Establishment of High Value Tree Species Breeding Center in Cambodia

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1. Introduction

Forest resources have been depleted dramatically from about 73% before 1970 to 48.14% in 2016 due to agricultural expansion, illegal logging, land encroachment, population growth and socio-economic development in the economy. Reduction of forest resources have led to the loss of biodiversity, diminish the ecological functions of forests, and affected to livelihood of people who live near and around the forest areas. Cambodians in the rural areas rely mainly on forest resources, both timber and non-timber forest products, for household consumption, livelihood and income generation. Seeing this vast benefit provided to environment and socio-economic development, the Royal Government of Cambodia (RGC) established conservation strategies for forest genetic resources and currently implementing in situ conservation in protected areas and developed tree plantations for conserving the trees ex-situ. While the establishment of protected areas is compatible with sustainable uses and for other purposes, these may not effectively conserve genetic resources of precious tree species. As a result, some important tree species, like *Dalbergia cochinchinensis*, are still threatened and their population in the natural forests has gradually declined. The species and other valuable indigenous tree species are listed as vulnerable or endangered in IUCN red list.

Despite the effort to conserve forest genetic resources in their natural habitats, the first large valuable indigenous tree species plantation is established through the project "Establishment of High Value Tree Species Breeding Center in Cambodia". Advanced technology in tree breeding and rural economic development is also introduced. This project was proposed by the Institute of Forest and Wildlife Research and Development (IRD) of the Forestry Administration (FA) of Cambodia, supported by Asia Pacific Network for Sustainable Forest Management and Rehabilitation (APFNet). The project has a period of eight years, from 2020 to 2028, and will get a technical support from the Chinese Yunnan Academy of Forestry and Grassland (YAFG). The project aims to conserve and develop genetic resources of rare and endangered tree species by enhancing the capacity and knowledge of local staff and foresters and promoting green economic development in rural areas of Cambodia.

This booklet describes the planned developments and main activities of the project, including the forest genetic resource conservation garden and the eco-forest farms. This booklet hopes to raise awareness of the readers on the importance of conserving the genetic resources and the benefits of eco-forest farms.

2. Goals and Objectives of the Project

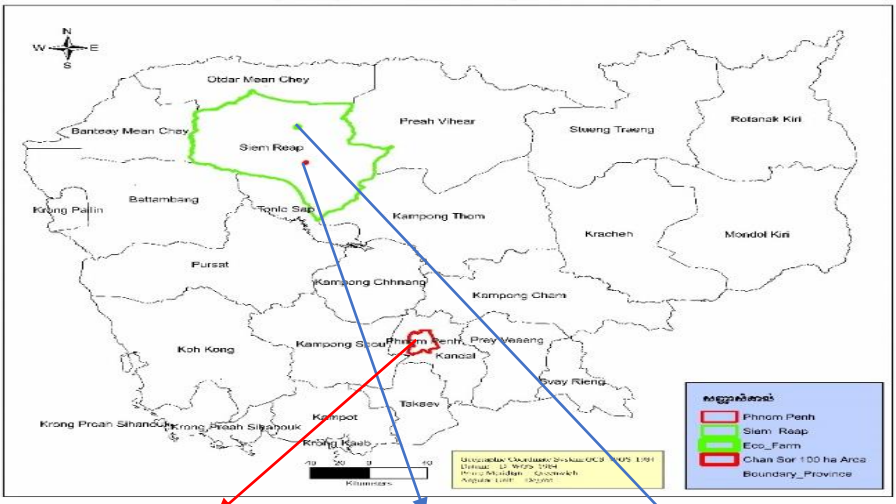
The overarching goal of this project is to conserve and develop genetic resources of rare and endangered tree species in Cambodia by enhancing the capacity and knowledge of local staff and foresters and promoting green economic development in rural areas.

The specific objectives are:

1) To conserve and develop genetic resources of valuable tree species in Cambodia through germplasm resources collection, propagation, and planting of valuable tree species;
2) To enhance the capacity and knowledge of local government staff and foresters through capacity building;
3) To promote natural resources conservation through rural economic development and reducing dependence on forest with eco-forest farm as alternate community livelihoods; and
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.

3. Location

The project sites are located in Siem Reap province (northwest part of Cambodia) and Phnom Penh, capital city of Cambodia.The breeding center will be constructed in the IRD compound in Phnom Penh consisting of comprehensive business building and nursery greenhouse. A 100-hectare forest genetic conservation garden will be established in the Forest Restoration and Development Area “Chan Sor” which is located in Chan Sor commune, Banteay Srey district, Siem Reap. Approximately 40 km away from Chan Sor the Forest Restoration and Development Area, a 20-ha Eco-Forest Farm will be established as a green economic development for rural people.



The breeding center in Phnom Penh

The conservation garden in Siem Reap

The eco-forest farm in Siem Reap

4. Conservation and Development of Valuable Tree Species

A breeding center will be built to help conserve and mitigate the decline of valuable tree resource. The Center will also conduct ex-situ conservation of genetic resources by researching and producing tree seedlings for establishing forest genetic resource conservation garden. IRD will get technical support from the Yunnan Academy of Forestry and Grassland (YAFG) of China.

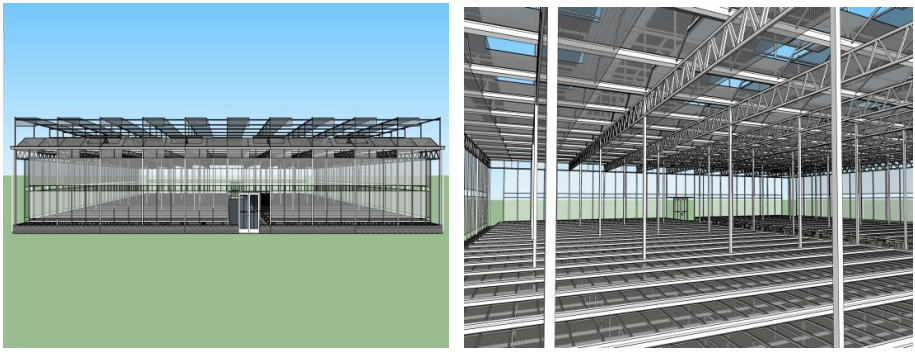
4.1 Construction of High Value Tree Breeding Center

The High Value Tree Breeding Center will be constructed in the IRD compound in Phnom Penh city covering a total area of 1,755 sq.m. Initially, the project team of IRD and a private company had worked together in designing the high valuable tree species breeding center during the preparation phase from June to September 2020. Based on the design plan, the center will have a greenhouse covering 806.4 sq.m., 480 sq.m. comprehensive business building (including 240 sq.m. tissue culture room, and 240 sq.m. office and meeting rooms); 19 sq.m. pump station; and 150 m road (with width of 3 m), as well as auxiliary works like irrigation system, instrument and equipment, electricity distribution, etc. The comprehensive business room covers an area of 480 sq.m. that include the tissue culture lab in the first floor, while offices and meeting rooms are located on the second floor. To meet the required standard, the tissue culture laboratory will have different sections that include a preparation room, a washing and sterilization room, a sterile operation room, culturing room, and buffer room. After completion of the building, facilities and equipment will be installed. These parts are the basic facilities necessary for tissue culture and will be fully equipped with instruments and materials for tissue culture.

Layout of the breeding center

4.2 Construction of Nursery Greenhouse

The nursery greenhouse will be established next to the comprehensive building covering an area of 806.4 sq.m. using the Venlo greenhouse structure type, the most well-known greenhouse structure suitable for all crops. This greenhouse will be installed with a 32-mesh insect-proof net and equipped with an electrical external and internal sunshade system, an irrigation system and a power distribution system.



Structure of the nursery green house

After completing the construction of the center, the tissue culture laboratory and greenhouse will be operated to produce seedlings with annual production of about 0.5 to 1 million seedlings.

4.3 Collection of Germplasm of High Value Tree Species

The production of seedlings will be produced through seeds and asexual reproduction such as cuttings and tissue culture. Germplasm resources of 100 high valuable tree species were collected from natural forests all over Cambodia. Following the collection manual designed by the experts from YAFG, the project team collected information on fruiting season of high value tree species which have already been identified during the project development. Before conducting field survey, the project team coordinated with local forestry officials and community forestry from different areas and provinces to locate good mother trees in the natural forests. The mother trees with straight trunk were identified for seed collection. The heights and DBH of mother trees and other surrounding tree species were recorded including the slope, elevation, situation of the areas etc. Seeds of at least ten mother trees are collected per species. The seeds collected from each mother tree were packed and labeled, ensuring that the seedlots collected from each mother tree were not mixed together. This is to ensure traceability of the sources of seeds up to the mother tree level. Some of the collected seeds were sent to YAFG in China for research and development in a laboratory while the rest were treated and transferred to Siem Reap province for germination in a tree nursery.

Identification of mother tree

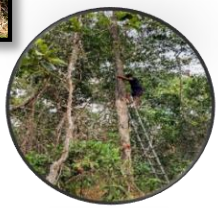
Drying seed under sunlight before keeping in storage

Collection of germplasm resources

Data recording about mother tree

Flower and leaf of mother tree are also noted

Seed collected



Climb up to the top to collect

4.4 Establishment of Forest Genetic Resource Conservation Garden

A detailed design was developed to guide the project team in developing the site. The IRD project team has worked with a private company in preparing the detailed plan and conducted a ground check of the site. The completed plan for the conservation garden has three zones: the seedling collection and display zone, the tropical tree garden zone and the close-to-nature forest management zone.

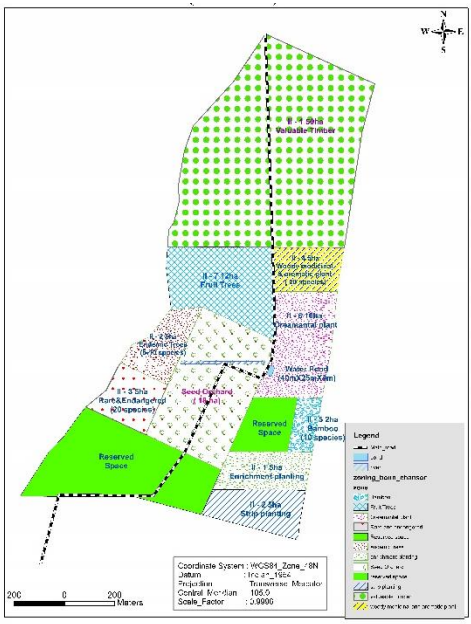
Seedlings from a tree nursery in Siem Reap province will be used for the establishment of forest genetic resource conservation garden in Chan Sor Forest Research and Development Area located in Soth Nikum district, Siem Reap province. The garden, covering 100 hectares, will be developed for the consideration of the 100 species that include high-value, endemic, rare and endangered tree species such as *Dalbergia concinchinensis, Pterocarpus macrocarpus, Afzelia xylocarpa, Xylia dolabriformis*, etc.

(see annex 1 for list of all tree species). Silvicultural practices such as mixed tree planting, thinning, pest control, and tending will be applied in the area.

Discussion on draft design plan before actually checking at the site

Verification of the design plan with ground check among the project team and private company

In the seedling collection and display zone, precious tree species will be planted in the 0.5-hectare land. The tropical tree garden in the second zone consists of different sub-gardens including a valuable 50 hectare-Timber Garden planted with 50 different high value tree species; an Endemic Species Garden covering an area of 5 ha planted with 10 endemic species; a Rare and Endangered Tree Species Garden covering 5 ha planted with 20-30 species of endangered tree species, a Woody Medicinal & Aromatic Plant Garden covering 5 ha planted with 20 species of woody medicinal and aromatic plants; a Bamboo Garden covering 2 ha planted with 10 bamboo species; an Ornamental Tree Garden covering 10 ha planted with 20 species of ornamental trees; and an Economic Fruit Tree Garden covering 12 ha



planted with 5-10 species of fruit trees. The third zone is intended for the Close-to-Nature Forest Management covering 5 ha. In this zone, enrichment and strip planting methods and planting with high value tree species will be done. In addition to establishing these gardens, other facilities including entrance, road, drainage and irrigation system, education and visitor center, pavilion and so on will be constructed while a tree species identification system will be set up for all 100 species planted in the gardens. This Forest Genetic Resources Conservation Garden will become a large-scale exhibition site for valuable, endemic, rare and endangered species and provide new amenities for the public such as an environmental awareness education center and a recreation site for visitors.

5. Capacity Building and Awareness Raising

Improving capacity of responsible staff of the Forestry Administration and local government is crucial in achieving the project objectives, particularly, in the conservation and development of biological resources. The IRD will cooperate with Yunnan Academy of Forestry and Grassland (YAFG) in organizing training courses on various topics such as breeding, tissue culture, nursery management, greenhouse management technology, in-situ and ex-situ conservation, integrated afforestation technology, forest management, pests and diseases control, water and soil erosion control etc. One training will be provided to 25 staffs every year in Cambodia. So, within 8 years, the project will be able to provide training to about 140 officials. In addition to the local trainings, 11 trainees will be selected to attend a one-month intensive training course in Yunnan Academy of Forestry and Grass Land in China every year on the abovementioned topics. The training includes theory and actual operation. Approximately, 88 trainees will be able to attend the training courses in China within the project period. It is expected that both training courses in Cambodia and China will enhance capacity of the FA staff on scientific research knowledge on development and conservation of biological resources, particularly, on tissue culture, which is a promising technology of preserving the genetic resources of valuable timber species in Cambodia.

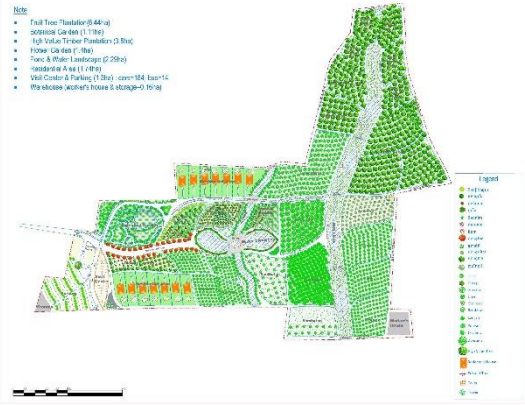
6. Eco-Forest Farm as a Green Economic Development for Local Community

The project will establish a 20 ha Eco-Forest Farm in a village near the Khun Ream research station, located about 40 km from the City of Siem Reap. The model Eco Forest Farm will be introduced as a new approach for rural livelihood development in Cambodia that will reduce dependence on forest resources and provide sustainable livelihoods to the communities living around the forests. The eco-forest farm site is

located near famous tourist sites including a unique Bonteay Srey temple, Kulen Mountain, Kbal Spean and so on, that has attracted many tourists, particularly international tourists, every year.

Established on existing farm land of local communities, the eco-forest farm is designed to cater specifically to tourists who want to experience local culture and rural life. The project team has collaborated with a private company to come up with a detailed plan before starting the activities. Recently, the plan has been completed and the project team has already initiated some works in the field such as site identification, land preparation, constructing the fence, and planting some trees.

Site identification and land preparation



General layout of the eco-forest farm

The eco-forest farm will consist of fruit trees and high value native timber tree plantations using agroforestry techniques. Livestock and aquaculture will also be introduced. The project will construct 14 lodging houses, and generally improve infrastructure to attract tourists. The area will be divided into different zones such as a fruit tree plantation of 10 ha, a 1 ha botanical garden, high value timber plantation covering 2 ha, a flower garden covering 1 ha, a pond and water landscape covering 2 ha, a residential area of 2 ha, a visitor center and a parking area of 1 ha, and an access road and an irrigation system.

The eco-forest farm will showcase green economic development by combining tourist houses and services, agroforestry and sustainable land management practices including multistory cropping where fruits, vegetables are planted and arranged to occupy vertical canopy; integrated farming that combines the farming systems such as fish, crop production, livestock, composting, biogas among others; and soil conservation measures such a mulching and organic farming.

7. Project Publications and Dissemination

The lessons and experience of the project need to be disseminated to the public to raise interests in conserving the genetic resources as well as the sustainable livelihoods. The project will then document and compile the proceedings of the project into a publication. The successful experiences and technologies will be featured in the following publications:

- ✓ A book on "Major Indigenous Valuable Timber Tree Species in Cambodia" in Khmer, Chinese and English
- ✓ At least 2 research papers on valuable tree species germplasm, effective propagation and plantation are published
- ✓ Production of poster, video clip, internet, technical manual
- ✓ A summary report on lesion learned and best practices of the project
- ✓ Dissemination of project outcomes during the international workshops and academic exchange tour

Annex 1 : List of 100 High Value Tree Species

	Zone	Area (ha)	Species No.	Recommended species
I	Seedling collecting & display zone	1		
II	Tree Garden	89		
2.1	Valuable timber tree garden	50	50	*1.Afzeliabijuga* *2. Afzeliaxylocarpa* *3. Altingiaexcelsa* *4. Anisoptera costata* *5. Aquilaria crassna* *6. Artocarpusasperulus* *7. Artocarpussampor* *8. Castanopsishystrix* *9. Chukrasiatabularis* *10. Crudiachrysantha* *11. Dalbergiacochinchinensis* *12. Dalbergia cultrate* *13. Dalbergiaodorifera* *14. Dalbergiaoliveri* *15. Dehaasiacuneata* *16. Dialiumcochinchinense* *17. Diospyros cambodiana* *18. Diospyros castanea* *19. Diospyros crumenata* *20. Diospyros decandra* *21. Diospyros malabarica* *22. Diospyros mollis* *23. Diospyros pilosanthera* *24. Dipterocarpus alatus* *25. Dipterocarpus costatus* *26. Dipterocarpus dyeri* *27. Dipterocarpus intricatus* *28.Dipterocarpus obtusifolius* *29.Dipterocarpus tuberculatus* *30.Dipterocarpus turbinatus* *31. Dysoxylumloureirii* *32. Erythrophleumfordii*

				33.Fagraeafragrans *34.Heritierajavanica* *35.Hopeaferrea* *36.Hopeahelferi* *37.Hopeaodorata* *38.Lagerstroemia calyculata* *39.Lagerstroemia cochinchinensis* *40.Litseavang* *41. Manglietiaforrestii* *42. Magnolia champaca* *43. Manglietiadandyi* *44. Mesuaferrea* *45. Paramicheliabaillonii* *46. Pinus merkusii* *47. Pterocarpus indicus* *48. Pterocarpus marcropapus* *49. Senna siamea* *50. Shoreaguiso* *51. Shorearoxburghii* *52.Sindoracochinchinensis* *53. Tectonagrandis* *54.Toona ciliate* *55. Toonasureni* *56. Vitex pinnata* *57. Glutalaccifera*(Kroeul); 58. *Xyliaxylocarpa* (So Kram) *;* *59. Shoreavulgaris* (Chor Chong); 60. *Hopeapierrei* (Koki Khsach);
2.2	Cambodianendemic species garden	5	10	*1. Canthiumcambodianum* *2. Cinnamomumlongipetiolatum* *3. Diospyros embryopteris* *4. Dracaena cambodiana* *5.Gardenia angkorensis* *6. Madhucabejaudii* *7. Madhucacambodiana* *8. Madhucakompongsonensis* *9. Mangiferacambodiana* *10. Lagerstroemia petiolaris*

				11. Vitex thorelii *12.Syzygiumcambodianum* *13. Wendlandiacambodiana*
2.3	Rare and endangered tree species garden	5	20	*1.Afzeliabijuga* *2. Afzeliaxylocarpa* *3. Aglaia spectabilis* *4. Aquilaria crassna* *5. Artocarpussampor* *6. Cinnamomumporrectum* *7. Dalbergiacochinchinensis* *8. Dalbergiaoliveri* *9. Dipterocarpus dyeri* *10. Dipterocarpus turbinatus* *11. Erythrophleumfordii* *12. Erythrophleumsuccirubrum* *13. Fagraeafragrans* *14. Gardenia angkorensis* *15. Haldinacordifolia* *16. Heritierajavanica* *17. Pinus merkusii* *18. Pterocarpus marcropapus* *19. Shorea vulgaris* *20. Sindoracochinchinensis* *21. Tetramelesnudiflora* *22. Toonasureni* *23. Artocarpus rigidus* (Khnol prey); 24. *Shoreafarinosa*(Lombo); 25. *Canangalatifolia* (Chhkesreng); 26. *Dipterocarpus retusus* (Chheutealpreng) 27. *Hopeaferrea*
2.4	Woody medicinal & aromatic plant	5	20	*1. Aquilaria crassna* *2. Borassusflabellifer* *3. Careyaarborea* *4. Cassia alata* *5.Chukrasiatabularis* *6. Cinnamomumcambodianum* *7. Cinnamomumcaryophyllus* *8. Cinnamomumlitseifolium* *9. Cratoxylumprunifolium*

				10. Dasymachalonlomentaccum *11. Diospyros decandra* *12. Dipterocarpus intricatus* *13. Dracaena cambodiana* *14. Euonymus cochinchinensis* *15. Hydnocarpusanthelminthicus* *16. Irvingiamalayana* *17. Knema globularia* *18. Mitragynaspeciosa* *19. Payenaelliptica* *20.Zingiberofficinale* *21.Willughbeia edulis* *22. Cinnamomumcassia (ChheuEm);* *23.Cinamomum iners.* *24. Strychnosnux-vomica (Sleng);* *25. Acacia intsii (Thmear)*
2.5	Bamboo garden	2	10	*1. Bambusabambos* *2. Bambusablumeana* *3. Chimonobambusayunnanensis* *4. Chimonocalamusdelicatus* *5. Dendrocalamus asper* *6. Dendrocalamusbrandisii* *7. Dendrocalamuspeculiaris* *8. Gigantochloaalbociliata* *9. Thyrsostachyssiamensis* *10. Vitnamosasapusilla* *11. Vietnamosasaciliata*

2.6	Ornamental plant garden	10	20	*1. Alstoniascholaris* *2. Bombax ceiba* *3. Butea monosperma* *4. Cassia garretiana* *5. Cassia fistula* *6. Cassia javanica* *7. Dipterocarpus alatus* *8. Fagraeafragrans* *9. Ficusaltissima* *10. Handroanthuschrysanthus* *11. Hydnocarpusanthelmintica* *12. Lagerstroemia floribunda* *13. Lagerstroemia loudonii* *14.Mimusopselengi* *15. Museaferrea* *16.Polyalthialongifolia* *17.Saracadeclinata* *18.Streblus asper* *19.Syzygiumcumini* *20. Tabebuia rosea* *21. Tetramelesnudiflora.* *21. Ochnaharmandii (Angkea Sil);* *22. Bauhinia spp. (Choeung Ko)*
2.7	Economic fruit tree garden	12	10	*1. Anacardiumoccidentale*(Cashew nut) *2. Persea Americana* (Avocado) *3. Macadamiaintegrifolia*(Macadamia) *4. Pliniacauliflora*(Jaboticaba) *5. Bertholletiaexcelsa*(Brazil nut) *6. Citrus maxima*(Grapefruit) *7. Citrus limon*(Yellow lemon*)* *9. Litchichinensis*(Litchi) *10. Duriozibethinus*(Durian) *11. Mangiferaspp (Mango)*