Bamboo Resource Assessment outside the Forest Area

Field Manual

Forest Survey and Carbon Measurement Section
FOREST RESEARCH AND TRAINING CENTER, BABARMAHAL
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1. Background

Bamboo is an important non-wood forest resource available in both forest and non-forest areas of Nepal. They are found both in natural forests as well as in private land. Specially, they are prominent around public settlement. People cultivate bamboo due to its multiple-use properties in both protective services (e.g., soil conservation, reclaiming degraded lands, etc.) and productive services (e.g., construction materials, scaffoldings, furniture, fuel wood, etc.). Furthermore, bamboos are also found naturally occurring in different physiographic regions of the country. Climatically, distribution of bamboo is extensive throughout Nepal. Small bamboos, at high altitudes, reach the tree line where snow fall is regular. These bamboos are used for handicrafts. On the other hand, larger sized bamboos are found on lower altitudes in both natural forests and public lands.

Bamboos are one of the fastest growing plants with an ability to survive in a wide variety of climatic and edaphic conditions. They can grow at an extreme diverse range of soil conditions varying from organically poor to mineral rich; and moisture level from drought to flooding which makes them effective for reclaiming degraded lands due to which bamboos are considered as successful species for ecological restoration. Bamboos play an important role in carbon sequestration and biodiversity conversation. Their diversity in terms of size, being light yet strong, hard, and straight, fast growth and abundance make them amenable to versatility of use which is often species specific. They are widely used in furniture, construction, shoots as food, pulp and paper industry, handicrafts and so on. They are also known as green gold and poor man's timber, cradle to coffin timber.

Bamboos belong to the family Poaceae (Graminae), grow in the tropical, sub-tropical and temperate regions of the world with an uneven distribution based on annual precipitation, altitude, soil conditions and temperatures. There are about 90 genera and 1200 species of bamboo found in the world (FAO, 2005). Likewise, 12 genera and 53 species of bamboo have been reported in Nepal (Das, 2002). The distribution of bamboo in Nepal is from Terai to High Mountain (50-4000 m from msl) both in natural forests as well as farmlands. Both tropical bamboos of South-East Asia and temperate bamboos of Tibet and Bhutan are found in Nepal (Karki, et. al., 1995; Ghimire, 2008).

However, a review of inventories and mapping of bamboo resources shows that there is almost no information available for Nepal, therefore, an accurate, comparable, up-to-date, spatially explicit data/maps of bamboo resources for Nepal is important and urgent. All the resource information of Bamboo in Nepal is not based on scientific studies but only from proxy estimation. There is still a noticeable gap in bamboo cover (spatial map) and total bamboo biomass (bamboo inventory) in Nepal. So, this assignment has been planned to conduct bamboo resource assessment throughout the country.

2. Objectives of the Assignment

The main objective of this assignment is to assess bamboo resources outside the forest area in Nepal.

Specific objectives of the assignment include:

1. Navigate and establish potential bamboo plots.
2. Conduct field inventory of bamboo resources.
3. Assess the available bamboo species and their usages.
4. Prepare spatial map of bamboo resources.
5. Collect bamboo samples for biomass estimation.
6. Develop taper equations and biomass models for major seven bamboo species.

3. Scope of the work

To achieve the above-mentioned objectives, the consultant shall carry out the following activities:

Conduct a preliminary assessment and spatially map out important bamboo hotspots all over the country outside the forest's areas using the method approved by FRTC.

1. Locate the bamboo plots and record the coordinates of each bamboo clump (हरेक बाँसको झ्याङ्गको) that fall inside the plots.
2. Measure the diameter of the clump from at least two sides and calculate average diameter of clump.
3. Identify all bamboo species and their usages that occur inside plots and discussed over the meetings with local people and authorities.
4. Collect data on mean diameter, mean height, mean internode distance and number clump.
5. Collect data on diameter, height, internode distance of the bamboo at breast height, this is done on 3 bamboo stumps of different ages i.e., first year, 2 year and more than 2 years of bamboo.
6. If different bamboo species occur inside the same clump, collect data on mean diameter, mean height, mean internode distance and number of culms for each bamboo species inside every clumps.
7. Collect photographs and herbarium samples for identifying unknown bamboo species.
8. Harvest 50 bamboo culms of each 7 major species, measure height after felling, diameter at breast height, diameter at each node, internode distance of the bamboo at breast height. Weight those bamboo stems properly, for developing the biomass equation. Collect the lateral leaves and twigs and weight them for calculating the proportion of the leaves and twigs weight in a stem.
9. Collect the sample of part of bamboo shoot/stem, and transport them to the office with proper labelling, for calculating thickness and the ratio of airdry to oven dry. At least,

50 samples culms of minimum one meter in length should be transported to Kathmandu for drying purpose.

10. Prepare the density and abundance maps for each bamboo species.
11. Duly enter and validate data and submit final data i.e., inventory and social workshop data, (both soft and hard copies).

Disseminate results in a workshop, incorporate feedbacks, prepare a final technical report, and submit to the FRTC.

4. Field Measurements and Techniques

4.1. Plot level data

Basic information on the plots is crucial for the permanent follow up of the plots and track the measurements for quality assessment and quality control too. Things to consider for basic information is as follows:

Name of the crew leader	Last Name: First Name	Date	YYYY/MM/DD
Bamboo owner's name	Last name: First Name	Tole	Local Name
Plot ID	Given by FRTC, (Annex -1)	Land Use	i.e., crop land, private forests,
Coordinate (X)	UTM UPS WGS 84	Slope	In percentage
Coordinate (Y)	UTM UPS WGS 84		
Province	Province Name	Altitude	Altitude in m
District	District Name	Aspect	In Degree (0 to 359)
Local Level	Full name	Number of bamboo clumps	i.e., 1,2,3,4…….
Ward	Ward no in two digits i.e., 08	Number of Bamboo Species	i.e., 1,2,3
Photo ID	Photo ID displayed in Camera: (for all directions and center of the plot)		

4.2 Clump information

This section consists of the dimension and the status of the clump. Before collecting the information on clump plot number and the number of clumps inside the plot should be mentioned. Herbarium of every clump inside the plots should be collected and carefully tagged on the specimen. Besides this following information should be collected for every clump.

4.2.1 Species Local Name

General local name more especially in Nepali language should be mentioned.

4.2.2 Species Code

Species codes of bamboo species: as mentioned in annex II of the manual.

4.2.3 Coordinates

Coordinates of the clump should be mentioned in UTM UPS WGS 84 Metric System with Zone ID. i.e., 3397665, 3095876 and 44 R.

4.2.4 Clump Base diameter

The diameter of the clump at its base should be measured. The diameter of the clump should be measured in at least two lateral sides. Later the average of these two diameters will be considered as diameter of the clump.

4.2.5 Clump Crown Diameter

The diameter of the clump crown should be measured. The diameter of the clump crown should be measured in at least two lateral sides. Later the average of these two diameters will be considered as diameter of the clump crown.

4.2.7 Age of the clump.

The owner of the clump should know the year of establishment of the clump. However, age of the bamboo clump should be considered according to the local people.

4.2.8 Specimen.

Species identification of the bamboo is crucial for the bamboo resource assessment. The specimen of the clump should be taken for the further identification of Bamboo Species. Simply small portion of node section of the culm, branch and foliage twigs is taken.

4.3 Culms information inside the Clump

This section is to collect the information on the number of different types of culms inside the clump. Age of the culms and status of the culms is focus. Bamboo culms were purposively divided as a category of first year, second year and aged more than 2 years. Along with it, Dry/dead stems, green /alive without broken stems and broken stems should be counted without missing the single culms. Along with this information the status of the culm i.e., dead, diseased, flooded etc. should be mentioned in Remarks in Sheet 2.

4.4. Culm dimension

This part of the field survey focuses on the dimensions of the culm inside the clump. Following measurements

4.4.1 Age category

The age of the culm should be mentioned in reference to the LRP. The category less than or equal to one year, more than one year and less than or equal to two years and more than two years are symbolized as 1, 2, and 3 respectively.

4.4.2 Size category

Size category should be named as “s” for small sized culm, “m” for medium sized culm and “l” for large sized culm. There is limited study on the size category of the bamboo. However, it depends upon the species and locality of the bamboo. We should consider representatively three biggest bamboos as large, three smallest as small and other three medium sized culms as medium category.

4.4.3 Diameter at 30 cm height above the ground level

Diameter of the culms is measured above 30 cm above the ground level using diameter tape.

4.4.3 Diameter at Breast height

Normally, for the tree inventory, the diameter is measured in the 1.3m above the ground level so did in the National FRA in Nepal also. The diameter of the bamboo is also measured at 1.3m above the ground level. If any discomfort, radial roots, or defects are present in the 1.3m then just upper side of the defect is considered as point of measurement.

4.4.4 Height Measurement

The process of height measurement of the bamboo culm is quite complex. Bamboo tip is not defined as in other tree species. Bamboo normally reaches a culmination height and starts to bend down towards the ground. Biomass and carbon should be considered as function of total height i.e., both standing and leaning parts. So, it is important to calculate the total height of the bamboo for further biomass calculation. First, measuring the bamboo height up-to culmination point. Vertex can be used for measuring the height up-to culmination (tc) but if the Sunto-clinometer is used then, extra calculation should be done for measuring the height of the bamboo. Then, base distance from seeding point is measured (b). Then, the height of bamboo (H) is calculated using the formula as Sqrt of (square of tc + square of base(b)).

4.4.5 Culm Wall thickness

Culm wall thickness is crucial measurement for biomass calculations. However, it is the function of the species, and site-specific characteristics. Culm wall thickness is measured using vernier calipers at 1.3m above the ground surface.

4.4.6 Count of internodes

The internodes until the tip of the bamboo plant should be counted and mentioned.

4.5 Measurement for Developing Biomass model and taper form.

The tree dimensions like diameter, height, culm thickness and age are the important factor for developing the biomass model of bamboo plant which is already discussed in the previous parts of the manual. Those dimensions are used to establish the relationship with the weight of the bamboo plant. So, this part is focused on the measurement of green weight of bamboo

plant and finding the ratio of the green weight to the dry weight of the culm, branches, and leaves of the bamboo plant.

4.5.1 Measurement of green weight of the Bamboo plant

After the felling of the bamboo plant the stem, branches and leaves are separated in proper way with minimum possible loss in biomass. Then, culm, branches and leaves are weighted by a weighing machine in kilo grams as mentioned in the formats below.

Sample ID	Species/ Local name	D30 (cm)	DBH at 1.3 m (cm)	Base (m)	Total height (m)	Total length (m)*	Culm wall Thickness at BH	Number of nodes	Green weight (kg)		
									Stem or culm	Branch	Foliage**

4.5.2 Measurement of green weight of the sample

To calculate the ratio between green weight and dry weight, samples of the culm, branches and leaves are taken from the field to the laboratory. The green weight of those samples is taken as mentioned in the table below.

Bamboo Sample ID	Species	Green Weight of Culm Sample	Green Weight of Branch Sample	Green Weight of Leaf Sample

4.5.3 Measurement for taper form

The diameter of the felled bamboo plant is measured first at base i.e., at 30 cm of above the ground level. Then the diameter of the culm should be measured in every 2m height from the ground level i.e., 2, 4, 6, 8, continue to the tip.

References

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Karki, M. B., & Karki, J. B. S. (1995). National bamboo and rattan information database. *Nepal, Tribhuvan University, Institute of Forestry, Pokhara, Nepal*.

Singnar, P., Nath, A. J., & Das, A. K. (2015). Culm characteristics and volume-weight relationship of a forest bamboo (Melocanna baccifera (Roxb.) Kurz) from northeast India. *Journal of Forestry Research*, *26*(4), 841-849.

Annex-I: **List of bamboo species**

SN	Local name	Latin name
Large bamboo		
1	Kande bans	*Bambusa bambos*
2	Deu /Mungeri bans	*Bambusa pallida*
3	Dhanu/Bholka/Harauti/Harod/Ghar/Ban/Moto bans	*Bambusa balcooa*
4	Choya/Khasre/Tama/Khosre/Phusre/Tame bans	*Bambusa nepalensis*
5	Mal/Makla//Thulo/Lisingfa bans	*Bambusa nutans* subsp. *cupulata*
6	Taru/Tharu/Sate /Chille /Ghar bans	*Bambusa nutans* subsp*. nutans*
7	Jhapta/Chav/Chab /Kada/Koraincho bans	*Bambusa tulda*
8	Phor bans/Phond bans	*Bambusa* sp.
9	Singare/Singaray bans	*Bambusa vulgaris* Schrad. Ex Wendl.
10	Pahelo/Butte bans	*Bambusa vulgaris* 'Vittata'
11	Lota bans	*Bambusa vulgaris* 'Wamin/
12	Dhungre/Rakshashi bans	*Dendrocalamus giganteus*
13	Choya/Tama/Guliyo/Dhungre/Ban bans	*Dendrocalamus hamiltonii* var. *hamiltonii*
14	Kalo bans/Bhalu bans	*Dendrocalamus hookeri*
15	Bhalu bans/Okla bans/Mokla bans	*Dendrocalamus sikkimensis*
16	Kath/Kathe/Gathe/Geniya/Laathi/Lathi/Munger bans	*Dendrocalamus strictus*
17	Kath/Ban/Katas bans	*Dendrocalamus strictus* var. *wild*
18	Dhungre bans	*Dendrocalamus* spp.
19	Lahure/Nigale/Rani/Jhagadiya bans	*Melocanna baccifera*
20	Pahelo Nigale bans	*Phyllostachys bambusoides*
21	Kat bans	*Phyllostachys edulis*
22	Moso bamboo, Chiniya Bhalu bans	*Phyllostachys pubescens*

Small bamboo		
23	Nibha bans/ Nibha nigalo/ /Gopi/Lyas bans	*Ampelocalamus patellaris*
24	Malingo/Malinge Nigalo/Sano maling	*Arundinaria racemosa*
25	Mugi bans/Murali nigalo/Murali bans	*Bambusa alamii*
26	Chigar	*Borinda chigar*
27	Kalo nigalo	*Borinda emeryi*
28	Gopi nigalo/Gopi bans/Gopay /Murali bans	*Cephalostachyum latifolium*
29	Seto Gopi nigalo	*Cephalostachyum latifolium* var. *variegata*
30	Diu/Tite nigalo	*Drepanostachyum falcatum*
31	Tite Nigalo	*Drepanostachyum falcatum var. glomeratum*
32	Tite Nigalo	*Drepanostachyum intermedium*
33	Ban Nigalo	*Drepanostachyum khasianum*
34	Putru/Putre?suruwal Nigalo	*Drepanostachyum* sp.
35	Ghunre/Malinge Nigalo	*Himalayacalamus asper*
36	Malinge Nigalo	*Himalayacalamus brevinodus*
37	Malinge Nigalo	*Himalayacalums cupreus*
38	Thudi/Singhane Nigalo	*Himalayacalamus falconerii*
39	Tite Nigalo	*Himalayacalamus fimbriatus*
40	Padang	*Himalayacalamus hookerianus*
41	Seto Nigalo	*Himalayacalamus porcatus*
42	Malingo Nigalo	*Himalayacalamus* sp.
43	Jarbuto	*Thamnocalamus spathiflorus* subsp, *nepalensis*
44	Rato Nigalo	*Thamnocalamus spathiflorus* subsp, *spathiflorus*
45	Ghoredo/ Bhodar Nigalo	*Thamnocalamus spathiflorus* var. *crassinodus.*
46	Malingo/Maling/ /Khosre Malingo/Malinge nigalo	*Yushania maling*
47	Maling/Malingo	*Yushania microphylla*
48	Kucho Nigalo	*Yushania* sp.
49	Deu/Deo/Ringal/Baghbutte Nigalo	*Yushania/Chimnobambusa* sp.

Annex-II: **Species codes**

SN	Species Code	Local name	Latin name
1	401	Kande bans	Bambusa bambos
2	402	Deu /Mungeri bans	Bambusa pallida
3	403	Dhanu/Bholka/Harauti/Harod/Ghar/Ban/ Moto bans	Bambusa balcooa
4	404	Choya/Khasre/Tama/Khosre/Phusre/ Tame bans	Bambusa nepalensis
5	405	Mal/Makla//Thulo/Lisingfa bans	Bambusa nutans subsp. cupulata
6	406	Taru/Tharu/Sate /Chille /Ghar bans	Bambusa nutans subsp. nutans
7	407	Jhapta/Chav/Chab /Kada/Koraincho bans	Bambusa tulda
8	408	Phor bans/Phond bans	Bambusa sp.
9	409	Singare/Singaray bans	Bambusa vulgaris Schrad. Ex Wendl.
10	410	Pahelo/Butte bans	Bambusa vulgaris 'Vittata'
11	411	Lota bans	Bambusa vulgaris 'Wamin'
12	412	Dhungre/Rakshashi bans	Dendrocalamus giganteus
13	413	Choya/Tama/Guliyo/Dhungre/Ban bans	Dendrocalamus hamiltonii var. hamiltonii and undulatus
14	414	Kalo bans/Bhalu bans	Dendrocalamus hookeri
15	415	Bhalu bans/Okla bans/Mokla bans	Dendrocalamus sikkimensis
16	416	Kath/Kathe/Gathe/Geniya/Laathi/Lathi/ Munger bans	Dendrocalamus strictus
17	417	Kath/Ban/Katas bans	Dendrocalamus strictus var. wild
18	418	Dhungre bans	Dendrocalamus sp.
19	419	Lahure/Nigale/Rani/Philim/Jhagadiya bans	Melocanna baccifera
20	420	Pahelo Nigale bans	Phyllostachys bambusoides
21	421	Kat bans	Phyllostachys edulis
22	422	Kante, Kande bans, spiny bamboo	Bambusa bambos
23	423	Moso bans	Phyllostachys pubescens
24	501	Nibha bans/ Nibha nigalo/ /Gopi/Lyas bans	Ampelocalamus patellaris
25	502	Mugi bans/Murali nigalo/Murali bans	Bambusa alamii
26	503	Gopi nigalo/Gopi bans/Gopay /Murali bans	Cephalostachyum latifolium

Annex-III: **Province code**

Province	**Code**
Province 1	1
Madhesh	2
Bagmati	3
Gandaki	4
Lumbini	5
Karnali	6
Sudur Pashchim	7

Annex-IV: **District code**

District	Code
ACHHAM	1
ARGHAKHANCHI	2
BAGLUNG	3
BAITADI	4
BAJHANG	5
BAJURA	6
BANKE	7
BARA	8
BARDIYA	9
BHAKTAPUR	10
BHOJPUR	11
CHITWAN	12
DADELDHURA	13
DAILEKH	14
DANG	15
DARCHULA	16
DHADING	17
DHANKUTA	18
DHANUSHA	19
DOLAKHA	20
DOLPA	21
DOTI	22
GORKHA	23
GULMI	24
HUMLA	25
ILAM	26
JAJARKOT	27
JHAPA	28
JUMLA	29
KAILALI	30
KALIKOT	31
KANCHANPUR	32
KAPILVASTU	33
KASKI	34
KATHMANDU	35
KABHREPALANCHOK	36
KHOTANG	37
LALITPUR	38
LAMJUNG	39
MAHOTTARI	40
MAKAWANPUR	41
MANANG	42
MORANG	43
MUGU	44
MUSTANG	45
MYAGDI	46
NAWALPARASI	47
NUWAKOT	48
OKHALDHUNGA	49
PALPA	50
PANCHTHAR	51
PARBAT	52
PARSA	53
PYUTHAN	54
RAMECHHAP	55
RASUWA	56
RAUTAHAT	57
ROLPA	58
RUKUM	59
RUPANDEHI	60
SALYAN	61
SANKHUWASABHA	62
SAPTARI	63
SARLAHI	64
SINDHULI	65
SINDHUPALCHOK	66
SIRAHA	67
SOLUKHUMBU	68
SUNSARI	69
SURKHET	70
SYANGJA	71
TANAHU	72
TAPLEJUNG	73
TERHATHUM	74
UDAYAPUR	75
NAWALPUR	76
RUKUM EAST	77

Annex-V: Species selected for developing biomass and taper equations

SN	Species Code	Local name	Latin name
1	403	Dhanu/Bholka/Harauti/Harod/Ghar/Ban/ Moto bans	Bambusa balcooa
2	404	Choya/Khasre/Tama/Khosre/Phusre/ Tame bans	Bambusa nepalensis
3	405	Mal/Makla//Thulo/Lisingfa bans	Bambusa nutans subsp. cupulata
4	406	Taru/Tharu/Sate /Chille /Ghar bans	Bambusa nutans subsp. nutans
5	407	Jhapta/Chav/Chab /Kada/Koraincho bans	Bambusa tulda
6	413	Choya/Tama/Guliyo/Dhungre/Ban bans	Dendrocalamus hamiltonii var. hamiltonii and undulatus
7	414	Kalo bans/Bhalu bans	Dendrocalamus hookeri

Note: If any of these seven species are not found in the sample plots and/or nearby localities, then samples from other species of bamboo, that are the most abundant in the sample plots, will be taken for biomass and taper study. However, change in this regard shall be made after thorough consultations between the service provider and the client.