

**Terms of Reference (ToR) for Consultancy Services for
Development of Tree Volume and Biomass Allometric Equations for *Castanopsis species* and
Schima wallichii in Nepal**

1. Background

Nepal is one of the leading countries in Reducing Emission from Deforestation and Forest Degradation, sustainable management of forests and conservation and enhancement of forest carbon stocks (REDD+), under the World Bank's Forest Carbon Partnership Facility (FCPF). Its Emission Reduction Program Document (ER-PD) has been included into the Carbon Fund portfolio of the FCPF. Nepal completed implementation of the first phase of the REDD+ readiness project in 2015. Nepal's request for an additional readiness grant was approved by the 21st Participants Committee meeting of the FCPF in 2015. Nepal and the World Bank signed the grant agreement for additional readiness funding of USD 5.2 million in January 2017. Among other readiness activities, improvement of the national forest inventory and monitoring system for a robust and functional Monitoring, Reporting and Verification (MRV) system is one of the focused areas of the ongoing 2nd phase of REDD+ readiness. It is expected that Nepal will enter into implementation phase of the REDD+ in 2020 after negotiation and signing of the Emission Reduction Payment Agreement (ERPA) between the Government of Nepal and the World Bank in 2019.

Under the second phase of REDD+ readiness, REDD Implementation Centre (REDD IC) is supporting the Forest Research and Training Centre (FRTC) to strengthen the National Forest Monitoring System (NFMS) to make it compatible to the requirements for REDD+ process which is very important for improving national forest reference level and establishment of a robust and functional MRV system. Developing accurate and country representative allometric equations for 16 major tree species is one of the major activities proposed for the second phase of the REDD+ readiness project, which will certainly help FRTC in developing a robust and functional NFMS.

Allometric equations are statistical models for calculating tree volume and biomass, using the relationships between different tree characteristics. Variables involved in building allometric equations vary but some common variables are diameter and tree height. Those variables are relatively easy to measure in the field, compared to measuring the volume and biomass directly for each tree, which is mostly not realistic as it requires a destructive method.

Estimation of aboveground biomass is an essential aspect of studies of carbon stocks and the effects of deforestation and carbon sequestration on the global carbon balance. Weighing tree biomass in the field is by far the most accurate method of estimating aboveground tree biomass, but it is an extremely time consuming and destructive method, generally limited to small areas and small tree sample sizes. The need for quantification of carbon stocks for different forest types is also relevant for the emerging carbon credit



market under REDD+. Allometric equations can be used to assess many ecosystem services provided by forests, including the estimation of forest carbon stocks, by processing data collected in the field.

The choice between different allometric equations has large implications for carbon accounting. When estimating the aboveground biomass of a forest, the use of species-specific equations is preferred because trees of different species may differ greatly in tree architecture and wood density.

Allometric equations for different tree species that could be used for Forest Reference Level (FRL) development and MRV for REDD+ process in Nepal are not available. For the estimation of carbon stock during FRA Nepal (2010-2014), allometric model developed by Sharma and Pukala (1990), wood density developed in other countries was used. However, there is a consensus that this model is not accurate and there is a high uncertainty in biomass and carbon estimation using this model. Furthermore, this model does not meet standard and accuracy of UNFCCC reporting requirements and may not be appropriate to claim the emission reduction credits for the REDD+ results-based payment. So to upgrade the data base for REDD+ process, there is an urgent need to develop species specific allometric equations for major tree species and forest types taking account of FRL as well as MRV of the REDD+ process.

This TOR is developed for the service provider/s who are interested in this assignment to collect the data from sampled trees and develop the allometric equations for two major tree species namely *Castanopsis species* and *Schima wallichii* found in mid-hill region of Nepal. The data collection should follow the protocol of destructive sampling of trees of both species covering the mid hill regions of Nepal.

2. Objectives of the Assignment

The main objective of this assignment is to develop tree volume and biomass allometric equations for *Castanopsis species* and *Schima wallichii* found in mid-hill region of Nepal.

Specific objectives of the assignment include:

- To collect tree attributes for estimating above-ground tree volume and biomass models.
- To develop allometric models/equations for tree volume and biomass.

3. Scope of the Work

Following tasks need to be carried out for successful completion of this assignment:

3.1 Desk Review and Analysis

Desk review and analysis of FRA process in Nepal, latest FRA reports published as well as other relevant documents including FRL, MRV reports completed for the REDD+ readiness and other published or unpublished reports related to developing allometric equations in Nepal and other parts of the world is very important for successful completion of this assignment.

3.2 Consultation with the Technical Committee and other Stakeholders



Regular consultations and discussion with technical committee formed to supervise and oversee this assignment under the leadership of FRTC/REDD IC is critical as the consultant team will work under the guidance of the committee. Other related experts from FRTC as well as focal persons from the REDD IC, Department of Forests and Soil Conservation and Ministry of Forests and Environment (if any) will also be consulted regularly. Consultations with the relevant provincial Ministry officials, DFO staff, representatives of the Local Governments and local communities including the concerned Community Forests Users Groups (CFUGs) are also very important.

3.3 Sampling Design for Selection of Trees

Sampling design for selection of trees for harvesting and measurement is critical for developing accurate and representative allometric equations. It should be ensured that trees are representatives of all diameter classes and spread over the species' distribution range. The firm should work closely with the technical committee and REDD IC and FRTC for the sampling design and selection of sample trees.

Samples and measurements should be taken from the following 2 tree species from the Mid-hill physiographic region of Nepal.

1. *Castanopsis species*
2. *Schima wallichii*

3.4 Harvesting and Measurement of Trees in the Field

After selecting the trees, harvesting and measurements in the field is most vital part of the assignment. Strict protocol needs to be followed for harvesting and measurement. The particular assignment includes the measurement of standing tree, felling of sample trees, measurement of felled trees, stripping leaves, limbing, cross cutting and disk making, weighing fresh weight of the different tree parts in the field, taking samples of branches and leaves, entering data into computer, analyzing data and developing equations and report writing. The total number of trees to be felled and measured will be 115 for both tree species with different diameter class covering their species distribution range throughout Nepal.

The assignment also includes taking disk samples of stem (four – six), branch (four - six) and foliage (two) from each harvested tree and handed over the samples to FRTC lab at Kathmandu for air-dry and over-dry biomass estimation. The firm should follow the protocol prepared to collect the disk samples and record the required information precisely. Drying of sample and further processing will be done in FRTC Lab whereas FRTC will supervise and monitor the processing.

3.5 Management of Harvested Trees and their Parts

Stems/branches of felled trees should be piled. Branches should be cross-sectioned and piled in the form of Chatta at depot (*Ghatgaddi*), as prescribed by the concerned Divisional Forest Office and/or Forest User Group. Finally, the harvested materials and their records should be handed over to the concerned authorities. The firm should make necessary arrangements for the fieldwork including travel and logistics.



3.6. Data Entry

The data collected during the field works should be entered into any computer software such as Ms Excel worksheet. All the hard copy data collected in the field and digital formats should be handed over along with report.

3.7 Data Analysis, Development and Validation of the Allometric Equations

Volume and biomass equations including bark ratio of two species will be developed. Data analysis should be based on strong statistical ground and should be comparable with global models. This assignment includes collection of data to assist the allometric biomass modelling, analysis of data and development and validation of the equation.

The consultant should conduct field measurement to develop tree volume and biomass (allometric) equation for total tree height, 10 cm top, and 20 cm top diameter.

4. Reporting and Deliverables

4.1 Inception Report with Detail Action Plan and Timeframe

Inception report with detail action plan and timeframe as well as methodology shall be submitted within two weeks of the signing of the contract. Step by step field protocol, data sheets should be developed by the firm and included in the inception report. This should be presented at the inception workshop. After incorporating all the feedbacks, suggestions and inputs from REDD IC, the technical committee, and the participants of the workshop, the inception report must be finalized and submitted to REDD IC before actual implementation of the fieldwork.

4.2 Intermediate Reporting

The firm shall submit monthly progress report from the start of the contract.

4.3 Draft report and Final Report

The firm shall submit two hard copies with digital copy of the draft report to REDD IC for comments and suggestions. REDD IC and technical committee will provide comments and suggestions on the draft report within ten days. The comments and suggestions received shall be incorporated in the final report by the firm. Three hard copies and soft copies of report, data, analysis sheets shall be submitted to REDD IC. In addition to this, all relevant photographs, maps, raw data, data processing methodology and final data used for completion of the assignment need to be submitted to REDD IC. The firm should submit the hard and digital copies of field data to REDD IC. Similarly, the firm should produce a publishable document incorporating the allometric equations and the procedure to come up with the equations for wider dissemination.

The firm should provide following data that are collected from the individual trees:

- General information about the location of the tree (such as physiography, aspect, altitude, forest type, management regime, development status etc.);
- Species, DBH, quality, height; diameter at various sections (including 10cm top, 20 cm top); length/height (of a whole tree or sections of tree),

- Biomass of stem, branch and foliage, bark thickness and any other relevant data.

5. Team Composition and Qualification of the Firm and Experts

5.1 Qualification of the Firms

National firms legally registered within the concerned authorities with clear mission, vision and objectives and registered in national VAT system are eligible to apply. The firms should have relevant work experience in forest biometry, forest inventory, SFM, REDD+ and /or related field in Nepal. The firm must have Tax clearance of the last fiscal year.

5.2 Team Composition, Responsibilities and Qualification of the Team Members

The assignment will be executed from a team of experts including a Team Leader cum Senior Forest Biometrician and four field crews. Each field crew will be composed of one Biometrician, one forest technician and necessary skilled and unskilled field labour. Furthermore, Local resource persons and the representative of the concern forest authorities are also required to facilitate the fieldwork. Forest Officer from FRTC/REDD IC will be involved in monitoring and quality assurance.

5.2.1 National Team Leader cum Senior Forest Biometrician

Roles and responsibilities: The National Team Leader cum Senior Forest Biometrician will lead the team in close coordination with and under the guidance of the technical committee formed under the leadership of FRTC for overseeing this assignment. The team leader will:

- Study and analyze FRA documents, NFI system and other published or unpublished related documents;
- Develop a plan of actions with timeline of each of the actions after discussion with other team members;
- Coordinate the team and make sure that all the crew members are trained and capable to perform their respective jobs for the assignment;
- Prepare the inception report for presentation in the inception workshop;
- Coordinate consultation meetings and policy discussions at all levels;
- Manage all administrative, financial and other logistic issues of the assignment;
- Make sure that all the field works (harvesting and measurement of selected trees) are completed following a scientific protocol and data are recorded and kept properly.
- Take all responsibilities for the data processing and finalizing the models.
- Prepare final report combining reports from all the thematic experts.

Required qualification: The team leader must be a Nepali national and have strong knowledge on biomass modeling and forest resources assessment. He or She must have minimum qualification and experience as below:

- Hold at least postgraduate degree (Masters, preferably PhD) in forestry;
- Have at least ten years working experience in related field;
- Understanding of biometry and statistical software/programming as well as theory and principles of biomass modeling;



- Good understanding of climate change, REDD+, biomass and carbon trading policies and related issues;
- Sound knowledge of forestry sector institutions, current program implementation arrangements and process in Nepal;
- Writing, facilitation and communication skills in English and Nepali;
- Having experience of leading a team of experts is preferable.

5.2.2 Statistician/Data Analyst

The expert should have strong knowledge and skill on data handling, processing and analyzing the model. Statistician is responsible for sampling design, data management, data analysis, modeling, selecting appropriate models, and assist team leader in meetings/workshops and report writing. S/he must have minimum qualification and experience as below:

- Hold Masters degree in relevant field. Preferences will be given to statistician having experience in forestry and environment sector;
- Have at least five years working experience in related field;
- Strong knowledge and skill on statistical software/programming and data analysis as well as theory and principles of biomass modelling.
- Having experience on similar projects will be an added benefit.

5.2.3 Biometrician – Four

Roles and responsibilities: The biometrician of the team are responsible for leading the field crews and coordinating respective forest assistants and other field crew members to carry out the field works including harvesting and measurement of trees in the field under the guidance of the Team Leader.

Required qualification: The Biometrician must be a Nepali national and have a strong knowledge and skills of forest resource assessment, and sample plot measurement. They must:

- Have minimum qualification of bachelor's degree in forestry;
- Have at least three years of work experience in forestry sector (in forest inventory and standing tree measurement) in different parts of Nepal;
- Be experienced in managing field crews in forestry related works such as forest resource assessment activities.

5.2.4 Forest Technician/Assistants - Eight

The forest assistant is responsible for coordinating the tree harvesting and measurement in the field. S/he is also responsible for the quality of the data collected in the field. S/he is responsible in harvesting and measurement of the trees to get the accurate data following the guidelines developed by the team under for the field works.

Required qualification: The Forest Assistants must be a Nepali national and have a strong knowledge and skills of forest resource assessment, and sample plot measurement. They should have minimum qualification of Certificate level (or Diploma level) in forestry and work experience in forestry.

6. Inputs to the Firm

6.1 Documents and Consultations

FRTC and REDD IC will provide access to background documents to carry out the assignment. These include:

- Final reports of the relevant REDD+ readiness studies including MRV and FRL;
- Reports and methodologies about biomass modelling and related works;
- Reports of ongoing NFI system and periodic reports of FRA in Nepal;

Both FRTC and REDD IC will provide the firm necessary help and support for organizing the consultations at all levels.

6.2 Equipment and Tools

FRTC/REDD IC can support some equipment to the firm, however it is the responsibility of the firm to manage required equipment/tools for the assignment. The equipments and tools provided by FRTC/REDD IC must be returned in good condition to REDD IC/FRTC after completion of the assignments. Similarly, the firm should provide capacity development trainings and related activities for the handling of the equipment.

6.3 Trainings

FRTC and REDD IC will facilitate the firm for the training and orientation for field crew members regarding field navigation, measurement, data collection and data entry in the field. Field crews will only be mobilized after they are trained properly for the job they will carry out.

7. Supervision, Monitoring and Quality Control

FRTC and REDD IC will be responsible for supervision, monitoring and quality control of the data taken in the field by the firm. Separate budget will be allocated for this purpose (Firm will not be responsible for the cost associated with this). The firm will carry out the activities under the coordination and supervision of the technical committee formed for this assignment. Supervision and monitoring of the work will be done simultaneously with the measurement activities conducted by the field crews. FRTC staff will supervise and facilitate the measurement process during the field inventory.

8. Safety and Precaution

Firm should be ensured all the safety and security measures such as full safety equipment and accessories for each crew including first aid, field gear, insurance etc.

9. Intellectual Property Rights

All the data collected in the field, daily field books, original sets of maps used, processed data and the database developed during this assignment will be the property of REDD IC and must be submitted to the REDD IC along with the final report by the consulting firm. The data should not be used for any other purpose or transferred to any third party for any reasons without the prior written consent of REDD IC.

10. Selection Process and Criteria

Selection process of the qualified firm/s will start from advertising for “Expression of Interest (EoI)”. Method of selection will be QCBS. The shortlisted firms based on EoIs submitted will be requested to



submit the full proposal following The World Bank Procurement Regulations for IPF Borrowers, July 2016 Revised November 2017 and August 2018.

11. Work Schedule

The assignment should be completed by June 2020. Further details of the assignment will be provided in RFP.

12. Application Procedure

Eligible firm/consortium of the firms should submit "Expression of Interest (EoI)" with the following documents:

- Letter of EoI
- Copy of registration and renewal certificates, copy of tax clearance certificate of the last F/Y, and copy of VAT registration certificate,
- Profile of the firm with general and specific work experience (details of assignments/similar assignments undertaken in the past)
- Capacity (financial turnover of last 3 years and infrastructure/office/equipment/vehicle etc.)
- Roster of potential key experts with name, position, qualification, work experience and specific work experience (in years) and nationality.
- Letter from partnering firm/institution if joint venture is proposed.

The shortlisted firms will be requested to submit the full proposal along with following documents:

- Full technical proposal for the assignment in a sealed envelope. The proposal should include commitment letters from the proposed experts along with duly signed CVs;
- Detail financial proposal for the assignment in a separately sealed envelope.

Contact Information

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