

Government of Nepal
Ministry of Forests and Environment
REDD Implementation Center



**Terms of Reference (ToR) for Consultancy Services for
Development of Allometric Equations for 16 Major Tree Species in Nepal
(Budget Head 2.12.1.86)**

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. This second phase of the readiness project will be completed in December 2019. 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+ at the latest January 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 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. Which characteristics involved varies between different allometric equations, 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. Allometric equations for relating tree diameter at breast height (DBH) or other easily measurable variables to standing volume of wood or total biomass, C, and nutrient stocks are commonly used for forest inventories and ecological studies.

Estimation of aboveground biomass is an essential aspect of studies of C stocks and the effects of deforestation and C sequestration on the global C 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. National forest inventories use allometric equations for REDD+ MRV.

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 FRA purpose, very old allometric model developed by Sharma and Pukala (1990), density base on other countries was used because other models were not available. 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 using robust scientific approach to select the sample trees from different parts of the country representing different management regimes of forest resources. This was also discussed during the development of the second phase of REDD+ readiness grant proposal.

This TOR is developed for the service provider/s who are interested in this assignment to collect the partial data from sampled trees develop the allometric equations by collecting for major tree species found in different parts of Middle Mountain, High Mountain and High Himal physiographic regions of the country. The data collection should follow the protocol of destructive sampling of trees of various species and regions. **As this assignment is only targeted for the collection of data, data analysis and preparation of allometric biomass models and validation of these models will be done in programs in following years.**

2. Objectives of the Assignment

The main objective of this assignment is to support FRTC and REDD IC for the collection of data/samples of individual trees of various species to develop accurate allometric equations for 16 major tree species found in different ecological regions of the country. However, this particular assignment only includes the collection of partial datasets for some major tree species mostly in Middle Mountain, High Mountain and High Himal regions. The major species are listed in the State of Nepal's Forest 2015, prepared by FRA/DFRS.

Specific objectives of the assignment include:

- Samples design and identification of location and numbers of trees.
- To collect tree attributes for estimating aboveground and belowground tree biomass of major tree species of the country. (species mostly from Middle mountain, High Mountain and High Himal regions)
- To collect the attributes for estimating Fresh, Air dry and Oven dry biomass of tree.



- To collect necessary data for bark ratio.
- To prepare the data ready for allometric biomass models/equation.

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 State Ministry officials, 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; climatic zones/physiographic zones as well as forest management regimes. The sampling design should identify the sufficient number of trees for each species in each physiographic region and also cover the horizontal (East-West) and vertical (North-South) distribution of species should be covered for the data collection.

The firm should work closely with the technical committee and REDD IC and FRTC for the sampling design selection of sample trees.



3.4 Harvesting and measurement of trees

After selecting the trees, harvesting and measurements of the trees in the field is most vital part of the assignment. Strict protocol needs to be followed for harvesting and measurement. Harvesting include felling and sectioning of the trees to measure necessary tree attributes. The biomass of stem, branches and foliage should be measured from the harvested trees.

As this assignment also include the preparation of air dry and oven dry ratio, sample should be collected for the air dry/oven dry ratio from various sections of the stem/branch for each species. For certain percent of tree samples for above ground biomass, belowground samples should also be collected for biomass ratio (Above ground/Below ground biomass ratio). So, this assignment also includes the excavation, extraction and measurement of belowground portion of trees for biomass.

3.5. Data Entry

The data collected during the field works should be entered in a systematic data entry form designed by REDD IC and FRTC. All the hard copy data should be also in digital formats.

3.6 Data analysis, development and validation of the allometric equations.

Not Applicable for this particular assignment

As this assignment is only designed for the collection of data to assist the allometric biomass modelling, analysis of data and development and validation of the equation is not in the scope of this assignment. Development of models or equation will follow in upcoming assignment when the data collection from sufficient number of trees will be achieved.

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 the one month of the signing of the contract for the assignment. This should be presented at the inception workshop. After incorporating all the feedbacks, suggestions and inputs from the



participants of the workshop, the inception report must be finalized and submitted to the FRTC and REDD IC within the one month of the inception workshop.

4.2 Intermediate reporting

The firm shall submit intermediate progress report in every 2 weeks from the start of the contract.

4.3 Final/Completion report

The firm shall submit hard copies with digital copy of final report after completion of the activities to REDD IC. In addition to this, all relevant photographs taken, maps, and raw data used for completion of the assignment need to be submitted to the FRTC and REDD IC. The firm should submit the hard and digital copies of field data to FRTC and REDD IC.

4.4 Measurement data

The firm should provide the data in a systematic way i.e. designed in a specific data sheets designed by REDD IC/FRTC. The measurement of data from the destructive sampling should follow the strict protocol for measurement. Following are the major data that should be collected from the individual trees:

- 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
- Below ground biomass of trees (certain percentage of trees that will be collected for above ground biomass) etc.

4.5 Samples for Laboratory Analysis

The firm is should prepare and collect samples for Air Dry and Oven Dry biomass ratio for each tree species. The samples should be disks of sufficient thickness from various part of stem/branch of trees. 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 facility and FRTC staff will conduct and supervise the processing.

4.6 Submission of Data

The firm should submit all field collected data in hard copies and digital formats. The firm is also responsible for the entering data in designed database system prepared by REDD IC and FRTC. Submission of necessary photographs, maps and other relevant document and information is also required.

5. Team composition and qualification of the firm and experts

5.1 Qualification of the firms

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 inventory, SMF, REDD+ and /or related field in Nepal. The firm must have registered for at least five years with valid registration, Tax/VAT clearance, demonstrated annual transaction, audit and renewal.

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 Forest Biometrician**, at least 5 crews (including at least 1 Biometrician and at least 1 forest technician) depending on the number of field crews to be mobilized. Furthermore, numbers of Local Resource Persons as well as some skilled forest labors need to be mobilized for tree harvesting and measurement activities.

5.2.1 National Team Leader cum Senior Biometrician

Roles and responsibilities: The National Team Leader cum Forestry Expert 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.
- Prepare final report combining reports from all the thematic experts.

Required qualification: The team leader cum Forestry Expert must be a Nepali national and have strong knowledge on biomass modelling 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 with forest modeling a part of study.
- Have at least 10 years working experience in related field.
- Understanding of statistical software/programming as well as theory and principles of biomass modelling.
- 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; and;
- Writing, facilitation and communication skills in English and Nepali.
- Having experience of leading a team of experts (must have led at least one similar project)

5.2.2 Biometrician

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 Biometrician and the Team Leader.

Required qualification: The Biometricians 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 (preferably master's degree) in forestry;
- Have at least 3 years of work experience in forestry sector (in forest inventory and standing tree measurement will have an advantage);
- Be experienced in managing field crews in forestry related works such as forest resource assessment activities.

5.2.3 Forest Technician

The Forest Assistants are responsible for coordinating the tree harvesting and measurement in the field. They are also responsible for the quality of the data collected in the field. Supervise the 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 (preferably BSc) in forestry and at least 3 years of work experience in forestry.

5.2.4 Labors

The labors are responsible for actual harvesting of trees. They are also responsible for less destruction of surrounding forest and the quality of harvested trees. Labor having skill on felling and section of trees should be preferred.

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 may provide available major equipment (power chain saw, weighing machine etc.) to the firm necessary to carry out the field works (FRTC may not be able to provide all the equipment's required for the assignment). Firm should be responsible for the arrangement of minor equipment (Diameter tape, Linear tape, etc). The firm should be responsible for arrangement, proper use and safety of all the equipment. All the equipment provided for the work must be returned to FRTC in good condition. Firm will be responsible for replacing any damaged or lost equipment.

6.3 Trainings

FRTC 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. 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 FRTC and must be submitted to the FRTC 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 FRTC.

9. Selection Process and Criteria

Selection process of the qualified firm/s will start from advertising for "Expression of Interest (EoI)". 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.

10. Work Schedule

The assignment should be completed by June 2019. Further details of the assignment will be provided in RFP.

11. Application Procedure

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

- Letter of EoI
- Profile of the firm
- Copy of registration and renewal certificates
- Copy of annual audit report for last three years and tax clearance certificate
- Roster of potential experts
- 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

Ms. Saraswati Aryal

REDD Implementation Center,

Babarmahal, Kathmandu

Phone: 01-4239126

Email: info@redd.gov.np