of representing these flows exist and can be selected according to participants' needs and capacities.

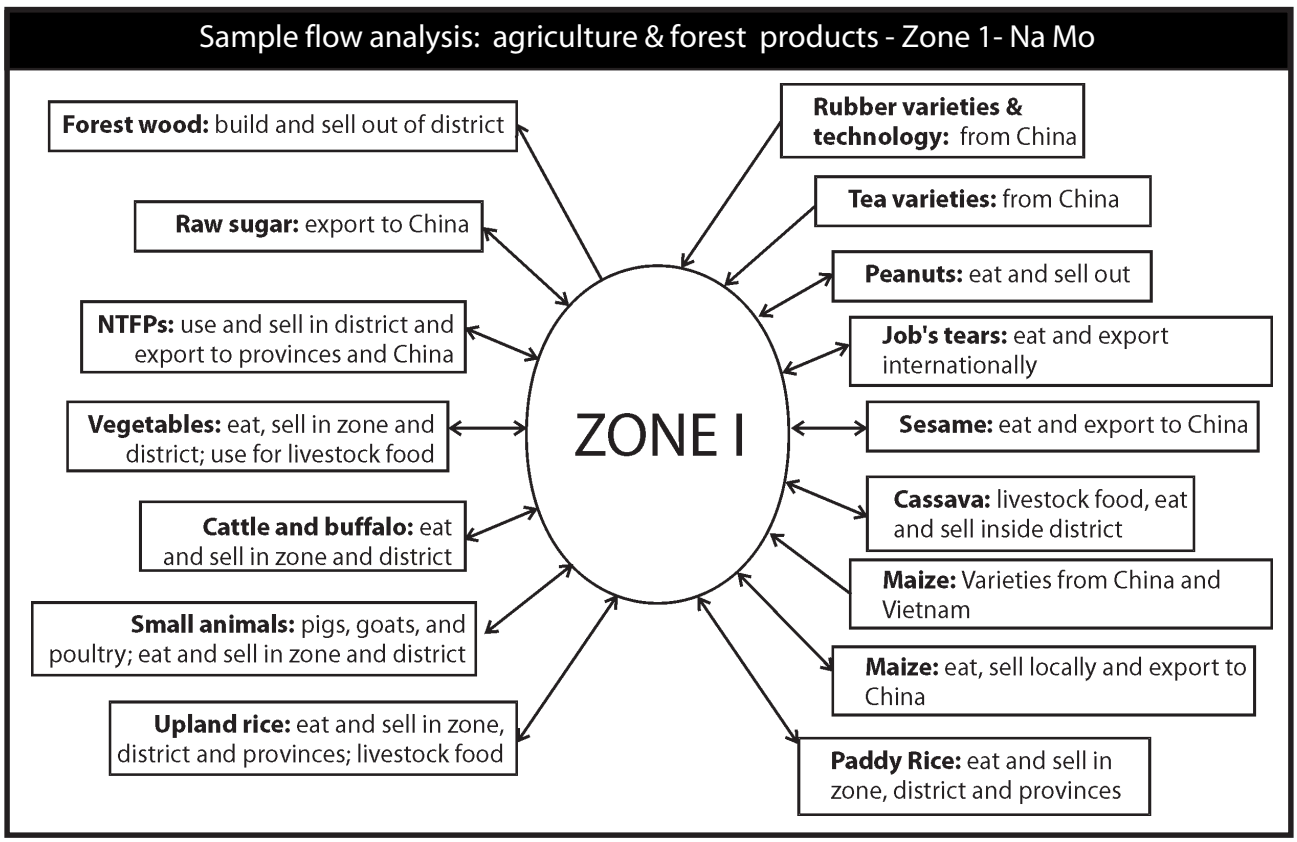
Venn diagrams (decision analysis tool):
Venn diagrams are used to analyse relationships among agro-ecosystem communities, and projects and agencies providing support to them. They are useful in identifying potential development partners or detecting where

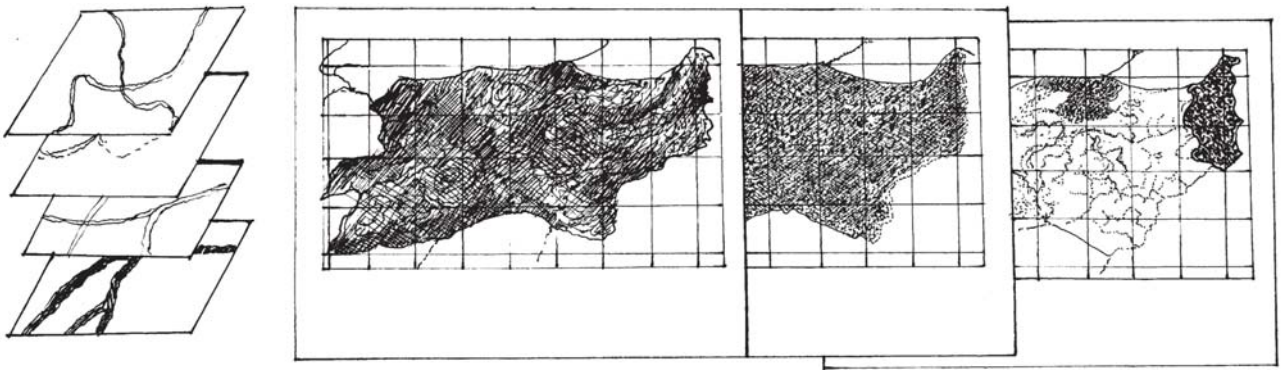
inter-agency cooperation could be improved. In Venn diagrams, overlapping circles represent good cooperation, touching circles represent some cooperation and non-touching circles represent poor or no cooperation.

Problem-cause diagrams (decision analysis tool):
Problem-cause diagrams or 'problem-solution trees' are used to analyse the causes of problems, identify the linkages between them, understand the way farmers cope with the problem, and identify appropriate solutions. Problem diagrams begin with a broad statement of the overall problem, which is then broken down into component problems, and eventually the root causes; these are then examined to identify farmer responses to the problem, and finally, alternative solutions are proposed.

System properties tables (system properties analysis tool):
The four system properties of productivity, stability, sustainability and equitability are analysed for each agro-ecological zone using a system properties table. Analysis proceeds by listing those attributes of the agro-ecosystem, which have positive and negative effects on the four system properties, and explaining the way this occurs. This identification of the important elements in each system encourages a more balanced analysis than the traditional focus on productivity would provide.

Pair-wise ranking (prioritisation tool):
Pair-wise ranking provides a means of objectively ranking or prioritising issues, problems and solutions. Objectivity is improved if multidisciplinary groups conduct the ranking, as it then incorporates a variety of different per-

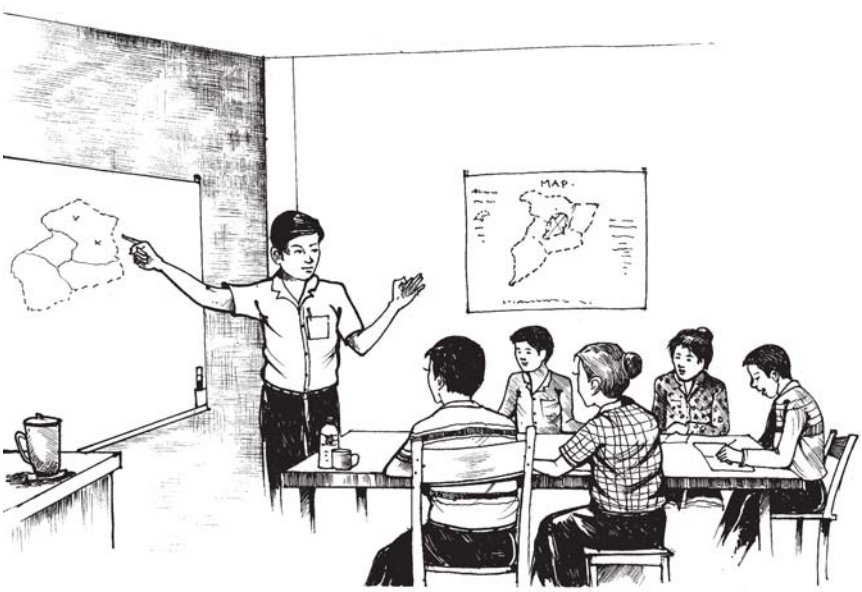




spectives and points of view. Pairwise ranking proceeds by listing the problems to be compared, and then comparing each problem with every other problem, in turn. When all comparisons have been completed, the scores are totalled to provide a ranking of the relative importance of each.

Impact assessments:
Once proposed solutions to the key problems have been generated by AEA, a simple assessment technique can be used to assess the impact of each proposed solution on important cross-cutting issues such as gender, poverty and the environment. These assessments are used to modify each solution in order to enhance positive impacts and reduce potentially negative impacts in regard to these cross-cutting issues.

Innovation assessment or problem solution ranking (prioritisation tool):
When designing development programmes it is necessary to have some means of setting priorities for the set of proposed solutions to key problems generated by AEA. Innovation assessment is used to assist with this by allowing participants to set priorities in a rational and objective manner. Innovation assessment proceeds by scoring each of the proposed programmes according to a sub-set of selected factors. These factors are chosen according to the objectives of the study, but will commonly include the effect of the proposed programme on system productivity, stability, sustainability and equitability; its cost and time taken to implement; its overall feasibility; and its impact on poverty, gender and the environment.



Key issues and proposed solutions

Example issues and problems arising from agro-ecological zoning and system analysis	
KEY QUESTIONS	**PROPOSED SOLUTIONS**
Lower elevation, potentially productive upland agro-ecosystem - Zone 1	
Some people in the zone in Viengthong, Buakkham, Na Ngiou, and Phou Samay villages gather NTFPs and hunt wildlife in the Phou Khoum and Phou Sa areas of the Nam Et-Phou Loei NBCA.	• Conduct LUP-LA in the 3 villagers that utilise the forest and land resources in the NBCA to designate the forest and land areas they have rights to access • Prepare Village Forest and Land Use Agreements for these villagers in consultation with NBCA staff at district and provincial levels • Delineate a buffer zone in the area between the villagers and the NBCA boundary
There is a lack of school teachers and school materials and equipment.	• Secure funds from outside sources, international donors, NGOs, and the private sector to support school construction and equipment and upgrade teacher skills
Villagers lack funds for family production activities.	• Develop village based savings and loan groups to support production inputs (GOL and villagers); low interest rates on inputs to create incentives
Village merging is incomplete in some places, ie. Sop Kuan and Hat Saang, land allocation has not been undertaken.	• Assess the need for village merging before proceeding • Assess the availability of land in proposed village merging locations for proposed new settlers • Delineate village boundaries and land use zones before proceeding with land allocation
There are many disease outbreaks (epidemics).	• Secure funds from outside sources, international donors, NGOs, and the private sector to support health centre construction; District Health Service undertakes training on hygiene, sanitation, and disease prevention
Road access between villages is lacking/inadequate.	• Expand the road network between villages; involve villagers in the road network expansion; also extend electricity to villagers in the future
Villagers still practise a lot of shifting cultivation.	• Training and demonstration of improved conservation farming methods; study tours/exchange visits to outside areas
Many villagers still consume a lot of opium; a total of 149 persons in the zone (138 males and 11 females).	• Conduct education programs on the risks/impacts of opium addiction; conduct detoxification clinics at the district centre
Depletion of stream fish populations.	• Prepare village agreements and management rules to help villagers manage the fish resources

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This article was adapted from: Agro-ecological Analysis Manual. LSUAFRP, NAFRI. 2005.

Improving Livelihoods in the Uplands of the Lao PDR was produced in 2005 by NAFRI, NAFES and NUOL.