Asia-Pacific Network for Sustainable Forest Management and Rehabilitation

Establishment of High Value Tree Species Breeding Center in Cambodia

PROJECT PROPOSAL

Institute of Forest and Wildlife Research and Development,
Forestry Administration, Cambodia

Date of submission: October 29th, 2019

Project title	Establishment of High Value Tree Species Breeding Center in Cambodia		
Supervision agency	Forestry Administration (FA)of Cambodia		
Executive Agency	Institute of Forest and Wildlife Research and Development (IRD) (Cambodia)		
Technique supporting Agency	Yunnan Academy of Forestry and Grassland, China (YAFG)		
Project period	1 Jan 2020-30 December 2027		
Total budget(US$)	**Expected APFNet Grant(US$)**	**FA Counterpart (US$) (in cash and in-kind)**	**YAFG (US$) (in cash and in-kind)**
6,860,904.4	**5,492,584.4**	**861,200**	**507,120**

Outline of the Project:

Forest germplasm resources are important natural resources that are seriously threatened by rapid economic development in Cambodia. Construction of tree breeding center can served as shelter for valuable forest genetic resource. The project is composed of 4 major components. Firstly, High Value Tree Species Breeding Center that will be constructed in Institute of Forest and Wildlife Research and Development (IRD) campus in Phnom Penh (contains tissue culture and diagnostic lab., green house, and related equipment); Secondly, 100 ha Forest genetic resource conservation garden of valuable trees in research station of IRD in Siem Reap (Chansor restoration site); Thirdly, 20 ha eco-forest farm in research station of IRD in Siem Reap; and fourthly, capacity building. The outcome of the project will support conservation of existing valuable tree plant species in the area and also serve as ex-situ seedbank s of other endangered plant resources in other regions of Cambodia. The total budget is US$6,860,904.4, of which APFNet's grant is US$5,492,584.4 and counterpart contributions from FA is US$861,200, and from YAFG is US$507,120.

The overarching goal of this project is to conserve and develop genetic resources of rare and endangered tree species in Cambodia through enhanced capacity and knowledge of local staff and foresters and promoting green economic development in rural areas.

The specific objectives include:

Objective 1 To conserve and develop genetic resources of valuable tree species in Cambodia through germplasm resources collection, propagation, and plantation of valuable tree species;

Objective 2 To enhance the capacity and knowledge of local government staff and foresters through capacity building programs;

Objective 3 To promote natural resources conservation through rural economic development and reducing dependence on forest with eco-forest farm as alternate community livelihoods; and

Objective 4 To disseminate and extend the project experiences and lessons through publication, leaflets, posters, videos, internet for better sustain the management activities after the project is accomplished.

Outputs and Activities:

Output 1 High Value Tree Species Breeding Center Constructed

Activity 1.1 Designing of High Value Tree Species Breeding Center
Activity 1.2 Construction of greenhouse;
Activity 1.3 Construction of auxiliary facilities, including comprehensive business room, pump station, and water tank;
Activity 1.4 Construction of tissue-culture laboratory including preparation room, washing & sterilization room, sterile operation room (inoculation room), and culturing room;
Activity 1.5 Procurement Polymerase Chain Reaction (PCR) equipment and laboratory equipment for the diagnostic laboratory
Activity 1.6 Installation of instruments, equipment and laboratory ware
Activity 1.7 Opening ceremony of "YAFG-IRD Joint Laboratory for Valuable Tree Species Breeding" hold at IRD Cambodia

Output 2 Tissue-culture & diagnostic lab. and greenhouse and equipment well operated and maintained

Activity 2.1 Operation of the Tissue Culture Room and Greenhouse
Activity 2.2 Maintenance of equipment and facility of the tissue-culture and diagnostic lab and greenhouse

Output 3 Valuable tree germplasm resources of Cambodia collected

Activity 3.1 Designing of valuable tree germplasm resources collection
Activity 3.2 Collection of precious tree germplasm resources in Cambodia

Output 4 Seedling of high value tree species cultivated in Siem Reap

Activity 4.1 Technical designing of seedling production
Activity 4.2 Producing seedling by seeds
Activity 4.3 Producing seedling by asexual approach

Output 5 Forest genetic resource conservation garden of valuable tree species established (100ha)

Activity 5.1 Designing of demonstration base establishment
Activity 5.2 Land preparation of demonstration base
Activity 5.3 Establishment of 50 ha. valuable timber trees garden (50 species)
Activity 5.4 Establishment of 5 ha. endemic species garden (10 species)
Activity 5.5 Establishment of 5 ha. rare and endangered tree species garden (20 species)
Activity 5.6 Establishment of 5 ha. woody medicinal & aromatic plant garden (20 species)
Activity 5.7 Establishment of 2 ha. bamboo garden (10 species) cluster bamboo
Activity 5.8 Establishment of 10 ha. Ornamental plant garden (20 species)
Activity 5.9 Establishment of 12 ha. Economic fruit tree garden (10 species)
Activity 5.10 Establishment of 5 ha. enrichment plantation using precious trees in secondary forest
Activity 5.11 Establishment of 5 ha. strip planting using precious trees in secondary forest
Activity 5.12 Construction of 0.5 ha seedling awning
Activity 5.13 Construction of accessory facility
Activity 5.14 Maintenance and monitoring of demonstration sites of precious tree plantation

Output 6 Ten sessions of domestic training on seedling cultivation and afforestation technology conducted

Activity 6.1 Training for forestry officials, researchers, students and rural community people

Output 7 Overseas Training conducted

Activity 7.1 Overseas Training

Activity 7.2 Exchange visits by government officers

Output 8 Demonstration site for eco-forest farm as alternate livelihood improvement and sustainable land use for communities involving 10 farmers (20ha)

Activity 8.1 Design of eco-forest farm

Activity 8.2 Land preparation and construction of infrastructure, including the pond, house, road office and etc.

Activity 8.3 Planting of economic and valuable tree

Activity 8.4 Maintenance of demo site

Activity 8.5 Infrastructure development

Activity 8.6 Establishment of pond and water landscape

Activity 8.7 Construction of tourist houses

Activity 8.8 Purchase and installation of equipment and supplies

Activity 8.9 Promotion of the eco-forest farms online and website

Output 9 "Major Indigenous Valuable Timber Tree Species in Cambodia" published

Activity 9.1 Book writing in Chinese and English

Activity 9.2 Translation of Khmer manuscript

Activity 9.3 Edition and publication of Chinese, Khmer and English manuscript

Output 10 Dissemination and summary of best practices and lessons learned

Activity 10.1 Publication of research papers on valuable tree species germplasm,effective propagation and plantation.

Activity 10.2 Production of poster, video clip, internet, technical manual

Activity 10.3 Dissemination of project outcomes during the international workshops and academic exchange tour

Prepared and Submitted by:	Reviewed and Nominated by:
	SOKH HENG, Ph.D. Director, Institute of Forest and Wildlife Research and Development (IRD) Council Representative Signature
Signature Date:	Signature Date:

Abbreviations and Acronyms

AWP	Annual Work Plan
CTSP	Cambodia Tree Seed Project
DANIDA	Danish International Development Agency
DBH	Diameter at Breast Height
EA	Executing Agency
CFA	Cambodia Forestry Administration
FAC	FA Cantonment
FAO	Food and Agriculture Organization
IRD	Institute of Forest and Wildlife Research and Development
NGO	Non-Government Organization
PCR	Polymerase Chain Reaction
PSC	Project Steering Committee
REDD+	Reducing Emissions from Deforestation and Forest Degradation
RGC	Royal Government of Cambodia
YAFG	Yunnan Academy of Forestry and Grassland
YFGA	Yunnan Forestry and Grassland Administration

Contents

1 Background

1.1 Context and Situations of Target Economy

Cambodia used to be one of the economies with rich forestry resources in the world. Based on forestry statistics of Cambodia, the economy's forest cover in 1960s was estimated to be 13.2 million ha comprising 73.04% of the economy's land area comprising high value tree species. The forest cover has decreased to 54.48% in 2015 and most of the forests are fragmented. Many indigenous species, especially valuable timber species, continue to be exploited and listed as vulnerable or endangered species. The main drivers of deforestation and forest degradation, and biodiversity loss include agricultural encroachment and land utilization, conversion, fragmentation and loss of natural habitat, wild fires, pests and diseases, poor land management, overgrazing, over-logging for fuelwood and construction, climate change, displacement and loss of landraces. The lack of scientific knowledge on the conservation of biological resources, low institutional capacity and strong dependence on forest resources by local communities also significantly contributed to the degradation and loss of the forest. A large-scale gene rescue approach is needed to reverse the trend and to recover the germplasm of valuable trees through species collection, breeding and appropriate restoration techniques in Cambodia. At the same time, the rural economic development needs to be addressed as an alternative approach in addressing the over exploitation of the forest resources.

Geographic Location. Cambodia is a pivot in the Great Mekong Sub region (GMS), located in the south of Indo-China Peninsula in the Southeast Asia, and covers 181,035 km^2. Cambodia borders with Vietnam in the south and southeast and Laos in the north, neighbors Thailand in the west and northwest, and links with Gulf of Siam in the southwest.

Topography. Cambodia has vast flat lands and surrounded by high mountains and hills along the borders of Viet Nam, Lao PDR and Thailand. The east is the gentle plateau, which is the western slope of Truong Son Mountain Range; the north border is Chuor Phnom Damgrek from east to west; the southwest border is Cardamom Mountains, and its highest peak is Aoral Mountain 1,813 m high in the east; the Central and South Cambodia are flat Mekong River Delta Plain, which is the main agricultural area of Cambodia. The two project sites IRD in Phone Penh and research station of IRD in Siem Reap are located in the middle part is a broad and flat Mekong Delta plain, surrounded by agricultural area.

Climate Conditions. Cambodia has tropical monsoon climate, relatively warm throughout the year with annual average temperature of 29 ~ 30℃. It is divided into dry and rain seasons, of which rain season lasts from May to October, and October has the highest rainfall, i.e. 2/3 of annual rainfall; while the dry season lasts from November to April of the following year, with January and February having the least rainfall. The annual rainfall is about 2,000mm on average and varies in different places depending on the landform and monsoon: about 5,400mm in the southern end of the Elephant Mountain and about 1,000 mm in the east of Phnom Penh. The annual mean rainfall in two project sites IRD Phnom Penh and Siem Reap are 1,637mm and 1,495mm respectively

Hydrology. Cambodia is abundant with lakes and fresh water resources. Tonle Sap Lake is the largest freshwater lake in Southeast Asia,with over 2,500 km^2 water area in the dry season and over 10,000 km^2 in the rainy season. Cambodia has several islands in the coastal area such as Koh Kong and Koh Rong Islands. Mekong River, which originates from Mekong River of China and runs through five economies in Southeast Asia. Cambodia has its largest water resources in the eastern part spanning 500 km.

Socio-Economic Conditions. Cambodia has an estimated population of 16.01 million as of 2018 composed of over 20 ethnic groups such as Khmer, Cham and Phnong. Khmers are the dominant ethnic groups. The official language is Khmer, and Cambodians are mostly Buddhists. Tourism and agriculture sectors are the most important industry of the economy. The forest sector is not mainstreamed but play an increasingly critical role in conservation of biodiversity and prevention of natural disasters.

Forest Resources. Cambodia is relatively abundant with forest resources, covering 9,457,000 ha of forest and a forest cover of 54% (FAO FRA 2015). Per capita forest area is 0.95 ha, higher than the global per capita level. There are more than 200 timber tree species found in Cambodia and main forest types include: evergreen forest, semi-evergreen forest, deciduous forest, dry shrub land.

The forest resources are not evenly distributed in its territories. The eastern part of Cambodia is dominated by dense broad-leaved forests and grasslands; broad-leaved evergreen forests grow in mountainous areas in the north; sparse needle leaved forests grow in alpine areas in the southwest, and dense primitive forests are in rainy coastal areas; evergreen forests and mangrove forest are growing in the narrow belts along the Gulf of Siam.

Cambodia is teeming with high value tropical timber trees (such as rosewood, teak, ironwood and sandalwood) and non-forest timber products (including rattans, bamboos, medicinal herbs (Mainly cardamom, *Scaphium scaphigerum, Nuxvomica*, Agarwood, gamboge, cinnamon, sandalwood, etc.) and fruit tree.

Forest Policies. In Sub-Programme 2.5: Conservation and Development of Genetic Resources and Seed Sources of the National Forest Programme (2010-2029), clearly emphasized that "the forestry sector has an obligation, through the Government's ratification of the Convention on Biodiversity (CBD), to comply with the National Biodiversity Strategy and Action Plan, which calls for the development and implementation of recovery program for all endangered plant species, both in-situ and ex-situ". Therefore, the implementation of the project will contribute greatly to conservation of forest genetic resources and to Cambodia's obligations towards climate change mitigation.

The Project Site

The project will build High Value Tree Species breeding center in the compound of IRD in Phnom Penh, the Capital of Cambodia, while the Forest genetic resource conservation garden and eco-forest farm will be established in Siem Reap province (see location map in Annex B).

The Forest genetic resource conservation garden is located in Chan Sar (longitude:104°8′6.36″; latitude:13°21′48.14″), 30 km away from Siem Reap city. Most of the area is flat. This makes the area very accessible to visitors but with no electricity. The slope is mostly less than 0.5 degrees. The place is state-own forests under management of Institute of Forest and Wildlife Research and Development, has no conflict with surrounding communities.

Community forest used for Eco-forest farm is near to Both Khun Ream Forest Research Station of IRD. The location of Eco-Farm in Khun Ream is 104°04′46.53″ longitudinal and 13°43′29.03″ latitudinal, which is 40 km away from Siem Reap city, has good access road and available electricity. The detailed social-economic condition of the site is in Annex F

The two areas receive uniform rainfall, approximately 1,500 mm per year. The vegetation is degraded secondary forest, with average tree height at 9.67m and average Diameter at Breast Height (DBH) at 9.99cm. Soil fertility is heavily degraded. Total nitrogen of top soil is only 0.12% (0.95% in primary forest); Organic matter is 2.33% (9.49% in primary forest); Available phosphorous is 28.2 ppm (183.5ppm in primary forest); Exchangeable potassium is 0.12 mg/100g (23.08 mg/100g in primary forest)

1.2 Problems/Issues to be Addressed

Valuable timber tree species are distinguished due to hard and dense texture, dark and dull colors, and clear and beautiful grains and are usually used for luxury furniture, musical instrument, art-ware, and house decoration. These timber tree species are considered strategic resources for socioeconomic development and on increasing demands with the development of social economy and connoisseurship of the public.

To mitigate the decline of valuable tree resources, Cambodia has banned harvesting “endangered or rare tree species” under the Cambodia's 2002 Forestry Law, and *Dalbergia cochinchinensis* is protected under its Forestry Law No 35. The Royal Government of Cambodia has exerted efforts and implemented various projects to reverse the loss of valuable forest plants genetic resources in the past decades. For example, the “National Forest Gene Conservation Program” and “Establishment of Forest Genetics Research Center for Restoration of Major Timber Species in Cambodia” are aimed at developing a forest gene conservation strategy in order to conserve the genetic diversity of some useful and economically important tree species. These efforts have laid a solid foundation for the implementation of this project. However, the previous efforts cover only very limited tree species e.g. few *Dalbergia* spices, and *Pterocarpus macrocarpus*, while there are still many valuable tree species that are at the brink of extinction. In addition, although seed is still a major means of seedling production, it has some limitation as some species produced limited or recalcitrant seeds.

Tissue culture will be considered in the proposal as a complementary technology of increasing production of planting materials. Tissue culture provided a promising technology of preserving the genetic resources for some valuable timber species. IRD has an existing tissue culture laboratory that has been producing annuals and monocots like orchids. However, this tissue culture lab is small to adequately produce

the desired seedlings for tree plantations. Additionally, the design of existing laboratory is not according to standard and may render the tissue cultures vulnerable to contamination during the tissue culture process. The current tissue culture laboratory also lacks the facility and technology to test tissues from collected plant samples for pathogens, particularly virus, and increases the risk of spreading diseases carried by the infected tissue-cultured plants to disease-free areas. To solve these problems, a standardized tissue culture laboratory will be established by this project, including preparation room, washing and sterilization room, sterile operation room, culturing room, virus and disease diagnosis lab and buffer room.

Despite the efforts exerted by the FA in restoring degraded landscapes, there has been limited success. Lessons learned from the earlier experience indicate that poverty is dragging the progress of forest restoration. There is a growing realization that conservation should be coupled with providing sustainable livelihoods to the communities living around the remaining forests. In this proposal, a demonstration site for green economic development through the establishment of eco-forest farms will be piloted in the village near the Khun Ream research station where the Seed Source area is located. The communities adjacent to the Seed Source area mostly engaged in farming and occasionally enter to the forest during dry season to collect woods as alternate sources of income. Encroachment and cultivation are also happening around the Seed Source area. It is expected that by providing alternate sustainable livelihood will reduce the pressure to the forest. The project will organize the farmers to develop their farms for agroforestry and will promote the area for tourism.

2.0 Significance and Necessity

Forest germplasm resources are important natural resources which is seriously threatened by rapid economic development in Cambodia. Construction of tree breeding center can serve as shelter for valuable forest genetic resource. The project will be conducted by Institute of Forest and Wildlife Research and Development (IRD), both in IRD compound in Phnom Penh and research station in Siem Reap of Cambodia, to conserve valuable tree species and propagate more endemic and endangered plant resources in Cambodia.

Through the implementation of this project, the scientific research capability of IRD will be strengthened on tissue culture, pathogen screening/diagnosis and ex-situ cultivation (Ex-situ conservation refers to the maintenance of genetic materials outside of the “normal” environment where the species has evolved and aims to maintain the genetic integrity at the time of collection). The plantation demonstration of valuable tree species in Siem Reap will serve the purpose of ex-situ conservation.

Meanwhile, Siem Reap province is a world-famous for tourism. The establishment of demo sites in Siem Reap province, through exhibition of valuable timber trees, endemic, rare and endangered tree species, woody medicinal and aromatic plants, ornamental tree plants, economic fruit trees and bamboos, will most likely become a new amenities for public environmental awareness education and recreation site for visitors.

In addition, an eco-forest farm (agritainment) will be established near IRD's Forest station in Siem Reap by rural communities to promote rural development and conservation of forest resources. The eco-forest farm will be developed for fruit trees and high value native timber trees plantation, agroforestry, animal husbandry, fish farming, and lodge construction.

The proposed eco-forest farm applies the principle of agroforestry. However, the eco-farm will cater specifically to tourists who want to experience the rural life. The eco-forest farm will plant a combination of timber species, fruit trees and vegetables including flowers that may be of interest to the tourists. The demonstration site however will be developed as a system. It is important therefore that the farmers and their production activities will be organized to ensure a sustainable supply of fruits or vegetables. The pilot site will also be a showcase of agroforestry technologies as part of sustainable farming.

3.0 Goal and Objectives

3.1 Goal

The goal of this project is to conserve and develop genetic resources of rare and endangered tree species in Cambodia through enhanced capacity and knowledge of local staff and foresters and promoting green economic development in rural areas.

3.2 Objectives

Objective 1 To conserve and develop genetic resources of valuable tree species in Cambodia through germplasm resources collection, propagation, and plantation of valuable tree species.
Objective 2 To enhance the capacity and knowledge of local government staff and foresters through trainings, practicum and cross visits.
Objective 3 To promote natural resources conservation through rural economic development and reducing dependence on forest with eco-forest farm as alternate community livelihoods.
Objective 4 To disseminate and extend the project experiences and lessons through publication, leaflets, posters, videos, internet for better sustain the management activities after the project is accomplished.

4.0 Outputs and Activities

Output 1 High value tree species Breeding Center constructed

The high value tree species breeding center to be built will cover 1,755 m^2, including 806.4 m^2 of nursery greenhouse, 480 m^2 comprehensive business building (including 240 m^2 of tissue culture room, and 240 m^2 of office and meeting rooms); 19 m^2 of the pump station; and 150 m of road construction (with width of 3 m), as well as auxiliary works like irrigation system, instrument and equipment purchase, electricity distribution, etc.

Activity 1.1 Designing of High Value Tree Species Breeding Center
Activity 1.2 Construction of greenhouse;

Activity 1.3 Construction of auxiliary facilities, including comprehensive business room, pump station, and water tank;
Activity 1.4 Construction of tissue-culture laboratory including preparation room, washing & sterilization room, sterile operation room (inoculation room), and culturing room;
Activity 1.5 Procurement materials of diagnostic laboratory for PCR lab
Activity 1.6 Installation of instruments, equipment and laboratory ware
Activity 1.7 Opening ceremony of tion of instruments, equipment and laboratory wareation room, washing & sterilizati

Output 2 Tissue-culture diagnostic lab. and greenhouse and equipment well operated and maintained

Under the technical support of Yunnan Academy of Forestry and Grassland, technicians and administrative personnel who receive professional training will be recruited to team up the tissue culture and diagnostic laboratory and greenhouse operation and management, develop research on valuable tree species tissue culture and seedling breeding technology; and to produce seedlings of valuable tree species to meet requirements of conservation and new plantation establishment.

Meanwhile, the lab., greenhouse and equipment will be maintained annually. Experiment equipment, irrigation equipment, temperature control equipment, greenhouse and seedling awning, water and electricity supply facilities will get regular maintenance.

Activity 2.1 Operation of the Tissue Culture Room and Greenhouse
Activity 2.2 Maintenance of equipment and facility of the tissue-culture and diagnostic lab. and greenhouse

Output 3 Valuable tree germplasm resources of Cambodia collected

Under technique support from Yunnan Academy Forestry, at least 100 species of valuable tree genetic resources including valuable timber tree species, Cambodian endemic species, rare and endangered tree species, woody medicinal and aromatic plant, ornamental tree plant, economic fruit tree, and bamboo in Cambodia will be collected in terms of seeds, cutting, and seedling. The collected propagation materials will be used to produce seedlings by tissue culture, cutting and seeds, and further used to establish valuable tree Forest genetic resource conservation garden, or distribute to other plantation projects.

Activity 3.1 Designing of valuable tree germplasm resources collection
Activity 3.2 Collection of precious tree germplasm resources in Cambodia

Output 4 Seedling of high value tree species cultivated in Siem Reap

Seedlings of valuable tree species will be produced from the second year of the project in the way of asexual (such as tissue culture and cutting) or sexual (seed) depending on types of propagation materials gathered.

Activity 4.1 Technical designing of seedling production

Activity 4.2 Producing seedling by seeds
Activity 4.3 Producing seedling by asexual approach

Output 5 Forest genetic resource conservation garden of valuable tree species established (100 ha)

Dalbergia oliveri, Dalbergia cochinchinensis, Aquilaria crassna, Afzelia xylocarpa, Pterocarpus macrocarpus, Dysoxylum loureiri, Diospyros crumenata, Lasianthus kamputensis and other valuable tree species which have large market demands but are scarce will be collected and propagated through tissue culture and seeding in the tree breeding center. The produced seedlings are going to be applied to establish 100 ha Forest genetic resource conservation garden in Siem Reap within first 5 years by adopting mixed plantation with consideration of landscape architecture. At least 50 plants of each tree species are required. Meanwhile, density control, mixed planting pattern, fertilization, target tree management, tending, straight stem control, knot-free timber cultivation and bio-pest control technologies are going to be adopted and demonstrated in plantation.20-30 ha plantation will be established every year and overall 100 ha forest genetic resource conservation garden will be completed within 5 years. Accessory facilities for forest genetic resource conservation garden are constructed as well.

Activity 5.1 Designing of demonstration base establishment
Activity 5.2 Land preparation of demonstration base
Activity 5.3 Establishment of 50 ha. valuable timber trees garden (50 species)
Activity 5.4 Establishment of 5 ha. endemic species garden (10 species)
Activity 5.5 Establishment of 5 ha. rare and endangered tree species garden (20 species)
Activity 5.6 Establishment of 5 ha. Woody medicinal & aromatic plant garden (20 species)
Activity 5.7 Establishment of 2 ha. bamboo garden (10 species) cluster bamboo
Activity 5.8 Establishment of 10 ha. Ornamental plant garden (20 species)
Activity 5.9 Establishment of 12 ha. Economic fruit tree garden (10 species)
Activity 5.10 Establishment of 5 ha. enrichment plantation using precious trees in secondary forest
Activity 5.11 Establishment of 5 ha. strip planting using precious trees in secondary forest
Activity 5.12 Construction of 0.5 ha seedling awning
Activity 5.13 Construction of accessory facility
Activity 5.14 Maintenance and monitoring of demonstration sites of precious tree plantation

Output 6 Ten sessions of domestic Training on seedling cultivation and afforestation technology conducted

Provide technical training classes for local forestry officials, forestry technicians, forestry technology promotion workers, and rural community of Cambodia. Contents of training include tissue culture, nursery management, greenhouse management technology, ex-situ conservation, integrated afforestation technology, forest management etc. One training will be carried out each year with 25 persons each training with a total of 10 sessions.

Activity 6.1 Training for forestry officials, researchers, students and rural community people

Output 7 Overseas Training conducted

Selected qualified Cambodian forestry officials, technicians and forestry technology extension personnel will be sent to Yunnan Academy of Forestry and Grassland, the technical supporting unit of the project, to attend theory study and actual operation training on seedling breeding, tissue culture, in-situ and ex-situ conservation of rare and endangered species, as well as mixed tree plantation establishment and management. Other training content includes tree genetic improvement, forest management, forest protection, economic trees cultivation, gardening, water and soil erosion control, ecology, molecular biology, microorganism, pests and disease control, entomology, etc.

Activity 7.1 Overseas Training

Activity 7.2 Exchange visits by government officers

Output 8 Established 20-hectare demonstration site for eco-forest farm as alternate livelihood for communities involving 10 farmers

The eco-forest farms are a strategy of reducing pressure to the forest. It is very similar to agri-tourism which has been gaining success in many agricultural economies. In this proposal, the target beneficiaries will be the farmers living around the Seed Source area in Khun Ream. The project will establish eco-forest farms near IRD's Forest station in Siem Reap with the aim of promoting rural development and conservation of forest resources. The farms in the area will be organized to develop their areas to eco-forest farm consisting of fruit tree and high value native timber trees plantation using agroforestry techniques, and introduction of livestock and aquaculture. To attract the tourists, the project will also assist the participating communities in the construction lodging house, eco-tourism training and small infrastructure developments.

The farmers will be benefited by the sale of the products (e.g. fruit trees, vegetables, chicken, and fish) that will be bought by the tourists visiting the area. An entrance fee will be collected to the tourists who will briefly visit the site and from the lodging fees. The members of the family may also get employment from the project. The collected fees from the lodging and entrance fees will be shared among the famer cooperators.

The eco-forest farms will showcase the following agroforestry and sustainable land management practices: (1) multistory cropping where fruits, vegetables are planted and arranged to occupy a vertical canopy; (2) integrated farming that combines the farming systems such as fish, crop production, livestock, composting, biogas among others; (3) soil conservation measures such as mulching and organic farming.

The farmers and the FA staff will also be trained on how to market the site to ecotourists. The social and online platforms will be tapped to advertise or promote the site. The famers will be trained also how to orient the tourists.

Several activities will be conducted to achieve the output:

Activity 8.1 Design of eco-forest farm
Activity 8.2 Land preparation and construction of infrastructure, including the pond, house, road office and etc.
Activity 8.3 Planting of economic and valuable tree
Activity 8.4 Maintenance of demo site
Activity 8.5 Infrastructure development
Activity 8.6 Establishment of pond and water landscape
Activity 8.7 Construction of tourist houses
Activity 8.8 Purchase and installation of equipment and supplies

Output 9 "Major Indigenous Valuable Timber Tree Species in Cambodia" published

Based on first hand and second hand data collection from Cambodia and other economies, the book named "Major Indigenous Valuable Timber Tree Species in Cambodia" are going to be composed and published in English, Khmer and Chinese in the fifth project year. Valuable timber trees species, endemic species, rare and endangered tree species, woody medicinal & aromatic plants, ornamental plant species and economic fruit tree species will be included in the book. The main contents will include general natural and socio-economic condition of Cambodia, forest type, major valuable tree species, biological and ecological characters of the species, distribution and utilization of the trees, seedling raising, plantation and management technology etc.

Activity 9.1 Book writing in Chinese and English
Activity 9.2 Translation of Khmer manuscript
Activity 9.3 Edition and publication of Chinese, Khmer and English manuscript

Output 10 Dissemination and summary of best practices and lessons learned

Activity 10.1 Publication of research papers on valuable tree species germplasm, effective propagation and plantation. Among the potential topics for research may include:

- Comparative field performance (growth, insect infestation, etc.) of tissue cultured and ordinary planted seedlings
- Protocol testing of tissue culture techniques of different species
- Disease screening of collected tissue cultures
- Socio-economic impacts of eco-forest farms to the communities

The topics may be changed depending on the needs. The research will be conducted in coordination with the Royal University of Agriculture.

Activity 10.2 Production of poster, video clip, internet, technical manual
Activity 10.3 Dissemination of project outcomes during the international workshops and academic exchange tour

5.0 Budget, Funding Resources and Financial Management

5.1 Budget and Source of Funds

The estimated total budget for this project is about USD 6.86 million that will be used to cover the cost of operations over a period of 8 years. Out of this, nearly 5.5 million USD (80%) will be funded by APFNet while the remaining 1.36 million USD (20%) will be provided as counterpart fund. The counterpart fund will be provided by the Royal Government of Cambodia (RGC) and Yunnan Academy of Forestry and Grassland (YAFG) in the form of in-kind which includes rental of facilities, the salary of key officials, and pre-study costs in Cambodia contributed by IRD and YAFG. The detailed breakdown of cost by component is shown in Annex A-5-1.

To increase the efficiency of the use of the resource, an independent monitoring and audit will be put in place aside from the internal monitoring and performance assessment that will be conducted by the project management staff. The financial control and disbursement will be handled by the Administration and Finance Officer of the project. The detailed breakdown of the costs is presented in Annexes 1 and 2.

5.2 Assets Management

5.2.1 Fixed Assets Management

The procurement of fixed assets will be done following the established procurement procedures of the Royal Government of Cambodia and APFNet Manual for Project Identification, Implementation and Management (PIIM, 2013). The files of fixed asset will be established and managed by the Accountant who will be designated by the project. The department in charge of the project should carry out an inventory of fixed assets at least once a year. All the equipment and other fixed assets, which are procured with APFNet's grant, shall be APFNet's property and shall bear APFNet logo and be kept sound during the implementation of the project, according to APFNet project management guideline. After all project activities are completed and validated by APFNet, APFNet might hand over these equipment and other fixed assets to EA of this project.

5.2.2 Current Assets Management

Current assets include cash, bank deposits and low value consumables. After each activity finished, the handling personnel should fill in the account application form, after audited by the finance department and signed by project director.

5.2.3 Audit

An independent auditing firm will be selected by IRD and inspect the project financial situation annually. Executive agency should submit financial report and audit report annually to APFNet for its approval.

6.0 Monitoring and Evaluation

According to APFNet Guidelines for Project Identification, Implementation and Management (PIIM,2013), the Project requires internal and external monitoring and evaluation.

6.1 Internal Monitoring

During the course of implementing the project, an annual-basis internal monitoring will be conducted by project management team to know the progress and effects of implementation of activities of the project. The monitoring includes the progress of implementation of activities and the effects of each activity. The former refers to the progress of purchase, construction, establishment, and installation of equipment and facilities and project sites. The latter includes monitoring of the growth of trees in plantations, and benefits generated from the project implementation, etc. Unexpected accidents and remedial measures should be reported to the APFNet.

6.2 External Evaluation

APFNet will recruit the international expert to conduct external evaluation every year in the first 5 years and then once every two years in the subsequent 3 years, so as to guarantee the realization of outputs and objectives and the achievement of project goal. The evaluation covers detailed comparison between completion and work plan of all activities, effects of project implementation, outstanding achievements and existing problems. In addition, the ecological, social, economic influences of the project implementation are important during the evaluation.

International experts are required to carry out evaluation and submit evaluation reports on time. Domestic consultants can also be recruited to work with international experts if necessary, and Project management team and project staffs are required to assist the evaluation. External evaluation has to be based on monitoring reports, annual project progress report, oral reports of project management team, and field surveys, etc.

7.0 Dissemination and Sustainability

7.1 Dissemination

The outputs and results in the process of project implementation will be publicized through leaflets, posters, videos, internet and publications.

(1) Media: through local newspapers and magazines. The objectives, content, funding agencies of the project, achievements, experience and practice of the project will be publicized.
(2) Project publicity signboard: the publicity signboard of demonstration project will be set up at significant position of the project demonstration sites. The contents of the signboard include the basic information of project, including the project goal, objectives, activities and expected outputs, implementation institutions and duration, and brief introduction of AFPNet as the funding agencies of this project
(3) Internet: the implementation progress and progressive achievement will be shown at the websites of IRD, APFNet and other possible platforms to have a wider dissemination about the lessons learned, achievements realized, and experiences accumulated of the project.
(4) Publication: technical publication of “Major Indigenous Valuable Timber Tree Species in Cambodia” and research paper will provide the reference for other

economies.

7.2 Project Sustainability

7.2.1 Social and Economic Sustainability

The introduction of the alternate livelihoods (i.e. eco-forest farms) will directly provide socioeconomic benefits to the target communities from the sale of the farm products. The target communities will benefit from the project through employment and benefits sharing of the fees collected from the visitors. The tissue culture laboratory can also contribute economically to the FA by reducing the cost of collecting seeds. Once a good mother tree is identified, there is an assurance that the planting materials provided by the FA are of good quality. On the long run, the FA will be producing and distributing planting materials of superior quality.

7.2.2 Environmental Resource Sustainability

The project will be consistent with the objective of the government to increase the forest cover of Cambodia by 60%. The area planted with valuable tree species will directly support the goal of increasing the forest cover. The tissue culture laboratory on the other hand will support the production of planting materials. There is an expected increase on the demand of planting materials which the tissue culture laboratory can fill in the gap in case of shortage of seeds. For example, there are only very few seeds sources of *Dalbergia oliveri* and *Toona sureni*. In the case of rosewoods (Dalbergia species) and *Pterocarpus macrocarpus*, the FA have a problem in finding the seeds since they are highly seasonal (i.e. no fruiting after mass fruiting). The tissue culture laboratory therefore can provide sustainable supply of planting materials even during the off-season and sustain the restoration efforts of the government. The eco-forest farm on the other hand will help reduce the local community's dependence on forest resources, resulting to reduced deforestation and forest degradation. The eco-forest farm will also motivate the communities to adopt a sustainable land management practices, as a main attraction of the site.

7.2.3 Administration System and Strategy Sustainability

The project organization and management system consist of the state FA, the IRD, and local FAs. The IRD will have in its team technical staff who will conduct the monitoring and overall supervision of the project.

8.0 Guarantee System

8.1 Human resource

The project management team will be prepared for the official start of implementing the project. Preparatory activities such as formulation of the Annual Work Plan, recruitment of the Project Staff, and briefing of the recruited project staff will be done.

The project will be headed by the Director of IRD. Under him will be a Project Coordinator and several key personnel. The staff will be recruited are those who are competent in the field of biology, plant cultivation, silviculture and facilitation. International Consultants and Domestic Consultants will be hired to provide technical backstopping on specific task.

Project Office under the direct supervision of Project Director is responsible for developing project progress report, project publicity materials.

Yunnan Academy of Forestry and Grassland will provide technical support to the IRD in the overall process of the project including project designing, implementation, training, monitoring and evaluation. YAFG has completed forestry research disciplines, according to actual requirements of the project, YAFG will send relevant experts and technicians to stations in Cambodia, help fulfill the work and tasks, and provide relevant technical training for local people, so as to improve local forestry scientific research capabilities. On the other hand, Yunnan Academy of Forestry and Grassland will provide professional technical training about relevant disciplines to relevant scholars, technicians, etc. selected by the Cambodian side.The Project organizational chart is illustrated in figure 2.

The project will be guided by the Project Steering Committee (PSC). The PSC will be composed of the Director General of the CFA or his representative, the APFNet representative, and YAFG representative, and the project director from IRD. The PSC will provide general guidance and policy support on the effective implementation of the project. The PSC will review the work plan and the progress of accomplishing the targets. They will also review the AWP and endorse the AWP and progress report for APFNet secretariat's approval. With APFNet secretariat's approval, the AWP is valid for implementation.

The operation and actual implementation of the project will be implemented by the Project Director and its Project Staff. Their functions are as follows:

- Project Director (Part Time). The Project Director will be responsible on the general supervision of the project and deciding on matters that will be referred to him by the Project Coordinator. He will serve as a liaison of the project and to the APFNet secretariat.
- National Project Coordinator (Part Time). Work under direction of Project Director and will be responsible for coordinate the key stakeholders (including the international and national expert, project staff) to fulfill their own responsibilities to ensure the project implementation is on track.
- Project field Coordinator (full Time)
- Admin/Financial Officer (full Time). Oversee the administrative matters, record all expenses in accordance with the budget, prepares the financial report.
- Nursery Plant Propagator. He will be responsible in the culture and propagation of the plant-lets produced through tissue culture.
- Tissue Culture Laboratory Technician. He/she will be responsible in developing protocols for the culture of vascular plants and production of disease free plant-lets.

- Diagnostic Laboratory Technician. He/she will be responsible in developing protocols and phytosanitary screening of ex plants.
- Field Project Staff/Local FA Staff. Implements the different activities in accordance with the work plan and upon the directive of the Provincial coordinators.

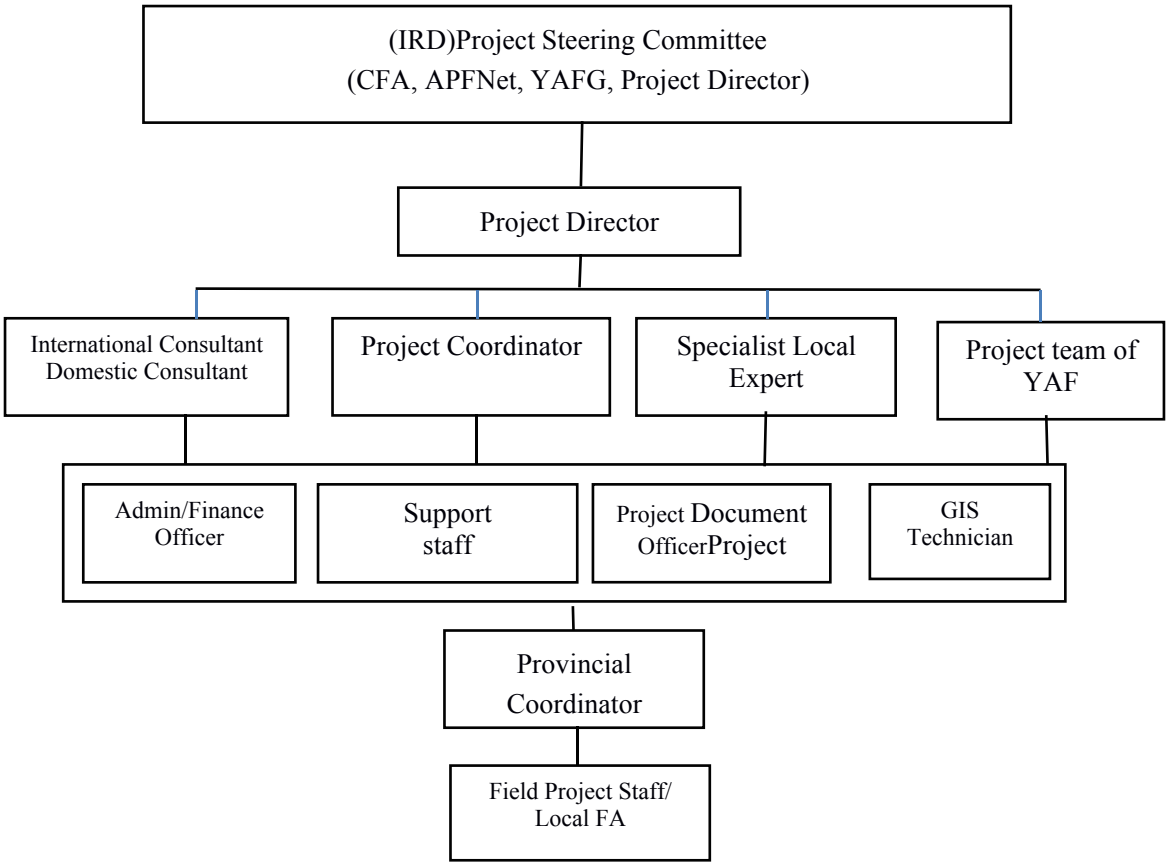

Figure 2. Project Organizational Chart

8.2 Material Resources

The project will provide its existing facilities like the building and some equipment such as laptop computers, a communication system, cabinets and fixtures. On the initial operation, the project will provide its facilities, computers for the preparatory woks. The project will further augment the existing equipment and facilities of the IRD to increase its capabilities when the operation became fully operational.

8.3 Organizational Capacity

The executing agency IRD is a government agency under the Forestry Administration of the Royal Government of Cambodia that is vested to undertake researches and trials related to forestry. Its main research areas include: forest growth and yield research; restoration of degraded forests; plantation cultivation; biodiversity conservation; community forestry; climate change and research on forest products.

IRD comprises five departments, namely, the administration and planning office, the forest and wildlife training center, the social, economic, environmental and impact assessment center for forest resources, the forest development and plant research center, and the wildlife and forest soil research center. It has established long-term cooperative relations with 12 international organizations. The IRD has extensive experience in terms of implementing restoration projects, REDD and community developments. The staffs of IRD have experience engaging the NGOs, the CFs in preparing the management plan, nursery establishment and tree planting activities, and extension of forestry technology.

The technical supporting agency Yunnan Academy of Forestry and Grassland (YAFG) has completed forestry research disciplines. There are 265 in-service employees and 198 specialized technicians, of whom 67 with senior titles, 22 PhDs, 65 Masters, 35 tutors of master candidates, 26provincial technological innovation personnel. YAFG has fully equipped laboratory on soil, plant propagation, microorganism, genetic analysis, insects, ecology, forest products processing and test etc., which can fulfill requirement of forestry related researches.

Besides, YAFG has gained experience on international cooperation, and have accomplished some technical supporting project in developing economies, e.g. International Training Course on Sustainable Tropical Forest Management (4 sessions from 2004-2007); Reforestation Project on Cut-over area in North- East Cambodia (2008-2012); Research on Current Situation, Future Cooperation and Development Strategy of the Forestry in Great Mekong Sub-Region (2013-2014); Sustainable Forest Rehabilitation and Management for the Conservation of Trans-boundary Ecological Security in Mountain Mainland Southeast Asia– Pilot Demonstration Project of Lao PDR, Myanmar and China/Yunnan (2013-2015); Integrated Forest Ecosystem Management Planning and Demonstration Project in Greater Mekong Sub-region (2016-2020); SANFRI Visiting Scholar Program in YAFG(2018-2019) etc.

9.0 Assumptions and Risk Management

Several risks have been identified that may have constrained the achievement of the results. These include among personnel changes in the FA, the risk in the area and the unexpected delay of some projects. The different risks are identified in the table below.

Risks	Mitigating measures
1 Coordination problems between participant agencies which influence the implementation of project activity	1.1 Clarify the responsibility, right, interest of each agency; 1.2 Strengthen the communication between project agencies; 1.3 Coordinate through PSC and project leading team.
2 Changes on the duties and assignments of the well-trained staff	2.1 Sign contract with project staff at beginning of the project 2.2 Set up back-up staff for key position

Risks	Mitigating measures
3 During the 8 years of the project implementation, the factors of rising price may result in the budget shortfall	3.1 Save costs as far as possible in the process of project implementation process, do not waste; 3.2 In the initial stage of the project, each outsourcing task will be fixed in the way of the contract to reduce the effect of the price rise; 3.3 Implement the project and purchase the equipment as early as possible.
4 Project execution agency lacks of technical strength which impacts the project results	4.1 Strengthen the training for project technicians on key techniques before the beginning of each project activity; 4.2 The Breeding Center will be jointly established and maintained by IRD and YAFG. Necessary researchers and experts will be sent to Cambodia and work with colleagues in IRD; 4.3 Strengthen participation of technical support agency to ensure application of scientific and technological measures; 4.4 Invite competent consultants to solve key problems.
5 Poor forest management on demonstration forest leading to poor performance of the plantation	5.1 Enhance capacity of local project staff on forestry management; 5.2 Strengthen monitoring on new plantation 5.3 Enhance education and publicity on forest protection awareness;
6 Not all valuable trees can be propagated by tissue culture	6.1 Seed seedlings and cutting seedling need to be produced simultaneously 6.2 Purchase seedlings throughout the economy
7 Some listed species is protected rare and endangered plants; a series administrative procedure may need for approval of propagation materials collection. This may affect the progress of the project implementation	7.1 To start the application process after project initiation;
8 Electricity is essential for running the project. Unstable and inaccessible of electric power may affect the project progress.	8.1 Prepare power generators in project sites. 8.2 Connecting electric line to state power grid