



Lao People's Democratic Republic
Peace Independence Democracy Unity Prosperity

**LAO PDR NATIONAL AGRO-BIODIVERSITY PROGRAMME
AND ACTION PLAN II (2015-2025)**



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LIST OF ABBREVIATIONS

ABD	Agro-Biodiversity
ABP	Agricultural Biodiversity Project
ABS	Access and Benefit Sharing
ACTAE	Towards an Agro-ecological Transition in South East Asia
ACIAR	Australian Centre for International Agricultural Research
AEC	ASEAN Economic Community
AFD	Agence Française de Développement
ADB	Asian Development Bank
AFACI	Asian Food and Agriculture Cooperation Initiative
ALiSEA	Agro-ecology Learning alliance in South East Asia
ARC	Agriculture Research Center (NAFRI)
ASEAN	Association of Southeast Asian Nations
BCC	Biodiversity Conservation Corridors Programme
BEI	Biotechnology and Ecology Institute
CAWA	Climate Change Adaptation in Wetland Areas
CEP-BCI	Core Environment Programme and Biodiversity Conservation Corridors Initiative
CAB	Crop Associated Biodiversity
CBD	Convention on Biological Diversity
CEP	Core Environment Programme
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CPGRFA	Commission for Genetic Resources for Food and Agriculture
COP	Conference of Parties (CBD)
DAFO	District Agriculture and Forestry Office
DANIDA	Danish International Development Assistance
DALAM	Department of Agriculture Land Management (MAF)
DFID	Department for International Development
DFRM	Department of Forest Resource Management (MoNRE)
GDG	Gender Development Group
DLF	Department of Livestock and Fisheries (MAF)
DoA	Department of Agriculture (MAF)
DoEC	Department of Extension and Cooperatives (MAF)
DoF	Department of Forestry (MAF)
DoFI	Department of Forest Inspection (MAF)
DoPC	Department of Planning and Cooperation (MAF)
EIA	Environmental Impact Assessment
EM	Effective Micro-organism
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field School
FSCAP	Forest Sector Capacity Development Project
GRET	Gender and Development Association
GMS	Greater Mekong Sub-Region
FRC	Forestry Research Center (NAFRI)
GPAAGR	Global Plan of Action for Animal Genetic Resources
GEF	Global Environment Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMO	Genetic Modified Organisms
GoL	Government of Lao PDR
HDI	Human Development Index
HRC	Horticulture Research Center (NAFRI)
IBA	International Biodiversity Area
ICEM	International Centre for Environmental Management
ICBF	Integrated Conservation of Biodiversity and Forests
IDRC	International Development Research Center

IK	Indigenous Knowledge
INGO	International Non-Governmental Organization
IPM	Integrated Pest Management
IRRI	International Rice Research Institute
ITM	Institute of Traditional Medicine
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
IUCN	International Union for Conservation of Nature (The World Conservation Union)
IWRM	International Water Resources Management
JICA	Japan International Development Agency
JTF	Japanese Trust Fund
KfW	Kreditanstalt für Wiederaufbau (German Reconstruction Credit Institute)
LALD	Land Allocation and Land Development Department (MoNRE)
LARF	Lao Agricultural Research Fund
LARReC	Living Aquatic Resources Research Center (NAFRI)
LDN	Least Developed Nation
LMO	Living Modified Organism
LRC	Livestock Research Center (NAFRI)
LURAS	Lao Upland Rural Advisory Service (Project)
MAF	Ministry of Agriculture and Forestry
MDG	Millennium Development Goal
MEA	Multilateral Environment Agreement
MIS	Management Information System
MoE	Ministry of Education
MoFA	Ministry of Foreign Affairs
MoH	Ministry of Health
MoIC	Ministry of Industry and Commerce
MoNRE	Ministry of Natural Resources and Environment
MoST	Ministry of Sciences and Technology
MRC	Mekong River Commission
NABP	National Agro-Biodiversity Programme
NACA	Network for Aquaculture Centres in Asia-Pacific
NAFRI	National Agriculture and Forestry Research Institute
NBSAP	National Biodiversity Strategy and Action Plan
NPA	National Protected Area
NTFP	Non Timber Forest Products
NUDP	The Northern Uplands Development Programme
NUoL	National University of Laos
PAFO	Provincial Agriculture and Forestry Office
PBSAP	Provincial Biodiversity Strategy and Action Plans
PDR	People's Democratic Republic
PFP	Programme Focal Point
PGRFA	Plant Genetic Resources for Food and Agriculture
PPC	Plant Protection Center
PPP	Public Private Partnership
PRC	Policy Research Center (NAFRI)
RBP	Rice Biodiversity Project
SDC	Swiss Development Cooperation
SDG	Sustainable Development Goals
SEA	Strategic Environmental Assessment
SEADEC	Southeast Asian Fisheries Development Center
SEARICE	South East Asia Regional Initiative for Community Empowerment
SEIA	Social and Environmental Impact Assessment
SIDA	Swedish International Development Cooperation Agency
SMTA	Standard Material Transfer Agreement
SNV	Netherlands Development Organisation

SU-SUFORD	Scaling Up Sustainable Forest for Rural Development Project
TABI	The Agro-Biodiversity Initiative
TWG	Technical Working Group
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UAFRC	Upland Agriculture and Forestry Research Center
WFP	World Food Programme
WHO	World Health Organization
WWF	World Wide Fund for Nature

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EXECUTIVE SUMMARY

The first National Agro-Biodiversity Programme, running from 2005 to 2012, was designed to serve as the framework for the effective conservation and management of agro-biodiversity. Although it was successful in raising awareness on agro-biodiversity and was instrumental in developing a number of projects designed to address agro-biodiversity issues, it had a number of shortcomings. Most importantly, there was a lack of a broad stakeholder involvement, resulting in inadequate GoL and donor funding support for the programme. There was also insufficient coordination and information exchange, particularly with focal points of international treaties and among the different technical components of the programme. Implementation arrangements were weak and became outdated with the creation of MoNRE and the reorganization of MAF.

In 2014, with the assistance of FAO, MAF began the revision of NABP II through a participatory process led by NAFRI. Where appropriate, the lessons learned from NABP I were analyzed and incorporated in the new 10-year programme which will run from 2015-2025. This document presents the status, trends and threats to Agro-biodiversity in Lao PDR followed by a framework for the sustainable conservation and use of agro-biodiversity in support of national priorities on food security, poverty-reduction and socio-economic development.

Agro-biodiversity is a subset of biodiversity and is defined as the variety and variability of animals, plants, fungi and micro-organisms that are used directly or indirectly for food and agriculture. It includes crop, livestock, forest and fish resources and comprises the diversity of genetic material (species, varieties and breeds) used for food, fodder, fiber, fuel and medicine.

Lao PDR is globally unique in regard to agro-biodiversity with well over 100 plant and animal species being cropped and between 1,000-2,000 species being collected for food and other purposes. It is endowed with very high bio-diversity values comprising 8,000-11,000 species of flowering plants, over 100 species of mammals, 700 species of birds and 166 species of reptiles and amphibians and an unknown number of fungal species. The country has a highly diverse ethno-cultural make-up involving many ethnic groups following different farming systems and livelihood practices, producing a rich cultural dimension to agro-biodiversity.

Lao PDR is largely an agrarian society and its agro-biodiversity resources not only support national social and economic development generally, but also underpin rural livelihoods and promote self-sufficiency and

food security. As such, agro-biodiversity is particularly important to the poor and remote marginalized groups and plays a key role in poverty reduction.

Lao PDR's rich agro-biodiversity is not only important for agriculture by helping to maintain ecological services for nutrient recycling, soil moisture retention, pest and disease control and pollination. It also helps to sustain wider ecosystem services for the supply of water, energy, minerals and raw materials and wildlife conservation on which the business, transport, energy and tourism sectors are dependent. Finally, agro-biodiversity plays a key role in socially important ecosystem services such as the provision of potable water, maintenance of water quality, waste removal, soil erosion control, reduction of rainfall runoff and flood-control. Thus, the protection and sustainable use of the agro-biodiversity and its supporting systems significantly increase the country's resilience to climate change.

The NABP II identifies six generic farming (eco) systems in Lao PDR, each with its own unique agro-biodiversity characteristics:

1. **Paddy Rice-Based Agro-Ecosystems.** Flat or terraced, banded rice land where standing water is maintained in the field for extended periods.
2. **Integrated Agriculture Systems.** Multi-enterprise farming systems including field crops, vegetables, fruit, livestock, and fish.
3. **Upland Agro-Ecosystems.** Gently rolling or steep land under permanent agriculture or swidden rotation.
4. **Forest Ecosystems.** Forested areas used by local communities for the collection of food, fiber, herbs, medicines, fuel and other products.
5. **Commercial Agriculture Systems.** Large areas of commercial agriculture including industrial crops, pastures, fruit trees and forest plantations.
6. **Wetland Ecosystems.** Areas of permanent or seasonal standing water or water-logged conditions.

At the landscape level, these systems appear as a mosaic of different land types and management strategies with the agro-biodiversity resources in each being used by local communities in a variety of ways to support their livelihoods.

Despite the country's rich ecological base, biodiversity has been significantly reduced by population growth, land use changes, resource extraction and the transition to a market economy. Agro-biodiversity values are facing additional threats from land concessions, monocrop plantations, hydropower projects and mining. National policy initiatives such as the stabilization of shifting cultivation, resettlement and

village consolidation have also impacted on agro-biodiversity. Climate change is already affecting ecological systems and will increasingly reduce agro-biodiversity in the future.

Lao PDR is a signatory to a number of international conventions relevant to agro-biodiversity. The most important of these include the Convention on Biological Diversity, the Nagoya Protocol, the Treaty on Plant Genetic Resources for Food and Agriculture, the Global Action Plans for plant and animal genetic resources, the Ramsar Convention and CITES. Lao PDR plays an active role in the FAO Commission on Food and Agriculture Genetic Resources through its membership on the forestry, animal, and plant sub-committees.

The legal framework in respect to biodiversity in Lao PDR is mainly governed by the Environmental Protection Law, the Forestry Law, the Wildlife and Aquatic Law, the Water and Water Resources Law, the Fisheries Law, the Land Law and legislation covering Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) which is currently in draft form. The National Biodiversity Strategy and Action Plan specifically emphasize agro-biodiversity as an important sub-set of biodiversity and acts as an umbrella framework for NABP. MAF's Agriculture and Forestry Research Strategy recognizes the importance of agro-biodiversity and includes sustainable agro-biodiversity management as one of its four national research programme areas. Unfortunately, the other legal and policy instruments governing agriculture and natural resources do not specifically address agro-biodiversity as a component of biodiversity and consequently, it does not receive the attention it deserves.

The recently established Agro-Biodiversity Sub-sector Working Group intends to use the NABP II as their reference document is to raise awareness and advocate for policy and legal reform in regard to agro-biodiversity.

In line with the 8th SEDP, NABP II is designed to support three major development goals of Lao PDR: (i) achieving food security, (ii) reducing poverty, and (iii) enhancing government capacity to ensure the sustainable management and use of natural resources. The programme will act as a framework for a coordinated, multi-sector approach to better manage, utilize and conserve agro-biodiversity in order to support the three aforementioned goals.

The NABP II comprises three outcomes and 12 outputs:

Outcome 1. An enabling policy environment and legal framework for the sustainable use and conservation of agro-biodiversity in Lao PDR.

- Outputs:
- 1.1 Increased information on and awareness of agro-biodiversity issues ensures they are main-streamed across all policy, planning and decision-making processes in Lao PDR.
 - 1.2 Agricultural policies, strategies and development programmes and plans closely aligned with international treaties related to agro-biodiversity, the environment and climate change.
 - 1.3 Improved collaboration between Lao PDR and international institutions active in agro-biodiversity policy, planning, research, extension, and training.
 - 1.4 Fair and transparent access to agro-biodiversity resources and equitable sharing of the benefits from their management, use and conservation.

Outcome 2. Organizational and technical capacity for the conservation and sustainable use of agro-biodiversity in government, the private sector and farmers is developed and strengthened.

- Outputs:
- 2.1 Improved knowledge of the importance, value and distribution of agro-biodiversity resources in the three eco-regions.
 - 2.2 Improved capacity of government agencies to conduct research on issues relevant to agro-biodiversity.
 - 2.3 Improved capacity of government, NGOs and the private sector to provide relevant advice to farmers on the management use and conservation of agro-biodiversity.
 - 2.4 Improved capacity of farmers to conserve, manage and use plant and animal genetic resources to the benefit of all agricultural value chains.

Outcome 3. Floral, faunal, fungal and other elements of agro-biodiversity in all ecosystems in Lao PDR are effectively managed, utilized and conserved.

- Outputs:
- 3.1 More diversified, sustainable and productive agriculture production systems established in the three eco-regions.
 - 3.2 *In situ* and *ex situ* national gene-banks for plant and animal agro-biodiversity resources are established and operational.
 - 3.3 Proven technologies are available and being adopted by farmers for the improved management and use of plant, animal and mushroom agro-biodiversity resources.

3.4 Green value-chains, improved processing and value-adding technologies for agro-biodiversity resources are being used by farmers.

The NABP II will run for ten years (2015-25) and is broad-based, involving a number of ministries, departments and development partners. MAF is the main implementing agency and, along with other MAF departments, NAFRI's five Research Centers play important implementation role based on their technical mandates for agro-biodiversity.

The NABP-II work plan is open for expansion and currently covering, committed and proposed agro-biodiversity research related to development and extension interventions containing 42 activities and 160 sub-activities. It is anticipated that the interventions will be funded by GoL by in-kind and cash contributions totaling US\$ 2.1 million as well as a range of donors including international conventions, multi-lateral and bilateral organizations, NGOs and the private sector of a total of US\$, 18.7 million.

The NABP II is overseen by a multi-ministerial National Agro-Biodiversity Steering Committee who reviews progress, provides direction and approves annual workplans and budgets. Responsibility for day-to-day management lies with a Programme Management Unit (PMU) appointed by MAF. The PMU directs implementation and liaises closely with National Focal Points to ensure coordination and alignment with international conventions. The PMU is assisted by an Advisory Board comprising relevant International Organizations, Round Table Sector Working Groups and the Private Sector who provide technical assistance and support the mobilization of resources for programme implementation.

A communication and awareness strategy for NBPA II identifies key stakeholders and seeks to ensure effective dissemination to promote inter-agency coordination. The strategy will use a range of different media to ensure the timely communication of important agro-biodiversity issues and to make agro-biodiversity information available to a wide range of stakeholders at national, provincial and local levels.

1. INTRODUCTION

The overall aim in preparing the Lao PDR National Agro-Biodiversity Programme (NABP-II) is to develop a strategic approach and framework for the sustainable use, development and conservation of agro-biodiversity in support of national priorities on food security, poverty-reduction and socio-economic development of the country.

From a global perspective, Lao PDR is in a unique position in regard to agro-biodiversity due to a number of important agro-ecological and socio-economic characteristics. The country is situated in one of the world's biologically richest and most endangered terrestrial eco-regions, and is in one of the 10 most important global biodiversity hot-spots (Russell, 2000) with extremely high bio-diversity values, comprising three physiographic regions with very different agro-climatic characteristics: (i) the Northern Highlands – a rugged mountainous region with a dry sub-tropical climate; (ii) the Annamite Range – a mountainous topography with high monsoonal rainfall; and (iii) the Mekong Plain – an alluvial plain along the Mekong and its larger tributaries with a tropical monsoon climate and variable rainfall. These characteristics combined give Lao PDR high level of agro-biodiversity and diverse farming systems.

Lao PDR remains largely an agrarian society, with over two thirds of the population engaged in farming with agriculture and forestry accounting for one third of GDP (ADB, 2012). Agricultural production falls largely under six major agro-systems¹ in Lao PDR, each with highly diverse sub-systems comprising rich species mixes of plants, animals, fungi and micro-organisms. Although new agricultural techniques are being introduced, the use of traditional farming methods still continues, helping to maintain agro-biodiversity values.

Since 1993, an extensive protected area system has been established with over three million hectares (14% of the total land area) designated as National Protected Areas (NPAs). Today, the Protected Area System is made up of 18 NPAs and numerous provincial and district protected areas, all of which are used by villagers and contain important agro-biodiversity resources.

Lao PDR has a highly diverse ethno-cultural make-up with 47 distinct ethno-linguistic groups (Stuart-Fox, 2006). The farming and livelihood practices of these different ethnic groups vary significantly producing a rich cultural dimension to agro-biodiversity in the country, much of it not yet properly understood or recorded.

¹ Lowland rice-based, upland, integrated-agriculture, forest, wetlands, and large-scale commercial agro-ecosystems

With support from the Food and Agriculture Organization (FAO) and United Nations Development Programme (UNDP), the National Agricultural and Forestry Research Institute (NAFRI) prepared the first NABP (2005-12) which was endorsed by the Ministry of Agriculture and Forestry (MAF) in January 2005. Since its inception, the social, economic, environmental, agricultural and institutional context has changed dramatically. Thus, in 2014, with the assistance of FAO, MAF began the revision of the NABP I through a participatory process led by NAFRI. This involved a series of workshops and consultations with key stakeholders in government, partner organizations and the private sector over a period of 15 months. The outcome is the NABP II (2015-2025) which is described in the remainder of this document.

1.1 Definition of Agro-Biodiversity

Agro-biodiversity is a subset of biodiversity and that can very simply be defined as the variety and variability of animals, plants, fungi and micro-organisms that are used directly or indirectly for food and agriculture. It includes crop, livestock, forest and fish resources and comprises the diversity of genetic material (species, varieties landraces and / breeds) used for food, fodder, fiber, fuel and medicine.

Although for the sake of simplicity NABP II focuses primarily on the plant, fungal and animal kingdoms, all five kingdoms (Protists², Fungi, Plants, Animals and Bacteria) are recognized and covered by the programme, as and where appropriate. Non Timber Forest Products (NTFPs) are an integral part and an important element of agro-biodiversity in Lao PDR, and comprise all plants, animals and fungi harvested for use or sale.

Under the more detailed definition of agro-biodiversity adopted by the Convention on Biological Diversity (CBD), agro-biodiversity includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that contribute to maintaining productive agro-ecosystems. Under this definition it is argued that agro-biodiversity is the outcome of the interactions among genetic resources, the environment and the management systems and practices used by farmers and is the result of both natural selection and all human interventions since agriculture began.

The CBD Conference of Parties (COP) identifies the following five dimensions of agro-biodiversity:

- 1) Plant genetic resources, including crops, wild plants and trees harvested and managed for food; pasture and rangeland species; animal genetic resources, including domesticated animals and wild

² Protists include brown algae and plankton

animals hunted for food; wild and farmed fish and other aquatic organisms; and microbial and fungal genetic resources.

- 2) All components of biodiversity that support ecosystem services upon which agriculture is based. These include the diverse range of organisms that contribute to nutrient cycling, pest and disease regulation, pollination, pollution control, sediment regulation, erosion control, maintenance of hydrological cycles, climate regulation and carbon sequestration.
- 3) Abiotic factors, such as local climatic and chemical factors and the physical structure and functioning of ecosystems, which have a determining effect on agro-biodiversity.
- 4) Socio-economic and cultural factors including human activities and management practices, traditional and local knowledge of agro-biodiversity, cultural factors and tourism activities associated with agricultural landscapes.
- 5) Traditional knowledge relating to the usage, collection, cultivation, domestication, processing and trade of plant and animal species.

Following the above definitions, agro-biodiversity can also be expressed as the result of the interactions among natural ecosystems, agro-ecosystems, genetic resources and management systems and practices. As such, biodiversity and agriculture are strongly interdependent, and biodiversity has enabled agricultural systems to continue to evolve ever since farming began some 10,000 years ago. While biodiversity is critical for agriculture, agriculture also contributes to biodiversity conservation and the sustainable use of natural resources. Indeed, sustainable agriculture both promotes and is enhanced by biological diversity.

1.2 Global Importance of Agro-Biodiversity

Historically, conservation efforts world-wide tended to focus on establishing protected areas to conserve biodiversity resources. More recently, scientists have recognized that protected areas are necessary but not sufficient for the conservation of biodiversity, and focus began to turn to the role of multifunctional landscapes and agro-ecosystems as important contributors to the management and conservation of biodiversity. In recognition of this, the Third Conference of Parties to the CBD established an Agro-biodiversity Programme in 1996.

Despite a growing recognition of its importance as evidenced by the CBD, the actual extent of all biological diversity worldwide remains largely uncertain. A recent study (Mora *et al.*, 2011) predicted that there are

around 8.7 million eukaryotic species³ globally, of which 2.2 million are marine. Of these, only 1.2 million species have been catalogued suggesting that some 86% of existing species on earth and 91% of species in the ocean still await description. As a consequence, further exploration and taxonomy is required to fill this significant knowledge gap in regard to global biodiversity.

Although the knowledge gap for plant and animal species used in agriculture is much smaller, it is still significant and underlines the importance of identifying and recording indigenous knowledge of agro-biodiversity resources.

Crop, animal and fungal genetic resources (germplasm), the key building blocks of agro-biodiversity, are extremely important biological resources. They are the foundation of all food production and the key to feeding a growing world population, particularly in times of climatic and other environmental change. Demand for germplasm has increased because of enhanced biotechnology, and future human welfare will depend heavily on its improved conservation.

Due to the limitations of further expanding agricultural land, increased food production must come largely from increased crop and livestock productivity, and continued access to genetic material for breeding will be the cornerstone of achieving these higher yields. Over the past century germplasm has been collected and stored in a network of national and international gene-banks, concentrated mainly in industrialized countries. Although this is an important accomplishment, further action is required to maintain the evolutionary processes that generate new germplasm. One way of achieving this is through *in-situ* germplasm conservation in close collaboration with the world's farming community.

³ Eukaryotic organisms have membrane bound nucleus and include plants, animals, fungi, algae, flagellates, amoeba, and slime molds.

2. AGRO-BIODIVERSITY IN THE LAO CONTEXT

Lao PDR is endowed with productive and ecologically unique forests and farming landscapes and been identified as one of the centers of origin of domesticated plant and animal species and is a primary center of origin of cultivated rice (Russel, 2000). With this combination of natural biodiversity and agriculture, Lao PDR is of outstanding global importance in regard to agro-biodiversity. The country's rich use of agro-biodiversity resources is exemplified by the data compiled for plants, animals and fungi presented in Table 1.

Table 1: Estimate of Lao agro-biodiversity resources

Organism	Wild (used)	Gen-plasm (gene bank)	Cultivated		Raised (animals)	
			Species	Varieties/land races	Species	Breeds
Plants	2,500*	17,000	135*	180*	-	-
Rice	-	14,500	1*	30*	-	-
Non rice crops	50*	2,500	100*	150*		
NTFP**	500*	-	14*	-	-	-
Medicinal plants	1,700	-	20*	-	-	-
Animals	800*	-	-	-	40*	50*
Livestock	-	?	-	-	20*	50*
Insects, etc.	100*	-	-	-	10*	-
Fish & Aquatic	200*	-	-	-	10*	-
Macro fungi	100*	-	5	-	-	-
Total	3,400*	17,000	140*	180*	40*	50*

*: Estimate by ABP. **: Excluding medicinal plants and macro fungi.

2.1 Agro-Biodiversity and Livelihoods

As described above, the people of Lao PDR make tremendous use of the country's diversity and although declining, agriculture and forestry are still an important economic sector, accounting for 30 percent of total GDP and two thirds of the labor force (MPI, 2011). In spite of being a rice surplus economy, food insecurity and malnutrition remain serious problems with 50 percent of rural children under the age of five chronically malnourished and two-thirds of the rural population vulnerable to food insecurity (WFP, 2006). Quite apart from crops and livestock, the agro-biodiversity used in Lao PDR includes a wide-range of wild plants, animals and fungi that contribute significantly to family nutrition and balanced diets. In addition,

the numerous natural medicines and traditional remedies obtained from these wild products also contribute to family health and well-being.

Although agro-biodiversity is important to both rural and urban populations in Lao PDR, poor, remote and marginalized groups depend on it the most. As a consequence, agro-biodiversity plays a central role in poverty reduction, enhancing the quality of rural life, and sustaining ethnic cultures.

There is a huge wealth of indigenous knowledge associated with agro-biodiversity, particularly among the many ethnic groups in Lao PDR. Most of this knowledge remains un-documented and many organisms still need to be described and officially named. Unless action is promptly taken, this valuable information will be lost.

Gender roles in the management and use of agro-biodiversity resources vary significantly between males and females but are not always static, shifting in response to changing agro-ecological and socio-economic conditions and the introduction of new technology (Souvanthong *et al.*, 2009). Males and females have a somewhat different understanding of many aspects of agro-biodiversity, and possess different skills in the management of these resources which need to be fully incorporated in all biodiversity management plans.

Agro-biodiversity plays a key role in protecting farmers against global market price fluctuations. With over 80% of the population involved in farming and with the increasing move away from subsistence to market oriented production, Lao farmers are becoming increasingly vulnerable to changes in the global price of food and other agricultural commodities. By maintaining a degree of diversity of crops and other agricultural products on-farm diversity helps to buffer farmers against market price movements and promotes more stable income generation.

In other words, farmers use agro-biodiversity in support of livelihood improvement and to obtain economic returns. Thus, improved agricultural technologies and extension packages that promote the use and conservation of agro-biodiversity must be able to clearly demonstrate economic advantages, if they are to be adopted and used by farmers. As with organic products, Geographic Indications (GI), fair trade and other accreditation schemes, agro-biodiversity certifications could be introduced to enhance economic returns from these products through premium prices that a growing number of consumers world-wide are willing to pay for.

2.2 Agro-Biodiversity and Ecosystem Services

Agro-biodiversity resources are an integral part of the ecosystem services that maintain key functions crucial to Lao PDR's economic, social and ecological well-being. Agro-biodiversity helps to maintain soil nutrient status through fallow development, nitrogen fixation and by-product re-cycling; it promotes soil moisture retention through enhanced ground cover, multi-layered canopies and variable depth root-zones; it supports pest and disease control through mixed and inter-cropping, through the inclusion of botanical pesticides and by maintaining the pool of natural-enemies; and it promotes pollination.

Enhanced agro-biodiversity values help to maintain socially important ecosystem services. By supporting improved hydrological cycling and more efficient water management, agro-biodiversity contributes to the sustainable provision of domestic and potable water for rural and urban populations alike. More effective hydrological cycling systems contribute to the maintenance of water quality through natural filtration and waste removal. The more even ground cover created by diversified cropping systems reduces rainfall runoff and thereby reduces soil erosion and contributes to flood-control both locally and nationally.

Thus, the enhanced agro-biodiversity supports the wider ecosystem services that sustain the supply of water, energy, minerals and raw materials and conserve local traditions, ethnic cultures, wildlife and scenic values on which the business, transport, energy and tourism sectors are dependent.

Through its contribution to ecosystem services, the protection and sustainable use of the agro-biodiversity play a key role in enabling Lao PDR to better adapt to climate change. With its sensitive mountainous terrain, and its large agrarian population Lao PDR is particularly prone to climate change, and increasing climate risks are placing further pressure on the environment and biodiversity values, including agro-biodiversity. Thus, by maintaining a high agro-biodiversity the country will be in a better position adapt to extreme weather events that can be expected to increase in the future.

2.3 Agro-Biodiversity and Economic Development

Lao PDR is committed to leaving the 'Least Developed Country' status by 2020, and the utilization of agro-biodiversity resources will have an important role to play towards achieving this objective. Except for a slight dip during the financial crisis in 1997 and 1998, Lao PDR has experienced steady economic growth. This has resulted in an improved quality of life for the people, evidenced by a steadily increasing GDP per

capita (7% or more over the past ten years), a reduced incidence of poverty (now standing at 27.6%), a declining infant mortality (currently 54 deaths per 10,000 live births), longer life expectancy (now 65 years) and a high rate of enrollment (97.4%) in primary education (MPI, 2011 and World Bank, 2015 and ADB, 2014a).

While the Country's high population growth of 1.6% per annum (Index Mundi, 2015), a forest loss of - 0.5% per year, industrial development, urban growth and investments in hydropower, mining and infrastructure have had severe negative impacts on biodiversity values (ADB, 2014b). Increased demand for land, water, energy and food has created unsustainable competition among these sectors which is further eroding biodiversity values.

Despite the transition from a rice deficit to a rice surplus, food insecurity is still a serious problem in Lao PDR. Over the past 15 years, the nutritional status of the Lao people has not significantly improved, and over the last 10 years there has been no improvement in chronic malnutrition. According to the World Food Programme, 50 percent of rural children under the age of five are chronically malnourished and two-thirds of the rural population is food-insecure or vulnerable to food insecurity (WFP, 2006). The rural poor are most prone to malnutrition due to their reliance on natural resources, including wild plants, fish, meat and insects as fat and protein sources. Agro-biodiversity plays a key role in the nutrition of the rural poor, and further loss will intensify the already critical situation.

Forests, wetlands and agro-ecosystems in Lao PDR provide environmental services that have high economic value. The most important from a financial standpoint are (i) carbon sequestration; (ii) watershed protection; (iii) biodiversity conservation; and (iv) scenic and cultural values. These services support and sustain the agriculture, hydropower, and tourism sectors which are critical to the national economy. As such, there is a huge potential for Payment for Ecosystem Services (PES), but the market in Lao PDR is still to capture from such revenue streams.

2.4 Overall Status, Trends and Threats to Agro-Biodiversity

The Lao People's Democratic Republic is still rich in the diversity of its ecosystems and the species therein. It is home to 8,000-11,000 species of flowering plants, over 100 species of mammals, 700 species of birds and 166 species of reptiles and amphibians (GoL, 2003) and 5,000-10,000 of larger fungal species (Pedersen,

2015). Many of these species are used either directly or indirectly for agriculture and food and therefore represent important agro-biodiversity resources.

Lao PDR is particularly rich in rice varieties. Since 1996, NAFRI and the International Rice Research Institute (IRRI) have collaborated in the collection of 237 accessions (samples) of wild rice representing at least 5 wild species and more than 14,000 accessions representing a potential of some 3,000 varieties⁴ of cultivated varieties. Glutinous rice is the staple rice type favored by the Lao people, and around 85 percent of the samples are of glutinous varieties reflecting a potential impressive diversity. Some of local varieties, previously in decline, are now finding favor in national and international markets. In particular Khao Kai Noi (little chicken rice), an aromatic glutinous rice variety⁵ has found niche outlets in both domestic and international markets and is now enjoying a strong resurgence.

Since 2000, NAFRI in collaboration with other partners and cooperating farmer networks has maintained a collection of indigenous tuber crops for propagation and research. Other significant crop agro-biodiversity collections in Lao PDR include local accessions of cereals (millet and Job's tears), pulses, vegetables, industrial crops and fruit trees (see Tables 3.8 and 3.9). The current accessions include 312 legume, 230 spice and 225 mustard species, with the remainder comprising gourds, egg-pants, tomatoes and other minor crops. Lao PDR is unique in the diversity of NTFPs. Over 700 species of wild plants are used for food and other purposes (NBSAP, 2012), and of these over 100 have been identified and described. An important sub-category of the NTFPs are the mushrooms of which somewhere between 50-100 species are used for food and medicine (ABP, 2014).

Although Lao PDR is still exceptionally rich ecologically, biodiversity has been significantly reduced by population growth, land use changes, resource extraction and the transition from subsistence farming to a market economy. Agro-biodiversity values are facing additional threats from land concessions, monocrop plantations, hydropower projects and mining. National policy initiatives on the stabilization of shifting cultivation, resettlement and village consolidation have also had significant impacts on agro-biodiversity. Climate change and increasing water scarcity is already affecting ecological systems, and the livelihoods of Lao farmers, particularly the poor and vulnerable groups (ADB, 2014c).

The introduction of improved varieties has greatly eroded diversity in rice and other crops. Increased demand for NTFPs from cross-border markets has led to rapid depletion of some of these products, particularly rattan, orchids and bark products (Foppes *et al.* 2005) and some medicinal plants (Sydara,

⁴ Rough estimate, as very few rice varieties have been described according to international standards

⁵ Khao Kai Noi consists of four more or less distinct varieties, a black (Khao Kai Noi Dam), a yellow (Khao Kai Noi Leuang), a red (Khao Kai Noi Daeng), and one with black stripe (Khai Kai Noi Lai Dam).

2014). Hydropower development has reduced fish species diversity (Ziv *et al.*, 2012) and hunting has significantly reduced wildlife populations (WCS, 2015).

Both plant and animal invasive alien species⁶ pose a significant threat to agricultural production generally and agro-biodiversity resources in particular. The number of introduced invasive species in the country is already substantial (Tables 7.1, 7.2 and 7.3) and continues to increase.

2.5 Legal Framework

The legal framework in respect to biodiversity in Lao PDR is mainly governed by the Environmental Protection Law, the Forestry Law, the Wildlife and Aquatic Law, the Water and Water Resources Law, the Fisheries Law, the Land Law and legislation covering Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA). However, none of current laws specifically recognize agro-biodiversity as an important element of biodiversity. Even the Agriculture Law makes no specific reference to agro-biodiversity. The current laws covering sustainable management of agro-biodiversity are summarized in Box 1:

A decree on Strategic Environmental Assessment (SEA) is currently in draft form defining the regulations and procedures for SEA when developing policies, strategies and programmes that may adversely affect the environment. As yet, agro-biodiversity impacts are not specifically addressed in the draft decree.

Box 1. Agro-biodiversity related laws

Forestry (2007): Currently under revision, covers activities specifically related to forestry including NTFPs and forest-based agro-biodiversity resources. It calls for management plans to be developed for all conservation, protection and production forest categories.

Agriculture Law (1998): Aims to promote agricultural production to guarantee food and agricultural commodity supply expand agro-industrial processing and contribute to national economic without damaging the environment.

Fisheries Law (2009): Comprises regulations governing fisheries and the promotion of aquaculture, conservation, protection, development and the sustainable use of aquatic agro-biodiversity.

Water and Water Resources Law (1996): Under revision as Law on Water Resources containing issues on flood management, data sharing, and water quality.

Land Law (2003): Currently under revision, it sets out rules for the management, protection and use of land, including biodiversity resources on the land to balance economic development and environmental protection.

Wildlife and Aquatic Law (2007): Defines prohibited species, permitted uses and rules to promote sustainable utilization and regeneration of biodiversity without harmful impacts and to restrict anthropogenic pressure on wildlife.

Environmental Protection Law (1999): Sets the legal basis for management, monitoring, restoration and protection of the environment, natural resources and biodiversity for the sustainable development of the country.

Biotechnology Safety Law (2014): Sets the principles, regulations and measures on management and monitoring of biotechnology safety to ensure safety in research, development, handling, movement, and the use of Genetic Modified Organisms (GMOs).

⁶ Alien invasive species are defined as non-native introduced species posing or likely to pose environmental or economic harm or harm to human, animal or plant health. Thus, invasive species are species not native to the ecosystem under consideration.

2.6 Institutional and Policy Context

The institutional framework for natural resource management and biodiversity conservation in Lao PDR is complex and underwent a major re-organization with the creation of MoNRE. Responsibility is now shared between MoNRE, who through their Department of Forest Resources Management are responsible for conservation and protection forests, and MAF who manage production forests through the Department of Forestry (DoF) and the Department of Forest Inspection (DoFI).

The Government of Lao PDR has developed a number of important policies and strategies that directly or indirectly support the conservation and sustainable use of agro-biodiversity.

The **8th National Social and Economic Development Plan (NSED)**, currently being finalized, emphasizes sustainable development and an integrated rather than a sectoral planning approach. Improved agro-biodiversity management promotes both of these national policy priorities and provides opportunities for NABP II to align with and support the 8th NSED.

The **National Growth and Poverty Eradication Strategy**, formulated in 2004, is the framework under which the government plans to end poverty by 2020 and sustain economic growth with a particular focus on rural areas and poverty districts. The aim is to provide an enabling environment for growth and development in the four key sectors of agriculture/forestry, education, health, and infrastructure. The strategy recognizes that the most important policy objective for the agriculture and forestry sector is the improvement of household food security. To achieve this, sustainable forest and watershed management will be enhanced, disparities between lowland and sloping land farming will be reduced and rural living standards will be improved through the development of market-based agriculture. Due to the extremely high reliance of the poor on the natural resource base, effective agro-biodiversity conservation and management will be central to the success of this strategy.

The goals of the **National Environmental Management Strategy** (to 2020) are to: (i) ensure that environmental resources are conserved in order to promote sustainable development; (ii) protect the environment and maintain eco-system services; (iii) manage water resources to ensure sustainable use; (iv) encourage the wise use of land to enhance production for domestic and export markets; (v) promote the use of environmental safeguards across all development sectors; (vi) protect natural, historical and cultural heritage; (vii) participate in and fulfill national obligations in international environmental agreements; and (viii) support environmental education and awareness to promote international, regional and national co-operation.

The **Forestry Strategy** (to 2020) provides guidance on the sustainable management and development of the forestry sector in line with national policies, strategies and priority programmes for national socio-economic development. It provides a rolling framework for the formulation of future plans and projects in the forestry sector as well as for requesting official development assistance and donor projects. The Strategy provides a comprehensive review of the status of the sector, including forestry stocks, forest resource use and management and past and on-going policies and programmes. It identifies future challenges and development objectives for the sustainable development of the sector, and describes recommended policies, programmes and actions including sedentary practices using improved conservation-oriented farming methods. As such, it provides the framework for the management and utilization of forestry-related agro-biodiversity resources.

MAF **Agricultural Strategy 2025 and Vision 2030** seek to ensure food security through clean, safe and sustainable agriculture and to build an agricultural production system that can significantly contribute to the nation's economy in line with its objectives of industrialization and modernization. The strategy includes 9 action plans and 120 projects/intervention areas related to crops and 7 action plans and 58 projects/interventions areas related to livestock and fisheries. Although the commercialization of the agriculture has a strong focus, the new strategy and vision acknowledges and support the sustainable use of genetic resources and nice products including various vegetables, fruit trees and NTFPs.

The **Agriculture and Forestry Research Strategy** (2015-2025) identifies the degradation and loss of agro-biodiversity and natural resources as one of the seven most important constraints facing agriculture. The strategy has four goals (i) guaranteeing food security, safety, and nutrition, (ii) the commercialization of agricultural production along with high value addition, (iii) ensuring the sustainable management agro-biodiversity and forest resources, and (iv) promoting resilience to climate change. The strategy comprises four research programmes, one of which is a sustainable agro-biodiversity programme, which has the stated aim of "Supporting the development of improved methods, mechanisms and technical recommendations to ensure the sustainable management of natural resources (land, forestry, agro-biodiversity (genetic resources)).

The National Strategy for Traditional Medicine (2012-2015) was approved the Ministry of Health on 2013 and includes a strategic direction to conserve national medicinal plant resources and to protect intellectual knowledge on traditional medicines of Lao ethnic groups. The strategy updates on policy, develops procedures and promotes the protection (e.g. establishing conservation areas) and the sustainable use of medicinal plants, including quotas.

The **Poverty-Focused Agricultural Development Plan** (2003-2020), part of the National Poverty Eradication Plan, defines priority projects to be implemented in the sector up until 2020. It emphasizes the need for development in the agriculture sector to achieve food security through environmentally sound approaches. Agro-biodiversity conservation and utilization is of critical importance if this plan is to meet its objectives as the poor and marginalised groups are most reliant on agro-biodiversity resources. As such, it is vital that NABP II is aligned with the plan.

The **National Climate Change Strategy** (2010) has the goal of ensuring that Lao PDR is capable of mitigating and adapting to climatic change in a way that protects the environment, promotes sustainable development, reduces poverty, enhances the quality of life and promotes public health. The strategy seeks to: (i) reinforce sustainable development goals; (ii) increase the resilience of all sectors to climate change; (iii) enhance cooperation among national stakeholders and international partners; and (iv) promote public awareness in regard to climate change vulnerability and impacts. The strategy identifies seven priority areas, including agriculture and food security, forestry and land use change and water resources, all of which are crucial to protecting agro-biodiversity resources from the effects of climate change.

The **Upland Development Strategy** (2016-2020) has four major objectives: (i) integrated rural development is established as a process for eradicating poverty in upland areas; (ii) food and nutrition security is derived from improved livelihoods and income guaranteed by increased production and better links to markets; (iii) strengthened capacity of local government improves the delivery of public services and creates an enabling environment for private sector and civil society involvement; and (iv) sustainable natural resource management including the sustainable use and conservation of agro-biodiversity.

The second **National Biodiversity Strategy and Action Plan** (NBSAP) is currently being developed and is now in draft form. It consists of three parts: (i) the current situation; (ii) the strategy; and (iii) the national action plan. Globally, it is guided by directions set by the CBD, but at the national level it is aligned with the 8th National Social and Economic Development Plan (NSEDP). It builds on the gains achieved under the first NBSAP, but in addition to establishing direct interventions, it also seeks to address the underlying issues affecting biodiversity loss. Such issues may require interventions beyond the forest and agriculture sector, such as the eco-system services; hence the second NBSAP seeks a broader participation and involvement in its implementation.

Within the overall framework of the Round Table Sector Working Group on Agriculture and Rural Development, the **Agro-Biodiversity Sub-sector Working Group** (sSWG-ABD), chaired by NAFRI and co-chaired by FAO, has the goal of supporting work on the conservation and sustainable use of agro-

biodiversity including the directions set in the NABP-II. More specifically, the sub-sector working group is intended to provide a platform for discussion and exchange and to facilitate knowledge capitalization on agro-biodiversity in support of awareness-raising, advocacy, capacity building, programme planning and policy recommendations.

Lao PDR became a member of the **Association of Southeast Asian Nations** (ASEAN) in 1997, and will accede to the ASEAN Economic Community (AEC) in 2015. As a consequence, Lao PDR is bound by a number of regional agreements that have a bearing on agro-biodiversity conservation and management. Foremost in this regard is Article 1.9 of the Charter which seeks to “Promote sustainable development so as to protect the region’s environment, the sustainability of its natural resources, the preservation of its cultural heritage and the high quality of life of its people.” In support of this, the ASEAN Heritage Parks initiative was launched in 1984 with the aim of protecting the region's most important natural treasures. There are now 35 such protected areas, including the Nam Ha National Protected Area in Lao PDR.

The **ASEAN Center for Biodiversity** (ACB) which was established in 2005 with the mandate to facilitate cooperation and coordination among ASEAN Member States and with relevant national government, regional and international organizations, on the conservation and sustainable use of biological diversity and the fair and equitable sharing of benefits arising from the use of such biodiversity in the ASEAN region.

2.7 Agro-Biodiversity Projects and Programmes

The Agro-Biodiversity Initiative

The Agro-Biodiversity Initiative (TABI) is a long-term commitment of the Lao Government and the Swiss Agency for Development and Cooperation that seeks to conserve, enhance and manage the biological diversity found in farming landscapes in order to improve the livelihoods of farm-families in Lao PDR. It is based on the recognition that biodiversity conservation, economic development and poverty reduction are mutually supportive goals that can be achieved through the sound management and productive use of agro-biodiversity resources.

TABI has two main goals. Firstly, to conserve, enhance, manage and sustainably utilize the biological diversity of farming and forest landscapes to improve the livelihoods and incomes of upland farming families in northern Laos; and secondly, to raise the status of agro-biodiversity as a key component in the development policies, practices and scenarios of Lao PDR. The Programme has 5 Technical Outcomes:

1. Options and systems for agro-biodiversity-based livelihoods are designed, demonstrated and applied by upland farming communities and other stakeholders.
2. Participatory forest and land use planning ensures village agricultural land and forest resource tenure and sustainable management.
3. Integrated spatial planning and agro-biodiversity knowledge management and exchange tools support evidence based decision making.
4. Government policies promote agro-biodiversity conservation and sustainable use, and land management, for improved food security and livelihoods in upland communities.
5. Partner institutions incorporate and use agro-biodiversity tools and concepts for uplands livelihoods development.

TABI is not a conventional project, but rather a programme or 'facility' that provides funding and technical support to ongoing programmes, projects and local initiatives in agriculture, environment, livelihoods, education, health, etc. with the intention of embedding agro-biodiversity issues in decision-making processes at the national and local levels. To achieve this, TABI supports inclusive policy development, improved coordination, information exchange and capacity building in regard to agro-biodiversity in both government and civil society.

TABI has generated a number of important outputs and lessons learned. Most notably, the programme has developed, tested and refined a land use planning methodology that specifically addresses agro-biodiversity. This Forest and Land use Planning, Allocation and Management (FALUPAM) process has been received favorably by both MAF and MoNRE and a detailed user-manual has been produced. Other important outputs include numerous Sub-Project Agreements with government agencies and local communities for agro-biodiversity management and conservation pilot activities and a wide range of knowledge products related to agro-biodiversity conservation and use.

The Agricultural Biodiversity Project

The Agricultural Biodiversity Project⁷ (ABP) was prepared with the support of UNDP and FAO with MAF as the national implementing partner. Its goal is to mainstream biodiversity conservation into decision making by farmers and government. The project (2011-16) is funded by a GEF and provides local support for small-scale agro-biodiversity initiatives with local communities and for piloting provincial Strategy and Action Plans. At central level the project assists the government in the formulation of NABP II and in the

⁷ Full title of project is: Mainstreaming Biodiversity in Lao PDR's Agricultural and Land Management Policies, Plans and Programmes.

coordination of the subsector working group on agro-biodiversity. The project also supports local to central linkages with regard to agro-biodiversity planning, implementation and monitoring.

The project has two technical components:

1. National policy and institutional frameworks for sustainable use and in-situ conservation of biodiversity in agro-ecosystems.
2. Capacities and incentives to mainstream biodiversity, especially agro-biodiversity, at provincial, district and village levels.

Important outputs from this project include a range of IPM and agro-biodiversity related farmer field schools, two provincial biodiversity strategy and action plans, surveys of a range of agro-biodiversity species and a number of locally implemented agro-biodiversity initiatives.

Biodiversity Conservation Corridors Initiative and the BCC Project

The ADB's Core Environment Programme and Biodiversity Conservation Corridors Initiative (CEP-BCI), now in its second phase, began in 2006 with the aim of addressing emerging problems and environmental concerns within the Greater Mekong Sub-region (GMS). A major component of the programme is support for the improved management of trans-boundary conservation landscapes in five GMS countries, including Lao PDR. An important part of this has been support for sustainable livelihoods which has focused largely on linkages between farming and biodiversity conservation. It is anticipated that the programme will run until 2020.

The BCC Programme in Lao PDR is administered by MoNRE's Department of Forest Resources (DFRM), and its intended impact is "Climate resilient, sustainable forest ecosystems benefiting local livelihoods in the biodiversity corridors." The programme has four components:

1. Institutional and community strengthening.
2. Biodiversity corridors restoration and ecosystem services protection.
3. Livelihood improvement and small-scale infrastructure support.
4. Project management and support services.

Important outputs of BCI/BCC include (i) proven methods for the establishment of multi-use biodiversity conservation corridors, (ii) participatory methods for analyzing climate change impacts and planning adaptation measures and (iii) methods for the valuation of ecosystem services.

Northern Uplands Development Programme

The multi-donor funded (EU, AFD, GIZ, SDC) Northern Uplands Development Programme (NUDP) is an initiative of MAF's Department of Planning and Cooperation to implement a programme-based approach to upland development in Lao PDR. The programme comprises six components as follows:

1. Land and landscape management.
2. Local governance and planning.
3. Pro-poor rural economy.
4. Support the emergence of farmer organizations.
5. Improving delivery of public agricultural advisory services.
6. Food facility action.

The programme includes three cross-cutting areas aimed at improving national policy development and promoting aid effectiveness: (i) knowledge capitalization and policy formulation (ii) support for the Vientiane Declaration, and (iii) improved governance and management of official development assistance.

Integrated Conservation of Biodiversity and Forests

The recently-initiated Integrated Conservation of Biodiversity and Forests in National Protected Areas and Corridors Project (ICBF) supported by KfW will run from 2015-2022. It addresses biodiversity conservation, utilization and management in NPAs, buffer zones and conservation corridors in two target sites, one in the North and another in the central region.

The Project adopts a landscape level approach to biodiversity management in order to improve rural livelihoods. The overall Programme Objective is that "The socio-economic living conditions of poor rural households are improved through sustainable management of natural resources". It has three components: (i) protected area planning and management, (ii) law enforcement in conservation landscapes, and (iii) sustainable land and forest management.

2.8 Lao PDR Membership of International Conventions

In response to the loss of biodiversity globally a number of international conventions have been created with the aim of improving the management and conservation of natural resources. Lao PDR is party to many of these multilateral agreements. Lao PDR also plays an active role in the FAO Commission on Food

and Agriculture Genetic Resources through its membership on three sub-committees, namely forestry, animals, and plants.

The Convention on Biological Diversity

In 1992, an historic set of international agreements were established during the United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil. Key among these agreements was the Convention on Biological Diversity, which commits the global community to the conservation and sustainable use of biodiversity. The Convention has three objectives: (i) the conservation of biological diversity; (ii) the sustainable use of the components of biodiversity; and (iii) the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

Lao PDR became a party to the CBD on the 20th September, 1996 through accession, and in 2004 produced the first National Biodiversity Strategy (to 2020) and Action Plan (to 2010). The latest (4th) Lao National CBD Report was submitted to the Secretariat in 2010 prior to the 10th Conference of Parties (COP) in Nagoya.

The DFRM of MoNRE acts as the Lao National Focal Point for the convention and conducted an assessment of the implementation of the first NBSAP as a precursor to developing the second NBSAP with deadline end 2015. The assessment revealed that NBSAP implementation fell short in nine key areas: (i) biodiversity research, (ii) recording of indigenous knowledge, (iii) expansion of NPAs, (iv) implementation of NPA management plans, (v) drafting of a Biosafety Law, (vi) expansion of ecotourism, (vii) land use planning and allocation, (viii) Ramsar accession, and (ix) stricter EIA/ESIA laws.

In 1996, COP 3 established an agro-biodiversity programme under the CBD. The programme had three objectives: (i) to promote positive effects and mitigate negative impacts of agricultural practices on biological diversity in agro-ecosystems and their interface with other ecosystems; (ii) to promote the conservation and sustainable use of genetic resources of actual or potential value for food and agriculture; and (iii) to promote the fair and equitable sharing of benefits arising out of the utilization of genetic resources. Lao PDR developed and endorsed the First National Agro-Biodiversity Programme in 2004.

Since the establishment of the Agro-Biodiversity Programme 1993, agro-biodiversity has gradually gained in prominence under the CBD. COP 4 endorsed a recommendation to develop a multi-year programme of work on agro-biodiversity. COP 5 requested FAO and other relevant organizations to support the implementation of the work programme. In addition, it welcomed the contribution that the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources provides to the CBD and

endorsed its policy recommendations. The COP also expressed support for the Global Strategy for the Management of Farm Animal Genetic Resources.

COP 6 adopted provisions for the International Pollinator Initiative, soil biodiversity, animal genetic resources, trade liberalization and genetic use restriction technologies. COP 7 recognized the importance of the International Treaty on Plant Genetic Resources for Food and Agriculture and urged the parties to ratify this instrument. COP 9 considered the report of the review of the programme of work on agro-biodiversity, and agreed to integrate biofuel production and use into the agro-biodiversity programme. COP 10 stressed the importance of agro-biodiversity for food security in the face of climate change, and also requested FAO to undertake further studies on the valuation of the ecosystem services provided by agro-ecosystems.

As part of their obligations under CBD, Lao PDR has formulated two Provincial Biodiversity Strategy and Action Plans (PBSAPs) in Attapeu and Xieng Khouang provinces, and another is currently being planned for Luang Prabang, with technical and funding support from the ABP project.

The Cartagena Protocol on Biosafety

The Cartagena Protocol on Biosafety, an adjunct to the CBD, is an international agreement which aims to ensure the safe handling, transport and use of living modified organisms (LMOs) resulting from modern biotechnology that may have adverse effects on biological diversity. Lao PDR became a party to the treaty in August, 2004 through accession.

The Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology. It establishes an advance informed agreement (AIA) procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory.

The Protocol also establishes a Biosafety Clearing-House to facilitate the exchange of information on living modified organisms and to assist countries in the implementation of the Protocol. In the case of Lao PDR, with a high rate of endemism and biodiversity, it is needed to restrict the usage of exotic plant or animal species both in the wild and in agro-ecosystems.

The Nagoya Protocol

The Nagoya Protocol on access to genetic resources is an international agreement aimed at sharing the benefits arising from the utilization of genetic resources in a fair and equitable way. It includes provisions for appropriate access to genetic resources, thereby contributing to the conservation of biological diversity

and the sustainable use of its components. It was adopted by COP 10 of the CBD on 29 October 2010 in Nagoya, Japan. With Cambodia's ratification, the protocol reached 58 ratifications/accessions, and thereby came into force on 12 October 2014. Lao PDR became a party to the protocol on that day through accession.

It is expected that the Nagoya Protocol will provide greater legal certainty and transparency for both providers and users of genetic resources by creating a framework that promotes the use of genetic resources and associated traditional knowledge while at the same time strengthening the opportunities for fair and equitable sharing of the benefits from their use. The Protocol will create new incentives to conserve biodiversity, sustainably use its components, and further enhance the contribution of biodiversity to sustainable development and human well-being.

Lao PDR continues to develop human and institutional support for policies and issues related to access and benefit-sharing (ABS), and a national ABS Framework is being developed and refined by the Science and Technology Research Institute of the Ministry of Science and Technology (MoST) with the support of UNEP-GEF. Although a national framework on ABS is still to be developed, valuable experiences have been gained in access and benefit-sharing by promoting the plantation of economic crops including agarwood, for oil extraction and incense. The key concept is a joint collaboration between the government, a private company (such as the Lao Agar International Development Company Ltd.) and farmers. Technology is then transferred from research institutions to farmers and additional knowledge, marketing and credit are provided by a private company.

Commission on Genetic Resources for Food and Agriculture

Lao PDR is an active member of FAO's Commission on Genetic Resources for Food and Agriculture (CGRFA) which was established by FAO in 1983, to deal with issues related to plant genetic resources, including monitoring the operation of the international arrangements. The commission oversees a number of activities including undertaking negotiations, preparing and adopting plan of actions, and issuing guidelines. The latest being voluntary guidelines to support the integration of genetic diversity into national climate change planning (FAO, 2015).

Treaty on Plant Genetic Resources for Food and Agriculture

The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) came into force in June 2004 and Lao PDR has been a party to the Treaty since 2006 which covers all plant genetic resources relevant to food and agriculture, including wild relatives. The objectives of the Treaty are "The

conservation and sustainable use of plant genetic resources for food and agriculture and the fair and equitable sharing of the benefits arising from their use, in harmony with the Convention on Biological Diversity, for sustainable agriculture and food security.

The Treaty aims to: (i) recognize the contribution of farmers to the diversity of crops that feed the world; (ii) establish a global system to provide farmers, plant breeders and scientists with access to plant genetic materials; and (iii) ensure that recipients share the benefits they derive from the use of these genetic materials with the countries where they originated. Currently, the ITPGRFA focuses on those crops for which modalities to exchange genetic materials already exist, for example initiatives by IRRI on the exchange of rice germplasm. However, further work is needed in regard to the genetic resources of more less cultivated crops (ITPGRFA, 2010). In 2007, GoL produced a country report on the State of Plant Genetic Resources for Food and Agriculture in Lao PDR.

Global Action Plan for Plant Genetic Resources

The First Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture, adopted in 1996, was superseded by a second plan which was adopted by the FAO Council at its 143rd Session in November 2011. The plan provides a framework for the implementation of plant conservation and management activities in the face of new developments, opportunities and challenges in the 21st century. The current plan aims to:

- i. Promote cost efficient and effective global efforts to conserve and sustainably use plant genetic resources.
- ii. Link conservation with use for more sustainable management of plant germplasm.
- iii. Strengthen crop improvement and seed systems to foster economic development.
- iv. Create capacities, strengthen national programmes and widen partnerships for the management plant genetic resources.
- v. Strengthen implementation of the International Treaty on Plant Genetic Resources for Food and Agriculture.

The Lao government is currently implementing the plan by establishing a national information sharing mechanism which will be used to prepare the country report on the state of plant genetic resources for food and agriculture to update the previous 2007 Country Report. When completed, the updated report will be submitted to FAO's Commission on Genetic Resources for Food and Agriculture and will contribute

to the preparation of the Second Report on the State of the World's Plant Genetic Resources for Food and Agriculture.

The Global Action Plan for Animal Genetic Resources

The Report on the State of the World's Animal Genetic Resources for Food and Agriculture identified significant gaps in capacity to manage Animal Genetic Resources. In response, the international community adopted the Global Plan of Action for Animal Genetic Resources (GAPAGR) in 2007. The Plan was later endorsed by the 34th FAO Conference. It includes 23 strategic priorities for action grouped into four priority areas: (i) characterization, inventory and monitoring of trends and associated risks; (ii) sustainable use and development; (iii) conservation of genetic diversity; and (iv) policies, institutions and capacity-building.

Lao PDR produced a Country Report on Animal Genetic Resources for Food and Agricultural in 2007, which contains a number of recommendations on how to improve the contribution of farm animals in the country. The Lao PDR Country Report also contributed to the first Report on the State of the World's Animal Genetic Resources and to the Report on Strategic Priorities for Action. These strategic planning documents will help to focus global and regional efforts to enhance the contribution of livestock to national economies and their livelihood strategies (FAO, 2007).

The Ramsar Convention

Ramsar, the convention on wetlands, is an international treaty that provides the framework for national action and international cooperation for the conservation and management of wetlands and their biodiversity resources. The Convention recognizes wetlands as among the most diverse and productive ecosystems, providing essential ecological services and supplying all of the world's fresh water. As such it uses a broad definition of wetlands, which in the Lao context, includes all lakes and rivers, underground aquifers, swamps and marshes, wet grasslands, peatlands, and all human-made sites such as fish ponds, rice paddies and reservoirs.

Ramsar's mission is "The conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world." Ramsar currently has 168 signatories and 2,186 sites worldwide covering a total of 208.5 mill ha.

Under the three pillars of the Convention, the Contracting Parties commit to: (i) work towards the wise use of all their wetlands; (ii) designate suitable wetlands for the list of Wetlands of International Importance

and ensure their effective management; and cooperate internationally on transboundary wetlands, shared wetland systems and shared species.

Lao PDR acceded to the Ramsar Convention on 28 September 2010, and currently has two designated Ramsar sites, Beung Kiat Ngong Wetland in Champassak Province and the Xe Champhone Wetland in Savannakhet Province. The Lao National Focal Point for Ramsar is MoNRE's Department of Environmental Quality Promotion.

Convention on International Trade in Endangered Species of Wild Fauna and Flora

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Today, it accords varying degrees of protection to more than 35,000 species of animals and plants, whether they are traded as live specimens, fur coats or dried herbs.

CITES is an international agreement to which countries adhere voluntarily. CITES is legally binding on its Parties, in other words they have to implement it. However, the Convention does not take the place of national laws, rather it provides a framework to be respected by each Party, which has to adopt its own domestic legislation to ensure that CITES is implemented at the national level. Lao PDR became a party to CITES on 30th May, 2004 through accession to the Treaty and by 2015, CITES had a membership of 180 Parties.

DoF of MAF is the responsible management authority for CITES, the Ministry of Science and Technology (MoST), through its Biotechnology and Ecology Institute is the responsible scientific authority, while MAF's Department of Forest Inspection is the responsible agency for enforcement.

2.9 First National Agro-Biodiversity Programme (NABP I)

The first NABP was endorsed by MAF in January 2005, and was intended to run until 2012. The programme was aligned with all the biodiversity-related international agreements to which Lao PDR is a signatory, in particular CBD and the ITPGRFA. It was also designed to support and supplement a number of important national policy instruments, including the 5th National Socio-Economic Development Plan (2001-2005), the Strategic Vision for the Agriculture Sector (2000-2020), the National Growth and Poverty Eradication Strategy to 2020.

The NABP I was designed to serve as the framework for the effective conservation and management of agro-biodiversity. It comprised five technical and two cross cutting components: (i) crop and crop-associated biodiversity; (ii) livestock development and management; (iii) non-timber forest products and other terrestrial biodiversity; (iv) sustainable use and conservation of aquatic biodiversity; (v) household-based integrated agriculture production systems; (vi) management arrangements; and (vii) integrated participatory planning approaches.

NABP I was successful in raising awareness of the importance of agro-biodiversity to the social, economic and environmental health of Lao PDR and contributed to the improved understanding of the role of agro-biodiversity in national development. The programme was also instrumental in fostering the emergence of a number of projects designed to address important agro-biodiversity issues, including (i) the SDC-funded Agro-Biodiversity Initiative (TABI), (ii) the GEF-funded Mainstreaming Biodiversity in Lao PDR's Agricultural and Land Management Programmes, (iii) ADB's Biodiversity Conservation Corridors Programme (BCC), (iv) the multi-donor Northern Uplands Development Programme (NUDP), and more recently, (v) KfW's Integrated Conservation of Biodiversity and Forests Project (ICBF).

The findings and lessons learned from the experience of implementing NABP I identified a number of areas that need further strengthening under NABP II:

- NABP was developed in a participatory manner involving all stakeholders within NAFRI. However the broader involvement of external stakeholders and distribution of the final document among national and international partners was somewhat limited.
- There was insufficient follow-up and inadequate national and international funding to support the implementing major parts of the programme.
- NABP I did not fully reflect evolving national needs and priorities and in order to better respond to developments it needs regular and continuous updating.
- NABP I implementation arrangements were weak and are now outdated due to the creation of MoNRE and the reorganization of MAF.
- Responsibility for land-use planning now lies with MoNRE although MAF and other agencies are also involved and active in implementation at the field level.
- There was inadequate coordination and information exchange with Focal Points of International treaties and conventions.

- There was insufficient interaction among the various technical components of NABP I during programme implementation.
- There was an overlap of responsibilities between ARC and HRC for germplasm collection and conservation.
- There was poor horizontal and vertical integration and communication among broader stakeholders in the implementation of the programme.

The above findings and lessons learned were analyzed, and where appropriate they have been incorporated in NABP II.

3. AGRO-BIODIVERSITY IN FARMING SYSTEMS

Farming systems in Lao PDR are extremely diverse and vary significantly according to prevailing bio-physical and socio-economic conditions. Despite these differences, the most important attributes of these systems can be described within a simple subset of generic farming and ecosystem system types, and are a useful way to describe the country's agro-biodiversity resources.

The following six 'agro-ecosystems' can be identified in the Lao PDR:

1. Paddy rice-based agro-ecosystems
2. Integrated agriculture systems
3. Upland agro-ecosystems
4. Forest ecosystems
5. Large-scale commercial agriculture systems
6. Wetland ecosystems

At the landscape level, these systems appear as a mosaic of different land types and land management strategies, and local communities typically make use the agro-biodiversity resources in these systems in a variety of ways as part of their overall livelihood strategies.

The main characteristics, important uses, key services, important agro-biodiversity and the major threats, problems and opportunities facing each farming system type are described in Table 2.

Table 2: Major farming systems identified by NABP-II and their agro-biodiversity characteristics, threats and opportunities

PADDY RICE-BASED ECOSYSTEMS	INTEGRATED AGRICULTURE SYSTEMS	UPLAND AGRO-ECOSYSTEMS	FOREST ECOSYSTEMS	LARGE-SCALE COMMERCIAL AGRICULTURE SYSTEMS	WETLAND ECOSYSTEMS
Description: Flat or terraced, bunded rice land where standing water is maintained in the field for extended periods.	Multi-enterprise farming systems including field crops, vegetables, fruit, livestock, and fish.	Gently rolling or steep land under permanent agriculture or swidden rotation.	Forest areas used by local communities for the collection of food, fiber, herbs, medicines, fuel and other products.	Large areas of commercial agri-culture including industrial crops, pasture, fruit trees and forest plantations.	Areas of permanent or seasonal standing water or water-logged conditions
Sub-systems: 1. Lowland rainfed paddy 2. Lowland irrigated paddy 3. Upland paddy	1. Integrated upland systems 2. Integrated rice-based systems 3. Home-gardens	1. Rotational (swidden) 2. Permanent agriculture 3. Natural grasslands	1. Tropical evergreen 2. Semi-evergreen 3. Mixed deciduous 4. Dry dipterocarp 5. Coniferous	1. Food and industrial crops 2. Tree crops including fruit trees 3. Timber 4. Livestock	1. Rivers 2. Streams and creeks 3. Lakes 5. Ponds 4. Swamps
Agro-biodiversity resources: 1. Rice (cultivated and wild species), 2. Grass and weed species 3. Fish and other aquatic species 4. Algal species	1. Domesticated crops/landraces 2. Fruit trees and herbs 3. Livestock breeds and fish species 4. Others (insects, NTFPs, etc.)	1. Fallow succession species 2. NTFPs (domesticated & in fallows) 3. Upland crop species/landraces 4. Livestock and wildlife species	1. NTFPs 2. Tree species Wildlife species	1. Some NTFPs 2. Bred and introduced crop species	1. Fish species 2. Aquatic animal species 3. Aquatic plant species 4. Tree species
Ecosystem services: Nutrient cycling Nitrogen fixation Erosion control and sediment sink Weed control Provisioning: rice, fish aquatic spp. Rice farming indigenous knowledge Traditional livelihoods	By-product re-cycling Nutrient cycling Food chain Provisioning: rice, vegetables, fruit, meat, fish, herbs and medicines Traditional livelihood IK Handicrafts	Nutrient cycling Carbon sequestration (fallows) Rainfall infiltration (fallows) Pollination (fallows) Wildlife conservation (fallows) Provisioning: Upland crops/NTFPs Ethnic diversity and IK Eco/cultural tourism	Hydrological cycling/rain infiltration Microclimate regulation Carbon cycling and sequestration Nutrient cycling Pollination Wildlife conservation Provisioning: NTFPs, timber, fuel, etc. Eco-tourism/NTFP-based IK	Carbon sequestration (tree crops) Rain infiltration (fruit & tree crops) Provisioning: labor opportunities	Hydrological cycling Water transport Water purification Aquatic biodiversity Aquatic species conservation Provisioning: fish/aquatic animals aquatic plants, aquaculture Wetlands nature-tourism
Threats to agro-biodiversity: Insecticides and herbicides Loss of traditional rice varieties	Agro-chemicals Market-oriented production	Shortened fallows Mono-cropping Land concessions Soil erosion	Deforestation Forest fires Over-grazing Plantation forests Over exploitation of NTFPs	Unsuitable land concessions Extensive mono-cropping Market price fluctuations Agro-chemicals	Land reclamation Increased demand for water Climate change Water pollution Sedimentation
Opportunities: Integrated fertility management Green manuring Integrated pest management (IPM) On-farm water management incl. Rice-fish Niche rice varieties Organic rice	NTFP domestication Processing and value added Green value chain development Livestock crosses with wild species Animal health programmes Organic farming Village school ABD programmes Agro-biodiversity farm-stays	<i>In situ</i> germplasm conservation NTFP domestication Soil improvement (bio-char, etc.) Integrated pest management Return (to some) old varieties Market links/info.	Strengthened conservation and sustainable use Conservation corridor establishment NTFP sustainable management and domestication NTFP value-chain development Eco/nature tourism	Landscape level land mgt. planning Valuation of ecosystem services Strengthened environmental safeguards Improved land use planning Community land titling	Rehabilitation of riparian forest Check dams/CARE rings to rehabilitate aquatic biodiversity Community protection and management of wetlands

3.1 Paddy Rice-Based Ecosystems

Description

Paddy rice-based ecosystems are paddy rice areas where water is maintained in bunded fields for most of the growing season. There are three major types of paddy rice ecosystems in Lao PDR – lowland rainfed, lowland irrigated (gravity and pump) and upland (gravity irrigated). Paddy rice is the dominant rice production system in Lao PDR (Table 3.1), and over 90% of the total rice production comes from the paddy rice ecosystem. The 48% increase in production between 1990 and 2000 is mainly attributable to increased yields.

Agro-Biodiversity Characteristics

Paddy rice has been grown since the dawn of agriculture, and due to the wide range of ecological niches it occupies and the different phases it passes through during the cultivation cycle, it provides habitats for a wide range of wild species, including plants, mammals, birds, fish, amphibians, reptiles, molluscs, crustaceans, and insects. A recent study of paddy field area of three villages in Xieng Khouang Province recorded 95 wild species and confirmed the rich diversity of indigenous knowledge associated with their use (Pedersen *et al.*, 2013).

Much of this biodiversity is directly useful to humans, and accounts for a large part of the daily intake of animal protein, micronutrients and essential fatty acids of the rural population, especially in poorer households. The biodiversity of the paddy rice ecosystem also plays an important role in the biological control of pests and insect vectors that reduce crop yields and cause diseases in both livestock and humans.

Although both glutinous and non-glutinous varieties are grown in paddy and upland the upland rice ecosystems, Lao PDR is particularly renowned for the diversity of its glutinous rice, and some 85% of all rice varieties grown in the country are attributed to this rice type. Glutinous rice varieties are favored for home consumption due to their good taste, tolerance to extreme climate, pests and diseases and their lower fertilizer requirements, whereas non-glutinous rice is largely grown commercially and for sale using mainly improved varieties.

The huge diversity of traditional rice germplasm that once existed in Lao PDR is reflected in the results of the germplasm-collection missions that were supported by IRRI between 1995 and 2000 in which over

13,000 samples were made and resulted in more than 5,000 lowland rice accessions indicating a great potential for development of improved varieties. Further, from five wild rice species (*Oryza rufipogon*, *O. granulate*, *O. ridleyi*, *O. nivara*, and *O. officinalis*) a total of 124 germplasm have been collected, see Table 3.6.

In 1990, traditional varieties accounted for 95% of the lowland rice grown, but by the early 2000's only 20-30% remained in traditional varieties (Inthapanya *et al.*, 2006). In 2007, over 30 indigenous rice varieties were cultivated by farmers. Today, the main cultivated rice varieties include 12 improved varieties and 12 traditional varieties used for subsistence and/or for sale (Table 3.2).

Lowland rice fields contain numerous aquatic species that are also important elements of agro-biodiversity in wetlands. As such, there is some overlap between these two ecosystem types in regard to aquatic biodiversity, and some additional information is presented under wetland ecosystems (Section 3.6).

Threats to Agro-Biodiversity

Since the green-revolution in the mid-1960's lowland rice farming has undergone a dramatic transformation. This has created a range of pressures that are having significant impacts on the agro-biodiversity of lowland rice ecosystems.

The increased adoption of high-yielding rice varieties in Lao PDR means that the wide range of local paddy rice varieties previously grown have been replaced by a much narrower range of high yielding varieties. These varieties also tend to be of shorter duration which means there is less time for the natural ecology of the rice field to fully develop, resulting in lower floral and faunal diversity.

With increasing population and the potential for higher yields and higher profits, the area of lowland paddy has expanded, creating extensive mono-crop rice areas with much lower agro-biodiversity values than the traditional, smaller isolated parcels of paddy land. In addition, the large expansion of irrigation in lowland rice ecosystems, means that water is available to farmers at the same time, leading to synchronised planting and harvesting which reduces temporal elements of biodiversity in the ecosystem.

The increased use of insecticides kills not only the rice pests, but also a wide range of beneficial insects that are part of rice-field biodiversity. Increasing use of herbicides greatly diminishes the floral biodiversity in lowland rice ecosystems, and all chemical pesticides are inherently dangerous to

aquatic animals, and significantly diminish these elements of agro-biodiversity. The higher use of chemical fertilizers required by high yielding varieties largely replaces the natural nitrogen fixing and nutrient cycling processes that supply nutrients in traditional paddy rice systems.

Finally, the more thorough land preparation and tillage operations due to increased farm mechanisation in lowland rice, not only result in a more homogenously-sterile physical environment for natural plants and microorganisms, but the increased use of heavy machinery has also resulted in fewer buffalo.

Opportunities for Agro-Biodiversity Development

A number of opportunities exist for improving the productivity and profitability of lowland rice ecosystems through the judicious use of agro-biodiversity.

Integrated soil fertility management, including biological diversity additions in the form of green-manure, effective micro-organisms (EM) and nitrogen-fixing algae such as azolla, can enhance soil fertility without the negative impacts on rice-field biodiversity caused by chemical fertilizers. Integrated Pest Management (IPM), including the use of botanical pesticides such as neem, lemon grass, etc. can reduce pest populations without endangering beneficial insects and pollinators.

Properly managed fish farming in rice paddies (currently standing at approximately 5,000 ha or 0.1 % of the total wet season paddy rice area) has been shown to have valuable biological and economic benefits, including weed and insect pest control and increased fertilization from supplementary fish feeding.

Value chain opportunities exist for niche-market rice varieties. Geographic Indication (GI) certification for endemic rice land races such as 'Little Chicken' (*Khao Kai Noi*) offers the potential for enhanced market access and increased prices, particularly in western countries (Table 3.5). Organic rice offers similar market opportunities, and has the added benefit of enhancing biodiversity in the rice paddy by reducing the use of agro-chemicals.

Responsible Agencies

NAFRI's Agricultural Research Centre (ARC) has responsibility for research and development on paddy rice in Lao PDR, as well as for *in-situ* and *ex-situ* germplasm conservation, while MAF's Department of Extension and Cooperatives (DoEC) has responsibility for agricultural extension.

Since 2000, ARC has conducted numerous agro-biodiversity research studies in collaboration with a range of international development partners. These research partnerships are summarised in Table 3.10.

3.2 Integrated Agriculture Systems

Description

Integrated agriculture production systems are farming systems comprising a mix of different enterprises including rice, field crops, vegetables, fruits, livestock, and aquaculture. They include rice-based systems, upland systems and home-gardens around the house. These systems are organised to optimise the positive synergies created by high levels of agro-biodiversity, including soil fertility use, pest control, pollination and climate and market resilience.

Agro-Biodiversity Characteristics

A well-managed integrated farming system can provide a wide range of different crops, fruits, vegetables, herbs, spices, fish and animal products. Home-gardens, in particular, have high agro-biodiversity levels comprising fruits (papaya, banana, citrus, pineapple, mango, tamarind, jackfruit, etc.); vegetables (aubergine, chilli, leafy-vegetables, spring onions, garlic, legumes, etc.); other crops (ginger, taro, lemon grass, kalangal and various medicinal plants); trees (teak, acacia, eucalyptus, bamboo, etc.); livestock (cattle, buffalo, horses, goats, sheep, native and improved pigs, chickens, ducks, geese, turkeys, insects, rabbits, etc.) In one garden in Phonexay District of Luang Prabang, more than 50 different plants were recorded (Sodarak, 2003). Unfortunately, many of these plus other organisms such as herbs, mushrooms and insects often go un-reported in many agricultural surveys.

Domesticated NTFPs often occur in integrated farming systems, including bitter bamboo, cardamom, broom-grass, eaglewood, oyster mushroom, wood ear, and straw mushroom.

High levels of plant and animal biodiversity in these integrated systems are important for farm-family nutrition by promoting a balanced diet and ensuring an adequate intake of carbohydrates, proteins and vitamins. Although integrated farms widely exist throughout Lao PDR, there is still very limited knowledge of their impact on nutrition, food security and biodiversity values.

Livestock production is extremely important component of integrated farming systems, accounting for 16 per cent of GDP. Almost 90 percent of all farm households raise at least one livestock type in addition to various crops (Wilson, 2015). The most important types of livestock are cattle, buffalo, pigs, goats, chickens, and ducks. Livestock provide food, income and manure, and large animals are also raised for draft purposes and as a source of savings for use in family emergencies. The national herd of all non-poultry livestock has more than doubled between 2000 and 2012 (see table 4.1). The largest increase has been in pigs and the smallest in buffalo, the latter reflecting the increased use of mechanical tillers.

Traditional livestock management practices in smallholder systems are based on free range grazing, browsing and foraging. A major constraint to livestock production is diseases, especially in poultry and pigs. In some upland areas, farmers reported that more than 80% of their chickens die each year from diseases (Souvanthong *et al.*, 2009). The general lack of efficient veterinary services, forage and affordable animal feed are the major constraints to livestock raising.

Uncontrolled breeding is the norm and little effort has been made in genetic improvement, improved inventory and characterization. There is an active cross-border trade between Laos and Thailand and Laos and Vietnam, with an estimated 100,000 head exported each year (Soukanh *et al.* 2008).

In regard to large animal germplasm, there is no phenotype characterization for either buffalo or cattle in Laos and breeding is largely through un-controlled cross-breeding, with little effort having been made for genetic improvement and recording. The main breed of cattle is the Chinese Yellow.

Both native and the commercial pig species are raised in Lao PDR with more than 80 percent are of native breed stock and are classified into four indigenous phenotypes⁸ (Soukanh *et al.* 2008). Pork is the second most consumed meat in the country and demand and production continues to increase (Table 4.1).

Goats are mostly found in upland areas and are gaining in popularity due to an increasing local demand for goat meat. Native goats in Lao PDR belong to the Katjang phenotype that is widespread throughout Southeast Asia (Soukanh *et al.*, 2008).

Poultry remains an important source of food and cash income for rural Lao families, particularly for the poor who cannot afford to invest in larger animals. Production, predominantly chickens, is increasing in

⁸ Type 1: Moo chid, Moo Markadon, Moo Boua (nationwide distribution); Type 2: Moo Lat (mainly northern upland areas); Type 3: Moo Nonghet or Moo Hmong (mainly in Nonghet District of Xieng Khouang Province); Type 4: Moo Deng or Moo Berk (mainly in Mounlapamok and Khong districts, Champasack Province).

importance in Lao PDR. From 16 million birds in 2001 the population increased to an estimated 28 million in 2012 which included 1.2 million imported broilers and 400,000 laying hens (Table 4.1). Despite the introduction of improved poultry breeds, native chickens remain important, particularly in traditional farming systems. Two species are dominant, firstly *Gallus gallus* (white earlobe) mainly in the north, and secondly *Gallus spadicus* (red earlobe) mainly in the south. Within these two species, five distinct phenotypes⁹ have been identified (Bouahom *et al.* 2007).

Threats to Agro-Biodiversity

The move from a subsistence-based agriculture to more market-oriented production is reducing the importance of integrated farming to some extent. Mobile vegetable shops in the back of pick-up trucks is now a common site in some Lao villages, and shows how purchased food is beginning to replace home production. Market-access difficulties, the lack of fresh vegetable value chains and the general absence of processing or value-adding activities also reduce the income generating potential of these systems.

Agro-chemicals, particularly insecticides are being used more frequently in integrated agricultural production systems. This disrupts the natural biological control that exists in the more traditional integrated farms. Pesticide use also threatens the agro-biodiversity in the aquaculture component in these systems. In addition, the prevalence of animal diseases throughout the country tends to discourage livestock-raising and its integration with cropping systems, thereby reducing this source of agro-biodiversity. Invasive alien species also threaten the productivity of integrated farming systems, including plant, animal and aquatic species (Tables 7.1, 7.2 and 7.3).

Opportunities for Agro-Biodiversity Development

Organic production offers a new economic opportunity with an excellent market potential, particularly for export and in areas close to tourist and urban centres. Domestic organic certification schemes are available in Lao PDR through DoA, and can be obtained by following a set of practical guidelines (MAF, 2011). Other eco-friendly techniques such as the use of EM, organic manure, biochar¹⁰ and compost for soil fertility improvement; mulching and capillary irrigation for the

⁹ Kai Ou (mainly by Hmong villagers in the North), Black bone chickens (widely raised), Kai York (fighting cocks, mainly in the south), Kai Chae with white wattles and Kai Chae with red wattles (small, widely raised).

¹⁰ Biochar is a solid material obtained from the carbonisation of biomass which can be added to soils to reduce soil acidity, improve fertility, increase agricultural productivity, and provide protection against some foliar and soil-borne diseases. It is also beneficial in reducing emissions from biomass that would otherwise naturally degrade to greenhouse gases.

maintenance of soil-moisture; and the introduction of pollinators and other beneficial insects for crop health and pest control can also be used in conjunction with organic farming to further enhance agro-biodiversity in integrated farming systems.

IPM, including the use of botanical pesticides is a promising production technique that not only controls pest damage, but also enhances biodiversity in integrated farming systems. In particular, the mixed planting of a variety of different crop plants in a seemingly random pattern is a common practice, particularly in home-gardens which could be further exploited using native species.

NTFP domestication is a valuable opportunity for increasing the species mix in integrated systems. A number of NTFPs have already been successfully domesticated, but further research into the domestication of naturally-occurring NTFP species including medicinal plants is still required.

Diversified livestock production, including fish could be used to enhance animal biodiversity in home gardens. Techniques to achieve this include the greater use of fish species, the farming of wild animals, and better crossing of domestic livestock. Indigenous poultry - chickens, ducks, geese, and turkeys – are poorly understood and need to systematically be studied. Although pigs have been the subject of a country-wide characterization programme, further work on breed identification and genetic analysis is still needed.

The agro-biodiversity found in integrated farming systems also offers a number of income-enhancing opportunities. Firstly, green value chain development through processing and value adding activities could provide significant economic benefits, particularly for niche products. An agro-biodiversity certification scheme for Lao products could be considered as a means of promoting domestic and international market access; the development of 'farm stays' based on agro-biodiversity and traditional livelihoods could also be promoted as a Lao tourism product.

Small integrated farming systems could be established in rural primary and secondary schools as an educational and awareness-raising mechanism. Village school agro-biodiversity programmes have been successfully promoted by TABI and ABP in Xieng Khouang and Luang Prabang Provinces, which has led to the development of small gardens, arboreta and herbaria in some schools. This has stimulated interest in agro-biodiversity the subject as part of the curricula for rural schools. Based on this, a curriculum for agro-biodiversity teaching has been developed by Xieng Khouang Education Department and approved by the Ministry for use throughout the province and for future expansion to other provinces.

Responsible Agencies

Due to the multi-enterprise nature of integrated agriculture, responsibility is shared among a number of agencies, DoA (crops including fruit trees), DLF (livestock and fish), including ARC (rice and field crops), HRC (fruit and vegetables), LARReC (fish and aquatic organisms), ITM (traditional medicine), and FRC (NTFP domestication).

During the past decade, HRC has developed a seeds storage facility in NAFRI, and has collected over 2,100 accessions of vegetable and fruit germplasm that is commonly found in integrated farming systems (see Tables 3.8 and 3.9).

Since 2000, LRC, DLF and HRC have conducted numerous agro-biodiversity research studies in collaboration with a range of international development partners. These research partnerships are summarized in Tables 3.10, 3.11 and 4.2.

3.3 Upland Agro-Ecosystems

Description

Upland ecosystems are gently rolling or steeply sloping non-terraced land above the flood regime. They include three subsystems: (i) permanent farmland cropped each year; (ii) rotational rice and upland crop swiddens, and (iii) natural grassland.

Agro-Biodiversity Characteristics

Permanent upland systems include field crops, fruit trees and small-holder tree plantations (teak, rubber, eucalyptus, tea, coffee, etc.). In most cases, these are grown as monocrops, and as such, tend to have lower agro-biodiversity values. In some cases, naturally-occurring NTFPs have been domesticated and are grown in these permanent systems. Broom-grass and paper mulberry and wild tea are common examples of NTFPs domesticated for use in permanent upland fields. In many cases, these are grown in association with other crops which also helps to maintain diversity.

Upland rice systems utilise many different varieties (see table 3.2 and 3.6) grown in rotational swidden systems which maintain extremely high levels of agro-biodiversity by virtue of the fallow period between crops. The fallows, traditionally of 10 years or more, represent what is essentially a

natural succession back to forest. As such, they are dynamic systems rich in plant biodiversity which provide a habitat for a wide range of animals, including some important wildlife species. Fallow fields are also an important source of NTFPs and provide grazing for livestock.

Fallows also provide a number of important ecosystem services, including carbon sequestration, nutrient cycling, water retention, pollination and wildlife conservation. Different ethnic groups manage their fallow rotations in different ways, and there is a rich cultural diversity and much indigenous knowledge associated with rotational swidden systems.

Non-rice crops in this system include jobs tears, maize, sorghum, millet, cassava, soybean, mungbean, groundnut, sugarcane and a range of minor crops. If the fallow period is long enough, ideally five years or longer, these systems are stable and maintain biodiversity values. Maize tends to be an exception to this as it normally relies on the heavy use of herbicides and often cropped continuously for two or even three years. Further, upland maize can cause pests build-up, soil erosion and fertility decline, all of which impede fallow re-generation. Instead of natural succession back to forest, the fallow may revert to *Imperata* dominated grassland or weedy species mixes with much lower levels of biodiversity.

Natural grasslands are found in upland areas in Lao PDR, particularly in Xieng Khouang province in the north, where they occur as pure grassland or forest savannah. Dominant monocot species include *Themeda arundinacea*, *Curculigo orchioides* and *Curcuma* species, while trees in the savannah sub-system are dominated by two pine tree namely *Pinus merkusii* and *Pinus kesiya*. Grasslands are surprisingly high in biodiversity values, including grass and tree species germplasm, a variety of bird and wildlife species, domestic livestock and NTFPs.

Grasslands provide a number of important ecosystem regulating and provisioning services, including nutrient cycling, animal fodder and NTFPs. In Xieng Khouang Province, they are also important for cultural tourism and are known internationally as the home of the Plain of Jars. They are used by local villagers for cattle-grazing, planting forage crops, the collection of NTFPs such as mushrooms and ginseng and for trapping wild swallows.

Threats to Agro-Biodiversity

Probably the greatest threat to upland ecosystems agro-biodiversity comes from shortened fallow periods that impede natural succession and greatly reduce biodiversity levels. Mechanised tillage

operations in maize lay the soil open to the elements, causing soil erosion and fertility loss which also impacts negatively on species-rich fallow development. The use of high levels of herbicides in maize is also a serious threat to agro-biodiversity. Over one million tons of maize is produced annually in the uplands (Index Mundi, 2015) hence it represents a serious threat in this ecosystem.

Increasing population levels, village consolidation and the government's upland rice stabilisation policy have all been major drivers of shortened fallow periods. Insecure land tenure in the uplands means that land concessions have been granted in traditional village-use areas, which has also led to reduced fallow periods.

The major threats to agro-biodiversity in natural grasslands include over-grazing, grass fires (both accidental and for harvesting ginseng), encroachment and land grabs.

Opportunities for Agro-Biodiversity Development

Purposefully managed fallows could be used to not only increase species diversity, but also to maximise the presence of useful species of plants and NTFPs. Fallows could also be used for *in situ* germplasm/biodiversity conservation. Fallows are already used for the domestication of some NTFPs, but this could be further expanded and exploited with other NTFP species. In situations where soil erosion is a problem, species-rich contour hedgerows could be used for soil conservation while simultaneously increasing plant biodiversity and providing a refuge for beneficial insects and wildlife.

Opportunities for enhancing agro-biodiversity in grasslands include improved fire control, rotational grazing and sustainable pasture management and improved livestock disease control. Community land titling would promote improved villager ownership and management of grasslands and thereby also enhance agro-biodiversity values.

There is a rich diversity of indigenous knowledge associated with upland ecosystems in Lao PDR, that remains largely unrecorded and only partly understood. Surveys to identify and better understand how this knowledge in regard to agro-biodiversity is used would provide valuable insights into upland ecosystems and also help to highlight possible interventions for their sustainable management.

Responsible Agencies

NAFRI's Upland Agriculture and Forestry Research Center (UAFRC) has the responsibility for research and development on the major upland crops in Lao PDR, along with responsibility for germplasm/agro-biodiversity conservation. The most important upland crops coming under ARC's

mandate are upland rice, maize, sorghum, millet, job's tears, sesame, groundnut, soybean, mung bean and tuber crops such as sweet-potato, cassava, taro, and yams. The Horticulture Research Center (HRC) plays a similar role for vegetables and fruit crops as does the Forestry Research Center (FRC) for NTFPs.

Upland crop accessions in the NAFRI gene bank were quite limited during the period between 1993 and 2003, but between 2004 and 2013 there was a sharp increase in the number of accessions for all the main crops held by ARC (Table 3.7). The germplasm made available in this way was used to create new varieties for all these upland crops (Table 3.3). Accessions of home-garden and fruit tree species are also expanding as materials continue to be collected (Tables 3.7, 3.8 and 3.9).

3.4 Forest Ecosystems

Description

Forest ecosystems are areas with significant natural tree cover and standing timber that are used by local communities for a variety of livelihood purposes. The major forest types found in Lao PDR are: (i) tropical evergreen, (ii) semi-evergreen, (iii) mixed deciduous, (iv) dry dipterocarp, (v) savannah, and (vi) pine forest.

Under the current legal framework in Lao PDR, three national forest categories are recognised: (i) conservation forest, (ii) protection forest, and (iii) production forest. These forest categories, which were designated 22 years ago, no longer reflect reality on the ground, particularly for the protection and production forest categories. The three categories are mirrored at the village level, but because they were designated and delineated by local communities as part of the Land Use Planning process they are a much better reflection of the true situation at this level.

Agro-Biodiversity Characteristics

In combination, the three national forest categories support high levels of biological diversity, especially the conservation forests in which the National Protected Areas (NPAs) are located. The NPAs cover three million hectares, 14% of the total land area of the country. Unlike National Parks in many neighboring countries, Lao PDR recognizes the rights of villagers to reside in these areas, and within certain parameters, make use of the natural resources for livelihood purposes. However, with

these rights come responsibilities and enclave communities assist in protection activities and act as the local custodians of the biodiversity.

The forest ecosystems are rich in plant and animal biodiversity, comprising most of an estimated 8 - 11,000 species of flowering plants, 166 species of reptiles and amphibians, 700 species of birds 90 known species of bats, over 100 species of large mammals, 500 indigenous fish species, and 3,000 – 5,000 larger fungi (GoL, 2003, and Pedersen, 2015).

NTFP are defined as “All biological materials (excluding timber) collected from natural or man-made forests and riverine habitats used to support local livelihoods” (NAFRI, 2007) comprising over 700 species of wild plants and fungi used for food and other purposes; these include wild vegetables, bamboo, shoots, tubers, wild fruits, sugar palm and mushrooms. In addition, as many as 90 percent of the over 1,400 species of wild animals is estimated to be used in some way by local people (NBSAP, 2012). This includes numerous species of mammals, fish, frogs, snakes, shrimp, soft-shelled fresh water turtles, crabs and insects, which constitute the major source of protein and household income in many areas of the Lao PDR.

New medicinal species are continuously been recorded and a major part of the 1,700 species is collected in forest ecosystems and of which many are endangered species¹¹. Some 20 species are cultivated (Kongmany, 2014) whereas both wild species and cultivated species are exported, see tables 5.5-7. According to one study conducted by the Sustainable Forest for Rural Development Project (SUFORD) in 2010, cash income from NTFPs was estimated to be worth on average US\$204 per rural household. The non-cash income, i.e. value of household consumption was estimated to be US\$489. Together, the total income per household comes to US\$693 per household. With approximately 73% of the Lao population living in rural areas, their combined NTFP income (cash and non-cash) could be worth as much as US\$510 million per year, which is equivalent to about 9.0% of the 2010 national GDP.

In addition to biodiversity conservation and food, medicine and material supply, the forest ecosystems provide important ecosystem regulating services, such as rainfall infiltration, hydrological cycling, micro-climate regulation, and carbon sequestration.

Threats to Agro-Biodiversity

¹¹ *Bistorta vivipara* syn. *Polygonum viviparum* L. is new record for Lao PDR, locally used as medicinal plant (Souliya, 2015)

Forest ecosystems in Lao PDR are under threat from a number of sources and the forest area is declining at a rate -0.5 % per year (ADB, 2014). High population growth coupled with industrial, urban, hydropower, mining, and other infrastructure development have been the major drivers of deforestation. The remaining forests and the biodiversity resources they contain are under threat from forest fire, human encroachment, illegal logging, hunting and over-exploitation of NTFPs.

In regard to the status and threats to important NTFPs, the harvest of cardamon and malva nuts are declining largely due to their high demand for export. The stock of some tree resin products are decreasing, such as Dammar resin, Bong bark and Nyang oil, while others such as Benzoin are increasing due to better management and closer collaboration between local authorities and private sector extraction companies (Soukone, 2008). Due to over-harvesting, some other products such as Haktinhung fern have declined dramatically, almost to the point of extinction. The status and trends of these, other important NTFPs and medicinal plants are presented in Table 5.1-7.

Opportunities for Agro-Biodiversity Development

As a precursor to effective biodiversity conservation in forest ecosystems, a review and re-survey of the three National Forest Categories is required to better reflect reality at the ground level. Once the legal framework has been adjusted in this way, a number of opportunities could be explored for increasing the utilisation of biodiversity while simultaneously promoting forest and bio-diversity conservation.

The further development of eco and nature-tourism in a sustainable manner with the involvement of local communities will not only improve livelihoods, but will give villagers an added incentive to maintain pristine forest resources. Such tourism development might include farm home-stays and demonstrations on the collection and use of forest products in rural livelihoods.

The development of methods for the sustainable management of NTFPs and medicinal plants would not only increase family income, but would also help to maintain adequate levels of these resources. Domestication could also be used to reduce the pressure on wild NTFP resources. A number have already been successfully domesticated, most notably cardamom, eaglewood, broom grass, oyster mushrooms, straw mushrooms, *Lentinus* spp. and various medicinal plants. Processing and value-chain development for NTFP products and medicinal plants would help to add value while also protecting existing stocks. Most importantly, strengthening the conservation of forest ecosystems

through the close involvement and benefit-sharing schemes with local guardian communities would provide very significant benefits.

Public-Private partnerships to develop sustainable harvesting and processing systems for NTFPs and medicinal plants also have a good potential. Such an opportunity is clearly demonstrated by the partnership developed between Agroforex and FRC on Benzoin. Agroforex has invested around US\$ 400,000 to get benzoin listed in the Codex Alimentarius by the Joint FAO/WHO Expert Committee on Food Additives with the support of FRC (Soukone, 2008).

There is much indigenous knowledge associated with NTFPs and medicinal plants and their management and use by different ethnic groups. Studies to identify and understand this would certainly assist with devising methods for their sustainable management.

Responsible Agencies

Responsibility for the management, use and conservation of forests and forest resources is shared among MoNRE (conservation and protection forests), DoF (production forests) and NAFRI's FRC (NTFPs).

The mandate for research forest products lies with the FRC, and since 2000, FRC has conducted numerous research studies in collaboration with a range of international development partners. These research partnerships are summarised in Table 5.4.

The mission of Institute of Traditional Medicine (ITM) is to gather, catalogue, research and disseminate information on indigenous medicinal plants. It has a small laboratory, a herbarium and a small medicinal plants garden on its grounds in Vientiane as well as in some provinces. The ITM is also instrumental in the establishment of district conservation area for medicinal plants.

The role of the newly-established Biotechnology and Ecology Institute (BEI) of the Ministry of Science and Technology (MoST) is to provide research and development services on ecology and biodiversity. The institute has a herbarium, animal museum and a botanical garden. The herbarium, established in 2011, now holds 8,000 dried specimens, of which 1,185 were retrieved from existing collections in the Museum d'Histoire Naturelle in Paris. A fungarium is also being established at BEI, with support from a Darwin Initiative supported project.

3.5 Large-Scale Commercial Agriculture Systems

These production systems comprise substantial areas of commercial agriculture managed by large, often international agri-businesses who have been granted land concessions by national, provincial or district authorities. The various systems include (i) fruit trees, (ii) industrial crops, (iii) tree-plantations, (iv) livestock, and (v) commercial fisheries.

Agro-biodiversity Characteristics

These production systems tend to be grown entirely as monocultures or comprise single-species livestock or fishery systems and consequently have low levels of agro-biodiversity. They also follow commercial production practices, often with high levels of mechanisation and significant use of chemicals which further reduce agro-biodiversity values.

The ecosystem services these systems provide tend to be rather limited. The fruit and tree crop systems provide some carbon sequestration and hydrological and nutrient cycling services, whereas intensive cattle production systems particularly contribute to green-house gas emissions. Provisioning services may include employment opportunities and are sometimes limited NTFPs, depending on the access rights of local communities.

Numerous specialized fruit tree orchards are emerging in Lao PDR, dominated largely by banana and mango plantations. These plantations usually involve land concessions to foreign investors, mainly Thai companies in Champasak and Salavan provinces producing ‘*Namwa*’ and ‘*Hom*’ type bananas for export to Thailand, and Chinese companies in northern provinces, growing their own cultivars. Mango orchards are spread throughout the country, growing many local varieties¹² of which ‘*Muang keo*’ is the most popular. Nearer larger urban areas ‘*Nam dok mai*’, a Thai variety, is commonly grown for the fresh market, see table 3.3.

Sugarcane plantations are located close to the three factories in Champasak, Khamouan and Savanakheth provinces using introduced varieties. In the northern provinces of Phongsaly and Luang Namtha sugarcane is grown by local farmers and transported across the border to a Chinese mill.

¹² Local mango varieties include Keo, Kasor, Kasen, Kuang Ngan, Oklong, Nga Xang Khai, etc. Popular exotic species from Thailand include Khiao Savoy, and Nam Dok Mai.

Since 2005 the coffee area has increased from 42,500 ha to some 70,000 ha¹³ and is now a major export earner. Introduced varieties of Rubusta and Arabica are mainly grown on the Bolevan plateau in the south, with increasing proportion being produced organically. Between 2005 and 2011 the tea area more than tripled to some 3,000 ha. Tea (including domesticated wild tea) is mainly grown in the northern provinces. Although it has good prospects, significant research, extension and marketing support is still needed. Much of the coffee and tea production is in the hands of foreign investors, mainly from Viet Nam and China.

In recent years tree plantations (acacia, eucalyptus, teak, and other species) have increased significantly. The rubber area has increased significantly in recent years, and now stands at well over 130,000 ha (Shonweger *et al.*, 2012). Investment in rubber is mainly by Chinese companies in the north and by Thai and Vietnamese companies in the southern and central provinces.

Whereas the number of households with commercial chicken has declined from 4,400 in 1998/99 to 4,000 in 2010/11, the commercial chicken production has more than doubled from 0.6 million to 1.4 million over the same period. In the commercial farms exotic breeds of chicken and pigs (crossbreeds involving Landrace, Yorkshire, etc.) are raised.

Threats to Agro-Biodiversity

These large scale production systems are often in themselves a threat to biodiversity, particularly where they replace natural forest or rotational upland cropping systems. The poor planning and siting of these systems is a major threat to biodiversity, and many of the land concessions granted for these systems are in unsuitable sites. The presence of extensive monocrops reduces the connectivity between natural ecosystems thereby impacting negatively on biodiversity.

There can also be significant social impacts from these systems. In some cases, villagers lose their traditional rights of access to the land which increases the pressure on other land and resources. Although these systems may provide some wage labour opportunities, these are usually very limited due to the levels of mechanisation generally used. Because the concession period is limited, there is no incentive for the concessionaire to maintain the land in a good productive state, and this may result in significant land degradation by the time the concession expires and land is handed back to the villagers.

¹³ Vientiane Times, 31 May 2015

Opportunities for Agro-biodiversity Development

Because of their extensive nature, a 'landscape-level' land management planning approach is needed to appropriately site large agri-business plantation systems. Such an approach would ideally include a valuation of the change ecosystem services expected as a result of the concession. Certainly, strengthened environmental safeguards and improved planning methods are required for granting land concessions for these systems. In the longer term, community land titling would help to protect villagers against land-grabs and the inappropriate siting of land concessions.

The commercial livestock farms could better utilize surplus of farmyard manure, a much needed input to organic produces.

Responsible Agencies

Responsibility for the approval, management and monitoring of commercial-scale agricultural production systems is shared among MPI (planning and approval) MoNRE (monitoring and environmental safeguards) and MAF (research and technical support).

3.6 Wetland Ecosystems

Wetlands are defined as areas of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres¹⁴. For the purposes of NABP II, wetlands are taken to include rivers, streams (all year), creeks (seasonal), lakes, ponds, swamps and rice paddies¹⁵.

Although strictly speaking not wetlands themselves, the riparian areas associated with all wetlands help to protect wetland ecosystems by providing a number of important ecological services, including (i) the slowing of floodwater and prevention of erosion; (ii) trapping sediment and filtering potentially harmful chemical run-off; (iii) the provision of leaf-fall and organic matter inputs to streams; (iv) creating shade and regulating water temperatures; and (v) providing habitats, refuges and corridors for wildlife.

¹⁴ The RAMSAR Convention, UNESCO 1994.

¹⁵ The agro-biodiversity characteristics of rice paddies are dealt with in Section 3.1 on Lowland Rice-based Ecosystems.

Agro-biodiversity Characteristics

Wetlands in Lao PDR cover a diverse topography, ranging from floodplains to high-elevation wetland areas, and include the Mekong River, its 14 main tributaries, and more than 100 streams in addition to numerous swamps, lakes, reservoirs and ponds. These wetlands support a remarkable level of biodiversity. The combination of shallow water, high levels of nutrients, and high primary productivity is ideal for the development of organisms that form the base of the food web which in turn supports myriad species of mammals, birds, fish, amphibians, shellfish, reptiles, and insects.

The aquatic fish biodiversity is extremely rich with more than 480 fish species being identified in Lao PDR, including 22 introduced species, and new species are regularly discovered. Among other aquatic animals, about 37 amphibians, 7 species of crabs and 10 species of shrimps have been recorded, but these records cover only about 15% of the estimated total aquatic biodiversity (MRC, 2013).

Riparian areas are important generators of agro-biodiversity resources and provide many products, particularly plant species that support local livelihoods. A study carried out in Northern Laos identified 276 plant species collected from riparian areas that were utilized by local communities (Gregory *et al.*, 2007). Of these 186 species were used for food, 75 species used as medicine and only a small number of the plant species were used for construction.

The contribution of fish to both household and national diets is extremely important. A fisheries survey in Luang Prabang Province estimated that the average yearly per capita consumption of fish and aquatic products is 29 kg per person per year, with fresh fish accounting for 16 - 22 kg/capita per year. Fish and aquatic animals account for 43% of the total animal food consumption (LARReC, 2005).

Capture fisheries in the Mekong river and its tributaries, reservoirs, lakes, wetlands and rice fields in Lao PDR amounts to nearly 90,000 tons and fish produced from pond aquaculture and cage culture totals some 55,000 tons (Table 6.2) and continues to increase (MRC, 2013). Despite the huge diversity of fish in Lao PDR, it is interesting to note that the 11 most important fish species used in aquaculture are all introduced species. To make better use of indigenous species and thereby promote diversity, LARReC is conducting research to develop aquaculture systems for 17 indigenous fish species. The research, which is at a quite an advanced stage for some species, aims to develop management techniques, including artificial reproduction, hatchery, fry, fingerlings, feeding and pest control (Table 6.3).

Lao PDR's wetlands provide vital environmental, economic and cultural services to the Lao people, particularly in rural areas. These ecosystem services include providing habitat for a wide variety of species, flood protection, water purification and groundwater renewal. Wetlands also supply resources essential to rural livelihoods, including fish, aquatic animals, edible aquatic plants, fodder for livestock and tourism opportunities. One aspect that should be emphasized is the importance of women and children in the collection of NTFPs from wetlands and associated riparian areas.

Threats to Agro-Biodiversity

Increasing population pressure and the water, food and energy nexus is creating intense competition among these scarce resources, which in turn, is placing increasing pressure on wetlands in Lao PDR. Significant declines in aquatic products from wetlands are reported by all villagers (Souvanthong *et al.*, 2009 and 2010; Gregory *et al.* 2007).

The increased demand for water, especially for hydropower is causing major changes to the ecology of rivers and wetlands in the country. The numerous storage dams on the Mekong tributaries reduce wet season river flow (through storage) and increase dry season flow (through release). The resulting change in the hydrological regime is causing major changes to the ecology which is having significant impacts on wetlands biodiversity. Inter-basin transfer schemes have even greater impacts as demonstrated by Nam Theun 2 which transfers water from the Nam Theun river to the Xe Bangfai basin, resulting in reduced flows in the former and increased flows in the latter.

Other threats include wetlands conversion to other land uses such as agriculture, and land reclamation for residential or industrial purposes. As Lao PDR develops industrially, the threat of chemical run-off and water pollution increases accordingly. Soil erosion caused by more intensive farming and the loss of riparian forest causes increased sediment loads which are often trapped in wetlands, thereby changing their ecology. Increasing numbers of invasive aquatic species, including African Sharptooth Catfish, Giant Mimosa and the Golden Apple Snail also pose a significant threat to wetlands biodiversity (Table 7.3).

Loss of water-body connectivity, caused mainly by the development of irrigation and transport infrastructure, is already threatening some fish populations. Habitat loss through land development activities, the destruction of fish breeding grounds and illegal and destructive fishing methods further threaten the biodiversity of aquatic ecosystems.

Wetlands are especially vulnerable to climate change, and all the above threats can be expected to increase as climate change intensifies.

Opportunities for Agro-biodiversity Development

Because wetlands are so vulnerable to development pressures from other sectors such as industry, transport, hydropower and agriculture, protection of the biodiversity they contain and the services they provide will require strengthened environmental legislation. The new Forest and Land Laws currently being drafted and the draft decree on Strategic Environmental Assessment will provide some additional protection for wetlands, but additional measures will also be needed. Increasing the number of Ramsar Sites from the existing two would provide additional protection. A shortlist of proposed sites for this has been prepared by IUCN (Table 6.1).

Conservation and rehabilitation of riparian forest through an effective village PLUP process would provide added protection for wetlands and the biodiversity they contain. Establishing the legal basis for strengthened community protection and management of wetlands, possibly by providing community title, would be a positive step, along with improved water-quality monitoring and stronger penalties for offenders.

On-the-ground interventions to enhance the biodiversity values of wetlands might include fish ladders to improve water-body connectivity, check dams to conserve water in creek-beds, and CARE rings¹⁶ to re-habilitate aquatic biodiversity in seasonally dry wetlands. Development of aquaculture systems for indigenous fish species, as currently being studied by LARReC, is another a promising method of increasing farm incomes through the judicious use of natural biodiversity.

Responsible Agencies

Responsibility for wetlands management is shared among MoNRE (protection and conservation), LARReC (research and development), and DLF (fisheries management). Responsibility for the Ramsar Convention lies with MoNRE's Department of Environmental Quality Protection.

Since 2000, LARReC has conducted numerous research studies in collaboration with a range of international development partners. These research partnerships are summarised in Table 6.4.

¹⁶ CARE rings are circular concrete rings strategically placed in creek beds, paddy fields or other low-lying areas that are protected and kept moist in the early wet season to allow aquatic flora and fauna to establish and develop on a timely basis and act as a seeding source when fully-inundated conditions occur.

4. NABP II FRAMEWORK

4.1 Goal and Objective

NABP II is designed to support three major development goals of Lao PDR: (i) achieving food security, (ii) reducing poverty, and (iii) enhancing government capacity to ensure the sustainable management and use of natural resources. The programme will act as a framework for a coordinated, multi-sector approach to better manage, utilize and conserve agro-biodiversity in order to support the three aforementioned goals.

The objective of NABP II: Improved conservation and utilization of the agro-bio-diversity and will be measured through five indicators i.e. national on-farm genetic diversity maintained, ABD-related green value chains established, export of agro-biodiversity products increased, increased use of endemic plant and animal genetic material in national breeding programs, and climate resilient crop/animal varieties bred, see Annex 1.

4.2 Outcomes and Outputs

The NABP II comprises three outcomes of four outputs each as described in the following. Corresponding indicators and activities are presented in the complete logical framework matrix in Annex 1 and Annex 2.

Outcome 1: An enabling policy environment and legal framework for the sustainable use and conservation of agro-biodiversity.

Output 1.1: Increased information on and awareness of agro-biodiversity issues ensures they are main-streamed across all policy, planning and decision-making processes in Lao PDR.

Output 1.2: Agricultural policies, strategies and development programs and plans are closely aligned with international treaties related to agro-biodiversity, the environment and climate change.

Output 1.3: Improved collaboration between Lao PDR and international institutions active in agro-biodiversity policy, planning, research, extension, and training.

Output 1.4: Fair and transparent access to agro-biodiversity resources and equitable sharing of the benefits from their management, use and conservation.

Outcome 2: Organizational and technical capacity for the management and conservation of all types of agro-biodiversity in government, the private sector and farmers is developed and strengthened.

Output 2.1: Improved knowledge of the importance, value and distribution of agro-biodiversity resources in the three eco-regions.

Output 2.2: Improved capacity of government agencies to conduct research on agro-biodiversity issues.

Output 2.3: Improved capacity of extension agents from government, NGOs and the private sector to provide relevant advice to farmers on the management use and conservation of agro-biodiversity.

Output 2.4: Improved capacity of farmers to conserve, manage and use plant and animal genetic resources to the benefit of all agricultural value chains.

Outcome 3: Floral, faunal and fungal elements of agro-biodiversity in all ecosystems are effectively managed, utilized and conserved.

Output 3.1: More diverse, sustainable and productive agriculture production systems in all eco-regions.

Output 3.2: In situ and ex situ national gene-banks for plant and animal agro-biodiversity resources are established and operational.

Output 3.3: Proven technologies are available and being adopted by farmers for the improved management and use of plant, animal and mushroom agro-biodiversity resources.

Output 3.4: Green value-chains, improved processing and value-adding technologies for agro-biodiversity resources are being used by farmers.

5. NABP II IMPLEMENTATION

5.1 Implementing Agencies

Implementation responsibility for NABP II is broad-based and involves a number of ministries, departments and development partners. These include MAF, MoNRE, Ministry of Education (MoE), Ministry of Health (MoH) and MoST. MAF is the main implementing agency, and along with other MAF departments, NAFRI's five Research Centers play a lead implementation role according to their technical responsibilities: ARC (rice and upland crops), HRC (horticulture and integrated farming), LRC (livestock), FRC (Forestry and NTFPs) and LARReC (fish and aquatic flora and fauna) and PRC (Policy related work). Each of these research centers has their research and development agenda for the implementation of NABP II. The research and development agenda of these agencies are described in Annex 8 and part of the ongoing and proposed agro-biodiversity interventions outlined in Annex 2.

5.2 Estimated Implementation Budget

A summary of the estimated budget that will be required to implement the proposed activities under NABP II is presented in Table 3. A more detailed budget breakdown for each proposed sub-activity is presented in Annex 2.

Table 3: Estimated NABP II implementation budget

Outcome	Estimated GoL budget (US\$)	Estimated external budget (US\$)
1. Enabling policy environment and legal framework for the sustainable use and conservation of agro-biodiversity	763,680	5,824,210
2. Organizational and technical capacity for the management and conservation of all types of agro-biodiversity in government, the private sector and farmers is developed and strengthened	527,300	6,610,050
3. Floral, faunal and fungal elements of agro-biodiversity in all ecosystems are effectively managed, utilized and conserved	811,300	6,241,100
Total	2,102,280	18,675,360

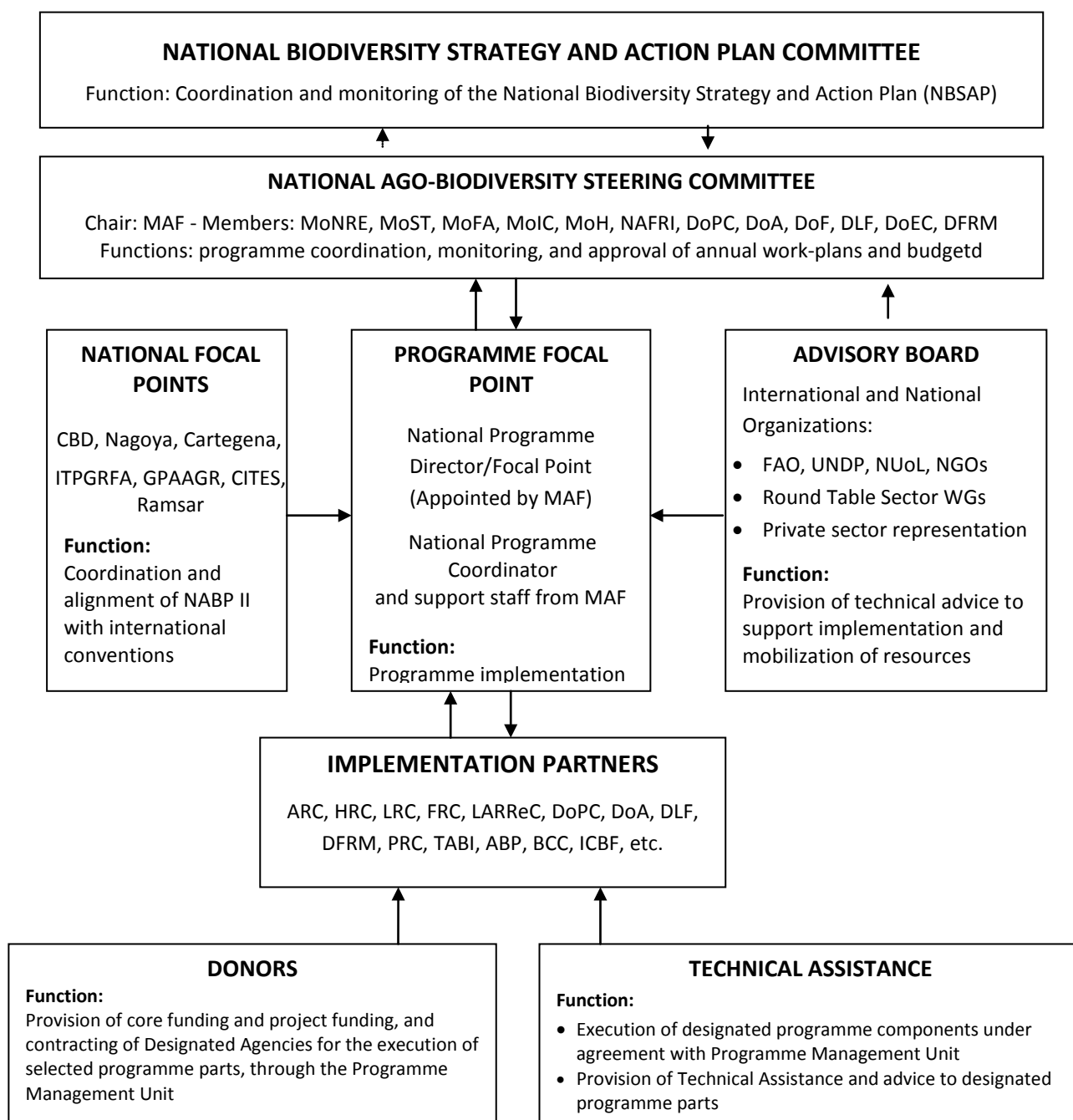
It is anticipated that the NABP II will be funded through a range of different budgetary sources, including MAF, international conventions, multi-lateral and bilateral donors, NGOs, existing projects and programmes and the private sector. An important lesson from NABP I was that it was not very successful in attracting funding and many of the proposed activities remained unimplemented or were only partly completed due to the lack of budget.

5.3 NABP II Management

By its very nature, NABP II is a complex, multi-agency programme requiring careful coordination during implementation. Because of the cross-cutting and interdisciplinary nature of the interventions required, concerted action on agro-biodiversity presents a unique opportunity for improved inter-agency cooperation that would not be possible for commodity-specific interventions. The proposed NABP II organizational structure recognizes this and is designed to promote such cooperation wherever possible. Figure 1 presents the NABP II organogram and shows how it links key stakeholders for coordinated programme implementation under the auspices and guidelines governing agro-biodiversity as laid out in the CBD.

The NABP II will be directed and led by a National Agro-Biodiversity Steering Committee, chaired by MAF with members from relevant line ministries and departments. The Steering Committee meets annually to review progress, provide direction and guidance and approve the coming year's annual workplans and budget. Following its Annual General Meeting, the NABP II Steering Committee reports to the National Biodiversity Strategy and Action Plan Committee on progress and achievements of the NABP II and receives guidance from them on how the programme can better assist Lao PDR in meeting its obligations under the CBD. By this means, CBD and NABP II are well-coordinated, closely-integrated and mutually-supportive.

Programme implementation and day-to-day management of NABP II is the responsibility of a Programme Focal Point (PFP) led by a Programme Director appointed by MAF. The director is supported by a Programme Manager and a team of professionals from relevant partner agencies. The PMU works in close cooperation with all stakeholders and is responsible for programme planning, budgeting, monitoring and coordination. The PMU compiles the NABP II Annual Report which is submitted to the Steering Committee one month prior to the annual meeting.

Figure 1: National Agro-biodiversity Programme Management Structure

Implementation of NAB II programme activities will be by relevant government departments and development partners who will report results and lessons learned to the PMU on a regular basis. In addition to on-the-ground implementation of activities, development partners will also provide technical advice as required by the PMU. Under the direction of the PFP, NAFRI's Policy Research

Center (PRC) will analyze key lessons learned from programme implementation and develop policy briefs as appropriate.

As part of their coordination role, the PFP liaises with the Focal Points of relevant International Conventions on a regular basis and ensure NABP II alignment with these treaties. The PFP is also responsible for coordination with other line ministries, most notably MoNRE, MoST, MoE, MoH MoFA and MoIC. Coordination with development partners is through an Advisory Board comprising international and national organizations, including private sector representation. Support for NABP II from the international community adheres to the principles of the Vientiane Declaration on Aid effectiveness and is mainly through the Round Table Sector Working groups, most importantly the Sub-Sector Working Group on Agro-biodiversity.

Communication and awareness activities

In support of programme implementation, a communication and awareness activities need to be put in place to ensure effective dissemination and promote awareness, understanding and inter-agency coordination during implementation. This would include making agro-biodiversity information available to a wide range of stakeholders at Government websites. Its target audience is at three levels: (i) national decision-makers, GoL agencies, development partners and the general public, (ii) provincial and district level technical staff and (iii) farmers and local schools. A range of media will be used including programme brochure, briefs and factsheets on key challenges and achievements; periodic progress reports; traditional media such as case-studies, success stories and press releases; and video spots on programme activities, key outcomes and important experiences.

ANNEX 1: LOGFRAME of NABP II – OBJECTIVES, OUTCOMES AND OUTPUTS

Objective/Output/Activity	Indicators	Means of Verification	Assumptions
Objective: The improved conservation and utilization of agricultural biodiversity.	<ul style="list-style-type: none"> National genetic diversity stabilized Sustainable export of agro-biodiversity products increased following international conventions guidelines Increased use of local plant and animal genetic material in national breeding programs Plant and animal gene banks fully established and operating effectively On-farm incomes increased and stabilized 	Agriculture Census data Indicator species data PAFO and DPI data Socio-economic surveys PLUP monitoring data ABP/TABI reports NAFRI genetic resource data ITM Medicinal Plants data Botanic gardens/herbaria Import/export records	<ul style="list-style-type: none"> Good environmental management remains a GoL policy priority Climate change trends do not diverge significantly from current global model predictions
Outcome 1: An enabling policy environment and legal framework for the sustainable use and conservation of agro-biodiversity.	<ul style="list-style-type: none"> Effective ABD awareness program operating ABD-related policy briefs produced ABD considerations included in Land/Forest/Water/Environment Laws by 2025 ABD considerations are required for relevant laws and decrees Laws related to ABD are properly enforced 	NABP II communications strategy Future drafts of ABD-related laws New drafts of SEA/SEIA decrees DOFI enforcement records Monitoring and Evaluation studies	<ul style="list-style-type: none"> 3 National State Forest categories realistically re-designated DOFI is properly staffed and resourced Land and resource access rights continue to be respected
Output 1.1: Increased awareness of agro-biodiversity issues ensures are main-streamed across all policy, strategy, planning and decision-making processes.	<ul style="list-style-type: none"> NABP II fully integrated with the NSEDP by 2020 ABD considerations included in the next National Agriculture Strategy Increased private sector involvement in ABD National ABD awareness programme operating ABD incorporated in school curricula 	Draft of 9th NSEDP Draft of new National Agriculture Strategy NABP II Communications Strategy NABP II distribution list	<ul style="list-style-type: none"> Good environmental management remains a GoL policy priority Long term sustainable development goals are not affected by short-term economic imperatives
Output 1.2: Agricultural policies, strategies and development plans are closely aligned with international treaties related to agro-biodiversity, the environment and climate change.	<ul style="list-style-type: none"> National legislation strengthened in line with international conventions Lao PDR is meeting its MEA treaty obligations Lao PDR is active on MEA sub-committees NABP II contributes positively to CBD/NBSAP 	Relevant laws and decrees Lao country COP reports Minutes of MEA national committee meetings	<ul style="list-style-type: none"> Lao PDR continues to take its MEA obligations seriously Lao PDR continues to become increasingly globalized
Output 1.3: Improved collaboration between Lao PDR and international institutions active in agro-biodiversity policy, planning, research, extension and training.	<ul style="list-style-type: none"> Lao PDR collaborating in international research programs Lao delegates are attending and presenting papers to international ABD gatherings GoL officials trained abroad on ABD topics 	NAFRI and other research reports Proceedings of international conferences Overseas training records	<ul style="list-style-type: none"> Lao PDR continues to attract donor support Lao PDR continues to maintain good international relations ASEAN AEC operates effectively
Output 1.4: Fair and transparent access to agro-biodiversity resources and equitable	<ul style="list-style-type: none"> ABD considerations routinely sued in PLUP ABD considerations incorporated in LUP procedures at village and 	PLUP Operations Manual PLUP implementation manuals Village land-use	<ul style="list-style-type: none"> GoL continues support for PLUP Land and resource access rights continue

Objective/Output/Activity	Indicators	Means of Verification	Assumptions
sharing of the benefits from their management, use and conservation.	<ul style="list-style-type: none"> higher levels Villagers have equitable access and share the benefits from the utilization of ABD resources Community titles provided for the management of ABD resources by villager 	<ul style="list-style-type: none"> agreements Land title registers 	<ul style="list-style-type: none"> to be respected – 3 State Forest categories re-viewed and re-delineated
Outcome 2: Organizational and technical capacity for the management and conservation of all types of agro-biodiversity in government, the private sector and farmers is developed and strengthened.	<ul style="list-style-type: none"> ABD - focused research studies conducted Private sector companies funding ABD research ABD-focused extension packages being used ABD technologies adopted by farmers Improved cooperation amongst government, private sector and farmers 	<ul style="list-style-type: none"> NAFRI Annual Reports NAFRI Research Center reports DoEC extension and other MAF bulletins PAFO/DAFO reports Farmer surveys 	<ul style="list-style-type: none"> – GoL provides adequate research and extension budgets – Lao and global economy continue to grow
Output 2.1: Improved knowledge of the importance, value and distribution of agro-biodiversity resources in the three eco-regions.	<ul style="list-style-type: none"> ABD-focused PBSAPs conducted ABD information included in PAFO/DAFO reporting protocols Indigenous knowledge on ABD is captured documented and used An ABD Management Information System is established, being used and regularly updated 	<ul style="list-style-type: none"> PBSAP reports and survey results PAFO/DAFO reports Contents of ABD database MIS reports 	<ul style="list-style-type: none"> – Adequate GoL and donor funding for ABD-related studies
Output 2.2: Improved capacity of government agencies to conduct research on issues relevant to agro-biodiversity	<ul style="list-style-type: none"> Increased number of NAFRI research studies on ABD-related issues Increased number of research articles on Lao ABD in peer-reviewed journals Increased LARF funding for ABD research topics Increased donor funding for ABD research 	<ul style="list-style-type: none"> Lao agriculture research reports Annual reports of NAFRI research centers LARF finding records International agriculture journals ODA funding statistics 	<ul style="list-style-type: none"> – Adequate GoL and donor funding for ABD-related research – Continued interest in ABD-related issues
Output 2.3: Improved capacity of extension of government, NGOs and private sector to provide relevant advice to farmers on the use and conservation of agro-biodiversity	<ul style="list-style-type: none"> ABD-based technologies available for extension to farmers Manuals on ABD management techniques Private sector actively promoting ABD-based technologies 	<ul style="list-style-type: none"> DoEC extension bulletins DoEC annual reports PAFO/DAFO reports Agri-business company reports 	<ul style="list-style-type: none"> – Adequate GoL funding for agricultural extension – Continued private sector involvement in agriculture
Output 2.4: Improved capacity of farmers to conserve, manage and use plant and animal genetic resources to the benefit of all agricultural value chains.	<ul style="list-style-type: none"> Increased on-farm use of ABD resources Farmers adopt ABD-based production techniques Farmers effectively utilizing ABD-based value chains Farm incomes increase from ABD value -added 	<ul style="list-style-type: none"> Agriculture Census data PAFO and DPI data Cluster village statistics PLUP monitoring data MDG/SDG monitoring data 	<ul style="list-style-type: none"> – Adequate GoL funding for agricultural extension
Outcome 3:	<ul style="list-style-type: none"> Increased diversity of farming systems to adapt to climate change 	<ul style="list-style-type: none"> District poverty assessment data 	<ul style="list-style-type: none"> – National and global economy remains

Objective/Output/Activity	Indicators	Means of Verification	Assumptions
Floral, faunal and fungal elements of agro-biodiversity in all ecosystems are effectively utilized and conserved.	<ul style="list-style-type: none"> and market fluctuations • Key ecosystem function indicators identified, maintained and/or improved • PES and ABD certification opportunities are identified • Information on invasive alien species collected and used for its control • Male and female farmers better understand importance of ADB 	State of Environment reports National EPA data MoNRE monitoring data MDG/SDG monitoring data Gender disaggregated farmer surveys	stable – Environment protection laws properly enforced – Climate change trends do not diverge significantly from current global model predictions
Output 3.1: More diversified, sustainable and productive agriculture production systems established in all eco-regions.	<ul style="list-style-type: none"> • Improved food security of farm families • Better-balanced and healthier diet • Reduced incidence of child malnutrition • Increased farm family incomes 	Agriculture census data WFP monitoring data PAFO and DPI data Socio-economic surveys PLUP monitoring data	– Global world food prices remain stable – Adequate funding for agricultural extension
Output 3.2: <i>In situ</i> and <i>ex situ</i> national gene-banks for plant and animal agro-biodiversity resources are established and operational.	<ul style="list-style-type: none"> • National germplasm accessions expanded • Increased <i>in situ</i> germplasm conservation by farmers in all 3 eco-regions • Increased use of ABD in breeding programmes • Increased sharing of Lao ABD resources both regionally and nationally 	NAFRI gene bank accession data Research Center annual reports Lists of new variety/breeds releases ITPGRFA Country Reports GPAAGR Country Reports	– Adequate GoL and donor funding for germplasm collection and storage – Continued international support for ITPGRFA and GPAAGR
Output 3.3: Proven technologies are available and being adopted by farmers for the improved management and use of plant and animal agro-biodiversity resources.	<ul style="list-style-type: none"> • Increased number of ABD-based technologies released by NAFRI research centers • Increased availability of ABD extension materials • Increased farmer adoption of ABD-based technology 	Research Center annual reports DoEC extension material lists PAFO/DAFO reports Agricultural Census data	– Adequate GoL funding for agricultural research and extension – Climate change trends do not diverge significantly from current global model predictions
Output 3.4: Green value-chains, improved processing and value-adding technologies for agro-biodiversity resources are being used by farmers.	<ul style="list-style-type: none"> • New ABD-based value chains developed • Increased farm-gate prices for ABD products • Increased farm incomes • Increased trade in ABD products 	PAFO/DAFO reports Market price data District poverty assessment data Ministry of Industry & Commerce data	– Global world food prices remain stable – Regional food demand remains strong – ASEAN AEC progresses smoothly

ANNEX 2: LOGFRAME of NABP II – ACTIVITIES, SUB-ACTIVITIES AND ESTIMATED BUDGET

Outcome 1. An enabling policy environment and legal framework for the sustainable use and conservation of agro-biodiversity

Output 1.1 Increased information on and awareness of agro-biodiversity issues insures they ae main-streamed across all policy, strategy, planning and decision-making processes in Lao PDR.

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
1.1.1 Produce policy briefs, reports and other materials to promote a common understanding among policy makers of the importance of ABD	1.1.1.1 Present NABP II at sSWG ABD and SWG ARD and prepare a brochure on NABP-II (ABP)	NAFRI	0%	500	1,000
	1.1.1.2 Prepare policy syntheses, briefs and reports on agro-biodiversity related topics (Think Tank and others)	NAFRI, PRC	20%	1,000	45,000
	1.1.1.3 Awareness raising and policy advocacy through media (ABP, TABI and others)	NAFRI, PRC, others	25%	500	20,000
	1.1.1.4: Prepare Policy Brief on ABD in climate-smart and multi-functional landscape through the FALUPAM process (TABI, others)	DALAM, DoF, NAFRI	20%	500	25,000
1.1.2 Strengthen national legal, policy and strategic frameworks for agro-biodiversity to support sustainable agriculture development	1.1.2.1 Support for agro-biodiversity related policy development (Various donors & projects)	MAF	20%	5,000	50,000
	1.1.2.2. Prepare a Rice policy (FAO)	NAFRI	90%	5,000	30,000
	1.1.2.3. Prepare a Fisheries Strategy Implementation Plan (FAO)	DoLF/LARReC	90%	5,000	400,000
	1.1.2.4 Conduct integrated spatial planning for agro-biodiversity management and conservation (TABI, and others)	PAFO, DAFO	50%	20,000	450,000
	1.1.2.5 Develop and test forest-regeneration strategies that promote NTFP abundance and sustain ecosystem services (SFLM GEF/UNDP, TABI and others)	FRC, PAFO, DAFO, ITM/P/DoNRE	10%	10,000	250,000
	1.1.2.6 Provide agro-biodiversity comments to sectoral and cross-sectoral legislation and strategic work (sSWG ABD members)	NAFRI through sSWB ABD	5%	1,000	10,000
	1.1.2.7 Develop 3 rd NBSAP and report to CBD (UNEP & IUCN)	DOFM	90%	5,000	50,000
	1.1.2.8 Report on progress on PGRFA and GAPs	NAFRI/MOST	0%	2,000	20,000
	1.1.2.9 Provide agro-biodiversity inputs to Climate Change Law (ABP & others)	DOFM	0%	1,000	10,000
1.1.3 Support the integration of ABD considerations in all key national development strategies and planning processes	1.1.3.1 Present and provide recommendation to all agro-biodiversity related strategic work at sSWG ABD meetings (sSWG ABD)	NAFRI, FAO	10%	1,000	5,000
	1.1.3.2 Identify agro-biodiversity assets as part of the Conservation Corridor Landscape Approach (ICBF/KfW).	DFRM, KfW	5%	6,000	60,000
	1.1.3.3 Include agro-biodiversity parameters in draft SEA decree (CEP-BCI/ABP)	MONRE, ADB	5%	3,000	30,000
	1.1.3.4 Review, assess and re-delineate state forest lands (3 Forest Categories) including recognition, validation and role of ABD in multifunctional landscapes (WB/EPF, TABI)	DoF	20%	10,000	900,000

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
1.1.4 Public awareness campaigns on the importance of the conservation and sustainable use of agrobiodiversity	1.1.4.1 Raise public awareness and understanding of the importance of diversity in livestock production systems	LRC	5%	1,000	15,000
	1.1.4.2 Prepare information and awareness materials for the public on medicinal plants (Donglong-Dong south , Phoukout District (ABP))	ITM	90%	1,000	5,000
	1.1.4.3 Prepare general information and awareness materials for the public on medicinal plants	ITM	0%	2,000	20,000
	1.1.4.4 Establish demonstration garden of medicinal plants at schools	ITM	0%	10,000	100,000
	1.1.4.5 Increase awareness of the value of aquatic resources, and document and disseminate successful management practices (TABI and others)	LARReC, DLF,P/DAFO,	20%	5,000	125,000
	1.1.4.6 Study edible plants and increase awareness of their value in the southern part of Lao PDR	BEI, MOST	90%	37,500	0
	1.1.4.7 Prepare public awareness materials on Biosafety (Biosafety artoon, case stores, booklets, information sheet, brochures)	MOST and MAF	0%	7,000	25,000
	1.1.4.8 Public survey on GM crop perception	BEI	0%	2000	10,000
	1.1.4.9 Host and maintain a website on ABD issues in Lao PDR (TAB and others)	MAF, NAFRI	80%	20,000	60,000
	1.1.4.10 Produce/screen videos via TV etc on the role of ABD in livelihoods and income (TABI)	MAF, NAFRI	10%	2,000	50,000
	1.1.4.11 Conduct awareness campaigns on harmful effects of pesticide use on ABD (TABI, LURAS, and others)	MAF	10%	10,000	150,000
1.1.5 Develop National regulation on material exchange (SMTA), benefit sharing, and on preventing measures for GMOs	1.1.5.1 Develop capacity of the development and implementation of National ABS frameworks	BEI, MOST	60%	12,200	22,400
	1.1.5.2 Draft the ABS regulations to implement ABS and traditional knowledge (Article 22 and 24 under the Biotechnology Safety Law (2014))	BEI, MOST	0%	10,000	10,000
	1.1.5.3 Develop an ABS Ministerial Decree and administrative instruments to implement the regulation	BEI, MAF, ITM, APB	0%	50,000	100,000
	1.1.5.4 Develop technical guidelines for environmental release, food-feed and contained use of GMOs	MOST, MAF, APB & sectors	0%	30,000	100,000
	1.1.5.5 Prepare risk assessments on GMOs	MOST	0%	8000	20,000

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
1.1.6 Strengthen agro-biodiversity considerations in Social and Environmental Impact Assessments (SEIA) and Strategic Environmental Assessments (SEA)	1.1.6.1 Incorporate agro-biodiversity issues in environmental planning and management tools for SEA (ADB)	MoNRE, MPI, MAF	5%	5,000	100,000
1.1.7 Develop ABD curriculum and training materials-for primary and secondary schools colleges and universities	1.1.7.1 Develop and use ABD-based local curriculum in schools in XKH (TABI)	DoE	90%	2,000	20,000
	1.1.7.2 Develop medicinal plants curriculum for secondary schools	ITM, MoE	0%	2,000	20,000
	1.1.7.3 Develop biodiversity curriculum materials for colleges and universities	NUoL	0%	5,000	30,000
	1.1.7.4 Develop biotechnology safety and ABS of genetic resource curriculum materials for university students	MOST and NUoL	0%	10,000	50,000
	1.1.8.5 Develop medicinal plant herbariums at village schools (TABI)	MAF, MOE	90%	5,000	20,000
1.1.8 Develop and implement an NABP II communications strategy to direct and support the dissemination of ABD information and promotional material.	1.1.8.1 Prepare an action plan for NABP II implementation (sSWG ABD)	NAFRI	0%	1,000	5,000
	1.1.8.2 Prepare information brochure and web-based information material (ABP)	NAFRI	20%	1,000	10,000
	1.1.8.3 Produce publications, media releases, and information packages on ABD issues and activities (TABI, ABP).	MAF, MoNRE	30%	10,000	100,000
	1.1.8.4 Update NAFRI website (ABP, FAO)	NAFRI	0%	500	2,000

Output 1.2 Agricultural policies, strategies and development programmes and plans closely aligned with international treaties related to agro-biodiversity, the environment and climate change.

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
1.2.1 Strengthen national legislation in line with international environmental conventions and treaties	1.2.1.1 Strengthen national legislation related to marketing and trade of aquatic resources to align with international conventions and treaties	NAFRI, LARReC, DLF	0%	50,000	120,000
	1.2.1.2 Mainstreaming agro-biodiversity related issues in MAF planning and decision making (sSWG-ABD), TABI, ICBF)	MAF, NAFRI,	0%	50,000	20,000
1.2.2 Establish ABD management guidelines to support integration of ABD considerations in the implementation of all relevant international treaties	1.2.2.1 Support MAF, MoNRE and MoST to prepare management guidelines on the implementation of international treaties including funding, compliance, reporting, and the importance ABD considerations (FAO and others).	NAFRI, MoNRE, and MoST	0%	10,000	50,000
	1.2.2.2 Develop and test a methodology to identify and manage High Agro-biodiversity Value (HACV) assets at the landscape level (IBCF).	DFRM, KfW	5%	10,000	200,000
1.2.3 Build capacity in the national committees for international conventions to allow them to better meet Lao PDR's obligations under them	1.2.3.1 Establish and train point(s) for export and import permission of plant varieties	NAFRI (ARC, HRC, FSRC) & DOA	0%	50,000	300,000
	1.2.3.2 Establish National Biosafety Committee and Technical Coordination Committee for making decisions on import and export of GMOs and their products	MOST, MAF, MOH, MONRE and others	0%	10,000	10,000
	1.2.3.3 Establish Centre for Biotechnology and Ecology and upgrade staff capacity on Cartagena on Biosafety and Nagoya Protocol on ABS	BEI, MOST, UNEP	0%	10,000	20,000
	1.2.3.4 Establish technical working group on Nagoya Protocol on ABS and ITPGRFA	MOST, NAFRI, IUCN, UNEP, APB	0%	10,000	30,000
1.2.4 Promote Lao PDR active membership of and contribution to COP activities and MEA sub-committees	1.2.4.1 Support the attendance of MAF/MONRE officials at CBD COP to promote consideration of ABD resources in Lao PDR	MOST, MAF, MOH, MONRE and others	0%	10,000	50,000

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
1.2.5 Develop national and provincial sustainable use regulations concerning trade in NTFPs in line with international treaties and conventions	1.2.5.1 Establish a national programme to monitor and regulate the harvesting and trade of NTFPs aligned with CITES and ITPGRFA	FRC	0%	5,000	20,000
	1.2.5.2 Promote supportive policies on bamboo resource allocation and tenure, import and export tax reduction and exemption, investment incentives and improvement of the quota system (GRET, WWF, and TABI), SDC	MAF, DOF, PAFO, DPI, LWU, DOIC, PONRE,	50%	10,000	500,000

Output 1.3 Improved collaboration between Lao PDR and international institutions active in agro-biodiversity policy, planning, research, extension and training

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
1.3.1 Support the collaboration of Lao researchers in regional and international research networks and programmes.	1.3.1.1 Promote international research exchange and networking and joint research programmes with international research institutions	NAFRI, ARC, HRC, FSRC, LRC & FRC	0%	100,000	300,000
	1.3.1.2 Promote agro-ecology practices through eco-systems and Conservation Agriculture approaches (ACTAE, CIRAD, Gret and others)	DALAM, MoNRE, Others	10%	50,000	1,000,000
1.3.2 Strengthen the consideration and role played by ABD in regional GMS and ASEAN environment programmes	1.3.2.1 Regional cooperation through ASEAN Biodiversity initiatives (Regional Agro-Biodiversity project)	NAFRI, MoNRE	10%	2,000	200,000

Output 1.4: Fair and transparent access to agro-biodiversity resources and equitable sharing of the benefits from their management, use and conservation

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GoL	Non GoL
1.4.1 Develop and disseminate PLUP methods that give effective consideration to agro-biodiversity issues	1.4.1.1 Develop, implement and disseminate Forest and Land use Planning/Zonation and Management methodologies (e.g. FALUPAM) that give effective consideration to agro-biodiversity issues (TABI/SDC)	MAF, MoNRE	70%	50,000	435,000
	1.4.1.2 Carry out forest and land use planning and management (ICBF/KfW, SFLM/GEF/UNDP, CCL and others)	P/DAFO M/P/DoNRE	10%	50,000	500,000
	1.4.1.3 Support the integration of NTFP quotas into existing development planning systems (TABI and others)	FRC	0%	5,000	30,000
	1.4.2.4 Identify important NTFP assets at the landscape level prior to implementing land use planning and management so that the process is pre-informed regarding key NTFPs to be 'flagged' (ICBF)	DFRM, KfW	5%	1,000	10,000
1.4.2 Support the development of appropriate systems of community management rights for ABD resources	1.4.2.1 Develop co-management and conservation agreements with local communities (ICBF, KfW and SFLM, UNDP/GEF)	DFRM and LALDD	5%	50,000	500,000
	1.4.2.2 Develop and facilitate the management of multifunctional, ABD-rich and climate-smart landscapes as part of the FALUPAM Process (TABI and others)	DALMA, DoF, PAFOs	20%	10,000	150,000
1.4.3 Advance the development of effective land policy and that supports the sustainable management and conservation of ABD resources	1.4.3.1 Establish strategies or guidelines for monetary and non-monetary benefits to related stakeholders and local communities from benefit sharing mechanism of diversification of crop/plant/NTP varieties	APB, MOST and others	0%	10,000	50,000
	1.4.3.2 Strengthen the legal frameworks governing villager rights in regard to the collection and use of NTFPs	FRC, ITM, DoA	0%	5,000	20,000
	1.4.3.3 Demonstrating Private-Public-Community Partnerships on Access and Benefit Sharing	BEI, APB	0%	20,000	80,000
	1.4.3.4 Develop, implement and disseminate FALUPAM to ensure that adequate consideration is given to ABD issues (TABI)	MAF, SDC	30%	20,000	800,000
1.4.4 Promote Lao PDR active membership of and contribution to COP activities and MEA sub-committees	1.4.4.1 Establish technical working group on the international conventions and provide support to create database on the concerned issues	MOST, MAF, MONRE, APB	0%	25,000	100,000
	1.4.4.2 Support the attendance of MAF/MONRE officials at CBD COP to promote consideration of ABD resources in Lao NBSAP (TABI)	MAF, SDC, IUCN	20%	2,000	10,000

Outcome 2: Organizational and technical capacity for the management and conservation of all types of agro-biodiversity in government, the private sector and farmers is developed and strengthened.

Output 2.1 Improved knowledge of the importance, value and distribution of agro-biodiversity resources in the all eco-regions

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
2.1.1 Assess the status, distribution, abundance and trends of agro-biodiversity resources in the eco-regions of Lao PDR	2.1.1.1 Prepare reports to CBD and others conventions and treaties	DFRM, NAFRI	0%	10,000	60,000
	2.1.1.2 Assess and map status and use of NTFP resources (abundance, distribution, habitat) in the 3 eco-regions (ABP, TABI, CAWA & others)	FRC, PAFO, DAFO	20%	5,000	160,000
	2.1.1.3 Prepare PBSAP for Lang Prabang (IUCN/ABP)	DFRM, PoNRE	20%	5,000	45,000
	2.1.1.4 Study role and function of trees outside forest (FAO)	FAO	99%	0	15,000
	2.1.1.5 Assess and record the status of NTFPs during FALUPAM (TABI)	MAF, SDC	50%	20,000	300,000
	2.1.1.6 Assess the status of NTFPs at the landscape level (ICBF, KfW)	DFRM,	0%	10,000	50,000
2.1.2 Improve the understanding of both the constraints and opportunities for agro-biodiversity enhancement in different ecosystems across the country	2.1.2.1 Prepare NBSAP II, conduct consultation meetings and facilitate follow-up meetings (TABI, ABP, UNEP, IUCN)	NAFRI, DFPM MoNRE,	90%	0	See under 1.1.1
	2.1.2.2 Prepare PBSAPs in Attapeu, Xieng Khouang and Luang Prabang provinces, conduct consultation meetings & facilitate follow-up meetings (ABP, IUCN)	DoPC, PoNREs	90%	10,000	80,000
	2.1.2.3 Assess the driving forces and threats to NTFP resource availability of and to forest ecosystems	FRC	0%	5,000	30,000
	2.1.2.4 Conduct Agro-ecosystems Analysis and High Conservation Value (including ABD values) assessments at the landscape level in two sites (ICBF, KfW).	DFRM	5%	2,000	50,000
	2.1.2.5 Analyze ecosystem impacts based on interventions across the country	BEI, MOST	40%	25,000	0
2.1.3 Capture, document and make use of indigenous knowledge on ABD to develop improved agricultural production techniques	2.1.3.1 Characterize, inventory, monitor and record the diversity of animal genetic resources	LRC, DLF, DoEC	20%	1,000	10,000
	2.1.3.2 Assess the impact of the harvesting/collection of major NTFPs by villagers	FRC	0%	5,000	30,000
	2.1.3.3 Capture indigenous knowledge through FALUPAM (TABI)	FRC and DALAM	0%	5,000	40,000
	2.1.3.4 Document and make use of IK for e.g. KKN Rice, honey from native bees, river weeds, broomgrass, broom grass, high-value forest root/tubers, cardamom, orchids for medicinal purposes, styrax, bamboo shoots, bamboo worms, mushrooms, native chicken, native pigs, native gingers, and Melientha (TABI, LUCAS, ABP, and others)	NAFRI, PAFOs, DAFOs, LWU, LNFC, DONREs, ITM	40%	10,000	150,000

2.1.4 Establish and operationalize an agro-biodiversity and Management Information System	2.1.4.1 Establish monitoring and evaluation mechanisms for status and trends of NTFPs	FRC, PAFO,DAF	0 %	2,000	20,000
	2.1.4.2 Establish a platform and MIS for regional agro-ecological information exchange - Agroecology Learning Alliance in South East Asia (ACTAE/ALISEA/GRET)	DALAM PAFO,DAFO	0 %	10,000	200,000

Output 2.2 Improved capacity of government agencies to conduct research on issues relevant to agro-biodiversity

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
2.2.1 Strengthen research capacity on issues relevant to agro-biodiversity in all agro-ecosystems in Lao PDR	2.2.1.1 Develop survey and identification capacity of macro-fungi (mushrooms including ecological and economic importance (ABP, DARWIN INITIATIVE, TABI and others)	DoPC, BEI FSR, NoUL, PPC & BEI (MoST), PAFOs, SU(LPB)	80%	10,000	700,000
			0%	50,000	300,000
	2.2.1.1 Purify Khao Kai Noi (KKN) native rice by in-situ farmer seed production groups in Xieng Khouang and Huaphan Provinces incl. establishment of Geographic Indicator (GI) (TABI & other projects)	ARC, P/DAFO	75%	10,000	100,000
	2.2.1.2 Survey and record local varieties of fruit trees (AFACI, TABI and others)	HRC, P/DAFO	70%	5,000	95,000
	2.2.1.3 Collect and characterize local varieties of vegetable (tomato, chili, cucumber, pumpkin, egg-plant and yard long bean) (AFACI)	HRC	50%	5,000	30,000
	2.2.1.4 Improve breeding of eggplant and tomato (NIAS)	HRC	60%	5,000	40,000
	2.2.1.5 Study and collect wild rice in various ecological systems	ARC	0 %	10,000	200,000
	2.2.1.6 Characterize and evaluate root, tuber and vegetables (sorghum, chili, eggplant, wild sugarcane, germplasm, etc.)	ARC, HRC	0%	10,000	200,000
	2.2.1.7 Establish a national breeding programme for improvement of indigenous livestock breeds of cattle, buffalo, pigs and poultry	LRC,DLF,P/DAFO	20%	5,000	10,000
	2.2.1.8 Develop and strengthen the research capacity in the livestock sector	LRC	10%	5,000	50,000
	2.2.1.9 Survey and identify fungal species potential for medical use and improved nutrition	BEI, PPC,ITM,NUoL	0%	10,000	200,000
	2.2.1.10 Survey and identify edible and poisonous fungal species (ABP)	BEI, NUoL	60%	5,000	50,000
2.2.1.11 Assess status, trends and threat of aquatic resources in all wetland types (CAWA & other projects)	LARReC/MoNRE	0%	5,000	200,000	
2.2.1.12 Enhance knowledge and use of biological agents to control plant pests and diseases	NUOL	0%	10,000	500,000	

	2.2.1.13 Develop and strengthen the research capacity in GMO detection	BEI, FDD, MAF	0%	10,000	100,000
	2.2.1.14 Sub-regional project for strengthening capacity for risk assessment and management of CMOs	MOST, MAF, MOH, MoNRE, NUoL, MIC	0%	60,000	1,200,000
	2.2.1.16 Establish model agreements that regulate access to crop genetic resources and traditional knowledge maintained by farmers	BEI, BEI	0%	10,000	40,000
	2.2.1.17 Assess the impact of fish conservation zones (TABI, FISHBIO, WWF, ABP)	PAFOs, DAFOs	10%	1,000	25,000
	2.2.1.18 Assess the impact on fisheries of irrigation weirs (TABI)	PAFOs, DAFOs	0%	1,000	25,000
	2.2.1.19 Study the ABD and other aspects of irrigation via wood/bamboo waterwheels (TABI)	PAFOs HPN	0%	500	8,000
2.2.2 Assist in accessing small grants for research studies on all aspects of ABD management use and conservation	2.2.2.1 Assist government agencies and local communities to access-small grants (e.g. from Environment Fund) for activities that enhance agro-biodiversity at the local level (NUPDP, ABP, others, ICBF?)	NAFRI, P/DAFO	60%	10,000	656,000
	2.2.2.2 Support the Lao Agricultural Research Funds to promote research on agro-biodiversity	MAF, ACIAR, NAFRI, SDC	90%	10,000	100,000

Output 2.3 Improved capacity of government, NGOs and the private sector to provide advice to farmers on ABD conservation and management

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
2.3.1 Upgrade extension services on all aspects of agro-biodiversity management at provincial and district levels	2.3.1.1 On-the-job training in formulation and implementation of indigenous agro-biodiversity activities (ABP, TABI, ICBF and others)	PAFOs, DAFOs	50%	100,000	1,000,000
	2.3.1.2 Strengthening institutional and human capacity at the community level to promote the sustainable use of aquatic resources (TABI, ABP and others)	LARReC, PAFO, DAFO	20%	100,000	100,000
2.3.2 Develop and disseminate extension materials on all aspects of ABD management for agro-ecosystems in the three-Lao ecoregions	2.3.2.1 Develop training materials, resources and extension systems for the sustainable management of NTFPs (ABP, TABI, LUCAS and others)	FRC, ITM, DoA, LWU,	10%	5,000	50,000
	2.3.2.2 Develop training material for commercial oyster mushroom production (ABP)	PPC	10%	1,000	5,000
	2.3.2.3 Develop training material and curriculum for agro-biodiversity/ecofriendly IPM/FFS in rice	ABP	0%	1,000	5,000
2.3.3 Implement ABD-related extension programmes in all agro-ecosystems in Lao PDR	2.3.3.1 Domesticating medicinal plants for commercial production	ITM, NAFRI, DoA	0%	10,000	200,000
	2.3.3.2 Carry out ABD friendly IPM/FFS in seed production in native species	ARC, PAFO & DAFO	0%	50,000	500,000

Output 2.4 Improved capacity of farmers to conserve, manage and use plant and animal genetic resources to the benefit of all agricultural value chains

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
2.4.1 Strengthen institutional and human capacity at the community level to promote the sustainable management of ABD	2.4.1.1 Train villagers in sustainable land use planning/ FALUPAM including forests management, (TABI and others)	FRC, ITM, DoA	10%	2,000	30,000
	2.4.1.2 Build farmer capacity in animal husbandry with an emphasis on the management of agro-biodiversity	LRC, DoEC	0%	2,000	20,000
	2.4.1.3 Strengthen village authorities in NTFP management/domestication/storage/marketing and establish NTFP user groups at the village level	FRC, PAFO, DAFO	0%	2,000	20,000
	2.4.1.4 Develop management capacity at national, provincial, district and village levels to support sustainable fish capture and aquaculture (TABI, ABP and others)	LARReC, DLF,P/DAFO	5%	20,000	150,000

2.4.2 Support processing and value-added development of agro-biodiversity based value chains	2.4.2.1 Increase awareness of the importance and value of NTFPs among stakeholder groups at all levels	FRC	0%	2,000	15,000
	2.4.2.2 Increase value to NTFP in wetlands (CAWA)	MoNRE/DAFO	0 %	5,000	100,000
	2.4.2.3 Support river-weed, bamboo, broom grass, honey processing and value adding (TABI and others)	MAF, SDC	80%	2,000	60,000

Outcome 3: Floral, faunal and fungal elements of agro-biodiversity in all ecosystems are effectively managed, utilized and conserved

Output 3.1 More diversified, sustainable and productive agriculture production systems established in the three eco-regions

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percentage completed	Estimated Budget USD	
				GOL	Non GoL
3.1.1 Promote the development and sustainable use of agro-biodiversity resources in all agro-ecosystems	3.1.1.1 Conservation and management of wetlands resources in Boeng Kiat Ngong and Xe Champhone (CAWA, GEF/FAO/IUCN, TABI and others)	MoNRE/DAFOs	5%	10,000	500,000
3.1.2 Strengthen national legal frameworks for agro-biodiversity to support sustainable agriculture development	3.1.1.2 Strengthen the legal framework to support development of a sustainable livestock sector	NAFRI, DLF, DoEC	10%	5,000	10,000
3.1.3 Develop and disseminate ABD-based techniques and technologies to maintain and enhance ecosystem	3.1.3.1 Promote eco-system services concept (ABP, ICBF)	NAFRI/MoNRE	0%	10,000	100,000
	3.1.3.2 Expand small animal husbandry systems through the sustainable use of agro-biodiversity resources	LRC,DLF,PAFO, DAFO	10%	5,000	20,000
	3.1.3.3 Promote sustainable use and development of husbandry systems for indigenous livestock breeds	LRC,DLF,PAFO, DAFO	10%	5,000	20,000
	3.1.3.4 Promote crop varieties and diversified farming systems with high nutritional values and short maturity (ACIAR)	ARC	85%	5,000	35,000
	3.1.3.5 Support for the measurement and maintenance of ecosystem services in biodiversity conservation corridors	MONRE, ABD	10%	20,000	1,000,000

3.1.4 Improve the control and spread of invasive alien species	3.1.4.1 Study invasive plant pests and diseases pests in vegetables, coffee, rice, banana, maize	NUOL	0%	10,000	500,000
	3.1.4.2 Survey and analyse invasive plants and animals in rice fields and prepare a database	ARC, HRC, NAFRI	0%	100,000	300,000
	3.1.4.3 Promote resilience of aquatic-systems, adaptation to climate change and control alien aquatic species in Lao wetlands (CAWA & others)	NAFRI, LARReC, DLF/MoNRE	5%	10,000	125,000
3.1.5 Develop and disseminate aquaculture systems including rice-fish based on indigenous fish species	3.1.5.1 Promote rice-fish and rice duck farming systems to improve nutrition and control harmful insects and golden snails (using IPM)	ARC, others	0%	50,000	200,000
	3.1.5.2 Promote aquaculture/capture fisheries using indigenous species	ARC	0%	5,000	50,000

Output 3.2: *In-situ* and *ex-situ* national gene-banks for plant and animal agro-biodiversity resources are established and operational

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
3.2.1 Strengthen <i>in-situ</i> and <i>ex-situ</i> conservation including national plant fungal and animal gene-banks and germplasm conservation and dissemination systems	3.2.1.1 Develop a seed bank including data base management system for all cultivated crops and local varieties/landraces used by farmers ARC (IRRI, Searice, new DP)	ARC	85%	10,000	284,000
			0%	10,000	300,000
			0%	10,000	200,000
			0%	50,000	500,000
	3.2.1.2 Identify and support in-situ conservation areas for food crops (field gene bank)	ARC, HRC	20%	10,000	150,000
	3.2.1.2 Identify and establish district biodiversity conservation areas with important medicinal plants	ITM & MoNRE	20%	10,000	100,000
	3.2.1.2 Strengthening <i>In situ</i> and <i>ex situ</i> gene-bank management for long term conservation in fruit trees and vegetables	HRC	70%	10,000	50,000
	3.2.1.4 Identify native non-rice crops (vegetables, industrial and ornamental crops, spices, roots, and tubers) for in-situ and ex-situ conservation and possible breeding and multiplication at central and farm level	ARC	0%	10,000	800,000
3.2.1.5 Identify native rice (landraces) in remote areas in 10 provinces for in-situ and ex-situ conservation and possible breeding and multiplication at central and farm level – including farmer field Schools	ARC	0%	10,000	400,000	
3.2.1.5 Expand and strengthen the existing national livestock semen-bank	LRC, DLF, DoEC	20%	10,000	100,000	
3.2.1.6 Establish conservation areas using in-situ and ex-situ conservation measures (herbarium, seed-bank, and gene-bank)	FRC/BEI	0%	10,000	100,000	

	3.2.1.7 Capacity develop, survey, identify and store fungal species in fungarium	BEI, NUoL, PPC	70%	10,000	500,000
	3.2.1.8 Capacity develop, survey, identify and store yeast from traditional fermented food in the country	BEI, MOST	40%	68,000	0
	3.2.1.9 Survey and data collection of traditional medicine plants in four districts of Xekong Province	MOST	20%	28,000	0
	3.2.1.10 Survey and data collection of Champa flower that is the national flower in the country	BEI, MOST	30%	12,500	0
	3.2.1.11 Establish gene bank of endangered orchid and ornamental plant species by using tissue culture technique	GRD, BEI, MOST	0%	10,000	35,000
	3.2.1.12 Support ex-situ and in-situ conservation of Anoectochilus (nha bai lai) by reintroduction the species in Xieng Khouang Province.	APB, MOST and MAF	0%	10,000	60,000

3.3 Proven technologies are available and being adopted by farmers for the improved management and use of plant and animal agro-biodiversity resources

Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
3.3.1 Promote the conservation,-and sustainable use of ABD resources at the community level	3.3.1.1 Identify and market high quality products from existing NTFPs	FRC, PAFOs, DAFOs. ITM	0 %	5,000	20,000
	3.3.1.2 Establish sustainable harvesting and storage guidelines for major NTFPs resources	FRC, ITM?	0 %	5,000	20,000
	3.3.1.3 Identify and establish sustainable management systems for under-utilized NTFP species	FRC, ITM? MoNRE?	0 %	5,000	20,000
	3.3.1.5 Promote the use of edible wild plants for food and income resources to support local livelihoods in five provinces of the central part	BEI, MOST	30%	44,000	0
	3.3.1.6 Campaign increases local community awareness on the importance of genetic resources and traditional knowledge associated with biological resources, and related access and benefit-sharing issues, including the need to participate in the national ABS policy-making process.	MOST	0%	5,000	40,000
3.3.2 Promote conservation and domestication of endangered species at	3.3.2.1. Identify and develop endangered NTFPs species for conservation and domestication	FRC	0 %	5,000	40,000
	3.3.2.2 Domesticate medicinal plants	ITM, P/DFO, MOST	0 %	10,000	50,000
	3.3.2.3 Promote conservation and propagation of Pom Bee Ka Thing (<i>Panax vietnamese sis Ha</i>	BEI, MOST	30%	40,000	0

the community level	et Grushv.) in Xieng Khouang, Xekong and Attapeau provinces. (Donor/project).				
	3.3.2.4 Conservation and collect of medicinal orchids by using tissue culture (Donor/project).	BEI, MOST	80%	49,000	0
3.3.3 Design and implement ABD-based extension programmes for all agro-ecosystem types	3.3.2.1 Identify and develop distinct (core) rice varieties within local name group??? e.g. for drought, flood, cool, disease resistance and taste preference (ANDREW?)	ARC	0 %	5,000	50,000
3.3.4 Conduct Farmer Field Schools (FFS) focusing on ABD management, use and conservation	3.3.3.1 Conduct FFS/IPM on rice, vegetables and ABD management in Phonexay (Luang Prabang) and Phoukout (Xieng Khouang) districts (ABP, FAO..)	PAFO, DAFOs	80%	10,000	200,000
	3.3.3.2 Introduce climate smart agriculture to farmers by on-farm selection and seed production and develop community seed banks using the FFS Approach (CAWA.FAO)	DAFOs	0 %	10,000	100,000

3.4: Green value-chains, improved processing and value-adding technologies for agro-biodiversity resources are being used by farmers

3.4.Activity	Ongoing and proposed sub-activity (project/donor)	Implementing agencies	Percent completed	Estimated Budget USD	
				GOL	Non GoL
3.4.1 Establish ABD-based value chains and support producer groups	3.4.1.1 Carry out value chain studies in fruits (CAWA & others)	HRC	0%	10,000	100,000
	3.1.3.2 Undertake an assessment of existing best practices in value-chain management of important NTFPs	FRC	0%	2,000	15,000
	3.1.3.3 Study post harvest and marketing of NTFPs with high economic potential	FRC	0%	1,000	20,000
	3.1.3.5 Assess potential for new and sustainability of existing small-scale NTFP processing groups/cooperatives at district and provincial levels	FRC, P/DAFO	0%	500	12,000
	3.1.3.6 Study and promote transparent value chains/marketing models for selected NTFPs	FRC	0%	1,000	25,000
3.4.2 Support the development of Geographic Indication (GI) certification for promising ABD resources	3.4.2.1 (2.4.2.1) Purify Khao Kai Noi (KKN) native rice by in-situ farmer seed production groups in Xieng Khouang and Huaphan Provinces incl. establishment of Geographic Indications (GI), (TABI, ...others?)	ARC, P/DAFO	75%	5,000	90,000
	3.4.2.3 Establish Geographic Indications (GI) for outstanding crops/landraces/varieties (various donors)	ARC	10%	10,000	100,000

ANNEX 3: CROP-RELATED AGRO-BIODIVERSITY DATA

Table 3.1: Rice production by province and system, 2011-2012

Province	Region	Production (ton)	Share of country (%)	Share by season/system (%)		
				Wet season	Dry season	Upland
Savannakhet	Central	697,850	22.7	18.6	4.1	0.1
Vientiane Capital	Central	335,660	10.9	7.6	3.3	-
Vientiane Province	Central	275,330	9.0	7.4	1.1	0.5
Saravane	South	271,115	8.8	6.7	1.8	0.3
Champasack	South	259,050	8.4	6.6	1.8	-
Khammuane	Central	237,510	7.7	6.0	1.6	0.1
Xayabury	Central	177,525	5.8	4.4	0.4	1.0
Borikhamxay	Central	161,395	5.3	4.1	0.9	0.3
Luang Prabang	North	105,510	3.4	1.9	0.5	1.1
Bokeo	North	97,805	3.2	2.1	0.4	0.7
Xieng Khouang	Central	95,200	3.1	2.6	0.0	0.5
Huaphanh	North	91,655	3.0	1.6	0.2	1.2
Oudomxay	North	69,175	2.3	1.6	0.1	0.6
Luang Namtha	North	62,580	2.0	1.5	0.2	0.3
Attapeu	South	55,700	1.8	1.6	0.1	0.1
Phongsaly	North	49,325	1.6	0.9	0.1	0.7
Sekong	South	28,255	0.9	0.7	0.1	0.2
Total		3,070,640	100	75.8	16.6	7.6

Source: Lao www.decide.la.en

Table 3.2: Major glutinous and non-glutinous rice varieties

Rice type	Improved variety	Local variety/ land race)
Glutinous	Tha Dok Kham 8 [^] , Tha Dog Kham 11 [^] , VTE 450-1 [*] , Tha Dok Kham1-Sub 1 [*] , Ta Sa 3, Ta Sa 7, Phon Ngam 5 [*] , Phon Ngam 7 [*]	Chao Kam Neo [^] , Hom Nang Nouan [*] , Hom Sa Ngiem, Hom Lai, Kai Noi [^] , Mueng Nga, Na Xang, Ta Kied
Non glutinous	VTE 450-2 [*] , Hom Savan [^] , Hom Shampa, Tha Dok Kham 49 (12) [^]	Kham Chao [^] , Chao Lao Soung [*] , Chao Deng, Chao Na

[^]: Mainly subsistence, ^{*}: Mainly for sale

Source: ARC (2015)

Table 3.3: Major field crop varieties

Common name	Improved variety	Local variety
Soybean	SJ56 , CM60, DT12, DT 84, SKK1*	
Mungbean	Chainart726 DX2086	
Groundnut	KKU40^, KKU60^, Thainan9^	Thua Din-Met deang*, Thua Din-Met khao*
Maize	Khao Niew Tem Muang*, Sugar75*	Saroi* (different color)
Sugarcane	LVN10, VTE450, CP888	Oy-Dam (hoc)*, Oy-Kyo*
Cassava	Nep*, Rayong 72, Kasetsart 50	Yot Deang*
Yard long bean	Thua Phak Yao-003*, Aummata*	
Tomato	Chiatai 382*, various imported	Big tomato*
Eggplant	Various imported	Simoang*, Kuepom (Kuekop)*
Chili	Various imported	Mak-pik Tor*, Mak-pik Kin-heang*, Mak-pik Ki Nou
Cucumber	Various imported	Mak-taeng Kikai*, Mak-taeng Fon*
Lettuce	Various imported	Kadon*, Mak-taeng Fon*, Dok-chan* Salad-daeng*
Mango	Kiew Savoi* Nam Dok Mai*, Fa Lan, Sam La Du, Hom Thong, Phim Saen Man, Australian Kaem Daeng	Mak Muang-Keo^, Mak Muang-Aoklong*, Mak Muang Kiew, Mak Muang Karsor, Mak Muang Khai, Mak Maung Kasen, Mak Muang Kaem Daeng, Mak Muang Pa, Mak Muang Nga Xang
Banana	Various imported	Mak Kouy Nam*, Mak Kouy Khai*, Mak Kouy Ngao*, Mak Kouy Tanee, Mak Kouy Musi, Mak Kouy Hom, Mak Kouy Tip, Mak Kouy Tip Chan, Mak Kouy Mue Nang, Mak Kouy Kam

^: Mainly subsistence, *: Mainly for sale

Source: ARC (2015)

Table 3.4: Area and production of major crops, 2007 and 2012

Major crops	2007		2012	
	Area (ha)	Production (tons)	Area (ha)	Production (tons)
Rice	817,250	3,065,760	933,767	3,489,210
Maize	212,105	1,096,235	196,815	1,125 485
Groundnut	15,965	36,070	21,620	46,020
Sugarcane	24,765	1,222,000	20,490	1,055,675
Soybean	9,145	13,820	3,885	6,360
Vegetable	130,640	1,225,370	121,595	910,085
Mungbean	3,685	4,790	3,365	4,325

Source: ARC (2015)

Table 3.5 Geographic Indication (GI) products

Common name	Scientific name	Variety	Distribution		Eating quality	Yield (t/ha)
			Province	Altitude		
Rice	Oryza sativa	Kai Noi Deang	Huaphan and Xieng Khouang	1,050 - 1,200	Aromatic, soft texture	4-4.5
		Kai Noi Leuang		650 - 1,100	More aromatic than other Kai Noi varieties, soft texture	4-4.5
		Kai Noi Lay/Lay Dam		1,050 - 1,200		4-5
		Kai Noi Dam		1,050 - 1,200	Aromatic, soft texture, good taste	4-4.5
Coffee	Coffea canephora	Rubusta	Champasak, Phongsaly, Saravan, Sekong	400 - 1,300	Strong taste	1.5 (dried)
	Coffea arabica	Arabica		400 - 1,300	More aromatic	1.5 (dried)
	Coffea dewevrei	Typica and Catimor		300-1,000	More sour	0.9 (dried)

Source: Bounphanouxay, C. et al. (2009) and PAFO, PAFO, Champasak Province

Table 3.6: Rice germplasm collection in Lao PDR, 1990 - 2015

Common name	Scientific name	Lowland	Upland	Total	Land race	Breeder lines	Currently used
Glutinous	<i>Oryza sativa</i>	5,273	6,467	11,740	1,1706	34	60
Non glutinous	<i>Oryza sativa</i>	834	1,664	2,498	2,492	6	13
Wild Rice	<i>Oryza nivar</i>			74			
Wild Rice	<i>Oryza rufipogon</i>			41			
Wild Rice	<i>Oryza granulata</i>			6			
Wild Rice	<i>Oryza officinalis</i>			6			
Wild Rice	<i>Oryza ridleyi</i>			1			

Source: ARC (2015)

Table 3.7: In-country collected germplasm and origin of newly introduced field crop species

Common name	Scientific name	Traditional Lao planting material				Newly released varieties		
		Germplasm collection			Land race	Variety	Origin	
		1993-03	2004 -13	Total				
Soybean	<i>Glycine max</i>	-	z	139	11	2	Vietnam	
						3	Thailand	
						2	Lao PDR	
Mungbean	<i>Vigna radiata</i>	5	30	35	16	1	Vietnam	
						1	Thailand	
						1	Lao PDR	
Cowpea	<i>Vigna unguiculata</i>	-	41	41	13	5	Thailand	
						4	Lao PDR	
Groundnut	<i>Arachis hypogaea</i>		21	21	3	3	Lao PDR	
						3	Thailand	
Maize	<i>Zea mays</i>	3	209	212	212	1	Lao DPR	
						30	1	Lao PDR
		400	800	1200			1	Vietnam
Sorghum	<i>Sorghum bicolor</i>	6	105	111	6		Various countries	
Sugacane	<i>Saccharum officinarum</i>		5	5	5		Lao PDR	

Source: ARC (2015)

Table 3.8: In-country collected germplasm and origin of newly planted minor crop species

Common name	Scientific name	Traditional Lao planting material			Newly released varieties		
		Germplasm collection			Land race	Variety	Origin
		1993-03	2004-13	Total			
Amaranth	Amaranthus spp.	-	22	22	22	3	Lao PDR
Angled luffa	Luffa acutangula	-	29	29	29	-	-
Basil	Ocimum basilicum	1	12	13	13	4	Lao PDR
Cabbage	Brassica spp.	4	54	58	58	-	-
Bottle gourd	Luffa cylindrical	-	25	25	25	-	-
Chili	Capsicum annum	62	203	265	265	3	Lao PDR
						1	China
						1	Thailand
						1	Vietnam
Chinese cabbage	Brassica oleracea var. capitata		2	2	2	4	Lao PDR
						1	Thailand
Chinese mustard	Brassica chinensis	14	95	109	109	1	Thailand
Chrysanthemum	Dendranthema grandiflora		10	10	10		
Coriander	Cucumis sativus	14	123	137	137	1	Lao PDR
						1	Thailand
Brassica	Brassica oleracea		15	15	15		
Cucumber	Cucumis sativus	18	158	176	176	2	Lao PDR
Dill	Anethum graveolens	7	91	98	98	3	Lao PDR
Eggplant	Solanum melongena	57	122	179	179	4	Lao PDR
Lab bean	Brassica spp	2	17	19	19		
Lettuce	Lactuca sativa	2	58	60	60	2	Lao PDR
Luffa	Luffa cylindrica		2	2	2		
Okra	Hibiscus esculentus		5	5	5	1	Lao PDR
Pak Choi	Brassica campestris	9	78	87	87	4	Lao PDR
						1	Thailand
Pumpkin	Cucurbita moschata	10	145	1,155	155		
Sesame	Sesamum indicum		11	11	11		
Small bitter gourd	Momordica charantia		4	4	4		
Snake gourd	Trichosanthes cucumerina	1	16	17	17		
Sponge gourd	Luffa cylindrical	1	94	95	95		
Sugar pea	Pisum sativum	1	16	17	17		
Sweet basil	Ocimum × citriodourum		2	2	2	1	Lao PDR
Sword bean	Canavalia gladiata	2	2	4	4		
Tomato	Lycopersicon esculentum	50	38	88	88	2	Lao PDR
						2	Thailand
Jack Bean	Canavalia ensiformis		61	61	61		
Watermelon	Citrullus lanatus		23	23	23		
Wax guard	Benincasa hispida		25	25	25		
Winged bean	Psophocarpus tetragonolobus		23	23	23		
Yam bean	Pachyrhizus erosus	1	9	10	10		
Yard long bean	Vigna sesquipedalis	11	80	91	91	1	Lao PDR
						2	Thailand
Adzuki bean	Vigna angularis		2	2	2		

Source: ARC (2015)

Table 3.9: In-country collected germplasm and origin of newly planted fruit species

Common name	Scientific name	Traditional Lao planting material			Newly released varieties		
		Germplasm collection			Land race	Variety	Origin
		1993-03	2004-13	Total			
Mango	Mangifera indica	8	-	8	8	2	Lao PDR
						5	Thailand
Longan	Dimocarpus longan				3	3	Thailand
Tamarind	Tamarindus indica	2		2	2	2	Thailand
Rose apple	Syzygium samarangense	1	1	2	2	1	Thailand
Sugar apple	Annona squamosa		1	1	2	2	Lao PDR
Sapodilla	Manilkara kauki		1	1	1	5	Thailand
Pomelo	Citrus maxima	5	1	6	6	3	Lao PDR
						1	Thailand
Lemon	Citrus aurantifolia	3	1	4	3	1	Lao PDR
					1	1	Thailand
Lychee	Litchi chinensis	2		2	2	2	Thailand
Banana	Musa spp				10	NA	China
Dragon fruit	Hylocereus undatus				1	1	Thailand
Guava	Psidium guajava				2	2	Thailand
Indian hog plum	Spondias pinnata						Lao PDR
Jujube	Ziziphus jujuba				2	2	Thailand
Jackfruit	Artocarpus heterophyllus				2	1	Thailand
						2	Vietnam
Custard apple	Annona reticulata				3		
Orange	Citrus sinensis				2	NA	Various
Pine apple	Ananas cormosus				2	2	Thailand
						1	Vietnam
						1	Research
Papaya	Carica papaya				3	Several	Thailand
Passion fruit	Passiflora edulis				2		
Burmese grape	Baccaurea ramiflora				2	2	Thailand
						2	Vietnam
Star fruit	Averrhoa carambola				2	1	Malaysia
Raspberry	Rubus multibracteatus				1		

Source: Hat Dok Keo Horticulture Research Center

Table 3.10: Recent and ongoing external support related to agro-biodiversity under ARC

Key external support	Agency/donor	Period
1. Germplasm and characteristic of landrace rice 2. Rice breeding programme 3. Rice cultivation technology	IRRI	1992 - present
1. Effective use of fertilizers and planting time	CCARA	2011- present
1. Germplasm collection	DARE	2010 - present
1. Database on organic rice research 2. Nutritional properties of rice 3. Rice policy	FAO	2012 - present
1. Testing of rice varieties in different agro-ecological zones	Bioversity International	2013 - present
1. Use of biotechnology for improved rice varieties	GCP	2006 - 2011
1. Improved varieties adapted to climate change	Bioversity International	2013 - present
1. Tissue culture for teak propagation 2. Strengthening tissue culture lab	ACIAR, Australia	2013 - present
1. In-situ conservation of wild rice	RIHN, Japan	2007 - 2013
1. Sorghum conservation 2. Erianthus procerus conservation	NIAS, Japan	2012 - 2014
1. Conservation and characteristics of cassava	CIAT, Australia	2006 - 2010
1. Database on rice 2. Study on rice blast 3. Testing and selection of upland rice varieties 4. Develop hybrid fodder maize 5. Testing soybean varieties	LARF, Australia	2005 - 2010
1. Development of rice seed network	Japan	2006 - 2009
1. Study on rice blast resistance 2. Improved cultivation techniques of cassava	JIRCAS	2010 - present
1. Improved tissue culture Lab 2. Improved soil and plant analysis Lab	Lao-Thai project	2000 - 2004
1. Improved aromatic rice	EU	2007 - 2011
1. Improved hybrid maize in Laos	Lao-Vietnam project	2001 - present

Source: ARC (2015)

Table 3.11: Recent and ongoing external support related to agro-biodiversity under HRC

Key external support	Agency/Donor	Period	Location
Vegetable germplasm conservation and seed production	DED, Germany	2002-2006	HRC
Integrated plant and insect pollinator, IPM/FFS	FAO, Netherlands	2004-2007	Vientiane Capital
Fruit tree production, IPM/FFS	German Agro Action, Germany	1999-2001	Luang Prabang Province
Vegetable and fruit tree development	FAO	2004-2007	Luang Prabang and Champasak provinces
Chili germplasm collection, characterization and conservation	AFACI, Korea	2012-2014	Selected provinces

Source: HRC (2015)

ANNEX 4: LIVESTOCK-RELATED AGRO-BIODIVERSITY DATA

Table 4.1: Status and trends in animal livestock, 2000-2012

Livestock	2000	2004	2008	2012
Buffalo	1,028,000	1,101,700	1,154,500	1,188,000
Cattle	1,144,800	1,266,100	1,397,700	1,691,800
Pig	1,325,000	1,727,300	2,358,600	2,793,700
Goat/sheep	121,400	140,600	268,900	443,800
Poultry	13,494,200	19,590,600	21,213,700	28,778,700

Source: LRC (2015)

Table 4.2: Recent and ongoing support related to agro-biodiversity under LRC

Key support	Agency/donor	Period
Improvement of productivity of local goat breeds	ACIAR	2007
Food security through improved livestock: a case study	SIDA	2009
Native pig breeds	SIDA	2011
Indigenous chickens, important part of rural livelihoods	FAO	2008
Legumes for pigs project	ACIAR	2006 - 2012
Smallholder pig system	ACIAR	2012 - 2015
Cattle improvement	Lao government	2012 - 2014

Source: LRC (2015)

ANNEX 5: NTFP-RELATED AGRO-BIODIVERSITY DATA

Table 5.1: Yearly harvest of NTFP, 2009-2013

Common name	Scientific name	Harvest ton/year					Stock (2015)
		2009	2010	2011	2012	2013	
Cardamom	Amomum spp.	202	322	397	15	407	Stable
Malva nuts	Scaphium macropodum	0	58	5	578	50	Declining
Sugar palm fruits	Arenga westerhoutii	2,330	1,500	3,726	2,875	4,030	Stable
Damar resin	Shorea obtuse	1,562	16,000	521	1,130	518	Declining
Broom grass	Thysanolaena maxima	1255	20	2350	3072	3,120	Stable
Rattans cane	Calamus spp.	160,000	92,000	493,000	170,000	70,000	Declining
Draceana	Draceana lourei	58	23	67	2,030	50	Declining
Paper mulberry	Broussonetia payriflora	350	250	330	331	440	Stable
Nyang oil	Dipterocarpus alatus	30	2	0	0	0	Declining
Bong Bark	Persea kurzii	550	420	690	316	835	Stable
Benzoin	Styrax tonkinensis	45	52	112	54	65	Increasing
Rattans fruits	Calamus spp.	30	0	15	3	20	Declining
Peuak meuak bark	Boehmeria malabarica	0	0	422	530	163	Declining
Bamboo shoots	Dendrocalamus spp.	640	452	985	213	3,100	Stable
Bamboo canes	Various species	800,000	2,910,000	1,822,000	889,000	2,163,000	Stable
Haktinhung	Helmintostachys zeylanica	0	0	0	0	0	Almost exhausted
Stick lack	Lacca spp	0	0	0	0	0	Declining

Source: Annual Quota Evaluation, DoF/MAF

Table 5.2: Less utilized, but promising NTFP species

Common name	Scientific name	Stock	Growing area	Use
Bitter bamboo	Indosasa sinensis	Abundant	Northern part of Lao	Food (shoot & cane)
Rattan	Daemonorops jenkinsiana and Calamus tenuis	Abundant	Mountainous area	Food (shoot) & cane
Sugar palm fruits	Arenga pinnata	Sufficient	Mountainous areas	Food/dessert
Amorphophallus	Amorphophallus spp	Sufficient	Open areas	Medicine
Vitiver	Vetiveria zizanioides	Sufficient	Xiang Khouang P.	Medicine
Taraw palm	Livistonia saribus	Sufficient	Dry deciduous forest	Edible fruit
Lingzhi	Ganoderma spp	Sufficient	Various forest types	Medicine
Shitake	Lentinus erodes	Sufficient	Various forest types	Food & medicine
Matsutake	Tricholoma matsutake s.l.	Sufficient	Dry upper deciduous	Food
Brittle cap	Russula spp	Abundant	Deciduous forests	Food
Oyster mushroom	Tricholoma ostreatus	Sufficient	Deciduous forests	Food
Wood ear	Auricularia auricula s.l.	Abundant	Deciduous forests	Food

Source: FRC (2015) and ABP

Table 5.3: Major woody domesticated NTFPs

Common name	Scientific name	Main province	Use
Eagle wood	<i>Aquilaria crassna</i>	Champassak, Vientiane, Bolikhamzay	Essential oil
Paper mulberry	<i>Broussonetia papyrifera</i>	Luang Prabang, Oudomsay, Sayabury,	Bark, leaf
Benzoin	<i>Styrax tonkinensis</i>	Luang Prabang, Oudomsay, Huaphanh	Resin
Siset	<i>Pentace burmanica</i>	Champassak	Bark
Machilus	<i>Machilus/Persea kurzii</i>	Champassak, Savannaket, Bolikhamsay, Sekong	Bark
Bamboo	Bambo spp.	Vientiane Province, Attapeu, Bolikhamxay	Cane and shoot
Rattan	Rattan spp.	VTE, Bolikhamxay	Cane and shoot
Cardamom	<i>Amomum sp.</i>	Champassak, Salavan, Oudomsay, Phongsaly, Luang Namtha	Fruit, rhizome

Source: FRC (2015)

Table 5.4: Recent and ongoing external support related to agro-biodiversity under FRC

Key external support	Agency/donor	Period
Promotion of sustainable use of NTFPs	Government of Netherlands	1996 - 2001
Survey of Rattan in Lao PDR	Darwin initiative, DFID	1998 - 2001
Lao Tree Seed Project: 101 seed sources and tree descriptions	Danida	1998 - 2003
Demonstration of Rattan plantation for shoots	Asian-EU, Asian ITTO	2003 - 2004
Propagation technique for orchids and puak muak	SIDA	2003 - 2006
Study on broom grass domestication/propagation	SIDA	2004 – 2006
NTFP Marketing Study	FAO	2004 – 2006
Manual on 100 important NTFPs of Lao PDR	Various	2009
Research on oil distillation of <i>Aquilaria sp</i>	JICA	2010
Research on trends in timber and NTFP use	FSCAP/JICA	2013
Study on the impact of NTFPs on farmer livelihoods	JIRCAS	2011 – 2014
Promotion of sustainable use of rattans	IKEA/WWF/SDC	2006 – 2016
Study on sustainable use and marketing of bamboo	GRET	2012 – 2014
Study on sustainable use and marketing of bamboo	SNV, GDG,	2005 – 2014

Source: FRC (2015)

Table 5.5: Exported medicinal plants

No	Local name	Scientific name	Enterprise
1	Dok Pheung	Dendrobium spp.	Wild & cultivated
2	Hua Tom Ngeune	Stephania rotunda	Wild
3	Hoa Sam Sib	Stemona tuberosa	Wild
4	Vane Bai Lai	Anoetochlus farmosus	Wild
5	Kheua Haem	Cosciniium fenestratum	Wild
6	Hoa Sam Phan Hou	Hydnophytum formicarum	Wild
7	Vane Hang Xang	Grammotophyllum speciosum	Wild
8	Chan Dai Deng	Dracaena cambodiana	Wild
9	Khing	Zingiber officinalis	Cultivated
10	Khae	Cinnamomum cassia	Wild
11	Man Kha Kai	Cadonopsis pilosa	Wild
12	Nhane	Styrax tonkinensis	Cultivated

Source: ITM (2015)

Table 5.6: Endangered medicinal plant species

No	Local name	Scientific name
1	Kout Tin Houng	Helminthostachys zeylanica
2	Khing Pha	Polygonatum kingianum
3	Kha Yom Phou	Rauvolfia serpentine
4	Hoa Tom Ngeune	Stephania rotunda
5	Man Onh Ling	Polygonum multiflorum
6	Man Kha Kai	Codonopsis pilosa
7	Kheua Haem	Cosciniium fenestratum
8	Vane Hoa Tor	Disporopsis longifolia
9	Tin Houng	Paris marmorata
10	Pom Bi Ka Thing	Panax vietnamensis
11	Mak Chong Ban	Stercularia lychnophora
12	Leu Lang Lai	Aeschynanthus marmoratus
13	I tu Ton	Cinnamomum camphora
14	Mai Tha Lo	Cinnamomum pathenoxylon
15	Hat Mee	Artocarpus lakaocha
16	Lep Meu Nang	Schefflera elliptica
17	Ien Don	Eurycoma harmandiana
18	Kok Xi Din	Curculigo orchidoides
19	Chan Dai Deng	Dracaena cambodiana
20	Seng Beua	Strychnos nux-vormica
21	Yang Bong	Litsea monopetala
22	Pom Khen Ter (Pom Ka Deng)	<i>Bistorta vivipara</i> Syn. <i>Polygonum viviparum</i>

Source: ITM (2015 and ABP)

Table 5.7: Domesticated medicinal plants

No	Local name	Scientific name	Enterprise
1	Khing	Zingiber officinale	Foreign company
2	Khi Min Kheun	Cucuma longa	Villagers
3	Mone	Morus alba	Villagers
4	Nha Nuag Meo	Orthosiphon stamineus	Villagers
5	Nhane	Styrax tonkinensis	Foreign company
6	Phak Nok	Centella asiatica	Villagers
7	Phak Bua Leuat	Eleutherine subaphylla	Villagers
8	Rasa Bi, Sam Phan Bi	Andrographis paniculata	Villagers
9	Van Hua Deo	Cucuma xanthorrhiza	Villagers, some areas
10	Van Phai	Zingiber cassamunar	Villagers
11	Kao Bok	Catharanthus roseus	Villagers
12	Khae	Cinnamomum cassia	Foreign company
13	Nhor Ban	Morinda citrifolia	Villagers
14	Phak I Houm	Morinda oleifera	Villagers
15	Fang Daeng	Caesalpinia sappan	Villagers
16	Nam Khor	Uncaria rhynchophylla	Foreign company
17	Hed pek	Poria cocos	Foreign company
18	Mak Kieng	Citrus aurantium	Foreign company
19	Dok Pheung	Dendrobium spp.	Foreign company

Source: ITM (2015)

ANNEX 6: FISH AND AQUATIC ANIMALS RELATED AGRO-BIODIVERSITY DATA

Table 6.1: Short list of the top five priority sites of the wetlands in Lao PDR

Wetland site	Priority	Status
Beung Kiat Ngong wetlands, Champassak Province	1	Ramsar Site, NPA
Siphandone Wetlands, Champassak Province	2	Bio hotspot, IBA
Nam Theun wetlands, Khammouane Province	2	IBA, NPA, upland wetlands
That Luang Swamp, Vientiane capital	2	Urban wetlands
Xe Champhone wetlands, Savannakhet Province	5	Ramsar Site, Crocodile site

Source: IUCN (2011a)

Table 6.2 Estimated fish production and yield from fish capture and aquaculture in Lao PDR, 2007

Type of fisheries	Water source	Area ('000 ha)	Total production (tons)	Yield (kg/ha/year)
Capture fisheries	Mekong river and tributaries	304	21,329	70
	Large reservoirs	96	8,405	87
	Lakes and wetlands	114	17,220	150
	Irrigation reservoirs	60	9,000	150
	Rice fields	1,161	33,143	50
Sub-total		1,238	89,097	507
Aquaculture	Fish ponds	22	33,000	1,500
	Oxbow lakes	15	9,000	600
	Rice-fish culture	5	1,500	250
	Cage culture	NA	11,250	NA
Sub-total		42	54,750	2,350
Total		1,280	143,847	2,850

Source: LARReC (2015)

Table 6.3: Indigenous fish species used in research for potential aquaculture development

Indigenous fish species	Research progress
Anabas testudineus	Breeding technique (100%), feeding and growth rate (30%)
Barbonymus gonionotus	Fingerling producing to support the aquaculture (80%)
Catlocarpio siamensis	Increase parent stock (30%)
Chitala ornata	Increase parent stock for further research (20%)
Cirrhinus microlepis	Artificial breeding technique (100%)
Cirrhinus molitorella	Increase parent stock in the process for further research (70%)
Clarias macrocephalus	Artificial breeding technique (100%), feeding and growth rate study (50%)
Coius undecimradiatus	Increase parent stock for research (5%)
Hemibagrus filamentus	Artificial breeding technique (100%), growth rate study (30%)
Hemibagrus wyckioides	Artificial breeding technique (100%), growth rate study (60%)
Henicorhynchus lobatus	Increase of parent stock for research (30%)
Labeo chrysophekadion	Artificial breeding technique (100%)
Osphronemus exodon	Artificial breeding technique (100%), nursing (100%) and growth rate study (30%)
Osteochilus macrocephalus	Increase stock for further research (70%)
Pangasianodon hypophthalmus	Artificial breeding technique (100%), growth rate study (30%)
Pangasius conchophilus	Artificial technique (100%), growth rate study (30%)
Probarbus jullieni	Artificial technique (100%), growth rate study (10%)

Source: LARReC (2015)

Table 6.4: Recent and ongoing support related to fish agro-biodiversity

Key external support	Agency/donor	Period	Nat. Agency
Research of Mekong indigenous fish species	IDRC	1991-1994	LARReC
Dry and wet season migration of Mekong Fish, Hou Som Yai Channel, Champassak	IDRC	1992-1994	LARReC
Importance Mekong River deep pools	NAFRI, DANIDA	2002	LARReC
Productivity of aquatic animals in rice fields	FAO	2003	LARReC
Monitoring fish catchments in Mekong River	MRC	2003-2013	LARReC
Monitoring of wet season fish migration, Hou Som Yai channel, Champassak	MRC	2003-2013	LARReC
Introduced artificial breeding technique to the Mekong indigenous fish species	CIRAD	2005-2010	LARReC
Fish bypass through the Mekong to flooded area	ACIAR	2010-2014	LARReC/NUOL
Indigenous prawn research on population management	JIRCAS	2007-2014	LARReC
Fish biodiversity management	JIRCAS	2007-2014	LARReC
Aquaculture improvement	JICA	2000-2010	DLF
Implementing Strategy for Fisheries and Aquaculture Management and Development	FAO	2014-2015	DLF
Culture-based fisheries	ACIAR (NACA)	2013-2014	DLF
Rehabilitation of fisheries resources/ habitat/ fishing grounds, Nam Houm Reservoir	JTF (SEAFDEC)	2013-2014	DLF
Lao-Thai transboundary fisheries management, Bokeo Province	MRC	2013-2015	DLF/LARReC
Lao-Cambodia transboundary fisheries Management, Champasak and Attapeu provinces	WB (MRC/IWRM)	2013-2015	DLF
Community fisheries, Bolikhamxai, Khammouane, and Savannakhet Provinces	WWF	2014-2015	DLF
Aquatic resources management and development in Attapeu, Champasak and Sekong Provinces	WB (MRC/IWRM)	2013-2015	DLF

Source: LARReC (2015)

7: INVASIVE ALIEN SPECIES IN LAO PDR

Table 7.1: Invasive alien plant species and their origin

Common name	Scientific Name	Origin
Giant sensitive plant	<i>Mimosa diplotricha</i>	Central and South America
Blady grass/spear grass/cogon grass	<i>Imperata cylindrica</i>	Unknown, probably East Africa
Leucaena	<i>Leucaena leucocephala</i>	Southern Mexico and northern Central America
Chinese fever vine	<i>Paederia foetida</i>	Temperate, and tropical Asia
Mexican devil	<i>Ageratina adenophora</i>	Mexico
Palmer's pigweed	<i>Amaranthus palmeri</i>	Americans across North America
Devil weed	<i>Chromolaena odorata</i>	North America
Water hyacinth	<i>Eichhornia crassipes</i>	Amazon basin (South America)
Jungle rice	<i>Echinochloa colonum</i>	North America
Giant mimosa	<i>Mimosa pigra</i>	South America
Asian water moss	<i>Salvinia cuculata</i>	Probably South America

Sources: Country report of Chay Bounphanousay, 2014; Nghiem et al., 2013 and LARReC (2015) and ABP

Table 7.2: Invasive alien animal species and their origin

Common name	Scientific Name	Origin
African sharp-tooth catfish	<i>Clarias gariepinus</i>	Africa
Nile Tilapia	<i>Oreochromis niloticus</i>	Central Africa
Common carp	<i>Cyprinus carpio</i>	Asia
Golden apple snail	<i>Pomacea canaliculata</i>	South America
Brown rat	<i>Rattus norvegicus</i>	Probably Northern China

Sources: LARReC (2015) and ABP

ANNEX 8: AGRO-BIODIVERSITY RESEARCH AND DEVELOPMENT AGENDA BY KEY AGENCIES AND CENTERS

1. Rice and major food crops - ARC

The Agriculture Research Center (ARC) has identified the following agro-biodiversity issues for crop-based agro-biodiversity conservation, management and use:

- Strengthen existing crop gene-bank facilities at ARC and develop a National Gene-bank for plant genetic resources to support the exchange and *in situ/ex situ* conservation of plant genetic resources for food and agriculture.
- Facilitate seed multiplication, dissemination and storage; develop processing and value added activities; promote trade and the marketing of major crops both nationally and in the region.
- Set-up a national policy framework aligned with the agro-biodiversity conventions promoting PGRFA.
- Strengthen the capacity of farmers to conserve seeds, manage the cultivation and value chain marketing of major crops, and develop new varieties based on indigenous germplasm.
- Increase public awareness on the value of plant genetic resources, document and disseminate successful management practices and develop partnerships with key stakeholders.

2. Agro-biodiversity in Agriculture Systems - HRC

In pursuing the goal of *“Optimize integrated and diversified crops and small animal productions systems and crop-associated biodiversity into traditional and improved integrated farming systems in order to achieve self-sufficiency, provide a balanced diet and increase cash-income for farmers”*, the Horticultural Research Center (HRC) has proposed following interventions:

- Strengthen the existing fruit and vegetables seed gene-bank at HHRC and/or develop a national gene-bank on plant and animal genetic resources for the exchange and *in situ* and *ex situ* conservation of plant and animal genetic resources.
- Emphasize the importance and promote household-based integrated agriculture production systems and home gardens in the three eco-regions of Lao PDR.
- Diversify household-based integrated agriculture production techniques to improve the quality of ABD resources (fruits, vegetables, mushrooms, livestock, insects, fish and other aquatic resources) for family-consumption and cash-income generation.
- Evaluate the impact of climate change on the resilience of integrated agriculture systems and modify agro-biodiversity techniques to maintain ecosystem services.
- Awareness-raising on nutritional needs in upland areas in collaboration with the Ministry of Health (MoH).

3. Livestock - LRC

In the support of the goal to *“Sustainably conserve livestock breeds and develop the value chain (breeding, feeding, housing, handling) of main livestock and small animal husbandry in different production agro-systems and eco-regions in order to achieve self-sufficiency, ensure food security and increase market-oriented cash-income for livestock farmers while using and conserving animal genetic resources”*, the Livestock Research Center (LRC) is proposing to:

- Characterize, inventory livestock genetic breeds and monitor trends and associated risks;
- Reinforce existing livestock gene-bank at LRC and (or) develop a National Gene-bank on animal genetic resources, exchange breed, and conserve these resources, both in situ and ex situ in the context of emergencies and climate change;
- Sustainable use and development of animal productions systems (breeding, feeding, housing, handling);
- Secure the diversity of indigenous livestock species by better implementing and harmonizing the Global Plan of Action for Food and Agriculture. Conserve genetic diversity of indigenous livestock breeds;
- Draft policies and regulations, strengthen capacity of institutions and all stakeholders to sustainably developed livestock breeds and disseminate knowledge products on best livestock management practices to all actors.

4. Forestry sector - FLC

The overall goal of the Forestry Research Center (FRC) related agro-biodiversity management in the forestry sector is to *“Conserve NTFP biodiversity, develop and sustainably manage the value chain (harvesting, planting, storage, processing, marketing and trade) of NTFPs from forest ecosystems and agro-ecosystems to achieve self-sufficiency, sustain food security and provide complementary cash-income for farmers while using and conserving plant and animal genetic resources”*.

Under this overall goal, FRC has the following strategic priorities for the forestry sector:

- Increase awareness on the availability, value, importance and distribution of NTFPs in the eco-regions of Lao PDR.
- Foster the conservation and sustainable use of NTFPs (harvesting, storage, processing, marketing and development) at community level.
- Expand the successful pilot models for harvesting, domesticating, processing and marketing key NTFPs and increase the planting of domesticated NTFPs (Cardamom, Rattans, Bamboos, etc.).
- Study the less-used species of NTFPs and establish ex-situ and in-situ conservation systems.
- Develop national and provincial plans for the sustainable use, monitoring and trade of NTFPs which are fully-aligned with international treaties and conventions.

5. Fish and Aquatic Animals - LARReC

Pursuing “Sustainably conserve fishery resources and other aquatic biodiversity in different aquatic systems and eco-regions) and develop aquaculture systems for indigenous fish in order to achieve self-sufficiency, ensure food security, provide a protein-rich diet and increase cash-income for farmers while using and conserving aquatic genetic resources”, the Living Aquatic Resources Research Center (LARReC) has proposed to:

- Improve knowledge of the status, abundance, trend, threat of fish indigenous aquatic resources; and other aquatic animals (OAAs) in different aquatic systems and eco-regions;
- Strengthen institutional and human capacity at the community level to promote the sustainable use of fish aquatic resources at national and provincial levels to support sustainable fish capture and aquaculture;
- Reinforce biodiversity related National legislation, market and trade aligned with international conventions and treaties (ITAPGRFA, CITES, RAMSAR, CBD);
- Increase awareness and communication of the value of fisheries and other aquatic resources, and document and disseminate successful management practices;
- Foster resilience of aquatic-systems and adaptation to climate change, control alien fish species proliferation in rivers, reservoirs, lakes and tributaries.

ANNEX 9: LIST OF REFERENCES

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