LAO PEOPLE'S DEMOCRATIC REPUBLIC

Barrier Analysis and Enabling Framework for Mitigation

Technology Needs Assessment

Supported by

August 2017

Barrier Analysis and Enabling Framework for Mitigation

Vientiane, August 2017

Reviewers:

Department of Climate Change
UNEP Risoe Centre on Energy, Climate and Sustainable Development (URC)
Asian Institute of Technology (AIT)

Country Coordination:
Department of National Disaster Management and Climate Change,
Ministry of Natural Resource and Environment

National Consultant:
Mone Nouansyvong

DISCLAIMER

This report is intended to identify barriers and enabling framework for developing and sustaining technologies for climate change mitigation in forestry and agriculture in Lao PDR. This report is an input for preparation of technology action plans and project ideas for accessing funding for climate change mitigation. The results, suggestions, and conclusions presented in this publication are entirely those of the author, revivers and coordinator, and should not be attributed in any manner to the Global Environment Facility (GEF), which funded the production of this publication.

Contents

List of Tables

Abbreviation

ACB	ASEAN Centre for Biodiversity
APFnet	Asia-Pacific Network for Sustainable Forest Management and Rehabilitation
ASEAN	Association of South East Asia Nations
ASFN	ASEAN social forestry network
ASOA	ASEAN Standards for Organic Agriculture
CBD	the Convention on Biodiversity
CIFOR	Centre for International Forestry Research
CliPAD	Climate Protection through Avoided Deforestation
COP	Conference of the Parties
DAFO	District Agriculture and Forestry Office
DFRM	Department of Forest Resource Management
DOF	Department of Forestry
DOFI	Department of Forest Inspection
EIA	Environmental Impact Assessment
ESMP	Environmental and Social Management Plan
FAO	Food and Agriculture Organization (of the United Nations)
FIM	Forest Information Management
FIP	Forest Investment Programme
FIPD	Forest inventory and Planning Division
FLEGT	Forest Law Enforcement Governance and Trade
FRDF	Forest Resource Development Fund
FSC	Forest Stewardship Council
GDP	Gross Domestic Product
GHG	Greenhouse gas
GIZ	Deutsche Gesellschaftffs Internationale Zusammenarbeit (German Agency for International Cooperation)
GOL	Government of Lao PDR
IFOAM	The International Federation of Organic Agriculture Movements
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
JICA	Japan International Cooperation Agency
MAF	Ministry of Agriculture and Forestry
MEM	Ministry of Energy and Mines
MOF	Ministry of Finance
MONRE	Ministry of Natural Resource and Environment
MPI	Ministry of Planning and Investment
MRV	Monitoring, Reporting and Verification
NAFES	National Agriculture and Forestry Extension Service
NAFRI	National Agriculture and Forestry Research Institute
NGOs	Non-Government Organizations
NPA	National Protected Area
NSAP	National Strategy and Action Plan on Climate Change
NUOL	National University of Laos
NWFPs	Non-Wood forest products
ODA	Official Development Assistance
PAFO	Provincial Agriculture and Forest Office
RECOFTC	Centre for People and Forests
REDD	Reducing Emissions from Deforestation and Forest Degradation
REL	Reference Emissions Level
R-PP	Readiness Preparation Proposal
SESA	Strategic Environmental and Social Assessment

SFM	Sustainable Forest Management
SIDA	Swedish International Development Agency
SNC	Second National Communication
SNV	Netherland Development Organisation
SUFORD	Sustainable Forestry and Rural Development
TWGs	Technical Working Groups
UNDP	United Nations Development Programme
UNCTAD	United Nations Conference on Trade and Development
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WCS	World Conservation Society
WREA	Water Resources and Environmental Administration
WRI	World Resource Institute
WWF	World Wide Fund for Nature

Executive Summary

This Barrier Analysis and Enabling Framework (BAEF) is a crucial element of the Technology Needs Assessments (TNA), which is the translation and implementation of the technology transfer as specified in the Agenda 21, as well as in Articles 4.3, 4.5 and 4.7 of the United Nations Framework on Climate Change Convention (UNFCCC). The Global Environment Facility (GEF) supported the TNA, particularly under the Poznan Strategic Programme on Technology Transfer, endorsed by the UNFCCC's 14th Conference of the Parties (COP 14) in 2008. The programme consisted of (1) technology needs assessments (TNAs), (2) piloting priority technology projects and (3) dissemination of successful demonstrated technologies.

The Lao PDR engaged in the programme implemented TNA between 2011 and 2013 (phase I) and 2015 to 2017 (phase II). Phase I focused on the prioritisation of climate change mitigation and adaptation technologies, which resulted in 16 technologies/practices under 3 sectors namely forestry, agriculture and water resources. The following selected priority technologies to enhance climate change mitigation and adaptation are mainly public provided or other non-market goods except biogas and biomass energy which were classified as capital and consumer goods.

Climate change mitigation technologies

Forestry sector

1. Effective conservation forest management/protected area management,
2. Sustainable village forest management
3. Optimal or sustainable plantation forests
4. Optimal agroforestry

Agriculture

1) Feed improvement
2) Organic farming
3) Biogas
4) Biomass (agriculture l residue-based energy)

Climate change adaptation technologies

Water resources

1. Early warning system
2. Disaster impact reduction fund
3. Climate change resilient rural infrastructure
4. Water supply system

Agriculture

1. Livestock disease prevention and control
2. Agricultural development subsidy mechanism
3. Climate resilient rural infrastructure and
4. Crop diversification

The TNA phase II focussed on (1) Barriers and or Gaps Analysis and Enabling Framework (BAEF), (2) development of Technology Action Plans (TAP) and (3) project ideas for four prioritised mitigation technologies in the three sectors. This report covers only BAEF for the mitigation technologies in the forestry and agriculture sector. Others were reported separately.

The BAEF were performed following the barrier analysis processes and techniques from the TNA guidelines. Barriers were compiled, screened, and decomposed and analysed its root causes by literature review, key informant interviews and 3 stakeholder consultation workshops. Specifically, the barriers compiled from literature review, interview and meetings were screened and ranked to derive essential barriers, by expert judgement-voting and scoring, respectively. The voting was to discard irrelevant, invalid and non-essential barriers and keep essential barriers. The ranking was to prioritize the most important barrier, and it was obtained by scoring, where score "1" was given to insignificant barrier,

"2" to moderate and "3" to the most significant barrier. Once key barriers were identified, they were decomposed by categorising barriers, define barrier within each category, its elements and dimensions using decomposition matrix, and then using a logical problem tree analysis to map out root causes of the key barriers. Finally, analysis results were validated and reached consensus by 3 stakeholder consultations namely technical workshop, forest focus group and stakeholder consultation meetings.

Findings suggested that, based on the technology development cycle and diffusion curve, the technologies in both forestry and agriculture sector, particularly effective protected area management, sustainable community forest management, optimal plantation forests, agroforestry, animal feed improvement, organic farming, biogas and biomass energy have quite major development. However, there are not fully developed and deployed effective and sustainable practices in the development and management. There several gaps in research and development, demonstration, markets, evaluation on the technology development and learning while enabling environment such as legal framework, human resources, incentives including subsidies and tax reduction are insufficient.

Barriers that hinder effective development and deployment of the mitigation technologies of the forestry and agriculture sector consist of financial and economic and non-financial and economic barriers. In which, there are 5 common financial and economic barriers faced by technologies of both sector namely: 1) insufficient financial resources for promotion, development and management of the technologies, 2) insufficient win-win financing and financial risk management mechanisms, 3) low or not financial and economic feasibility for investment, and 4) marginal profit while investment cost is high, and 5) inadequate financial and economic incentives including subsidies. There are also 6 common non-financial and economic barriers: 1) insufficient skills for promotion, development and management of the technologies, 2) limited financial, economic and technical feasibility studies and information, 3) technical difficulty and utility limitation of the technologies, 4) inadequate reference projects such as successful interventions and best practices, 5) insufficient policy framework and 6) variable markets. In addition, there are other specific barriers to specific technologies, such as inadequate and variable raw materials supply for biogas and biomass energy technology; geographical and physical difficulty to access to survey, plan and develop some areas of the protected areas, and existing environmental impact of existing plantations.

In conclusion, to ensure the development and sustainability of the technologies in both sectors, the following enabling environments are also needed to be in place in response to the barriers and effectively implemented.

Barriers	Measures	Enabling framework
Inadequate public budget for promotion, development and management of the technologies	Promote and maximise revenues from enterprises and reinvestment in the of the technologies	1. Policies on the promotion of environmentally friendly technologies 2. Promote national science and technologies R&D
	Enhance resources mobilisation and access to financial and technical supports from external	
	Improve public budgeting and financial mechanisms including incentives and subsidies	
	Improve effectiveness and transparency of financial aids	
High investment cost	Reduce tax, improve cost sharing and transfer mechanism while promoting incentives	

Barriers	Measures	Enabling framework
Limited capital and access to finance	Increase trustworthiness and financial capacity of the entrepreneurs	3. Effective management and allocation of public budget 4. Effective and transparent financial aids policy and management system 5. Policy for promotion investment, business and development private sector including capital market and access to finance 6. Promote macro-economic growth 7. Integrated land use and spatial plan including land suitability map 8. Effective law enforcement, especially natural resource, environment and impact assessment 9. Reference, especially successful projects and best practices
	Develop and implement policies including warrants for facilitation to access to finance	
	Improve financial risk management mechanism, implying requirements and procedures to access to finance	
	Enhance capital and financial markets	
Market failure	Improve market information and marketing	
	Improve quantity and quality of products	
Limited organisational capacity and staff technical knowledge and skills	Improve HRD systems including capacity need assessment, HRD and capacity building plan, staff knowledge management	
	Improve high education and professional training	
	Improve HRD polices and financing	
Insufficient and conflict legal framework	Improve R&D effective legal framework and best practice law enforcement	
	Improve law on legislation development, especially promotion of public and multidisciplinary participation in a legislation development	
	Complete legal framework	
Technical	Improve R&D on the technologies including its value chain, alternative technologies and guidelines on sustainable or effective practices for promotion, development and management of the technologies	

Chapter 1 Introduction

1.1 Background

Technology transfer has been under focus since the Rio Summit in 1992, when it was included in Agenda 21 as well as in Articles 4.3, 4.5 and 4.7 of the UNFCCC. The technology transfer issues were subsequently brought about to discuss in COP1 in Berlin, Germany in 1995 and COP4 in Buenos Aires, Argentina in 1998. Of which, the Decision 2 of COP4 (2/CP4) requires GEF to provide funding to developing country Parties to enable them to identify and submit to the COP their prioritised technology needs, especially key technologies needed in particular sectors of their national economies that are conducive to addressing climate change and minimising its negative consequence. Following this, GEF provided funding to 92 countries between 2000 and 2004 as the first round of Technology Needs Assessments (TNAs). Furthermore, in response to COP13 requests, GEF proposed the Poznan Strategic Programme on Technology Transfer, which was endorsed by COP14. This programme consists of three funding windows such as (i) technology needs assessments (TNAs); (ii) pilot of priority technology projects; and (iii) dissemination of successfully demonstrated technologies. Then in 2009, a new round of TNAs commenced in 36 developing countries and was successfully concluded in April 2013.

The Ministry of Natural Resources and the Environment (MoNRE) and relevant ministries and organisations in Lao PDR implemented the TNA project from 2011 to 2013. Phase I project resulted in the identification and selection of 16 technologies/practices as priority technologies for climate change mitigation and adaptation, which are categorized under three sectors namely forestry, agriculture and water resources. Of the 16 technologies, eight of the climate change mitigation technologies are in the forestry and agriculture sectors, and eight adaptation technologies under the agriculture and the water resources sectors (Table 1).

TABLE 1 PRIORITY CLIMATE CHANGE MITIGATION AND ADAPTATION TECHNOLOGIES

Climate mitigation technologies	**Climate adaptation technologies**
Forestry sector	**Water resources**
1. Effective protected area management	1. Early warning system
2. Sustainable community forest management	2. Disaster impact reduction fund
3. Optimal or sustainable plantation forests	3. Climate change resilient rural infrastructure
4. Optimal agroforestry	4. Water supply system
Agriculture	**Agriculture**
1. Feed improvement	1. Livestock disease prevention and control
2. Organic farming	2. Agricultural development subsidy mechanism
3. Biogas	3. Climate resilient rural infrastructure
4. Biomass (agricultural residues-based energy)	4. Crop diversification

1.2 Barrier Analysis and Enabling Framework Report and Organisation

This report is an outcome of the TNA project phase II, which is being implemented between 2015 and 2017. This phase of the project focussed on (1) Barriers Analysis and Enabling Framework (BAEF), (2) development of Technology Action Plans (TAP), and (3) Project Ideas for the prioritised technologies

in forestry and agriculture sector. This report covers only Barriers and /or Gaps Analysis and Enabling Framework for prioritised mitigation technologies. The TAP and project concepts for the mitigation technologies, BAEF, TAP, and project ideas for adaptation technologies were reported separately.

The barriers analysis and enabling framework described in this report were identified following the barrier analysis processes and methods suggested in the TNA guidelines. Those include barrier identification, screening, and decomposition and root cause analysis by literature review, ranking and problem tree analysis, key stakeholders interview and consultations. The details on barrier analysis process and methods were mainly described in Chapter 2 and a summary in Chapter 3 and 4: barrier analysis of each technology in forestry and agriculture sector, respectively.

This report consists of five main chapters. Chapter 1: introduction provides an overview of technology transfer and TNA project background, including a brief of the TNA project implementation in Laos and outcomes. Chapter 2 methodology, describes the process and techniques for analysis of barriers and identification of measures to overcome the barriers. Chapter 3 provides details on barriers analysis and enabling framework for the 4 mitigation technologies and practices in forestry sector, particularly effective protected area management, sustainable community forest management, optimal or sustainable plantation forests and agroforestry. Chapter 4 describes detailed barriers analysis and enabling framework for the 4 mitigation technologies in the agriculture sector, including feed improvement, organic farming, biogas and biomass (agricultural residues biomass-based) energy. Chapter 5, conclusion, summing up and highlighting the barrier analysis process and results as well as barriers and enabling framework for developing and sustaining the 8 mitigation technologies in forestry and agriculture sector.

Chapter 2 Methodology

2.1 Analysis of Technology Barriers

Barrier analysis was conducted in accordance with the TNA guideline series "overcoming barrier to the transfer and diffusion of climate technologies" (Nygaard & Hansen, 2015). It included compilation, screening and prioritisation, decomposition of the barriers and analysis of its root causes. Importantly, it included stakeholder consultation meetings which were organised to validate and agree upon the analysis and results.

Barriers compilation and synthesis were initially performed by the TNA project team (Annex 1) including national consultant, by literature review and interview of key informants. The literature reviewed are polices, strategies, plans and study reports in the forestry, agriculture and relevant sector (e.g., the documents in Annex 2). The interview was carried out before and after stakeholder consultation meetings. However, the interview focused on key informants and stakeholders who have responsibilities and involved in the technologies application, management and promotion at different levels and aspects. It comprised formal and informal interview, but appointments including objectives were always set and informed in advance before the interview taking place. Pre-stakeholder consultation meeting, there were 5 groups of questions, apart from general introduction and discussion, for interview and discussion. Those are: 1) what is the state and problems on the deployment and diffusion of the technologies in forestry or agriculture sector? 2) What are the key barriers and factors that impede developing and sustaining the technologies? Any financial-economic, policy, capacity, technical barriers etc. and what are they? 3) Do the barriers really hinder or what are their effects? Would the technologies be fully and sustainably developed if such barriers are addressed? 4) What were/are the actions to cope with the problems or barriers? Were or are there financial-economic, policy, capacity, technical measures etc. and are they efficient and effective or what are the gaps? 5) Should we repeat or do differently to ensure effective or sustainable solutions and what should be done first, second and best practices to address the barriers? Post stakeholder meeting interview focused on clarification, obtaining more information and validation, while the 5 questions were also used to collect information from stakeholders who missed attending the consultation meeting.

Once the barriers compilation and synthesis completed, project team meetings were held, and the listed barriers were discussed, including validated and screened of irrelevant, invalid and insignificant barriers by voting in the meetings. The remaining barriers after the screening were then decomposed by classifying them into 8 main categories (financial and economic, market failure and imperfection, policy and regulation, organisational capacity and human skills, information and awareness, technical and other barriers) and then decomposed further into 3 subcategories to investigate barriers within the category, elements and dimensions with the use of a barrier decomposition matrix. In addition, logical problem tree was used to understand why the technologies are not effective deployed and develop and identify root causes.

There were 3 main stakeholder consultation meetings were organised to validate and reach consensus of the barriers analysis and results, while coordination, especially feedback and exchanges with technical working on climate change (Annex 1) on the barrier analysis was ongoing process. A three-

day technical stakeholder consultation workshop was held in May 2016 to seek for consensus, comments and in additional information to improve the identified barriers including the categorisation and decomposition, problems and solution trees. In the consultation workshop, the stakeholders (Annex 1) were introduced about the objective of TNA, especially BAEF approach and preliminary outcomes, by the project team, before having in-depth discussion on the development targets, identified barriers and measures of each technology. The discussion included focus group discussion, which the participants were divided into three groups: agriculture, forestry and agriculture-forestry bioenergy according to their expertise to: 1) revisit the project team's complied, decomposed of barriers and identified root causes, 2) brainstorm, revise and complete longlist of barriers, and 3) prioritise the key ones to be addressed and then 4) map out the problem and solution trees. The prioritisation of the barriers was performed by ranking or scoring by each group of the participants who were introduced about technique and rule before deciding ranking against the barriers. Three scales of ranking were applied to prioritise the barriers. Rank or score 1 meant insignificant or indirect barrier, 2 was moderate and prerequisite and 3 is most significant barrier. To do ranking, the participants were free to rank the barriers themselves based on their perception and expert judgement. However, few participants who have least knowledge and information about the technologies, barriers and were not confident to rank were voluntarily excluded.

One-day focus group consultation meeting was organised in March 2017 as a follow up BAEF in forestry sector, in particularly as there were several issues to be addressed, especially information gaps and discrepancy on the development and mitigation targets and some barriers to sustainable or effective protected area, community forest management, plantation and agroforestry development and management, perceived by different levels of management.

The third stakeholder consultation meeting was held in May 2017 for two days to only validate and agree on the barriers analysis and results, but also action plans to the mitigation technologies in both forestry and agriculture sector.

Finally, long-listed and prioritised barriers of climate change mitigation technologies in agriculture and forestry sector were finalized and presented in Annex 3 and 7. Key barriers decomposition are as in Annex 4 and 8 and problems and solutions trees in Annex 5 and 9. Furthermore, the most important barriers were discussed in detail in Chapter 3 and 4: barrier analysis and enabling framework for forestry and agriculture sector.

2.2 Identification of Measures and Enabling Framework for Technology Deployment and Diffusion

The measures to overcome the barriers in the forestry and agriculture sector were identified based on the barriers analysis, including the problem trees in Annex 5 and 9. Basically, the problems trees were converted into solutions trees. However, based on available information, there were some assessments of the measures impact, feasibility and practicality. In addition, the stakeholder consultation workshop in May 2016, following up meetings and final one in 2017 were important platform for justifying and approval of the measures.

Chapter 3: Barrier Analysis and Enabling Framework for Forestry Sector

3.1 Preliminary targets for technology transfer and diffusion

3.1.1 Overall development goals and targets of forest sector

The overarching development goals of natural resources and environment management are to ensure "natural resources and environment are effectively managed in green growth and sustainable directions, be ready for coping with disaster and climate change and impacts effectively" (MoNRE, 2015). Forestry sector was expected to contribute to 9% of the gross domestic production (GDP) by 2020 (MPI, 2015). Forest cover increases to 70% of total land area by 2020 by restoration of 6 million ha of potential forest establishing plantations of 500,000 ha on the unstocked forestland (MAF, 2005; MoNRE, 2015; MoNRE and IUCN, 2016; MPI, 2015). In addition, deploy 3.1 million ha of production forest under forest stewardship certificate (FSC) and forest law enforcement, governance and trade (FLEGT) scheme (MPI, 2015). In addition, it also aims at achieving specific targets of subsectors and technologies as follows.

3.1.2 Development goals and targets of protected area, village forest, plantation forests management and agroforestry

Preliminary targets for technology transfer and diffusion of the effective protected area management, sustainable village forest, plantation forests and agroforestry were defined in the forest law, national strategies and plans mentioned above, and subsectors strategies and plans on the four technologies. In addition, some targets were added, updated or adjusted during TNA processes, especially mitigation targets or objectives that are not clearly and inclusively defined in the strategies and plans. So, specific objectives and targets of them were elaborated as follows.

1. Protected area management

Protected area or conservation forests management (PAM or CFM), in principle, aims for conserving nature, biodiversity, ecosystems and other valuable natural, historical, cultural, tourism sites for sustainable use, educational and scientific research experiments (GOL, 2007). For enhancement of sustainability and mitigation, following developments are targeted.

1. Most of the protected areas (PAs) or conservation forests including resources, ecological functions, services and values are well-maintained and/or enhanced by 2025 and onward;
2. 70% of potential forests of about 1.3 million ha in the PAs are preserved, regrown and become primary forests by 2030;
3. At least 80% of total degraded forestland areas of 0.6 million ha in the PAs are restored by 2020 and totally by 2030;
4. Forest encroachment, deforestation and degradation are minimised to the extend it deserves or at least no worse than current situation by 2030;
5. 30% of the PAs deploys carbon credits and other payment of ecosystem service mechanisms by 2025 and 50% by 2030;

6. On average, at least 35% of financial needs of about USD 8.8 million are secured per year by 2025 and 50% by 2030.

2. Community forest management

The overall objective of community or village forest management is to ensure sustainable management of forest resources including non-timber forest products (NTFP) for livelihood improvement of villagers (MAF, 2005). In addition, for sustainability and enhancement of climate change mitigation, the following objectives or targets were set.

1. Financial resources to cover at least 30% of financial needs by 2025 and 45% by 2030;
2. 30% and entire NTFP harvesting areas/programmes in village forests employs a sustainable or an effective NTFP management and harvesting schemes by 2020 and 2030, respectively;
3. 20% to 50% of the village forest areas deployed sustainable forest management systems including deployment of FSC, FLEGT, carbon credits and other payment of ecosystem service mechanisms by 2015 and 2030;
4. Most of the village forest areas including resources, ecological functions, services and values are well-maintained and/or enhanced by 2025 and onward;
5. Most of the protection and conservation zones or 50% of village forests including its services and values are effectively managed and preserved by 2020 and become forests with carbon stock close to (about 70% of carbon stock) of origin forest by 2030;
6. and deforestation and forest degradation are minimal for the rest of the forest areas by 2030.

3. Plantation forests

The targets for the plantation development are to:

1. Pursue establish 500,000 ha of plantations by 2020 or about 100,000 ha increased from the current plantation of 400,000 ha;
2. Deploy 30% of the existing plantations to be operated under sustainable or optimal plantation as well as FSC, FLEGT and carbon credit schemes by 2020 and 65% by 2030;
3. Substantially increase timber and non-timber forest products from plantations, income and employment in the plantation sub-sector, while reduce pressure on natural forests from 2020 onwards.

4. Agroforestry

The target of agroforestry for sustainability and mitigation are:

1. Adopting agroforestry appropriately on 50% of former shifting cultivated areas by 2020 and 80% by 2030;
2. 50% of the existing and 80% of the new proposed agroforestry projects employ sustainable and optimal agroforestry and best practices;
3. Substantial increase of production, commercialisation of agroforestry products, income and employment from agroforestry;
4. Maintenance or enhancement of carbon sequestration in agroforestry systems including soil carbon and nutrients, and minimising negative impacts from agroforestry systems.

3.2 Barrier analysis and possible measures for enabling effective protected area management

3.2.1 General description of protected area management

Protected area or conservation forests management (PAM or CFM), in principle, aims at conservation of nature, biodiversity, ecosystems and other valuable natural, historical, cultural and tourism sites for sustainable use, educational and scientific research experiments (GOL, 2007). Effective PAM, especially securing forest areas and resources, preventing from deforestation and degradation of 4.4 million ha of existing conservation forest, restoration of potential forests (23% of total PAs, (MAF, 2012)) and degraded forestland, apart from the conservation, are also essential for climate change mitigation.

PAM, despite increased the government efforts, are not effective or optimised. PAs conversion, because of development projects, was approximately 57,000 ha and 67,000 ha per year. Those included loss in 3% of dense forest, 25% medium and 11.5% of low density forests (MAF, 2010). Some PAs lost 30-40,000 ha a year due to encroachment (Vientiane Time, 2016a, b). Ecosystem services, on the other hand, have not been fully and sustainably exploited so that revenues from this source is marginal. Revenues from ecotourism, for example, are attainable only few NBCAs such as Nam Ha and Nam Et-Phou Louey earned quite significant income and contributed to PAM and livelihood improvement (Schipani and Morris, 2002; Nam Et-Phou Louey NPA, 2017). Although carbon credit mechanisms including Reducing Emission from Deforestation and Forest Degradation (REDD) have been introduced in Laos since 2009 (MAF, 2011), but credit earning is unguaranteed or questionable (Vongvisouk et al., 2016).

PAM is classified as other non-market or publicly provided goods. Forest ecosystem services including ecotourism and carbon credits are, however, tradable in a certain market, which local communities and private sector are also key actors in the PAM and developments.

3.2.2 Identification of barriers for protected area management

The identification of the barriers to effective PAM follows barrier analysis process as discussed in Chapter 2. Barriers were firstly compiled, screened, decomposed and then analysed of problems and root causes, by literature review, key information interviews, information analysis and stakeholder consultations. As a result, a list comprising 32 barriers or problems was derived (Annex 3), and after screening and revising of the long-listed barriers, decomposition to investigate elements and dimensions of barriers (Annex 4) and problem analysis using logical problem tree (Annex 5); it found that there are some similar and related barriers which can be grouped and revised, while some were not underlying barriers. So, only 15 barriers were finally identified as important obstacles to PAs management and development. Of which, four of them, those scored 3, are very crucial ones which is difficult for CFD, DoF or MAF alone, for example, to overcome and prevent them from occur (Table 2). Those critical barriers are: 1) Inadequate financial resources and investment on PAM, 2) insufficient human resources, 3) tools, best practices and successful models for effective and sustainable PAM, and 4) deforestation, forest degradation, conversion and conflict of interest on land and resources uses, and they were divided into financial and economic and non-financial and economic as discussed in detail in subsection of 3.2.2.1 and 3.2.2.2.

TABLE 2 SUMMARY OF BARRIERS TO EFFECTIVE PROTECTED AREA MANAGEMENT

Broad categories of barriers	Barriers	Score
Economic and financial	1. Inadequate financial resources and investment on PAM	3
	2. Limited revenues from ecosystem services to reinvest in PAM	2
	3. Low return on investment (especially, district and village PAs)	2
	4. Insufficient financial and economic mechanism for effective and sustain financing PAM	2
Legal and regulatory framework	5. Inadequate policies on PAM including resources uses and ownership, sustainable settlement, public participation, development of livelihood and involvement of communities that reside within protected areas	2
Institutional and organisational capacity and human skills	6. Limited staff and technical skills on effective and sustainable protected area management	3
	7. Ineffective and inadequate professional training and learning	2
	8. Inadequate public participation in PAM	2
	9. Insufficient effective and sustainable best practices and successful models for all PAs	3
Information and awareness	10. Inadequate accurate and updated information on forest resources including ecosystem service, values and changes	2
Technical	11. Sustainable or effective PAM is long and costly process	1
	12. Protected area's main goals are for conservation and limited business activities, so it is hard to be financially self-reliant	1
	13. Multifaceted and multidisciplinary of effective or sustainable PAM and no single model fits all, while difficult and time consuming to define and develop and made available effective or sustainable models in time of need	2
Other	14. Deforestation, forest degradation, conversion and conflict of interest on land and resources use	3
	15. Geographical or physical difficulty to access to conduct forest resources inventory, demarcation, plan and develop of some areas	1

Remark: *Score 3 = crucial and urgent; 2 = important and needed; 1 = important but to be solved later*

3.3.2.1 Financial and economic barriers

1. Inadequate financial resources and investment in protected area management

PAM is underfinanced. Only eight NBCAs received major financial and technical support over the years, while other eight of them received intermittent or some support with the rest received little or no support (ICEM, 2003, MAF, 2011; Robichaud, 2014). In addition, it resulted in incompletion of: 1) forest resources inventory, zoning and assessment of biodiversity and its ecosystem service values, 2) strategy, site management and business plans, 3) on site staff and capacity building, 4) research and development (R&D), information and best practices, 5) demonstration and extension of the effective and successful PAM and 6) awareness raising and improvement of livelihood of local communities

residing in and around the PAs. Ultimately, socioeconomic and environmental benefit from PAs are not maximized, while several PAs are at risk of encroachment.

The financial shortage could be about USD 7.6 million per year, based on financial needs for PAM of USD 8.8 million per year[1] and actual budget allocation of about USD 1.2 million per year[2]. The financial shortage stemmed from public budget deficit while potential revenues from protected areas' ecosystem services and resources tax or fees have not been fully tapped and re-invested. Furthermore, financial support derived from resource mobilisation remained small.

Public budget for PAM was, for example during 1997, about US$ 0.01 per hectare (ha) (Paine et al, 1997). Recently, the average public sector's budget for PAM is only about US$ 0.15 million per year (MAF, 2016), or approximately US$ 0.06 per ha. This limited investment is mainly the result of national budget deficit. For example, the annual budget deficit between 2005 and 2010, on average, was about US$ 0.27 billion or 4.98% of GDP (MPI, 2011) and US$ 0.38 billion or 4.07% of GDP between 2010 and 2014 (MPI, 2015). The budget deficit was also forecasted to continue and government needs to mobilise additional fund of US$ 21.4 billion to implement the National Socioeconomic Development Plan (NSEDP) between 2016 and 2020 (Vientiane Times, 2016). In addition, it is due to incomprehensive plans and development priority, insufficient information and awareness of cost-benefits or low and taking long to gain return on investment, which made decision making on the public budget allocation for PAM variable, especially in the course of budget limitation. Hence, government budget allocation tends to favour sectors that generate more immediate and higher incomes rather than PAs.

Financial support from development partners and international organizations remained significant, but it is variable, although the disbursement rate was high (91.16% in 2012-2012 and 86.21% in 2012-2013 for natural resource and environment sector (MPI, 2013). Donors funding for PAM increased steadily since the establishment of the (20) national protected areas from 1993 to a peak in 2000. The funding, thereafter, sharply declined from US$36 million in the year 2000 to US$14 million in 2003, and so did the share of PAM of donor funds, which dropped from 89% or US$6 million to just 7% or about US$1 million (Emerton et al., 2006). This financing downturn could possibly result from variable resource mobilisation and allocation in the regional and global level, though commitments to support PAM of many countries remained strong (Emerton et al., 2006).

Financial commitments and support from the private sector is, in general, weak. Despite there is good initiative and example regarding private sector's contribution for sustainable developments, such practice has not been replicated, universally standardised and enforced in other development projects.

[1]This budget is about US$ 2/ha. The global mean budget for maintaining existing conservation forest ranged from US$ 0.5 to 2.5 per ha (Ervin and Gidda, 2012). Annual budget of forest division in Vientiane province was about US$ 16,000, while budget required for a basic activity of PAM, the boundary demarcation was US$ 86,000 (GFA & FoF, 2013). Financial needs for implementation of forestry, 2005 to 2020, US$ 180 million (MAF, 2005), and budget for priority PAM programme 2012-2020 under the biodiversity convention (CBD) was US$ 13.5 million (Lao PDR, 2012).

[2]This based on 1) budget for PAM in 1997 was about US$ 1 per sq. km (Paine et al, 1997), 2) annual public budget allocation for PAM was US$ 0.375 in 2006 (Moore et al., 2011) and US$ 0.15 million per year for 2016 (MAF, 2016), and 3) estimated financial support from development partners, international organisations and the private sector was less than US$ 1 million a year, on average.

Nam Thuen 2 hydropower project, for example, apart from financing social and environmental activities of the affected people and areas, contributes additional US$ 1 million per year for poverty reduction and developments elsewhere in Laos. On the other hand, some hydropower, mining, infrastructure and agriculture development projects, apart from limited contribution, have not implemented environmental mitigation measures including forest offset and compensation effectively, especially paying US$ 800 per ha of PA converted, contributing US$ 2/ha in additional for conservation of PAs in the watershed area and to allocate 1% of their annual income for PAM as required by the Decree on Conservation Forest (GoL, 2015).

Revenues from ecosystem services and reinvest in PAM are remained limited since its potential has not been fully exploited and law enforcement is ineffective. It was estimated that revenues from ecotourism that directly paid for PAM might be only US$ 30,000-75,000 per year[3] for the last 15 years, while potential revenues from tourists for PAM could be double or triple if it is substantially and effectively promoted and marketed (Annex 5). Business that makes use of PAs including ecotourism did not contribute 1% of its total revenue for PAM as required by the Decree on Conservation Forest (2015).

Revenues from non-timber forest product (NTFP) are quite substantial, but reinvestment for PAM is marginal. It was estimated that total annual NTFP cash income was about US$ 128 million (NAFRI, NUoL, SNV, 2007), which US$ 11 million a year[4] worth of NTFP was collected at the buffer zones of PAs. Although, the revenues from NTFP and reinvestment in PAM are not quantifiable, it could be limited since it lacks mechanism and ineffectiveness of collecting resources fee or tax.

Earning from REDD is not yet realised, and has been placed on hold (Vongvisouk et al., 2016). More than 10 REDD projects have been implemented in Laos since 2009 (MAF, 2011), but the majority of the inventions are at early stage, where strategy, reference emissions level (REL), monitoring, measurement, reporting and verification (MRV) are being developed. Earning from this source, however, largely depends on the international carbon market, which is subject to variables.

Resource mobilisation, especially access to additional funds other than existing ones remained sparse, due to non-government organisation (NGOs) and non-profit organisation (NPO) only recently emerged in Laos. Total fund secured by NGO and NPO in 2011-2012 was US$ 23,041,023, and accounted for only 5% of overseas development assistance (ODA) (MPI, 2012), but undefinable or small fund was secured for natural resource management including PAM. Secondly, it is because of Conservation Forest Division (CFD), Department of Forestry (DoF) of the Ministry of Agriculture and Forestry (MAF) and the majority of stakeholders have not had resources mobilization strategy and plan, information on sources of funds, capacity to develop financeable proposals to exploit available funding opportunities.

[3]There was no systematic record of tourists and incomes to protected areas. It was estimated that number of tourists was about 15,000 per year (about 6% of total annual tourist) and paid US$ 2-5 for protected areas on average. Tourist arrivals were 737,208 in the year 2000 (CPC, 2001) and 4,158,719 in 2014 (http://www.lsb.gov.la/statistic2014.php) or increased 0.25 million tourists per year. Nam Ha NBCA which is recognised as the top ecotourism destination received about 2,000 tourists, US$ 34,000 in total and US$3,000 for PAM during 2000 and 2002 (Schipani and Morris, 2002), and there is not increase much or fluctuated. Number of tourists visited other protected areas are limited.

[4]It was estimated that earnings from NTPF such as bamboo, cardamom, rattan, resins, herbs and vegetables etc. in the buffer zones, approx. 10% of total area or 440,000 ha at US$ 25 per ha/yr., on average

3.3.2.2 Non-financial and economic barriers

1. Inadequate technical skills and understaffed for protected area management

Inadequate technical skills

Technical skills of staff, for example, the Conservation Forest Divisions (CFD), Department of Forestry (DoF), Ministry of Agriculture and Forestry (MAF) and key stakeholders[5] deems insufficient for ensure PAM effectiveness and sustainability. The main knowledge and skills gaps, apart from overall management, are economics, social and climate change aspects of PAM as outlined in the Table 3 below. Consequently, it left policy, plans and management tools and information incomplete and not able to secure adequate financial resources and protect PAs from encroachment.

TABLE 3 KEY KNOWLEDGE AND SKILLS GAPS ON EFFECTIVE PROTECTED AREA MANAGEMENT

Main skills categories	Elements of skills gaps
Overall knowledge and skills on effective and sustainable PAM	Insufficient skills to adopt, develop and apply effective or sustainable PAM including indicator and criteria, code of conduct and standard operation procedures, best practices
Financial and Economic	Insufficient skills to research, develop (R&D) and apply: 1. Financial and environmental economic tools and models to assess: 1) ecosystem service, resources values and potential revenues, 2) financial needs, cost-benefit and return on investment in PAM and 3) develop sustainable financing models including subsidizing, payment for ecosystem services (PES) and taxation 2. Best practices to promote natural resource enterprise and marketing including ecotourism and benefits sharing schemes 3. Resource mobilization techniques to: 1) analyse financial sources and feasibility of funding and access, 2) develop financeable proposals, 3) engage and cooperate with donors, and 4) develop effective and transparent aids management system
Social and governance	Insufficient skills to R&D and apply: 1. Best practices of different forest governance and stewardship models and mechanisms for effective and sustainable PAM; 2. Best practices and measures to address violation of laws including wood and wildlife trafficking, encroachment and conservation of protected areas (PAs);

[5] Faculty of Forestry (FoF), Faculty of Environmental Science (FoES), Faculty of Economics and Business (FoEB) of NUOL; National Agriculture and Forestry Research Institute (NAFRI), Department of Forest Inventory and Planning (DFIP), MAF; DDMCC, EPF, Depart of Land, Environment Promotion of MoNRE; Economic Research Institute (ERI) and MPI

	3. Best models or circumstances to promote people and nature harmony, social-culture and traditional knowledge for PAM and address poverty and environmental nexus 4. Best practices for conflict management
Climate change and ecological sustainability	Insufficient skills to R&D and apply tools, techniques and standard operation procedures for: 1. Forest and soil carbon inventory, accounting and monitoring system and markets 2. Sustainable natural resource use/harvest and carrying capacity 3. Effective forest offset 4. Effective ecosystem and forest resources restoration
Cross-cutting	Insufficient skills on: 1. Organisational and HR development and effectiveness, and leadership for sustainable and effective PAM 2. Integrated resources planning and development including integrated watershed management, rural, land use and spatial planning 3. Natural resources conflict management 4. Insufficient PAM extension skills

The knowledge and skills gaps are mainly resulted from ineffective human resources development (HRD) system, including ineffective professional education and on the job training. PAM study at higher education provided by the Faculty of Forestry (FoF) and Environment Science (FoES), National University of Laos (NUoL), for instance, are not in-depth, and inclusive. PAM specialisation study and practice hours are shorted and not enriched with practical experiences and best practices. In addition, it does not provide adequate social and economic skills for sustainable PAM. On the other hand, Faculty of Economics and Business (FoEB), NUOL lacks study and research on environmental economics and enterprises. These caused by insufficient investment, teaching and research materials and facilities, quantity and quality teachers and researchers, and management of human resource (Siharath, no date; Simmalavong, 2014). In addition, it is because of ineffective coordination among higher education institutes and with demand side.

Professional training is rather limited and ineffective. Practical training on sustainable or effective PAM for Forest Conservation Divisions (FCD), for example, were not more than 3 times a year in last five years, on average and variable in term of training topic and trainees. Majority of the PAM trainings were supported by international organisations, but lack of continuity. More intensive on protected area and wildlife management, which is being carried out by FoF, NUOL, under the World Bank (WB) and Environmental Protection Fund (EPF). It is 2 weeks-training and expected to cover all 18 provinces, between February and December 2016. This training is, however, somehow generic and focuses on mainly planning process and ecological aspects rather than economic and social aspects of PAM. In addition, it lacks training on how to apply best practices to cope with current problems faced by PAM such as forest resources encroachment, conversion, forest impacts and offset related with development projects, low tourism products and marketing, sustainable NTFP, sustainable re/settlement, livelihood improvement and economical and business models. On the other hand, in-house and on the job training was seldom and

The staff skills gaps are also results from ineffective and insufficient HR and capacity development plan, staff knowledge management, which CFD and majority of stakeholders, especially public sector have not had comprehensive ones. Leadership, especially initiative, motivation and influence on in-house training and self-learning, while crucial, especially in the event of budget shortage, are limited. In addition, learning culture is not yet imbedded in organisations.

Understaffed

Staff, particularly field and extension staff are inadequate. There are totally 344 staff working in or related with conservation forest management throughout the country. Those included 124 staff in the department of forestry, 180 staff in the conservation forest office in the capital, provincial and district offices, while there were only 40 staff based in some NBCAs (MoNRE, 2016). Based on these numbers, the ratio of staff per area of conservation is one per 13,000 ha which, in overall, deems about sufficient although it is lower than global average number of staff per conservation area. Meanwhile, when considers only field-based staff, the ratio is one staff per 110,000 ha; which mean that there is only small number of staff overseeing the large area of the conservation forest at local levels and on site. In comparison to the management practice globally, on average, there were 27 staff per 100,000 ha or one person per 3,700 ha of conservation forest (WCMC, 1999).

Failure to secure adequate staff is mainly resulted from financial and economic factor. MAF, especially CFD, DoF planned in last 5 years to recruit and or assign about 20-30 staff and volunteers per year to base on sites and do extension works, but there is not enough quota, budget for salary and implementation of activities including site developments, facilities and incentives to do so. On the other hand, it is because of low commitment and responsibility, ineffective law enforcement, organisational development and leadership.

2. Inadequate techniques, best practices and successful models for protected area management

Techniques, best practices and successful project of all aspects including financial, economic, legal, organisational to be a guide and reference project or practice for effective and sustainable PAM are insufficient. Furthermore, PAM effectiveness framework including criteria and indicator (C&I) and operation procedure has not been adopted and localised for Laos' context.

The absence of these best practice guidelines primarily resulted from insufficient research including capacity, especially skills, tools and budget to carry out systematic review of effectiveness of existing guideline and PAM, and research on the mentioned elements and aspects. Annual budget for research on PAM is possibly US$ 0.3 million shortage or 1.4 million to complete necessary guidelines in the Table. The budget shortage is mainly in the area of 1) R&D on the best practices on overall and specific aspects of PAM, 2) review of existing and formulating best practice guidelines, 3) capacity buildings and trainings, 4) workshop and dissemination at national and local levels.

3.2.3 Identified measures

Based on the development targets described in the section 3.1, key barriers in the section 3.3.2 and solutions tree in Annex 3, and the actions identified in the action plan for PAM (Annex 4); measures to

fully deploy effective or sustainable conservation forest management were elaborated and summarised as follows.

3.3.3.1 Financial and economic measures

1. Secure financial resources and investment on effective protected area management

Securing financial resources and investment is exceptionally needed in order to address financial shortage and ensure effectiveness of conservation forest management. The financial investment management to be improved comprise: (1) enhancing access to financial supports and resources mobilisation, (2) maximising revenues from and reinvest to protected areas and (3) increase effectiveness and efficiency of financial resources allocation and management.

To enhance access to financial supports or resources mobilisation; financial and investment need assessment, financing and subsidizing models and mechanism, analysis of return on investment on protected area, sources of funds, resource mobilisation plan and financeable proposal, financing and subsidizing models and mechanism including taxation and subsidising for effective or sustainable conservation forest management will be researched and developed. Forest resources and ecosystem service inventory, valuation, strategy, site and business management plans and business plans will be conducted and developed to provide information and strategies to sustainably exploit and increase revenues from and to conservation forests. In addition, law enforcement, especially collection of fee, contribution and compensation on protected offset will be strengthened.

Once financial support and investment are secured; apart from normal project and programme M&E, an effective financial resource management system will be improved to increase effectiveness of financial aids and public investment management. This includes: (1) improvement of public investment budget allocation model, procedures and criteria, (2) financial support and investment record, tracking and reporting system, and (3) dialogue or platform for reflecting and planning to improve financial management effectiveness. Capacity building is, in the meantime, needed to enable implementation of the financing and investment management measures. More details on planning, capacity and law enforcement etc. were discussed in the non-financial measures section below.

3.3.3.2 Non-financial and economic measures

1. Enhance capacity on sustainable conservation forest management

Improvement of capacity of stakeholder is strategic measure to address barriers and enhance optimization of the conservation forest management. The capacity to be improved is on both quality and quantity. Qualitatively, the skills on policy, planning and management, and other economic, social and conservation aspects of conservation forest management as follows are needed.

1) Policy for sustainable financing
2) Policy for exploitation of forest resources, service and biodiversity
3) Policy for promotion of good performance and enforcement for law violation practices
4) Strategic, site, enterprise and resource mobilisation planning

5) Procedures for sustainable or effective management practices
6) Financing mechanism and models, cost and benefit analysis including return on investment
7) Valuation of ecosystem service
8) Ecosystem service payment mechanism or models
9) Harmonisation of people and conservation forestland
10) Integrated development planning
11) Biodiversity and ecosystem or habitat restoration
12) Forest restoration including forest and soil carbon restoration

Quantitatively, at least, on minimum average, a team of 3 professional staff of national and local levels are assigned to in charge of each protected area directly or indirectly to facilitate development and management activities at site level. About 110 volunteers are secured and trained to assist field activities. In addition, it requires staff delegation system in place to facilitate support form national levels on site management, resource mobilisation and improvement of performance.

Realising these requires 1) systematic and comprehensive sector and technologies review, 2) effective human resource development system including human resource development plan, staffing and staff knowledge management, and 3) quality educational and research curriculum including materials and facilities.

2. Research, develop and apply best practices, technique and successful PAM models

Develop a reference project, guidelines and best practice that provides a benchmark, examples and lessons is fundamental for upscaling and expansion of effective or sustainable conservation forest management, including mitigation. The reference project and best practice shall focus on similar areas required for capacity and skills building mentioned above while guidelines shall focus on how to sustain protected areas and standard procedures to be taken. The reference project, guidelines and best practice would build from review of conservation forest management performance, success and failure related with specific measures and approaches employed for enhancing management such as payment on ecosystem service, REDD+, nature-based or ecotourism, village and livelihood-based natural conservation, protected areas offset and integrated and participatory planning etc. In addition; research, learning exchange and adoption of best practices available in regions that possibly applicable for Laos is needed. Importantly, the best practice is clearly defined and capacity of MAF, MoNRE and relevant faculties of university of Laos are strengthened to carry out research and development of the model projects and best practices.

3.3 Barrier analysis and possible measures for enabling sustainable community forest management

3.3.1 General description of sustainable community forest management

Sustainable community or village forest management (SCFM or SVFM), in overall, is a management mechanism in which village play a prominent role in managing forest resource for biodiversity conservation and securing their livelihood. It has great climate change mitigation potential, especially reducing encroachment, conversion while enhancing restoration and prevention of forest degradation. Reducing deforestation, and enhancing forest protection and restoration by smallholders, for example, could possibly reduce emissions from 15,000 to 120,000 tCO_2 annually (MAF, 2010),

SCFM have been implemented in Laos for decades. The outstanding interventions were between 1994 and 2010, when Laos received strong technical and financial support from development partners (Braeutigam, 2003; Manivong and Sophathilath, 2007). Those initiatives have provided foundations and lessons for the SCFM in Laos, although some targeted villages of some programmes had not accomplished and unable to effectively implemented forest management plans (MAF, 2005).

Land allocation had been accomplished in 6,830 villages and each village, on average, has village forest area of about 1,200 ha (MAF, 2005). In addition, 1 million ha of degraded forests excluding from production, protection and preservation forest's boundary could be allocated as village forests (MAF, 2010). These village forests are; however, underdeveloped and its socioeconomic and environmental benefits have not been either fully exploited or maximized. Most of them have not been completely surveyed, assessed its economic and environmental protection potentials and values. Site management plans are not in place. Critically, some of the village forests are currently overexploited, and majority are degraded and at risk of conversion for other development purposes.

Sustainable community forestry management (SCFM) is non-market or publicly provided goods. Village forest resources and ecosystem services including NTFP, ecotourism and carbon credits are, however, tradable in a certain market. So, local communities and private sector also have prominent roles in the developments.

3.3.2 Identification of barriers to sustainable community forest management

As described in Chapter 2, barriers that restrict developing and sustaining community forests were identified following the barrier analysis process and techniques which include barriers identification, screening, decomposition and problem analysed with the use of logical problem tree. Through the process, barriers were long-listed (Annex 3). Fifteen important barriers were identified (Table 4) following the screening of the longlisted barriers, decomposition (Annex 4) and problem tree analysis (Annex 5). Among those, six of them are essential ones which gained score 3 (Table 4). They include 1 financial and economic barrier: and non-financial and economic barriers as discussed in subsection 3.3.2.1 and 3.2.2.2.

TABLE 4 SUMMARY OF THE BARRIERS TO SUSTAINABLE COMMUNITY FORESTRY MANAGEMENT

Broad categories of barriers	Barriers	Score
Economic and financial barrier	1. Inadequate financial resources and investment from the public, private and development partners on SVFM	3
	2. Low revenues e.g., from ecosystem services including NTFP, ecotourism and carbon trade, and re-investment in SVFM	2
	3. Low return on investment in SVFM	2
	4. Insufficient financial mechanisms for financing SVFM	2
Legal and regulatory framework	5. Inappropriate and or conflicting legislation, especially definition of village forest	2
Institutional and organisational capacity and human skills	6. Understaffed (skilful extension and field staff)	3
	7. Limited technical skills on SVFM including legal, organisational, financial, social, economic, mitigation and extension skills	3
	8. Ineffective and inadequate professional training and learning course on SVFM	2
	9. Insufficient techniques, best practices and successful models for SVFM	3
	10. Overtask or multitask at community/villages level	2
Information and awareness	11. Inadequate accurate and updated information on forest resources and SVFM best practices	2
Technical	12. Multifaceted, multidisciplinary SVFM and no single SVFM model fits all, while difficult and time consuming to define and develop and made available effective or sustainable models on SVFM in time of need	2
	13. Sustainable or effective SVFM is long and costly process	1
Other	14. Encroachment and degradation of village forest	3
	15. Overlapping and conflict of interest on land and resource uses	2

Remark: *Score 3 = crucial and urgent; 2 = important and needed; 1 = important but to be solved later*

3.2.2.1 Financial and economic barriers

1. Inadequate budget and financial investment in VFM

Village forests is underfinanced. The financial shortage could be about US$ 7 to 15.2 million per year, based on available annual budget of about US$ 1.2 million per year[6], and financial needs of US$ 8.2 to

[6]This based on interview an expert judgement, mean annual public investment in VFM in last 10 years was about US$ 5,000-10,000 per province or US$ 90,000-180,000 through the country and financial support from donors was about US$ 1 million.

16.4 million[7] in order to maintain basic and more inclusive management, including restoration of potential forests, degraded lands, and improvement of local people livelihood.

Inadequate budget for VFM is due to (1) shortage of the public budget and investment, (2) decrease of financial support from development partners and international organisations, (3) limited and variable contributions from private sector, (4) small revenues from ecosystem service and reinvestment for VFM, and (5) little fund obtained from resource mobilisation. The public investment in the VFM, on average, is US$ 0.14 million[8] per year. This shortage public investment is mainly because of small national revenues, ineffective budgeting and public budget deficit. On the other hand, VFM was deemed lower investment priority compares to economic and infrastructure sector. In addition, there is no comprehensive plan and attractive project proposal or low cost-benefits and return on investment in village forests for justification on investment. These also affected decision on the budget allocation, leading undermining investment in VFM.

Financial support on SVFM was largely derived from development partners and international organisations. Their support is, however, intermittent and fluctuated. As presented in the Table 6, the financial support from the development partners declined since 2004. Despite accurate information is not available, direct financial aids to VFM from this source in last 5 years may be less than US$ 0.10 million per year, on average.

Financial commitment and contribution from private sector is undeniable or scanty. Even some forest offset programmes due to the development projects' impacts and compensation were underfinanced. on the other hand, the government has not had effective policy and mechanism to enforce and/or promote private sector to contribute to VFM.

Revenues from ecosystem service such as ecotourism, NTFP and carbon credits and reinvestment in VFM is relatively small and uncertain. Ecotourism may generate less than US$ 15,000 per year[9] in last ten years. Although number of tourist increased steadily, the majority were mass tourists. In the meantime, natural or ecotourists were mainly visiting NBCAs rather than village forest areas which are degraded and low ecotourism attractions. Importantly, ecotourism marketing was not intensive and ineffective.

NTFP enterprise has potential for reinvestment in SVFM, but the potential has not fully exploited, NTFP has not been sustainably managed and reinvestment for conservation. Total annual NTFP cash income collected from village forests was estimated to be about US$ 25 million a year[10]. Increase

[7] Village forest areas is about 8.2 million ha, US$ 1 to 2 per ha is required or approximately US$ 1,200 to 2,400 per village for basic and more inclusive management, respectively.

[8]This based on interview of VFD and forest sector at provincial level, where annual public investment in VFM is approximately US$ 5,000-10,000 per province, on average or US$ 90,000-180,000 through the country.

[9]The data derived from expert judgement. It was estimated that, on average, 5,000 tourists or 2% of annual total tourists per year and they generated 3$/person for VFM.

[10]The data derived from expert judgement. It was estimate that only 1 million ha of village forests are used for NTFP collection and average income from NTPF such as bamboo, cardamom, rattan, resins, herbs and vegetables etc. was about US$ 25 per ha/year. So, total income generation would be 25 million/yr. This amount of income was about 20% compare to estimate total potential income from NTFP of US$ 128,086,797 made by NAFRI et al., (2007).

income from NTFP is hard since several of village forests are degraded forests and areas of the forest reduced due to conversion. The proportion of NTFP collection and enterprise deploy sustainable practices are unknown or possibly be less than 15% of the village forest areas. In addition, capacity to promote and deploy sustainable NTFP management including harvesting and enterprise are limited.

Carbon credits, especially from reduction emissions from deforestation and degradation (REDD) has not been fruitful. There are more than 10 REDD inventions in Laos since 2009 (MAF, 2011), but earning from emissions reduction scheme has not been realised. The policy, reference emissions level (REL), monitoring, measurement, reporting and verification (MRV) has not been ready, whereas carbon markets are not guaranteed.

Resource mobilisation, especially accessing and acquiring additional financial support from other sources, other than the normal financial support from public, private and existing donors is limited. Total fund secured by non-governmental organisations (NGOs) and non-profit organisations (NPOs) in 2011-2012, was US$ 23,041,023, accounted for only 5% of oversees development assistance (ODA) (MPI, 2012), and none of fund was for SVFM. So far, resources mobilization strategy and plans, are not in place, financial sources information, knowledge and skills to assess and develop financeable proposals are insufficient.

3.2.2.2 Non-financial and economic barriers

1. Limited capacity to pursue SVFM

Capacity of Village Forest Division (VFD) and Department of Forestry (DoF), Ministry of Agriculture and Forestry (MAF) and another key stakeholder[11] on SVFM is apparently limited. The knowledge and skills gaps can be summarised in the Table 8. Because of the knowledge and skills shortage, SVFM strategy and plans, information, management mechanisms, policy and financial are not be able developed.

Quantitatively, number of staff, especially skilful and strong commitment extension staff at district and village level is limited. At the village level, even though each village has its village forest committee to oversee village forest development and management, their technical capacity on SVFM is scanty.

TABLE 5 KEY KNOWLEDGE AND SKILLS GAPS ON SUSTAINABLE VILLAGE FOREST MANAGEMENT (SVFM)

Main skills categories	Knowledge and skills gaps
General skills for SCFM	Insufficient skills to develop and apply SCFM including indicator and criteria, code of conduct and standard operation procedures, best practices
Financial and economics	Insufficient skills to define and apply tools for assessment of: 1) financial needs, 2) natural resources and environmental economic valuation, 3) cost-benefit and return on

[11]Faculty of Forest (FoF) and Faculty of Environment (FoE) of the National University of Laos (NOUL); National Agriculture and Forestry Research Institute (NAFRI) and National Agriculture and Forestry Extension Service Department (NAFES) of MAF; DDMCC and Environmental Research Institute (ERI) of MoNRE; and Rural Development and Poverty Reduction Committee (RDPRC).

Main skills categories	Knowledge and skills gaps
	investment, and development of 4) environmental taxation, 5) benefits sharing schemes/models, 6) effective and best practices on SCFM financing models, including subsidising
Natural resources, especially NTFP enterprise and commercialisation including marketing	Insufficient skills to promote natural resources, especially NTFP, ecotourism and carbon enterprise and commercialisation including R&D of: 1) sustainable business planning and management models, 2) markets analysis and marketing, 3) standardisation and certification of products and sources, 4) product development and diversification, 5) access to finance and 6) incentives and
Resource mobilization	Insufficient skills to: 1) identify and analyse financial sources and feasibility of access, 2) develop financeable proposal, including analysis of financial and economic, cost-benefit and return on investment, 3) prepare engagement plan with potential donors, and 4) develop financial aids registry or database and 5) financial fi aids management
Social	Insufficient skills to: 1) Assess, develop and apply best practices and models on community-based resource management, sustainable community organisation and participation in SCFM; 2) Analyse and identify best ways or circumstances where people can live in forest conservation harmony ways, and (2) analyse and promote best practices on the use of social-culture and traditional knowledge to protect and benefit from conservation in sustainable or balance manner; 3) Assess, develop and apply best practices, including integrated socioeconomic and rural development models to address forest conservation and poverty nexus
Ecological, natural resource and environmental managing techniques	Insufficient skills to: 1) Develop and apply SCFM including best practice guidelines for practitioners and replication; 2) Promote including demonstration and facilitation of sustainable forest resources including sustainable NTFPs harvesting schemes, payment for ecosystem service (PES), carbon credits, REDD, NAMA including skills to apply tools for forest and soil carbon assessment and monitoring, reporting and verification (MRV); 3) Inspect and certify phyto-hygiene/plant sanitation of NTPF products for export; 4) Apply biotechnologies for NTFP domestication and product development.
Management	Insufficient skills on: 1) Law enforcement including to assess, develop and apply best practices and measures to address violation of laws as well as wood and wildlife trafficking, encroachment and conversion of village forests; 2) Natural resources conflict management.

These staff's skills gaps are fundamentally resulted from inadequate and ineffective human resource development (HRD) system, especially high professional education and staff capacity enhancement. Study on village forest at higher education in Laos, particularly at the Faculty of Forestry is, in general, not practical, causing by insufficient investment, teaching and research materials and facilities, quantity and quality teachers and researchers, and management of human resource demand and supply (Siharath, no year; Simmalavong, 2014). Sustainable and best practices, for example, have not been included in the curriculum.

Professional training including on the job train and orientations for newly recruited staff was seldom and not standardised. Training on VFM is only few times a year[12] and it lacked continuity and consistency of both training topics and trainees. Internal on the job-train and organisational learning culture is not well-established. In addition, practical and standard SVFM training models and modules are unavailable. Moreover, HR and capacity development plan, including capacity needs assessment, staff knowledge management system, capacity building models and M&E are inexistent or incomprehensive.

Financial shortage is another constraint for skills development. The budget for training was at least about US$ 0.1 million per year shortage so that there is no sufficient budget for improvement of curriculum and training models on SVFM, HRD and capacity development plans, staff information and knowledge, training for village forest sector in national and local levels, capacity building M&E system promote local capacity builder and capacity exchange platform.

2. Insufficient best practices, techniques and successful project for reference of SVFM extension and development

Best practices, techniques and successful for guidance and reference are shortage. Assessment and define to what extent and how effective and sustainable existing community forest programmes is are not conducted. So, this underlies VFM effectiveness and sustainability.

The lack of SVFM best practice guidelines were primarily resulted from inadequate capacity, particularly R&D skills as outlined in Table 9 and budget as discussed earlier. Financially, although the financial needs and actual available budget have not been defined, the budget shortfall could be about US$ 0.1 million per year for best practices and techniques improvement and US$ 5 million for start-up of a references projects.

Apart from financial and human resources, developing and defining effective and sustainable best practices and techniques are difficult as SVFM is complex and there is no single approach and model works for all. In addition, best practices may change overtime and may not be able define or have it in place in the time of need.

3.3.3 Identified measures

3.2.3.1 Financial and economic measures

1. Securing sufficient financial investment for SVFM

Securing adequate financial resources and sustainable financial investment management is a primary goal. It is believed that, with sufficient financial resources, for example US$ 2-4 million per year or 20 million until 2030; majority of SVFM components and village would be also well-progressed, forest areas would be well-preserved, and generate substantial benefits for locals, or otherwise. Importantly, this investment is perceived financially and economically viable or justifiable; especially in the course

[12]there is no systematic record, monitoring and report on the training, and the number was derived from expert judgement

of ecosystem service markets are well-functioned. In this case, village forests may generate cash income for approximately US$ 21 million per year (Annex 6).

To sustain financial resources for SVFM, it needs to: 1) increase budgets for village forests and 2) effectiveness financial management. Increase budget for SVFM can be addressed by (1) maximising revenues from ecosystem service of village forests, (2) public investment and (3) access to financial supports or mobilisation of resources from all potential donors and sources. To fulfil these, following set of activities and capacity shall be conducted and enhanced.

1) Assessment of financial and investment needs for SVFM,
2) Forest resources inventory and assessment of ecosystem service values,
3) Analysis of financial and economic return on investment or cost and benefits of individual or combined village forest sites, including its ecosystem services and products,
4) Development of business plans to maximise revenues from village forest ecosystem service,
5) Development of village forest financing and subsidizing models and mechanism including environmental and forest taxation,
6) Identification and analysis of financial sources,
7) Development of resource mobilization plans, and
8) Preparation of financeable project proposals to attract public, private investment, international supports, and access to other financial sources for village forest ecosystem services entrepreneurship.

While financial resources are securing, an effective financial management system or mechanism shall be established to ensure financial resources is manage effectively and transparently. So, apart from normal project and programme monitoring and evaluation (M&E); financial aids and investment management systems including financial database- recording, tracking, reviewing and reporting system will be developed among the Ministry of Agriculture and Forestry (MAF), Planning and Investment (MPI) and Finance (MoF).

Implementations of these financial and support measures, while they are possible, require substantial financial and technical assistance from international organisations and development partners. The financial support, apart from direct funding and mobilisation of resource for SVFM, includes capacity building for socioeconomic analyse, develop sustainable financing models and access to funds for village forests. In addition, it requires technical support on the development of sustainable ecosystem services enterprise and access to markets including carbon credits.

3.2.3.2 Non-financial and economic measures

1. Strengthen technical skills on SVFM

Strengthening capacity on SFVM is exceptionally needed. Capacity, particularly knowledge and skills on both specialisation and cross-cutting area are required for all key stakeholders such as the Village Forest Division (VFD) of the Forest Department (DoF), National Agriculture and Forestry Institute (NAFRI), Environmental and Natural Resources Research Institute (ENRRI), Faculty of Forestry (FoF) and Environment Science (FoES) of the National University of Lao (NUoL), Forestry and

Environmental Protection Fund (FF, EPE), Committee for Rural Development (CRD) and Department of Disaster Management and Climate Change (DDMCC). Key knowledge and skills to be improved are as those in the Table 8.

In addition, an effective human resources development system including a human resources development plan, staff performance M&E and demand-supply management mechanism will be developed to ensure effectiveness, efficiency, consistency and continuity of the human resource and skills development.

2. Improve village forest legislation and enforcement

Both improvement and enhancement of laws and regulations are needed for SVFM. The laws and regulations to be amended and developed include 1) specific decree or regulation on village forest, particularly a complete and clear village forest definition, objectives, principles, procedure and measure for planning and management including organisation arrangements in the regulation and promotion of SVFM, 2) amendment of SVFM definition, principles and so as forest law, and 3) other subordinate legislations (Table 5) to provide, apart from above, measures and promotion of all dimensions of SVFM.

Ensure effectiveness of law enforcement is critical for SVFM. Enforcement to be enhanced is in the area of forest conversion and offset, promotion of best village forest management performance and punishment of law violations. To achieve this, a comprehensive law enforcement review, research and development on best practices will be conducted to make available best practice guidelines on implementation of punishment, fine and other financial and economic measures.

3. Develop best practices and reference project

The best practice guidelines and reference project, especially ones that suggest the most effective and best methods and ways to develop and expand SVFM in sustainable manner. However, best practices and reference projects are diverse but it is important the best practices and reference projects are relevant with the capacity needs (Table 8). Since several VFM projects had been piloted in Laos and regions; best practices and reference projects will be commenced by review and case study of previous project experiences in term of success and failure of the interventions. Furthermore, it is needed to study and expose to successful projects in neighbouring countries and elsewhere in order to consolidate, define and introduce the most suitable ones for Laos and local context.

3.4 Barrier analysis and possible measures for enabling optimal plantation forest

3.4.1 General description of optimal plantation forest

The plantation forest, in principle, is promoted to establish on the degraded forest and barren forestland, for wood supply, forest conservation and restoration. The forest plantation for wood and non-wood supply must be taken place in the production forest land while the forest plantation for conservation shall be established in the conservation and protection forests to enhance protection functions, ecosystems and values of the forest (GoL, 2007). This means there is great potential for carbon storage and sequestration because of the plantation establishment.

Plantation forest area increased sharply in last decades. The area was less than 5,000 ha in 1975, but went up to 200,000 in 2007 (Phimmavong, Ozarska, Midgley and Keenan, 2009), and then 400,000 ha (MPI, 2015). Despite great potential carbon sequestration, it largely depends on actual implementation since some development of plantation may cause carbon leak or conversion of natural forest (Vandergeest, 2003; Baird and Shoemaker, 2007; Barney, 2008) instead of sequestration.

Sustainable commercial plantation forests are market goods while plantations for conservation are considered as non-market or public provided goods. As for commercial plantation, although private sector and entrepreneurs including local communities are the key actors and wood or non-wood products from plantation are tradable in mass market; public sector still have critical roles on the promotion/extension, particularly sustainable plantation management techniques. Plantation for conservation is largely dependent on public investment.

3.4.2 Identification of barriers for promotion of optimal forest plantation

The identification of barriers to sustainable plantation were carried out based on the barrier analysis process discussed in Chapter 2. Results showed that, although there are number of barriers (Annex 3), there are only seventeen important barriers. Seven of them are critical obstacles, which received highest score, score 3 (Table 6). Elements, dimension and root causes of key barriers were also outlined in Annex 4 and 5, respectively. In addition, those key barriers were divided into financial and economic barriers and non-financial and economic barriers, and disused in detail in 3.4.2.1 and 3.4.2.2.

TABLE 6 SUMMARY OF BARRIERS TO SUSTAINABLE PLANTATION DEVELOPMENT AND MANAGEMENT

Broad categories of barriers	Barriers	Score
Economic and financial	1. Low profit and not financial and economic feasible (some plantations)	2
	2. High investment cost on sustainable plantation practices	3
	3. Limited access to finance	3
	4. Inadequate public financial support for promotion/extension	3
Market failures and imperfection	5. Small and variable domestic wood and non-wood product markets and prices/Higher demand and preferable to wood from natural forests	3
	6. Insufficient market information	2
	7. Variable supply of products to market	3
	8. Limited access to external market due to variable product quality	2

Policy, legal and regulatory	9. Insufficient legal and regulatory framework and unclear policies on sustainable plantation	3
Institutional and organisational capacity and human skills	10. Limited technical knowledge and skills on human resource development, R&D and extension of optimal and sustainable plantation including legal, organisational, financial and economic, social and environmental responsibility, carbon trading etc	3
	11. Ineffective and inadequate professional training and learning course on sustainable plantation	2
	12. Inadequate resource materials on sustainable plantation such as handbook, guidelines and best practice on sustainable plantations	2
Information and awareness	13. Inadequate information, especially updated information on sustainable plantation including land and species suitability and trade-off between plantations and other land use	3
Technical	14. It is long and costly process while it is difficult to maintain productivity, soil nutrients and carbon	2
Other	15. Not all tree species/plantations growth well and economic viable in Laos.	2
	16. Land use conflict and overlapping areas for plantations and other land uses, especially infrastructure and mining areas	2
	17. Existing/unsolved environmental and social impacts	2

3.4.2.1 Financial and economic barriers

1. Financial and economic unviable

Some plantations have low productivity, and not financially and economically unfeasible. Some Eucalyptus camaldulensis plantation, for example, had mean annual increment (MAI) only 5 to 6.2 m^3/ha/year, which is not financially and economically viable. MAI of 10 m^3/ha/year, and farm gate price of US\$10/m^3, the return on investment was about 3%, and -4%, for investment cost of US$ 600/ha and US$ 900/ha, respectively. For the investment and price, to be financially viable or gain return about 17% and 9%, MAI of at least 20 m^3/ha/year (MAF, 2005).

Other species such as rubber and Jastropha also have low cost-benefit ratio (Table 7), which are quite challenge for development unless financial and economic incentives and subsidies are given.

TABLE 7 INVESTMENT COST AND RETURN ON INVESTMENT OF KEY PLANTATIONS

No		Species	Investment (US$/ha/yr. for 25 yrs.)	Return on investment (US$/ha/yr. for 25 yrs.)	Cost-benefit ratio (per year)
1		Rubber	718.65	2,161.25	3.01
2		Jatropha	245.85	1,080.00	4.39
3		Eucalyptus	193.90	1,250.00	6.45
4		Palm	283.19	2,000.70	7.06
5		Acacia	166.95	1,250.00	7.49
6		Teak	97.21	781.25	8.04
		Average	**284.29**	**1,420.53**	

Source: *Khambanseuang et al., 2009*

2. Limited capital and access to finance

Limited capital and access to finance have been major barriers for business development in Laos (ADB & WB, 2007; GIZ, 2008 and 2014, Kyophilavong et al., 2007; Kyophilavong, 2011), and it is true for the sustainable commercial plantations development. Private sector, especially domestic plantation investors and smallholders are facing limited capital to fully and effectively deploy sustainable plantation forest management (SPFM) practices and expand business. Access to finance to increase capital, in the meantime, is problematic. Majority of investors including smallholders have limited acceptable collateral, weak business financial management system, and shortage of skills on financial and business planning and preparation of bankable proposal. Capital market is, on other hand, underdeveloped. Capital cost or interest rate is considerably high, with lots of requirements, complicate procedures, and lack of long-term loan. Furthermore, policy to facilitate access to finance and handling with risks are inexistent.

3. Inadequate public budget for extension of sustainable plantation development

Public sector has limited budget for development of plantation for conservation and promotion sustainable commercial plantation, especially R&D, capacity building, facilitating to access to markets, information and exchange, development policy and plans to enable sustainable plantations. Although government sets target to plan to establish 20,000-30,000 ha per year for environmental protection, the targets are hardly achieved because of budget shortage. Budget for maintenance of plantation after planting as well as budget for extension of sustainable plantation is also scanty.

The shortage of the budget is not only because of overall public budget deficit and ineffective budgeting; lack of sustainable plantation strategy, site management and resources mobilisation plan, research to identify land and tree species suitability, financial needs and analysis, financial models and mechanism also amongst the causes.

4. High investment cost for planation establishment and sustainability

High investment cost is a fundamental barrier for sustainable plantation. As for key species such as teak, acacia, eucalyptus, Jatropha, palm and rubber; investment cost range from US$ 97.21 to 718.65 per year (Table 12). Despite lower labour and land concession cost; the cost on imported technologies or equipment for establishment and processing wood and non-wood products, unexploded ordnance (UXO) clearance, infrastructure and social and environmental responsibility remained a huge burden to, especially domestic and smallholder plantation developers. The cost on imported technologies or equipment for establishment and processing wood and non-wood products may account for 40% of total cost. UXO is, in general, critical for developments including plantations since large land area of Laos and potential areas are contaminated with UXO. Although there are substantial supports from development partners, but UXO clearance remained incomplete. The cost for UXO clearance ranged from US$ 1,563 to US$ 9,338/ha or on average US$ 3,551/ha[13] or US$ 1,900[14].

[13] UXO Lao, "Real cost and productivity analysis 2001", Vientiane, May 2002

[14] http://www.irinnews.org/report/90072/laos-cluster-bomb-focus-raises-hopes-development

Plantations are usually established in remote area with poor road access, so expenditure on road development is usually topped-up.

Cost on the social and environmental responsibility, especially inclusive environmental assessment (EA) and implementation of mitigation measures including compensation is relatively high, especially when it is required to carry out by intentional entity. Although the cost of EA varied depending on project types[15], scale of impacts and compensation. The expense normally ranges from US$ 35,000-100,000 for IEE and US$ 100,000-150,000 for ESIA, on average. FSC certification could possibly cost US$ 2-5/ha. Moreover, there is additional cost on, for example, restoration of soil fertility, which may cost another US$ 25-50/ha for first 10 years.

5. Insufficient incentives

Insufficient financial and economic incentives is main barrier private sector and for small holder plantation to ensure inclusive and sustainable plantation development. In general, in Laos, technologies for plantation establishment and products processing are imported. As mentioned, cost on plantation development is relatively high, while incentives such as tax exemption or reduction for importing technologies and export wood and non-wood products, subsidy and other cost sharing mechanism on sustainable plantation practices is neither insufficient nor exist. Without incentive, upscaling and expansion of sustainable plantation would be hardly achieved.

3.4.2.2 Non-financial and economic barriers

1. Unclear plans and inadequate information for plantation development

The information and plantation forest development plans that define location, provide information about suitable areas and tree species are inexistent. The absence of these plans is associated with incomplete integrated land use planning including land suitability assessment and mapping, information about commercial trees and markets, inadequate organisational capacity, technical skills and budget.

The integrated land use planning and titling were initiated by Ministry of Natural Resources and Environment (MoNRE) and agriculture and forestry (MAF) some years ago but it is incomplete. Similarly, land suitability assessment and mapping had been conducted by MAF 10 years ago but it is not updated and areas suitable for tree species have not identified in detail. The integrated planning was piloted in few provinces such as Oudomxay and Champasack 10 years ago under SIDA's funded strengthening environment management (SEM) and Finnish government funded environment management support programme (EMSP) but it was in initial stage or at provincial level, the plans have not been updated and downscaled to district and village level. Lack of integrated planning and coordination resulted conflict and overlapping allocation of forestland amongst land uses such as plantations, mining, hydropower and other land uses (MAF, 2005).

[15] (20-200 ha required initial environmental examination (IEE) and >200 required social and environmental impact assessment (ESIA) (MoNRE, 2013)

The absence of these management plans is mainly because of limited skills and experiences. In addition, inadequate financial support and lack of exchange on information and synergy or integration of development plans including land uses among sector.

2. Limited technical knowledge and skills on sustainable plantation forest management

Technical knowledge and skills of particularly the plantation forest management division (PFMD), DoF and key stakeholders[16] on sustainable plantation forest management (SPFM) and climate change mitigation are relatively limited, and it is one of the most critical obstacles for extension and development of sustainable plantation. Those knowledge and skills gaps are on both general and specific areas of SPFM, as summarized in the Table 8. As a result, it derived performance gaps such as incomplete policy, strategy and plans, facilitate access to finance, develop guidelines for sustainable plantation and law enforcement to cope with negative impact caused by plantation developments.

TABLE 8 KEY KNOWLEDGE AND SKILLS GAPS FOR SUSTAINABLE PLANTATION DEVELOPMENT

Main skills categories	Sub-categories or specific elements of skills
Financial and Economic	• Financial and economic analysis such as cost and benefits including return on investment of different types of plantations including trade-off analysis, • Access to finance including business planning and development of bankable or financeable proposal
Market	Analysis and identification of potential wood and non-wood products markets, networks and feasibility of access
Policy	• Development and application of best practices on the enforcement of penal measures regarding law violations.
	• Development of comprehensive policy and incentives for promotion of good performance on sustainable plantation development
Technical	Research and application of: • Sustainable plantation development, certification and marketing under FSC and FLEGT mechanism, • Criteria, indicators and best practices on sustainable plantation development in Lao context, • Assessment and mapping of land and tree species suitability, • Sustainable extraction of use of harvest residues including maximum rate of extraction, • Best practice for soil carbon and nutrients enhancement including retention of harvest residues, optimal and precise fertilisation for sustainable productivity and reduction of environmental impacts, • Agroforestry, especially incorporation of cash crops in plantations to maximise land use and soil nutrients, • Best practices on resource valuation and compensation trade-off analysis between plantations and other land uses, • Techniques and equipment for resource efficient processing,

[16] Faculty of Forestry, Faculty of Environmental Science, Faculty of Economics of NUOL; NAFRI, MAF; DDMCC, Depart of Land, Environment Promotion of MoNRE; Economic Research Institute (ERI) and MPI

Main skills categories	Sub-categories or specific elements of skills
	• Phytosanitary, Carbon credits mechanisms.

The limitation of capacity or skills mainly resulted from weak human resources development system, including ineffective higher education and professional capacity building, learning environment and financing. Plantation forest management (PFM) study is primarily provided by FoF, NUOL. The PFM curriculum is still generic and has not been incorporated sustainable plantation forest management (SPFM) practical experiences and best practices. The curriculum is somehow imbalanced or study focus on economics and business, market, climate change and technologies on plantation and wood efficiency.

Professional training for several relevant organisations, particularly FPD, DoF and the key stakeholders are scanty. In addition, majority of the stakeholders have not had comprehensive human resource and capacity development plan and targets; leading to trainings are performed on ad hoc basis, not systemized and standardised with continuous monitoring and evaluation. The absence of HRD plan also affected the HRD financing. Staff information management and capacity mapping to ensure effective staffing is neither ineffective nor non-functioning, and this caused staff and skills development mismatched and ineffective. Management of human resources supply and demand as well as coordination between educational institutes and public and private employment organisations are ineffective, which also affected staff and skills needs and supply imbalance or mismatch.

Inadequate financial investment and support is a root cause for inadequate and effective capacity building. Annual budget shortage has been possibly US$ 0.15 million. It includes that shortage budget for short and long-term training, development of human resource development plan and system, research and improvement of curriculum, teaching and research materials and facilities is inadequate. The causes of financial shortage were as described above.

Another important factor that impacted capacity is insufficient leadership. Leadership of PFMD, DoF as well as MAF, especially initiatives to promote and enhance self-learning e.g., on the job train and learning culture is not well-established, while it is crucial in the circumstance where budget is not available. Lack of initiative would leave this internal learning opportunity and capacity development.

6. Insufficient sustainable plantation development guidelines, best practices and reference project

The sustainable plantation forests (SPF) guidelines, best practices and reference project are neither available nor defined, and the absence of such these restricts practitioners and developers how to promote and develop in sustainable manner. Although SPF guidelines such as FSC guidelines are deployed by some plantations in Laos, this guideline has not localised and adopted to enforce universally through the country.

The absence of BPG is due to insufficient research including research capacity, policy and budget shortage.

7. Market failure

Market failure is an essential obstacle for effective development and sustaining plantation. Markets are preferable to wood and non-wood products from natural forest which diverse and high-quality wood. Access to regional market is problematic due to not only quantity and quality product, but also certification sources of products and sustainable production, which are costly. In addition, knowledge and skills on the market are limited.

3.4.3 Identification measures

3.4.3.1 Financial and economic measures

1. Enhance access to finance for the development and expansion of sustainable plantation

Increase access to and secure enough capital is determinant for development and expansion of plantations, especially the plantation that sounds financially and economically feasible (Table 14). To realise this, it needs to strengthen capacity of plantation developers, especially small-scale and farmers on business and financial management while financiers, capital market including procedures and requirement to access capital is being improved and simplified. In addition, favourable enabling environment should be in place such as policy on monetary including commercial interest rate of loan, business promotion, mechanism to facilitate and guarantee for access to finance.

Important capacity to be enhanced for private sector include business planning and financial system management, feasibility study, sustainable and carbon management plantation practices, financial-economic analysis and bankable proposal development, business networking and partnering, business and economic laws.

2. Increase financial incentives for sustainable plantation

Financial support for, for example, development policies and plan, capacity building, laws enforcement and increase awareness are needed to be improved. Importantly, study on financial needs and mechanism or models to ensure resources for promotion of sustainable plantation shall be conducted and are in use. Financial policy and incentives shall be in place to facilitate access to finance and reduce financial barriers for private sectors and small household farmers. In addition, public and private dialogue such as business forum on financial access and incentives shall be organised as a platform to address financial constraints.

3.4.3.2 Non-financial and economic measures

1. Development of sustainable plantation forest development plans

Strategy and action plan will be developed to provide specific development target, suitable areas and species, measures to achieve that goals and financial needs for the measures and actions. Development of this strategy and plan requires completion or implementation of following actions.

1) Assessment and mapping suitable areas, plant species and systems,
2) Plantation sector performance review including review of technical, financing, legislation, human resource, investment and trade of plantation products, and markets aspects,
3) Research and development of best practice guidelines and model on sustainable plantation forests.

2. Strengthen human resources development and capacity

Stakeholder capacity building is core measure for effective and sustainable plantation development. Key capacity, knowledge and skills to be strengthened include financial, economic and business, climate change, technical and policies skills on sustainable plantation (Table 8).

Capacity building should be for both short-term and long-term. In short-term, practical short-course trainings and study visits are needed. Long-term capacity building should be carried out through both trainings and formal education system.

3. Develop sustainable plantation guidelines, best practice and reference project

Guideline including C&I of sustainable plantation, best practice and reference project will be researched and developed to guide sustainable plantation practice including M&E. Guideline on sustainable plantation will be formulated by study and adopting, for example, FSC or ITTO sustainable plantation guidelines. Development of best practice may start from defining best practices and review of existing performance, using the formulated guidelines. In addition, it needs to study and deploy regional models that sounds practical to promote and develop sustainable plantation in Laos.

4. Improve access to market

It is inevitable that, in order to increase access to regional market, for example, quantity and quality of products to be improved. It means it calls for investment in skill labour, processing and quality control technologies. In addition, it needs to register or implement under FSC and FLEGT schemes.

3.5 Barrier analysis and possible measures for enabling agroforestry

3.5.1 General description of agroforestry

The agroforestry is a technology or management technique that could provide multi-benefits, both socioeconomic and environmental including climate change mitigation and adaptation. Normally there are four main systems of agroforestry: Agrisiviculture (crops and trees), Sivolpastoral (pasture/animal and trees), Agrosilvopastoral (crops, pasture/animal and trees) and others (multipurpose) (Nair, 1985 and 1993). Carbon sequestration or storage can be enhanced by converting low carbon land use systems (e.g., grassland and agriculture landscape) to tree carbon-richer system (Bouman, 2001), promoting agroforestry on degraded forest grassland, and unproductive crops areas(Nair et al. 2009),optimization of crops yield (Akinnifesi et al., 2008), conservation of existing carbon pools and substitute fossil fuels by wood products (Schlamadinger et al., 2007) and increase or maintain soil carbon storage and vegetables in agroforestry systems (Unruh et al., 1993; Albrecht and Kandji, 2003 and Makuba et al., 2006).

Agroforestry for mitigation has been initiated in Laos since last 5 years. Those initiatives include a rubber-based agroforestry system for sustainable development and poverty reduction project in the southern of Laos and this intervention could possibly reduce 1.17 million tCO2 in 30 years. A small-holder agroforestry carbon offset programmes in Vientiane province, if properly developed would reduce 27, 000 tCO_2 in 15 years. However, these carbon credits have not been achieved yet.

Agroforestry is market goods. The agroforestry practices are applied by large group of farmers and its products tradeable in mass market. Despite agroforestry development is run by private sector and farmers, government has prominent role on extension, especially sustainable practices. Importantly, since agroforestry is in early stage of development or loosely developed, substantial technical and financial supports from government and development partners on the demonstration, provision of information and good practices, and creation of enabling environment are prerequisite for upscaling and sustaining.

3.5.2 Identification of barriers to agroforestry

Identification of barriers to agroforestry promotion and development were carried out based on the barrier analysis process as mentioned in Chapter 2. As a sequence, it found that there are several barriers (Annex 3) that restrict the optimisation, development and sustainability of agroforestry. Of which, there are 15 important barriers and 6 very important ones, scored 3 (Table 9). Elements, dimension and root causes of key barriers were outlined in Annex 4 and 5, respectively. In addition, they were classified into financial and economic barriers and non-financial and economic barriers as discussed in section 3.5.2.1 and 3.5.2.2, as follows.

TABLE 9 SUMMARY OF BARRIERS TO AGROFORESTRY DEVELOPMENT

Broad categories of barriers	Barriers	Score
Economic and financial	1. Low and marginal profits and benefits (some systems)	2
	2. High investment cost on sustainable practices	2

	3. Inadequate public financial support including incentives, subsidy	3
	4. Limited capital and access to finance	3
Market failures and imperfection	5. Small and variable agroforestry markets/High demand and competitive products from intensive (mono) cropping systems and import	3
	6. Variable production and quality	2
Policy, legal and regulatory	7. Unclear legal framework agroforestry including definition	2
Institutional and organisational capacity and human skills	8. Insufficient technical skills on agroforestry	3
	9. Ineffective and inadequate professional training and learning course on agroforestry	2
	10. Inadequate resource materials such as handbook, guidelines and best practice on different types of agroforestry systems	2
Information and awareness	11. Insufficient information and awareness on agroforestry including land and tree species suitability, cost-benefits and return on investment of agroforestry systems, mitigation potentials, markets, successful projects and best practices	3
Technical	12. Some species are not suitable for agroforestry systems/site and species specific	2
	13. It is difficult to define optimal agroforestry including compatible species and production systems that generate maximum profit and benefits	3
	14. It is difficult to quantify carbon sequestration	2
Other	15. Pest and disease outbreak and damage caused by floods and landslide	2

3.5.2.1 Financial and economic barriers

1. Limited capital and access to finance

In general, about 95% of enterprise in Laos is micro, small and medium enterprise and about 0.83% invested in agriculture and forestry sector (GIZ, 2014). Private sector, especially small and medium agroforestry entrepreneurs have limited capital and encountered financial constraints for up-scaling and sustaining agroforestry systems. Apart from their capital limitation, access to capital and financial supports is problematic. Limited access to capital is because of two main factors, external and internal factor. Externally, capital market is undeveloped, resulting in high cost of capital, especially interest rates of loans or credits and lack of long term loans which unfavourable for agroforestry business. This situation is mainly caused by ineffective monetary policy and partnering with international financial institutes for development and promotion access to capital market. Internally, majority of small and medium enterprises have weak financial management systems and skills on financial-economic analyse and development of bankable proposal. These problems resulted from limited capacity building for and exchange amongst private sectors, ineffective enforcement and promotional measures on financial management of businesses.

Limited capital and access to finance related to government support were discussed in the following section.

2. Limited financial support for extension of agroforestry

Both financial support and facilitation to access to finance by government for extension and development of agroforestry is considerably limited. Activities such as research, survey, information dissemination and trainings were planned to boost agroforestry but they were not fully implemented due to inadequate budget and capacity. Financial incentives and fund for agroforestry is either limited or unclear. Limited financial support and facilitation to access to finance consequently restrict development of agroforestry sub-sector, including development of policy and plan, capacity and research.

Limited financial support from government is related with public budget constraint, ineffective budget allocation and management. On one hand, access to financial support is also affected by limited capacity to assess financial need, mobilize resources and develop favourable policy for access to finance or fund. Details on the capacity limitation issues were discussed in the non-financial and economic section below.

3. Insufficient incentives for extension of agroforestry

Incentives such as tax reduction and subsidy for agroforestry production and business are limited. It is another constraint limiting agroforestry development. The important incentives that are absent, apart from tax reduction and subsides, include:

1) Warrants for facilitate access to finance, market and technologies,
2) R&D and make available information on financial, economic and techniques of agroforestry,
3) Capacity building and exchange.

3.5.2.2 Non-financial and economic barriers

1. Limited knowledge and capacity

Key relevant organisations[17] have not had ability to develop and promote optimal agroforestry system effectively. Knowledge and skills to study and identify suitable areas and agroforestry systems that generate optimal socioeconomic and environmental cost-effectiveness and benefits including mitigation are insufficient. These are inhibited by incomplete organisation and human resources system on agroforestry. Secondly, it is the matter of finance, which is unmet the financial needs for capacity building.

Organisationally, there is either unclear or duplication of responsibility on agroforestry, amongst department of forest (DoF), agriculture and forestry extension service (DAFES) and agriculture (DoA). HR and capacity development plan, needs assessment, staff knowledge management and M&E system of these departments are neither inclusive nor inexistent. These undoubtedly affect effectiveness of the HRD including knowledge and skills development, and implied that coordination and or leadership of MAF is ineffective.

Education and research institutes such as FoF, FoA and NAFRI have not had sufficient agroforestry experts, practical curriculum, teaching and research materials and facilities to enhance quality of

[17] Faculty of Forestry, Faculty of Agriculture, Faculty of Economics of NUOL; NAFRI, DoF, DoAFE of MAF; CCI

education, R&D as well as human resource development. As for private sector, although Lao national and provincial chamber of commerce and industry (LNCCI and PCCI) exist, agroforestry business association has not established, while capacity of and capacity building within CCI is limited.

Both public and private sectors are facing budget insufficiency. Annual budget deficit for strengthening capacity of public, private sector and farmers may be, at least, US$ 0.5 million per year. The budget shortage for agroforestry capacity building is like other sector, which public and donner financing is insufficient, while agroforestry enterprises are small and not able to cover self-capacity building.

2. Insufficient legal framework on agroforestry

Agroforestry's definition, principles and guidelines about agroforestry and management including roles and responsibilities of organizations have not clearly provided in the existing forest law (2007), agriculture (2003) or specific regulations. This basically prevents the effective agroforestry development, management and promotion. Consequently, as mentioned, gaps on finance, capacity, policy and plan are largely remained unsolved. Limitation of knowledge and capacity on agroforestry are key underlying cause inhibiting the development of policies and organisation. The capacity limitation and causes were as discussion above.

3. Insufficient best practices and reference project on agroforestry

Best practices and reference project on optimal agroforestry systems that generate high and balance socioeconomic and environmental benefits including mitigation are neither available nor defined, and it is very difficult to identify, develop and promote the optimal agroforestry systems. BPG and reference project that provide: (1) good models or examples of agroforestry systems as well as appropriate combination amongst trees, crops, animals systems that yield maximum benefits, (2) practical guidelines and examples on how to establish, arrange inputs and finance, implement, monitor and evaluate the outcome and impacts are not available. Several agroforestry systems including home gardens are common in Laos, but R&D including capacity to review or assess and defines optimal agroforestry systems is limited. The absence of BPG and reference project is also associated with insufficient research budget.

4. Market failure

Market failure is critical for development of agroforestry. Markets are overwhelmed by imported and mono cropping product, which are more competitive in term of quantity and prices. Access to oversee market is also restricted by not only quantity of agroforestry product, but also quality, especially Phyto-sanitary, nutrients, storage and packaging.

3.5.3 Identified measures for promotion of agroforestry

Based on the assessment of the barriers and related factors; research, capacity building, development plans and policy and access to finance should be improved in order to substantially deploy agroforestry for mitigation and socioeconomic benefits.

3.5.3.1 Financial and economic measures

1. Increase public financial support and incentives for agroforestry development

Financial support for, for example, development policies and plan, capacity building, laws enforcement and increase awareness are needed to be improved. Importantly, study on financial needs and mechanism or models to ensure resources for promotion of sustainable plantation shall be conducted and are in use. Financial policy and incentives shall be in place to facilitate access to finance and reduce financial barriers for private sectors and small household farmers. In addition, public and private dialogue such as business forum on financial access and incentives shall be organised as a platform to address financial constraints.

2. Enhance financial access for agroforestry

Access to favourable capital is crucial for farmers and entrepreneurs to develop and sustain agroforestry production and businesses. To ensure access to finance; business and financial management capacity of the agroforestry producers and entrepreneurs shall be enhanced while improving capital market and more favourable environments including procedures and requirement to access capital.

The producers and entrepreneurs' capacity to be enhanced are: 1) business planning and financial system management, 2) marketing, 3) access and application of production and processing technologies, 4) feasibility study and design optimal agroforestry schemes, 5) sustainable plantation practices including carbon credit mechanism, soil nutrient and integrated pest management, plant and crop varsities improvement for higher production and climate resilience, 6) financial-economic analysis and bankable proposal development, 7) business networking and partnering, 8) legal knowledge and skills, especially contracting, requirements for import and export including plant sanitary and hygiene.

To improve capital market, capacity on capital market development of financial service and management institutes are necessary to strengthen; policy on business promotion, facilitate and guarantee for access to regional and international capital market should be in place.

3. Improve access to market

Penetration and access to market require not only improvement of quantity and quality of products, it needs to control imported agroforestry products as well. In addition, it also needs to improve market information, promotion and implement joint marketing.

2.5.3.2 Non-financial and economic measures

1. Technical capacity building

Capacity of relevant organisations on land and agroforestry suitability assessment for should be strengthened. The relevant organisations, particularly the National Agriculture and Forestry Research Institute (NAFRI), Natural Resources and Environment Research Institute (NRERI), Faculty of Agriculture, Forestry and Environment of National University of Laos (NUoL); and department of

disaster management and climate change (DDMCC), forestry, agriculture as well as climate change working group on agriculture and forestry sector should play prominent roles in the research and provision of information. The knowledge and capacity to be enhanced, apart from land and agroforestry suitability assessment and mapping, may include carbon accounting and mechanisms, agroforestry science and related areas such as eco-physiology of trees and crops including their components and interaction, ecology, soil nutrients and carbon, geographical information system (GIS), land use planning, landscape management, assessment and mapping with the use of multi-criteria and modelling. In addition, data and information management should also be strengthened in order to ensure that the information and available for sustainable agroforestry planning and promotion.

2. Develop guidelines, best practice and reference on optimal agroforestry systems

Guideline including C&I of optimal or sustainable agroforestry, best practices including best techniques, and successful interventions will be developed and promote as reference of sustainable agroforestry. Development of these tools will be carried out through research, demonstration and review. However, best practices and successful project will be defined. In addition, it may need study and exchange learns regarding successful project in the regions in order to design and introduce intervention in Laos.

2.6 Enabling framework for overcoming the barriers in forest sector

Based on analysis of barriers and measures in previous section, key common measures to cope with barriers and attain forestry sector technology development goals are improvement of financing and investment, technical capacity, information, policy development and enforcement, promotion and deployment of best practices and successful models.

Despite measures are in place, without favourable environments, implementation might be challenge, ineffective and inefficient. The enabling environment to enable and facilitate implementation of measures and address the barriers in forest sector are summarised as followings.

1. Network, cooperation and integration

Networking and cooperation is recognised as an enabling environment framework that triggers enabling environments for implementation of measures and tackling with barriers, especially through knowledge and information exchange, technology transfer, capacity building, access to funds and market. Several regional network and cooperation platform for village forests, protected areas, plantation and agroforestry exist such as ASEAN social forestry network (ASFN)[18], Asia-Pacific Network for Sustainable Forest Management and Rehabilitation (APFnet)[19], ASEAN Cooperation on Environment[20] and ASEAN Centre for Biodiversity (ACB)[21], and cooperation under the Convention on Biodiversity

[18] http://www.asfnsec.org/

[19] http://www.apfnet.cn/

[20] http://environment.asean.org/asean-working-group-on-nature-conservation-and-biodiversity/

[21] http://www.aseanbiodiversity.org/

(CBD)[22], UNFCCC, FLEGT and other schemes. These networks and cooperation are, however, needed to be enhanced and expanded. For example, expansion network and cooperation with Asia Forest Partnership (AFP)[23] which Laos has been a permanent member. To this end, however, policies and strategies on cooperation will be improved. Roles and mandates of relevant organisations and between technical and cooperation sectore will be clarified. Furthermore, a information management system will be established to monitor and evaluate effectiveness of networking and cooperation.

Domestically, expert groups, think-tank, social organisations and exchange platform, especially forum will be enhanced to facilitate, advocate and participate in sustainable village forest, protected areas, plantation and agroforestry development.

2. Macroeconomy

The government is maintaining and enhancing sustainable economic development and green growth, reduction of poverty and trade deficit, enhance integrated land use, law enforcement and transparency, and these are crucial for driving sustainable forest sector and technologies development. To gain advantage and opportunities, it needs to enhance integration and mainstreaming forest sector and technologies in macroeconomic development.

3. Regional financial and forestry products markets

Markets that works for wood, NTFP, carbon credits and other ecosystem service and products is critical for products from village forest, protected area, plantation and agroforestry systems. To expand and increase access to markets, it is necessary to enhance knowledge and capacity to promote domestic products and access to regional markets and opportunities under ASEAN Economic Community (AEC), least development countries (LDC), World Trade Organisation (WTO) trade preference and mechanisms.

Financial markets and services are, although favourable ones are limited, growing and improving overtimes and advantageous. So, readiness to access to finance such as the government warrants, financial risk management mechanism and capacity of private sector will be enhanced.

4. Improvement of information, technologies and access

Data and information on forest resources and environment is, despite limited, improving overtime. Information and Community Technology (ICT) and forestry technologies such as GIS-RS are much improved and accessible. These make easier and faster information exchange and access. However, to be useful and beneficial, capacity and application of the ICT and forestry technologies including equipment and techniques for of both public and private sector will be enhanced for promotion and deploy in the forestry sector and mitigation technologies.

[22] https://www.cbd.int/idb/2016/

[23] https://sustainabledevelopment.un.org/partnership/?p=1483

Chapter 4 Barrier Analysis and the Enabling Framework for the Agriculture Sector

4.1 Preliminary targets for technology transfer and diffusion

The overall goal of this sector is many folds. It is to ensure food security and safety, and the commercialisation of agricultural products that links with industrialisation and modernisation along with sustainable agriculture practices and climate resiliency. It is also to support sustainable growth of the national economy, and to increase the local income and reduce poverty. By 2020, the agriculture sector is expected to growth by 3.4% per annum and would contribute to 19% of the GDP on average (MAF, 2015; MPI, 2015). To achieve this, approximately US$9,900 million worth of investment is required in the agriculture sector, of which 1.5% is expected from public investment, 16.4% from official development assistance (ODA) and 82.1% from domestic and foreign direct investments. By 2025, an investment of US$ 23,375 million is needed, where 1.07% is expected to be invested by the public, 13.37% from official development assistance (ODA) and 85.56% by domestic and foreign direct investments (MAF, 2015).

The sector was the second largest source of emission and accounted for 7% of the total emission (MoNRE, 2010). Thus, this is a critical area that requires technology development for mitigation (MoNRE, 2013). Four key mitigation technologies selected known to have high co-benefits include feed improvement, biomass to energy, manure-based biogas and organic farming, amongst others (MoNRE, 2013).

Feed improvement and optimization is not only for mitigation enhancement. It also plays a central role in boosting livestock development. By 2020, livestock, especially cattle and buffalo, is targeted to increase by 6% and become one of the export earners, enhance food security, and increase local income and employment (MAF, 2015). The target for feed development is to produce 1.3 to 1.4 million tons of animal-processed feed by 2020 and 2025, respectively (MAF, 2015). The sector aims to protect and restore remaining pasture (1.7 million ha), and promote small livestock holders to produce sufficient forage and concentrates including optimal notorious feed for ruminant animals, especially cattle and buffalo[24].

Organic farming or agriculture development is targeted at 15% of the total agriculture production. It will also share 25% of agriculture product supply in tourist destinations, world heritage towns, economic zones and capital city by 2020. Approximately 70,000 farms and 35,000 ha will be certified as organic agriculture practice by 2025 (MAF, 2016), and will share 20% of the total agriculture product export value by 2025[25].

[24]This target has not been specified in agriculture development plan to the year 2025; it derived from the consultations during this barrier analysis and reporting.

[25]This target has not been specified in agriculture development plan to the year 2025; it derived from the consultations during this barrier analysis and reporting.

Manures-based biogas is also among the key renewable energies. Effective promotion of this technology could reduce GHG to great extent, particularly through reduction of methane emissions from manure management system, fuel wood utilisation and import of LPG. Biogas development to supply 19MW of electricity by 2020 and 51MW by 2025 has been targeted. Or it was expected that there would an investment increased from USD45 to USD192 million in 2020 and 2025, respectively, and at least 50,000 households will deploy the biogas (MEM, 2011).

Agriculture residue-based electricity is one alternative renewable energy technology that has substantial mitigation potential. Laos aims to make electricity accessible by 100% of households in urban areas and 90% of households in rural areas by the year 2020 (MEM, 2011; MPI, 2015). Electricity production is expected to be about 5,500MW and renewable energy is expected to share 80% of the total energy production, and 30% of those derived from small scale renewable energy (installed capacity equal or less than 15MW) by 2020 (MEM, 2011; MoNRE, 2015). Biomass-based electricity is expected to reach 24MW by 2020 and 58MW by 2025, and investment would increase from USD 52 to USD72 million by 2020 and 2025, respectively (MEM, 2011).

4.2 Barrier analysis and possible measures for enabling feed improvement

4.2.1 General description of feed improvement

Animal feed comprises three types: fresh (e.g. green grasses and leaves), semi-processed feed (e.g. fermented grasses and hay) and processed feed (e.g. concentrates and others according to nutritional formula). Feed improvement and optimization for mitigation means developments to increase productivity of degraded and low forage/pastural systems, optimal feed and concentrates for optimal growth of livestock, while reduce greenhouse gas.

A recent survey revealed that suitable and potential pasturelands for animal-raising, especially cattle and buffalos, remained approximately 0.65 million ha and 1.14 million ha, respectively (MAF, 2015). By contrast, the government expects that by 2020, supply of animals will be at least 120,000 per annum, with meat production yielding 45,000 tons and 10-15,000 tons for export (MAF, 2015; MPI, 2015). The pasture production, although there is no comprehensive study, was about 6 tonnes of wet weight or 3 tons of dry biomass per ha, on average. Currently, quite large area of pasture degraded and it is believed that the production decreased. As a result, it undermined livestock development, especially animal productivity, population and health.

Feed improvement, especially forage, started 20 years ago mainly under the support of development partners. Those support included cattle development and forage demonstration in Vientiane capital and in the provinces of Vientiane, Xiengkhuang, LuangNamtha and Champasak. Most of intervention, however, has been put on hold after the project ended due to lack of financial support for extension. Some varieties of imported grass such as *Brachiaria* species, including *B. brizantha*, *B. decumbens*or new hybrids, Mulato proved to be options for farmers since they are draught resistant and remain green late into the dry season. Small-grain cereals (*Sorghum sp.*, *Eleusinecoracana)* and some temperate cereals (oats, wheat) grown during the winter season give promising results to supplement both ruminants and non- ruminants during the cool season. However, expansion of the feed production has been limited.

Feed/forage production is a market goods. There is a specific market (livestock keepers) for feed. The feed production value chains are, however, simple and involves few actors. Since feed production is in an early stage of development, it requires more public support and enabling environment for diffusion.

4.2.2 Identified barriers for feed improvement

Barrier identification, as descried in Chapter 2, included barrier compilation, screening, decomposition and root cause analysis by literature review, key stakeholder interviews and consultation workshops. The result showed that, despite many barriers listed in Annex 7, there are 14 important barriers that are hindrance to feed improvement (Table 10). The elements, dimensions of barriers and root causes as outlined in Annex 8 and 9, respectively. The key barriers which scored 3 include 4 financial-economic barriers and 5 non-financial and economic barriers. The financial-economic barriers include: 1) low profit on the investment in feed development, 2) high investment cost, 3) Inadequate public financial support e.g., incentives, subsidy, and 4) limited capital and access to finance. Non-financial and economic barriers are: 1) small market, 2) Insufficient technical knowledge and capacity on feed development and business, 3) inadequate information on feed resources, suitable varieties and feasibility, 4) fragmented and 5) degraded pastureland.

TABLE 10 SUMMARY OF THE BARRIERS TO FEED IMPROVEMENT

Categories of barriers	Barriers	Score
Economic and financial	1. Low profit of livestock and feed improvement business	3
	2. High cost on feed development	3
	3. Inadequate public financial support e.g., incentives, subsidy	3
	4. Limited capital and access to favourable financial resources	3
Market failures and imperfection	5. Small and variable market (livestock industry)	3
Policy, legal and regulatory	6. Inadequate legal framework on feed/forage resources and technologies for feed development	2
Institutional and organisational capacity	7. Limited knowledge and technical skills on feed development	3
	8. Ineffective and inadequate professional training and learning programme	2
Information and awareness	9. Low awareness on feed/forage development technologies including inputs, production, processing and storage	2
	10. Inadequate accurate information on feed/forage resources, suitable forage varieties and feasibility for development	3
Technical	11. Biological and geographical limitation of forage/grasses to grow in Laos	2
	12. It is difficult or costly to develop suitable feed, especially concentrates to maximise productivity and reduce GHG emission	2
Others	13. Fragmented pastureland	3
	14. Degraded and unfertile pastureland	3

Remark: *Score 3 = crucial and urgent; 2 = important and needed; 1 = important but to be solved later*

4.2.2.1 Financial and economic barriers

1. High investment cost and low profit

Despite scant information on financial and economic feasibility study including estimate cost for feed development in Laos, investment in the development of forage, pasture, concentrates and feed supplementation package is perceived costly. It may cost, for instance, US$ 200 to 400 per hectare per annum for fencing pastureland or basic maintenance. The cost may be to 1,400 per hectare or higher to increase pasture productivity to e.g., 12-18 tons of dry mater per ha a year with a standard production system including imported seeds, fertilizer, land preparation including some UXOs clearance, operation and maintenance.

Such cost is problematic for small livestock holders to invest in. So, many of them choose low cost option, though insufficient fodder and livestock productivity. Medium and large entrepreneurs may have financial investment capacity to cover the cost, it affects their profit, limiting expansion of pastureland.

2. Limited capital and access to favourable financial resources

The majority of livestock keepers are micro-sized production or enterprise[26] and have limited capital. Access to finance is a challenge due to the high interest rate (8-12%) and complicated procedure for borrowing. It is again because of having limited collateral and financial capacity. In addition, some are low creditworthiness, which restricting access to finance.

3. Inadequate public financial support for extension

Financial support from the government on the research and promotion of feed including pasture restoration is limited. Activities such as survey of pastures and forage including trainings are planned annually but the budget allocated for implementation is not enough. The limited financial support from the government is relative to the public budget, which is also limited. Partly, it is due to the insufficient capacity to assess the financial needs, to mobilize resources and to develop a policy favourable for access to finance or incentives for forage development.

4.2.2.2 Non-financial and economic barriers

1. Insufficient legal framework on feed or forage development

Policy or regulation on animal feed and resources including pastureland management are inexistent. Law on agriculture was promulgated in 1998, but it failed to provide clear directions on feed and feed resources development and management. Concession or leased pastureland for livestock development and the conversion of pastureland are rather governed by decrees on state land lease or concessions (2009), law on land (2003), decrees on environmental and social impact assessment (2012), and

[26] Micro commercial production means production and enterprise that employ 1-5 labour, with total asset of less than 100 million LAK (US$ 12,000) and profit less than 400 million LAK (US$ 50,000) (GoL, 2017)

regulations on agriculture land management (2003). Despite these laws and regulations being enforced, the absence of specific policy and regulation including their objectives, principles of procurement and the technical aspects in management and promotion of feed development undermines the effectiveness and efficiency of feed development and management. To date, it is unclear whether and which pastureland and forage should be preserved, for example, for R&D and management by government, which ones are for commercialization, concession or lease, and which ones are for management by the private sector and small livestock holders. In addition, the measures and incentives for the promotion and management of native forage and imported feed, seeds and grasses are also inadequate. As a result, this ambiguity not only caused stagnancy in feed development, but some pasturelands were converted into other land-use types, such as for development projects, without proper trade-off analysis and mitigation measures.

The lack of awareness on policy and land management, research and information, capacity and financial supports are major factors hindering the development policy or regulation and plans including their effective implementation. Policies, regulations, and plan for the promotion and management of all type of land uses including pasture or grassland should be developed following land law. There is insufficient research and information that impedes planning. The details on capacity and financial gaps are discussed below.

2. Limited knowledge and capacity of feed and forage experts

The limited knowledge and capacity of key organizations including department of livestock and fishery (DoLF), national agriculture and forestry research institute (NAFRI) of MAF, faculty and schools of agriculture of NUOL and private sector inadequate. Knowledge and skills gaps are on: (1) forage resource and pastureland management, (2) biotechnologies for forage and feed optimisation, (3) optimal feed concentrates and forage production systems that are resilient to drought, pests, insects and acidity, (4) R&D on processing and storage technologies, and (5) soil nutrient management, carbon storage or sequestration by feed and pasture optimisation through their life cycles. These barriers have impeded the planning and management of forage resources and pasturelands, including the restoration of degraded ones. It has also contributed to the development of insufficient quality feed and suitable concentrates for the enhancement of animal productivity, while ensuring environmental conservation and climate change mitigation and adaptation.

The limited knowledge and skills is engendered by a weak human resources system, which involves the quality of higher education and the inexperienced organisations' human resources development (HRD). In higher education, the majority of students do not gain compressive and practical knowledge and skills due to the inadequate teaching materials, curriculum and experiences of teachers. In the workplace, HRD is not effective and lacks consistency and financing because human resources and capacity development plans, and especially the M&E of DoLF and the private sector are not in place. The lack of staff knowledge mapping and management in the organisation not only causes misuse and unsuitable positioning of staff, but it also undermines and discourages staff knowledge and skills development as well. Leadership is also a key factor influencing skills development, especially when there is financial shortage. Organisational initiative or culture to self-organised capacity building such as on-the-job training and learning has been limited, and has had significant negative impact on knowledge and skills development. Lastly, the management of HRD demand and supply as well as the coordination between

educational institutes and employment organisations on staff and skills needs and supply have been weak and has caused mismatched staff to skills.

Financial shortage is another main barrier for capacity building. It was estimated that the annual budget shortage for capacity building has been about US$ 0.2 million. This includes budget shortage for development of HRD plan including capability needs assessment, staff and knowledge information management system, HRD M&E, development of training modules and implementation, and exchange and R&D on forage and feed optimisation in both the public and private sectors. This budget gap is, as mentioned, affected by the overall public budget deficit, as well as limited international support and resource mobilisation. The private sector companies are mainly SMEs with limited budgets earmarked towards other areas of business rather than capacity building.

3. Ineffective law enforcement

The ineffective law enforcement is problematic for forage development, especially the conversion of pastureland to other land use without an impact assessment and in-depth trade-off analysis. As mentioned, pasture dramatically decreased due to land use changes and improper enforcement of measures.

The ineffective law enforcement is due to the limited awareness and capacity on pastureland management or the limited budget for inspection. It is also partly related to the unclear information about pastureland including demarcation as well as the inexistence of an integrated land use plan.

4.2.3.1 Identified measures for the promotion of feeds improvement

4.2.3.1 Measures for financial and economic barriers

1. Enhance access to finance

To enhance access to finance for feed development, the following actions and enabling environments are needed.

- Reinforce the Prime Minister's decree on commercial interest rate (not higher than 7% per year),
- Strengthen the capacities of entrepreneurs on business financial management systems and preparation of bankable proposal, including a financial-economic analysis on the feed development project,
- Improve access to domestic and overseas capital markets in order to provide favourable loans and credits for business development. This measure requires a comprehensive research, an improvement on existing policies and capital markets/financial institute networks and cooperation.

2. Increase public investment and financial support for extension

An increase in public investment for extension is needed, especially for research, dissemination of information, capacity building, land use planning, and demonstration of feed and forage development.

To secure financial support from public and development organisations, a feed /forage development plan, a plan for resource mobilisation, information on financial sources and fund directory, bankable feed project proposal and business plans are needed, along with the capacities and mechanisms to effectively manage the financial aid or fund. This means, apart from the project M&E or audit, there needs to be a centrally-linked or one-door aids effectiveness management system which ensures the M&E as well as the effectiveness, efficiency, relevance, impact and sustainability of the entire financial and technical support.

4.2.2.2 Measures for non-financial and economic barriers

1. Improve feed research and development

Research and development of feed is a necessary measure to provide information for the planning and expansion of feed/fodder development. In order to address the information gaps and extension, research and development will focus on:

1) Optimal feed, especially seeds, forage species and concentrates that maximise yield and nutrients while reducing emissions,
2) Soil carbon and nutrient management and mitigation potentials under different livestock land and grazing systems,
3) Inventory of feed or fodder resources and the identification of potential resources and species for development,

In addition, research and demonstration facilities and tools, and the development of research strategy and capacity on research need improvement.

2. Capacity building

Strengthening the capacity of stakeholders is a strategic measure to addressing the barriers that hinder development in the organic farming industry and climate mitigation. The capacities to be improved are around the areas of:

1) Sustainable farming including soil carbon and nutrient management techniques,
2) Organic farming certification and inspection including equipment and facilities for inspection,
3) Development of financial projects and business proposals including financial and economic analysis,
4) Resource mobilisation including the development of resource mobilisation plans,
5) Sustainable farmer organisations,
6) Marketing and access to market,
7) Organic product diversification and product processing technologies,
8) Research and establishment of development funds or subsidies for agriculture including organic farming,
9) Organic farm land management,
10) Research and monitoring of organic farm soil carbon and nitrogen.

3. Improve policy frameworks

An improvement on policies on feed and feed resources is a necessary measure to provide direction and references for feed development. Policies to be formulated are the:

1) Policy on feed and feed resources management including the import and export of feed/fodder and seeds,
2) Policy or regulations on livestock land such as pastureland management including conversion, concession or lease,
3) Policy on financing, subsidising, taxation and other financial incentives and mechanisms for the promotion of livestock including feed development and extension,
4) Policy to facilitate and guarantee access to finance or capital and technical support.

4.3 Barrier analysis and possible measures for enabling organic farming

4.3.1 General description of organic farming

Organic farming or agriculture is commonly known as farming systems and products that are free from synthetic chemicals, Genetically Modified Organism (GMO), and not organic chemistry (MAF, 2005). There are two types of organic production, organic by default and certified one. The organic agriculture by default accounted for about 80% of the total agriculture land (of app. 4 million ha) (Bounyasouk, 2014). Certified organic agriculture which meet and certified under Lao organic agriculture standards (MAF, 2005)[27] are relatively small. It reached a peak in 2013, when organic production areas and farmers reached 6,441 ha and 26 products with a total production of 18,340 tons (Bounyasouk, 2014), which increased from 5,989 ha and 1,342 farmers in 2011 (Panyakul, 2012). Currently, there are 17 companies, 88 farmer groups that consisted of 1,598 households who farms 3,002 ha and produce about 3,375 tonnes in 122 villages and 47 districts through the country (MAF, 2016).

Organic farming is an important environment friendly technology. It has substantial, apart from income and employment, climate change mitigation potentials. The prominent mitigation potentials are increase productivity, while enhancing restoration of soil carbon and nitrogen storage, particularly on low and degraded production systems.

Organic farming is categorised as a market or consumer goods. Besides the government's promotion, the deployment and diffusion of this agriculture practice largely depends on the markets. As described above, organic farming in Laos is a relatively small industry that is not firmly and fully developed with few entrepreneurs, production areas and products. At its early stage of development, the number of entrepreneurs, areas of production, products and markets are variable. In effect, the sustainability of organic farming depends on the public and external support for R&D, capacity building, access to production and processing technologies, markets and finance.

4.3.2 Identification of barriers for organic farming

The identification of barriers on organic farming, as described previously, follows the barrier analysis process mentioned in the Chapter 2. It resulted in a long list of barriers to organic farming with barrier categories and ranking, key barrier decomposition and mapped problems and solutions trees presented in Annexes 7, 8 and 9. The critical barriers are classified into two main areas: financial-economic and non-financial and economic, as follows.

TABLE 11 SUMMARY OF THE BARRIERS TO ORGANIC FARMING

Categories of barriers	Barriers	Score
Economic and financial	1. High investment cost per unit (compare with conventional farming)	3
	2. Limited capital and access to financial resources	3

Categories of barriers	Barriers	Score
	3. Inadequate public financial promotion/support such as incentives and subsidy	3
Market failures and imperfection	4. Small market	3
	5. High demand and competitive agriculture products from conventional farming	2
	6. High price of organic products	1
	7. Variable product quantity and low trustworthiness on quality	3
Policy, legal and regulatory	8. Unclear policies and regulation on organic land and resources management and development	2
Network failures	9. Ineffective networking and coordination with external organic farming networks	2
Institutional and organisational capacity and human skills	10. Ineffective professional training programme and learning courses	2
	11. Limited technical skills on business including access to markets and finance, resources mobilization production and processing techniques, soil nutrients and carbon management, standards and certification	3
	12. Inadequate skills, equipment and facilities for standards and certification	2
Information and awareness	13. Low information and awareness on organic farming operation procedure, standards and certification	2
Technical	14. Biological and geographical limitation of plants/crops	1
	15. Processed organic products can't be kept for long/easier to spoil	2
	16. Small scale, risk of insects and need special care which is time consuming, labour intensive and costly	2
	17. Difficult to apply precise organic farming (organic fertilizer)	2
	18. Difficult to growth offseason	2
Other	19. Undefinable organic farmland	2
Remark: *Score 3 = crucial and urgent; 2 = important and needed; 1 = important but to be solved later*		

4.3.2.1 Financial and economic barriers

1. High investment cost and limited capital

Although accurate financial and economic information is limited, the cost of organic farming is likely higher than that of conventional farming, especially when comparing the investment cost per unit of production. Investment cost varies for product and location. The higher cost of organic farming is due to higher cost on the more intensive labour, certification process, capital cost, maintenance of soil fertility and environment, transportation, processing technology and marketing of smaller and scattered production.

The general estimate for labour input and cost of organic farming in Laos is about double to that of conventional farming. In the case of organic coffee farming, although the investment cost is not as high as non-organic farming, the labour input for organic farms requires 605 man-days, whereas labour required for non-organic farming with low and high capital intensive are 390 to 502 man-days, respectively (Saysana, 2011). The certification process including application submission, reviews, inspections and certificate fee ranges from US$ 500-1,500 per product or a production system. In case

of coffee the process costed about US$ 160 excluding inspection cost (Saysana, 2011). Cost of capital is high since the loan interest rate ranged from 13% to 19%, or 15.41% per year on average (Saysana, 2011). Transportation cost is also high since the majority of organic farms are scattered in remote area where roads and logistics are relatively poor. Technology processing, storage and packaging are costly as they are mainly imported, while tax reduction for organic farming business is not enforced.

These higher costs are barriers for small or household farmers and business with limited capital. Although some larger organic entrepreneur such as coffee, rice and other cash crops farmers are able to afford the cost; these higher costs affect their return on investment and business expansion, leading to repression of small farmers or producers who engage in the supply chain.

2. Limited capital and access to financial resources

Limited capital and access to financial resources not only key barrier for organic farming, but also other businesses. Almost all of the organic farmers and entrepreneurs are small-scale and limited capital for production and business expansion. Access to finance of them remains to be a challenge. Existing capital markets and financial institutions are relatively small and are at early stages of operation, and offers only small short-term loans and credit services at high interest rates with complicating procedures and requirements. This barrier is due to the ineffective policy on financial management and the lack of facilitation to access to regional capital markets, as well as limited networking and collaboration to expand capital markets.

Entrepreneurs or private sector companies, meanwhile, have insufficient capacity, lack good financial management skills to develop bankable proposals inclusive of comprehensive financial and economic analyses, and lack the expertise and network to reach out to financiers within the country or overseas. The national and provincial chambers of commerce and industry were established in 1989 to be representatives of and facilitate development for the private sector, such as capacity building and learning and exchange activities for its member is. However, these activities are still limited and ineffective due to the lack of capacity building development plan or mechanism in place.

While financial support from the government and their development partners for the extension of organic farming is increasing. However, they are inadequate and have mostly been indirect support to the public sector and focused on the improvement of the certification system, organic farming guidelines, information exchange, some capacity building and the development market places. Subsidy on organic farming is not systemized and lack clear policy.

4.3.3.2 Non-financial and economic barriers

1. Limited access to markets

Despite organic coffee and organic rice being readily available in markets, putting organic vegetables and other organic products to market is challenging due to logistics and transportation barriers previously mentioned.

2. Inadequate policy for the promotion of organic farming

Despite the government promotes organic farming and commercialisation, the policies that for fostering organic farming are neither adequate nor practical (Table 12). This is hard to effectively promote and convince organic farmers and entrepreneurs to invest in the production and business expansion or to take risks in new interventions.

TABLE 12 ADDITIONAL POLICY FOR FOSTERING ORGANIC FARMING

Policy	Elements and dimensions
About financial and economic and non-financial and economic incentives for organic farming business	- Tax reduction and increment financing, revenue bonds, subsidy and subsidized loans, and facilitation to access to finance, fee on the use of public utilities (electric, water etc.) - Capacity building, access to technologies, information and market, rewards for high achievements of enterprises, corporate and extension staff
On organic farm land	Definition, principles and procedures for organic farming management including incentives for management
On the conservation and management of organic genetic resources including seeds	Definition, principles and procedures for conservation and management of genetic resources and prevention of invasive genetic resources
On the fair trade including management of pricing of both organic and non-organic products	Definition, principles and procedures for promotion of fair trade and management of pricing
On the agriculture development fund and assurance	Definition, principles and procedures for promotion and management of agriculture development fund and assurance
On the promotion of environmentally friendly technologies	Definition, principles and procedures for promotion of environmentally friendly technologies including fund and incentives

The absence of the policy resulted from inadequate budget, capacity and leadership. The annual budget required for law and policy review and development could be about US$ 0.3 million per year, or US$ 2.3 million for the development of policies and regulations listed in the Table 13. However, the budget has been undersupplied by about 90% of the required budget, on average. This includes budget undersupply for capacity building, policy review and analysis including hiring experts for capacity building and analysis, and stakeholder consultation meetings. This budget shortfall is related to the national budget deficits as discussed earlier.

The capacity and skills on policy analysis and development are inadequate. For instance, while the policy to incentivize and promote organic farming has been created after the first organic farming forum, lawmakers are unclear about how to enforce it. The agriculture standards division (ASD), the legislation and law division (LLD), and the department of agriculture (DoA) are mandated for law review and development. But they do not have enough staff with law and policy analysis experiences, and have not

been able to complete the tasks. Despite initiation and coordination among leaders from other divisions within MAF and the Ministry of Justice (MoJ), no policy has yet been developed. Furthermore, while policies have been identified as priorities of the agriculture development strategy by 2025, there is a lack of leadership to initiate and encourage implementation including the development of an implementation plan which sets targets for what policy to be developed sequentially.

3. Limited knowledge and capacity on organic farming

Limited knowledge and capacity are major barriers for developing and sustaining organic farming. Farmers, entrepreneurs and public sector staff still have limited skills on (1) the development and operation of different organic farming systems and products, including the certification systems, the financial and economic analyses of different crops and livestock production systems, and the access to market and finance; (2) the identification of production techniques and technologies for maximising and sustaining productivity; (3) phytosanitary inspection and certification; (4) processing high quality organic materials; (5) the management of organic land and resources, including seeds; (6) soil nutrient and carbon management and monitoring; (7) the policy, strategic and marketing planning; and (8) R&D on trade-off analysis and the identification of optimal organism farming systems that potentially generate maximum socioeconomic and environmental benefits.

One significant reason for knowledge and capacity gaps on organic farming, among other topics, is the poor quality of higher education and inadequate workplace training. For example, the Faculty of Agriculture at NUOL has been short of experienced staff and teaching facilities equipped to deliver practical and inclusive curriculum on organic farming. On-the-job organic farming training is insufficient and are offered only about two to three times per year by different stakeholders. Furthermore, there is no standardized module that covers most of the important crops and livestock production systems. Consequently, there is no best practice on organic farming training. The coordination between HRD demand and supply as with educational institutes and employment organisations on capacity needs and human resources supply has been weak and has caused capacity gaps and mismatched skills.

Another reason for knowledge and capacity limitations around organic farming is the insufficient budget. The organic farming association, under the Chamber of Commerce and Industry (CCI), lack sufficient budget for capacity building at both national and local levels. In the public sector, the DoA and the Department of Agriculture Extension and Cooperatives (DAEC) receives only small amounts of money for organic farming promotion and management. It is estimated that a budget deficit for capacity building could be around US$ 0.25million per year. This includes budget for capacity development on HRD planning, organic farming, products, commercialisation, which includes access to market and finance, development and operation of training modules, exchange and R&D.

Like other sector and technologies, the budget gap is correlated with the overall public budget deficit and the decline in international support. Organic farm entrepreneurs and their association are mostly SME with limited budget for capacity building. Despite the strategic plan on organic farming targeted towards the year 2020, the financial needs for capacity building is not defined; and a strategy for resource mobilisation has not been developed to seek for financial and technical support in both the public and private sectors.

4. Inadequate guidelines on specific organic farming systems and products

Practical guidelines for specific organic farming systems and products are inadequate. The current organic farming practices are based on the organic agriculture standards and principles defined in the decision on the organic agriculture standards (MAF, 2005), the manual for the Lao organic agriculture certification (DoA, 2011a), and the inspector's manual for organic agriculture farming (DoA, 2011b). While these only provide overall principles and standards, there is no specific guidance to step-by-step standard operations regarding: (1) production, processing, storage, packing, transport, inspection and quarantine of specific organic agriculture and wild products in order to ensure product quality and market requirements such as nutrition, aroma, colour, size and weight, sanitation and contaminations, (2) environmental management standards and impacts such as on soil, water and air quality, and occupational health management standards and impacts, and (3) measurable standards. The absence of a practical guideline and a standard operation procedure of each product not only causes difficulty for inspection, but also results in variable product quality and quantity standards, which finally impacts access to markets.

In sum, the absence of guidelines on organic farming is due to insufficient budget and capacity. The annual budget for research and development of these guidelines could be US$ 0.26 million; or it would cost about US$ 1.1 million to complete and make available the necessary guidelines. Thus far only 10% of the budget has been secured. The agriculture sector and organic farming stakeholders do not have a financing and resource mobilisation plan for R&D, or the capacity to formulate a plan.

4.3.3 Identified measures for promotion of organic farming

4.3.3.1 Financial and economic measures

1. Reduce investment cost and increase access to finance

Reducing investment cost on organic farming and products will alleviate financial burden and increase benefits which shall contribute to significant increase organic production. The most important cost reduction option is to ensure efficiency of organic farming business, which can be tackled by optimisation of production and agronomic solutions. This means it has to1) increase higher yield and healthier crops with the use of optimal or precise organic fertilizers application, resource recycled, crop management, land reclamation and organic land management, 2) Improve post-harvest technologies and bulk processing, 3) bulk or joined marketing improvement.

Second option is to reduce capital cost is lowering interest rate of loans or credits. The interest rate of loan shall be lessened by implementing the Prime Minister's decree on commercial interest rate (not higher than 7% per year). Secondly, analyse and introduce appropriate policy or directions to improve the capital market or guarantee and facilitate cooperation and access to capital with lower interest rate of overseas loan. To achieve these, capacity of domestic financial institutes and entrepreneurs are needed to enhance in order to capable to research and analysis of potential capital market the in regions including feasibility on cooperation.

Reduction or exception of import tax requires to appropriate policy for tax reduction or exception of organic farming business including import of product processing and packaging technology. A research on the impact, benefits or advantage and disadvantage of the policy, policy effectiveness and sustainability will be conducted to support policy formulation.

Promotion of organic farming value chain business such as manufacturing of equipment and packaging materials shall lead to reduction of investment cost, especially in long term. Promoting these businesses require creation 1) favourable policy and other business development enabling environment such as simpler procedure and requirement for start-up and operation of business, tax reduction, cheaper capital cost and easy access, 2) Improve curriculum, research facilities and demonstrations in education and research institutes. These initially require more financial and technical support and investment.

2. Increase access to capital and financial support

Increase access to and capital ready is determinant factor to boost organic farming. Improving access to finance or capital can be attained by implementation of following actions.

1) The Prime Minister's decree on commercial interest rate (not higher than 7% per year),
2) Capacity building for entrepreneurs to improve financial management system, feasibility study, development of bankable business plans including financial and economic analysis of the organic farm businesses,
3) Study and formulation of a policy and mechanism to facilitate and guarantee for access to domestic and overseas funds and loans.

3. Increase and effective management of financial support and investment for extension of organic farming

Increase financial support and investment for extension, especially for research, dissemination of information, capacity building, demonstration, marketing, development of infrastructure and policy is necessary in order to enhance favourable environments for organic farming development and sustainability. To secure financial support and funds from public, development partners and donors; effective resource mobilisation or access to, and management of financial support and funds are needed to be enhanced. In which, plans for resource mobilisation or access to financial support and funds plan, financial sources and fund directory, bankable organic farming project proposals and business plans including capacity to do so shall be developed. A financial aids and fund management system, apart from project or programme M&E, will be established to connect, record, monitor and evaluate effectiveness, efficiency, relevance, impact and sustainability, and provide directions for improving management of financial supports and investment from all sources.

3.3.3.2 Non-financial and economic measures

1. Increase capacity of organic farming stakeholder

Strengthening capacity of stakeholder is strategic measure to address barriers that hinders organ farming industry and mitigation. The capacity, especially knowledge and skills to be improved are:

1) Best practice and guidelines on sustainable or conservation farming including soil carbon and nutrient management techniques,
2) Organic farming inspection and certification including equipment and facilities for inspection,
3) Development of financial project and business proposal including financial and economic analysis,
4) Resource mobilisation including development resource mobilisation plan,
5) Sustainable farmer organisations,
6) Marketing and access to market,
7) Organic product diversification and product processing technologies,
8) Research and establishment of development fund or subsidy for agriculture including organic farming,
9) Organic farm land inventory, classification and management,
10) Research and monitoring of organic farm soil carbon and nitrogen,
11) Integrated and strategic planning and development,
12) Human resource development system including human resource or capacity development plan, staff knowledge management, monitoring and evaluation HRD including financing mechanism.

Realising these knowledge and skills require more investment as well as resource mobilisation. This means resource mobilisation plan will be developed, and research and policy on financing human resource will be conducted to provide directions for sustainable and effective human resource development.

2. Improve organic farming marketing

Although access to market is not the major problem, but since Laos also targeted to increase organic products, access to and penetration of market is key measure to expansion and sustaining organic farming. As mentioned above, improvement financial investment and capacity building on marketing are needed for expansion of organic farming and products. In addition, marketing areas to be enhanced are:

1) Research on organic products, markets, networks and development of organic market information,
2) Development of marketing strategy and promotional plan,
3) Products diversification and quality improvement including phytosanitary in accordance with ASEAN standard of organic agriculture (ASOA), international standard (ISO/IEC), AFTA, WTO and other regional market requirements,
4) Product packaging, trademark, labelling and inspection and accreditation,
5) Improve marketing network and joined marketing,
6) Development organic markets places and distribute channels,
7) Enhance effectiveness and extensiveness of promotion and advertisement in media,
8) Effective implementation of organic forum.

3. Improve policy framework for organic farming

Improvement of policy organic farming is important measure necessary for enabling environment and reference for developing and sustaining organic farming. Policies to be developed include the ones defined in the Table 15 as well as following policies:

1) Policy or regulations and directions on organic land management,
2) Policy on financing, subsidising, taxation and other financial incentives and mechanisms for promotion of organic farming and products,
3) Policy to facilitate and guarantee to access to finance or capital and technical support,
4) Policy and directions on guarantee and referencing for facilitating export organic products.

4. Improve organic farming and products management system

Improving organic farming and products management system is a fundamental measure for planning, capacity building, extension and marketing etc. These consist of improvement of registering and profiling organic farming businesses and products, and organic farming performance review and dialogue.

4.4 Barrier analysis and possible measures for enabling manure-based biogas

4.4.1 General description of manure-based biogas

The manure-based biogas is a GHG mitigation technology, particularly reduction of methane emissions from manure management system, fuelwood utilisation and import of LPG. Biogas could save 4.8kg/day of wood, 8.17kg/day of LPG, US$ 23/month from electricity and replacement of kerosene (SNV, 2006). In addition, it can reduce pollution such as water pollution, nuisance order and health related hygiene which may result from improper manure management.

Laos had annual biogas production potential of about 302.4m^3, which could be used to generate 51 MW of electricity (MEM, 2011). Currently there are approximately 5,000 manure-based biogas systems through the country. 3,000 biodigesters were established under biogas pilot programme during 2006-2012, of which more than 80% is 4m^3 biodigester and some are 6m^3 and 10m^3 (SNV, 2013). Based on a survey, 76% of the biogas owners are highly satisfied with their biodigesters while 67% affirmed that their plants have been functioning very well without any major problem (SNV, 2013). Despite strong support from the government, potentials and high satisfaction; expansions of the biogas are still on slow pace or only 10% of the target was met.

Biogas is market or consumer goods. There is a specific market and expansion of market depends on consumer awareness, promotion and commercial marketing cleaner energy, and change of energy consumption pattern. Since biogas is in early stage of development, public support and creation of enabling environment for diffusion is remained crucial.

4.4.2 Identification of barriers for manure-based biogas

Identification of barriers on biogas were also conducted according to barrier analysis process, which barriers were identified, screened, decomposition and analysis of root causes, through literature review, interview, analysis and validation of barrier list, key barriers and caused by consultations with key stakeholders. Key literature reviewed consists of agriculture development strategy to the year 2025 (2015), renewable energy strategy to the year 2025 (2011), biogas user survey (2011), summary report on the mini digester trial (2012),

Through the barrier analysis process including stakeholder consultations; long-list of barriers of biogas with barrier categorisation and ranking, key barrier decomposition and problems and solutions trees were formed as in Annex 6, 7 and 8, respectively. 7 critical barriers, 3 in the financial and economic and 4 in the non-financial and economic area, which are recognised as non-starter of biogas were discussed in the following.

TABLE 13 SUMMARY OF THE BARRIERS TO BIOGAS DEVELOPMENT AND SUSTAINABILITY

Broad categories of barriers	Barriers	Score
Economic and financial	1. Low profit	2
	2. High investment cost including high equipment cost, construction, operation and maintenance (O&M)	3

Broad categories of barriers	Barriers	Score
	3. Limited budget and financial support from government indulging incentives, subsidy and fund for biogas	3
	4. Investors, especially farmers have limited financial resources on biogas development	3
Market failures and imperfection	5. Small market (limited to livestock keepers)	2
	6. Small and variable supply of raw materials (manure)	3
	7. Limited accurate information about market/demand and capacity	3
	8. There are more energy options or demand e.g., wood which easier to access and use, hence distract use of biogas for cooking (grill)	2
Policy, legal and regulatory	9. Unclear policies on biogas promotion and regulation	2
Institutional and organisational capacity and human skills	10. Unclear or overlapping responsibility of amongst ministry of energy and mines, science and technology, livestock and environment on the management and promotion of biogas	2
	11. Ineffective and inadequate training and learning programmes	2
	12. Limited knowledge and technical skills on biogas including R&D on supplementary/substitute materials and more flexible biogas plants	2
Information and awareness	13. Inadequate financial and economic feasibility for diversifying new product or value-added e.g., bottled gas	1
	14. Little awareness on biogas including how to access to equipment, cost-benefits and return on investment	2
	15. Insufficient effective or best practice on awareness raising	1
Technical	16. Limited utility of biogas e.g., grill while it is common cooking culture of Lao	1
	17. Time consuming and strict O&M	2
	18. It is difficult or costly to design co-firing, R&D supplementary materials and more flexible biogas to use raw materials	2
Other	19. Unfavourable manure as a fuel and odder of methane	1
Remark: *Score 3 = crucial and urgent; 2 = important and needed; 1 = important but to be solved later*		

4.4.2.1 Financial and economic barriers

1. High investment cost

Investment cost on biogas is considerably high for rural households, especially poor and individual farmers who have limited financial resource (Keovilay, 2012). In order to sustain the biogas operation of a biogas programme (more than 1,000 biogas plants in the five provinces in the south of Laos), majority of biogas owners were subsidised about 24% of the total cost on average while financial support required by famers was about 50% of the total start-up cost (SNV, 2011).

Start up and maintenance cost is relatively high. On average, start-up or installation cost is at least US$ 300-400 (for 4-10 m^3 size biogas plants), of which construction materials and equipment accounted for approximately 72% of the total cost and the rest is the cost on unskilled labour and skilled labour which accounted for 15% and 12% of total cost, respectively (SNV, 2011). The construction materials are domestically available with a certain market price. The equipment such as gasifier and controller

are imported and tax reduction or exemption on the import such equipment is not executed. Domestic manufacture of equipment is likely possible, but its cost is perceived to be higher than imported one that the moment, though it could be more cost efficient in future and long-term.

The cost of materials (manure) is not major problem at the moment since most of the biogas owners own and have materials supplied from their livestock farms. Rising demand for manure for organic fertiliser for growing crops implies higher cost material supply associated with material variability and transportation in near future.

2. Limited capital and access to finance

Biogas owners or investors, especially small livestock holders are, in overall, have either insufficient capital or access to capital. This barrier restricts development and expansion of the biogas plants. Access to finance for biogas development is unprecedented and remained challenge. Majority of biogas owners, livestock farms or even extension workers are incapable develop bankable proposal including comprehensive financial and economic analysis. On the other hand, capital market is immature and favourable. Loans or credits served by domestic financiers fixed with high interest rates and complicated procedure and high requirements. Although the government issued an order to leverage commercial interest rate to 7% per annum, enforcement is infective. Favourable policy, guarantee, risk management or sharing mechanism or measures to facilitate access to domestic and regional capital sources are not clearly defined.

3. Limited public financial support and investment for biogas energy extension

Public budget investing on information collection and dissemination, capacity building and piloting of biogas is inadequate, leading to obstruction of extension works. Public investment might not be able cover major trainings and extension activities planned by and thinly spread amongst Department of Livestock and Fisher (DLF), Ministry of Agriculture and Forestry (MAF); Renewable Energy Research Institute (RERI), the Ministry of Energy and Mines (MEM); New Energy, Material and Innovation Institute (NEWII), Ministry of Science and Technology (MOST). Resource mobilisation, in the meantime, is ineffective. Information on financial and fund sources is scanty, resource mobilisation plan is not developed and capacity to fulfil this task is inadequate.

A main financial support on biogas is from development partners. The support is however fluctuated and not extensive. New biogas development projects under current cooperation programme between government and development partners are not identified.

4.4.2.2 Non-financial and economic barriers

1. Limited and variable materials supply

Material is determinant factor of the biogas. Shortage and irregular supply of raw materials can put biogas operation at risk which might lead to damage of digester and increase cost of maintenance or re-operation. It is the matter of fact that livestock farming in Laos is small to medium scale, free rang farming system and scattering. The amount of manure derived from such farming systems are small and

variable. Increase demand of manure to produce organic fertilizer or directly apply onto crop production might also divert raw materials from biogas. Assembling those raw materials is possible but it involves with high cost of transportation and storage. Substitute manure by other organic waste is theoretically possible for some materials, but technical knowledge and experiences on the use of such combined or substitute material is limited. Recently government, especially ministry of agriculture and forestry promotes integrated farming or corporate farming system and upscaling production in order for related with industrialization. The implementation of such programme is, however, slow progress due to insufficient budget for extension and support. In addition, capacity and experience to facilitate corporate and integrated farming models is limited.

2. Limited number and capacity of extension staff at local levels

Capacity, especially skills of stakeholder[28] on biogas equipment R&D is insufficient. It still relies on imported equipment, which affected cost and access. While MAF, MEM and MOST at national level are quite experienced in building biogas plants, skilful extension staff at local levels (provincial, district and village level) is not available. Fewer technical staff of department of agriculture and forestry (DAF), energy and mines (DEM) and of science and technology (DOST) at local levels is capable to demonstrate and facilitate biogas development biogas. In the meantime, biogas user groups have not had representatives who received trainings and be able to help themselves on maintenance, repair and access to biodigester equipment.

Lacking capacity on biogas equipment R&D implies weakness of education system on technologies, engineering and vocational development. It is fact that the stakeholders have limited experts, R&D facilities and financial support in the area of science and technology and engineering. Lacking of capacity at locals too, resulted from inadequate budget for training. So shortage of R&D, extension staff and budget hinder development and expansion of biogas on the ground.

3. Ineffective extension

Lack of information and capacity of stakeholders, especially farmers and local authorities are observable and this is an obstacle for biogas development and sustainability. Majority of existing biogas owners or farmers have not had capacity or experiences on biogas plant installation and maintenance, and potential biogas entrepreneurs and communities have not had sufficient information. These problems are mainly resulted from inadequate and ineffective information dissemination and trainings of entire target groups in local levels, especially dissemination of information on financial and economic including cost and benefits, equipment suppliers and training on installation and maintenance.

4. Technical weakness of biogas and other energy preference

Biogas can be efficient for small scales and some kinds of lightings and cooking, and somehow lessor preferred by users. Hydropower-based Electricity, which supplies more stable energy, larger and convenient is remained as more preferable choice for lightings. Fuel wood and charcoal is more

[28] Such as MAF, MEM and MOST, technical and vocational schools, faculty of engineering and agriculture of NUOL and private sector

preferable for cooking, especially grills which is common cooking style of Lao people. Furthermore, they are more affordable, easy to use and maintenance. So, limited utility of biogas and more energy options to choose from divert interest in biogas development and uses. This is matter of technical disadvantage of this technology and solving is challenge. However, larger biogas and diversification of biogas product such as bottled gas would leverage future deployment of biogas.

4.4.3 Identified measures for promotion of manure-based biogas

Fully and sustainably deployment and diffusion of the biogas requires more investments from both public, private sector and development partners. Specific measures to attract and increase such investment can be divided into financial and non-financial and economic as follows.

4.4.3.1 Financial and economic measure

1. Reduce cost on biogas investment

Reducing cost of biogas is a straightforward measure to alleviate financial burden and a mean of promotion for biogas developers, particularly farmers. The cost can possibly be reduced or alleviated in four pathways in the three development phases: pre-during and post construction of biogas. Those sound effective cost reduction options are reduction or exception of import tax, cost on capital, material and labour, cost sharing or subsidy by the government and promotion domestic production of biogas technology or equipment.

Reduction or exception of import tax requires favourable policy on the reduction or exception of biogas technology import tax. This means specific policy is needed to develop and enforced effectively. Development of policy should be supported by research on the impact, benefits or advantage and disadvantage of the policy, policy effectiveness and sustainability in both short and long term.

Capital cost reduction or lowering interest rate of loans or credits can be attained by implementation of the Prime Minister's decree on commercial interest rate of loans or credits (not higher than 7% per year). In addition, it is important to develop appropriate policy or directions to improve the capital market or guarantee and facilitate cooperation and access to more favourable capital of domestic biogas investors and financial institutes. To effective implementation of such activities, review of the capital market performance in Laos and analysis of potential capital market the in regions including feasibility on cooperation are needed.

Cost on the materials is reducible in term of reduction of cost on transportation, by promoting and shifting from scattered and small-scale materials supply to integrated farm system and bulk supply. This means it is needed to promote corporate and larger farming system, zoning of production areas and also improved transport and logistic system.

Reducing labour cost or skilled labour cost might be feasible, especially in long-term for example by enhancing local technical skills on biogas to replace skilled labour. While building capacity for local increases present cost, but it should be long term investment and cost efficient.

Cost sharing or subsidy by government is a preferable option and deem as useful promotion for local, especially in early stage of biogas deployment and diffusion. This method might not completely reduce the cost as cost is trans-located to the government. However, this can be a promotion or incentive and alleviates financial constraint for local for the start. To achieve this, policy on biogas subsidy is pre-requisite to provide guidelines for the subsidy implementation. Similar to formulation of policy on tax reduction for biogas, the development of the policy on subsidy should base on a comprehensive research and feasibility study in order to ensure effectiveness, efficiency and sustainability in application of subsidy policy and mechanism.

Promotion of manufacturing of biogas equipment is an option to reduce cost in long run. This is because the more producers and suppliers, especially by domestic and increase competition, biogas equipment cost is anticipated to decrease. To this end, it also needs to create enabling environment for business development and policy to promote investment including ease of access to finance.

To sum up, to implement the measures and address cost constraints for biogas, following actions are also needed.

1) Study and introduction of policy on tax exception subsidy mechanism and other incentives for biogas development;
2) Promote integrated, corporate and medium and larger farm along with production zoning in order to improve efficiency and optimisation of raw material collection and biogas production;
3) Enhance local or biogas owner capacity;
4) Enabling environment for business development including access to finance and improved logistic system.

2. Enhance access to finance

Improvement of access to finance and capital may take sometimes for Laos, where capital market and financial institutes are relatively small. Recent Prime Minister's decree which called for interest rate of commercial loan to stay not more than 7% per year, however, if implemented effectively, shall be helpful in reduction of financial barrier for entrepreneur including farmers and other biogas developers for the moment. To access to finance, in any case, these is immediate need to strengthen capacity and readiness of entrepreneurs such as financial and economic management system including record of company or producer group or individual household and bankable proposal including financial-economic analysis of the project.

4.4.3.2 Non-financial and economic measures

1. Ensure materials supply

To ensure adequate materials for biogas and in efficient manner, it requires promotion growth of livestock industry including type and size of farming such as integrated, corporate and larger farm with a standard of manure management. This means there is a need to promote and enhance establishment of livestock production group and farm standard. In addition, it also needs to ensure sufficient feed for livestock while reduce free grazing. To achieve these, following measures or enabling environment for

development livestock business including livestock market expansion and feed development and related technical extension.

2. Increase capacity for biogas extension and development

Enable stakeholder, especially extension workers, biogas groups and potential developers to construct and expand biogas is crucial measure. The capacity, especially knowledge and skills to be strengthened are listed below and to fulfil those, financial investment as well as resource mobilisation is needed.

1) Feasibility study including financial and economic analysis such as cost and benefits including return on investment,
2) Design, construction and maintenance of biogas plant,
3) Estimate of emission reduction for carbon credits mechanism such as CDM/JCM,
4) Development of bankable proposal for access to finance,
5) Capital market development and management,
6) Research and development of biogas equipment.

4.5 Barrier analysis and possible measures for enabling agricultural residues-based electricity

4.5.1 General description of agricultural residues-based electricity

Agricultural residues-based electricity is a second-generation biofuel which crops and plants dry matter are utilised as the main feedstock. The biomass plant and production process of electricity include feedstock preparation and storage, loading and burning feedstock in the boiler systems to produce steam that runs the turbine to produce electricity. Laos has this energy potential equivalent to 500 million tonnes of oil (MEM, 2011). Saw dust, rice husk and corn cobs only is about 580,000 tonnes, which can generate energy of about 8.5 million GJ or 200 KTOE[29] per year.

Renewable energy including biomass is, apart from boosting energy security, crucial for reduction of emissions and pollution. Despite the potentials and government promotes, biomass energy is just initiated and has not fully exploited in Laos. At present, there are few investors/developers and biomass plants with install capacity of about 3.5 MW (IEA, 2011). Definable ones are the 40 Kw corn cobs-based electricity scheme in Xayaboury province and160 Kw rice husk energy plant in Champasack province, which received financial support from neighbouring country. Two larger biomass plants using sugarcane's bagasse feedstock were planned to operate in Attapue and Savanakhet province, with capacity of 30 MW and 9.7 MW[30], respectively but it has not been entirely developed. In addition, biomass energy potentials from other agricultural and forestry residues, crops and plants have not comprehensively studied.

Biomass is market or capital goods. Developing and sustaining biomass energy requires relatively huge capital and investment. Although biomass energy potentials exist, it requires active public support to create favourable environment for developments, especially facilitation to access to finance, capacity building, demonstration and piloting in the beginning of deployment and diffusion.

4.5.2 Identification of barriers for biomass-based electricity

Barriers on biogas were identified following barrier analysis process: barrier identification, screening, decomposition and analysis of root causes, which were attained by literature review, interview, synthesis and validation of barriers in consultation workshops with stakeholders. As a result, long-list of barriers on biomass development with barrier categorisation and ranking, the key barrier decomposition and problems and solutions trees were mapped out as shown in Annex 7, 8 and 9, respectively. The most important barriers were grouped into two main areas: financial and economic and non-financial and economic barriers as follows.

TABLE 14 SUMMARY OF THE BARRIER TO BIOMASS ENERGY DEVELOPMENT AND SUSTAINABILITY

[29] https://www.asiabiomass.jp/english/topics/1502_01.html

[30] http://www.oeaw.ac.at/forebiom/WS2lectures/02-02-NLAEMSAK.pdf

Broad categories of barriers	Barriers	Score
Economic and financial	1. Low profit and/or not economic and financial feasible	3
	2. High investment cost, especially installation/start-up, O&M cost	3
	3. Unclear financial and economic of establishment of plantation to supply raw materials, co-firing system	3
	4. Undeveloped capital market and limited access to financial resources	3
	5. Inadequate public financial support including financial and economic incentives, subsidy and fund for feasibility, demonstration and initiation biomass energy	3
Market failures and imperfection	6. Uncertain market (off-grid and carbon credit)	2
	7. Low renewable energy price	3
	8. Small and variable agricultural and forestry production and supply of raw materials	3
	9. High demand for agriculture residues and wood waste for other purposes (return to field for soils conservation and cooking)	2
Policy, legal and regulatory	10. Unclear policies on biomass promotion, especially feed-in tariff or adder	3
	11. Unclear or overlapping responsibility of amongst ministry of energy and mines, science and technology, agriculture and forestry and environment on the management and promotion of biomass energy	2
Institutional and organisational capacity and human skills	12. Limited technical knowledge and skills on biomass energy, especially access to finance, resource mobilisation, engineering and R&D of supplementary raw materials and co-firing systems	3
Information and awareness	13. Inadequate accurate information of raw materials for feedstock, cost-benefits and return on investment on biomass	2
	14. Low awareness on biomass energy and reference/successful projects	2
	15. Inadequate and ineffective R&D and information dissemination	1
Remark: *Score 3 = crucial and urgent; 2 = important and needed; 1 = important but to be solved later*		

4.5.2.1 Financial and economic barriers

1. High investment cost

Biomass to energy technology remains costly, and this high investment cost is a main burden, particularly domestic investors. Despite government promotes domestic investors to develop and operate small scale renewable energy (<15 MW), there might be only fewer domestic investors who have adequate financial resources. Most of them might be able to cover only upfront cost such as FS including EIA and engineering design but access to additional fund is often needed. Based on the data provided in the renewable energy strategy to the year 2025, the cost for start-up of the biomass is approximately US$ 1.8 million per 1 MW. In cases biomass project is located in the remote area, poor road access and far from existing national and provincial grid and station system; the total investment cost could probably be US$ 2.5-3 million per 1 MW. The equipment and construction cost, for example, engineering, procurement and construction (EPC) may accounted for60-70% of total investment cost. The infrastructure such as transmission line and access road is costly, but varies depending on sites and enabling environment. Capital cost, especially annual interest rates of loan offered by domestic banks, which range from 9-12%. Consulting service such as feasibility study (FS) might cost US$ 0.3-0.5

million and environmental impact assessment (EIA) US$ 0.05-0.15 million. O&M cost including transportation raw materials might account for 5-10% per annum [31], and implementation of environmental and social management plan (ESMP) could be also high, depending on impact. This explicit high investment cost is because of equipment itself which is expensive and its import tax, capital cost and transaction, infrastructure and environment. In addition, it is due to high expenditure for international consulting service for FS, engineering design and construction, and O&M, as Lao experts and capacity are limited and/or it is required.

2. Low renewable energy prices

The price of renewable energy including biomass electricity price is treated the same as other energies or between US$ 0.05-0.65/kwh and there is no promotional price mechanism such as feed-in tariff or adder rates as many countries do. Although biomass energy deems feasible and profitable, the low energy price affected profit and attractiveness of the biomass energy business, especially when investment cost stays high.

These promotional prices are not applied since public fund to cover and apply higher prices is inadequate. Furthermore, the study on feasibility, trade-off and impact of the incentives has not been performed to provide information for support decision making.

3. Limited capital and access to finance

Biomass energy investors, especially domestic ones are in overall, have limited capital and access to finance. These prevent start-up and expansion of biomass energy business. Several renewable energy projects such as medium and large hydropower and mining projects were successfully accessible to favourable finance or loan from multi-banks and financial institutes.

Access to finance for small scale renewable energy including biomass projects are, however, remained challenges and lack of reference project. The capital market is undeveloped; interest rates of loans provided by domestic financiers are high and procedure and requirements are complicated. Implementation of the government order on the lowering commercial interest rate to 7% per annum is infective. Favourable policy and mechanism to warrantee or facilitate access to regional capital markets are inexplicit. The majority of domestic biomass investors are, in the meantime, still lack of financial and economic capacity such as financial management and development of bankable proposal including comprehensive financial and economic analysis. The Energy and Environment Partnership Mekong programme (EEP Mekong) for small scale renewable energy project is operating its 2nd four-year phase, from 2014 to 2018. So far, none of domestic entrepreneur or renewable energy including biomass project in Laos is capable to access to EEP.

4. Insufficient financial and economic incentives

[31]Based on interview and expert judgements

Financial and economic incentives such as cost sharing, subsidy and tax reduction for biomass energy business are either limited or inexistent. This is another barrier or factors that deter biomass energy development. The required incentives that are absent include:

1) Tax reduction, exemption or holiday for biomass energy business including importing of equipment,
2) Guarantee for facilitate access to finance, fund, network and technical support,
3) Cost-sharing and subsidy,
4) Promotional prices, feed-in tariff or adder rates,
5) Piloting project with private sector involvement.

5. Limited financial support and investment for biomass energy extension

Public financial investment on research, capacity building, feasibility and piloting of biomass energy is fairly limited and this becomes a limiting factor for extension of biomass business. Government allocates 1% of the GDP for research and development, but none of renewable energy research project is funded under this budget line. Public investment, for example, for research and extension by Renewable Energy Research Institute (RERI), the Ministry of Energy and Mines (MEM) is only 2.5%-5% of the required annual budget of US$ 100,000-200,000.

The local and rural electricity fund (LREF) to enhance access to electricity in rural area was established in 2005. Currently fund is small. The main source of income is from electricity consumption fee and not secured from other sources. Fund to investment and expand electricity network and supply in all rural areas through the country is insufficient.

4.5.2.2 Non-financial and economic barriers

1. Inadequate information and awareness on biomass energy

Information and awareness on biomass energy of several stakeholders is inadequate, and this is a root cause for biomass energy development. The information about biomass energy and feasibility, particularly financial and economic information, feedstock, technology and equipment, and actual mitigation potentials are scanty. Financial and economic information such as cost-benefits and return on investment on biomass is not widely available and accessible. There are some feasibility studies including financial-economic analysis of the operating biomass projects, but the information is reserved for the project and lack of sharing. Likewise, the information on materials for feedstock and technology, especially accurate quantity and quality of agriculture and forest residues availability from all sources and types, its optimisation is not available and completely researched. Information on suitable technologies or equipment, where and how-to access are also limited.

Dissemination of information and awareness raising, in the meantime, are not extensive and reach out to existing and potential entrepreneurs and effective. Dissemination of and facilitation to access to information by public sector was limited due to budget and information limitation. Information exchange amongst private sectors, for instance, via chamber of commerce and industry is also limited because of insufficient information and specific biomass business. In addition, cooperation with

regional chamber of commerce as well as exchange with regional biomass energy entrepreneurs is insufficient.
Lack of information and awareness resulted in a stagnant situation or ineffective promotion, leading to low intention or confidence to pursue biomass energy.

2. Variable raw material supply

Raw material and feedstock is crucial for biomass development and sustainability. Variable raw material and seasonal supply are critical for commencement and expansion of biomass energy. Supply of raw materials can be fluctuated since agriculture and forestry production in Laos is rather season dependence, crops production areas and quantity fluctuated and some crops are temporal production. In addition, the production is scattered and some limited access due to poor infrastructure. On one hand, demand for agricultural and forestry residues are increasing for soil conservation and other purposes, which part of residues is required to return to soil or be kept on the farms. Feasibility of alternative materials such as energy grasses and plantations for supplying as biomass and supplementing agricultural residues have not been comprehensively studied in Laos due to limited awareness, knowledge and budget.

Uncertainty of raw material and feedstock is not only challenge for the expansion of biomass energy, but it also put the existing business at risk. Existing entrepreneurs have no plan to expand the production capacity and new biomass investment project is likely pending due to information on biomass energy including accurate data on raw materials, energy prices and incentives remains unclear.

3. Insufficient capacity on the extension and development of biomass energy

Capacity, especially knowledge and skills of both public and private sector on biomass energy are considerably limited and this is essential barrier for extension and development of biomass energy. Knowledge and skills gaps are:

1) Feasibility study including engineering, financial and economic analysis such as cost and benefits including return on investment, and mitigation technologies,
2) Operation and management of biomass energy and chain businesses,
3) Design, construction and maintenance of biomass energy plant,
4) Estimate of emission reduction for carbon credits mechanism such as CDM/JCM,
5) Development of bankable proposal for access to finance,
6) Capital market development and management,
7) Research and development of feedstock including alternative feedstock such as energy grasses and plants,
8) Development of comprehensive policy to facilitate biomass energy business development, access finance and technologies, promote renewable energy prices and management of agriculture and forest restudies in sustainable manner.

The limitation of knowledge and skills is a consequence of weak human resources management and development and financial investment. Comprehensive and synergy human resource or capacity development plan of relevant governmental organisations such as renewable institute of MEM, new renewable and innovation of MOST, MoNRE and faculty of engineering of NUOL is not available.

Numbers of staff of these organisations have not had background on biomass energy, engineering, business and relevant specialisation. Furthermore, training needs assessment and implementation are still ad hoc and lack continuity and evaluation. Private sector which is represented by chamber of commerce and industry (CCI) has not had capacity development plan on business including biomass energy for their potential members.

Financial investment for capacity building is insufficient. Public budget for short and long-term capacity building, improvement of human resource development plan and management system, curriculum, research and research facilities is inadequate. In addition, effective mechanism for secure financial support or address budget shortage is not in place. Main causes of financial shortage were discussed above.

Limited knowledge and skills has profound impact and deter development energy biomass. As mentioned, it impeded research and information development, access to finance, development policy and enabling environment for sustaining biomass business and greenhouse gas mitigation.

4.5.3 Identified measures

4.5.3.1 Financial and economic barriers

1. Reduce investment cost on biomass energy

Reduction of the investment cost for biomass deems an effective way of biomass energy promotion. The cost can be reduced directly or indirectly. Possible options are to decrease and/or alleviate cost on capital, the electricity network, tax reduction or exception, material, consulting service and skill labour and subsidies by the government.

Reduction of capital cost or lowering interest rate of loans or credits is preferable and a critical measure to promote biomass energy business. The immediate action is implementing the Prime Minister's decree on commercial interest rate (not higher than 7% per year). Secondly, it is necessary to analyse and introduce appropriate policy or directions to improve the capital market or guarantee and facilitate cooperation and access to favourable capital of domestic biomass energy investors and/or financiers. To fulfil these actions, it needs review of the capital market performance in Laos and research and analysis of potential capital market the in regions including feasibility on cooperation.

Cost on the electricity network might not be entirely reduced. The cost burden can be relieved by cost sharing and makes a clear-cut responsibility on electricity network between biomass investors and public and electricity network development is pioneered by public sector. This means Securing fund for or enhance implementation of the electricity network expansion plan[32] will alleviate cost on electricity network that might bear by biomass developers/investors and trigger biomass energy development.

Tax reduction or exception for biomass energy projects that located in and contributing directly to rural electricity development and poverty reduction is allowed by policy on electricity, is deserved So,

[32]http://www.laoenergy.la/pageHotNews.php?id_hotNews=41

enhance implementation of this policy shall partly reduce cost on biomass energy. In addition, for sustainability and win-win situation, there is a need to research and to provide comprehensive framework, standard procedures or practice guidelines on reducible and exempt-able tax.

The cost on the materials/feed stock would be mitigated in term of reduction of material transportation cost. The transportation cost might be reduced by 1) improving transportation network and logistic system, and 2) promoting larger, more integrated and permanent agricultural production as well as bulk supply of materials. For sustainability and win-win situation, research and provide clear-cut responsibility between biomass project and public investment road access are needed.

Reducing cost on consulting service can be attainable by promoting domestic experts and technical skills and service. This measure sounds efficient, especially in longer term and aligns with labour law on promotion domestic labour and skills in development projects. So, there is a need to effective implementation of labour law. Research and development a standard guideline for enhancement of domestic experts and local capacity building in development projects is required to strengthen.

Subsidizing biomass by government is an important promotion measure, especially in the demonstration and piloting biomass energy deployment and diffusion. To implement this measure, there shall be research to develop a policy to provide principles and guidance for appropriate subsidy.

Promotion of domestic production of biomass equipment is also crucial for alleviating cost in long term and industrialisation and modernisation, which is in line with government policy. To achieve this, there is a need to develop a policy and mechanism for promotion of biomass business development, capacity building for private sector to access to finance, research and educational institute on biomass technology and equipment.

2. Upgrade renewable energy price

Increase biomass energy price is critical measure for promotion and development of biomass energy. Better price affects viability of biomass energy, and increase revenue which is important pull factor for investment. Pricing mechanisms such as feed-in tariff and adder are common practices in regions and are considered as effective and feasible measures for Laos as well. To ensure its applicability, effectiveness and sustainability; however, study on these pricing schemes, financial and policy readiness, alternatives and mechanism to cover such additional cost of government shall confirm feasibility; provide win-win and sustainable solutions or suggest when and how to apply.

3. Enhance access to finance

Enhancing access to and secure sufficient capital is determinant for biomass energy project. To access to finance or capital, following actions and enabling environment shall be proceed.

1) Reinforce the Prime Minister's decree on commercial interest rate (2015),
2) Strengthen capacity of entrepreneurs such as financial management system of enterprises and preparation of bankable proposal including feasibility study, financial-economic analysis and model of the biomass project,

3) Study and develop policy and mechanism to facilitate and guarantee for access to domestic and overseas funds and loans.

4. Increase public investment and financial support for extension

Increase financial investment for extension is required for biomass energy development and sustainability. Increase financing extension activities such as research on feedstock materials, capacity building, dissemination of biomass energy potentials and feasibility, piloting biomass projects and development of policy shall create favourable environments facilitating for biomass development. Two main measures or options to increase fund for extension are1) enhancing resource mobilisation or access to funds or financial support and 2) ensure financial or fund management effectiveness and reliability.

Effective resource mobilisation requires practical resource mobilisation plan and detail information or financial sources and funds directory, financeable project proposals with comprehensive financial and economic and environmental impact assessment in place. Capacity, in the meantime, shall be developed to enable preparation and implementation of these plans in effective manner.

Effective financial investment management requires a central-linked or one-door financial management system, in addition to common project M&E and financial audit, for record information, monitor and evaluating effectiveness, efficiency, relevance, impact and sustainability, and reflect whole financial aids and investments.

4.5.3.2 Non-financial and economic barriers

1. Ensure raw material supply for biomass energy

Sufficient material or feedstock supply is indispensable measure for biomass energy development and sustainability. Recent agriculture and forestry strategy promotes growth and sustainability of agricultural and forestry production and farmer groups. So, in overall, enhance implementation of the strategy would lead to secure adequate raw materials supply in bulk. In addition, research and development of alternative feedstock such as energy grasses and trees for shall provide opportunities to increase materials and supplement agricultural residues for biomass energy industry. The use of agricultural and forestry residues for energy, however, should not compromise soil conservation. This means regulations and guidelines on agricultural residues utilisation for energy shall be developed in order to maintain soil fertility and nutrients while it is secured for energy.

2. Increase capacity for extension and development of biomass energy

Improving capacity of stakeholder is essential measure to tackle with barriers and boost biomass energy development and sustainability. The capacity, especially knowledge and skills to be strengthened comprise:

1) Feasibility study including financial and economic analysis such as cost and benefits including return on investment,
2) Operation and management of biomass energy and its value change businesses,
3) Design, construction and maintenance of biomass energy plant,

4) Estimate of emission reduction for carbon credits mechanism such as CDM/JCM,
5) Development of bankable proposal for access to finance,
6) Capital market development and management,
7) Research and development of feedstock including alternative feedstock such as energy grasses and plants,
8) Development of comprehensive policy to facilitate biomass energy business development, access finance and technologies, promote renewable energy prices and management of agriculture and forest restudies in sustainable manner,
9) Human resource development system including human resource or capacity development plan, staff knowledge management, monitoring and evaluation HRD including financing mechanism.

Strengthening these knowledge and skills needs more financial investment as well as resource mobilisation. Resource mobilisation plan will be developed and implemented in the mean time

3. Development of policy to promote biomass energy

Having policies for promotion sustainable development of biomass energy is a necessity for biomass energy development. Policies on tax reduction, upgrade prices, subsidizing, facilitation to access to finance, and management of agricultural residue biomass, for example are imperative to be formulated and implemented. Exchanges on the implementation of similar policies in the regions shall provide information and lesson for selecting best practices for Laos.

4. Increase research, information and awareness on biomass energy

Research and make available information and data necessary for policy, strategy and project development are urgent need. The research and information shall focus on : 1) study of actual potentials of existing agricultural and forestry production residues and feasibility of energy grasses and trees, 2) available and suitable biomass technologies including hybrid system,3) feasibility study including financial and economic information such as cost and benefits, 4) study about access to capital/finance and funds, 5) cooperation and networking on technology transfer or exchange, 6) renewable energy pricing and related financial policy and mechanism and 7) research and development on biomass energy equipment.

Once information is available, another important task is to disseminate the information to ensure that stakeholder, especially biomass energy developers and target groups are awareness of and interested in development and support biomass energy.

4.6 Enabling framework for overcoming the barriers in agriculture sector

Base on the key barriers and measures on feed improvement, organic farming, biogas and agricultural residue biomass-based energy; enabling framework and environments for addressing those barriers and to effectively implement the measures to lead to substantial and sustainable development of agricultural mitigation technologies can be summarised as follows.

1. Network, cooperation and integration

Improving networking, seek for supports and cooperation with, for example, Food and Agriculture Organization of the United Nations (FAO), International Federation of Organic Agriculture Movements(IFOAM), and United Nations Conference on Trade and Development (UNCTAD). The International Federation of Organic Agriculture Movements (IFOAM) to promote organic farming is exceptional needed. To be effective, roles and responsibilities of relevant organisations on the cooperation will be clarified. In addition, it needs to enhance capacity and internal coordination to implement activities under Task Force ASEAN Standards for Organic Agriculture (ASOA).

Furthermore, organic expert and entrepreneur association, and exchange platform such forum will be enhanced to facilitate development and sustainability of organic farming, animal feed, biogas and biomass energy.

2. Macroeconomy

Macroeconomy including sustainable economic development and green growth, reduction of poverty and trade deficit, enhance integrated land use, climate resilient and food security which are driven by the government are advantageous for development agriculture sector and technologies. However, to optimise the opportunities, forest sector and technologies will be integrated and mainstreamed in accordance with the developments.

3. Regional financial and forestry products markets

Agricultural products and financial markets are, despite fluctuated, growing and advantageous. However, promotion of production, the government warrants and financial risk management mechanism to access to markets and capacity of both public and private sector will be strengthened. Furthermore, actions will be taken to increase knowledge and capacity to promote domestic products and access to regional markets under ASEAN Economic Community (AEC), least development countries (LDC), World Trade Organisation (WTO) trade preference and mechanisms.

4. Improvement of information, technologies and access

Improvement of information and available data together with fast developed Information and Community Technology (ICT) are advantageous for communication and access to information. However, to make uses of the opportunities effectively, capacity and application of the ICT in agriculture sector will be enhanced.

Chapter 5 Conclusion

Majority of the climate change mitigation technologies or practices in both forestry and agriculture sector, particularly effective protected area management, sustainable community forest management, optimal plantation forests, agroforestry, animal feed improvement and organic farming are publicly provided or other non-market goods, except biogas and biomass energy, which are classified as market goods, especially capital and consumer good. However, the government still has crucial roles on the promotion, development and management of the technologies or practices since most of them are still in early stage of development or not effectively and sustainably developed and deployed.

Barriers to effectively and sustainably develop and deploy the mitigation technologies of both sector, based on barrier analysis such as barrier identification, screening, decomposition and analysis of root causes, can be divided into two main categories: financial and economic and non-financial and economic barriers. In which, there are 5 common financial and economic barriers namely: 1) insufficient financial resources for promotion, development and management, 2) insufficient effective or win-win financing and financial risk management mechanisms, 3) low and or not financial and economic feasible investment, and 4) low profit and high investment cost of the technologies, and 5) inadequate financial and economic incentives; and 6 common non-financial and economic barriers included: 1) inadequate skills for promotion, development and management of the technologies, 2) limited information on financial, economic and technical feasibility, 3) technical difficulty or utility of the technologies, 4) insufficient reference projects and best practices, 5) insufficient and conflict policy framework and 6) market failure. In addition, there are other specific barriers to specific technologies, for example, inadequate and variable raw materials supply for biogas and biomass energy technology; geographical and physical difficulty to access to survey, plan and develop some areas of the protected areas, and environmental impact of existing plantations.

To overcome those barriers, following measures and enabling framework need to be in place and enable the implementation effectively.

Barriers	Measures	Enabling framework
Inadequate public budget for promotion, development and management of the technologies	Promote and maximise revenues from enterprises and reinvestment in the of the technologies	1. Policies on the promotion of environmentally friendly technologies 2. Promote national science and technologies R&D 3. Effective management and allocation of public budget 4. Effective and transparent financial aids policy and management system 5. Policy for promotion investment, business and development private sector including capital market and access to finance 6. Promote macro-economic growth
	Enhance resources mobilisation and access to financial and technical supports from external	
	Improve public budgeting and financial mechanisms including incentives and subsidies	
	Improve effectiveness and transparency of financial aids	
High investment cost	Reduce tax, improve cost sharing and transfer mechanism while promoting incentives	
Limited capital and access to finance	Increase trustworthiness and financial capacity of the entrepreneurs	
	Develop and implement policies including warrants for facilitation to access to finance	
	Improve financial risk management mechanism, implying requirements and procedures to access to finance	
	Enhance capital and financial markets	

Barriers	Measures	Enabling framework
Market failure	Improve market information and marketing	7. Integrated land use and spatial plan including land suitability map 8. Effective law enforcement, especially natural resource, environment and impact assessment 9. Reference, especially successful projects and best practices
	Improve quantity and quality of products	
Limited organisational capacity and staff technical knowledge and skills	Improve HRD systems including capacity need assessment, HRD and capacity building plan, staff knowledge management	
	Improve high education and professional training	
	Improve HRD polices and financing	
Insufficient and conflict legal framework	Improve R&D effective legal framework and best practice law enforcement	
	Improve law on legislation development, especially promotion of public and multidisciplinary participation in a legislation development	
	Complete legal framework	
Technical	Improve R&D on the technologies including its value chain, alternative technologies and guidelines on sustainable or effective practices for promotion, development and management of the technologies	

References

Akinnifesi, F.K., Sileshi, G., Ajayi, O.C., Chirwa, P.W., Kwesiga, F.R. and Harawa, R., 2008. Contributions of agroforestry research and development to livelihood of smallholder farmers in Southern Africa: 2. Fruit, medicinal, fuelwood and fodder tree systems. *Agricultural Journal*, *3*(1), pp.76-88.

Albrecht, A. and Kandji, S.T., 2003. Carbon sequestration in tropical agroforestry systems. *Agriculture, ecosystems & environment*, *99*(1), pp.15-27.

Baird, I.G. and Shoemaker, B., 2007. Unsettling experiences: Internal resettlement and international aid agencies in Laos. *Development and change*, *38*(5), pp.865-888.

Barney, K., 2008. China and the Production of Forestlands in Lao PDR. *Taking Southeast Asia to market: commodities, nature, and people in the neoliberal age*, p.91.

Bounyasouk, T., 2014.Organic and GAP Development Update in Lao PDR.

Bouwman, A., 2001. Global estimates of gaseous emissions from agricultural land. *FAO, Rome*, p.106.

Braeutigam, D., 2003. Community Based Forest Management in Cambodia and Laos. *Frame Conditions, Selected Examples and Implications. MRC-GTZ Cooperation Programme. Available online: http://tnmckc. org/upload/document/aifpws/2/2.1% 20BraeuD% 20CF% 20Cambodia% 20Laos% 20WP, 203*, p.20031125.

Carew-Reid, J.E.R.E.M.Y., 2003. Protected areas as engines for good governance and economic reform in the Lower Mekong region. *Protected Areas Programme*, p.5.

Cha, J.H. and Youn, Y.C., 2007. A Plantation Feasibility Study in Lao People's Democratic Republic Using SWOT Analysis. *The Journal of the Korean Society of International Agriculture*.

DoA, 2011a. *Manual for the Lao organic agriculture certification.* Agriculture standards division.

DoA, 2011b. *Inspector's manual for organic agriculture farming.* Agriculture standards division.

DoFL, 2016. *Livestock development strategy to the year 2020 of Lao PDR* (draft). Department of Fishery and Livestock.

DoLF and SNV, 2011. *Biogas User Survey 2011*.Lao Biogas Pilot Project (BPP). Department of Livestock and Fishery, Ministry of Agriculture and Forestry, Lao PDR and Netherlands Development Organisation

Duangsila.T and Pouangchompu.S., 2012. *Agroforestry Systems for Upland People in Lao PDR: Production, Benefit, and Farmers' Satisfaction Analysis*

EPF, 2014.The Protected Area and Wildlife Project (PAW), the Environmental and Social Management Framework (ESMF) for Environment Protection Fund (EPF) Lao PDR, Government's Office.

Ervin, J. and Gidda, S., 2012. Input to the Report of the High-Level Panel on Global Assessment of Resources for Implementing the Strategic Plan for Biodiversity 2011–2020: Target 11.

FAO, 2000. *Global Forest Resources Assessment 2000.* Main Report. FAO, Rome, Italy 512 pp.

FAO, 2005: *Livestock Sector Brief: Lao PDR*. Food and Agriculture Organisation of the United Nations, Rome, Italy.

Foley, S., 2009.Laos-Planting for the Future.

Ghimire, P.C., 2007. Biogas Pilot Programme (BPP).

GIZ, 2008. *Enterprise Survey Report 2007*.Human Resource Development Market Economy (HRDME). Deutsche GesellschaftfürTechnischeZusammenarbeit (GIZ).

GIZ, 2014. *HRDME Enterprise Survey 2013 for Lao PDR*, Vientiane, July 2014

GoL, 2015. *Decree on conservation forest*, Vientiane.

http://www.shanghaidaily.com/article/article_xinhua.aspx?id=197310 (cited in Vientiane Times). Accessed on Jan 30, 2016a.

http://www.vientianetimes.la/sub-new/Opinion/Opinion_Forests.htm. Accessed on Jan 30, 2016b.

ICEM, 2003.*Lao PDR National Report on Protected Areas and Development.* Review of Protected Areas and Development in the Lower Mekong River Region, Indooroopilly, Queensland, Australia.101 pp.

IPCC, 2000. *Land use, land-use change and forestry. amiable at:* http://www.grida.no/climate/ipcc/land_use/500.htm.

IPCC, 2007. https://www.ipcc.ch/publications_and_data/ar4/wg3/en/tssts-ts-2-6-technology-research.html. Viewed on 26 December

IUCN, 2011. *NBSAP Assessment: An assessment of Lao PDR's National Biodiversity Strategy to 2020 and Action Plan to 2010.* Gland, Switzerland: IUCN.46pp

Jude, A., 2012. *Overview of Renewable Energy Policies in the Mekong Region.* Policy and Incentive Mechanism for Renewable Energy Development in EEP Mekong Countries, Hanoi.

Keovilay, P., 2012. Household biogas technology to improve rural livelihoods in Laos. *Journal of Developments in Sustainable Agriculture*, *7*(2), pp.158-163.

Kubiszewski, I., Costanza, R., Paquet, P. and Halimi, S., 2013. Hydropower development in the lower Mekong basin: alternative approaches to deal with uncertainty. *Regional Environmental Change*, *13*(1), pp.3-15.

Lao, P.D.R., 2015. *Drivers of Forest Change in the Greater Mekong Subregion.*

Lao, P.D.R., 2015. Intended Nationally Determined Contribution. Available at: http://www4.unfccc.int/submissions/INDC/Published%20Documents/Laos/1/Lao%20PDR%20INDC.pdf

Lao, P.D.R., 2010. *Forest Carbon Partnership Facility (FCPF) Readiness Preparation Proposal (R-PP).*

Lao, P.D.R., 2009. National Adaptation Programme of Action to Climate Change. *Lao People's Democratic Republic [available at http://unfccc. int/resource/docs/napa/laos01. pdf]*.

Lao, P.D.R., 2005. Forestry Strategy to the Year 2020 of Lao PDR.

Lao, P.D.R., 2010. Strategy on Climate Change of the Lao PDR.

Lao, P.D.R., 2013.*Technology Needs Assessments.* Climate Change Mitigation.

Lao, P.D.R., 2010. *Readiness Preparation Proposal (R-PP).* Forest Carbon Partnership Facility (FCPF).

Lao, P.D.R., 2011. *Renewable energy development strategy of the Lao PDR,* Ministry of Energy and Mines.

LCA, 2010. Lao Coffee Association 2010 Report. Unpublished, Pakse District, Champasack Province. Lao PDR.

Lienhardp, S., Siphongxay, S., Tivet, F. and Seguy,L., n.d. *Improvement of Feed Resources for Animals in Smallholder Farming Systems of XiengKhouang Province, Lao PDR*

Luangmany, D., Voravong, S., Thanthathep, K.K., Souphonphacdy, D. and Baylatry, M., 2009. *Valuing environmental services using contingent valuation method* (No. tp200910t4). Economy and Environment Program for Southeast Asia (EEPSEA).

MAF, 2005. *Decision on the Lao organic agriculture standards.* Department of Agriculture.

MAF, 2010. *Strategy for Agriculture Development 2011-2015,* Department of Agriculture.

MAF, 2011. Annual Review of REDD+ Activities in Lao PDR, Vientiane, Department of Forestry.
MAF, 2012. *Forest Cover Assessment in 2010,* Vientiane, Department of Forestry Inventory and Planning.

MAF, 2012. *Report on Forest Cover Inventory 2010*, Department of Forestry.

MAF, 2016a. *Strategic Plan for National Organic Agriculture Development 2015, Vision towards 2030,* Department of Agriculture.

MAF, 2016b. *Report on the 5th Organic Forum,* Department of Agriculture.

Manolinh, T., 2010. Protected Area Sustainable Financing Legal Framework Study (unpublished), Sustainable NBCA under CBD framework, Department of Forestry.

Martin, G. Sounthone, K. Vichith, L. Khamphone, S. 2007. Non-Timber Forest Products. The NTFP practice Area of SNV Netherlands Development Organisation, Lao PDR.

Metz, B., Davidson, O.R., Bosch, P.R., Dave, R. and Meyer, L.A., 2007. IPCC, 2007: Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.

Midgley, S., Bennett, J., Samontry, X., Stevens, P., Mounlamai, K., Midgley, D. and Brown, A.G., 2012. *Enhancing livelihoods in Lao PDR through environmental services and planted-timber products*. Australian Centre for International Agricultural Research.

MoNRE, 2013. *Second National Communication on Climate Change of Lao PDR, Vientiane.* Available on: http://www.la.undp.org/content/lao_pdr/en/home/library/environment_energy/the-second-national-communication-on-climate-change-submitted-to.html

Moore, C., Eickhoff. G., Ferrand, J. and Khiewvongphachan, X., 2011.*Technical Feasibility Assessment of the Nam EtPhouLoey National Protected Area REDD+ Project in Lao PDR. Available on:* (http://theredddesk.org/sites/default/files/resources/pdf/2013/giz-clipad-technical-feasibiltiy-study-nam-phui-npa-lao-pdr-v1.4.pdf)

MPI, 2015.*The 8thNational socio-economic development strategy to 2016-2020 of the Lao PDR.* Ministry of Planning and Investment.

MAF, 2015. *Agriculture Development Strategy to the year 2025 and Vision to the year 2030*.Ministry of Agriculture and Forestry.

Makumba, W., Akinnifesi, F.K., Janssen, B. and Oenema, O., 2007. Long-term impact of a gliricidia-maize intercropping system on carbon sequestration in southern Malawi. *Agriculture, ecosystems & environment*, *118*(1), pp.237-243.

Manivong, K. and Sophathilath, P., 2007. Status of community based forest management in Lao PDR. *Bangkok, Regional Community Forestry Training Centre*.

MoNRE and IUCN, 2012. Action Plan for Implementing the Convention on Biological Diversity's Programme of Work on Protected Areas, submitted to the Secretariat of the Convention on Biological Diversity.

MoNRE and IUCN, 2016. *Fifth National Report to the Convention on Biological Diversity,* Department of Forest Resource Management (DFRM), Vientiane.

Nabuurs, G.J., Masera, O., Andrasko, K., Benitez-Ponce, P., Boer, R., Dutschke, M., Elsiddig, E., Ford-Robertson, J., Frumhoff, P., Karjalainen, T. and Krankina, O., 2007.Forestry in climate change mitigation. *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*.

Nair, P.R., 1993. *An introduction to agroforestry*. Springer Science & Business Media.

National Assembly, 2007. *Forestry Law,* Vientiane.

Nygaard, I. and Hansen, U.E., 2015. Overcoming Barriers to the Transfer and Diffusion of Climate Technologies.

Palm, C., Tomich, T., Van Noordwijk, M., Vosti, S., Gockowski, J., Alegre, J. and Verchot, L., 2004. Mitigating GHG emissions in the humid tropics: case studies from the Alternatives to Slash-and-Burn Program (ASB). *Environment, Development and Sustainability*, *6*(1-2), pp.145-162.

Panyasiri, 2010.Organic agriculture in Laos. Country report. Asian Network for Organic Farming Technology (ANSOFT/ AFACI).

Panyakul, V., 2012. Lao's Organic Agriculture: 2012 Update. *Earth Net Foundation Green Net, Vientiane*.

Panyakul, V., 2009. Organic agriculture in Laos PDR: overview and development options. *Earth Net Foundation/Green Net. International Trade Centre's project "Support to trade promotion and export development in Laos PDR" Project number LAO/61/89*.

Panyakul.V and Poeyjatuek.N., 2012. *Lao Organic Agriculture Forum.* Platform public-private sector dialogue. Activity Report, Vientiane.

Philaphone, M., 2011. Promotion of Organic Coffee Products for Export in Lao PDR. *Lao Trade Research Digest, 2,* pp.113-148.

Phimmavong, S., Ozarska, B., Midgley, S. and Keenan, R., 2009. Forest and plantation development in Laos: history, development and impact for rural communities. *International Forestry Review*, *11*(4), pp.501-513.

Phonvisay (LRC) and KhamsoneSisaath (LMD) (2015), The Lao Beef Industry in "Regional Workshop on Beef markets and trade in Southeast Asian and China", Ben Tre, Vietnam, 30th November – 3rd December 2015

Pinese, B., Brown, J.D., Waite, G.K., Burley, J., Nikles, D.G., Craswell, E.T., Isbell, R.F., Mertin, J.V., Hacker, J.B., Apan, A. and Dieters, M.J., 2003. *Review of protected areas and development. Lower Mekong river region* (No. CD 333.7820959 R454). International Centre for Environmental Management, Queensland (Australia)..

PMO, 2005. *Decree on the local and rural electricity development fund*, Prime Minister's Office, Vientiane.

Phounvisouk, L., Zou, T. and Kiat, N.C., 2013. Non-timber forest products marketing: Trading Network of trader and market chain in LuangNamtha Province, Lao PDR. *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*, *18*(4), pp.48-57.

Ramachandran Nair, P.K., Mohan Kumar, B. and Nair, V.D., 2009. Agroforestry as a strategy for carbon sequestration. *Journal of plant nutrition and soil science*, *172*(1), pp.10-23.

RECOFTC, 2014. *Community Forestry Adaptation Roadmap to 2020 for Lao PDR*, Bangkok.
Rigg, J.D., 2006. Forests, marketization, livelihoods and the poor in the Lao PDR. *Land Degradation & Development*, *17*(2), pp.123-133.

Rosales, R., Kallesoe, M.F., Gerrard, P., Muangchanh, P., Phomtavong, S. and Khamsomphou, S., 2005. Balancing the Returns to Catchment Management: The Economic Value of Conserving Natural Forests in Sekong, Lao PDR. IUCN Water, Nature and Economics Technical Paper No. 5, IUCN—The World Conservation Union. *Ecosystems and Livelihoods Group Asia*.

Robichaud, W., Marsh, C.W., Southammakoth, S. and Khounthikoummane, S., 2001. Review of the national protected area system in Lao PDR. *Lao-Swedish Forestry Programme (LSFP)/Division of Forest Resource Conservation (DFRC), Vientiane*.

Sihanath.G., n.d. *Forage development in Lao PDR.* Livestock Adaptive Research and Extension Division, Department of Livestock and Veterinary Services.

Saysana, V., 2011. Promotion of Organic and Fair-Trade Certification in the Lao PDR Coffee Sector: Benefits and Challenges for Farmers and Local Economies. Available at: https://shareok.org/bitstream/handle/11244/8348/Saysana_okstate_0664M_11657.pdf?sequence=1&isAllowed=y

Scheufelea.G, Smithb.H, and Tsechalichac.X., 2015. *The legal foundation of Payments for Environmental Services in Lao PDR*, Effective Implementation of Payments for Environmental Services in Lao PDR, Research Reports No.4

Smith, P., Martino, D., Cai, Z., Gwary, D., Janzen, H., Kumar, P., McCarl, B., Ogle, S., O'Mara, F., Rice, C. and Scholes, B., 2008. Greenhouse gas mitigation in agriculture. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *363*(1492), pp.789-813.

Southichack, M. 2009. The Lao Coffee Economy-A New Growth Path on the Horizon? Unpublished. *In. Sayana, 2011*.

Vandergeest, P., 2003. Land to some tillers: development- induced displacement in Laos. *International Social Science Journal*, *55*(175), pp.47-56.

Vientiane Times, 2016. Sangthong optimistic about organic rice exports. Viewed 19 December 2016

Verchot, L.V., Van Noordwijk, M., Kandji, S., Tomich, T., Ong, C., Albrecht, A., Mackensen, J., Bantilan, C., Anupama, K.V. and Palm, C., 2007. Climate change: linking adaptation and mitigation through agroforestry. *Mitigation and adaptation strategies for global change*, *12*(5), pp.901-918.

Voladet, S., 2009. *Sustainable development in the plantation industry in Laos: An examination of the role of the ministry of planning and investment*. International Institute for Sustainable Development.

Vongvisouk, T., Lestrelin, G., Castella, J.C., Mertz, O., Broegaard, R.B. and Thongmanivong, S., 2016. REDD+ on hold: lessons from an emerging institutional setup in Laos. *Asia Pacific Viewpoint*.

Annex 1 List of Stakeholders

1. TNA Project Team

No	Name and Surname	Organization	Position
1	Mr.Sangkhan Thiengthamavong	DCC, MoNRE	Director General
2	Mr. Syamphone Sengchandala	DCC, MONRE	Deputy Director General
3	Mr. Immala Inthaboualy	DCC, MONRE	Director of GHG inventory and mitigation division
4	Mr. Amphayvanh Oudomdeth	DCC, MONRE	Deputy Director of GHG inventory and mitigation division
4	Mr. BounEua Khamphilavanh	DCC, MONRE	Head of Unit, GHG inventory and mitigation division
5	Mr. Bounthee Saythongvanh	DCC, MONRE	Technical staff, GHG inventory and mitigation division
6	Ms. Thounheuang Buithavong	DCC, MONRE	Technical staff, GHG inventory and mitigation division
7	Ms. Vathsouda Nilathsay	DCC, MONRE	Technical staff, GHG inventory and mitigation division
8	Ms. Jam Chanmany	DCC, MONRE	Technical staff, GHG inventory and mitigation division
9	Mr. Mone Nouansyvong	TNA project	Consultant

2. Technical Working Group on Climate Change Excluding DDMCC, MoNRE

No	Name and Surname	Organization	Position
1	Mr. Khammanh Sopraseuth	Renewable Energy Promotion Institute, MEM	Director of Division
2	Mr. Soukphavanh Sawathvong	REDD Office, Dep. of Forestry, MAF	Technical staff
3	Mr. Soukan Bounthabandith	Dep. of Forest Inventory and Planning, MAF	Deputy Director of Division
4	Mr. Paiythong Chitvilaphon	NAFRI	Technical
6	Mr. Saysamon Chansanga	Renewable Energy Institute, MOST	Director of Division
7	Mr. Sonsana Phakhonekham	Dep. of Livestock and Fisheries, MAF	Technical staff
8	Ass. Pro. Dr.Sithong Thongmanivong	Faculty of Forestry (FoF), NUoL	Dean of FoF
9	Dr. Lamphery Kansombath	Faculty of Agriculture, NUOL	Chief of Division
10	Mr. Khamhou Tunalom	Institute of Natural Resources and Environment, MoNRE	Chief of Division
11	Mr. Tha Khonmixay	Dep. of Water Resources, MoNRE	Technical staff

12	Mr.Khamsen Ounkham	REDD Office, DoF, MAF	Director of REDD office
13	Mr.Khamphone Keodalavong	IED, MOCI	Chief of division
14	Mr. Saysamone Chansanga	RERI, MOST	
15	Mr. Sayabandith Insisiengmai	PTI, MPWT	
18	Dr. Dalavone Kithiphan	MoE	

3. Other Stakeholders Involved in Consultation Meetings, Interview and Provided Feedback

No	Name and Surname	Organization	Position
1	Mr. Athinan Manivong	Dep. of Technology and Innovation, MOST	Technical staff
2	Ms. Phetdalay Vorlaphim	Dep. of Irrigation, MAF	Technical staff
3	Mr. Linglong Sithisay	Dep. of Agriculture, MAF	Deputy chief of planning and cooperation of Division
4	Mr. Mongkod Keodouangdi	Department of Livestock and Fisheries, MAF	Technical staff
5	Ms. Oulavanh Sinsamphan	Faculty of Environmental Sciences, NUoL	Chief of Climate Change and Sustainable Development Division
6	Ass.Pro.Ouanma Thammavong	Faculty of Water Resources, NUoL	Dean of Faculty of Water Resources
7	Mr. Khamphaeng Phomphet	Dep. of Forest Resources Management, MoNRE	Technical staff
8	Ms. Chantha Souliya	Dep. of Environmental Promotion, MoNRE	Technical staff
9	Mr. Phothong Chandalaphet	Dep. of Land, MoNRE	Deputy Chief of Use Planning and Development Division
10	Ms. Chanthamany Siliya	Environment Protection Fund	Advisor
11	Mr. Bounpone Phoutha-amath	Dep. of Forestry, MAF	Chief of Conservation Forest Division
12	Mr.Khamphay Somsana	LNCCI	Chief of Lao Wood Furniture Association
13	Mr. Bounlueth Louangprasuet	Construction and renewable energy company	Director
14	Mr. Phaivanh Phiapalath	IUCN	Senior Programme Officer
15	Peter Fodge	Burapha Agroforestry Co., Ltd	Director
16	Ms. Sengdaovone	Secret of organic agriculture association	Head of secretariats, LNCCI
17	Mr. Dethoudome	Agriculture development bank	Chief of Account Division
18	Mr. Phouvanh	Nayobay bank	Chief of Credits Division
19	Mr. Suradej Punturaumporn	Krungsri bank	Manager of Leasing Service
20	Mr. Souphak	Lao Commercial Bank Public Company	Deputy Director

21	Mr. Khantara	Renewable Energy Development, MEM	Chief of Division
22	Mr. Syvang Xayavong	Renewable Energy Development, MEM	Deputy Chief of Division
23	Mr. Sami Janne	CliPAD, GIZ	Chief Technical Advisor
24	Mr. Ayako	WCS	Senior Officer
25	Mr. Bounthavy Sengtakoun	SNV	Biogas Advisor
26	Mr. Somephone Buansavanh	WWF	Director
27	Mr. Southavine	Forage and livestock entrepreneur, Xiengkhouang	Manager
28	Mr. Hongthong	PAFO, Xiengkhouang	Chief of Livestock and Fishery Division
29	Mr. Monkod	Dep. of Livestock and Fishery, MAF	Technical staff

Annex 2 Key literature review

Technologies in Forestry Sector	Key reviewed literature
Overall literature review for forestry sector	1. Law on forestry (2007) 2. Forest strategy to the year 2020 (2005) 3. Law on land (2003) 4. Environmental protection law (2013)
Specific literature on each forestry mitigation technology/subsector	
1. Effective protected area or conservation forest management,	1. Decree on conservation forest (2015) 2. The 5th national report to the United Nations Convention on Biodiversity Conservation (2016) 3. Assessment of the implementation of national biodiversity strategy and action plan (NBSAP) (2011) 4. Review on the national conservation forest system in Laos and protected areas and development in the four countries of the Lower Mekong River Region (2003)
2. Sustainable village/villages forest management	1. Village forestry adaptation roadmap to the year 2020 (2014), 2. Status of village-based forest management in Laos (2007),
3. Optimal or sustainable plantation forests	1. Forest and plantation development history: development and impact for rural communities (2009) 2. The economics of industrial trees plantations (2009)
4. Optimal agroforestry	1. Agroforestry systems for upland people (2012) and 2. Agroforestry and livelihoods in Lao PDR (2009)
Technologies in Agriculture Sector	
Overall literature review for forestry sector	1. the strategic plan for national organic agriculture development 2025 and vision towards 2030 (2016) 2. Law on agriculture (2003) 3. Law on land (2003)
Specific literature on each agricultural mitigation technology/subsector	
1. Feed improvement	1. National policy on sustainable livestock development in Laos (2014) 2. Laos beef cattle industry (2015) 3. Livestock sector brief (2005) 4. National food security and commercialized production programme, report on forage development in Laos, case study on food security through the livestock production (2009).
2. Organic farming	1. Report on organic agriculture forum (2016) 2. Agricultural commercialisation-a strategic directions (2014) proceedings of the Lao organic agriculture forum (2016) 3. Review of organic agriculture in Laos (2012, 2009) 4. Report on Lao Business Forum (2016)

3. Biogas	1. Renewable energy strategy to the year 2025 (2011) 2. Biogas user survey (2011) 3. Summary report on the mini digester trial (2012) 4. Trainee's manual for training of trainers for construction and supervision of biogas plant (2006).
4. Biomass (agricultural residue-based energy)	1. Renewable energy strategy to the year 2025 (2011) 2. Report on Lao Business Forum (2016)

Annex 3 Long-list barriers of technologies in forest sector

1. Effective protected area/conservation forest management

Longlist barriers to protected area management
1. Inadequate budget and investment on protected area management including resources inventory, zoning, planning, strategy and site development plans, legal framework, capacity building, patrolling, information and awareness, and R&D.
2. Financial needs assessment and review has not been systematically conducted for protected areas management
3. Limited revenues from ecosystem services including ecotourism and carbon trade because they have not been fully and effectively exploited
4. Inadequate financial and economic information and mechanism for sustaining protected area management
5. Study on potential fund and financial mechanism for sustaining conservation forest management has not systematically conducted for NBCA and protected areas at local levels
6. Small and variable tourist market (protected areas at local levels)
7. Carbon and other ecosystem service markets is not well-functioned/uncertain
8. Inadequate policies on the sustainable settlement, development of livelihood and involvement of communities that reside within protected areas in PAM
9. Lack of policy on sustainable financing and subsidies for PAM
10. Ineffective law enforcement, especially application of measures for law violence and promote best practices
11. Inexistent specific expert group/network on conservation forest and platform for exchange knowledge and information
12. key stakeholders have not had effective organisational management system including human resource and capacity development plan, staff knowledge management, effective recruitment staff recruitment, HRD monitoring and evaluation (M&E) and reporting system
13. Inadequate on-site staff
14. Inadequate protected area management and development strategy and site management and development
15. Ineffective systematic review of protected area management performance
16. Ineffective coordination and information exchange amongst stakeholders
17. Limited skills on organisational and human resource development
18. Limited technical skills on effective or sustainable protected area management
19. Not inclusive and practical protected area management curriculum and training
20. Lack of guidelines on effective protected area management
21. Insufficient public participation on protected area management
22. Ineffective forest information system
23. Inadequate data/information on protected areas' resources, ecosystem services including values and financial and economic feasibility on investment, mitigation potentials and best management practices and trade-off between protected area and other land uses (mining and hydropower)
24. Ineffective information dissemination and awareness raising
25. Inadequate effective methods, equipment and channels for awareness raising

Longlist barriers to protected area management
26. Multifaceted, multidisciplinary and difficult and time consuming to develop effective or sustainable models for all PAs and sites
27. Protected area's goals and roles are for conservation, only some business activities are allowed, so it is hard to be financially self-reliant
28. Poverty which lead to encroachment of forest
29. Overlapping protected areas and other land uses, especially mining and hydropower project areas, while it is difficult have information on the trade-off, leading to inappropriate decision and conversion of forest
30. Forest encroachment, conversion and conflict of interest on land and resources use
31. Uncooperative local people
32. Geographical or physical difficult to access to conduct forest resources inventory, plan and develop of some areas

2. Sustainable community or village forest management (SCFM/SVFM)

Longlist barriers to community or village forest management
1. Inadequate financial resources and investment from the public, private and development partners on SVFM, particularly: integrated land use planning and land allocation, forest resources inventory, development of SVFM strategy and plans, restoration of degraded forest and reforestation, capacity building, research and development of tools, resources and best practices for SVFM and development of SVFM model/reference project
2. Low revenues e.g., from ecosystem services including NTFP, ecotourism and carbon trade, and re-investment in VFM
3. Inadequate capacity to effectively mobilise resources for SVFM
4. Insufficient sustainable mechanism, financial and economic information e.g., financial needs, cost and benefits or return on investment for justifying and determining investment in SVFM
5. Ineffective economic and financing models for SVFM
6. Small and variable NTFP markets
7. Small tourist market (to villages including forest village)
8. Carbon and other ecosystem service markets is not functioning
9. Unstable supply of NTFP products as seasonal variable production of wild NTFP, lack of domestication and decline of wild NTFP due to overharvest and degradation
10. Incomplete decree and regulation on SVFM
11. Incomplete decree and regulation on forest and environmental business management and promotion
12. Lack of policy on financial support or subsidy VFM
13. Lack of policy on the promotion of best practices on SVFM
14. Inexistent specific expert group and platform for knowledge and information exchange
15. Ineffective networking with regional SVFM network
16. Ineffective organisational management systems
17. It is difficult to recruit and maintain SVFM extension experts and staff to base and facilitate SVFM at local levels
18. Inexistent of SVFM expert group/association
19. Ineffective HRD system
20. Lack of subsector village development strategy and plan, incomprehensive review and reporting of implementation
21. Lack of coordination mechanism amongst stakeholders
22. Limited formal and informal exchange platform/ communication channel amongst stakeholders
23. Limited technical knowledge and skills on SVFM including legal, organisational, financial, social, economic and mitigation, extension, leadership and human resource development skills

Longlist barriers to community or village forest management
24. Insufficient resource materials on SVFM such as handbook, guidelines and best practices on SVFM including: sustainable financing, sustainable or effective organisational arrangement and management, sustainable harvesting of NTFP, ecotourism and carbon trading and entrepreneurship, data collection and assessment or valuation of forest resources, biodiversity and ecosystem services and forest offset etc.
25. Ineffective forest and village forest information system including lack of central and linkage of information system/ resources centres and information, information facilities and equipment,
26. Inadequate information, especially updated information and awareness on SVFM including inaccurate information on village forests (area, number of villages, natural resources, ecosystem service and values), feasibility, especially cost-benefits and return on various NTFP, ecotourism and carbon trade and best practices
27. Ineffective information dissemination including limited disclosure/exchange and difficult to access to information amongst stakeholders
28. Ineffective coordination and information exchange amongst stakeholders
29. High demand of land for commercial agriculture, plantation and development projects which lead to conversion of village forest
30. Overlapping village forest and other land uses, especially infrastructure and mining areas which could lead to conversion of village forest

3. Optimal or sustainable plantation forests

Longlist barriers to optimal or sustainable plantation forests
1. Low profit and not financial and economic feasible (some plantations)
2. High investment cost on sustainable plantation practices including high cost on environmental and social impact responsibility, capital cost, transport, UXO clearance, tax, inspection and certification, resource efficiency technologies and maintain soil nutrients and carbon etc.
3. Limited access to finance
4. Inadequate public financial support for promotion/extension
5. Lack of sustainable or effective financing mechanism and models including financial incentives and subsidy to promote, alleviate cost and financial burden
6. Small and variable domestic wood and non-wood product markets and prices/Higher demand and preferable to wood from natural forests
7. Insufficient market information
8. Variable supply of products to market
9. Limited access to external market due to variable product quality
10. Incomplete legal and regulatory framework on sustainable plantation including land for plantation, financial incentives for sustainable plantations
11. Lack of empirical policy on the promotion of best practices and enforcement of polluter- pay regulation
12. Lack of regulation or guidelines on sustainable plantation development
13. Ineffective networking with external sustainable plantation networks
14. Inexistent of sustainable plantation expert group/association and platform for exchanges
15. Ineffective organisational management systems in plantation subsector
16. Lack of sustainable plantation extension unit at local levels
17. Lack of comprehensive sustainable plantation subsector strategy and plans, review and reporting of implementation
18. Lack of coordination amongst stakeholders including limited formal and informal exchange platform/ communication channel amongst stakeholders on sustainable plantation

Longlist barriers to optimal or sustainable plantation forests
19. Limited technical knowledge and skills on human resource development, R&D and extension of optimal and sustainable plantation including legal, organisational, financial and economic, social and environmental responsibility, carbon trading etc
20. Lack of resource materials on sustainable plantation such as handbook, guidelines and best practice on sustainable plantations
21. Ineffective forest and plantation forest information system including lack of facilities and equipment and linkage between information system/ resources centres
22. Lack of information, especially updated information on sustainable plantation including land and species suitability, productivity and growth model, cost-benefits and return on investment of different plantation systems, markets, production and processing technologies best practices and successful project and mitigation potentials of plantations through life cycle
23. Limited public disclosure and difficult to access to information
24. Ineffective coordination and information exchange amongst stakeholders, including ineffective communication between plantation research institutes and implementation/management organisations or demand and supply
25. Ineffective and inadequate information R&D and publication, dissemination and awareness raising
26. information dissemination and awareness raising
27. It is long and costly process while it is difficult to maintain productivity, soil nutrients and carbon
28. Not all communicable and introduced tree species/plantations growth well and economic viable in Laos. It is site and species specific.
29. Unclear or overlapping areas for plantations and other land uses, especially infrastructure and mining areas
30. Existing/unsolved environmental and social impacts

4. Optimal agroforestry

Longlist barriers to optimal agroforestry
1. Low and marginal profits and benefits (some systems)
2. High investment cost on sustainable practices high cost on labour due to labour intensive, irrigation/ watering system, seeds and fertilizer, inspection and certification (organic product), capital etc.
3. Inadequate public financial support including incentives, subsidy
4. Limited capital and access to finance
5. Undefinable sustainable financing mechanisms to optimise and sustain agroforestry
6. Small and variable agroforestry markets/High demand and competitive products from intensive (mono) cropping systems and import
7. Seasonal variable production
8. Inadequate infrastructure e.g., irrigation and logistics
9. Unclear legal definition of agroforestry
10. Unclear policy on financial incentives and subsidy of agroforestry
11. Lack of agroforestry expert group and platform for exchanges and networking with external agroforestry networks
12. Ineffective HRD systems
13. Lack of agroforestry extension unit at local levels
14. Non-functioning agroforestry systems group/association
15. Lack of subsector agroforestry development strategy and plans

Longlist barriers to optimal agroforestry
16. Ineffective coordination amongst stakeholders
17. Insufficient technical skills on agroforestry
18. Inadequate resource materials such as handbook, guidelines and best practice on different types of agroforestry systems
19. Ineffective forest and agroforestry information system including facilities and equipment and linkage or shared information system/ resources centres
20. Lack of updated and accurate information on areas and types of agroforestry systems including its performance, land and tree species suitability, cost-benefits and return on investment of agroforestry systems, mitigation potentials, markets, successful projects and best practices
21. Limited public disclosure and difficult to access to information
22. Ineffective coordination and information exchange amongst stakeholders, especially research institutes and implementation/ management agencies
23. Ineffective information R&D, publication, dissemination and awareness raising
24. Some species are not suitable for agroforestry systems/site and species specific
25. It is difficult to define optimal agroforestry including compatible species and production systems that generate maximum profit and benefits
26. It is long and costly process while it is difficult to maintain productivity, soil nutrients and carbon
27. Limited land for expansion of agroforestry
28. Pest and disease outbreak and damage caused by floods and landslide

Annex 4 Barrier Decomposition of Forestry Technologies

1. Decomposition of barriers on effective protected area/conservation forest management (PAM/CFM)

Broad categories of barriers	Barriers within a category	Elements of barriers	Dimension of Barrier elements
Economic and financial	Inadequate financial resources to invest in PAM	Inadequate public budget and variable financial support from development partners and international organisations for PAM	Financial investment in PAM has been less than US$ 1.2 million per year, while total financial needs have been at least US$ 8.8 million per year or approximately 83.36% of the budget has been shortage
		Limited revenues from ecosystem services including ecotourism, NTFP and carbon credits, because they have not been effectively exploited and ineffective for collection or resources tax/fee for reinvestment	It was estimated that only 30% of the potential revenues from ecotourism was tapped, minor from NTFP and no income from carbon credits. About US$1 million has been shortage for management including capacity enhancement to increase revenues from ecosystem service
		Insufficient capacity to mobilise resources for effective PAM	US$ 0.07 million per year has been shortage for R&D, development of resources mobilisation plan includes capacity building
	No sustainable financial and investment models for PAM	Study on potential fund and financial mechanism for effective PAM has not systematically conducted	Inadequate research and research capacity and at least US$ 0.1 per year has been shortage for the capacity building, research and development of financial mechanism for sustaining conservation forest management
Market failures and imperfection	Ineffective promotion of sustainable or effective PAM	No practical the best practice guidelines on sustainable or effective conservation forest management	About US$ 0.1 million has been shortage for R&D and dissemination of practical the best practice guidelines on sustainable or effective PAM
	Small and variable markets of PA's ecosystem service	Small tourist market (to NBCA and protected areas(PA)/conservation forest at local levels)	Less than 15,000 eco-tourists visited PA per year. About US$ 0.1 million shortage per year for tourism promotion, marketing including development of tourist products
		Forest carbon markets has not been functioned and carbon credits are variable	None of carbon credits are secured. About US$ 0.2 million shortage per year for feasibility study of carbon markets. About US$ 0.5 million shortage per year for carbon inventory and accounting system, MRV, capacity and development of mitigation policy

Broad categories of barriers	Barriers within a category	Elements of barriers	Dimension of Barrier elements
Policy, legal and regulatory	Incomplete legal and regulatory framework for effective PAM	Unclear directions, measures and procedures for conservation and management of forest, cultural and historical heritage, wetland, river, village forest, and useable and unusable resources.	About US$ 0.2 million shortages for the policy R&D
		Unclear policy on the development and management of local people living inside protected areas	
		Unclear measures and guidelines or operation procedures on the financing, resource mobilisation or access to fund for PAM	
		Unclear measures and guidelines or operation procedures the operation of business related with conservation forest	
		Unclear measures and guidelines or operation procedures for forest offset resulted from land use changes caused by development projects	
	Ineffective law enforcement	Inadequate skills on law enforcement, especially application of best practices and measures for: (1) law violation e.g., forest encroachment, (2) promotion of good performances and practices, (3) management of business related with conservation forest, and (4) forest offset	Lack of best practice and capacity building on application of measures for law violence. About US$ 0.25 million per year shortage for research, development of procedures, best practice guidelines and capacity building
Network failures	Inexistent specific expert group/network on conservation forest	- Fewer experts on PAM - Lack of awareness and promotion of social organisation establishment - Lack of cooperation and networking plan	About US$ 0.15 million per year shortage for promoting expert groups, cooperation and networking including plans
	Ineffective network expansion	Laos has not been member or connected with all important protected area or conservation forest networks	

Broad categories of barriers	Barriers within a category	Elements of barriers	Dimension of Barrier elements
Institutional and organisational capacity and human skills	Ineffective organisational management systems	Inadequate staff based in the protected areas	Only few NBCA are staffed. About 182 staff shortage to work on site in provincial, district and village level protected areas. About US$ 0.4 million per year shortage for support staff and volunteers patrolling and field activities, improvement of facilities such as offices or information centres for all necessary areas
		Inexistent of protected area expert group/association	About US$ 0.10 million per year shortage for support protected area expert group/association advocacy and exchanges
	Ineffective organizational planning and reporting system	- Inexistent conservation forest development strategy - Majority of individual conservation forest does not have development plans - No systematic review of conservation forest management performance	About US$ 0.12 million per year shortage for improvement of organizational planning and reporting system
	Lack of coordination amongst stakeholders	Limited formal or mandatory exchange platform/ communication channel amongst stakeholders	About US$ 0.10 million per year shortage for exchange platform/ communication channel amongst stakeholders
	Limited technical capacity and skills	Limited skills on human resource development (HRD) system, particularly HDR plan including capacity needs assessment, staff information and knowledge map/management, effective recruitment and staffing, human resources demand and supply management mechanism	About US$ 0.15 million per year shortage for improvement of human resource development (HRD) system

Broad categories of barriers	Barriers within a category	Elements of barriers	Dimension of Barrier elements
		Insufficient technical skills on effective or sustainable conservation forest management and extension particularly: - Forest resources inventory and multi-criteria for zoning - Environmental/ forest resources valuation - Environmental/forest economic, enterprise/ entrepreneurship - Ecotourism and other payment for ecosystem service - Forest carbon accounting and credits - Development of bankable proposal and feasibility study, including analysis of financial and economic, cost-benefit and return on investment - Development of resource mobilisation pan including research and analysis of financial/fund sources - Integrated resources/land and livelihood planning and development	About US$ 0.65 million per year shortage for improvement of the technical capacity and skills
	Lack of resource materials on effective conservation forest management	Lack of practical guidebooks, guidelines and other teaching and training materials and curriculum on effective conservation forest management	About US$ 0.15 million per year shortage for improvement of the practical guidebooks, guidelines and other teaching and training materials and curriculum on effective conservation forest management
Information and awareness	Insufficient information on financial and economic, social-	Financial and economic information gap: (1) ecosystem service and values, (2) financial needs for investment, (3) CBR and IRR.	Majority of conservation forests have not complete forest resources inventory and assessment of financial and economic, social-culture,

Broad categories of barriers	Barriers within a category	Elements of barriers	Dimension of Barrier elements
	culture, environmental and ecological aspects of conservation forests	Social-culture information gap: numbers, socioeconomic and culture-tradition of communities live inside and adjacent to conservation forests	environmental and ecological values. About US$ 0.15 million per year shortage for the improvement
		Ecological information gap: number, types and status of biodiversity, its habitat, biological property	
	Ineffective and inadequate information dissemination and awareness raising	Lack of best practices/effective methods and materials, and financial support for awareness raising	About US$ 0.15 million per year shortage for R&D of best practice guidelines, effective methods and materials for effective awareness raising
Other	Insufficient models and best practices to address poverty and forest conservation nexus issues	Encroachment for subsistent agriculture and collection and overharvest of NTFP	30-40,000 ha were encroachment annually. About US$ 0.50 million per year shortage for improvement of livelihood and address poverty and environmental nexus
	No policy to enforce integrated planning, including integrated land use, and overlapping conservation forest and other land uses	Lack of capacity, information and research on good practice and formulation of the policy on integrated planning and developments	US$ 0.13 million per year has been shortage to enhance research on good practice, capacity building, formulation and enforcement of the policy on integrated planning and developments

2. Decomposition of barriers on sustainable village forest management (SVFM)

Decomposition of barriers on sustainable village forest management (SVFM)			
Broad categories of barriers	**Barriers within a category**	**Elements of Barriers**	**Dimension of Barrier elements**
Economic and financial	Inadequate budget and difficulties to justify and determine financing and investing in SVFM	Public budget and investment on SVFM is limited and financial support from development partners on SVFM is fluctuated	Total investment on VFM was about US$ 0.2 million per year on average, while financial needs for SVFM is at least US$ 2 million/year or annual budget shortage has been about 90%.
		Incapable to effectively and sustainably exploit and increase revenues from village forest ecosystem service e.g., NTFP, ecotourism and carbon credit	Less than 50% of potential revenues from NTFP and ecotourism is exploited, and no effective mechanism for SVFM re-investment
		Incapable to effectively mobilise resources, and exploit financial support under cooperation agreements with development partners	Only small amount of fund derived from resources mobilisation, and perceived that only 3/4 of potential financial support under cooperation agreements with development partners has been obtained
		Shortage of information on financial needs, models or mechanisms and cost-benefits or effectiveness of investment on SVFM to support resource mobilisation, convincing and determining for investment	Insufficient R&D, including research capacity and financial support, and about US$ 0.1 million per year has been shortage for R&D of sustainable financing models for SVFM
Market failures and imperfection	Insufficient promotion of SVFM	Lack of practical the best practice guidelines on SVFM	US$ 0.15 million per year has been shortage for R&D and dissemination of practical the best practice guidelines on SVFM
	Small and uncertain market for village forest products and service such as NTFP, tourist and carbon sequestration	Insufficient market information on village forest products and service such as NTFP, tourist and carbon market	US$ 0.12 million per year has been shortage for R&D on market, products diversification and marketing ecosystem service
		Insufficient information on village forest products and service supply capacity such as supply capacity of NTFP, tourist and carbon sequestration	US$ 0.3 million per year has been underfinance for R&D on forest carbon, mitigation and MRV system for carbon credits

Decomposition of barriers on sustainable village forest management (SVFM)			
Broad categories of barriers	**Barriers within a category**	**Elements of Barriers**	**Dimension of Barrier elements**
Policy, legal and regulatory	Incomplete legal and regulatory framework	(1) Forest law (2007) and decree on VFM (2001) have not provided clear definition, principles, procedures and management arrangements for SVFM (2) Inadequate subordinate regulations or policy on particular aspects of SVFM such as financing or subsidizing, promotion of high achievements, and measure on conversion and offset of village forests.	About US$ 0.09 per year shortage for policy research and development
Network failures	No specific expert group on SVFM	Small number of SVFM experts and no platform for exchanges	About US$ 0.09 per year shortage for facilitation of SCFM/ SVFM experts group and knowledge
	Ineffective networking	Insufficient information on SVFM networks and ineffective coordination with existing and new networks	
Institutional and organisational capacity and human skills	Incomplete organisational management systems	Insufficient SVFM extension unit and specialised staff at local levels	At least 54 more quality staff for extension at provincial, district and village level. About US$ 0.12 per year shortage for support staff fieldwork and extension
		No SVFM expert group/association	*See above*
	Ineffective organizational planning, M&E and reporting system	No village forest subsector/technology development strategy and plan, M&E and reporting system at national and local levels	About US$ 0.08 per year shortage for policy research and development for development of strategy, planning, M&E and reporting system
	Ineffective coordination amongst stakeholders	Limited formal and informal exchange platform/ communication channel amongst stakeholders on SVFM	About US$ 0.06 per year shortage for improving coordination, including dialogue and exchange platform
	Insufficient technical capacity and skills on SVFM	insufficient skills on organisational and HRD and system (e.g., HRD plan, capacity needs assessment, staff knowledge management, effective recruitment and staffing, management of HR demand and supply side	About US$ 0.08 per year shortage for capacity building for enhancing human resource development system

Decomposition of barriers on sustainable village forest management (SVFM)			
Broad categories of barriers	**Barriers within a category**	**Elements of Barriers**	**Dimension of Barrier elements**
		Insufficient technical skills on SVFM, including skills on all aspects (ecological, financial and economic, social and policy) of SVFM)	About US$ 0.10 per year shortage for development of technical skills on SVFM and extension
	Insufficient resource materials on SVFM	Handbook, guidelines and best practices on all aspects of SVFM	About US$ 0.75 per year shortage for development of handbook, guidelines and best practice
Information and awareness	Little information and awareness on SVFM	No SVFM guidelines, especially best practice guidelines, and reference projects, and insufficient information dissemination	About US$ 0.08 per year shortage for R&D on best practice guidelines and reference projects
	Insufficient technical information on SVFM	Insufficient information on (1) overall village forests (area, number of villages, ecosystem service and values), (2) financial and economics e.g., CBR and IRR in SVFM, and models (3) criteria and indicators for SVFM	Insufficient research and About US$ 0.11 per year shortage for research and technical information on SVFM
	Ineffective information dissemination and awareness raising	Lack of information on best practices/methods and channel and materials on sustainable management of NTFP, ecotourism and carbon trade for awareness raising	About US$ 0.06 per year shortage for extensive and effective dissemination of information on SVFM
	Inadequate information dissemination and awareness raising	Information and awareness raising limited to project targeted villages which was approximately less than 5% of the total village forest	
Technical	Inappropriate defining or selection VFM	Incomprehensive criteria and indicators for selection of SVFM	About US$ 0.05 per year shortage for regulation revision and development of criteria and indicators for SVFM
Others	Incomplete integrated development planning including land use plan	Overlapping village forest and other land uses, especially infrastructure and mining	About US$ 0.06 per year shortage for addressing integrated planning and land use conflicts

3. Decomposition of key barriers on sustainable plantation forests (SPF)

Decomposition of key barriers on sustainable plantation forests (SPF)			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
Economic and financial	High investment cost on sustainable plantation practices	High upfront cost on (1) feasibility study, including ESIA[33], (2) inspection and certification systems, (3) efficiency resources processing and uses, including technologies, and (4) soil carbon and nutrient maintenance	Fulfilment of these could increase investment cost up from 5-10%
	High capital cost	High interest rate of loans	Interest rate is greater than 12% per year
	Limited and inconsistent financial promotion and support for SPF	Lack of financial and economic incentives such as reduction of tax (import of input and technologies, holiday, profit etc.)	Lack of study on financial and economic incentive feasibility and cost and benefit to support formation of policy on incentives. About US$ 0.8 million has been shortage for the study
		No subsidy or development fund to alleviate cost and financial burden to promote sustainable plantations	Lack of subsidy or development fund feasibility and cost and benefit study to support formation of policy on subsidy and access to fund/finance. About US$ 0.08 per year million has been shortage for the study
Market	Insufficient promotion of SPF	No practical including best practice guidelines on SPF	US$ 0.05 million per year has been shortage for R&D and dissemination of best practice guidelines on SPF
	Market failures and imperfection	Small and limited access to wood markets due to (1) little information on (end) markets and prices, (2) limited distribution channels of products,(3) unstable quantity and quality, fineness and phyto-sanitary of plantation wood products supply	US$ 0.07 million per year has been shortage for R&D, enhance access to markets and improve product quantity and quality
		Carbon credit mechanism for plantation is uncertain, limited market information and penetration	US$ 0.06 million per year has been shortage for R&D, enhance access to markets
Policy, legal and regulatory		No regulation on sustainable plantation forest	US$ 0.07 million per year has been shortage for development of capacity and regulations on SPF

[33]ESIA: environmental and social impact assessment, including management plans

Decomposition of key barriers on sustainable plantation forests (SPF)			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
	Incomplete legal and regulatory framework on sustainable plantation	No comprehensive policy on (1) financial incentives and subsidy, (2) promotion of best practices and (3) law enforcement on SPF	US$ 0.09 million per year has been shortage for capacity building and development of SPF policies
Network	Network complete and failures	Lack of expert group and platform for SPF exchanges	US$ 0.05 million per year has been shortage for promotion SPF expert group or think-tank
		Lack of information and clear responsibility on SPF and market networks and networking	US$ 0.05 million per year has been shortage for improvement information and mandates on SPF network and networking
Institutional and organisational capacity and human skills	Incomplete organisational management system	Inadequate SPF specialized extension unit or staff at central and local levels	US$ 0.07 million per year has been shortage for capacity building and staffing for extension of SPF
	Ineffective organizational planning and reporting system	No SPF strategy and plan, review or monitoring and evaluation (M&E) and reporting system	US$ 0.08 million has been shortage for development of SPF strategy, plan and M&E framework and US$ 0.09 for review and update every 3-5 years
	Lack of coordination amongst stakeholders	Limited formal and informal exchange platform/channel amongst stakeholders on SPF	US$ 0.02 million per year has been shortage for improvement of coordination on SPF until 2020
	Limited technical capacity and skills on SPF	Limited skills on human resource development (HRD) system e.g., HDR plan, including capacity needs assessment, staff information and knowledge management, effective recruitment and staffing, HR demand and supply management,	US$ 0.05 million per year has been shortage for improvement of HRD system
		Insufficient skills on SPF and extension, especially (1) identification of appropriate land and species/SPF systems, (2) sustainable harvesting rate and timing, (3)soil carbon and nutrients management for sustainable productivity, (4) forest economic, enterprise and marketing, (5) access to finance, including development of bankable proposal, feasibility study, and financial and economic analysis e.g., CBR and IRR	US$ 0.05 million per year has been shortage for improvement of skills on SPF and extension

Decomposition of key barriers on sustainable plantation forests (SPF)			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
	Insufficient resource materials on SPF	Shortage of research and development of handbook, guidelines and best practice on SPF	US$ 0.04 million per year has been shortage for R&D and development resource materials on SPF
Information and awareness	Insufficient technical information on SPF	Little and unshared information on (1) land/soil and species suitability as well as sustainable plantation systems, (2) feasibility, especially analysis of economics e.g., CBR and IRR, (3) mitigation potentials of plantations through life cycle	US$ 0.03 million per year has been shortage for R&D and development of technical information on SPF
	Ineffective and Inadequate information dissemination and awareness raising	Insufficient and effective methods, channels and materials for awareness raising	US$ 0.03 million per year has been shortage for R&D and development of effective methods, channels and materials for awareness raising on SPF
Other	Existing/unsolved environmental and social impacts due to overlapping plantation forests and other land uses, especially natural forests, inappropriate chemicals application and soil degradation		US$ 0.05 million per year has been shortage for R&D, M&E and reinforcement of SPF

4. Decomposition of barriers on agroforestry

Decomposition of barriers on agroforestry			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
Economic and financial	Limited access to favourable capital and financial sources		
	High capital cost	High interest rate of loan, undeveloped capital market and ineffective policy on the management of interest rate and expansion of capital	Interest rate is more than 12% per year

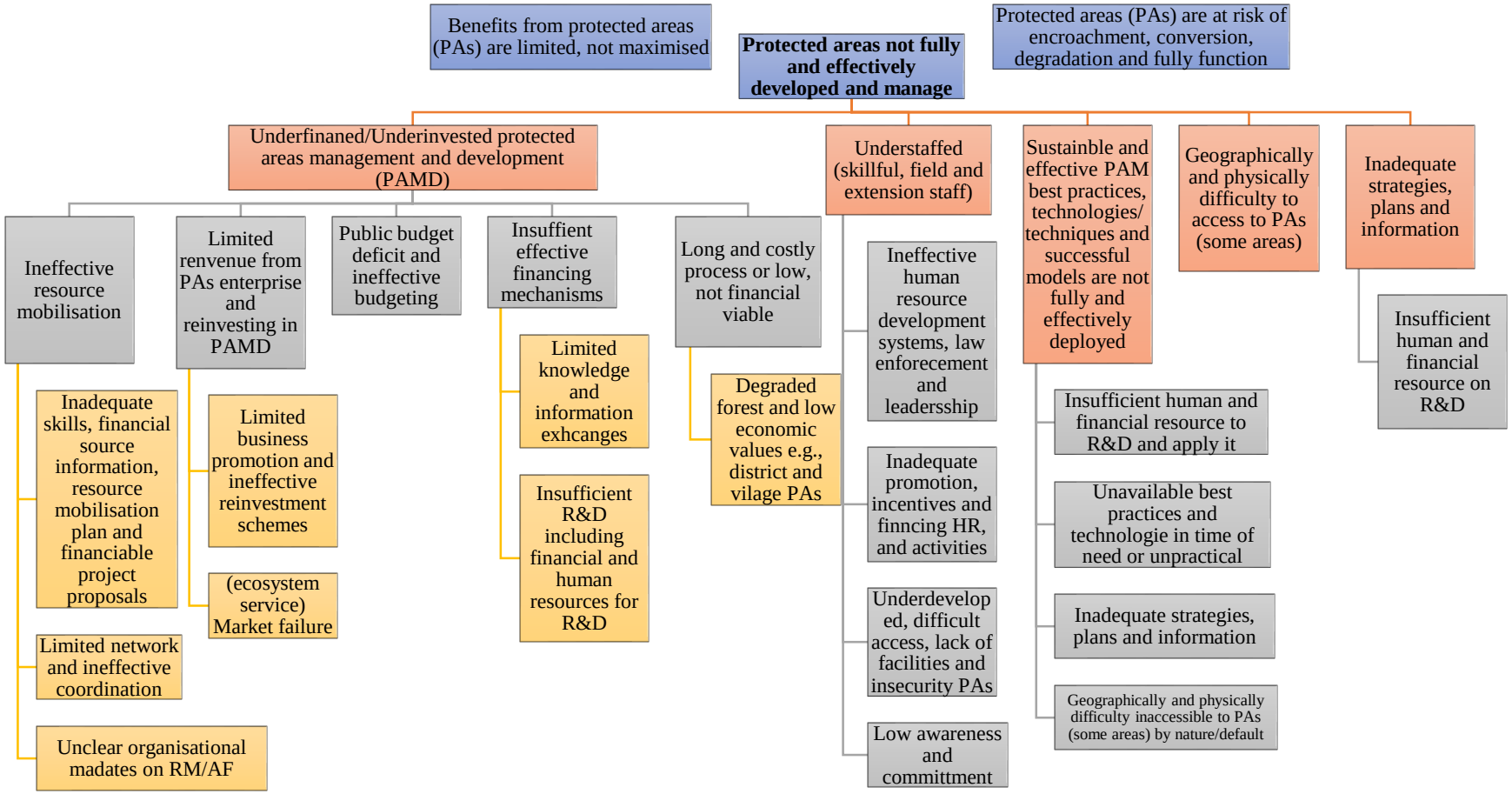
Decomposition of barriers on agroforestry			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
	Insufficient financial promotion and support	Insufficient financial incentives, subsidy or agroforestry development fund to alleviate cost and financial burden	Lack of financial and economic incentive and subsidy feasibility, and cost and benefit study to support formation of policy on incentives and subsidy. About US$ 0.3 million has been shortage for the study
Market failures and imperfection	Small and limited access to agroforestry product market	Local market is small and overwhelmed by and lessor competitiveness to regional agroforestry products which have competitive price and supply	Majority of agroforestry products are imported. US$ 0.05 million per year has been shortage for market R&D
		Limited access to regional markets due to variability of product supply quality (phytosanitary) and quantity	- Few agroforestry products meet the regional markets standard and phytosanitary requirements - Product supply is seasonal - US$ 0.06 million per year has been shortage for standardisation of the products including capacity building
	Limited market places and distribution channels/ overwhelm by imported agroforestry products	Local/domestic agroforestry products are higher or lessor competitiveness price	- Lack of R&D on the effective or appropriate mechanism for promotion of domestic and management of imported agroforestry products - Ineffective regulation on the business for domestic entrepreneurs - US$ 0.04 million per year has been shortage for R&D and enforcement of regulation on business for local people
	Lack of market information	Lack of regional market information such markets places, prices and products and requirements to access to markets	Lack of market research including capacity for research for Lao agroforestry products. About US$ 0.07 million per year has been shortage for the primary research
Policy, legal and regulatory	Incomplete legal and regulatory framework	No decree or regulation on agroforestry to provide clear definition, principles and procedures for promotion and management of agroforestry	About US$ 0.05 million has been shortage for formulation of the degree or regulation on agroforestry and US$ 0.05

Decomposition of barriers on agroforestry			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
			million per year for M&E of the degree or regulation implementation
		Lack of comprehensive policy on financial incentives, subsidy or fund for agroforestry	Lack of R&D including capacity on the financial incentives, subsidy or fund for agroforestry. About US$ 0.05 million has been shortage for formulation of the policy and US$ 0.05 million per year for M&E of the policy implementation
Network failures	Lack of agroforestry expert group/think-tank for advocacy	Fewer agroforestry expert and difficult to establish a agroforestry expert group/think-tank	About US$ 0.05 million has been shortage for formulation of the regulation or policy on the promotion and management of the expert group and individual consultants and US$ 0.03 million per year for facilitation of the expert group advocacy including dialogue and exchanges
		Lack of regulation or policy of the government to promote and manage agroforestry expert group and individual consultants	
	Ineffective networking with regional agroforestry networks	Lack of information and master plan for regional cooperation and networking	About US$ 0.05 million has been shortage for R&D and US$ 0.05 million per year for facilitation cooperation and networking including evaluation
Institutional and organisational capacity and human skills	Incomplete organisational management systems	Lack of mechanism and incentives to mobilise and dispatch of specialized staff for agroforestry extension at local levels	About US$ 0.05 million has been shortage for formulation of policy on mechanism and incentives and US$ 0.04 million per year for capacity building and facilitation dispatch programme at local levels
		No agroforestry expert group/association	*See network failure*
	Ineffective organizational planning, M&E and reporting system	Lack of agroforestry development strategy, M&E and reporting systems	About US$ 0.04 million has been shortage for formulation of the strategy and plans, and US$ 0.04 million per year for M&E of strategies and plans implementation
	Limited technical capacity and skills	Limited skills on HRD systems including (1) HDR planning, (2) capacity needs assessment, (3) staff information and knowledge map/management, (4) effective recruitment and staffing, and (5) management of human resources demand and supply	About US$ 0.05 million per year has been shortage for development of efficient skills on HRD

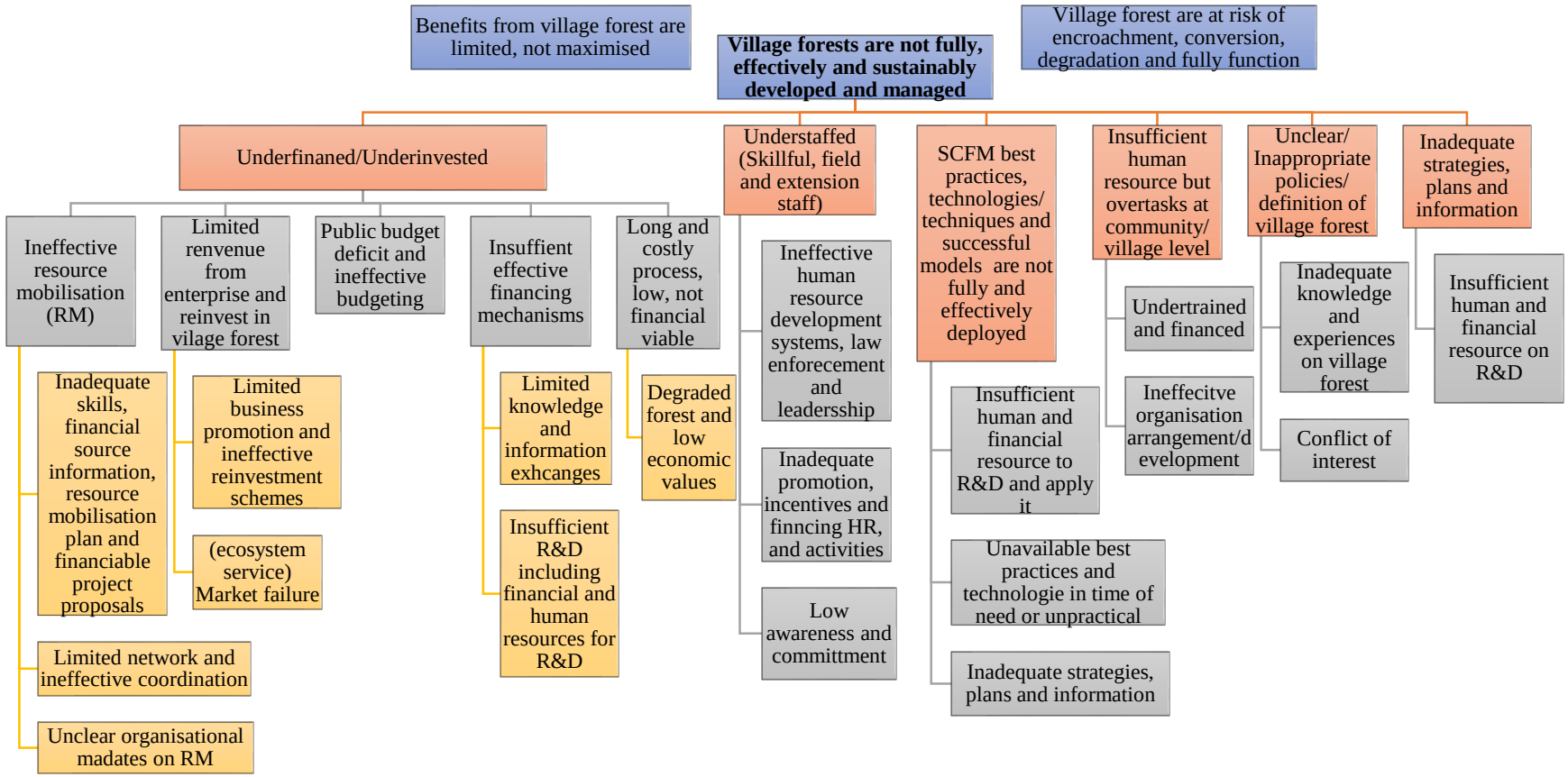
Decomposition of barriers on agroforestry			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
		Lack of technical skills on the development of agroforestry systems, especially (1) R&D on optimal agroforestry systems including tree-crops and livestock components for generation of optimum economic and mitigation, (2) financial and economic models including entrepreneurship and (3) marketing on agroforestry products and service	About US$ 0.07 million per year has been shortage for the development of skills on optimal agroforestry systems and business including marketing
	Lack of resource materials on agroforestry	Handbook and guidelines including best practices on different types of agroforestry systems	About US$ 0.025 million per year has been shortage for the development and facilitation of the application of the handbook and guidelines including best practices
Information and awareness	Insufficient information on agroforestry	Insufficient information on (1) overall agroforestry systems and performance, (2) optimal or suitable agroforestry including land/soil- tree-crops- and livestock components or combination, (3) cost-benefits and return on investment of each agroforestry system, (4) mitigation potential of each agroforestry system	About US$ 0.025 million per year has been shortage for information R&D including capacity building
	Inadequate and ineffective and information dissemination and awareness raising	Lack of R&D and evaluation of best practices/methods and materials, and financial support on effective awareness raising	About US$ 0.07 million per year has been shortage for R&D of best practices/methods and materials, and financial support on effective awareness raising
Technical	Difficult to define and evaluation the effects of optimal agroforestry systems	It is difficult, time consuming and costly for defining and evaluating optimal agroforestry systems, especially trade off and mitigation potentials amongst agroforestry systems	About US$ 0.08 million per year has been shortage for R&D and capacity building on R&D and evaluation of optimal systems including financial, economic and mitigation trade off amongst agroforestry systems
Other	Overlapping agroforestry systems and other land uses	Lack of integrated land use and land suitability and application of integrated planning and developments	About US$ 0.10 million per year has been shortage for R&D of integrated land use and land suitability including capacity building

Annex 5 Problems and solutions trees of technologies in forest sector

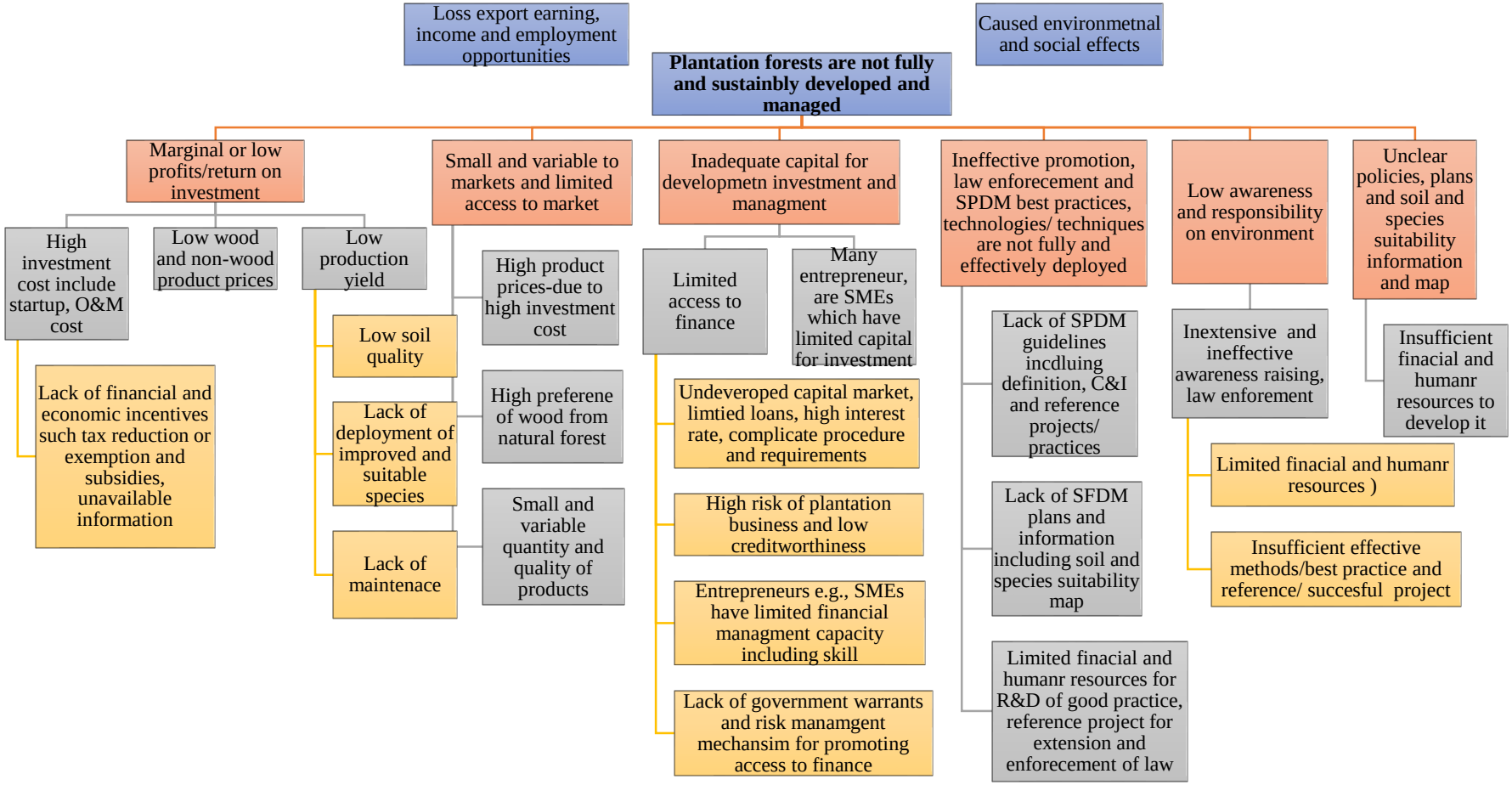
1. Effective Protected Area Management



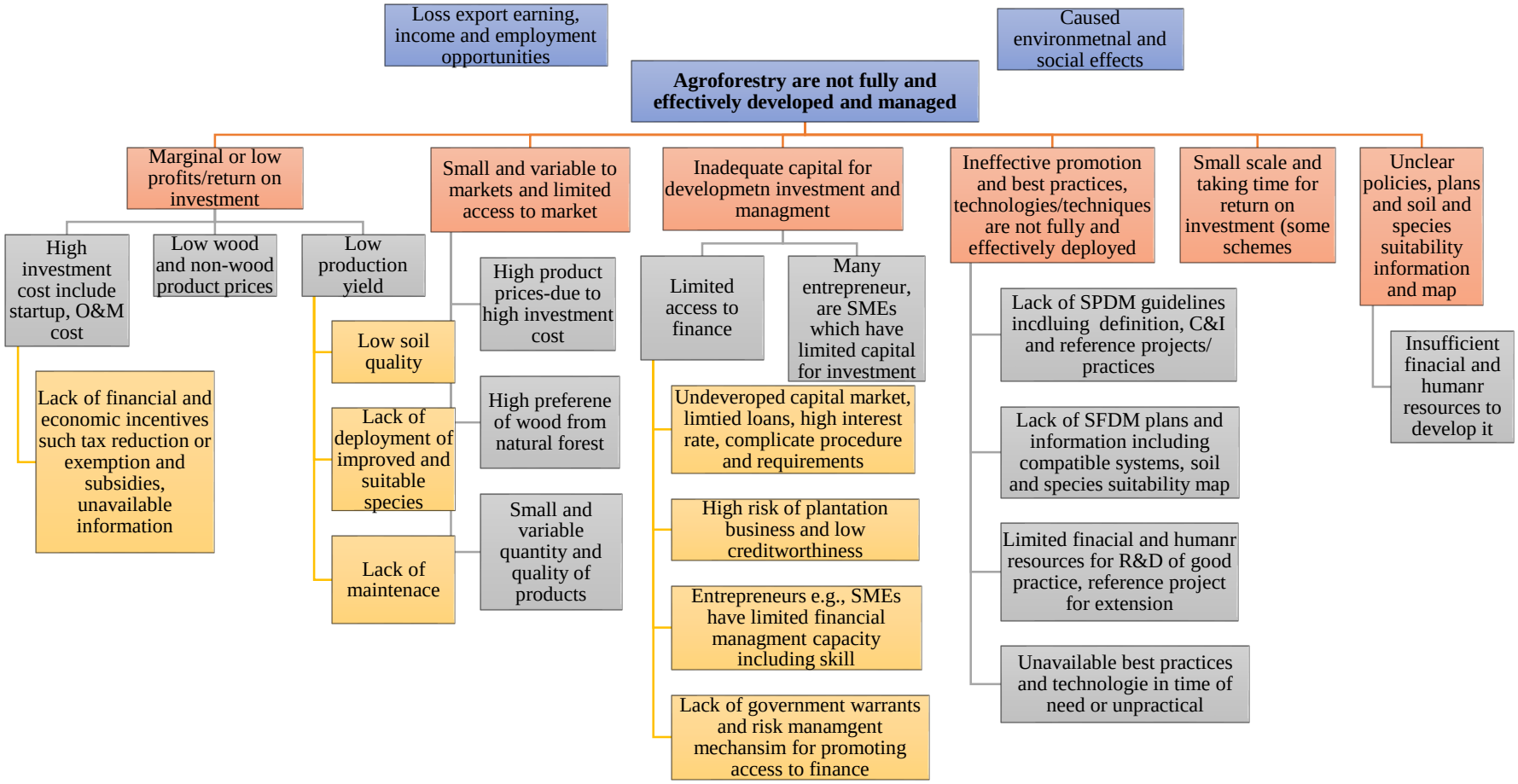
2. Sustainable Community or Village Forest Management (SCFM/SVFM)



3. Optimal or Sustainable Plantation Forests



4. Agroforestry



Annex 6 Estimated revenues from village and conservation forests

1. **Estimated primary revenue from conservation forests or protected areas per year in next 3 years (2017-2020)**

Forest ecosystem services	**Data and assumptions**	**Revenues (US$)**
1. Non-timber forest products (buffer zones only)	Bamboo, cardamom, rattan, resins, herbs and vegetables etc. at buffer zones (approx. 10% of total area or 440,000 ha): US$ 50 per ha/yr.	22,000,000
2. Carbon credits	1. Total conservation forest area: 4,400,000 ha 2. 60% of the village forest (600,000 ha) are implementable under carbon credit mechanism 3. Mean biomass stock is village 120 t dm/ha and increase 1.5 t dm/ha/yr. Total annual carbon sequestration is approx. 2,805,000 tCO2/yr. 4. Biomass loss (due to wood, NTFP collection, minor conversion etc.): 0.2 t md/ha/yr. Total emission is approx.806,666 tCO2/yr. 5. Carbon price: US$ 5/tCO2	9,991,666
3. Ecotourism/ Nature-based tourism	1. Total conservation forest area: 4,400,000 ha 2. Tourists: total tourist to Laos: 3,854,441 in 2014 (NSC, 2015). Estimated 4% increase of tourists between 2014 and 2020 or numbers of tourists are 4,677,994 in 2017 and 5,262,107 in 2020. Assuming 3 to 5% (or 46,780 to 157,864 tourists) in 2017 and in 2020, respectively are the nature and culture-based tourists who visit and pay US$ 5 per tourist as a fee for the protected areas/conservation forest.	216,790 to 731,565
Total		**32,225,566 to 32,780,986**

2. **Estimated primary revenue from village forests (outside PAs) per year in next 3 years (2017-2020)**

Forest ecosystem services	**Data and assumptions**	**Revenues (US$)**
1. Non-timber forest products	1. Total annual NTFP cash income is US$ 128,086,797 (NAFRI, NUoL, SNV, 2007) 2. Total village forest area: 8,000,000 ha 3. Bamboo, cardamom, rattan, resins, herbs and vegetables etc.US$ 25 per ha/yr.	25,000,000
2. Carbon credits	1. Total village forest area: 8,000,000 ha 2. 7.5% of the village forest (600,000 ha) are implementable under carbon credit mechanism	1,100,000

	3. Mean biomass stock is village 70 t dm/ha and increase 0.6 t dm/ha/yr. Total annual carbon sequestration under carbon credit mechanism is approx. 330,000 tCO2/yr. 4. Biomass loss (due to wood, NTFP collection etc.): 0.2 t md/ha/yr. Total emission is approx.110,000 tCO2/yr. 5. Carbon price: US$ 5/tCO2[34]	
3. Ecotourism	1. Total village forest area: 8,000,000 ha 2. Tourists: total tourist to Laos: 1,500,000-2,000,000 between 2017 and 2020; nature and culture-based tourists accounts for 3-5% of the total or 450,000-100,000 tourists; 2% of them or 9,000-20,000 tourists visit and pay US$ 5 per tourist as a fee for the village forest conservation.	45,000-100,000
Total		**26,104,500 to 26,200,000**

[34]85 percent are priced at less than US$10/tCO2e (WB, 2015), and this used bottom mean price of the price.

Annex 7: Longlist barriers of technologies in agriculture sector

1. Feed improvement

Longlist Barriers
1. Low profit of livestock and feed improvement business
2. High cost on feed development including production inputs e.g., seeds and fertilizer, irrigation/ watering system e.g., electric pump system, experts-consultancy services, logistics, capital and tax, UXO clearance, process and storage technologies including maintenance
3. Inadequate public financial support e.g., incentives, subsidy or agricultural development fund for promotion
4. Limited capital and access to favourable financial resources
5. Insufficient sustainable or effective financing mechanism for agriculture business including feed development
6. Small and variable market (livestock industry)
7. Forage is not widely commercialised (limited to livestock industry)
8. Inadequate policies on feed/forage resources management and development including concession, lease and conversion of pastureland and exploitation of feed resources, financial incentives, subsidies and warrants of market and price, and access to finance
9. Non-functioning animal feed expert group
10. Ineffective stakeholders' human development system including ineffective staff information and knowledge management, HR and capacity development plan, recruitment, trainings and learning, monitoring and evaluation, imbalanced between technical and administration staff, limited field-based extension staff
11. Ineffective and inadequate professional training and learning programme
12. Limited knowledge and technical skills on: 1) business and financial management including access to market and finance, financial and economic feasibility study and analysis, development of bankable proposal and value chain, 2) resource mobilisation including, 3) feed/forage production techniques, processing technologies and standards, 4) organisational including producer group and HRD, 5) policies for business promotion
13. Ineffective coordination amongst stakeholders
14. Low awareness on feed/forage development technologies including inputs, production, processing and storage
15. Inadequate accurate information on feed/forage resources and areas, techniques and best practices on optimal feed/forage species systems, concentrate formula, cost-benefits and return on investment
16. Ineffective R&D, information dissemination and exchanges
17. Biological and geographical limitation of forage/grasses to grow in Laos
18. It is difficult or costly to develop suitable feed, especially concentrates to maximise productivity and reduce GHG emission
19. Degraded or low grassland soil quality

2. Organic farming

Lonflist Barriers
1. High investment cost per unit (compare with conventional farming) on production including higher labour cost due to labour intensive, inspection and certification, transport and marketing
2. Limited capital and access to financial resources
3. Inadequate public financial promotion/support such as incentives and subsidy
4. Unavailable sustainable financing mechanism for promotion of organic farming
5. Small market
6. High demand and competitive agriculture products from conventional farming
7. High price of organic products
8. Variable product quantity and low trustworthiness on quality
9. Unclear policies and regulation on organic land and resources management and development
10. Inadequate or nuclear policies on financial incentives, subsidy and fund for organic crop and livestock farming business
11. Inactive organic farm/green agriculture organic expert group /association
12. Ineffective networking and coordination with external organic farming networks
13. Ineffective human development system including ineffective capacity needs assessment, staff information and knowledge management, HD and capacity development plans, recruitment and imbalanced between technical and administration staff, limited field-based extension staff
14. Ineffective training programme and learning courses
15. Limited technical skills on business including access to markets and finance, resources mobilization production and processing techniques, soil nutrients and carbon management, standards and certification
16. Low creditworthiness, due to inadequate skills, equipment and facilities for standards and certification
17. Low awareness on organic farming operation procedure, standards and certification
18. Misunderstanding or mixed understanding between sustainable, conservation, synthetic chemical free, green agriculture and organic farming
19. Inadequate information on feasibility, especially cost-benefits and return on investment on different organic farming systems or and crops and livestock, market, resource materials, mitigation potential, production and processing techniques and best practices
20. Biological and geographical limitation of plants/crops
21. Processed organic products can't be kept for long/easier to spoil
22. Small scale, risk of insects and need special care which is time consuming, labour intensive and costly
23. Difficult to apply precise organic farming (organic fertilizer)
24. Difficult to growth offseason
25. Undefinable organic farmland

3. Biogas

Longlist Barriers
1. Low profit
2. High investment cost including high equipment cost, construction, operation and maintenance (O&M)
3. High cost on feasibility, R&D for diversifying new product or value-added e.g., bottled gas
4. Limited budget and financial support from government indulging incentives, subsidy and fund for biogas
5. Investors, especially farmers have limited financial resources on biogas development
6. Small market (limited to livestock keepers)
7. Small and variable supply of raw materials (manure)

Longlist Barriers
8. Limited accurate information about market/demand and capacity
9. There are more energy options or demand e.g., wood which easier to access and use, hence distract use of biogas for cooking (grill)
10. Unclear policies on biogas promotion and regulation
11. Ineffective network and coordination amongst stakeholders including experts and platform for exchanges knowledge and information on biogas
12. Unclear or overlapping responsibility of amongst ministry of energy and mines, science and technology, livestock and environment on the management and promotion of biogas
13. Unclear biogas development action plans
14. Ineffective human development system including insufficient capacity needs assessment, staff information and knowledge management, HR and capacity development plan, and ineffective recruitment and HRD M&E
15. Ineffective and inadequate training and learning programmes
16. Limited knowledge and technical skills on biogas including R&D on supplementary/substitute materials and more flexible biogas plants
17. Inadequate financial and economic feasibility study and information for diversifying new product or value-added e.g., bottled gas
18. Little awareness on biogas including how to access to equipment, cost-benefits and return on investment
19. Insufficient effective or best practice on awareness raising
20. Limited utility of biogas e.g., grill while it is common cooking culture of Lao
21. Time consuming and strict O&M
22. It is difficult or costly to design co-firing, R&D supplementary materials and more flexible biogas to use raw materials
23. Unfavourable manure as a fuel and odder of methane

4. Biomass

Longlist Barriers
1. Low profit and/or not economic and financial feasible
2. High investment cost, especially installation/start-up, O&M cost
3. Unclear financial and economic of establishment of plantation to supply raw materials, co-firing system
4. Undeveloped capital market and limited access to financial resources
5. Inadequate public financial support including financial and economic incentives, subsidy and fund for feasibility, demonstration and initiation biomass energy
6. Uncertain market (off-grid and carbon credit)
7. Small and variable agricultural and forestry production and supply of raw materials
8. High demand for agriculture residues and wood waste for other purposes (return to field for soils conservation and cooking)
9. Unclear policies on biomass promotion, especially feed-in tariff or adder
10. Unclear or overlapping responsibility of amongst ministry of energy and mines, science and technology, agriculture and forestry and environment on the management and promotion of biomass energy
11. Inexistent biomass expert group for advice and advocacy and platform for exchanges knowledge and information on biomass

Longlist Barriers
12. Ineffective networking with regional biomass networks
13. Ineffective human development system including ineffective capacity needs assessment, staff information and knowledge management, HR and capacity development plan, staff recruitment and positioning, monitoring and evaluation of HRD
14. Ineffective and inadequate biomass energy professional training and learning programmes
15. Limited technical knowledge and skills on biomass energy, especially access to finance, resource mobilisation, engineering and R&D of supplementary raw materials and co-firing systems
16. Inadequate accurate information of raw materials for feedstock, cost-benefits and return on investment on biomass
17. Low awareness on biomass energy and reference/successful projects
18. Inadequate and ineffective R&D and information dissemination

Annex 8 Decomposition of agricultural technologies

1. Categorisation and decomposition of the key barriers on feed improvement

Broad categories of barriers	Barriers within a category	Elements of barriers	Dimension of Barrier elements
Economic and financial	High investment cost on production inputs, process and storage technologies	High cost of production inputs e.g., import of seeds, fertilizer and import duty	Imported duty on production inputs accounted for about 3 to 5% of the imported values
		High cost related with irrigation/watering system, especially electric pump systems	If irrigation/watering system has to be built by entrepreneur or farmers, it would add on and increase the total investment cost of about 10 to 15% for gravity/run off and electric pump system, respectively
		High cost on consultancy services on production and maintenance of (post-harvest) technologies for processed feed and storage due to lack of capacity, limited domestic experts and reply on regional experts-consultancy services	If local capacity builders/consulting service is not available, and has to employment of regional consulting service, the cost on consultancy service could increase from about 40 to 50% of the cost on consulting service
		High cost on (post-harvest) technologies for processed feed and storage due to: (1) imported technology related duty and (2) limited local technology producers and suppliers	Imported duty on the technologies for processed feed and storage accounted for about 3 to 5% of the imported values
		High cost on transport and logistics associated with limited or poor road and geographically difficulty to access to rural/farming areas and market places	If access road to farming areas has to be built by entrepreneur or farmers; forage and feed business is unprofitable. Improvement of roads and logistics by public sector, would reduce about 10 to 20% of the total cost on transport and logistics
	High capital cost	High interest rate of loan due to undeveloped capital market and ineffective policy on the management of interest rate and expansion of capital	Interest rate is more than 12% per year
	Lack of financial promotion/ support and options	Limited financial incentives, subsidy or agricultural development fund to alleviate cost and financial burden	- Nayobay bank offers loan with interest rate of about 5-7% per year, but the offer is only small and shorter loan and only for poor households

Broad categories of barriers	Barriers within a category	Elements of barriers	Dimension of Barrier elements
			- Lack of feasibility study on the financial incentives, subsidy or agricultural development fund and development of appropriate policy. About US$ 0.1 million per year has been shortage for the study and formulation of the policy
	Limited access to finance/capital	Complicated procedures and requirements of banks and financial institutes, especially collateral and comprehensive financial and economic analysis	Lack of R&D on capital market developments and policy. About US$ 0.15 million per year has been shortage for the study and formulation of the policy
		Majority of local livestock entrepreneurs and farmers have low business-financial management standard and insufficient skills on the development of bankable project including financial and economic analysis	About US$ 0.15 million per year has been shortage for strengthening capacity of the entrepreneurs
		Lack of win-win risk management system/mechanism and policy	About US$ 0.15 million per year has been shortage for study of the win-win risk management system/mechanism and policy
Market failures and imperfection	Small market/ livestock industry	Feed/forage production limits to livestock owner only, processed forage and concentrates are not widely commercialised	About US$ 0.17 million per year has been shortage for R&D of optimal feed and markets
Policy, legal and regulatory	Incomplete legal and regulatory framework	Lack of regulation on feed/forage resources management and development, especially unclear management mechanism including principles and procedures on concession, lease and conversion of pastureland and exploitation of feed resources	About US$ 0.15 million per year has been shortage for R&D of the regulations
		Lack of policy on financial incentives, subsidy and agricultural development fund, especially unclear directions on agriculture development fund, subsidy and incentives specified in the agriculture law	About US$ 0.15 million per year has been shortage for R&D of the policies
	Ineffective law enforcement	Ineffective implementation of agriculture law, including ineffective promotion of best practices and enforcement of measures for law violation	About US$ 0.1 million per year has been shortage for R&D of best practice guidelines and capacity building on law enforcement

Broad categories of barriers	Barriers within a category	Elements of barriers	Dimension of Barrier elements
		Ineffective enforcement of regulations on agricultural land management, decree on environmental impact assessment and land concession, especially enforcement of measures for inappropriate conversion concession and lease of pastureland as well as violence of the regulations.	About US$ 0.2 million per year has been shortage for R&D of best practice guidelines and capacity building on law enforcement
Network failures	No specific expert group	Limited expert on livestock feed including fodder and appropriate concentrates for emission reduction	About US$ 0.08 million per year has been shortage for facilitation of expert group establishment including dialogues and exchange
Institutional and organisational capacity	Ineffective human development system	Mismatch human resources demand and supply	About US$ 0.15 million per year has been shortage for improvement of human development system
		Lack of human resources development plan, including capacity needs assessment, monitoring and reporting.	
		Lack of staff information and knowledge management	
		Ineffective recruitment and orientation	
		Misallocation of staff such as mismatch job requirements and staff capacity/qualification Imbalanced between technical and administration staff, limited field-based extension staff	
		Lack of practical and effective training programme, learning course and facilities of educational institutes	
		Lack of systematic monitoring and evaluation of HRD and capacity building	
	Lack of technical skills	Limited technical skills on (1) business planning and financial management, (2) financial and economic analysis/feasibility and development bankable proposal, including CBR and IRR, (3) capital market development and management, (4) fund, subsidy and financial incentives for agriculture, especially livestock, (5) development feed/forage/ concentrates production, processing and storage technologies, (6) restoration soil	About US$ 0.3 million per year has been shortage for technical skills developments

Broad categories of barriers	Barriers within a category	Elements of barriers	Dimension of Barrier elements
		fertility (7) policy to facilitate to access to finance, and management of livestock land	
Information and awareness	Lack of information and awareness on feed/forage development	Lack of R&D and information on feed/forage improvement techniques, best practice and reference project on optimal feed/forage species and production systems, and concentrate formula	About US$ 0.12 million per year has been shortage for R&D and improvement of the feed/forage information and techniques, and dissemination
		Lack of R&D and information on cost-benefits and return on investment on feed/forage or pasture development, processed feed and concentrate development.	
		Lack of effective R&D, information dissemination, extension and exchanges	
Technical	Biological and geographical limitation of forage/grasses	Not all forage/ grasses species can grow in Laos, defined livestock land and only some species perceived to be efficient.	About US$ 0.14 million per year has been shortage for biotechnology R&D and improvement of the feed/forage
		Not all forage/grasses species can be grown or integrated all farm systems or only few species and systems perceived to be efficient	

2. Decomposition of the key barriers on organic farming

Decomposition of the key barriers on organic farming			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
Economic and financial		High labour cost due to labour intensive	Cost on labour of organic farming is about 14-15% higher than conventional one

Decomposition of the key barriers on organic farming			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
	High investment cost on production per unit (compare with conventional farming)	High cost related with irrigation/watering system	If irrigation/watering system has to be built by entrepreneur or farmers, it would add on and increase the total investment cost of about 10 to 15% for gravity/run off and electric pump system, respectively
		High cost on organic fertilizer and pest management (compare to synthetic fertilizer)	The cost on organic fertilizer and pest management is 8-10% higher compare to synthetic chemical fertilizer and pesticide
		High cost (per unit) due to small production (compare with conventional farming)	The cost (per unit) of organic product is 10-15% higher than conventional farm products
		High cost on processed organic products (compare with conventional farming) due to small amount and more complicate technologies for maintaining nutrients	The cost of organic product processing is 5-10% higher than conventional farm products
		High cost for inspection and certification	The cost for inspection and certification is about US$ 1,500-2,500, and increase 2-3% of total investment cost per unit
	High capital cost	High interest rate of loan due to undeveloped capital market and ineffective policy on the management of interest rate and expansion of capital.	Interest rate is more than 12% per year
	Lack of financial promotion/ support and options	Lack of financial incentives, subsidy or agriculture development fund to alleviate cost and financial burden	- Nayobay bank offers loan with interest rate of about 5-7% per year, but the offer is only small and shorter loan and only for poor households - Lack of feasibility study on the financial incentives, subsidy or agricultural development fund and development of appropriate policy. About US$ 0.1 million per year has been shortage for the study and formulation of the policy
	Limited capital and access to finance of entrepreneurs	Small enterprise and lack of business management skills	About US$ 0.12 million per year has been shortage for business management skills development, R&D and introduction of appropriate risk management mechanism
		Complicated procedures and requirements such as collateral	

Decomposition of the key barriers on organic farming			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
Market	Market failures and imperfection	Small (existing) market	Lack of R&D on the market developments and policy. About US$ 0.2 million per year has been shortage for the study and formulation of the policy to facilitate access to market
		Limited market places and distribution channels	
		Lack of market information	
		Mismatch demand and supply (quantity and quality)	
		Unstable supply of organic products	About US$ 0.15 million per year has been shortage for strengthening capacity on the production technologies
Policy, legal and regulatory	Incomplete legal and regulatory framework	Lack of regulation on organic land and resources management and development, especially unclear definition, principles and procedures for management and development of organic soil/land and resources	About US$ 0.18 million per year has been shortage for R&D of regulation and strengthening capacity on organic land and resources management
		Lack of policy on financial incentives, subsidy and agricultural development fund for organic farming and products	About US$ 0.15 million per year has been shortage for feasibility and trade off study of the financial incentives, subsidy and agricultural development fund
		Lack of empirical policy on the promotion of best practices on environmentally-friendly agriculture and enforcement of polluter- pay regulation	About US$ 0.1 million per year has been shortage for R&D of the policies on environmentally-friendly agriculture and enforcement of polluter- pay regulation
		Lack of regulation on particular organic livestock farming and products	About US$ 0.1 million per year has been shortage for R&D of the policies on particular organic livestock farming and products
Network failures	Lack of organic farming expert group and platform for exchanges	Limited number of experts and regulations or policy for promotion and management of the expert group	About US$ 0.07 million per year has been shortage for facilitation of the organic farming expert group and platform for exchanges
Institutional and organisational capacity and human skills	Ineffective human development system	Mismatch human resources demand and supply	About US$ 0.12 million per year has been shortage for improvement of human development system
		Lack of human resources development plan, including capacity needs assessment, monitoring and reporting.	
		Lack of staff information and knowledge management	
		Ineffective recruitment and orientation	

Decomposition of the key barriers on organic farming			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
		Misallocation of staff such as mismatch job requirements and staff capacity/qualification; and imbalanced between technical and administration staff, limited field-based extension staff	
		Lack of practical and effective training programme, learning course and facilities of educational institutes	
		Lack of systematic monitoring and evaluation of HRD and capacity building	
	Limited technical skills on business including financial management and development	Lack of skills on business planning, financial record, reporting and auditing	About US$ 0.18 million per year has been shortage for improvement of the technical skills on business including financial management and development
		Limited skills on access and facilitate to access to finance, especially bankable proposal and feasibility study, especially financial and economic analysis, especially cost-benefit and return on investment	
		Lack of skills to carry out research on financial/ capital sources and development financiers' directory such as information collection and analyse of potential financiers and capital, access channel, requirements and procedures, and contact	
		Lack of skills on networking and coordination for financial and capital market development	
	Limited technical skills on the application of organic farming or conservation agriculture techniques	Lack of skills on soil nutrients and carbon management as well as maintenance and restoration soil fertility	About US$ 0.28 million per year has been shortage for improvement of the technical skills on application of organic farming or conservation agriculture techniques
		Lack of skills on integrated pest management	
		Lack of skills on organic fertiliser development, especially optimal organic fertiliser formula and	

Decomposition of the key barriers on organic farming			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
		economic and financial analysis such as cost-benefits and return on investment	
		Lack of skills on the application of reduced or non-tillage techniques	
		Lack of skills on the inspection of standard and certification of organic products (for regional markets) of both vegetable and livestock farming and products	
	Lack of skills on the financing agriculture including organic farming development	Lack of skills on the establishment of agriculture development fund, financial incentives or subsidy	About US$ 0.28 million per year has been shortage for R&D and formation of the policy on the agriculture development fund, financial incentives or subsidy
	Lack of skills on resources mobilization	Lack of skills on the development of resources mobilization plan	About US$ 0.13 million per year has been shortage for development of skills on resources mobilization and formulation of policy to facilitate to access to finance
	Lack of skills on the formulation of policy to facilitate to access to finance	Lack of skills on information collection and analysis of policy to facilitate to access to finance	
Information and awareness	Lack of information and awareness/confidence on organic farming	Lack of information on feasibility, especially cost-benefits and return on investment on different organic farming systems or and crops and livestock	About US$ 0.13 million per year has been shortage for improvement of information and awareness
		Lack of resource materials for different types of organic farming systems or and crops and livestock	
		Lack of information on actual mitigation potential of different types of organic farming systems or and crops and livestock	
		Misunderstanding or mixed understanding between sustainable, conservation, synthetic chemical free, green agriculture and organic farming	

Decomposition of the key barriers on organic farming			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
Technical	Biological and geographical limitation of plants/crops	Not all plants/crops species and livestock are suitable for Laos or unprofitable	About US$ 0.19 million per year has been shortage for capacity building and address biological trade and small scale and variable production
	Difficult or costly to keep processed organic products for long period of time without concretisation of quality	Limited R&D on organic product storage and nutrients	
	Small scale and variable production	Seasonal variable production or cost inefficient for off-season production or overproduced in one season and shortage in other season.	
		Unsteady and unstable certified production areas and producers	

3. Decomposition of the key barriers on biogas

Decomposition of the key barriers on biogas			
Broad categories of barriers	**Barriers within a category**	**Elements of Barriers**	**Dimension of Barrier elements**
Economic and financial	High investment cost	High investment cost on construction, especially equipment such as burner and burning control system, which is imported , not manufactured and limited suppliers domestically	Equipment and construction material accounted for more than 70% of the cost for development biodigester.

Decomposition of the key barriers on biogas			
Broad categories of barriers	**Barriers within a category**	**Elements of Barriers**	**Dimension of Barrier elements**
		High cost on operation, especially cost of raw material (manure) including collecting, assembling and transport of raw material	High cost of material is related with small and scattered livestock farms and poor transport/logistic system
		High maintenance cost, especially replacement of burner and burning control system, which is imported , not manufactured and limited suppliers domestically	The maintenance cost accounted for about 10-15% of the operation cost
		High cost for diversifying new product or value-added e.g., bottled gas	High equipment cost such as gas bottles and compressor system , which is imported , not manufactured and limited suppliers domestically
		High investment cost on skill labour or technical services for construction and replacement of equipment, which majority of biogas owners are not able to make or help themselves	Skill labour or technical services cover 12% of total cost for installation. Recently, this cost is covered by government or donors/ projects.
	Unfavourable loan	High interest rate of loan due to undeveloped capital market and ineffective policy on the management of interest rate	Interest rate is more than 12% per year
		Unavailable long-term loan	No more than 3 years loan
		Complicated procedures and requirements for access to capital/finance	
	Limited financial capital and access to capital/finance	Small biogas holders have limited financial capital and collateral/asset	Most of existing biogas smallholders and potential investors could cover less than 50% of the biogas start-up cost
		Biogas generates low profit	
	Lack of financial promotion/ support and options	Lack of financial incentives or tax reduction for import biogas equipment	About US$ 0.07 million per year has been shortage for R&D on taxation, subsidy and awareness raising
		Lack of (renewable energy development) fund and financial subsidy for biogas	

Decomposition of the key barriers on biogas			
Broad categories of barriers	**Barriers within a category**	**Elements of Barriers**	**Dimension of Barrier elements**
		Lack of financial support for research, capacity building and awareness raising on biogas	
Market	Small (existing) market	Variable demand for manure-based biogas	About US$ 0.19 million per year has been shortage for livestock development and corporate farming
		Limit to livestock farms/keepers	
		No bottled gas product	About US$ 0.45 million per year has been shortage for R&D of new product e.g., bottled gas product
Policy, legal and regulatory	Incomplete legal and regulatory framework	Lack of policy or regulation to promote biogas development or environmentally-friendly technologies	About US$ 0.09 million per year has been shortage for R&D of policy or regulation to promote biogas development or environmentally-friendly technologies
		Laws have not provided clear-cut responsibility of amongst ministry of energy and mines, science and technology, agriculture and forestry and educational institutes on the management and promotion of biogas	
Network	Lack of network	Lack of biogas association and platform for exchanges knowledge and information	About US$ 0.08 million per year has been shortage for facilitation of expert group and exchanges knowledge and information
		Lack of expert group for extension of biogas	
Institutional and organisational capacity and human skills	Ineffective planning, promotion and reporting system	Lack of biogas development strategy/plan	About US$ 0.18 million has been shortage for planning including improvement information and capacity building and US$ 0.7 per year for implementation, evaluation and update the strategy every 3-5 years
		Inadequate and ineffective information dissemination via media, exchange/exhibition and seminars/workshops	
		Lack of subsector/technology performance review	
	Ineffective human development system	Mismatch human resources demand and supply	About US$ 0.08 million per year has been shortage for improvement of human development system
		Lack of human resources development plan, including capacity needs assessment, monitoring and reporting.	
		Lack of staff information and knowledge management	
		Ineffective recruitment and orientation	
		Misallocation of staff such as mismatch job requirements and staff capacity/qualification	

Decomposition of the key barriers on biogas			
Broad categories of barriers	**Barriers within a category**	**Elements of Barriers**	**Dimension of Barrier elements**
		Imbalanced between technical and administration staff, limited field-based extension staff	
		Lack of practical and effective training programme, learning course and facilities of educational institutes	
		Lack of systematic monitoring and evaluation of HRD and capacity building	
	Lack of technical skills on biogas and relevant areas	Limited technical skills on business including development of bankable proposal	About US$ 0.13 million per year has been shortage for improvement of the technical skills on biogas and relevant areas
		Limited technical skills on maintenance/repair of biogas	
		Lack of research skills on supplementary/ substitute materials for biogas	
		Lack of skills on resources mobilization including development of resources mobilization plan	
		Lack of skills on the analysis and formulation of policy to promote biogas	
Information and awareness	Lack of information and awareness on biogas	Lack of information on cost-benefits and return on investment on biogas	About US$ 0.08 million per year has been shortage for R&D and improvement of information on biogas technologies, materials and best practices
Technical	Limited utility of biogas	Biogas is only able to use for some lightings and cooking) or cannot function as electricity or wood	About US$ 0.14 million per year has been shortage for R&D and improvement of the biogas technological utility and materials
	Small and unstable supply of raw materials (manure)	Manure is derived from small, scattered farms and poor manure management system	
		High demand for manure for production of organic fertilizer	
Other	There are options for energy e.g., wood which is affordable		Fuel wood accounted for more than 50% of energy use in Laos and 85% of energy for cooking

Decomposition of the key barriers on biogas			
Broad categories of barriers	**Barriers within a category**	**Elements of Barriers**	**Dimension of Barrier elements**
	and has been main energy for cooking for Lao people.		

4. Decomposition of the key barriers on biomass energy

Decomposition of the key barriers on biomass energy			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
Economic and financial	High investment cost	High equipment cost biomass-fired power plant installation/ start-up cost such as feedstock storage and processing, boiler/ gasification system due to technology/equipment and import tax	- It estimated that start-up cost is around US$ 1.8 million per MW or US$ 0.05/kwh - Only few (domestic) investors are affordable
		High construction cost on electric transmission line due to project site (usually in remote area, lack of and far from national or local electric grid system)	
		High operation cost including collecting, assembling and transport of raw materials due to small and scattered producers/suppliers and poor infrastructure and logistic system	Operation cost is approximately 5-10% of the start-up cost. Of which, feedstock cost is about US$15/tone
		High cost on establishment of plantation to supply raw materials	Feedstock cost from this source may rank from US$ 20-30/tone
		High maintenance cost, especially replacement of equipment	Maintenance cost is approximately 5-10% of the start-up cost
		High investment cost on skill labour and technical services for construction and O&M, especially international experts/service	
	High capital cost	High interest rate	Interest rate of loan is more than 12% per year

Decomposition of the key barriers on biomass energy			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
		Unavailable long-term loan/credits	No more than3-years loans/credits
	Limited financial capital and access to favourable capital/ finance domestically and internationally	Most of (domestic) investors are small scale and limited financial capital and collateral/asset	Most of (domestic) investors could cover less than 50% of the investment cost
		Most of (domestic) investors are small scale and weak business and financial management system and capacity	Very few domestic investors is recognised as class one business
		Complicated procedure and requirements for access to finance	Lack of R&D on win-win risk management system/mechanism
	Lack of financial promotion/ support and options	Lack of financial incentives or tax reduction and promotional price for renewable energy	About US$ 0.14 million per year has been shortage for R&D and improvement of the financial incentives, subsidy and capacity building
		Lack of renewable energy development fund and financial subsidy	
		Lack of financial support for feasibility study and demonstration of biomass project	
		Lack of financial support for capacity building and awareness raising on renewable energy potential, technologies, feasibility and facilitating networking and access to finance	
Market failures and imperfection	Variable carbon markets/credits	No domestic market/depends on regional markets and requirements	About US$ 0.08 million per year has been shortage for R&D on the carbon market feasibility
Policy, legal and regulatory	Incomplete legal and regulatory framework	No regulation on biomass and agricultural residues	About US$ 0.15 million per year has been shortage for R&D and improvement of the legal and regulatory framework
		No comprehensive policy on promotion of renewable energy and technologies on biomass and agricultural residue energy	
		Laws have not provide clear-cut responsibility of amongst ministry of energy and mines, science and technology, agriculture and forestry and educational institutes on the management and promotion of biomass	

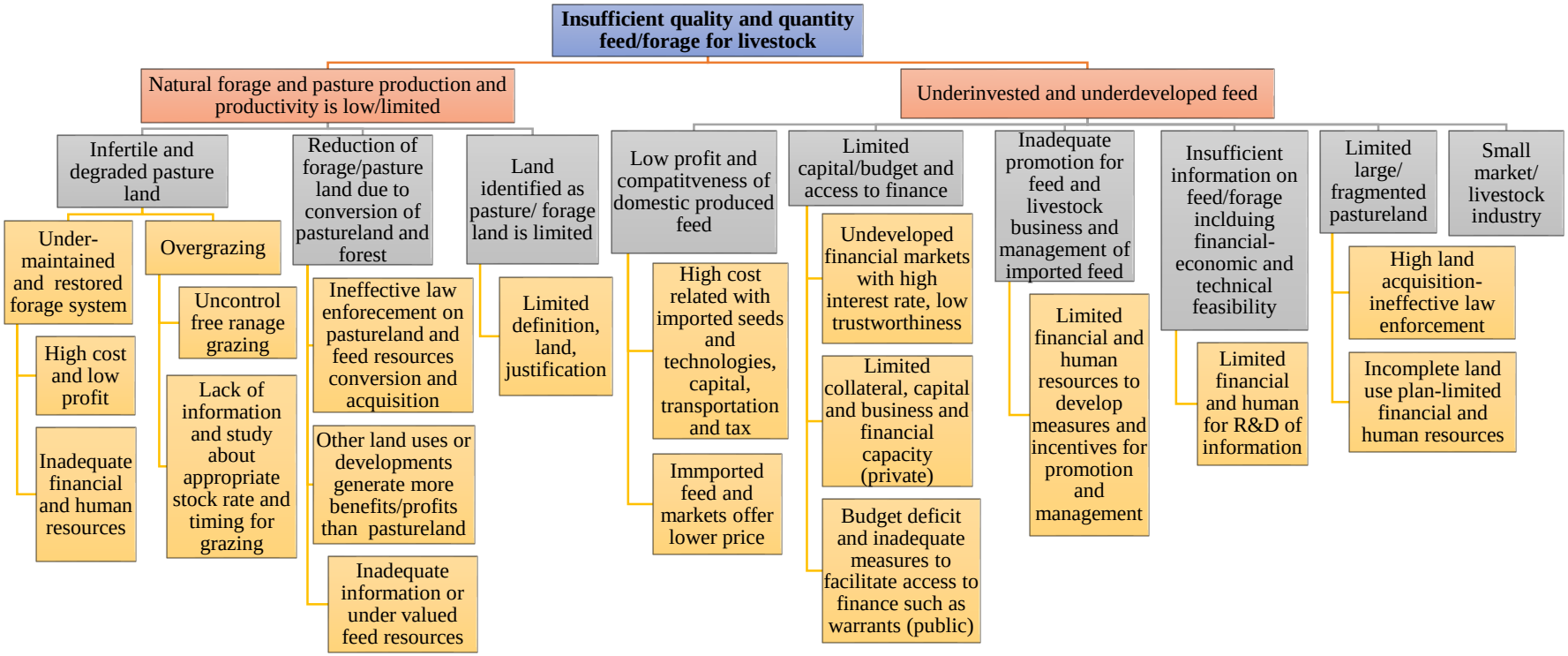
Decomposition of the key barriers on biomass energy			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
Network	Ineffective network and platform for exchanges	Not all energy including biomass energy investors registered and form association within national/provincial chamber of commerce and industry (N/PCCI)	About US$ 0.10 million per year has been shortage for R&D and improvement of the networking and exchanges
		Lack of coordination amongst biomass energy investors and other stakeholders within country and with oversea biomass/renewable energy network	
		Lack of expert group/platform to enhance N/PCCI on biomass technology and business barrier information exchange (under Lao business forum)	
Institutional and organisational capacity and human skills	Ineffective subsector/technology planning, promotion and reporting systems	Lack of specific biomass energy development strategy/plan	Renewable energy development to the year 2025 exists, but less detail on biomass and biomass energy development strategy/ plan with clear targets, directions and actions are not yet formulated.
		Lack of feasibility study	Feasibility study was only conducted for few projects by private sector
		Lack of demonstration and reference project	Only few small projects demonstrated but lack of evaluation and extension
		Lack of subsector/technology performance review	Performance review was partly included the renewable energy development to the year 2025 exists, but less details and no systematic and comprehensive review
		Inadequate and ineffective information dissemination via media, exchange/exhibition and seminars/workshops	Insufficient information dissemination via stakeholders' website, via media; no annual or routine exchange/exhibition and seminars/workshops
	Ineffective human development system	Mismatch human resources demand and supply	About US$ 0.15 million per year has been shortage for improvement of the human development system
		Lack of HRD plan, capacity needs assessment, M&E and reporting	
		Lack of staff information and knowledge management	

Decomposition of the key barriers on biomass energy			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
		Ineffective recruitment and orientation	
		Misallocation of staff and mismatch job requirements	
		Imbalanced between technical and administration staff, limited field-based extension staff	
		Lack of practical and effective training programme, learning course and facilities of educational institutes	
		Lack of systematic monitoring and evaluation of HRD and capacity building	
	Lack of technical skills on biomass business, technology and policy	Limited technical skills on business including financial management and development such as business planning, bankable proposal and feasibility study, especially financial and economic analysis, especially cost-benefit and return on investment	About US$ 0.25 million per year has been shortage for improvement of the skills on biomass business, technology and policy
		Lack of skills on networking and coordination including research and development of technology financier, developer and supplier directory, access channel, requirements and procedures	
		Limited technical skills on biomass technologies including maintenance/repair	
		Lack of research skills on supplementary/substitute materials for biomass	
		Lack of skills on resources mobilization including development of resources mobilization plan	
		Lack of skills on the information collection, analysis and formulation of policy to facilitate to access to finance	
	Ineffective coordination amongst ministry of energy and mines,	Lack of clear policy and regulation on technology including environmentally-friendly technologies, especially	About US$ 0.05 million per year has been shortage for improvement of the policy and regulation on

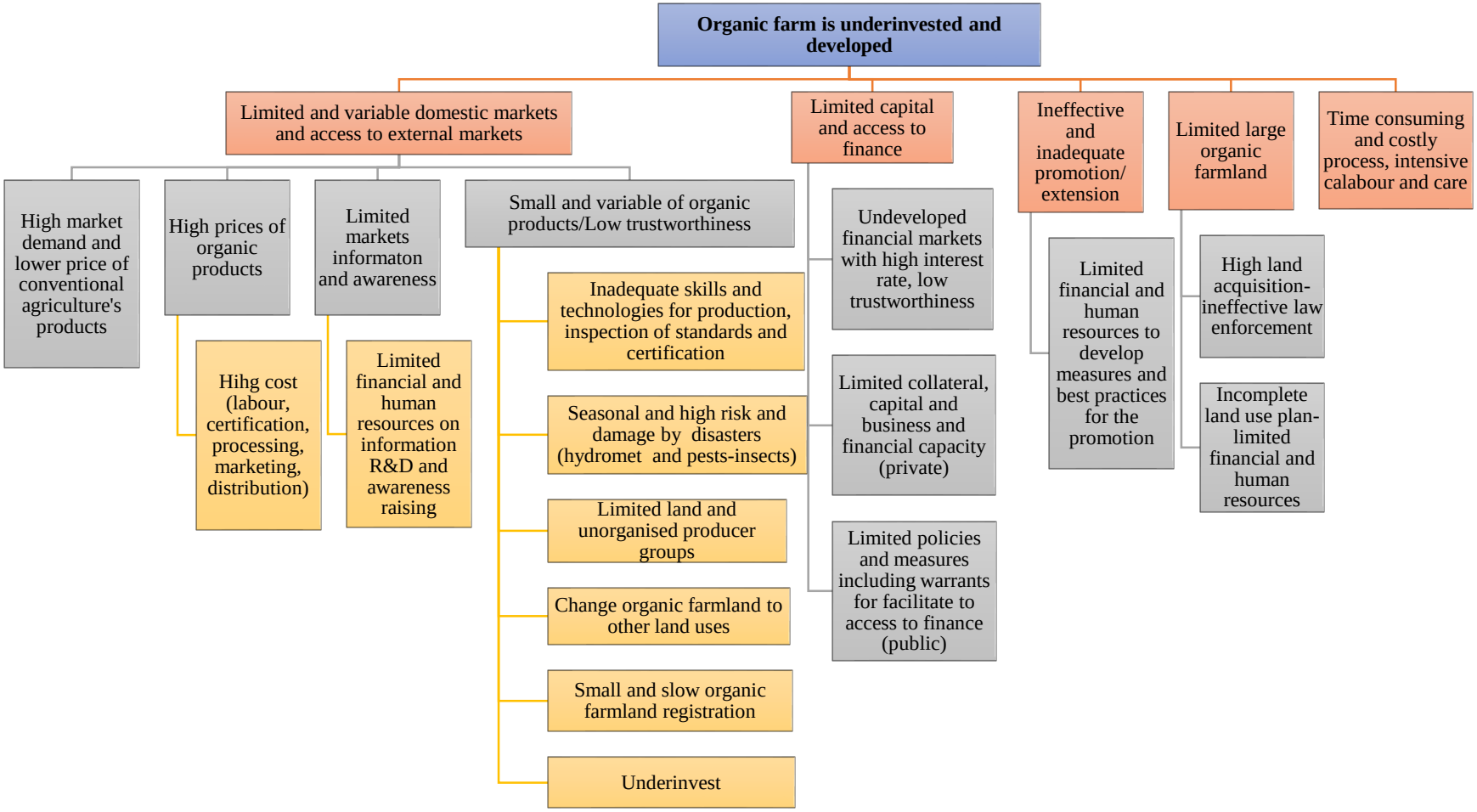
Decomposition of the key barriers on biomass energy			
Broad categories of barriers	**Barriers within a category**	**Elements of barriers**	**Dimension of Barrier elements**
	science and technology, agriculture and forestry and educational institutes on the management and promotion of biomass	organisational responsibilities on technology development and management	environmentally-friendly technologies, especially organisational responsibilities on technology development and management
Information and awareness	Lack of information and awareness/ confidence on biomass	Lack of information and awareness on biomass to energy technologies/hardware	About US$ 0.12 million per year has been shortage for R&D, improvement of information and dissemination
		Lack of information on materials, financial and economic information such as cost-benefits and return on investment on different types and combined biomass	
		Lack of information on actual mitigation potential and carbon market	
Technical	Small and unstable supply of raw materials	Agriculture residues and wood waste is derived from small, scattered suppliers and seasonal	About US$ 0.20 million per year has been shortage for support agroforestry sector development, residual biomass management and R&D on optional biomass
		High demand for agriculture residues and wood waste for other purposes (return to soil and cooking)	

Annex 9 Problems and solutions trees of technologies in agriculture sector

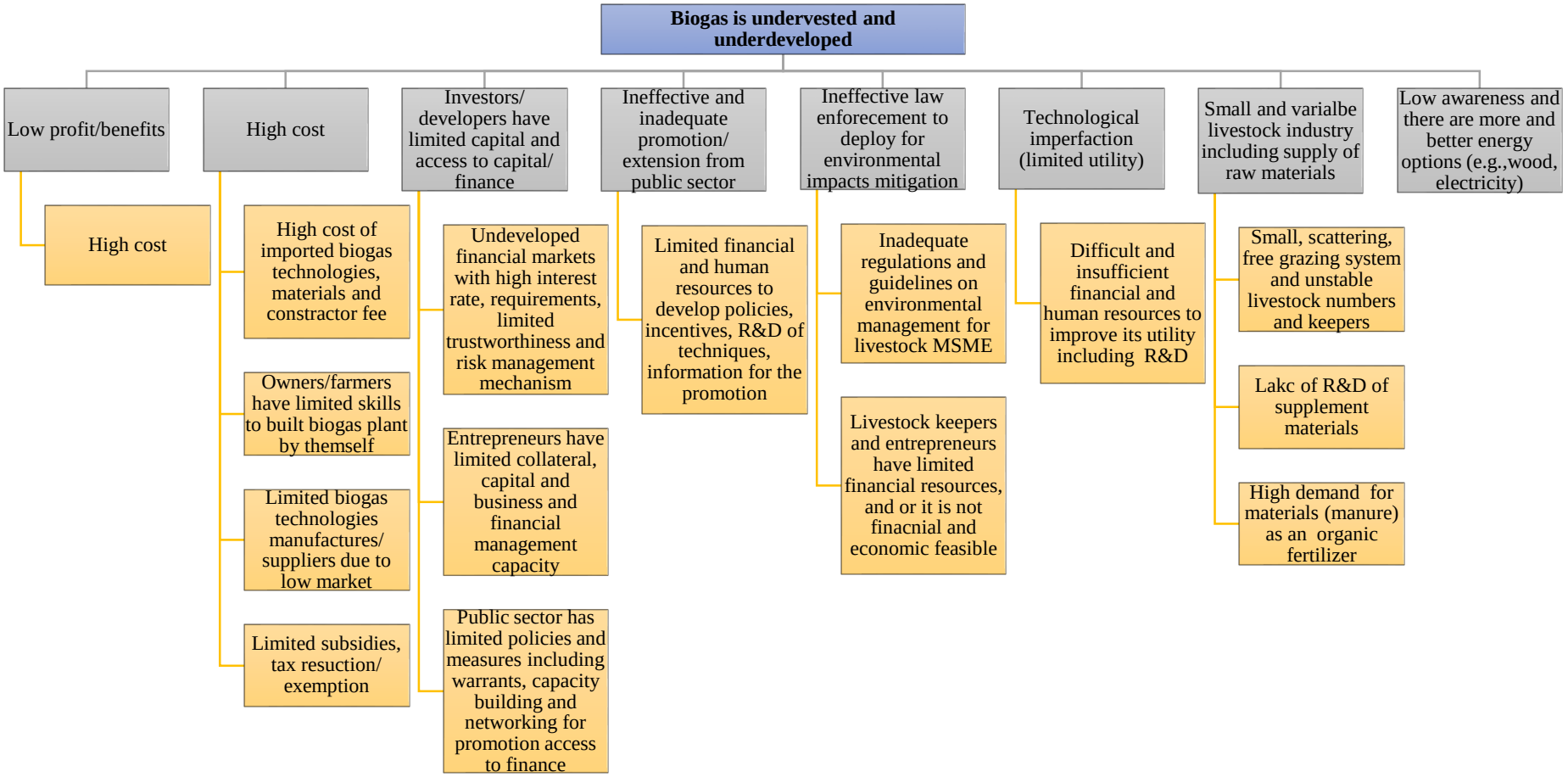
1. Feed improvement



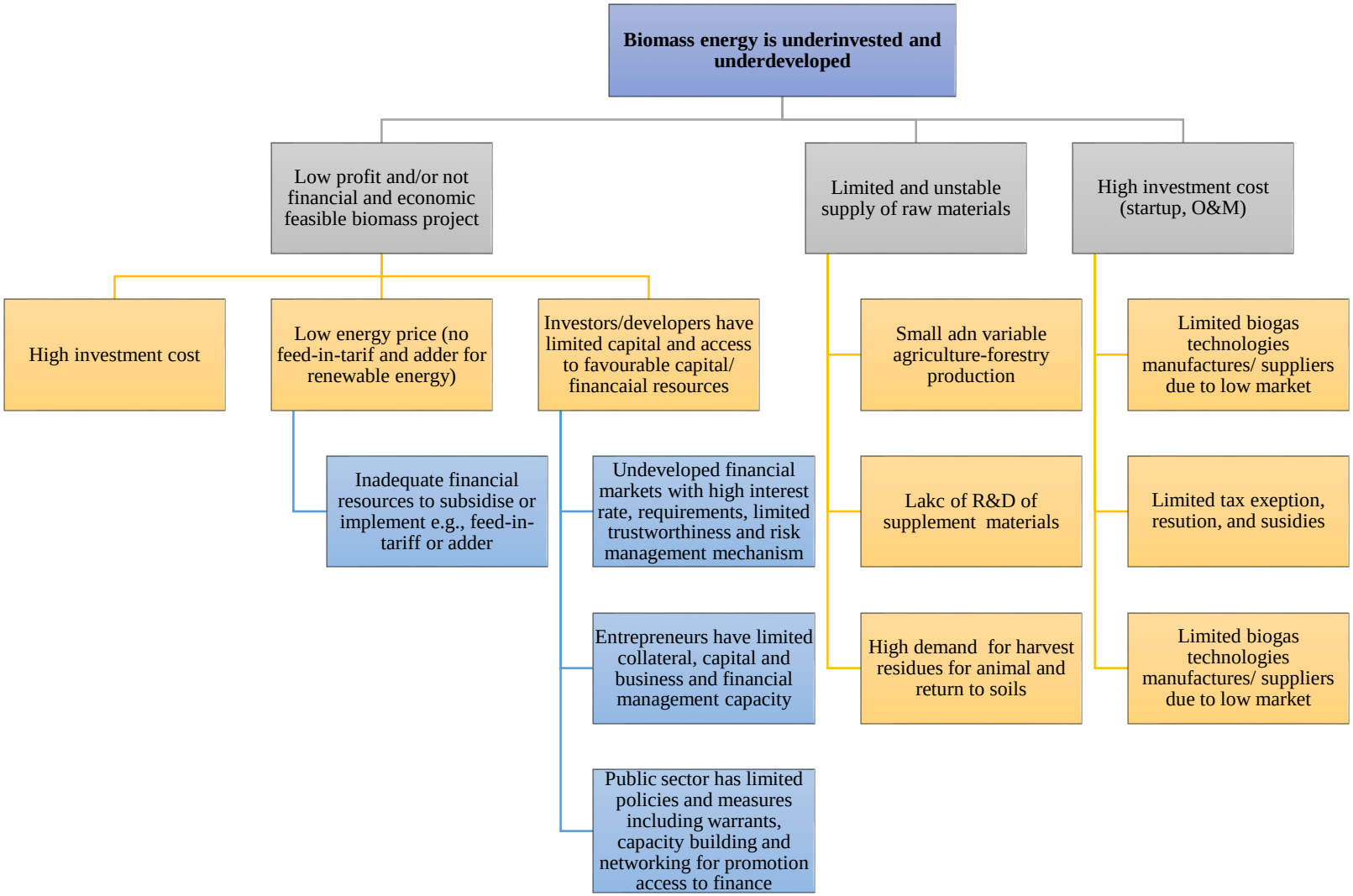
2. Organic farm



3. Manure-based biogas



4. Biomass


Biomass energy is underinvested and underdeveloped
Low profit and/or not financial and economic feasible biomass project
Limited and unstable supply of raw materials
High investment cost (startup, O&M)
High investment cost
Low energy price (no feed-in-tarif and adder for renewable energy)
Investors/developers have limited capital and access to favourable capital/ financaial resources
Small adn variable agriculture-forestry production
Limited biogas technologies manufactures/ suppliers due to low market
Inadequate financial resources to subsidise or implement e.g., feed-in-tariff or adder
Undeveloped financial markets with high interest rate, requirements, limited trustworthiness and risk management mechanism
Lakc of R&D of supplement materials
Limited tax exeption, resution, and susidies
Entrepreneurs have limited collateral, capital and business and financial management capacity
High demand for harvest residues for animal and return to soils
Limited biogas technologies manufactures/ suppliers due to low market
Public sector has limited policies and measures including warrants, capacity building and networking for promotion access to finance