

# Guide to Biodiversity in the Farmscapes of Lao PDR



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## Foreword

The importance of biodiversity for livelihoods and agriculture is increasingly recognised worldwide. In Lao PDR this is particularly apparent where the livelihoods of farmers are heavily dependent, not only on farming, but also on wildlife and non-timber forest products (NTFPs). However, little information exists on the importance of biodiversity for agriculture and livelihoods in Lao PDR, and research on the topic is limited.

This document, Guide to Biodiversity in the Farmscape of Lao PDR was originally developed as a guide to biodiversity in Thai farmscapes, as a part of the DANIDA supported SAFE Project in Thailand.

One component of the project has been to adapt the content to reflect Lao conditions, as there are major cultural and environmental differences between Thailand and Lao PDR, and to translate the guide into Lao.

This guide does not aim to be a comprehensive manual on the use and importance of biodiversity in the farmscape. Rather, it is an attempt to provide a first step in encouraging further research and a systematic approach into a field of research that concerns the livelihood of most people in Lao as well as the conservation of biodiversity and resources.

The adaptation, editing, and translation have been made by IUCN Lao PDR (International Union for Conservation of Nature). The core structure of the original document has been kept and chapters 6 and 7 have only had minor changes, whereas chapters 1-5 have been rewritten or significantly changed, by teams at NAFRI (National Agriculture and Forest Research Institute), and IUCN Lao PDR (International Union for Conservation of Nature).

It is our sincere hope that this document will be found useful and inspire to further work and progress in this field in Lao PDR.



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## 1. Introduction

The Lao People's Democratic Republic (Lao PDR) is a small, landlink country with a total area of 236800 sq.km and sparsely populated with about 6.5 million people. The country is highly ecologically diverse. It hosts globally significant biodiversity that emerges from the convergence of three mega-diversity centres – India, China and Southeast Asia and is also a primary centre of origin and diversity for cultivated rice (*Oryza sativa* L.), and other crops. The country has among the highest biodiversity in the world which harbours 8,000-11,000 plant species, 166 reptile and amphibian species, 700 bird species, over 500 fish species and over 100 species of large mammals. Over 1000 globally threatened species are found in the Lao PDR.



Despite being a biodiversity rich country, Lao PDR suffers the lack of information base for biodiversity that greatly impairs the use and development of these resources. Its management has been experiencing several problems and has been suffering from diverse pressures and threats from different sources. These include, as mentioned in several reports, illegal poaching, destructive fishing and



While reading this guide the reader should consider a few important questions:

- ✚ Where and what is Lao PDR farmscape biodiversity, why is it important and what is being done to protect it?
- ✚ What can be done to encourage both high biodiversity and high productivity on the farm?
- ✚ What are the research needs in order to understand farmscape biodiversity?
- ✚ How can the Government of Lao PDR effectively support farmscape biodiversity conservation and ensure long term viability?
- ✚ Finally, what are the impacts of urbanization on farmland biodiversity and what is needed to ensure that farmland biodiversity is maintained in the face of rapid urbanization?

collection of forest products due to market demand, encroachment for timber and land for agriculture due to unclear boundaries, fire, conversion for commercial cash crop cultivation and tree plantation, infrastructure development (hydropower, roads), community growth and aspirations for economic improvement and livestock grazing, increased income of urban residents and high cross-border demand. Degradation of biodiversity has been continuing as a



result of these pressures. In this situation, the remaining agricultural landscapes become even more important as a link or corridor between areas of high biodiversity, which can become more isolated.

Agriculture has a very important place in Lao PDR, as it contributes to approximately 50% of the total GDP of the country, and well over 80% of the labour force is involved in some aspect of agricultural production. The sector is largely subsistence agriculture that is characterized by low inputs and low outputs. The people of Lao PDR is among the poorest in the world whose economy is heavily dependent on utilization of natural resources for the survival and well-being.

Hence, agricultural biodiversity plays a very important role for the livelihoods of people in Lao PDR. Lao farmers are making tremendous use of this diversity, the quantity and quality of which is a direct consequence of their farming practices, culture, knowledge and the environment. The level of biodiversity on the farmscape of Lao PDR is in decline as a result of management practices which do not take biodiversity into account.



This handbook is intended to provide the reader with a brief overview of farmscape biodiversity in Lao PDR in terms of the special habitats which exist in each region of the country and the important functions of these habitats. This is an initial attempt to look at the biodiversity which exists at the farm and certainly only scratches the surface of this important issue. It is by no means a comprehensive guide and it is anticipated that after more attention



and research on this issue, a much better understanding will be gained and some of the perceptions presented may change. It should be noted that this guide is not intended to detract from the importance of the biodiversity of the remaining natural ecosystems in Lao PDR and the need for its conservation. Much has been done and documented about what exists in the natural forests of Lao PDR. Due to this reason, the focus of this guide is exclusively on farmscape biodiversity and not on natural ecosystems. Forest land encroached upon by agriculture resulting in ‘agroforestry systems’ is likewise given very brief attention in attempt to focus the attention of the reader on the important diverse, yet threatened biodiversity which exists on intensively farmed landscapes in Lao PDR. Finally, a discussion on crop diversity has been purposely omitted since the loss of crop genetic diversity, although important and alarming, has long been given much attention to in other forums and documentation.

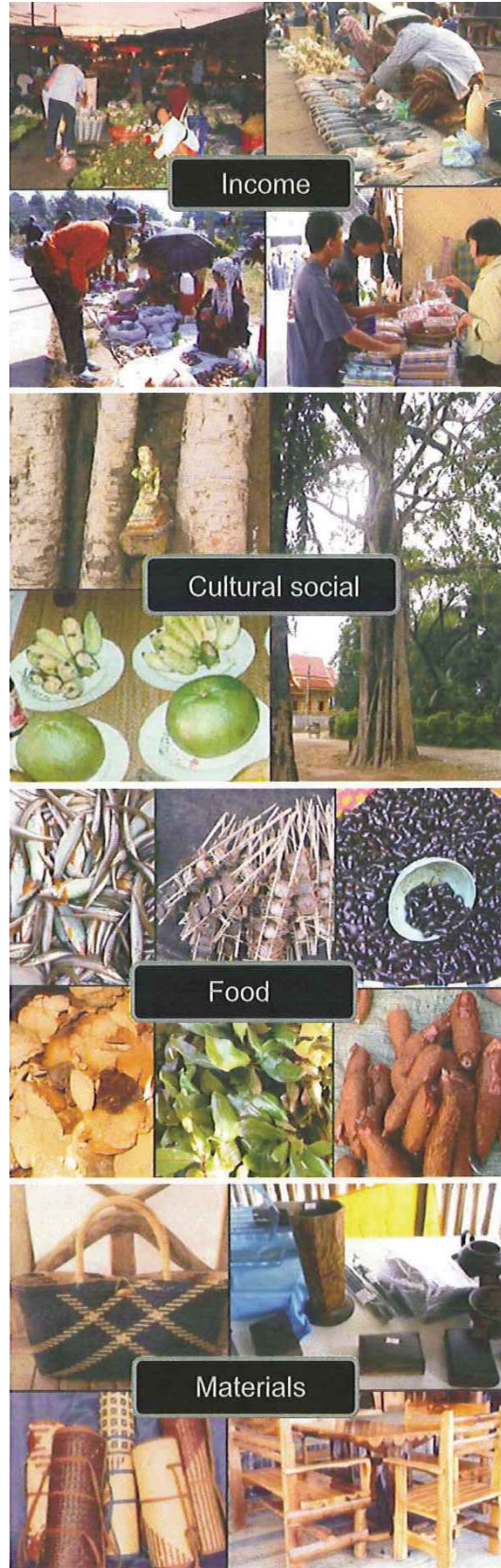
## 2. Importance of biodiversity for agriculture

Why is biodiversity important for agriculture and agricultural livelihood in Lao PDR? And why is it important to sustain such biodiversity? There are no simple answers to these seemingly simple questions because agriculture is the basis of a complex relationship between natural ecosystems, cultivation systems and society. A simple answer does not reflect the depth and complexity of the issue.

In Lao PDR, agricultural biodiversity refers to all components of biodiversity that are used for food and agriculture. According to the National Agro-biodiversity Programme, agricultural biodiversity includes crop and crop-associated biodiversity, livestock, non-timber forest products and other terrestrial food resources and aquatic biodiversity. Agricultural biodiversity also embraces non-domesticated food resources, both aquatic and terrestrial plants and animals.

Farmland in Lao PDR is composed of many diverse ecosystems which contribute to a rich natural resource base for the country. The biodiversity within these ecosystems performs ecological services essential for human survival such as providing the biological foundation for food production as well as a wide range of non-food goods and services such as materials for everyday farm use, medicine, income to the people of Lao PDR both in rural and urban areas and the support of social and cultural systems and also provide essential ecosystem services that contribute to regulating ecosystem functions as well as providing ecosystem resilience. Biodiversity forms the basis for food production through pollinators, biological control of crop pests, and soil development by means of nutrient recycling, all which have key functions in agricultural systems. The diversity of plants, animals and micro-organisms essential for maintaining the productivity and sustainability of farm crops, livestock and aquaculture is, even today, very poorly understood. Yet there is a growing understanding and acceptance that future food security is dependent on harnessing and sustaining agricultural biodiversity and its many functions in the farmscape [Pimbert, 1999].

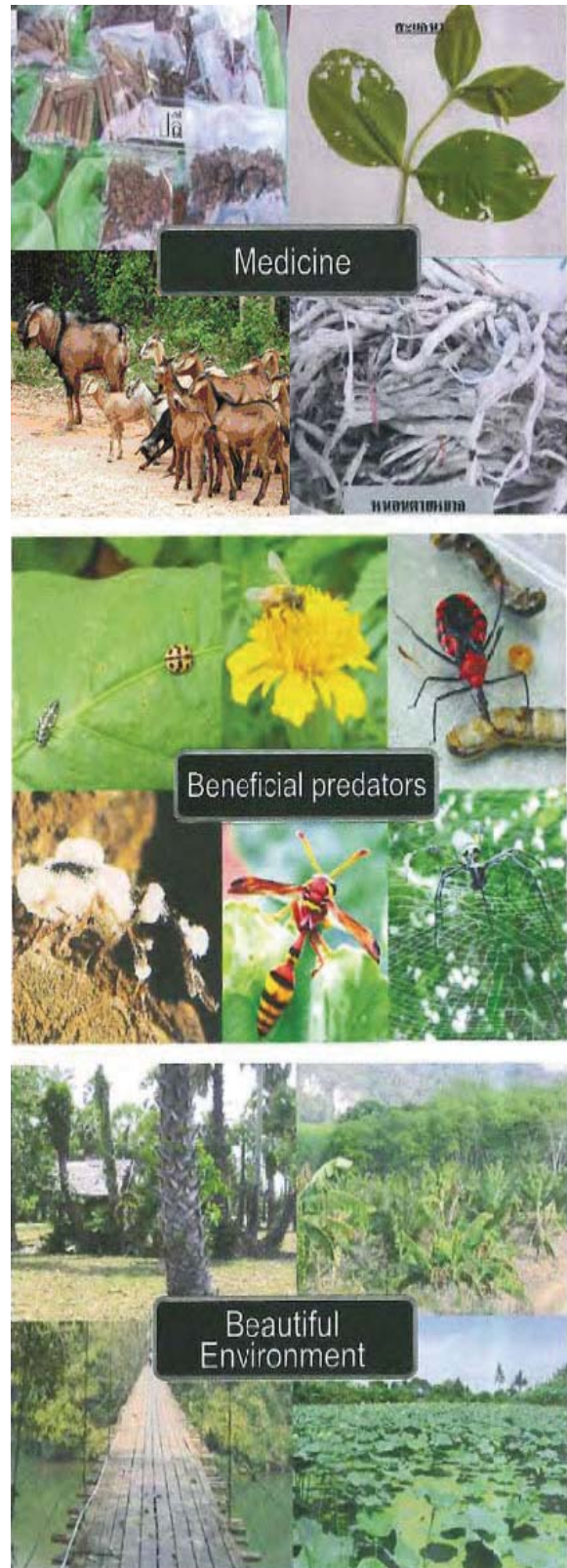
More and more natural ecosystems in Lao PDR such as forests, grasslands, wetlands are being converted to agricultural land, industrial tree plantations and settlement areas to provide food and other goods and





services to a growing number of urban consumers as well as for export to other countries. The unsustainable use of these resources has led to rapid changes in the natural environment (e.g. recently, the extinction of important indigenous species seems to be increasing) resulting in loss of some of indigenous forest, aquatic and micro-organism species, which could then lead to an imbalance in ecosystems. A consequence of this is the reduction of a variety of useful species that are important for food and agriculture, but also potential impacts on ecosystem functioning, resilience, and interactions. Due to the increased rate of reduction of natural ecosystems for farmland, agricultural land plays a greater role in providing habitats for biodiversity within the country. This also means that the farmers managing agriculture land have an ever increasing role in the conservation and management of the habitats on the farm where high levels of biodiversity exist. The expansion and intensification of agriculture has transformed the landscape into mosaics of intensively managed fields interspersed with forests, trees, rivers, streams, canals and other non-farmed areas. While these areas are important for providing habitats for many species, the nature of fragmentation also results in losses of many species of flora and fauna.

In today's highly competitive world, cost-effectiveness of farming practices is a major concern of farmers in Lao PDR. It is important, however, that all elements are reflected in assessing the cost-effectiveness of a production. Among others, loss of biodiversity is an important element to be considered. The biodiversity in Lao PDR has a substantial economic value that should not be overlooked. It needs to be fully appreciated and integrated into farm planning [MAF and STEA, 2003]. Recent field surveys revealed the high proportion and variety of products of importance to the daily livelihoods of rural Lao families gathered from both within the farmscape and nearby forests. They are used for food, medicines, provide a source of income and have many other uses. Over 450 edible NTFPs have been recorded so far, and include edible shoots and other vegetables, fruits, tubers, mushrooms, small water animals and wildlife. In poorer families, NTFPs can account for over 50% of the diet, especially when tubers, roots and bamboo shoots replace rice. Fish from forest streams play a critical role in food security and nutritional diversity. It is a major source of protein which accounts for as much as 70-90% of protein intake in the lowland areas of Lao PDR. In addition to maintaining their food security, all rural communities around the country use the wide range of natural ecosystems as source of their cash



income. NTFPs are estimated to make up over 40 percent of total rural income in Lao PDR. The diversity of NTFPs consumed reflects the rich agricultural biodiversity of the rural landscape in Lao PDR [MAF and STEA, 2003].

Unlike in many other countries, the loss of biodiversity not only means the loss of esthetical and social value which is difficult to assess, in Lao PDR biodiversity losses are, as mentioned above, directly linked to losses or reductions of a diversity of wild foods which are an important component of the diets of people and their daily life. Loss of biodiversity can also have an impact on the cost-effectiveness of production since loss of pollinators, beneficial insects, soil builders and other species is counterproductive to enhanced agricultural productivity. An understanding of how to maintain high levels of biodiversity in farmland areas is therefore essential. It is important to be profoundly aware of the consequences of reduced biodiversity on the farm.

The quality of biodiversity is difficult to measure and is a constant subject of discussion among researchers. Which indicators should be used for assessing the status of the biodiversity of a certain area? And how should it be measured? It is not enough to count species since the interaction as well as the function and ecological relationship of each species is important. Different species have different roles in maintaining diverse ecological systems. Physical elements of the landscape structure such as field size, degree of fragmentation, natural area buffers and the presence of "corridors" all have an impact on farmscape biodiversity. For ease of discussion the different functions of biodiversity in Lao PDR agriculture can be divided into seven categories:

- Income
- Supply of food
- Materials
- Medicine
- Social/cultural value
- Aesthetical value
- Beneficial predators

The categories are based on the benefits to farm livelihoods of the people living in the rural areas. These seven categories of functions represent how biodiversity is used by farm families. It includes functions related to the production of livestock and crops and uses of indigenous flora and fauna. It includes the functions of organisms and structures supporting agriculture production such as pollinators of plants, improvers of soil, and natural predators and parasites. It also includes aesthetic and cultural values. Such biodiversity can be found all over the farmscape: in the field, around the field and in the homestead. Farmscape biodiversity changes dramatically from season to season and within cropping cycles. The hardest and most critical time for biodiversity is the dry season when there are few plants, which form the foundation of the food chain. This is especially pronounced in the hot and dry lowland areas of the country. The dry season is also the time when most people have least resources and are more dependent upon supplementing their diet with natural foods from the farmscape as well as from wetland systems and nearby forests. Because the relative number and diversity of organisms is so low at this time, poorly planned or over-harvesting of natural organisms by farmers have the potential to have negative impacts on biodiversity.

The following chapters describe the major agro-biodiversity farmscape and their use and importance based on the 7 functional categories in the farmscape.



### 3. Agro-biodiversity Overview of Lao PDR

About 80% Lao PDR is mountainous with steep to moderate slope. In general, Lao PDR is influenced by tropical climate, which is mainly dominated by southwest monsoon and typhoons. The rainy season starts in mid-April and lasts until mid-October, and the rest of the period is dry season. Average rainfall ranges from 1650 mm to 1950 mm but high mean annual rainfall of more than 2500 mm are identified in northern and eastern part of Vientiane Province to western area of Bolokhamxai and upto more than 3700 mm in Bolaven plateau. Monthly rainfall very much differs. More than 90% of rain is concentrated in the rainy season. Mean temperature ranges from 22.4°C to 29.1°C. In lowland areas, mean maximum temperature increases to more than 32°C during the transition period from dry to rainy season and the mean minimum come down to below 10°C in dry season. Occasional occurrences of frost are identified in high mountainous areas above 1200 m amsl.

Laos has enormous water resources, both surface and ground water. There are 33 medium to big rivers of which 28 are tributaries to the Mekong River which flow down to South China sea and 5 in the north-eastern part of the country which flow eastward into the Gulf of Tonkin.

Most soils in Lao PDR are acidic; poor in minerals and organic matter; have comparatively less cation exchange capacity; and have a shallow layer of suitable soil for agriculture use. The soils that are appropriate for agriculture use are estimated to cover about 2.4 million ha, with a slope less than 30%, are mainly found in alluvial and depression areas along the Mekong river and other river basins. Of this area less than 260 000 ha are appropriate for irrigation [STEA 2000].

MAF and STEA (2004) described Lao PDR as a multi-ethnic society (49 main groups encompassing over 230 ethno-linguistic groups) with high cultural diversity. A high proportion all of ethnic groups, totalling 60% of the total population, can be found in every province. The groups' social systems, cultural characteristics and identity are linked to their languages, geographical area and surrounding ecosystem, their interaction with the physical environment, and their access to material goods. Based on these characteristics the country could be divided into four regions including North, East, Central and South (table 1). An overview of the agro-biodiversity of Lao PDR can be broadly described on such a regional basis.

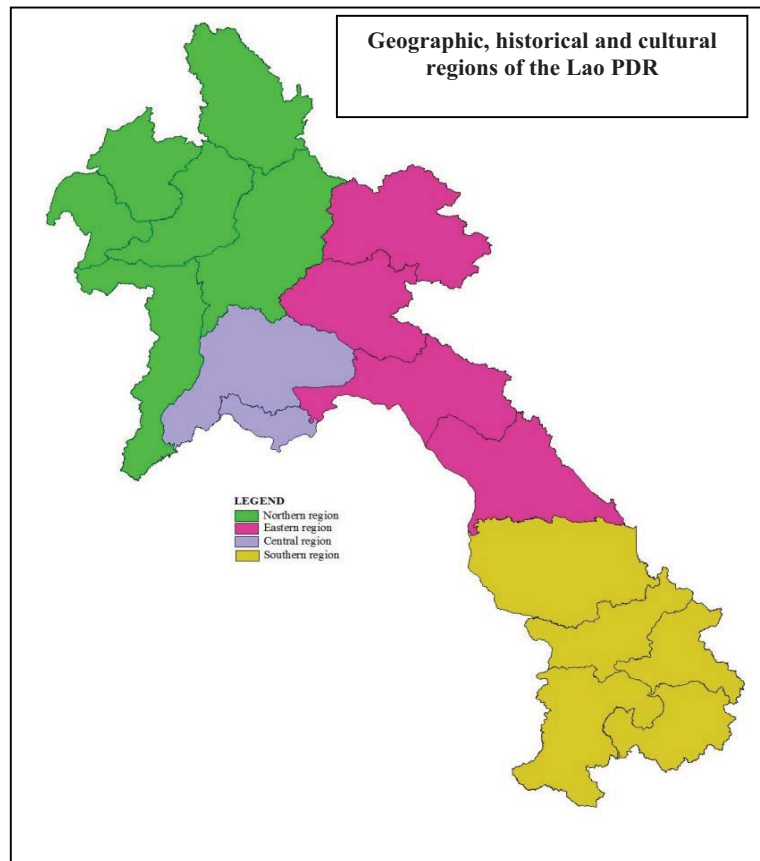


Table 1: Geographic, historical and cultural regions of the Lao PDR

Geographical Area	Region	Historical Lao Kingdom and External contacts	Provinces	Predominant Ethnic Categories
Upper Mekong	North	Louangphabang (Lanna Sipsong panna)	Louangphabang, Phongsaly, Lounagnamtha, Bokeo, Oudomxai, Xayabouly	Lue, Lao, Mien, Hmong, Tibeto-Burma, Khmuic, palaungic
Upper Annamite	East	Xiengkhouang (Sipsongchoutai, Than Hoa, Nghe An, Quang binh)	Houaphanh, Xiengkhouang, Bolikhamxai, Khammouane	Tai, Neua-Phouan, Phouthai, Nyo, Hmong, Khmuic, Vietic, W. Katuic
Central Plains	Central	Vientiane (Upper NE Thailand)	Vientiane province, Vientiane Capital	Lao, Hmong, and mixed internal migrants
Lower Mekong Basin	South	Champasak (Khmer, Lower NE Thailand)	Savannakhet, Saravanh, Champasak, Sekong, Attapeu	Katuic, Bahnaric, Lao, Phoutai

Source: NSC/ADB 2001 in Biodiversity Country Report 2004 (2004).

When talking about agricultural landscapes the discussion is usually focused on the physical land being cultivated: fields, orchards, and plantations. But the cultivated only covers a portion of the farmscape area. There are many other areas that are not covered by crops but still belong to the farmscape.

Five physically discernable ecosystems are found in the farmscapes in Lao PDR:

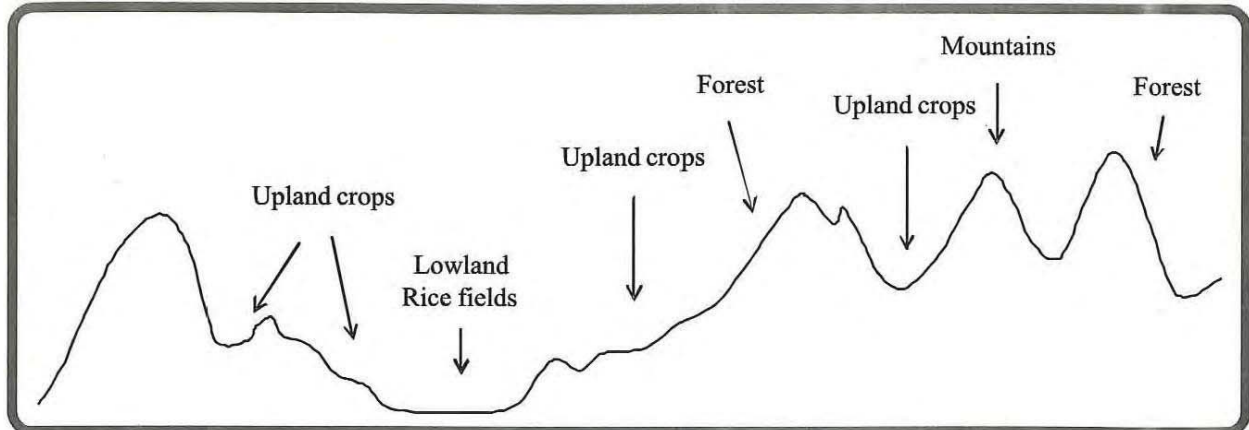
- Water ecosystems (including rivers, streams, ditches, ponds and wetlands and rice fields)
- Field borders (including roadsides)
- Trees and forest areas (including small parcels of forests within cultivated areas, individual trees, and groves)
- The homestead
- Cultivated and fallow fields (including annual and perennial crops)

The type and level of agro-biodiversity differ across the various farmscape ecosystems, which are further affected by specific physical and management variables. An important variable is also the extent of fragmentation of the various ecosystems in the farmscape and how isolated they are natural ecosystems.

### 3.1 Northern region

#### 3.1.1 Landscape characteristics of Northern Region (Louangphabang, Phongsaly Lounagnamtha, Bokeo, Oudomxai, Xayabouly)

The region is largely characterized by rugged topography with high mountains and steep slope. About ¾ of the region drains west and south-ward into Mekong River except its western part on the right bank of the Mekong drains eastward into the Mekong. Northern region is biggest in size and poorest compared to other regions. Several floodplains are identified along many rivers and along the banks of the Mekong



Rivers. Fertile valleys of varying extent are found interspersed with moderate sloping hills along most rivers running through the region. No large plain exists but a number of small plains are found in many places throughout the region. There are 15 large and medium-sized rivers throughout the region, all being Mekong tributaries. These rivers serve as very important sources of water for consumption, agriculture, ecotourism, transportation and industry. The seasonal changes of the rivers, especially the Mekong River in the north, are dramatic with much difference in water fluctuation between the dry and wet season. As water recedes in the dry season, a range of sub-ecosystems are revealed such as fertile lower part of the river bank, sandbars, pebble flats, reef beds, and rocky outcrops [Lazarus *et al.* 2006]. These areas become important cultivation land for many dry season crops such as beans, maize and vegetables as well as an important habitat for migrant birds, insects and other riparian animals. The region also has tremendous sources of ground water.

The climatic conditions are strongly influenced by an annual monsoon cycle, with the wet south-west monsoon from April to October (rainy season) bringing an average of about 90% of annual rainfall. The climate is characterized by two distinct seasons: rainy and dry seasons. Mean annual rainfall ranges from about 1200 mm to about 2000 mm in ordinary years and about 950mm to 1500 mm in drought years. Average mean temperature in the region ranges from 19-28°C, while the average maximum and average minimum temperature are in the ranges from 25-34.0°C and 14 – 23°C; respectively. In certain months e.g. December and January temperature may drop to near to freezing point in many high altitude locations.



The Mekong in the northern part is of strategic importance as it links the region, and the country to China, Myanmar and Thailand. The improved road networks (such as Road No. 1; No. 13 North and the newly constructed Road No. 3) act as important links of the region to the rapidly growing economies of China and Vietnam. This has tremendously influenced changes in many aspects: socially, culturally,



economically, and environmentally. Land use and farming systems and practices have undergone fast and great changes. A shift toward monocropping with rubber and other cash crops are evident in a rapid pace. Contract farming, whereby large commercial companies provide inputs, advice and finance to farmers is also increasing. The advantages of improved transportation make such contract farming more attractive economically.

The Northern region represents the largest deforested area in Lao PDR. A mosaic pattern of land use is very common. The land use system is fairly diversified. Paddy fields occupy the plains as well as the low-lying areas with gentle slopes in form of bunded terraces. Higher up the slope as well as at the tops of several mountains shifting cultivation is a prominent feature of farming system in this region. It covers areas with over 20% slopes and is found in all agro-ecological zones from mountain valley to top. The agro-forestry system is receiving growing interest in many areas as access to land becomes more difficult. Mosaics of fallows of different ages is found scattered in large continuous blocks. Forests have been cleared for agriculture use in the region and remain only in areas unsuitable for agriculture, remote places and protected areas. In areas of extensive upland cultivation, only small patches of forests are found on steep slopes and along the streams, being kept to protect the water sources. More than 60% of the region's habitat has been converted to shifting cultivation and mono-cropping of commercial cash crops and tree plantation such as rubber and teak. Aquaculture in ponds and empounded segment of streams has become important components of farming system in many parts of the region.

### 3.1.2 Dominant type of crops

Topography, climatic condition and cultural and socio-economic conditions of the north are diverse and influences the types of crops grown. Rice is the most important cultivated crop for the majority of people in the north. Paddy rice is prominently cultivated in paddy fields and bunded terraces in the flood plains and valley bottom while upland rice in shifting cultivation areas at higher slopes. With the trend toward decreasing fallow length, many farmers have begun to turn to non-rice crops such as soy bean, peas, maize, sweet corn, job's tear, sesame, ginger, banana, papaya, and a number of fruit species and varieties particularly tangerine, orange, citrus/lemon, mango, zyziphus, and longan. Root crops, cucumber, brinjal, and chilli are also grown during rainy season in their shifting cultivation plots. Lemon grass, papaya, chilli, basil, coriander, mint and other leafy vegetables and medicinal plants are found in homesteads and around the fish ponds mainly grown for daily home consumption. Raising poultry, sometimes together with pigs and/or fish farming are important integral components of the homestead production system. Watermelon, cucumber, gourds, chilli, egg plant and a number of species and varieties of green vegetables especially cabbage, lettuce, onion and garlic are widely grown along the river banks, in paddy fields, and on field borders, where access to water is possible during the dry season. This type of production is usually accompanied by a heavy use of chemical fertilizers and pesticides.

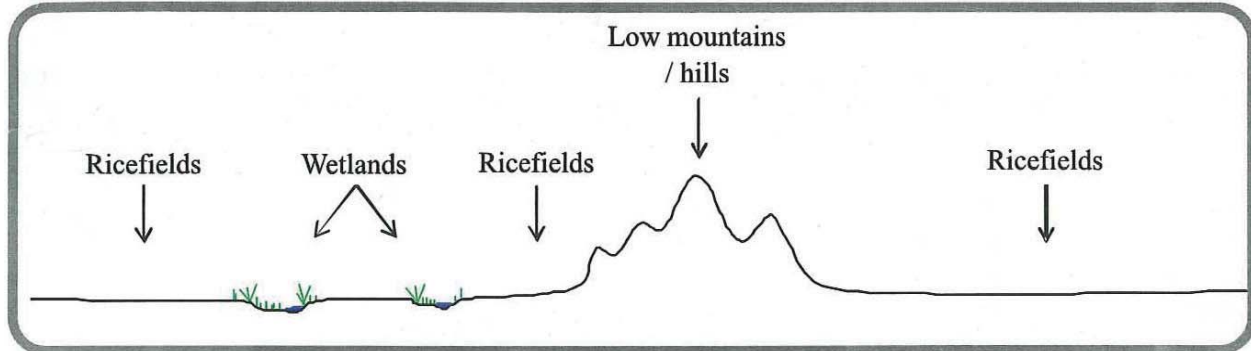
The crops grown, maize, job's tear and sesame are found to be cultivated extensively in most provinces and involves a heavy use of chemicals as there has been a very high market demand in China, Thailand and Vietnam. Teak plantations which were common under the taungya<sup>1</sup> system are found both in separate plots near to the settlement areas as well as in lines and in small patches within and at the edge of fields. With the rubber boom during the last 10 years, extensive areas along the roadsides and fallow land or even forests have been converted to rubber plantations which causes a number of livelihood problems locally as it takes away land which could have been available for other production systems (including livestock rearing). It also limits the access to wild resources for daily subsistence. Sugarcane is planted in some areas close to Chinese border e.g. in Phongsaly and Sing District. Tea is becoming another cash crop which is getting growing attention in higher altitude areas in Phongsaly and Oudomxai. Domestication of highly commercial NTFP has been expanding. Important products domesticated include paper mulberry, cardamom, galangal and sapan.

<sup>1</sup> An agro-forestry system for intercropping teak with agricultural crops in the early stages.

## 3.2 Eastern Region

### 3.2.1 Landscape characteristics of Eastern region

The eastern region has more diverse eco-region and ecosystem than other regions of the country covering



the provinces of Houaphanh, Xiengkhouang, Bolikhamxai and Khammouane. The region encompasses two plateaus: the Xiengkhouang plateau and the Nakai plateau, the Annamite range, limestones karst formations, lowland plains and a large wetland ecosystem. The region is rich in water resources which supports tremendous aquatic, semi-aquatic and riverine biodiversities. A number of main tributary rivers of the Mekong River originate in this region including Nam Ngum, Nam Xan, Nam Kading, Nam Ngiep, Nam Mang, Nam Hinboun and Xebangfai. In addition it also covers 2 main watershed areas of the two rivers, namely Nam Ma River and Nam Ka River which are located outside the Mekong River Basin and expanded in the eastern area of Houaphanh and Xiengkhouang provinces. Both rivers flow into Vietnam and finally into the gulf of Tonkin. The total area of these two watersheds is approximately 1.5 million hectare. The region also holds a number of National Biodiversity Conservation Areas such as Nam Et-Phoulei, Nam Xam, Phou Khaokouay, Nam Kading, Phou Hinpoun, Nakai-Namtheun, and Hin Namnor. Two corridor zones are also present.

The eastern region receives fairly high rainfall. Most parts of the region have mean annual rainfall over 2000 mm. Climatic conditions varies from hot in the lowland plain to sub-tropical at higher altitude in the



northern part. The mountains of the northern part are biologically distinct from the Annamites in the central part and the part lying along the Mekong (dry forests). Assemblage of subtropical species is predominantly present. The Annamite ranges and foot hills hold distinct wet evergreen forests with high species endemism. Dry forests are found in the limestones karst and lowland parts of the region.

Various farming systems are practiced in the region. These include lowland rainfed farming system, lowland irrigated farming system, upland rainfed farming system, highland farming system and plateau farming system. The lowland part of the region is prone to flooding. Integrated rice-fish culture in the paddy field is widely practiced, notably in Xiengkhouang and Houaphanh where the ethnic groups traditionally manage fish in their rice fields using a number of techniques that enhance fish recruitment and maintain broodstock during the dry season.

### 3.2.2 Dominant type of crops

In the lowland rainfed single cropping farming system traditional glutinous rice varieties are dominant. Double cropping of improved varieties in mixture with lesser proportion of traditional varieties of rice, dry season cash crops and vegetables growing are widely practiced in areas where irrigation exists. Free ranging system of large and small livestock is common. Extensive areas in the lowlands (Bolikhamxai and Khammouane) have been converted to agriculture land as well as to Eucalyptus and rubber plantations. Banana is widely planted in homesteads and areas around the farmland with pineapple, papaya, pumpkin and sugar cane. Tobacco is an important crop planted on paddy field in dry season under contract farming system with tobacco companies in Vientiane. Eaglewood, rattan, and fruit trees cover significant areas.

Upland rice under shifting cultivation system is prominent in sloping areas and more extensive in the north and eastern parts of the region. Highest number of crops cultivated is found in the upland rainfed farming system which include, after rice, sweet potatoes, soybean, ground nut, cassava, garlic, maize, cotton, papaya, banana, ginger and various sub-tropical fruit species. Melons and water melons are grown as dry season crops in some areas. Mulberry planting for silkworm rearing is another important feature of the region which fetches a sizable income to farmers.

The plateau farming system distinctly differs between Nakai and Xiengkhouang plateaus. Being a national biodiversity conservation area and less populated, agricultural activities are found in small pockets where there are settlements. Paddy rice is cultivated with horticulture crops mainly for local consumption. Upland rice is also cultivated but at lesser extent as a number of development activities have taken place in the area through compensation schemes of hydropower projects and biodiversity conservation programmes. In Xiengkhouang more diverse agriculture activities are found. With large areas of natural grassland Xiengkhouang plateau is dominated by large livestock raising. Upland rainfed and irrigated rice farming is widely practiced in suitable locations and at lower altitude. The area is very well known for temperate fruit trees such as plum, peach, pear and passion fruits. Vegetable growing and other crops such as cassava and potato are also found in many places. Many crops grown in the area have been introduced through projects. The soil on the plateau is highly acidic and not suitable for annual crops. Planting of introduced grass species and forage crops for feeding livestock is expanding as improved technologies to overcome acidity and other climatic barriers are available. Under a strong driving force of market demand extensive areas are also cultivated with maize. Fish aquaculture is another dominant activity on the plateau.

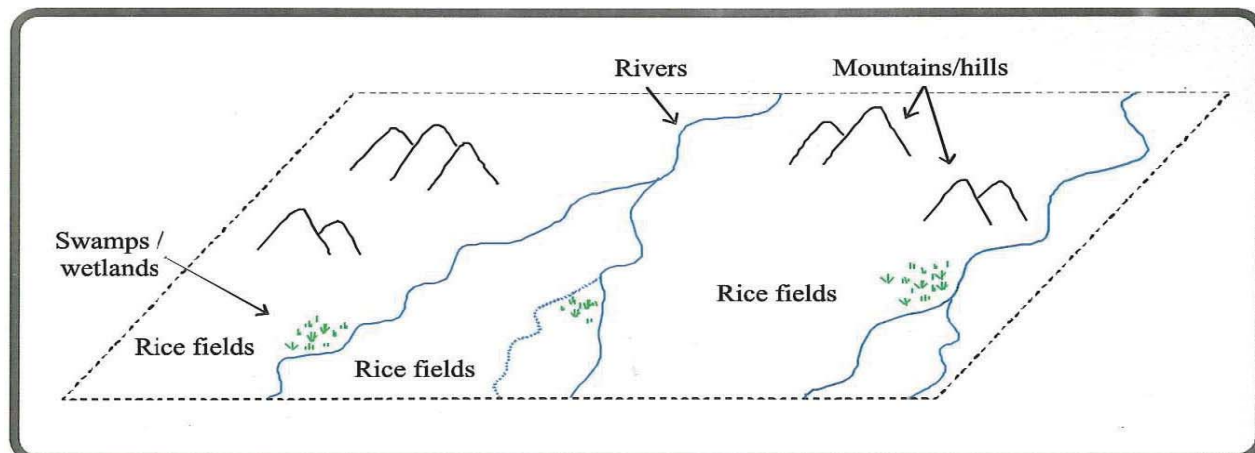
High altitude crops such as sub tropical and temperate fruit trees (plum, peach, local apple), asparagus, mustard and tea are cultivated in high land area. Some of the crops are local and some are introduced.



### 3.3. Central Region

#### 3.3.1 Landscape characteristics of Central region (Vientiane province, Vientiane Capital)

The central region is an important rice production area of Lao PDR. It covers a large flat alluvial plain created by the rivers Mekong and Nam Ngum and their tributaries on the western and southern parts. The topography of the region is rugged in the north and to the east. The region encompasses large wetland areas, both natural and manmade. A number of manmade reservoirs exist for irrigation and hydropower purposes. These provide the region with a vast supply of water for irrigation of rice through a networks of



a complex canal systems. Mean annual rainfall of the region ranges from about 1600 mm to 2500 mm. The region is relatively warm compare to the northern and eastern regions. The altitude ranges from 160 m amsl in Vientiane to 2820 m at Phoubia in Vientiane Province which is the highest point in Lao PDR. There are two distinct seasons, dry and wet each lasts more or less half a year. The wet season starts around mid- April and lasts until September. Being an area of increasing infrastructure and economic development activities land conversion is rapidly expanding. Large areas of wetland and agriculture land are converted as a result of rapid urbanization and high population growth.

#### 3.3.2 Dominant type of crops

The central region is densely populated and holds nearly one-fourth of the country population. A range of agricultural production activities is taking place and increasingly becoming bigger in scale in the region to feed the increasing population. The main crop grown in the central region is rice. Because of rich water resource and irrigation facilities most of the paddy field areas is cultivated twice a year. Nearly all permanent agriculture land is on areas with less than 5% slopes. As there is a great demand, vegetables and cash crops such as green leafy vegetables, long bean, tomato, egg plant, cucumber, water melon, sweet corn, papaya and banana are more extensively grown than in other regions to supply to Vientiane town. Fruit trees of several species, including sapota, zyziphus, mango, coconuts, lemon, pomelo, longan, and tamarind are expanding and evidently grown at a larger scale during the last decade. Most fruit varieties have been introduced from neighbouring countries, especially Thailand. Flower planting is receiving increasing interest. Rubber planting is relatively less active than in other regions. Instead biofuel crop plantation, particularly jatropha is expanding at a rapid rate both in Vientiane capital and in Vientiane Province. Domestication of NTFP at a commercial scale e.g. rattan for shoot production, bamboo for shoots and culms is sporadically found along Nam Ngum river and is far smaller compared to eagle wood which is planted rather widely. However, tree plantation of mainly



Eucalyptus and teak, are decreasingly grow, but still planted in small plots and also along farm borders and in homesteads.

Cultivation of many of these crops, especially vegetables involves extensive use of chemical pesticides. The use of chemical fertilizers are also high in rice farming. Natural food harvesting in the farmland as well as in natural streams is decreasing due to increased pollution and overharvesting.

Cattle, pigs and poultry farming are increasing in size and number. Different systems of fish farming such as ponds, in cages in rivers, in paddy fields, and in reservoirs is another distinctive feature of the central region. Fresh water shrimp and turtle farming are new business in the area and still at a smaller scale compared to fish and livestock.

In the mountain slopes and foothills, upland rice and other upland crops such as sesame, banana and fruit trees are the dominant crops.

### 3.4 Southern Region

#### 3.4.1 Landscape characteristics of Southern region (Savannakhet, Saravanh, Champasak, Sekong, Attapeu)

The southern region is the rice bowl of Lao PDR. The region is characterized by large areas of flat land covering most of the western part and extending from the north through to the south. This flat part is the driest area and covered by an extensive area of dry Dipterocarp forests, as well as where paddy fields are most concentrated. The big central portion of the southern part of the region is covered by Bolaven plateau. A large stretch of low lying of flat and gentle sloped land borders around the plateau before the region is curtained from Vietnam by the Phoulouang range on the far eastern end. The Mekong runs through the region as it enters into Champasak province. A number of main tributary rivers to the Mekong providas a tremendous supply of water to agriculture in many parts of the region throughout the year. Revealed river banks and emerged island along the river courses have added sizable fertile arable land suitable for planting several short rotation annual crops. The region is rich in forest and biodiversity. It encompasses 8 NBCAs covering more than one-third of total NBCAs in the country.



Like other parts of the country, the region has two distinct seasons, wet and dry. Despite being the most drought affected region the highest annual rainfall, above 3700 mm, in the country is concentrated to the Bolaven plateau. The plateau is highly humid and has very fertile soil suitable for a range of crops. Most parts of the region, in general, receive rainfall of above 2000 mm. The driest areas with mean annual rainfall of about 1400 mm are however found in the lowland plains in Savannakhet.

#### 3.4.2 Dominant type of crops

Paddy rice is the dominant crop in the lowland plain. Increased use of improved rice varieties is evident. In many areas, a ratio of up to 70:30 of improved to traditional varieties in terms of area cultivated is found. The main components of the farmscape in general is composed of paddy fields, pond for fish farming and lotus growing, homestead (with poultry, vegetables and crops for daily home consumption needs, tamarind and mango), trees (individuals and clump), field borders for keeping livestock and

growing non-rice crops such as cassava, banana, sweet corn and papaya). In many farmlands Eucalyptus is also planted in areas around or immediately next to the paddy field. Trees or groves within the farmscape is distinct feature of the paddy field in southern region. This forms a good source of food, fruits, wild vegetables, frogs, insects, to farmers and shelters for their livestock in many areas during rainy as well as dry season. Improvement and upgrading of road network in the region has left many ponds and grazing areas along the roadsides. Growing of leafy vegetables, beans, peas, onion, garlic and several other dry season crops is concentrated along the river banks, on submerged parts of the islands as well as in gardens near to the settlements. Watermelon is widely planted as a dry season crop in Savannakhet. Sugarcane cultivation is expanding in Savannakhet with the establishment of sugar factories. Tobacco is widely planted in all the provinces of the southern region for sale to tobacco factories in Savannakhet and Vientiane. A range of fruit species are grown in the lowland but mainly in form of few trees around homestead. There are not many fruit orchards present in lowland areas.



The plateau farming system is diverse in number of crops cultivated. Most of the natural habitat on the plateau is converted for agriculture use as the soil is very fertile. Urbanization takes up a sizable area. Several private companies are operating in the area. Most of the yields are for sale. The upper part of the plateau, above 800 m amsl, is mainly occupied by plantation of several coffee cultivars. Other crops grown include tea, saveu (local name), and cabbage. At altitudes between 600 – 800 m amsl, plantation of various fruit trees, both traditional and introduced species and cultivars, are dominant. Durian is the most planted fruit tree in

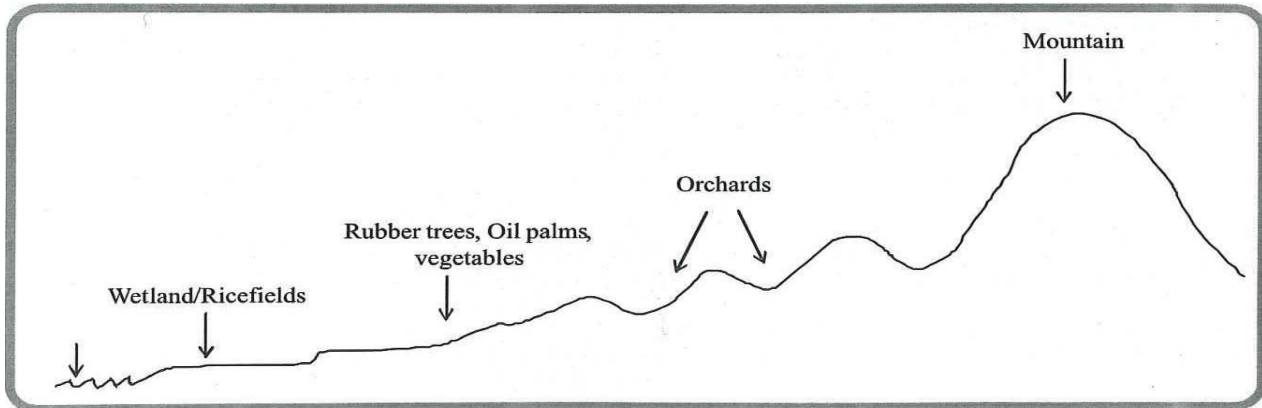
homesteads as well as in larger plantations. Local rambutan and soursop are occasionally seen. Pepper and betel leaf are also grown in small plot in residential areas. At lower altitudes, on the slopes, upland rice and a range of horticulture crops are grown among which banana is grown to a large extent. Other crops include papaya, pineapple and groundnut. A large area of this zone is converted to rubber plantation. Teak plantations covers a sizable area but are currently being converted to other land use. Cardamom is also grown in this zone.

Subsistence farming is still dominant along the eastern part of the region with shifting cultivation being the prominent system on foot hills and on the slopes of the mountain range. After upland rice, banana, maize, peanut, taro, cassava, and pineapple are also important crops. Along this tract, local people are among the poorest in Lao. Large areas of fallow and degraded forest lands are therefore being converted to Eucalyptus and Bongbark (*Persea kursii*) plantations by foreign companies under poverty reduction programmes. Rubber plantation is also expanding fast in many places.

## 4. Description of major agro-biodiversity farmscapes

The farmscapes of Lao PDR and their associated biodiversity is described in the following section. Earlier the geographical and climatic differences between the regions were described. These differences contribute to the differences in the nature of biodiversity in the regions. These differences will be highlighted in the text.





## 4.1 Water Ecosystems

Water ecosystems are plentiful in agricultural systems in Lao. The landscape is literally laced with an array of water bodies - large rivers, small streams, canals, ditches and ponds - and they are very important habitats for the biodiversity, especially during the dry season. The water ecosystems can be split into the following ecosystem categories:

- Farmland ditches
- Irrigation canals
- Rivers
- Rice fields
- Wetlands
- Ponds

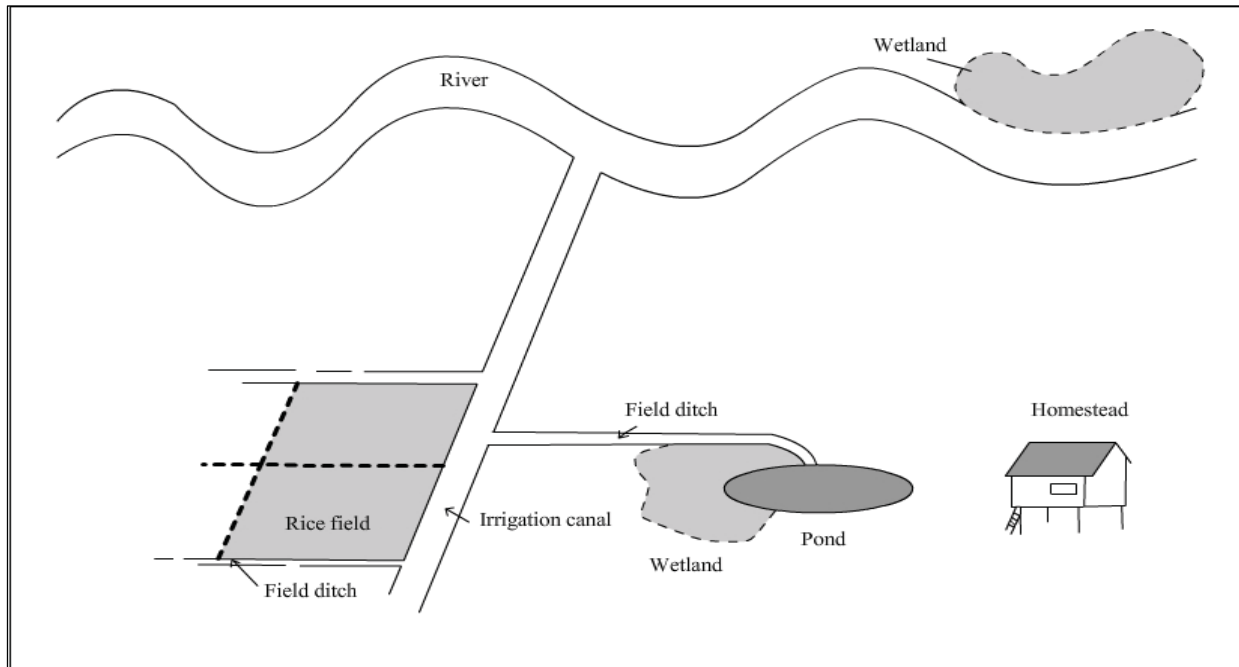


Each ecosystem has its own specific characteristics. Characteristics which differentiate these eco-systems from an ecological standpoint are:

- Depth of water
- Flow of water
- Area (width of water body)
- Plant community in water
- Animal community in water
- Seasonal fluctuations (in all of above)
- Shoreline characteristics



There are also many similarities between the water ecosystems, since most of them are connected they often share ecologically important sources of biodiversity



The figure below illustrates how the different water ecosystems in the landscape are linked and how they are dependent on each other.

Rivers begin in the mountains and flow through the agricultural areas of Lao. Water for irrigation flows from the rivers through canals to the fields. From the canals a further network of small field ditches distributes the water to each field.

In addition to rivers, there can also be other larger water bodies such as lakes and wetlands used for a year round supply of water.

Some water bodies come and go with the rainy and dry seasons, especially ponds, field ditches and some wetlands. The survival of the biodiversity associated with intermittent waterbodies is often dependent on the linkage between the intermittent and permanent water ecosystems which contains water the entire year.

### Differences between regions

There are many large rivers in Lao PDR that flow from the north to the south, such as Nam Khan, Nam Ou, Xe sap, Xedon, Xebanfai, Xekhong. In addition there are wetlands which provide available water throughout the entire year. The water resources are used for agriculture in the country e.g household garden using a canal to supply water for agricultural production.

Available water resources may change resulting from heavy rains during wet season and drought during the dry season. Particularly ponds, streams and some wetlands maintain critical level of biodiversity in relation to the level of water flows.

### 4.1.1 Farmland ditches

#### Characteristics

Farmland ditches are often narrow intermittent waterways, which come and go with the rainy and dry seasons and use of irrigation systems. They are often very straight to ensure an easy flow of water and will have a limited flow when water levels are low. The sides and bottoms of ditches will often be kept clear of or low in vegetation. In the wet season when there is plenty of water, the water is distributed to the fields by making holes in the sides of the ditches. When the water level is too low, the water is pumped from the ditch to the field.



During the dry season the farmland ditches will slowly dry out in areas where there is limited access to water. In areas with a plentiful water and multiple cropping supply ditches may remain wet the entire year.

#### Species

Farmland ditches have many plants on the banks, mainly grasses, low bushes and single trees, which are hosts to a variety of insects and other organisms. Some areas will also grow fruit trees on the ditch banks. The ditches are home to smaller types of fish, mussels, and often the rice pest, the golden apple snail. The ditches are important sources of biodiversity, acting as critical links between fields and other ecosystems.



B2

Importance of the Farmland Ditch Ecosystem for the Farmscape	
Ecological	Farmland ditches are very important reservoirs of biodiversity in the farmscape, being hosts to significant plant species for pollinators, predators and parasites, and acting as links between the larger water bodies and the farmfields.
Income	Farmland ditches are very important for irrigation of fields. These areas also are sources of materials and food items that can be sold.
Supply of food	Ditches may be sources of smaller fish, frogs, molluscs and other supplementary foods.
Materials	Woody species on ditch banks.
Medicine	Some medicinal plants can be found on the banks.
Social/Cultural value	No importance



### Management practices

Ditches are normally managed to reduce biodiversity. The farmers generally will keep the areas in and around the ditches free of most vegetation either by burning, cutting or spraying herbicides to ensure an easy flow of water out to the fields. Farmers also often believe that ditches may be sources of pests such as the golden apple snail, insect pests and plant weeds.

In areas where the ditches dry out during the dry season the farmers will set up fish traps to catch the fish that migrate to the larger waterways from the fields.



### Threats and long term concerns

The field ditch ecosystem is threatened both by the direct management of the ditch, with practices of keeping the ditch as free of pests and vegetation as possible, by chemicals, physical removal and fire, and also by the management of the field around the ditches.

The impact of agrochemicals used in the fields such as pesticides, herbicides and fertilizers extends far beyond the fields as they may drift during application or through runoff, whereby they affect the biodiversity in the ecosystems around the field. However the farm field ditches will often act as a "first filter" for the agrochemicals before they come to canals and rivers, thereby minimising the effects on the larger waterways, but reducing important biodiversity in the ditches in the process.



The extensive use of agrochemicals in and around the farmland ditches will limit the variety of or kill p.on-target organisms, such as fish, pollinators and natural enemies to the past's and decomposer organisms. Biodiversity in this farms cape is thus threatened by the use of agro-chemicals. The negative impact can be seen in some field ditches, which are more or less devoid of biodiversity.

### 4.1.2 Canals

#### Characteristics

Canals are waterways, which have water flowing or is present the entire year, and will most often have been built for irrigation. They are wide and have a greater water depth and flow than the farmland ditches and will usually have a high level of biodiversity in and around them. Some irrigation canals are built from concrete to ease the water flow and limit the loss of water. This also limits the biodiversity around the canals considerably.

Most canals are associated with a high level of plant species in the water and along the banks, which can be very dense.



**Species**

Canals provide habitat for very important aquatic species, different types of fish, eels, molluscs, etc. Depending on whether the canal is built of concrete or not, it will have an abundant variety of trees, bushes and other plants on the banks to support insects and riparian species such as birds, lizards, reptiles, frogs, birds, mammals, etc. Large monitor lizards are a common feature of Lao’s canals. Water hyacinth is often found growing on the water. The golden apple snail can also be found in or by the canals. Since canals connect rivers and farmland, they often contain species found in both of these other habitats.



**Management practices**

The sides and bottom of the irrigation canals are often kept with a limited amount of vegetation to ensure free and easy water flow. The sides are sometimes burned and cut free of vegetation and some farmers use herbicides to keep the vegetation down. Because canals are larger and not owned by individual farmers, there is less done to manage plant species. Less management is done on canals where farmers maintain a fish population for consumption. In these canals the water hyacinth often needs to be regulated.



Importance of the Canal Ecosystem for the Farmscape	
Ecological	Important for biodiversity, especially in the dry season as a reservoir of species.
Income	Boat transport of people and goods ensures the necessary water for the fields. The water hyacinth grown on some canals are used to produce furniture products. Considerable aquatic species are caught and sold from canals, as products from trees.
Supply of food	Supply of fish and plants from the banks.
Materials	Water hyacinth, rush and wood from trees on banks.
Medicine	Some medicinal plants are grown on the banks.
Social/cultural value	Boat transporting is socially important and the canals are also used for washing clothes and bathing people.

**Threats and Long term Concerns**

Farmers often dump garbage in agriculture areas, especially close to waterways such as the canal banks, making some canals virtual garbage dumps with heaps of plastic bags, bottles etc. Although important, little is known about toxic chemicals in canals and the impact on the organisms which live in them.



### 4.1.3 Rivers

#### Characteristics

Rivers are natural waterways as opposed to farmland ditches and canals, and for most ditches and canals the rivers are the source of water. The depth of water is much higher and the flow is faster, with seasonal fluctuations dependent on the monsoon seasons. Rivers are responsible for the extensive flooding in some areas during the wet season. The riverbanks hold a large amount of plant and riparian species and have many aquatic plants and fish in the water.



#### Species

Rivers provide important habitats for many aquatic and terrestrial species. The riparian zones defined by the rivers are important habitats for many types of birds, mammals, fish, crustaceans, and reptiles.

Importance of the River Ecosystem for the Farmscape	
Ecological	Extremely important habitat for biodiversity. The rivers are, together with the larger canals, critical reservoirs to maintain aquatic species for re-population of the smaller waterways and rice fields during the wet season.
Income	Ensures the necessary water for the fields, especially the areas which usually dry out. Rivers are sources for many aquatic species harvested and sold in the markets.
Supply of food	Supply of fish molluscs eels, frogs, etc. The riverbanks often hold a lot of different species of wild plant and animal foods.
Materials	The stems of weeds and trees that grow on the riverbanks can be used for household items such as baskets and furniture as well as to feed livestock.
Medicine	Medicinal plants are growing on the riverbanks.
Social/cultural value	Important for moving water away from flood prone areas. Very important for transportation of people and goods. Common to have cultural boat races on the rivers. The endangered catfish and dolphins now rarely found in rivers have great cultural value.



### Management practices

Riverbanks are usually not as intensively managed as much as the banks of farm field ditches and irrigation canals, though in some areas management by cutting, burning or spraying the banks can be seen.

### Threats and long term concerns

Garbage thrown in the river and on the banks is a major concern as it is for the canals. Using waterways for garbage disposal is an old tradition and a behaviour difficult to change. The garbage is both an esthetical concern, but also with regards to pollution of the water ecosystem.

Of greater concern is however the increasing amount of pollution from industries located close to the rivers discharging untreated wastewater into the river.



### 4.1.4 Lowland Rice Fields

Rice fields have to be considered the defining characteristic of the farmscape in Lao PDR and an important aquatic ecosystem. This is particularly true the central and the southern region.

#### Characteristics

Rice, being an indigenous crop, is perfectly suited for the tropical climate of Lao PDR. It has a wetland ecology, which has developed over many millions of years, and unless agricultural pesticides are applied on a regular basis, rice fields support a diverse and complex aquatic ecosystem.

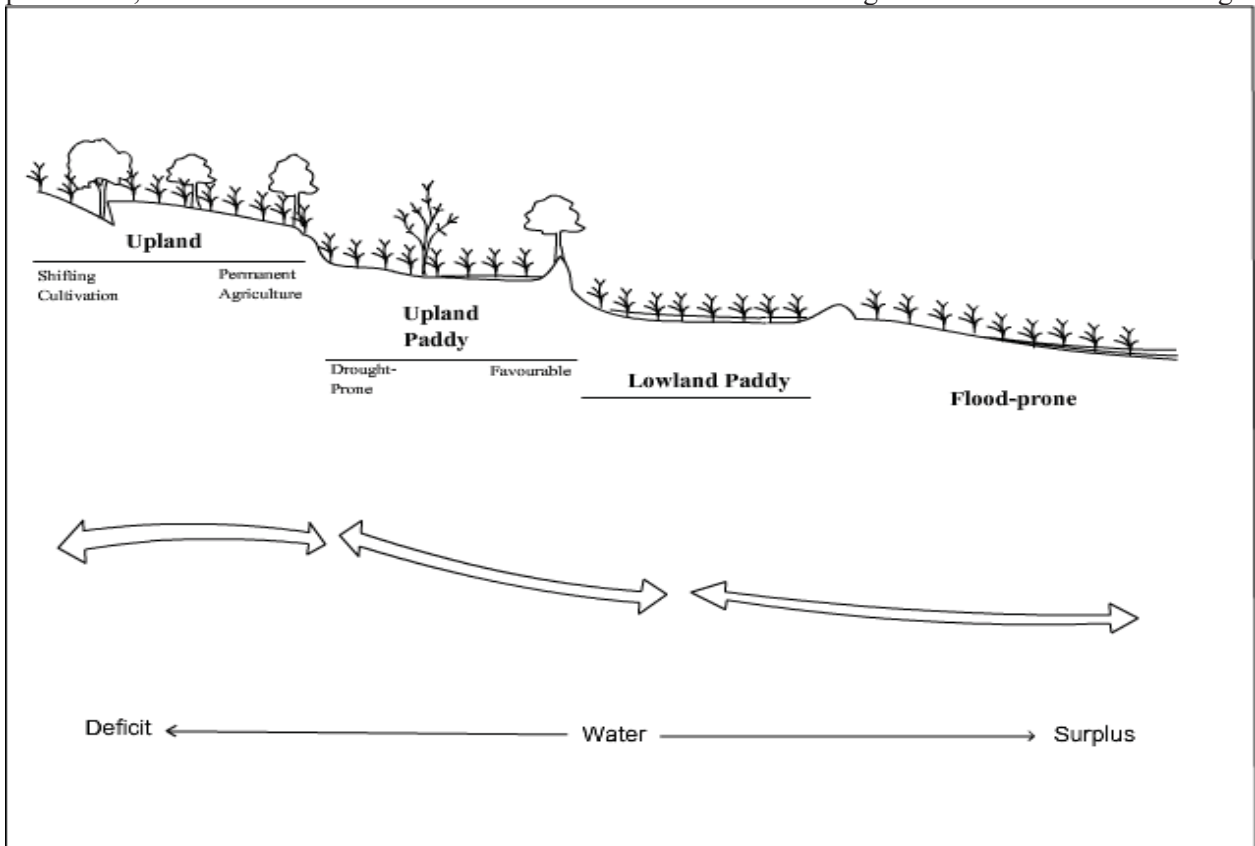
The figure below sums up the general characteristics of rice fields [Halwart & Gupta, 2004].

In addition to the obvious rice plants, rice fields can support a (limited) number of other plants, both aquatic and terrestrial. But the water environment contains a vast and dynamic population of worms, insects, fish, amphibians and molluscs, which support another biotic level of insects, spiders, birds, reptiles and mammals. Even the dikes surrounding rice fields support many species, which are linked to the species in the rice fields themselves. Rice field ecosystems are, because of their complexity, also inherently stable. That stability, which has been well documented over the years, is often destroyed through the use of agrochemicals.



Species

Rice is obviously the most obvious species in a rice field. Lao has an abundance of local rice varieties although in recent times farmers only plant a limited number of improved varieties. The specific variety of rice being grown probably has little effect on the overall rice field ecosystem, because all varieties provide the same "ecosystem function". Much has been said about the loss of local varieties of rice, and this is of considerable social, cultural and potentially economic concern, especially from a crop genetic diversity point of view. But the major ecological difference would probably be in terms of the amount and difference of chemicals used to support one rice variety versus another, and the level of water appropriate for a good crop. High yield varieties tend to be short and require greater water control for optimum production, where as traditional varieties are taller and withstand higher levels of water for longer



periods. This difference in water level may indeed have a significant impact on population of certain kinds of organisms, which require greater and more constant water depths, such as fish, shrimp etc.



Fish and shrimp are a very important component of rice fields, although not as much as they used to be. In the monsoon season, rice fields act as propagation grounds for countless species of fish. These fish used to be very important by-products of rice fields for which farmers were heavily dependent.

Crabs, while a pest of rice, are also a highly sought after food by farmers. Freshwater crabs are endemic rice field organisms. But they are also pests: they eat rice plants and dig holes in dikes causing water loss.

They can survive the long dry season in holes below the soil surface. During the driest parts of the year, farmers still dig them from the field as a source of food.

Rice fields with deep water are home to many types of molluscs. Some of these are important food sources for farmers. Others, like the golden apple snail, are very serious pests because they eat rice plants and reproduce quickly.



Rice fields are havens for insects. While there are many insects, which are harmful for rice, these pests are normally kept in check by an even larger population of beneficial insects. Most of the insects in a rice field are neither directly harmful nor beneficial for rice production. Yet they play an important role in terms of supporting the overall rice field ecosystem. Rural farmers, however, consider many species of insects important sources of food.

Importance of the Rice Field Ecosystem for the Farmscape	
Ecological	Rice fields support a very high level of biodiversity. Because rice fields are connected directly or indirectly to the entire water system in the country, rice fields have very large impact over a large area. Obviously, the heavy use of pesticides and fertilizers has a negative effect on this agrobiodiversity.
Income	Rice is the major cash crop in Lao PDR and basic food for many people around the world. Residue from the rice production includes rice husks and straws which can be used for organic fertilizer production. In general the use of agrucultural residue has increased and organc fertilizer can e.g. be used for mushroom farms or other products.
Supply of food	Rice is a very important basic food for people in both rural and urban areas. The rice fields also supply a variety of other foods to the farmers such as fish, frogs, crabs, shrimp, eels, insects, etc.
Materials	Straw for fertilizer production, mushroom production and cattle feed.
Medicine	No importance.
Social/cultural value	Rice has a very important social and cultural value in Lao PDR, especially the local variety sticky rice has a significant value.

### Management practices

Farmers and the Government of Lao have built an extensive network of irrigation canals around the central plains and southern Lao. Surface water areas can now be found throughout the year in these areas This provides opportunity for farmers to cultivate two crops of irrigated rice per year instead of one crop. Traditional rice obtained all the nutrients it required from the river-borne silts, which flooded the fields from time to time, and from the dung of animals, which grazed on the fields in fallow periods. Modern rice varieties, grown under a





tightly controlled water regime, require applications of chemical fertiliser instead. This increases cash investment costs, so farmers try to maximise yields by increasing the size of fields, expanding into marginal swamp/wetland areas, use more herbicides to kill weeds, and apply other pesticides to kill insect pests, snails, crabs and rodents. Farmers may also net and kill birds, or even poison them, so as to minimise losses of fish, which may survive the pesticide applications [Halward & Gupta, 2004].



The use of machines for land-preparation has almost totally replaced animal traction. Planting and harvesting is increasingly done by machines as well, although it is still common to broadcast plant rice by hand or direct planting of seedlings.

In many areas farmers will make ditches in one end of the field to catch the rice field fish when the water begins to dry up at the end of the rainy season.

### Threats and long term concerns

Pesticide use in the rice fields is probably the most serious threat to rice field biodiversity [Note: This refers to the rice field itself and not the surrounding areas, which are important sources of biodiversity for the rice fields. These areas may have a greater impact on rice field biodiversity than pesticide use inside



the fields.] The golden apple snail and planthopper species are becoming a problem and are considered rice pests in Lao PDR. Control of these species, as well as others, has led to a substantial use of pesticide which have serious side effects on the rice field ecosystem.

Changes in rice fields to control water better in order to increase production efficiency have led to a decrease in fish diversity. Water depths (lower) and the time that water is in the field (less) put serious constraints on the habitat for fish. Less water also means greater concentrations of pesticides. The absence of ditches and small ponds for fish when water levels drop is also a

significant limiting factor for fish populations.

The practice of burning rice straw substantially reduces the organic material in the soil, for which many organisms are dependent. Because everything is closely linked in a rice field, fewer soil organisms result in lower biodiversity overall in the field. The burning of the straw also extends to the field borders, which are important reservoirs of beneficial insects and spiders to repopulate rice fields at the beginning of the season and after applications of pesticides.

The larger the field, the less border areas to act as reservoirs of beneficial organisms and the further these organisms need to travel to populate the fields. Increasing field size (and subsequent reduction in dike areas) has the potential to have a negative impact on biodiversity in rice fields.

### Differences between regions

Ponds are usually man-made and are used to farm fish, for water storage, irrigation and drinking water for livestock. Ponds in many areas dry out during the dry season, particularly in the north.

### 4.1.5 Ponds

#### Characteristics



field ditches during the wet season. Farmers will often grow edible water plants on the ponds and many species of plants on the banks.

#### Species

Ponds are critical habitats supporting a myriad of insects, aquatic and plant species both in and on the water and on the pond edges. Many of the wild species seen on the river banks can also be found on the edges of the pond.

Ponds, artificial or natural, can be found all over Lao PDR and play an important role to secure drinking water for livestock such as water buffalos and for aquaculture purposes. Often the ponds will be close to a homestead, close to a field hut or on the edge of a field. The ponds are critical habitats for biodiversity and this is especially true during the dry season, where they function as critical reservoirs for maintaining species for repopulation of fish, snails, frogs etc. in the fields and farm



The edges of the ponds will often have a lush vegetation even during the dry season, providing important habitat for insect species and food for both people and livestock.

Importance of the Pond Ecosystem for the Farmscape	
Ecological	Very important habitat for supporting biodiversity, especially in the dry season.
Income	Extensively used in the subsistence economy. Some farmers will also have fish in the ponds for sale either fresh or fermented on the market.
Supply of food	Very important for supply of fish, frogs etc. and the water and banks also support a largely variety of edible plants.
Materials	Important supply of water for people and livestock.
Medicine	No importance.
Social/cultural value	Washing of body and clothes.

### Management practices

Ponds are very important for the farmers' subsistence economy. Access to water resources especially during dry season and ponds are usually dug for water storage and to maintain a healthy level of biodiversity in and around the ponds.

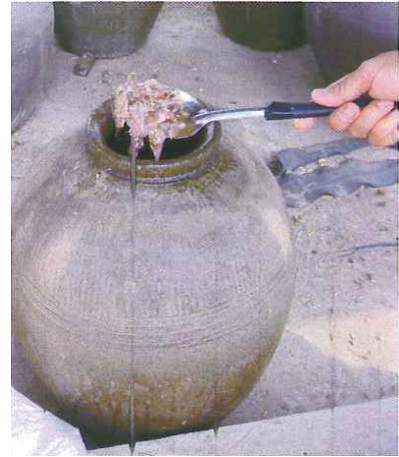
### Threats and long term concerns

Most ponds are connected to other water ecosystems and are adjacent to farm fields. Unavoidably they will also be affected by the increasing use of chemicals in agriculture. Ponds may be one of the least threatened aquatic ecosystems in the rural area.

#### 4.1.6 Wetlands

##### Characteristics

Wetlands are swampy areas where the soil is saturated with water, and can be found throughout Lao, from the uplands to the floodplains of the Mekong River. In size, wetlands can vary from a few square meters to many square kilometres. Most wetlands, particularly within farmland, are not recognized by farmers as being important and are given little attention.



Wetlands vary from areas with high water levels during the wet season to dry and swampy areas during the dry season. As wetlands dry up in the dry season they are often cultivated allowing a crop to grow on the residual soil moisture.

Wetlands have great water holding capacity, and they have an important function of helping to avoid flooding of nearby areas during and after heavy rains.



Importance of the Wetland Ecosystem for the Farmscape	
Ecological	Extremely important habitat, though under increasing pressure from agriculture.. Many wetlands are important spawning grounds for fish and vital nesting areas for birds. They are also important actors in the nutrient cycle ad in removal of pesticide residues.
Income	Hold a wide range of food and materials for the subsistence economy and for sale in markets
Supply of food	Important source of supplementary foods, such as fish, frogs, snakes, eels and a lot of edible plants and fruits
Materials	Rushes, firewood, water hyacinth
Medicine	Wetlands may contain medical plants and could be expected to hold yet unidentified plants usable for medicine.
Social/cultural value	Many wetlands in their own right or certain plants have historic, religious and other cultural value. The lotus flower found in the wetlands is for example a significant religious symbol. Religious significance is also placed on big snakes, like the cobra and python living in wetlands.

### Management practices

Most wetlands are not under active management but are used as local sources of fishing, catching of frogs, snakes and other reptiles, collection of plants and fruits for consumption and wood for fires. Most wetlands in the farmland are not recognized for their importance and are managed to reduce biodiversity. More often wetlands are managed by cutting down and burning the vegetation in an effort to limit the amount of birds, rodents, snakes etc. Wetlands in farmland are used for grazing of livestock, and as a source of water for irrigation. They are under increasing pressure from expansion from agriculture and in some areas, e.g. Vientiane, urbanisation.

### Differences between regions

Large wetlands are found in south and central Lao. Some wetlands are being converted for agriculture Wetlands in the north are distributed along riverbanks.



### Threats and long term concerns

Most wetlands are closely connected to the surrounding fields, or enclosed by fields. Spraying and application of agrochemicals will unavoidably affect the wetlands, but many wetland plants have the capacity to remove toxic substances such as pesticide residues or other pollutants, thus functioning as filters for agro-chemicals by removing or diluting agro-chemicals before they reach other water ecosystems. Although this filtering function is a positive aspect for downstream biodiversity, it is likely to have a cumulative negative effect on the wetland biodiversity itself, which is directly related to the local agriculture system. With the increasing use of agro-chemicals and smaller areas of wetlands, there is a risk that the wetlands will be overloaded with toxic substances as well as nutrients.

Many wetlands are under increased pressure for conversion to agriculture and urban expansion resulting in a significant loss of biodiversity. The unplanned nature of the conversion also results in a fragmentation of the remaining areas, hampering movement of species between them.

## 4.2 The Upland Farm Field Ecosystem (farmed and fallow fields)

### 4.2.1 Characteristics



The farm field ecosystem covers actively used farm fields, little used or low-productivity farm fields and fallow fields. The fields can be small, large, be located on flat lands or slopes. Fields can be used for the production of short term crops, such as vegetables, or perennial crops such as fruit, rubber and palm. In short, the farm field ecosystem is varied. Often large areas are used for growing vegetables and other plant crops creating a structural mosaic landscape of scattered fields with adjoining crops and uncultivated fallow land. [Alteri, 1999] Fallow fields are characterised by many different plant species.

A common man-made feature in the farm field are rest huts. Farmers use these huts full time during the growing season, and very little when no crops are being cultivated. In the north the huts are increasingly being turned from seasonal huts into homesteads with a large variety of vegetable and herb species being cultivated for consumption while the hut is in use. This trend of moving from the village to the farm hut where it is ease for livestock raising as this activity is difficult in the village.

### 4.2.2 Species

There are variations between regions, but all fields are used to grow crops for household consumption or economically valuable crops for the the market or barter.

Farmed and fallow fields are habitats for a number of plant and animal (especially insect) species. The farmed fields support greater biodiversity in the growing season, whereas the fallow fields provide continuous habitats throughout the year. One of the reasons that farmed fields are relatively low in biodiversity is the lack of weeds. The greater the plant diversity, the greater the animal (or insect) diversity. Also, the nature of annual cropping cycles means that there are periods when there is a large amount of plant biomass in the field and periods when there is none. These wide variations in plant biomass create huge fluctuations in the animal population as well. These wide fluctuations are one of the main reasons that the more stable "non field" areas are important reservoirs for biodiversity.

The importance of biodiversity in farm fields also extends below the surface. The roots of crops provide more surface area for biological activity to take place and the soil itself is a living complex system of organic matter, fungi, bacteria, protozoans, nematodes, insects and worms which assist plants in obtaining nutrients and fighting disease pathogens.

Importance of the Farm Field Ecosystem for the Farmscape	
Ecological	The fallow fields are very important habitats for biodiversity. This is also the case for some farmed fields, but the quality of the habitat and level of biodiversity is reduced drastically when the farmers use pesticides. While maintaining field biodiversity is important, such field biodiversity may be dependent upon "non field" areas.
Income	The crops from the farmed fields are highly valued cash crops, giving the farmscape high significance economically. The fields are the primary engine for agriculture.
Supply of food	Crops are also grown for markets as well as home consumption. Fallow and some cropped fields supply wild foods for local consumption. Crop residues are important sources of food for livestock.
Materials	Crop residues are often used as materials on the farm such as straw and stocks from maize and green beans.
Medicine	A few medicinal plants can be found on the fallow field, if it has been in fallow a longer period of time.
Social/cultural value	No importance.

### 4.2.3 Management practices

Fields are generally managed to keep biodiversity as low as possible. The focus is on productivity of one, or sometimes a few (if intercropped) species with the planned exclusion of other plant species which may compete. Depending on water availability, fields are multi-cropped as much as is possible with one crop being planted as soon as possible after another crop is harvested.



Many rice farmers use rice fields to grow soybeans, vegetables and other cash crops after the harvest of rice, and in the drier parts of the lower North and the Central regions it is common to grow sorghum as the second crop after maize. These second crops often require even larger applications of pesticides than rice and maize and in these areas there will be few birds at all, except from a few common and tolerant species. Generally the farmers use herbicides, pesticides and fertilizers extensively on the fields.

The land is generally prepared with machines, and the crops are sown either with a sowing machine or by hand depending on type of crop. Similarly, harvesting is done by hand or machine. Burning of the crop residue immediately after harvest is common due to the difficulty of incorporating it into the soil and a belief that it will reduce pest populations in the next crop. Further, many farmers do not fully understand the beneficial effects of good crop-residue management on the soil quality. If not burned, the residues are left in the field until the next land preparation [Cho & Zoebisch, 2003].

### 4.3 The Homestead Ecosystem

#### 4.3.1 Characteristics

When highly managed, mixed gardens of trees, shrubs and herbaceous species are located close to a farmers' homestead they are known as home gardens or the homestead ecosystem. All over Lao farmers maintain their home gardens to provide a rich variety of plant species, and are among the most diverse agricultural systems known. The homestead ecosystem is the result of long historical development and traditional homestead gardens are a major source of household requirements, being subsistence-oriented mixed with market crops to sell. Moreover, there is often an active seed and variety collection and swapping of desired home garden plants between farmers.



The typical home garden is an assemblage of trees, fruit trees, shrubs, climbers, herbs and creeping plants which provide food, fodder, construction materials, firewood, herbal medicines, religious functions and other social uses such as ornamentation and shade to the household. In addition the home garden provides a sanctuary for various types of animals (both wild and domestic) and insects.

Home garden systems are intensively managed and are

very diverse. Many of the plants in the home gardens are domesticated plant species that are not native to the area and are mixed with a large variety of indigenous plant species. Home gardens are extremely important for the rural people of Lao and research has shown that small, bio-diverse homesteads can produce many times more food than large, intensively cultivated single crop fields.



### 4.3.2 Species

Species richness in the homestead ecosystems ranges from relatively modest levels to very high diversity, exhibiting high taxonomic and structural diversity. For example, research has shown that a single homestead garden in Thailand can have more than 230 species. Most species are planted or allowed to grow after naturally germinating for the specific purpose of supplying the farmer with a long list of products; hence home gardens are very important for the subsistence economy.

The major types of fruit trees grown in Lao at the homestead are mango, papaya, banana, coconut, jackfruit, and durian. Typical vegetables include lemon grass, chilli, eggplant, and many species of leafy vegetables. Other herbaceous and medical plants are grown on the homestead as well. Bamboo is used both for bamboo shoots as well as an important source of material for furniture, fences and building material.

The year round green plants and flowers, particularly during the dry season, makes the homestead an important habitat for a large variety of insects. Domestic animals are kept at the home-stead which provide also fertilizer for the wide variety of plants.

The importance of the Homestead Ecosystem for the Farmscape	
Ecological	Home gardens are based mainly on cultivated plants, both introduced and indigenous. The home gardens are often irrigated during the dry season, and are therefore one of the few habitats with flowers in the dry season, supporting a large variety of insects. There is never a complete harvesting of the home garden plants, ensuring a continuous habitat for soil biodiversity. And considerable biomass on the ground (from plant and animal waste) contribute to a high nutrient recycling.
Income	Although extremely important for the subsistence economy, there is very little trade with home garden products. Few supplements are needed to a diet based on food from the homestead, reducing the need to purchase outside food inputs.
Supply of food	The products of the home gardens form the basis of the farmers' diet. Many different edible plants are grown; herbs, herbaceous plants, vegetables, fruits and nuts, and the home garden also supports farm animals for consumption and sale.
Materials	Home gardens support many different types of construction materials and firewood.
Medicine	A very considerable amount of medicinal plants are grown in the home garden and are regularly used by rural people.
Social/cultural value	The homestead has great social value as a source of comparisons, trade and discussion among community people. And of greater importance is the environmental ambience created by the home garden, in which informal and formal discussions take place and work is undertaken





clean with manual weeding and cultivation. Surplus fruits, vegetables or other products from the homestead are traded, given to relatives and friends and used directly by the family. Any excess can be sold at the market.

#### 4.3.4 Threats and long term concerns

Over the last 3-4 decades, the traditional practice of homestead gardens has declined in terms of their importance as farmers have become more dependent upon local and urban markets. The home gardens are still important and cultivated, but the diversity of plants is lower and there is a tendency to buy more products from the market instead of relying on homestead areas. The farmers are so to speak stepping into "the modern world", specialising in growing a few types of crops and getting more dependent on trade, effectively buying crops formerly grown in the home garden. There is danger that the knowledge of extensive home gardening and cultivation of medicinal plants is being lost with the old generation.



biodiversity levels within the various ecosystems in the farmscape is the weather and the season.

#### 4.3.3 Management practices

Home garden systems are managed all year round in an ad-hoc fashion by some families and intensively for optimal output by others. Many species are "low maintenance" species. The management of home gardens is often based on knowledge preserved over generations, often with older people involved in the management and exchange of information. The management is not static, as farmers are adapting to local environmental conditions and improving the output. If water is readily available, the farmers irrigate the plants. Generally no pesticides are used in the homestead ecosystems but instead are kept



clean with manual weeding and cultivation. Surplus fruits, vegetables or other products from the homestead are traded, given to relatives and friends and used directly by the family. Any excess can be sold at the market.

#### 4.4 Comparing wet and dry season biodiversity

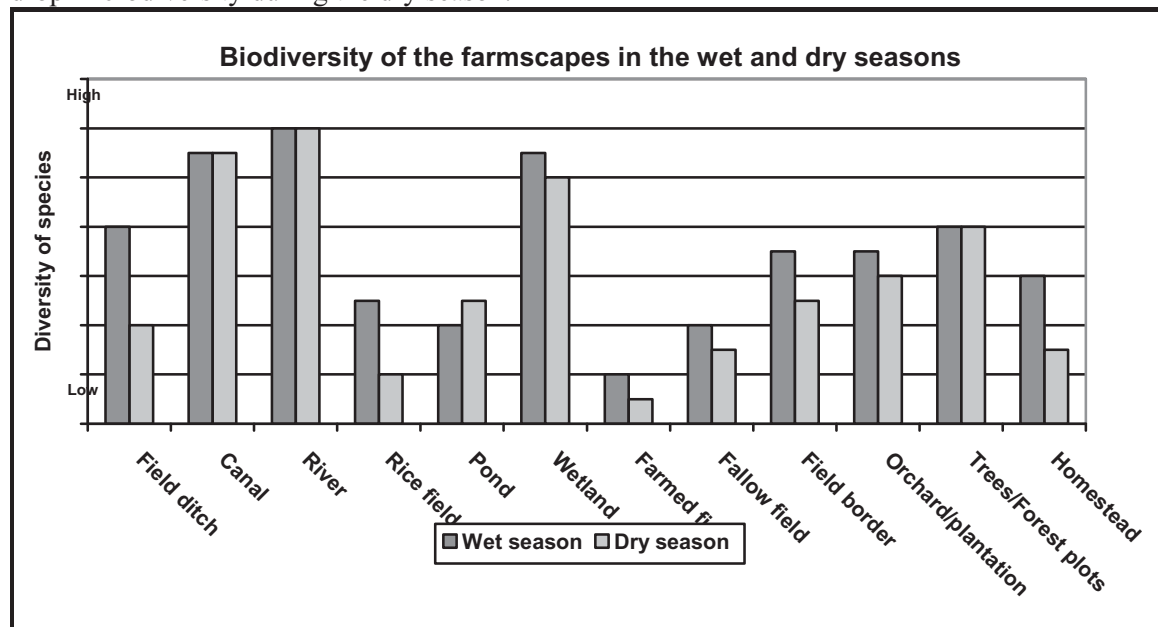
The characteristics of the different ecosystems found in the farmscapes in Lao has been described above as well as their importance, functions, major threats and concerns for the future. The farmers' decisions on crop and field management of the farmscapes affects the biodiversity in the farmscapes tremendously. Another important factor affecting



The following figure gives an overview of the relative level of biodiversity of various ecosystems in the farmscape in both the wet and dry season. These levels of biodiversity presented are relative estimations. There is no specific quantitative data to support this graph, however, it is based on what is thought to be the most likely changes in biodiversity for each ecosystem given the change in water availability. The biodiversity in some ecosystems are likely to be more affected by others during seasonal fluctuations. The figure also illustrates the relative difference in the biodiversity level of the different ecosystems with the farmscape overall. Some ecosystems, such as wetlands, canals and rivers are good providers of habitats for biodiversity all year around due to constant water availability whereas rice fields have a significant



drop in biodiversity during the dry season.



## 5. Major threats to agro-biodiversity in Lao PDR

There are a number of significant threats to agro-biodiversity in Lao PDR. These threats originate from both agriculture activities as well as from non-agriculture sources. The threats can be divided into 4 major groups based on the source of the threat: (1) changing agricultural practices; (2) changing land use; (3) Physical farmscape change and (4) over-exploitation of the biodiversity in the agricultural landscape.

These four factors are often interlinked and affected by changes in such things as human population growth patterns, agricultural productivity, marketing pressures, production technologies and industrial growth. These interlinked factors are associated with what is considered to be "development". How these

factors are managed can result in dramatically different outcomes on farmland biodiversity. It is important, therefore, to know the actual "costs" of agro-biodiversity loss and how threat factors can be managed so that the highest possible economic and environmental benefits from Laos' farmland can be achieved, for both the short and long term.

Many of the important functions of ecosystems in the farmscape, as described earlier in this handbook, can continue even with changes in biodiversity. Research shows, however, that the more diverse an ecosystem is the better it can withstand stress and impacts from agricultural management. Yet any adverse impacts involving biodiversity can become cumulative. The accumulation of any small changes in one area over time can induce large changes in another area, particularly when critical thresholds are exceeded. When this happens, certain types of habitats or ecological functions can collapse. Unfortunately, not enough is known about these thresholds nor their indicators to know where the thresholds are or the current state of the ecosystem.



Threats to biodiversity are not so much caused by overuse or ecosystem degradation of the farm fields themselves but rather the conversion of all of the land to farm fields resulting in the elimination of high biodiversity areas surrounded by or encompassing the fields. The landscape structure strongly affects its suitability as a functioning ecosystem. This includes the relative size of the nonfarmed natural areas and how fragmented (or conversely how connected) these areas are. Many of the non-cultivated spaces in the farmscape, such as riverbanks, irrigation canals, roadsides, field borders, forest lots and homesteads act as corridors to connect patches of habitat and are considered the most important sources of biodiversity in the farmscape and the most beneficial to agricultural livelihoods. Unfortunately, as discussed in earlier chapters, these areas are usually managed to reduce biodiversity rather than maintain or enhance it. Instead, explicit efforts should be made to conserve these non-farmed spaces, acknowledging that a strategic use of trees, wetlands and corridors such as field borders or riverbanks are essential for maintaining biodiversity and the services they are providing farming households. Though it is difficult to measure biodiversity, a clear example of the effects of habitat deterioration on the farm is the worldwide trend in declining populations of pollinators and natural enemies of crop pests.

### 5.1 Changing agricultural practices

Changing agricultural practices includes choices by farmers on which crops they grow, e.g. high yielding varieties, on which cultivation methods they use. Such choices may be influenced by the market and the price they can achieve for the crops they grow, by any subsidies or price incentives that they may receive for growing a particular crop, or by the information with which they are provided by extension workers, the media and other farmers. Because of the high proportion of subsistence farmers in Lao PDR, such choices may also be influenced by household food preferences.



Amongst the globally critically endangered, threatened and vulnerable species found in Lao PDR, more than 14 are found in agro-ecosystems and 39 are threatened by agriculture related activities. Lao's agro-biodiversity, including the ability of the agro-ecosystems to offer refuge and corridors to wildlife species are under threat from replacement of traditional crop varieties by high yielding 'modern' varieties and mono-cropping. Increasing use of high yielding varieties require increased use of agricultural chemicals which will inevitably put pressure upon the biodiversity associated with the agricultural landscape. The increasing use of agro-chemicals: pesticides, herbicides and fertilizers is also one of the major threats to



ago-biodiversity. Farmers use chemicals which are extremely toxic or have broad spectrum poisoning capabilities. This is particularly common for some crops such as watermelon, maize, and cabbage. Some of these chemicals kill organisms directly while others affect entire food chains. Herbicides are particularly damaging in that they kill plants, the basis of the food/energy chain upon which all other organisms are dependent. And they are applied indiscriminately on field borders and other non-farmed areas which are important reservoirs of natural enemy biodiversity for farm fields. Farm chemicals are disruptive to the ecology, which protects the fields making them more susceptible to pest outbreaks. And these chemicals make their way into the

food chain, finally, in the farming population itself with negative health impacts. In the farm ecosystem, such chemicals are known endocrine disruptors resulting in a wide range of negative environmental impacts over a wide range of species.

An area of biodiversity loss, which has received a lot of attention for a long period of time, is the loss of genetic diversity in the crops being cultivated by farmers. There are ever fewer crop varieties and larger amounts of land are planted to a smaller number of crop varieties.

Lack of information on biodiversity-friendly practices for commercial farming systems also leads to unnecessary losses of biodiversity from agro-ecosystems. This is aggravated by the loss of indigenous knowledge and experience in agro-biodiversity management and processing.

## 5.2 Changing land use

Changing land use can imply removing land from agricultural production altogether, and thus having an impact upon the overall biodiversity of the country including agro-biodiversity. Such changes in land use include the inundation of agricultural land by dams, mining and industrial developments. Conversion from traditional agriculture and forest land to "contract farming" of cash crops, including tree crops (e.g. rubber and *Eucalyptus spp.*), with little regard to existing biodiversity values, are causing losses in agro-biodiversity.



Encroachment into natural ecosystems for agricultural expansion and widespread unsustainable harvesting of wild animals and plants by farmers from natural habitats for food and marketing are also some of the major threats to biodiversity in the country. Therefore, it is critical to mainstream biodiversity



conservation into the agricultural sector to safeguard Lao's globally important agro-biodiversity and other biodiversity that occur in Lao's agro-ecosystems, as well as to minimize threats to biodiversity in other ecosystems.

### 5.3 Physical farmscape changes

Farming itself physically changes the natural environment. However, physical farming practices can be adjusted so that maximum farm output is ensured with least disruption to the local ecosystem-and ecosystem services. Research has well documented the importance of farm field borders for healthy farm field ecosystems, which can protect crops. It is important to manage these borders to ensure the maximum benefit to the fields from beneficial organisms, which exist and are dependent upon them. In Lao PDR, these borders not only contain important beneficial insects and organisms to protect fields from pests, but are often important sources of local foods in terms of plant and animal species. It is important to maintain healthy and diverse field borders. These borders are being increasingly converted into field as a result of low productivity and shortage of cultivable land.



While water is important for farm fields, it is also important to ensure that water sources are not completely drained or that waterways are blocked resulting in constrained movements of aquatic organisms. Removal of trees on the farmland also reduces important habitats for many organisms useful for the farm family. The quantity (or percentage) of the farmscape used for "non-cultivation purposes, how these are managed, and where they should be placed needs to be considered very carefully in order take full

advantage of the ecosystem and farm household services they provide.

### 5.4 Over-exploitation of these resources

The use of biological resources in and around the agricultural landscapes by households for their own food, fuel and shelter is a fundamental part the livelihood strategies of most rural people in Lao PDR. Often, the values these resources are underestimated. The farmscape is often assumed to be functioning effectively even under changed agricultural management or land use conditions. Some agro-biodiversity products are being overharvested due to increased population pressure and use of unsustainable harvesting practices. Combined with habitat degradation resulting from pollution and other development activities agro-biodiversity products are dramatically decreased. Some products are being lost. Continued over-exploitation of these resources can lead to loss or local



extinction of agro-biodiversity and the loss of their livelihood contribution unless a more sustainable management of these wild resources is practiced.

## 6. Recommendations to farmers and planners

It is important that farmers are able to both understand the importance of biodiversity and know how to preserve and enhance it. And this needs to be done within the context of farmer's goals to maximise long and short term productivity of the farm system. This is possible. The following discussion will provide broad recommendations looking at the major ecosystems in the farmscape discussed in the previous chapters.

### 6.1 Farm Fields

Farmfields probably offer farmers the fewest opportunities to conserve biodiversity because fields are the focal point of farm productivity. Even so, there are a number of broad recommendations:

- Use only the minimum amount of pesticides necessary to control pests. This means applying them selectively in the field where the problems exist and not broadly across the entire field.
- Use the least toxic pesticide which will accomplish the task.
- Often (but not always) botanical pesticides are less damaging than chemical pesticides. Keep in mind that even botanical pesticides are dangerous to the environment, however.
- Due to labor costs and availability, farmers use more and more herbicides. Herbicides are particularly damaging to biodiversity and their use needs to be considered carefully, evaluating Other potential non-chemical means of weed control. If used, be sure to use them where they are needed. Do not over spray to adjacent fields being used for agriculture purposes.
- Ensure that as much organic fertilizers used as is possible. Chemical fertilizers can be used but should be thought of as supplements to organic fertilizers, not as replacements.
- Do not apply pest control chemicals to fallow plots unless absolutely necessary.
- When harvesting, only take the economically important part of the crop and recycle the other crop residues. Do not burn.crop residues.
- Mulches are effective in preserving soil biodiversity. Use as much mulch as possible
- Ensure that the.ground is always covered with green crops or crop residues to protect it from the sun, rain and wind.
- When fallow or during other times when vegetation in the fields is very low place piles of crop residues in the field as reservoirs of beneficial organisms, for protection from predators and severe weather conditions

## **6.2 Rice Fields**

Rice fields need special mention because of their aquatic nature. All of the above recommendations for farm fields apply, but there are a few additional recommendations for rice fields to maintain high levels of biodiversity.

- Rice fields, when possible, should be connected to water networks to allow fish and other aquatic organisms access to the fields
- Small ponds and ditches should be created as habitat for aquatic organisms during times of water shortages. Ponds only need to be as large as one squaremeter and half meter deep to act as effective reservoirs for many species. Increasing the depth and area is useful, but this must be assessed in terms of loss in rice production versus how many organisms are gained.

## **6.3 Big Trees**

Individual trees within the farmland are a common sight in Lao PDR. They have many uses and should be preserved.

- Leave a few big trees (or even small trees) in the farmscape. Do not cut them down unless they pose a specific threat.
- Manage the trees for long term use. Cut their branches and wood for use, being careful that the health of the tree is maintained in this process.
- Encourage a diverse range of species of trees, not only one species. Plant more trees as old ones die.
- Trees with many flowers are particularly important
- Do not apply pesticides to these trees
- Leave natural weeds at the base of the trees
- Fieldborders are good areas to encouragetrees

## **6.4 Field and Road Borders**

A very significant amount of the farmscape is being used as the margins of fields, roads and other farmscape features. These margins are very important sources of biodiversity, and can be preservedand enhanced in a number of ways.

- Maintain a diverse selection of species.
- Flowering plant species particularly different species which have flowers at different times of the year should be encouraged
- Encourage small and/or large trees. Trees which may have an economicvalue, such as fruit, might be more desirable. Trees which give.too much shade should be avoided



- Vegetation in border areas should be harvested or pruned by cutting. Do not burn these areas.
- When vegetation is cut be sure to leave enough cover for various organisms that live there. Do not remove everything down to the soil.
- Never apply pesticides, particularly herbicides, in the fieldborder areas.
- Straw and other farm debris can be placed on border areas to create habitat for important beneficial insects, such as spiders.

## 6.5 Forest Parcels

Small forest parcels are remnants of diverse tropical forests and should be preserved as much as possible.

- Encourage as many species of trees and plants as possible.
- These areas can be enhanced by planting additional species known to have once existed in the area which may be absent or relatively few in number currently.
- Harvest and selectively manage these areas with the idea of ensuring long term sustainability. Use them...but do not over use them.
- Encourage the presence of ponds and ditches which hold water within the forest parcels. Forest parcels which have water contain main riparian species which would be absent without water.
- Ensure that the community sets usage rules for community forest areas, help all community members understand these rules, and enforce them.

## 6.6 Ponds

Ponds are a common feature of Lao farmscapes. They are often surrounded by other features such as borders, forest parcels, rice fields, etc. They are important sources of biodiversity.

- Many smaller ponds are better than a few larger ponds. This is because the border of the pond is also important for biodiversity and smaller ponds have more area, percentage wise, devoted to borders.
- Ponds should be spread throughout the farm, rather than concentrated.
- If possible, during the rainy season they can be connected to the farm fields for movement of aquatic organisms.
- Keep water in the ponds the entire year. Do not let them dry out.
- Ensure ponds have lots of light penetrating the water. Dense trees and too much
- water hyacinth is generally not good for aquatic organisms.

- Keep old tree limbs, tires or other non-toxic material in the ponds for protection of fish against predators, including people!
- Encourage a wide variety of fish and aquatic species.
- Do not harvest all of the fish. Be particularly careful in the dry season to avoid over-harvesting.
- Never wash pesticide containers or pesticide application equipment in ponds.
- Do not throw garbage in ponds.

### 6.7 Canals and Rivers

The recommendations for canals and rivers are the same for ponds, except for the recommendation to have many small ones instead of a few big ones.

### 6.8 Wetlands

Wetlands are natural ecosystems. They cover large areas of Lao and function as important biodiversity reservoirs. They also can act as important filters of toxic agro-chemicals. They need protection.

- Keep wetlands wet. Do not drain them.
- To the extent possible, ensure connections from one wetland to another, particularly during the rainy season. Connect wetlands to rice fields as much as possible.
- Even small wetlands (a few square meters) are important. Encourage and protect small. Wetland areas where they are feasible on the farm.
- If wetlands become dry during the dry season, they should be protected against fire. Do not burn wetlands.
- Encourage healthy growth of vegetation. Vegetation supports other organisms.
- Do not over-harvest aquatic species from the wetlands.

### 6.9 Farmland Ditches

Farmland ditches have many similarities to ponds and canals in terms of biodiversity preservation and enhancement.

- Encourage a wide variety of plant species on the edge of the ditches, particularly flowering species.
- Trees should be encouraged along the ditch area, particularly trees with economic or other benefits.
- Ensure the water flows easily through the ditch, and is not obstructed by a lot of debris.
- If possible, keep the ditch moist at all times. If possible during the rainy season dikes can be connected to the farm fields for movement of aquatic organisms.

- Encourage a wide variety of fish species.
- Do not harvest all of the fish. Be particularly careful in the dry season to avoid over-harvesting.
- Never wash pesticide containers or pesticide application equipment in ditches.
- Do not throw garbage in ditches.

## 6.10 Homesteads

Homesteads offer significant opportunities for high levels of "managed" biodiversity.

Plant a wide variety of plant species. This includes tree species as well as local herbs, vegetables and medicinal plants.

- If possible, have a small pond in the homestead, with plants on the perimeter.
- Ensure that plants get watered during the dry season. In some areas the flowers from plants in the homesteads during the dry season are critical sources of food for beneficial insects.
- Ensure that household garbage and broken farm equipment are disposed of in a way which does not pollute the environment. Bury or burn garbage if necessary.
- Pesticides should not be used in the homestead area. If necessary, however, use as little pesticides as possible and the least toxic pesticides available. Compost farm waste, or use as mulch.
- Manage "wet" areas in the homestead. These are areas where water is used and the ground remains wet during the entire year. These areas contain important plant and animal species.

## 7. Overview of the SAFE Project's Agrobiodiversity Habitat Action Planning (BAP)



Biodiversity is normally thought of as a physical entity. The Danida supported Sustainable Agriculture for Environment (SAFE) Project is working with rural communities originally in Thailand in a way in which biodiversity is thought of as an activity. Biodiversity is something communities should do something which is to be protected... something which is to be used... something which is an asset for the farm rather than something to be read about in a book or a long list of animals and plants.

The "habitat" is the focal point for planning by communities. The concept of habitat is used because protecting an area or the environment needed for a particular species is easier to make plans for than a particular species. And by protecting the habitat for a particular species, many other species will also be protected. A habitat is something that can be seen by communities and more easily monitored. Therefore, the SAFE Project helps communities to develop Habitat Action Plans (HAP) for their areas.



### **The process being promoted by the Project is composed of a cycle of activities:**

1. The *first activity* to undertake with the community is generating and/or assessing their interest regarding natural resource management at the farmscape level. Identifying negative changes which have occurred in recent years regarding natural resource degradation is an important point of discussion. Often the farmers can immediately talk about reductions in certain types of species which used to be important to them but which currently no longer exist or have very limited populations. In Thailand, farmers often mention different aquatic species such as frogs and specific fish species. They also note increases in other aquatic species, some of which are pests. They also note significant changes in plant species, such as trees, but also important plant species they used to eat as food or use as medicine.

2. The *second activity* is meeting with a group of the most interested and motivated farmers to gain a common understanding of biodiversity, the impacts of farming on biodiversity, and the concept of "farmscape" and "habitat". This is a very important activity because it forms the basis of an understanding of the inter-relationship between species and the impacts that their farm livelihoods are having on these species. This is the foundation of what is used to take action on enhancing biodiversity on the farm. It is important to have key people from the community involved in this as they will be able to get support from the community for the plans which are to be put in place later. Key people from the local school as well as the district administration office have often been important members.



3. The *third activity* to be undertaken with the community is identifying the specific micro-ecosystems or habitats in the farmscape area. While farmers are very much aware of the different ecological zones on their farms, they have never really thought of them in this way. This is the time when they are introduced to the various types of aquatic, forest and tree, field margins, home-stead, and field ecosystems found in their areas and how these differ from each other, ecologically. These constitute the "high biodiversity" areas in the local farmscape.

Once the high biodiversity habitats have been identified, the farmers (and often schools) are involved in collecting specimens or documenting important indicator species for these specific habitats. Obviously, the timing of this event has a significant impact on what species are available for observation. Regardless of the season, plants are the most obvious living organisms found during such activities and it is common that farmers will collect more than 100 species of plants after only one or two hours of collecting. Farmers are also requested to draw small pictures of species which they know exist but did not see during the collection exercise, or species which they did not want to collect so as not to kill them, such as animal specimens. Some of the species which are not seen may be the most important to the farmers so documenting them is critical.

After the specimens have been collected, they are documented by making a display. At that time, the species are named and the specific uses of them recorded. The local knowledge of community members regarding local species is impressive and even the community itself is impressed about how much they know about the hundreds of species which exist in their area. Bringing in older people for this exercise is important because they have a much greater knowledge of plant and animal species than the younger generation. While they may not know the names of all the species, there are few species which they are not familiar with.

4. The *fourth and next step* is very important: prioritizing the importance of the local species based on crop protection traits, economic, food, medicinal, social, aesthetic or other criteria. The SAFE Project has

found that it is amazingly easy for farmers to arrive at the most important plant and animal species in the farmscape through discussion, avoiding assigning numerical values to each criteria and each species. Farmers are encouraged to identify just the four or five most important animal and important plant species. Finally, two species (one plant and one animal) will be chosen by the community to develop habitat action plans. The final selection is not made only upon their importance only.

5. The *fifth step* is to identify the specific threats to the habitats of the top species and the level of these threats. Using the same process as was done to prioritize the importance of species, the community is asked to prioritize the level of threat for each of the species. These two prioritized lists are then compared and the final plant and animal species selected based on both the importance and level of threat. Only species which are both important and have a high level of threat are chosen. This is to avoid choosing species which are important but not being threatened, or species which are threatened but not important to the farmers.

For the selected species, the farmers develop habitat action plans (HAP's). Often, they may not know enough about the species to develop a good plan. The first step in the planning process, therefore, is to research the species selected so they know more about the ecological, habitat and life cycle requirements of the species. Farmers then put together a plan based on a S.W.A.T. analysis which identifies the major threats and opportunities for the species and habitat being planned for. Very specific activities are planned to take advantage of opportunities and minimize the threats to the habitat. A basic format for this can be seen on the following page.

<b>HCP Goal:</b>			
<b>Description of Habitat:</b>			
<b>Description of Major Associated Species and Their Relationship</b>			
<b>Name</b>	<b>Relationship</b>		
1.			
2.			
3.			
Etc.			
<b>Opportunities</b>	<b>Activity</b>	<b>Output</b>	<b>Timing</b>
1.			
2.			
3.			
<b>Threats</b>	<b>Activity</b>	<b>Output</b>	<b>Timing</b>
1.			
2.			
3.			
<b>Research and information needs</b>			



## 8. Conclusion

This guide to farmscape agrobiodiversity in Lao is an attempt to provide an introduction to the topic, to generate discussions, and to inspire to further research about biodiversity in the farmlands of Lao PDR.

The reality, unfortunately, is that little information exists and little research is being done. The authors of the chapters adapted to the Lao PDR conditions, willingly concede that much of the information contained here on farmland biodiversity will be modified as additional research and knowledge on this important topic increases.

Lao PDR is endowed with a wealth of farmland biodiversity on which the majority of its people being tremendously dependent upon it for their livelihood. Much of what people rely on is not just rice from the fields but all of the farmland biodiversity which supplies food, materials, medicine, and other livelihood necessities, as well as income.

This resource is, however, being actively exploited by enterprising farmers and is quickly being depleted. As discussed in this guide, this is due to a number of causative and closely interlinked factors originating within the farming system and practices itself, as well as from external sources.

Considering the current level of knowledge and awareness about agrobiodiversity and its management, this depletion is likely to continue or even increase.

Four major threats have been identified, including 1) change in farming practices as a result of growing need for increased productivity; 2) change in land use due to increasing pressures from development programmes and encroachment; 3) change in farmscape structure because of contracted field borders; and 4) depletion of farmland biodiversity due to over-harvesting and pollution.

We hope we are not too late to seriously bring agro-biodiversity under proper management.

It cannot be too soon that we take farmland biodiversity seriously and make plans for its conservation.

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