



# TRAINING MATERIALS FOR THE BIOPHYSICAL COMPONENT SURVEY OF THE BANGLADESH FOREST INVENTORY – CONCEPTS, PLANNING AND PROCEDURES

# Training materials for the biophysical component survey of the Bangladesh Forest Inventory – concepts, planning and procedures

Published by Forest Department, Ministry of Environment and Forests, 2017

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*This effort is financially supported by USAID with technical support from FAO and SilvaCarbon.*

**Suggested Citation:**

Kumar, M. F., Iqbal, M. Z., Mahmood, H., Costello, L., Henry, M., Rahman, L. M., Jalal, R., Das, S., Sidik, F., Hayden, H., Birigazzi, L., Uddin, M., Uddin, N., Akhter, M., Newaz, Y., Siddiqui, B, N., Sola, G., Ahmed, I., Nishad, H, M., Salahuddin, M., Rahman, M., Chowdhury, R, M., Hossain, B., Siddique, A, B., Rashed, A, Z, M, M., Misbahuzzaman, K., Siddique, M. R. H., Hoque, S., Hasan, M. N. (2017), *Training materials for the biophysical component survey of the Bangladesh Forest Inventory – concepts, planning and procedures*, Forest Department, Ministry of Environment and Forests, Government of the People’s Republic of Bangladesh.

ISBN: 978-984-34-2716-8

## Foreword

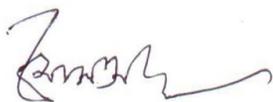
Bangladesh has a critical need for accurate assessment of tree and forest resources supported by robust scientific data. High population density and rapid economic growth have increased the demand for forestry products, while natural hazards jeopardize conservation efforts. To ensure the protection of tree and forest resources, scientific methods must be deployed to observe and measure forests and inform policy-making and implementation.

The Bangladesh Forest Inventory (BFI), led by the Bangladesh Forest Department (BFD) under the Ministry of Environment and Forests, is the first comprehensive assessment of the country's trees and forests. The BFI produces high-quality scientific data and imagery to inform conservation activities, such as where, how, and at what scale to plant new trees. Furthermore, it explores the direct benefits of forests to livelihoods, health, economic growth, soil, water, and natural resources.

The BFI also provides a framework for deploying technology and informing foresters on how forests are changing, how they are valued, and whether forest resources are being extracted sustainably. These tools and technologies are continually evolving. As such, regularly-updated training materials are needed to inform BFD personnel and other experts working in this field, such as university faculty and forestry students.

These training materials will inform teams on methods to collect, process, and analyze tree and forest information on an annual basis. The materials cover all aspects required to implement a continuous inventory, including the definitions, designs, methodologies, work processes, scientific parameters, and instruments needed to ensure the BFI remains a relevant and up-to-date tool.

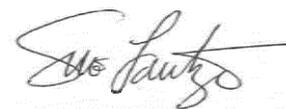
The training materials have been prepared through a consultative process, drawing on national expertise from the BFD, affiliated universities, and international experts working with the Food & Agricultural Organization of the United Nations and the United States technical cooperation program, SilvaCarbon. This is made possible by the support of the American People through the United States Agency for International Development (USAID). This document provides a solid foundation based on international best practices for improving forest monitoring and conservation and guiding sustainable development in Bangladesh.



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### **Disclaimer**

This report is designed to reflect the activities and progress related to the project GCP/GD/058/USAID “Strengthening National Forest Inventory and Satellite Forest Monitoring System in support of REDD+ in Bangladesh”. This report is not authoritative information sources – it does not reflect the official position of the supporting international agencies including USAID or FAO and should not be used for official purposes. Should readers find any errors in the document or would like to provide comments for improving its quality they are encouraged to contact one of above contacts.

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### ***This document is a joint effort by***

Bangladesh Forest Department (BFD)  
Bangladesh National Herbarium (BNH)  
Forestry Science & Technology Institute (FSTI)  
Soil Resources Development Institute (SRDI)  
Forestry and Wood Technology Discipline, Khulna University (KU)  
Shahjalal University of Science and Technology (SUST)  
Institute of Forestry and Environmental Sciences, University of Chittagong (CU)  
Institute of Statistical Research and Training, Dhaka University (DU)  
United States Agency for International Development (USAID)  
Food & Agriculture Organization of the United Nations (FAO)  
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**Chapter 1**  
**BFI DESIGN**  
**Biophysical component**

USAID FROM THE AMERICAN PEOPLE | SilvaCarbon | UN-REDD PROGRAMME | FAO Food and Agriculture Organization of the United Nations

**Content**

1. Background
2. Bangladesh Forest Inventory (BFI) 2016
3. Objectives
4. Zones: definition and zoning for inventory
5. Operational planning: preparation of the field inventory
6. Sampling design: sampling design, plot shape, inventory protocol
7. Technical Design:
8. Main Field Activities of BFI
9. Expected Outcome of BFI
10. Conclusion

**1. Background.**  
**1.1 Forest inventories in Bangladesh**

**Sub-national Level:**

- ☐ Sundarbans: 1958, 1983, 1997 and 2010
- ☐ Hill Forest of Chittagong and Sylhet: 1997
- ☐ Coastal Plantation: 1997
- ☐ Sal Forest: 2001
- ☐ Reserve Forest of CHT: 1959

**National Level:**

- ☐ National Forest Assessment (NFA)-2005-07 – 299 plot

**1. Background.**  
**1.2 Previous plot designs**

**Sundarban Carbon Assessment**

- Circular
- Cluster
- 10m: > 10cm
- 4m: Non-tree veg
- 3m: >10cm
- 2m: Herbs

**Protected Area Carbon Inventory**

- Circular
- Nested
- 17.84m: > 50cm
- 10m: > 20
- 4m: > 5
- 2m: saplings

**Sal**

- Circular
- Cluster
- 3x volume plots (17.84m)
- 4x area plots (5.64 – 7.98)

Plot size was different depending on locations

**NFA**

- Rectangle
- 4 sub plots
- Large area
- Less intensity
- 298 plots

## 2. Bangladesh Forest Inventory (BFI) 2016

- o Forest Department has been implementing BFI since, 2016
- o Bangladesh has been divided into five zones as planned
- o Systematic Stratified Random Sampling was used in designing BFI
- o Plots were located by Latitude and Longitude
- o Both Open Foris App and Field Form being used in data collection
- o Total 1858 plots will be measured
- o Total 12 field teams will perform field work
- o Total 4 QA/QC teams will monitor and facilitate the quality of field work



## 3. Objectives.

### 3.1 Forest monitoring and assessment at national level

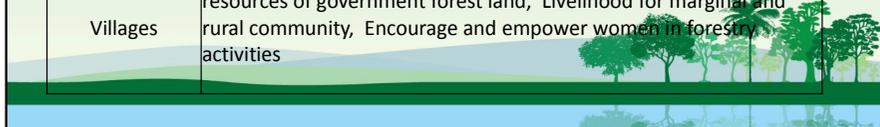
- To provide information on current status and trends of forest and tree resources
- To provide a baseline information for national forest monitoring
- To assist national scale management planning, policy decisions and international reporting requirements including UN REDD
- Identify links between forest resource use and forest status to assist in valuation of ecosystem services.
- Support management objectives within sub-national Eco-zones.



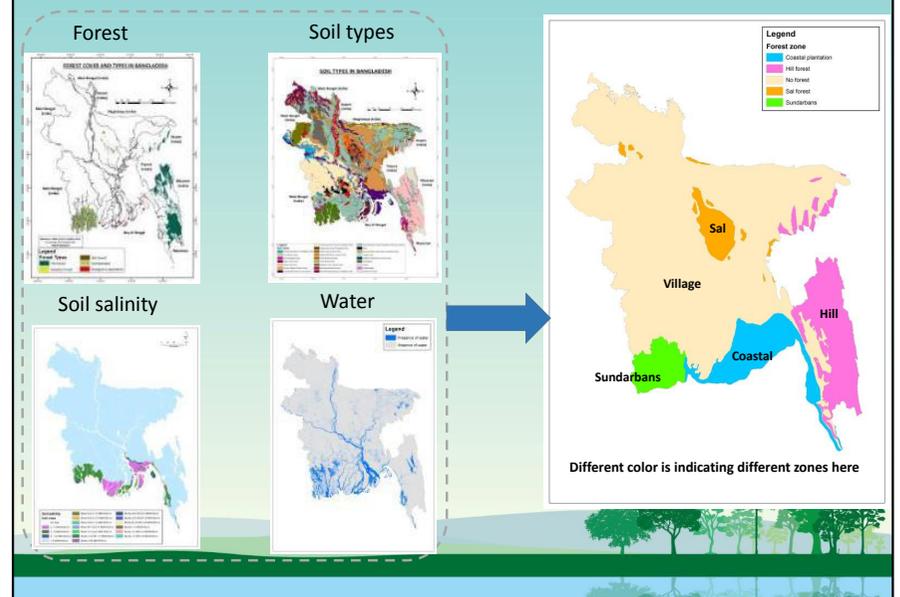
## 3. Objectives.

### 3.2. Sub-National objectives – an example of presenting how the collected data would be used to guide actions

Hill	Biodiversity conservation - Bring the barren hills/lands under tree cover through social forestry practice and plantation - Watershed management
Sundarbans	Biodiversity conservation, Revenue collection from the non-timber forest product, Tourism development
Sal	Reduce deforestation & forest degradation through social forestry, Biodiversity conservation
Coastal	Stabilize newly accreted land through plantation, Bring more lands under plantation to make a coastal green belt to protect lives and livelihoods of coastal community from natural disaster
Villages	Bring marginal land under tree cover; Reduce pressure on the resources of government forest land, Livelihood for marginal and rural community, Encourage and empower women in forestry activities



## 4. Zones: definition and zoning for inventory



## 5. Operational planning: preparation of the field inventory



### BFI Unit

The BFI Unit is located at BFD and responsible for the centralization of all information for the national forest inventory, coordination and communication of other national institutions, dissemination of information through the national information system, and reporting.



### Supervisors in Forest division office (FD) – 8 Nos.

Five Conservator of Forests (CF) posted in the field will be responsible for checking 5% of the field inventory plots assigned under his jurisdiction.



### QA/QC Team: 4 Nos. - 4 members in each

QA/QC team is independent, comprising 1 Coordinator, 1 Technical Expert, 1 Field Assistance and 1 Daily Laborer. They will ensure the field data quality collected by field teams through different checks.



### Field Inventory Team (FIT): 12 Nos.-7 members in each

The FIT is in charge of the preparation, data collection and provide the collected data to the FI Supervisor/central data base. The FIT is composed of: 1 Team Leader, 1 Deputy Team Leader, 1 Graduate/Diploma in Forestry, 2 Field Assistants and 2 Day Laborers

## 6. Sampling Design: sampling design, plot shape, inventory protocol

- A. Pre-stratified systematic sample with different intensities for each stratum (ecological zone):**
  - The sampling intensity within each ecological zone will be same.
  - Post-stratification within each ecological zone will be further conducted to reduce the sampling error.
- B. Precision requirement:**
  - Specifies the confidence interval, width and confidence level for the following parameters: biomass, volume and number of trees of live trees over 10 cm DBH.
- C. Subplot types:**
  - Nested circular subplots by DBH class: 30 cm+, 10-30 cm, 2.5-10 cm, 1-2.5 cm; dead wood transects, and soil samples.
- D. Total land area, forest land area, % of water area.**
- E. Assessment of the costs for remuneration, transport, equipment etc.**
- F. Minimize the weighted average variance of the key metric(s) subject to a fixed inventory budget.**

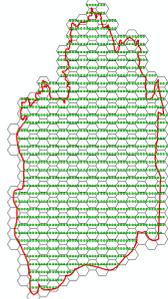


## 6. Sampling Design

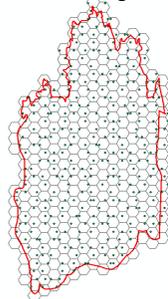
### 6.1 Systematic grids and Hexagon on Zones

- Grids of 1.5 Latitude X 1.0 longitude were created for all zones
- Plot numbers are calculated for each zone based on area, forest type, intensity, etc. to represent that zone
- Hexagons are drawn on each Zone
- One plot is selected from each hexagon by Random sampling
- Plots in water not considered

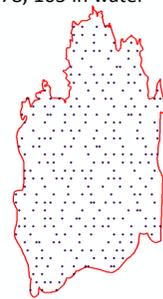
All plot location with hexagons



Random selection of plot for each hexagon

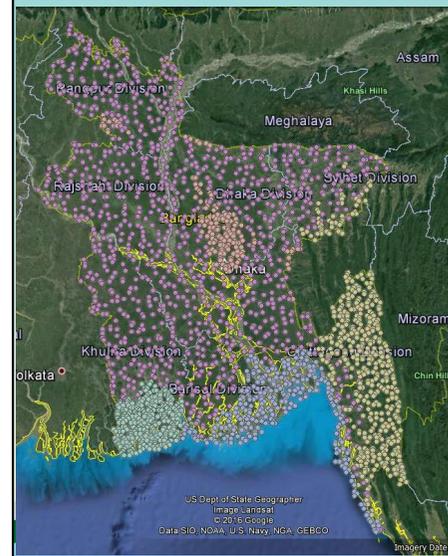


Plot within Sundarbans= 278, 105 in water



## 6. Sampling Design

### 6.2. No. of Plots to be measured



Zone	Number of plots		
	On land	On water	Total
Coastal	113	178	291
Hill	429	14	443
Sal	145	5	150
Sundarbans	173	105	278
Villages	998	85	1083
<b>Total</b>	<b>1858</b>	<b>387</b>	<b>2245</b>



## 6. Sampling Design

### 6.3. Intensity and average distance between plots

Forest zone	Total Area (1000 ha)	Number of plots	Total area of plots (ha)	Sampling intensity (%)	Average distance between plots (km)	
					Straight line distance	Travel distance along roads
Hill forest	1714	429	243.27	0.014	4.34	10.59
Sal forest	534.8	145	82.22	0.015	4.61	5.91
Sundarban	609.2	173	98.10	0.016	3.51	7.79
Coastal	1209	113	64.08	0.005	6.02	11.08
Villages	10890	998	565.92	0.005	6.70	13.40

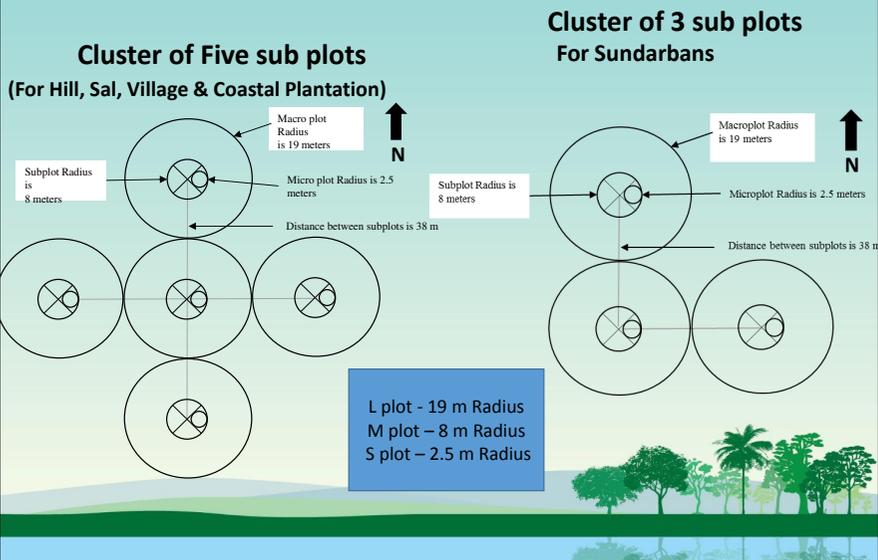
## 6. Sampling Design

### 6.4. Intensity and average distance between plots

Forest zone	Total Area (1000 ha)	Number of plots	Total area of plots (ha)	Sampling intensity (%)	Average distance between plots (km)	
					Straight line distance	Travel distance along roads
Hill forest	1714	429	278.43	0.016	5.91	14.42
Sal forest	535	145	60.11	0.011	7.10	9.09
Sundarban	609	173	67.37	0.011	5.55	12.31
Coastal	1209	113	44.23	0.004	9.64	17.74
Villages	10890	998	648.15	0.006	9.76	19.52

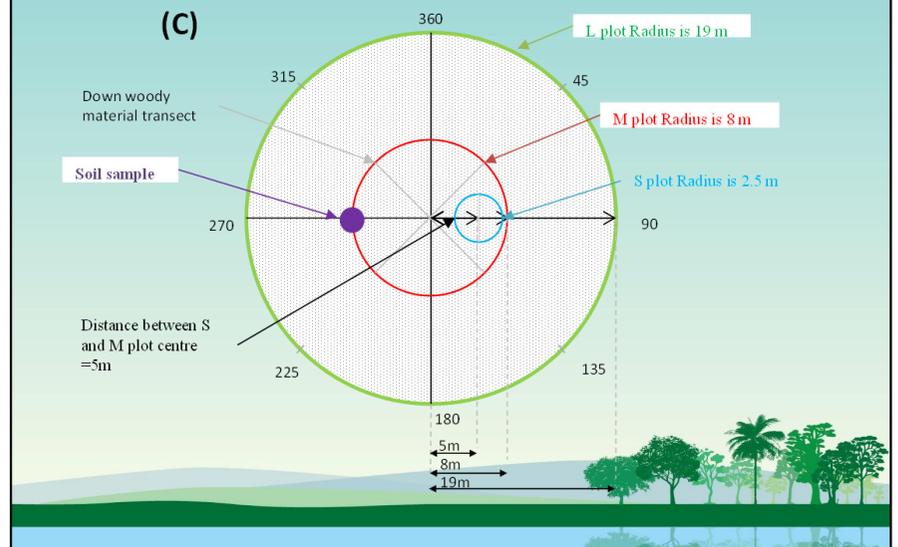
## 7. Technical Design

### 7.1. Circular Plots



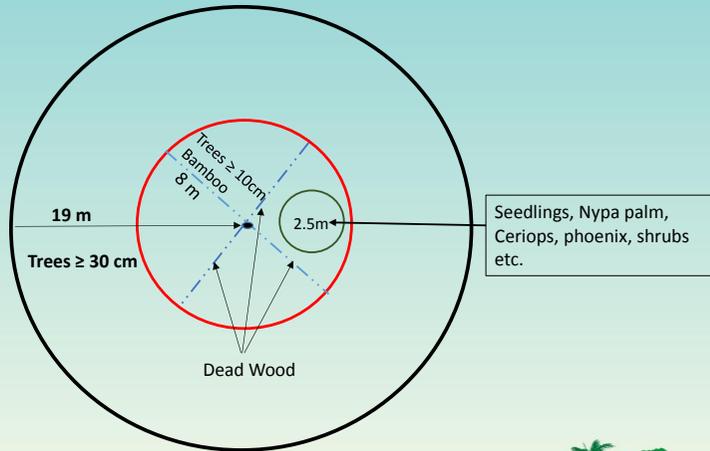
## 7. Technical Design

### 7.2. Circular Plot Details



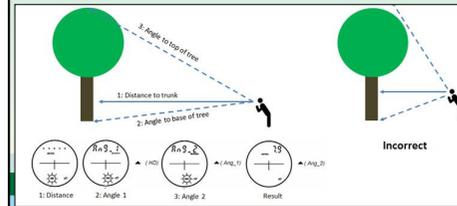
## 7. Technical Design

### 7.3. Measurements in each sub plot



## 8. Main Field Activities of BFI

- Height and DBH of Tree will be measured
- Crown Cover calculation
- Seedling count
- Woody Debris count and measurement
- Litter collection
- Soil Sample- Texture, Bulk Density and Carbon Content) collection



## 9. Expected Outcome of BFI

- Total wood stock estimation (timber, fuel wood, etc.)
- Calculation of above ground Carbon stored in the forest
- Calculation of below ground Carbon stored in the forest
- Regeneration status of tree analysis
- Number and extent of tree species in Bangladesh
- Monitoring the changes of forest resources over time
- Produce and implement of suitable/sustainable management plan for the forest

## 10. Conclusion

### Sustainability of the NFI

- Building on existing capacities and needs
- Avoid creating of parallel process

### Proposed institutionalization

- Establishment of BFI unit in BFD
- 5 Supervisors in 5 locations (Dhaka, Chittagong, Khulna, Sylhet & Bogra)
- 12 Field teams led by nominated ACF
- 5 QA/QC teams

### Considerations

- Data collection of one plot in one day
- Field campaign of data collection 5 months per year
- Complete Hill, Sundarbans and Coastal plantation first

### Future plan

- 10 Teams, 5 cycles of inventory, 20% plots per year




# Chapter 2 BFI Operationalization and Planning




# Content

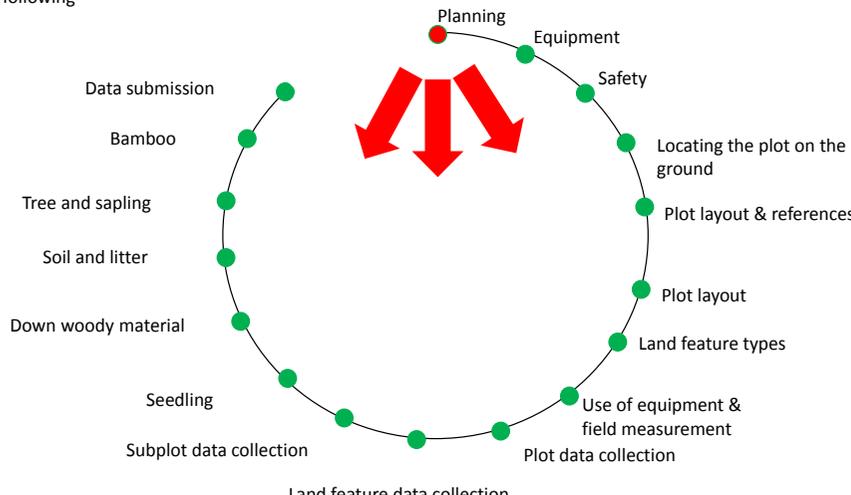



1. Introduction
2. Field inventory organization
3. Operational team composition
4. Responsibilities: field inventory team
5. Responsibilities: QA/QC team
6. Reporting channel
7. Team communication
8. Administrative procedure
9. Travel preparation
10. Contact in the field
11. Financial support
12. Safety
13. Field measurement components
14. Target setting



## 1. Introduction

A BFI field inventory manual has developed. The BFI operationalization and planning considering the different elements are following the guideline of the manual. The process of BFI field team operation is following-

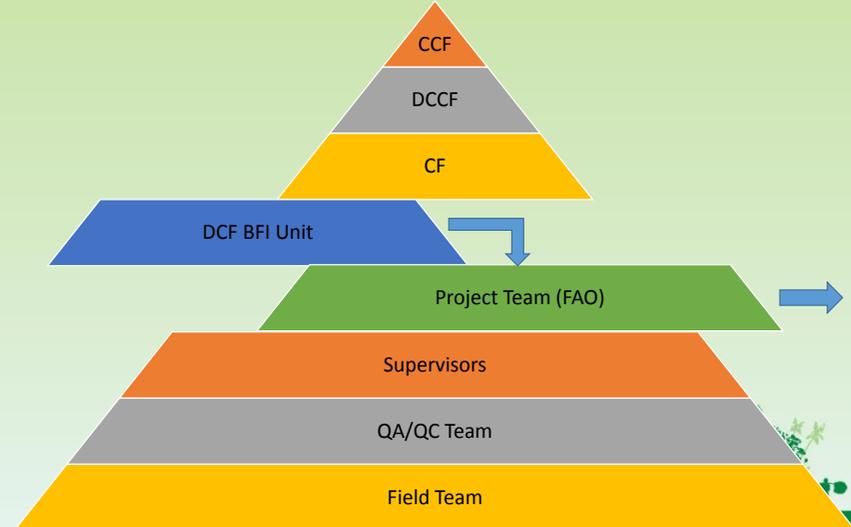


The diagram shows a circular process with 16 steps:

- Planning
- Equipment
- Safety
- Locating the plot on the ground
- Plot layout & references
- Plot layout
- Land feature types
- Use of equipment & field measurement
- Plot data collection
- Land feature data collection
- Subplot data collection
- Seedling
- Down woody material
- Soil and litter
- Tree and sapling
- Bamboo
- Data submission

Red arrows point from 'Planning' to 'Equipment', 'Safety', and 'Locating the plot on the ground'.

## 2. Field inventory organization



The organizational structure is as follows:

- CCF (top level)
- DCCF
- CF
- DCF BFI Unit (connected to CF)
- Project Team (FAO) (connected to DCF BFI Unit)
- Supervisors (connected to Project Team)
- QA/QC Team (connected to Supervisors)
- Field Team (bottom level, connected to QA/QC Team)

### 5. Operational planning: preparation of the field inventory



**BFI Unit**

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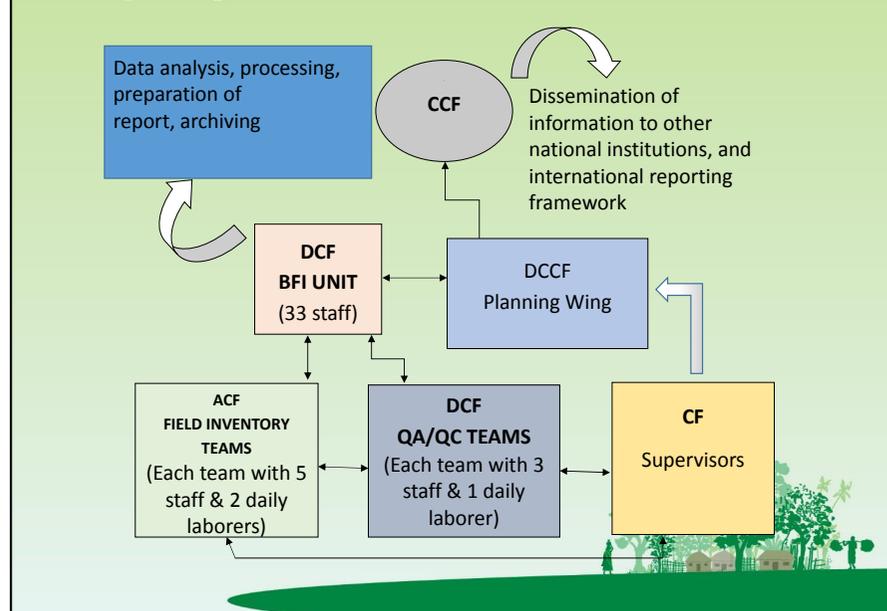
### 4. Responsibilities: field inventory team

Position	Nos.	Status	Responsibility
Team Leader (TL)	1	ACF	TL will organize and distribute fieldwork including local contacts; access the sampling units; delineation of plots; record measurements; quality control of the overall work and maintain liaison with BFI Unit.
Deputy Team Leader (DTL)	1	Forester	DTL will support the bio-physical measurement, LCCS data collection maintain records, and any other duties assigned by TL.
Graduate/Diploma in Forestry (GDF)	1	University forestry graduate/ FSTI Forestry Diploma	GDF will be responsible for recording biodiversity and environmental aspects. Also perform any other duties as assigned by TL & DTL.
Field Assistant (FA)	2	Forest guards	FA will assist in plot layout and distance measurements; soil profile establishment, soil sample extraction, standing tree diameter and height measurement, measurement on dead wood, litter, etc. Also perform any other duties as assigned by TL & DTL.
Daily Labors (DL)	2	DL will be engaged locally	DL will be responsible for: <ul style="list-style-type: none"> <li>i. Carrying of equipment, identifying tree species with local names (as far as they can), facilitate access to/and movement in plots, facilitate distance measurement, orientation in the field;</li> <li>ii. Facilitate contact with households selected for interviews and preparation of samples for transportation and carrying of samples in the field</li> </ul>
<b>TOTAL</b>	<b>7</b>		

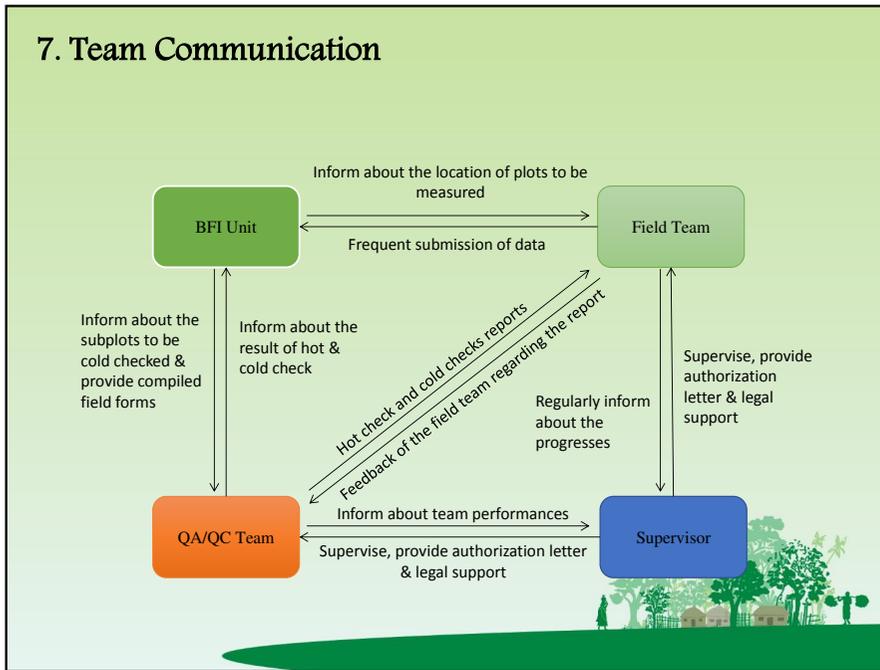
### 5. Responsibilities: QA/QC team

Position	Nos.	Status	Responsibility
Coordinator (C)	1	DCF/ACF	C will organize and distribute fieldwork including delineation of plots; record measurements; local contacts; access to the sampling units; quality control of the overall work and maintain liaison with BFI Unit
Technical Expert (TE)	1	University forestry teacher. TE will be engaged in consultation with the Universities.	TE will support the bio-physical measurement, maintain records, and help C to organize other activities
Field Assistance (FA)	1	Forest guard	FA will assist in plot layout and distance measurements; soil profile establishment, soil sample extraction, bio-physical measurement and any other duties assigned by TL & TE.
Daily Labour (DL)	1	DL will be recruited from local community who has access to the community.	DL will be responsible for carrying of equipment, identifying tree species with local names (as far as they can), facilitate access to/and movement in plots, facilitate distance measurement, orientation in the field.
<b>TOTAL</b>	<b>4</b>		

### 6. Reporting channel



### 7. Team Communication

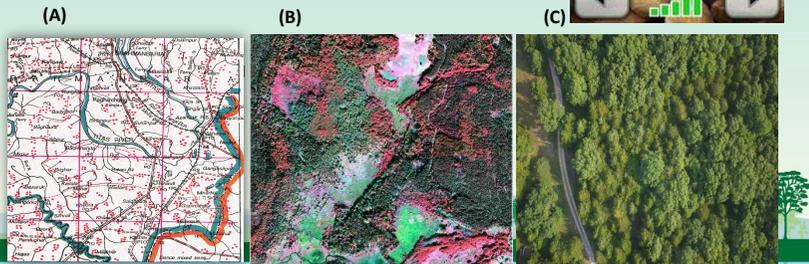


### 8. Administrative procedures

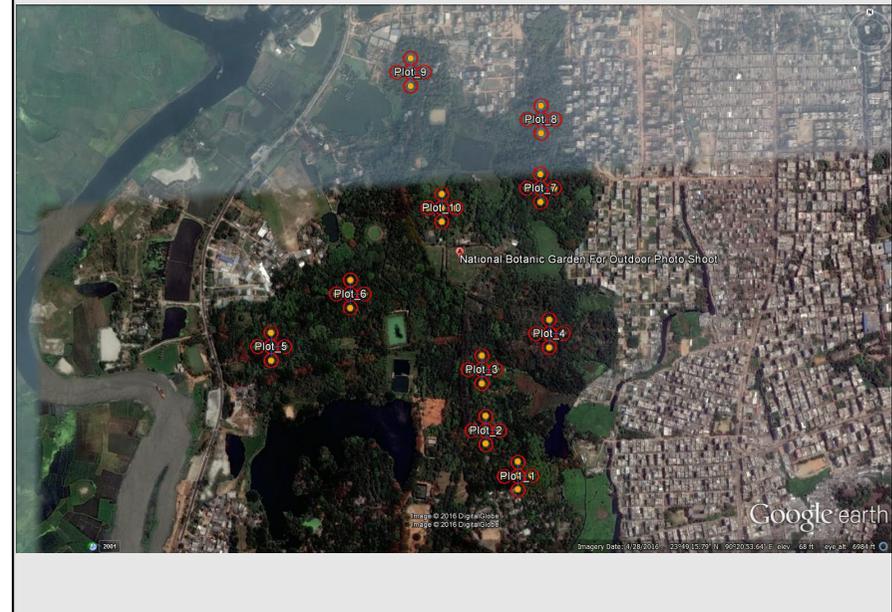
- Letter from Secretary, MOEF to Field Authorities (Commissioner, DC, UNO)
- Letter from the CCF to Field Authorities (CF, DFO)
- DFO will follow up dispatch of letters
- UNO will write to local Union Parishad Chairman
- FD contact CHT Regional Council for their cooperation
- (In plots of FD owned forest land, BFI unit will inform DFOs and District Administration.
- Inventory matters can be discussed in the District Development Coordination Committee (DDCC) Meeting and Upazila Development Coordination Committee (UDCC) Meeting to make aware all members of the committee.
- Tentative dates of measurements will be informed to local public representatives (UP chairman, members, headmen, karbari via FD field officials).
- Convene information sharing meeting in CHT region
  - Rangamati District HQ (and all upazila HQs)
  - Khagrachari District HQ (and all upazila HQs)
  - Bandarban District HQ (and all upazila HQs) involving
    - District Administration
    - Upazila Administration
    - Chittagong Hill Tract District Council
    - Army
    - BGB
    - Police

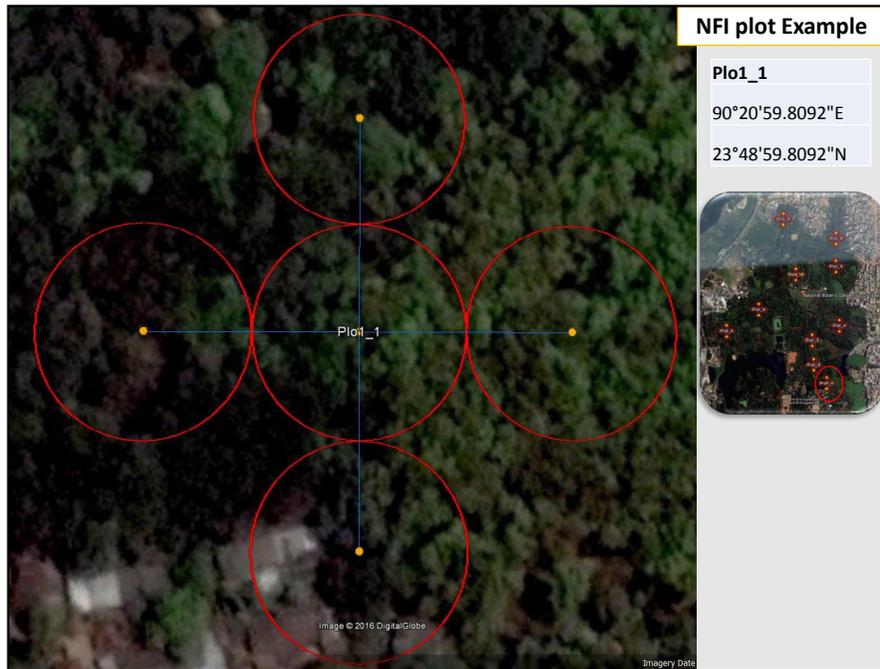
### 9. Travel preparation

- The GPS coordinates are provided by the BFI unit.
- Use different maps, pictures and images.
- Field team should review available maps to plan the most direct route to the plot.
- **THIS SHOULD BE DONE THE DAY BEFORE VISITING THE PLOT.**
- Also the GPS co-ordinates of plot locations will be uploaded to each team's GPS.
- The field team will receive the instruction from the BFI unit about which plot to visit



### NFI plots Exemplary view on Google earth





## 10. Contact in the field

**Forest Department area:**

- Inform the local FD authority.

**Private land:**

- Take necessary permission from the owner.

**The Sundarbans or Coastal areas**

- Contact for security measure.
- Necessary information about water level fluctuation and the most appropriate time to go to the field.

**In case of CHT plots**

- Communicate and take support from Police, Army, BGB and local administration because of security issue.
- In the case of Steep slope take care of accessibility
- **In the case of Border Areas take care of the situation**

## 10. Contact in the Field.....

Team must establish contact with the local representatives, land owner or relevant contacted persons (BO, RO, DFO, CF) or other potential persons.

The local people involved in the field measurement activities (in particular the Field Laborers and the Technical Expert for the Hill and Sal zones) should facilitate the communication with local people.

An introductory meeting should be organized to explain the aim of the visit to avoid misunderstandings. Some key points about the activities introduction are mentioned below:

- *This assessment is part of a larger programme of forest monitoring at national level.*
- *The information will be used to address issues related to the use of natural resources.*
- *The field information will be use by the country and the international community to assist sustainable natural resource management decisions.*
- *The data will not be used to control land ownership on the plot location.*

## 11. Financial support

- Group Transport cost (per plot basis)
- Honorarium (per plot basis)
- Monthly medical allowance for members outside FD

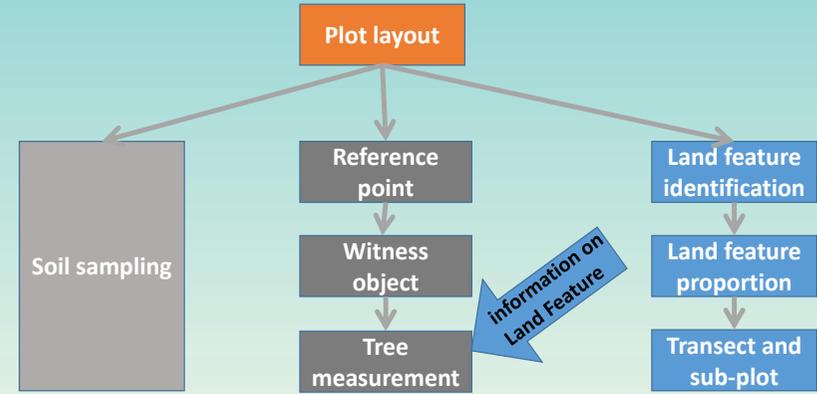
Payment will be made through suitable postal/bank channel:

## 12. Safety

Personnel will work in the field are subject to many safety hazards. These can be minimized by considering the following measures:

- **Wear protective clothing** : Long-sleeved shirts, long pants, and boots protects you from contact cuts, abrasions and stinging/biting insects.
- **First Aid Kit**: Any item used from the kit should be replaced as soon as possible. Contact the BFI Unit when replacement items are needed.
- **Take shelter in bad weather**: Wait till severe weather has passed before resuming work.
- **Protect from hot and humid condition**. Ensure bottles with drinks are full prior to departing for the field. Drink plenty of water to avoid dehydration during high temperatures.
- **Inform your presence to villagers and local community people**: Take information from nearby communities about the possible remote conditions. Also provide information on the objectives of the inventory to avoid misguided assumptions of the work.

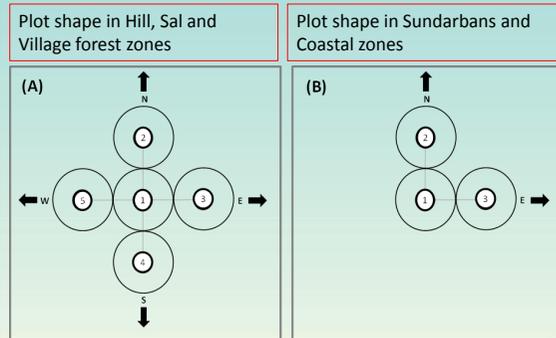
## 13. Field Measurement components

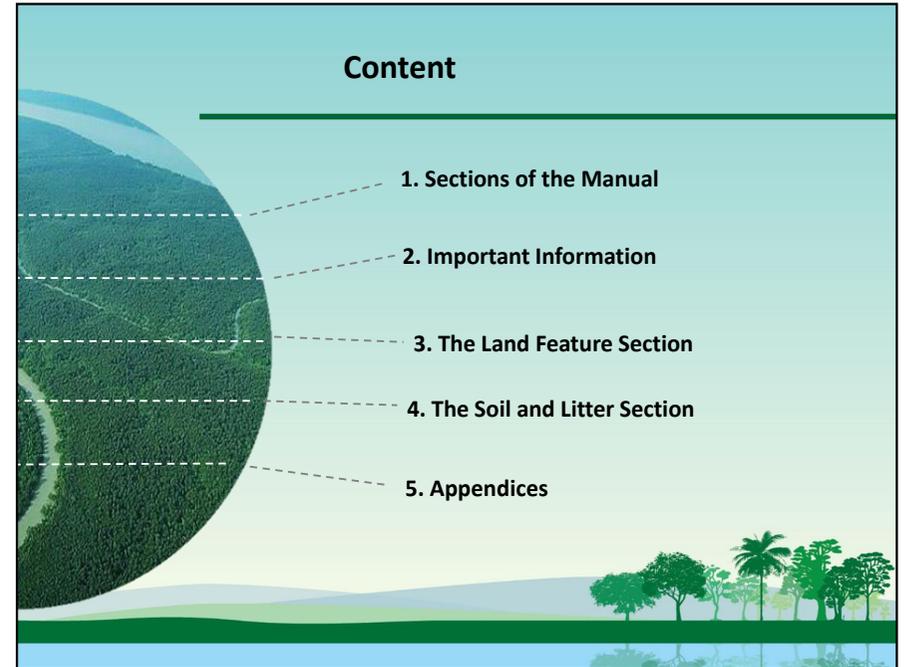
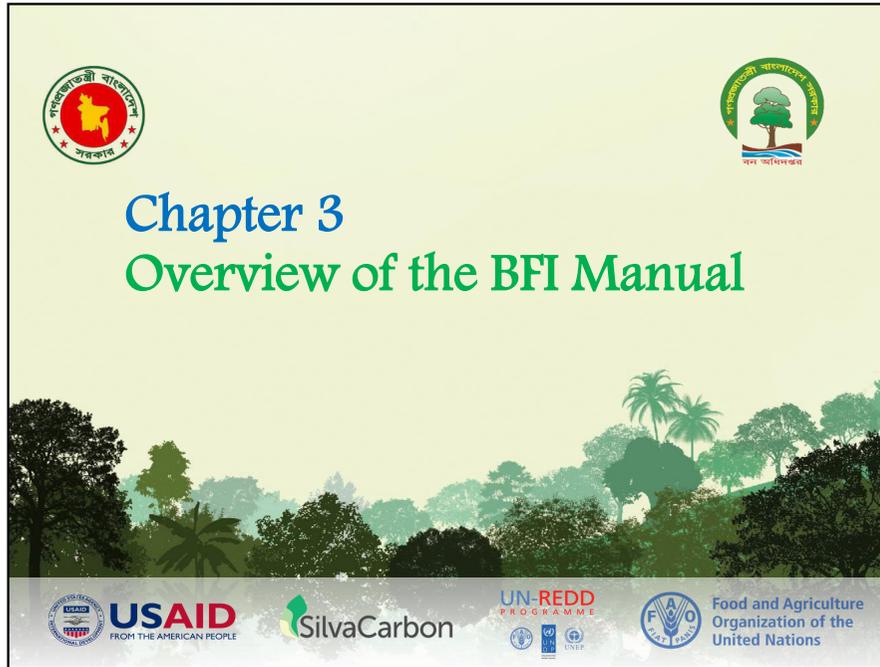


The chart shows basic field measurement components. Depending on circumstances team leader will distribute the work among team members to fulfill the task.

## 14. Target Setting

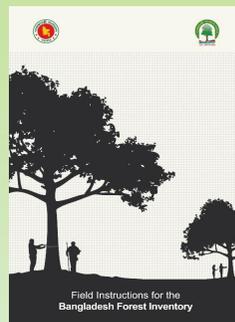
- One plot per day can be a good target for measurements in an ideal condition.
- However, the target may vary with situation and site condition.





### 1. Sections of the BFI Manual

- The BFI manual has structured into 15 sections
- Sections 1-6 are about general topics
  - Plot design, planning, equipment, etc.
- Sections 7-14 has described specific data collection attributes and process
- Section 15 is the Appendix
  - Includes definitions and field forms
- The table of contents is useful as a quick reference guide to the Field Team
- The paragraph number is referenced in both the Open Foris forms and the paper forms



**Open Foris Form**

**LF sketch form**

**Paper form**

### 2. Important Information

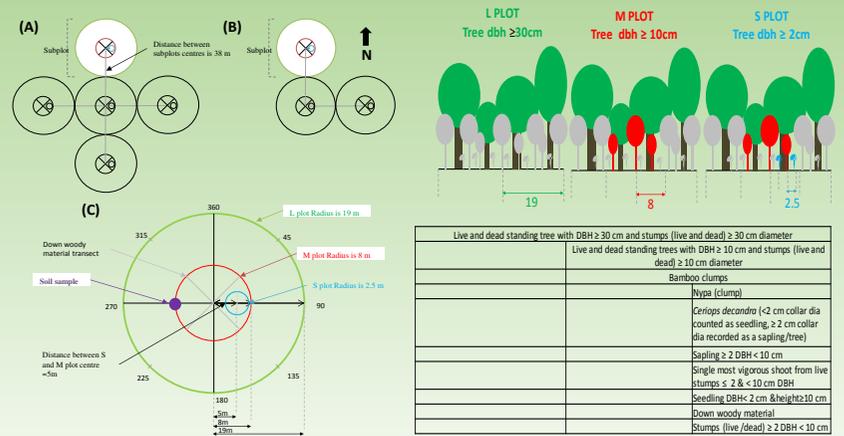


Figure 2: Plot Diagram (A) Sal, Hill, Coastal and Village zones, (B) Sundarbans zones, (C) Subplot structure

Figure 3: Rules for measuring different vegetation components within L, M and S plots.

## 2. Important Information

### 3.1 STEPWISE PROCESS OF ESTABLISHING A PLOT

#### 3.1.1 BEFORE GOING TO THE FIELD

**STEP 1:** The field team receives the instruction from the BFI unit about which plot to visit.

**STEP 2:** Maps and aerial images are reviewed to assist the location of the plot, undertake a preliminary assessment of land feature types and determine any accessibility issues.

**STEP 3:** Contact the local authority/people to get an overall idea about site conditions. In the case of Sundarbans or Coastal area it is necessary pre-determine water level fluctuation and the most appropriate time to go to the field.

#### 3.1.2 ARRIVING AT THE PLOT

**STEP 4:** Navigate to the plot centre (subplot 1) coordinates using the GPS. Note that the GPS will never provide 100% accuracy as it only provides +/- 3 m accuracy.

Once reached, install a red /white pole at Plot Center. If plot centre (subplot 1) is not accessible, the pole is erected at one of the other four subplots and noted accordingly in section 6.4.1. Use the distance and bearing function in the GPS to locate an accessible subplot, for example a point that is 38 m in a north, east, south or west direction.

Location of the plot center should be as accurate as possible. When taking the measurement, ensure that four or more satellites are recording positions. It may take up to five minutes for the GPS unit to establish contact with the satellites. For instructions on GPS use see section 5.3 and Costello et al. (2015).

## 2. Important Information

### 4: Using the Equipment

Code	Function	Description
SD	Slope Distance	Straight line distance between the TruPulse and the target.
VD	Vertical Distance	The distance between the target and the perpendicular to the path of the horizontal distance.
HD	Horizontal Distance	The level distance between the TruPulse and the plane of the target.
INC	Inclination	The angle of inclination between the TruPulse at level and the target.
HT	Height	Three-step height routine. The final calculation represents the vertical distance between the points on the target represented by ANG1 and ANG2.

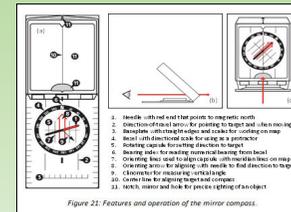


Figure 21: Features and operation of the mirror compass.

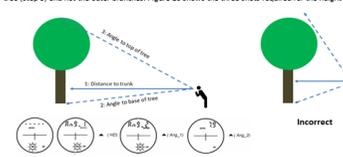
- Step 1: First measure the horizontal distance between the base of the tree and the observer.
- Step 2: Looking through the peephole, line up the horizontal line with the top of the tree and read off the corresponding number from the percentage scale (ignore the sign, which is on the right hand side. The scale on the left is in degrees and should not be used).
- Step 3: Use the horizontal line with the base of the tree and again read off the corresponding number from the percentage scale (ignore the sign).
- Step 4: If the base of the tree is level with you or below you (i.e. you're on the upward slope) then add the slope percentage value of Step 2 and Step 3. Ignore the sign to get the angle between tree top and base in percentage.
- Step 5: If the base of the tree is above you (i.e. you're on the downward slope) then subtract the slope percentage value of Step 3 from the slope percentage value of Step 2. Ignore the sign to get the angle between tree top and base in percentage.
- Step 6: Calculate the tree height using the following equation



Figure 17: Suunto compass and clinometer

#### 5.4.3 MEASURING HEIGHT WITH TRUEPULSE

Height Measurements involve a three step process. This includes one horizontal distance (HD) and two angle (INC) measurements – one to the top of the tree and one to the bottom. At each step prompts are provided through the eye piece. The device uses these results to calculate the height of the target. It is important to stand at a suitable distance from the tree so the aim can be clearly made to the top of the tree (step 3) and not the outer branches. Figure 16 shows the three shots required for the height routine.



## 2. Important Information

Each section of the field guide begins with a general overview of the data elements to be collected and provides necessary background to prepare Field team for data collection.

Descriptions of data elements follow the format provided below:

**ITEM NUMBER; DATA ITEM NAME:**

[table\_column name]

When collected	Specific criteria for when variable is recorded
Field width	X digits
Tolerance	Acceptable range of measurement
Values	Legal values/codes variables



## 2. Important Information

Detailed explanatory notes and figures are provided under different relevant sections

Example:

#### 12.8 RECORDING DIAMETER

Diameter at Breast Height (DBH) is recorded at 1.3 m by default. If the diameter is measured at a different height, record the height the DBH was measured (in meters).

#### DIAMETER OF STUMPS

Diameter on stumps less than 1.3 m in height. Use a diameter tape or other measuring instrument to measure the longest and shortest axes across the top of the stump. Record diameter at the average of the two measurements.

Note: for live stumps which are re-shooting, the diameter of the shoots between 2 cm and 10 cm are measured in the 2 plot. If there are multiple shoots coming from the one stump/root system, only the one most dominant shoot is measured.

This means that live stumps with shoots between 2 cm and 10 cm are ostensibly collected twice, once as a stump and once as a seedling or sapling.

Stumps are measured at the same diameter threshold as trees in the M (≥30 cm dbh) and L (≥30 cm dbh) plots.

#### SPECIAL DBH SITUATIONS

1. **Forked trees:** in order to qualify as a fork, the stem in question must be at least 1/3 the diameter of the main stem and must branch out from the main stem at an angle of 60 degrees or less. Forks originate at the point on the bole where the paths intersect. Forked trees are handled differently depending on whether the fork originates below 0.3 meter, between 0.3 and 1.3 meter, or above 1.3 meter.
  - a. **Trees forked below 0.3 meter:** Trees forked are treated as distinctly separate trees. Distances and bearing are measured individually to the center of each stem where it splits from the stump. DBH is measured for each stem at 1.3 meter above the top of the root collar.
  - b. **Trees forked between 0.3 meter and 1.3 meter:** Trees forked between 0.3 meter and 1.3 meter are also counted as separate trees, but only one distance and bearing to the central stump is recorded for each stem. Although a single bearing and distance applies to all, multiple stems should be recorded if they occur clockwise or counter-clockwise from the central stem (i.e. directly in front of another). The DBH of each fork is measured at a point 1.3 meter above the path intersection.
    - Multiple forks are possible if they all originate from approximately the same point on the main stem. In such cases, measure DBH on all stems at 1 meter above the common path intersection.
    - Once a stem is recorded as a fork that originated from a path intersection between 0.3 and 1.3 meter, do not re-measure any additional forks that may occur on that stem.
2. **Trees forked at or above 1.3 meter:** Trees forked at or above 1.3 meters are considered one single tree (see Figure 40). If a fork occurs at or immediately above 1.3 meter, measure diameter below the fork just beneath any swelling that would inflate DBH.

Please see Page- 84 in Manual diameter of stumps, special DBH situations etc. are described under section: 12.8 as notes

#### METHOD FOR SOIL COLLECTION IN HARD SOILS

In some cases the ground may be too hard to use an auger for soil sample collection. In this case pit may be dug with a shovel to the desired depths. It is very important not to remove samples only have soil from the appropriate depth class. The below steps should be followed:

- Step 1: Use a shovel or pick to remove surface grass and litter, clear a pit to 15 cm in depth.
- Step 2: Use a measuring tape to ensure an accurate depth. Ensure the side of the pit is vertical and flat.
- Step 3: Remove all loose soil from the pit so the sample will not be contaminated.
- Step 4: Use a small shovel to scrape an even section from the side of the pit. Be sure the soil represents an even sample. i.e. there is not more soil from the top of the pit than the bottom.
- Step 5: Put the sample in the plastic bag or jar and label to the naming convention specified above.
- Step 6: Repeat for the 15-30cm sample.
- Step 7: The bulk density cores may be taken from the same pit.

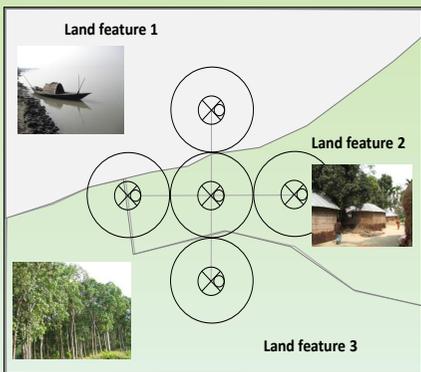


Step 1: Dig a pit using a shovel. Step 2: Mark the depth of sample layer with carpenter's tape. Step 3: Put the sample in plastic bag or jar and label appropriately.

Please see Page- 73 in Manual Method for soil collection in hard soils is described under section: 11.3.4

### 3. The Land Feature Section

4: RECOGNITION OF LAND FEATURES TYPES (need to mention here the page no. title of document from where it has been collected, section/sub-section is 4.



7: LAND FEATURE DATA COLLECTION.....(SOURCE OF DOCUMENT)

**7 LAND FEATURE DATA COLLECTION**  
Land Feature data is collected on all visited plots regardless of the presence of trees. Land Feature data are measured if the plot\_status=4. For example, if the plot is inaccessible due to inundation, the objects (water, sand deposits, floating vegetation) may be described. A description of the temporal variation may be attributed to the object/water to describe its ephemeral feature. Further information on land feature data is provided in section 04.

**7.1 LAND FEATURE DETAILS**

**7.1.1 LAND FEATURE ID**  
[L\_F\_ID]  
Auto generated unique identifier provided to all land features described in the field. One land feature cannot be located in two geographic locations.

When collected:	plot_status=4
Field width:	4 digits
Tolerance:	No errors
Values:	001 to 999

**7.1.2 LAND FEATURE STATUS**  
[L\_F\_STATUS]  
Three potential status can occur, depending on the presence of one or more land feature within a plot as described in p. 24). If only one land feature is identified, plot centre is assumed as the geographic point to represent the land feature. If more than one land features are present, you must select which the subplot centre best represents your land feature. If no subplot centre accurately represents the land feature (for example the plot centre is at the boundary of multiple LFs, or the plot is inaccessible but LF parameters can be measured from a distance (see 8.3.3 - plot\_status = 3)) the GPS coordinates for the land feature must be collected. We consider that not more than 4 land features can be present in one plot.

When collected:	plot_status=4
Field Width:	1 digit
Tolerance:	No errors
Values:	Code Description
	1 Center subplot Default location when there is only one land feature

### 4. The Soil and Litter Section

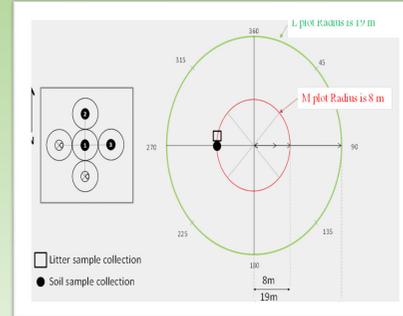
Step-by-step instructions

Methods

**11 SOIL AND LITTER MEASUREMENTS**  
Soil samples are collected in three subplots (as described in section Error! Reference source not found, below). Two samples are collected at each subplot which are analyzed to determine soil texture, bulk density and organic carbon. Strict protocols must be followed to ensure methods of sample collection, storing, transporting and processing allow for accurate laboratory analysis.  
Soil sample collection is not possible if the land is covered by water; therefore, the sequencing of soil sample collection in the mangroves is critical as the sampling window may last about 4 hours due to tides.  
Soil samples can be collected by one or two members of the team while the rest of the team focuses on the other data collection components.

**11.1 STEP-BY-STEP PROCESS FOR SOIL SAMPLE COLLECTION**

Step 1: Identify and record the LAND FEATURE ID that the soil sample was collected in (11.2.1)  
Step 2: Record the GENERAL SOIL CONDITION of the area (11.2.2)  
Step 3: Once the sampling point has been identified push the marker into the ground to mark the spot. This way you will avoid standing on and compacting the sampling point.  
Step 4: Establish the litter collection frame directly north of the sampling point (11.2.4)  
Step 5: Now begin walking the quadrats to the soil. If the GENERAL SOIL CONDITION is very hard, you may need to use a spade to collect the samples.  
Step 6: Once the spade is extracted and an intact core has been achieved, take a photo of the core next to a tape measure (see Figure 28).  
Step 7: Take the necessary samples from the quadrat and label container or bag with the naming convention: Plot/Subplot/Depth/Sample Type. For example for the top (0-15 cm) texture analysis in Plot 1, Subplot 2, label as: P 1 / SP 2 / 0-15 / TEXTURE  
Step 8: Take the bulk density core (11.2.6) and label appropriately as described above  
Step 9: Collect the litter from within the litter frame and place in a plastic bag. Poke small holes in the bag to allow for drying and avoid condensation. Remember to open the bag and leave the litter to dry once back at the office.  
Step 10: Describe any relevant information about the sample in the SOIL AND LITTER NOTES (11.3.2).  
Step 11: Clean your thoroughly after each use.



Diagrams >>



Dig a pit using a spade



Mark the depth of sample layer with a carpenter's tape



Put the sample in plastic bag or jar and label appropriately.

### 5. Appendices

1. Definitions
2. Equipment check list
3. Illustration of parts of the tree
4. Slope correction table
5. Field forms – Provided as a reference only. Multiple copies should be printed before going to the field
6. List of Forestry offices
7. Forest divisions
8. Forest Ranges
9. Forest Beats
10. List of BFI Contacts

16 APPENDICES

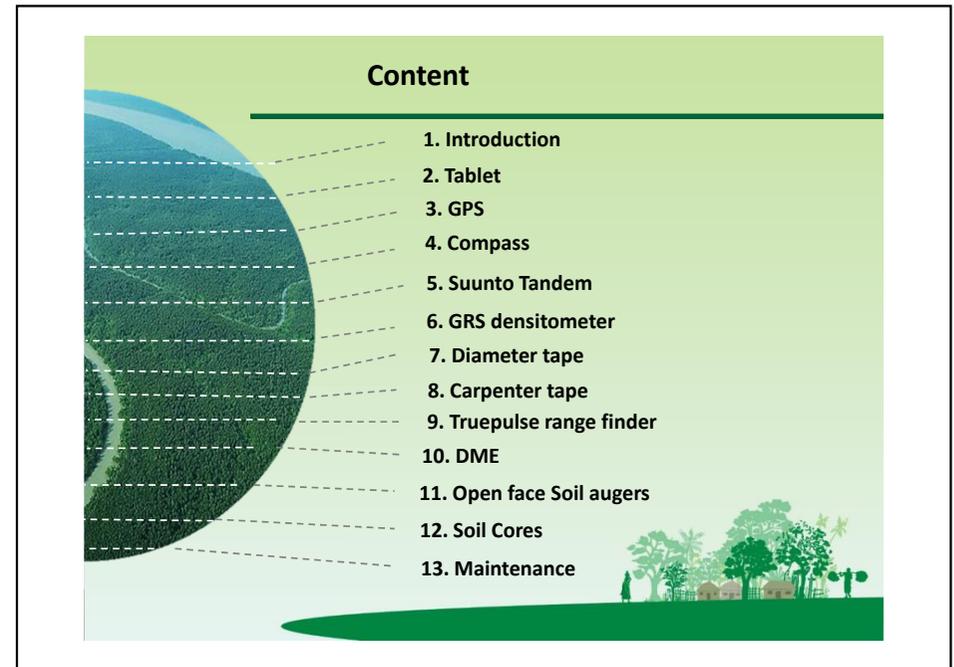
APPENDIX 1. DEFINITIONS

Abiotic	Pertaining to the non-living parts of an ecosystem, such as soil particles, bedrock, air, and water.
Afforestation	The establishment of a forest or stand in areas where the preceding vegetation or land use was not forest.
Agroforestry	A collective name for land-use systems and practices in which trees and shrubs are deliberately integrated with non-woody crops and/or animals on the same land area for ecological and economic purposes.
Artificiality	Artificiality refers to the extent to which an area is cultivated or managed.
Azimuth	Azimuth is the horizontal angle measured clockwise from any fixed reference plane or easily established base direction line.
Biotic factor	A biotic factor is any living component that affects the population of another organism or the environment.
bole height	The height between ground level and the crown point (point is the position of the first crown forming live or dead branch)
Breast height	A standard height for tree diameter measurement point. Generally, this height is 1.3 m from the ground level, or from the seeding point.
Canopy	The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees.
Canopy cover	The percentage of the ground or the horizontal forest area covered by a vertical projection of the outermost perimeter of the natural spread of the foliage of plants. Cannot exceed 100 percent (also called crown closure).
Clear cut	A method of harvesting used in even-aged stands, involves removing all or most of the trees in an area in one operation.
Coarse Woody Debris	Includes downed, dead tree and shrub boles, large limbs, and other woody pieces that are ≥3 cm in diameter and severed from their original source of growth.
Crown cover	Defined here as the proportion or percentage of the ground surface covered by the vertical projection of the tree crowns.
Dead tree	A tree is regarded as dead tree if it does not have any living branches. Trees that are alive but so badly damaged that cannot grow in the next growing season (e.g. trees killed by storm) are regarded as dead trees.
	All non-living woody biomass not contained in the litter, either standing, lying on the ground, or in the soil. Dead wood includes wood lying on the surface, dead roots,



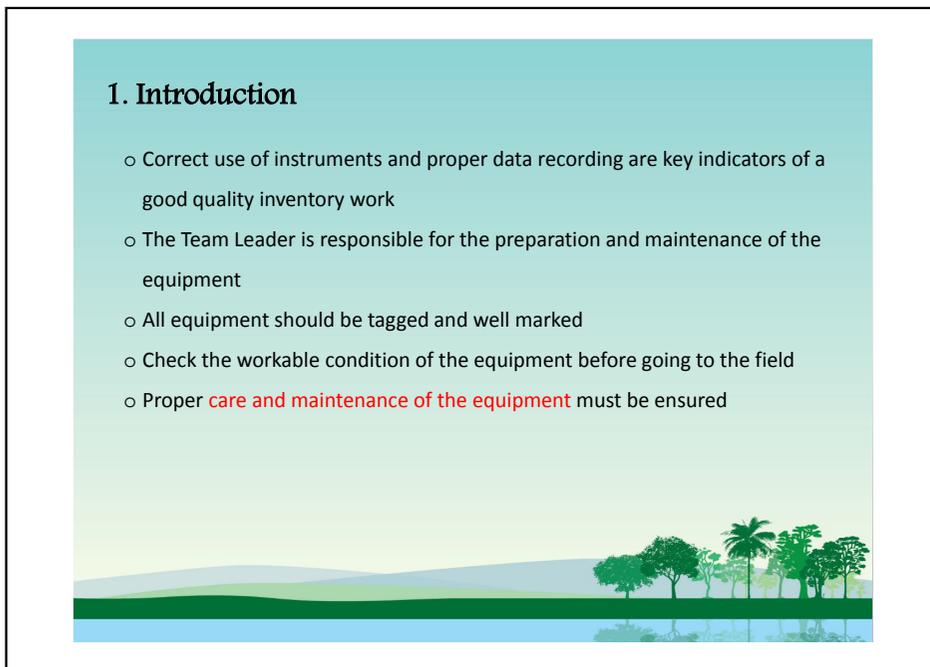
**Chapter 4**  
**Review and operation of field equipment & maintenance**

USAID FROM THE AMERICAN PEOPLE SilvaCarbon UN-REDD PROGRAMME FAO Food and Agriculture Organization of the United Nations



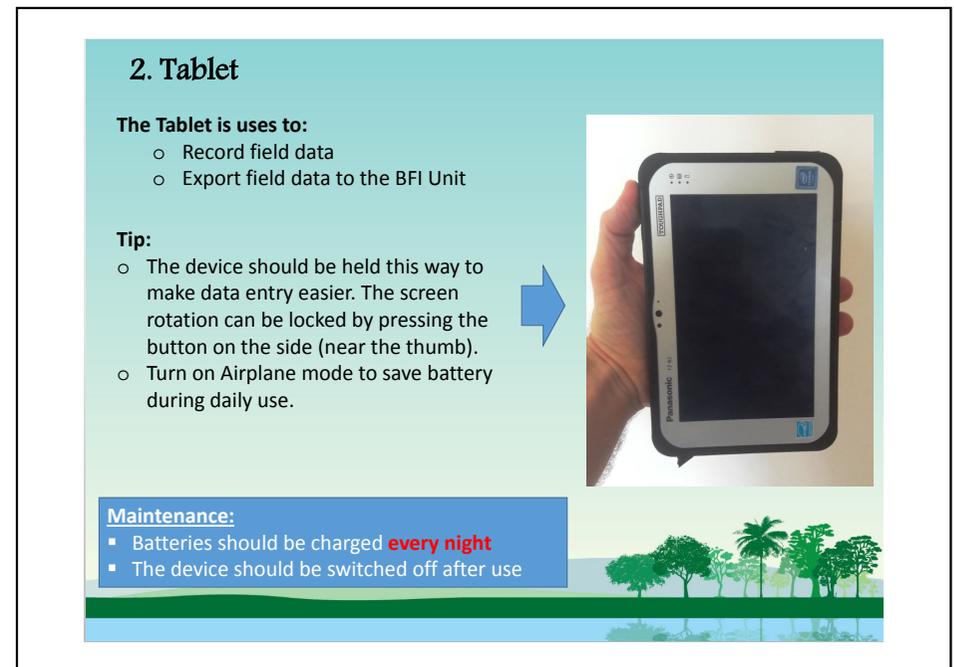
**Content**

1. Introduction
2. Tablet
3. GPS
4. Compass
5. Suunto Tandem
6. GRS densitometer
7. Diameter tape
8. Carpenter tape
9. Truepulse range finder
10. DME
11. Open face Soil augers
12. Soil Cores
13. Maintenance



**1. Introduction**

- Correct use of instruments and proper data recording are key indicators of a good quality inventory work
- The Team Leader is responsible for the preparation and maintenance of the equipment
- All equipment should be tagged and well marked
- Check the workable condition of the equipment before going to the field
- Proper **care and maintenance of the equipment** must be ensured



**2. Tablet**

**The Tablet is uses to:**

- Record field data
- Export field data to the BFI Unit

**Tip:**

- The device should be held this way to make data entry easier. The screen rotation can be locked by pressing the button on the side (near the thumb).
- Turn on Airplane mode to save battery during daily use.

**Maintenance:**

- Batteries should be charged **every night**
- The device should be switched off after use

### 3. GPS

The GPS unit is used to:

- Navigate to the plot location
- Record coordinates of reference points
- Determining location of subplots if Plot Centre is not accessible
  - Note: Plot coordinates are only provided for plot center. In case plots center is not accessible (e.g. under water) the distance and bearing function on the GPS can be used

All coordinates are to be taken with the GPS.  
The tablet is not used to record coordinates because it is not accurate enough

**The coordinate system used is Degree Decimal**

Degree Decimal	Deg/Min/Sec
92.8525245	92°53'37"
24.5052585	24°43'44"

**Maintenance:**

- Batteries should be removed after use
- Batteries should be charged every evening
- The device should be switched off after use



### 4. Compass

- The compass' provided are mirrored to assist accuracy
- A compass is used to:
  - Record the reference point bearing to the plot center
  - Record the bearing from subplot center to every tree
- **Tip:**
  - Ensure the red needle is exactly aligned with the red arrow on the base plate
  - Ensure the compass is calibrated to magnetic north



**Maintenance:**

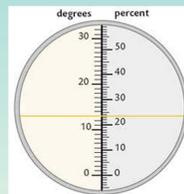
- Use only fresh water and mild soap for cleaning the compass

### 5. Suunto Tandem

- Sunnto Tandem acts as a compass and a clinometer both
- The compass is used to measure bearing (as described in the previous slide)
- The clinometer is used to measure slope and can also measure height
  - Height calculation formula:  $(a \times d)100$ ;
  - a= angle between top and base reading,
  - d= horizontal distance

**Tips:**

- When measuring slope be sure to read the percent measurement (on the right)
- When measuring bearing, read from the top line
  - The bottom line provides the reverse angle



**Maintenance:**

- Never attempt to disassemble
- Protect from shocks, extreme heat and prolonged exposure to direct sunlight.
- stored in a clean, dry environment at room temperature.
- Clean with a lightly moistened (warm water) cloth.

### 6. GRS densitometer

*The Densitometer is used to measure leaf cover*

- It is operated by looking through the device and recording when the target intercepts with the leaf or sky.
- If at least 50% of the ring in the viewing glass is covered by leaves a 1 is counted. If not, it is 0.
- Leaf cover is recorded along two 10 m transects. A count is recorded every meter. Therefore the maximum value is 20. The number of "1" counts is divided by 20 to get the percentage.



**Maintenance:**

- Keep densitometer in a sealed plastic bag to protect the lenses from scratching and reduce exposure, dirt and dust.
- Do not expose densitometer at high temperatures
- After working in rain leave densitometer in a warm dry location overnight

## 7. Diameter tape

*The Diameter tape is used to measure trunk diameter*

- Enfold the tape around the bole of the tree
- Where the number "0" aligns with the rest of the tape
- Measurement of the tree should be at 1.3 m height (Breast Height)
- The diameter can be read directly from the tape



### Maintenance:

- Don't apply force to much, it can be stretched.
- Wash the steel tape with non-saline water during working in mangroves
- Add oil to protect corrosion

## 8. Carpenter tape

*This is used to measure distance between points.*

- The carpenter's tape is used in the S Plot and to measure soil depths for example
- Open the tape
- Fix zero mark of the tape with one object and take the tape to the other object
- Take reading and get distance



### Maintenance:

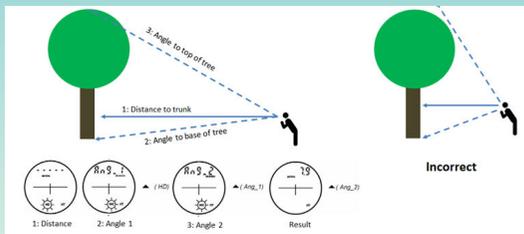
- Use carefully
- Don't apply too much force between two points of the tape.

## 9. Truepulse range finder

*Truepulse laser Rangefinder is used to measure distance, slope and height.*

### Tip:

- Use the filter and reflector to make sure only the reflector is being targeted.
- Ensure the device is calibrated



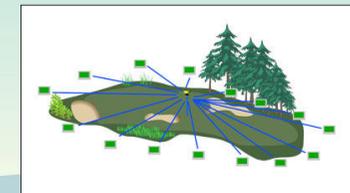
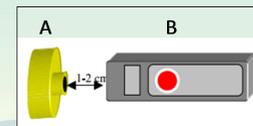
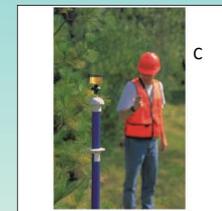
### Maintenance:

- Avoid staring directly at the laser beam for prolonged periods.
- Never attempt to view the sun through the scope, this can damage your eyes permanently.
- Do not expose the instrument to extreme temperatures.

## 10. DME

*The DME is used to measure horizontal distance.*

- It is particularly useful for measuring circular plots
- The DME consists of a transponder (A), the DME (B) and a pole for the transponder to attach to (C)
- The DME measures the distance between the DME and the transponder
- Only one button is used
- Maximum range = 30 m (approx.)
- **The DME must be calibrated before use**



## 11. Open face Soil augers

*Two types of soil augers are used to take soil samples*

- Small auger – in all zones except the Sundarbans (depth to 30 cm)
- Long auger – in the Sundarbans (depth to 1m)
- Soil Auger is pipe like metallic structure but half portion of this pipe is opened
- Augers are inserted vertically into the soil upto a desired level by giving pressure with fixed handle
- After attaining desired depth, the auger is twisted around and slowly pull up to get the full core of soil



### Maintenance:

- Twist the auger slowly otherwise it can bent
- After use clean the auger properly

## 12. Soil Cores

*Soil cores are used to collect bulk density samples*

- Bulk density provides information about pore space which has implications for plant growth.
- The cores are necessary in order to collect a known volume of soil.
- A pit is dug to reach the desired depth for the core to be taken.

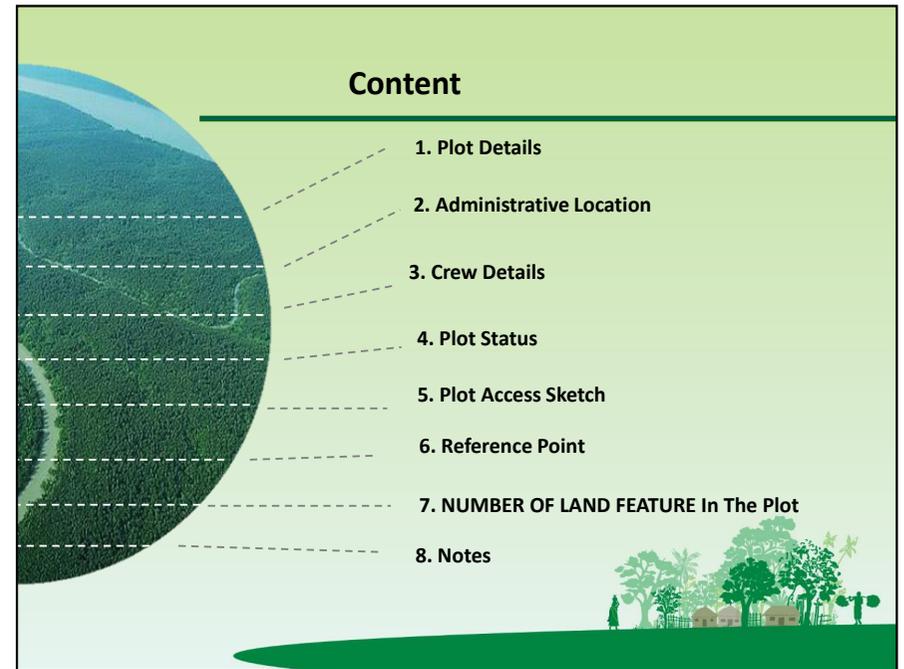
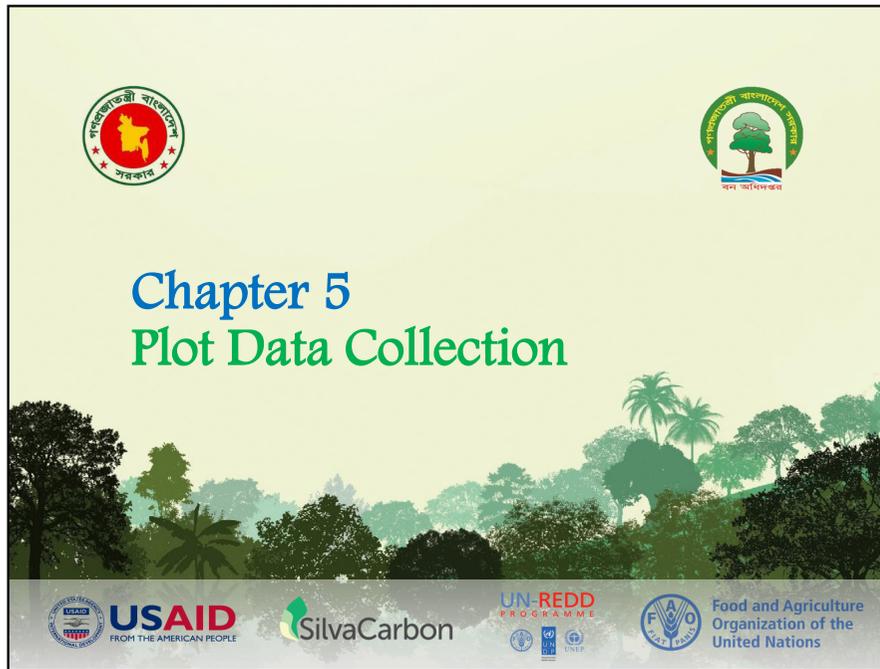


### Maintenance:

- Clean the core properly After use

## 13. Maintenance

- Several ecosystems particularly mangroves are extremely harsh on equipment
- All equipment should be cleaned with fresh water wiped with cloth and dried after every day's use in the field
- This is especially important for steel equipment with screw-on threads; these must be unscrewed and rinsed every day
- Some instruments need battery, so after completing daily works the battery should be removed
- When equipment will not be used for an extended period (more than ~3 days), coat the metal parts with a light oil as a protectant
- All instruments should be handled carefully
- Some instruments are water resistant but not water proof, so if we work in rain then after work the instruments should be dried in sunlight
- Before going to the field all necessary instruments should be checked
- In case of confusion repetition of measurements can be done



### 1. Plot Details

**INFORMATION ABOUT THE FOLLOWING ATTRIBUTES WILL BE ENTERED-**

- 1.1 PLOT RECORD
- 1.2 PLOT NUMBER
- 1.3 INVENTORY DATE
- 1.4 ARRIVING FROM
- 1.5 DEPARTURE TIME
- 1.6 FOREST OFFICE (From)
- 1.7 START TIME

When collected:	All plots	
Field Width:	1 digit	
Tolerance:	No errors	
Values:	Code	Description
	1	FD Field Office
	2	Another plot
	3	Other

### 2. Administrative Location

- 2.1 PLOT LOCATION
- 2.2 DIVISION
- 2.3 DISTRICT
- 2.4 UPAZILA
- 2.5 UNION
- 2.6 FOREST DIVISION
- 2.7 FOREST RANGE
- 2.8 FOREST BEAT
- 2.9 ZONE

The plot is located in which administrative area, those information will be collected under this section.

### 3. Crew Details

- 3.1 TEAM NUMBER
- 3.2 TEAM LEADER
- 3.3 DEPUTY TEAM LEADER
- 3.4 INVENTORY TYPE
- 3.5 PLOT STATUS
- 3.6 NONSAMPLED REASON
- 3.7 PLOT ACCESS SKETCH

This section contains relevant inventory team information as well as plot status (accessibility)

<b>When collected:</b>	All plots	
<b>Field width:</b>	1 digits	
<b>Tolerance:</b>	No errors	
<b>Values:</b>	Code	Definition
	0	Training
	1	Standard production plot
	2	Cold check
	3	Hot check

### 4. Plot Status

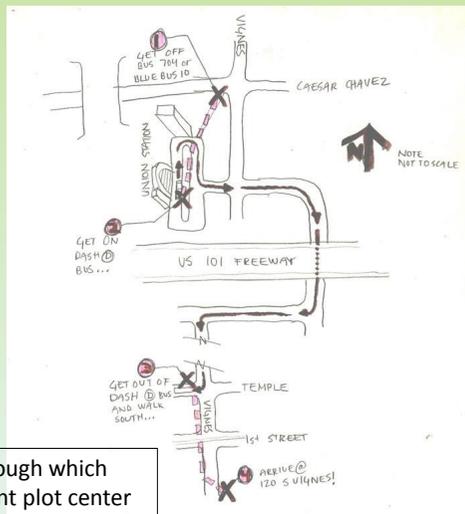
<b>When collected:</b>	All plots	
<b>Field Width:</b>	1 digit	
<b>Tolerance:</b>	No errors	
<b>Values:</b>	Code	Description
	1	Accessible - Sampled completely (5 subplots accessible and measured)
	2	Partially accessible - sampled (at least one subplot is measured)
	3	Inaccessible plot but Land Feature parameters measured from distance
	4	Not sampled - None of the parameter is measured

#### 4.1. NONSAMPLED REASON

<b>When collected:</b>	plot_status >1	
<b>Field width:</b>	1 digit	
<b>Tolerance:</b>	No errors	
<b>Values:</b>	Code	Definition
	1	Accessible
	2	Denied access - Access to the entire plot is denied by the legal owner, or by the owner of the only reasonable route to the plot. Because a denied-access plot can become accessible in the future, it remains in the sample and is re-examined at the next occasion to determine if access is available.
	3	Hazardous - Entire plot cannot be accessed because of a hazard or danger, for example cliffs, strip slopes, high water, security issues etc. Although most hazards will not change over time, a hazardous plot remains in the sample and is re-examined at the next occasion to determine if the hazard is still present.
	4	Restricted access - The plot cannot be accessible because it is located in a restricted area such as military areas, border areas.
	5	Inaccessible - The plot is inaccessible because it is located under water, and <b>inaccessible terrain</b>
	6	Skipped visit - Entire plot skipped. Used for plots that are not completed prior to the end of inventory and submitted for processing. This code is for office use only.
	96	Other - Entire plot not sampled due to a reason other than one of the specific reasons already listed. A field note is required to describe the situation

### 5. Plot Access Sketch

- **Hand drawn Map.**
- With field **crew experience** and **local experience**.
- **Reference object** may be identified during planning phase ?
- *Ideally, the RP should be identifiable from the aerial imagery however this may not always be possible.*
- Route to reach the plot should be clearly described.
- If you think you have reached , observe the surroundings.



This sketch indicates the way through which someone can reach to the relevant plot center

### 6. Reference Point (Rp)

- Ideally the RP should be a prominent object that is likely to remain *in situ* for the next 10 years.



- If a tree which is used as the RP, it should be one that is not likely to die or be cut before the next inventory (within 5-10 years).
- In situations where there are no large or prominent trees or features in the immediate vicinity (especially in the shrub land), the most significant tree, shrub or feature should be used.

**Detailed description of the RP should be provided in the notes**

Identify a Reference Point (RP)



Identify a Reference Point (RP)



Identify a Reference Point (RP)



Identify a Reference Point (RP)



### Identify a Reference Point (RP)



### Identify a Reference Point (RP)



#### RP BEARING

Measured from the RP to the plot center

#### RP HORIZONTAL DISTANCE

Measured from the RP to the plot center

If the Reference point not within eyesight of the PC, the GPS can be used, this is why "horizontal distance" is used.

#### RP GPS NORTH / LATITUDE (Y)

#### RP GPS EAST / LONGITUDE (X)

Co-ordinates will be recorded

#### RP SUBPLOT

- From which subplot the RP is selected.

#### RP PICTURE

- One picture

#### RP NOTES

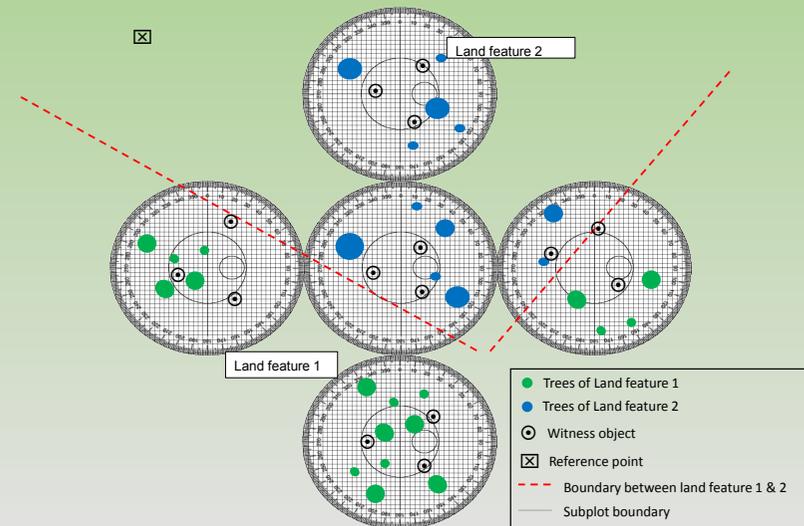
- Text, should be something which can clarify for future plot visit



Mark the RP with spray paint and a metal tag if appropriate

### 7. Number Of Land Feature In The Plot

Here the value would be 2, because there are two lf in the plot



### Next step: Plot center fixing

Install a pointed metal rod (pin) at the plot center at least 30 cm below the surface. Later this can be identified by a metal detector easily.

If for some reason the pin can not be established,  
>> provide **reason/justification** in the notes.



### 8. Record Plot Notes

- "Plot Notes" record any information that may assist the relocation of the plot.
- Describe any prominent features present in the plot area that are unlikely to change in the next ten years; examples include:
  - slope,
  - aspect,
  - topographic position,
  - recognizable physiographic features (i.e. streams, ponds),
  - human-made features (i.e. roads, houses, field boundary),
  - unusual or large trees



**Chapter 6**  
**Subplot Measurement**

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UN-REDD PROGRAMME  
FAO Food and Agriculture Organization of the United Nations

## Content

1. Subplot layout
2. Measurements
3. Edge trees
4. Establish witness objects
5. Record subplot data

### 1. Subplot Layout

Within a subplot there are 3 plots

**L plot Radius = 19 m**  
**M plot Radius = 8 m**  
**S plot Radius = 2.5 m**

Distance between S and M plot center = 5m

Down woody material transect  
Litter sample  
Soil sample

Largest one is L plot  
Medium one is M plot  
And smallest one is S plot

Centers of L and M plot are same but S plot center is different

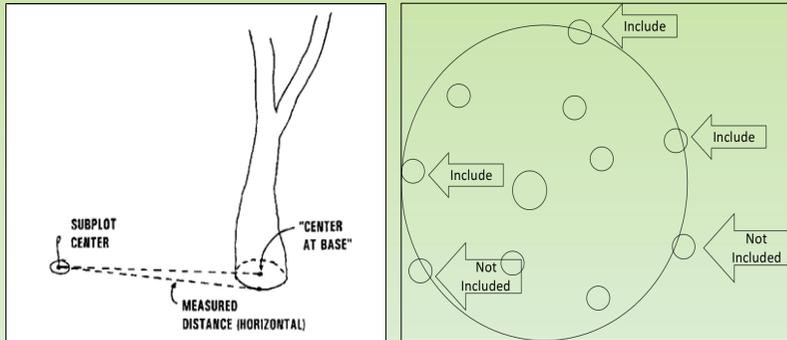
### 2. Measurements

**L PLOT** Tree dbh  $\geq 30$ cm  
**M PLOT** Tree dbh  $\geq 10$ cm  
**S PLOT** Seedling dbh  $\geq 2$ cm

For every plot level there are some specific criteria to be considered

Live and dead standing tree with DBH $\geq 30$ cm and stumps (live and dead) $\geq 30$ cm diameter	Live and dead standing trees with DBH $\geq 10$ cm and stumps (live and dead) $\geq 10$ cm diameter
	Bamboo clumps
	Down woody material
	Nypa (clump)
	<i>Ceriops decandra</i> (<2 cm collar dia seedlings counted, $\geq 2$ cm collar dia recorded as sapling/tree)
	Sapling $\geq 2$ DBH < 10 cm
	Single most vigorous shoot from live stumps $\leq 2$ & < 10 cm DBH
	Seedling DBH < 2 cm & height $\geq 10$ cm
	Stumps (live / dead) $\geq 2$ cm and < 10 cm DBH

### 3. Edge Trees



You can mark the trees at the edge to facilitate the identification of the trees inside and outside the plot.

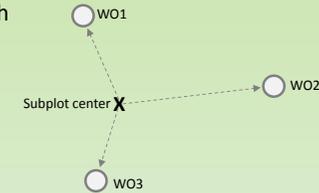


### 4. Establish Witness Objects

Establish witness objects (wo) for the subplot center

**THREE (3)** witness object are identified for each subplot.

1	Tree
2	Electricity Pole
3	House/structure
4	Other

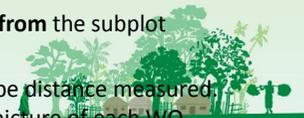


**STEP 11:** Install a red and white pole at subplot L center.

**STEP 12:** Identify three (3) witness objects (WO) as close as possible to the subplot center. Follow the same procedure outline in STEP 5 to select the WO.

**STEP 13:** Measure the slope distance and the bearing **from** the subplot Centre **to** the WO.

**STEP 14:** Make a spray paint mark at the point the slope distance measured. Nail a metal tag on the side facing plot center. Take a picture of each WO.



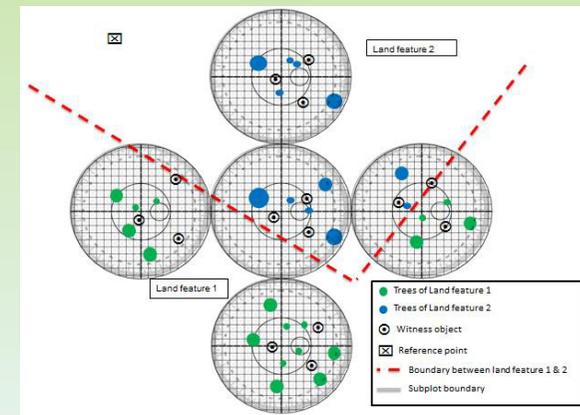
### Establish witness objects (wo) for the subplot centres

3 witness objects are selected around each sub-plot center. Witness objects are normally tree but in absence of tree it can be other objects too. Metal tags are inserted in every WOs.

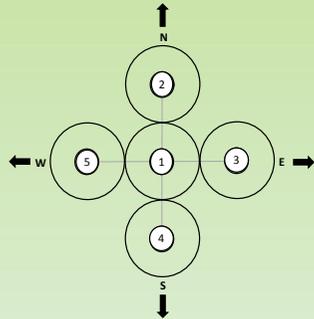


### Indicate the witness object on the land feature form

- ⊙ Witness object
- ⊠ Reference point



### 5. Record Subplot Data



#### SUBPLOT NUMBER

When collected:	PLOT_STATUS <3												
Field Width:	1 digit												
Tolerance:	No errors												
Values:	<table border="1"> <thead> <tr> <th>Code</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Center subplot</td> </tr> <tr> <td>2</td> <td>North subplot</td> </tr> <tr> <td>3</td> <td>East subplot</td> </tr> <tr> <td>4</td> <td>South subplot</td> </tr> <tr> <td>5</td> <td>West subplot</td> </tr> </tbody> </table>	Code	Description	1	Center subplot	2	North subplot	3	East subplot	4	South subplot	5	West subplot
Code	Description												
1	Center subplot												
2	North subplot												
3	East subplot												
4	South subplot												
5	West subplot												

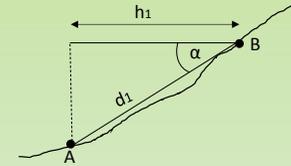
#### SUBPLOT STATUS

When collected:	All plots								
Field Width:	1 digit								
Tolerance:	No errors								
Values:	<table border="1"> <thead> <tr> <th>Code</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Sampled completely: all the components are measured</td> </tr> <tr> <td>2</td> <td>Partially sampled: partly inaccessible but the land features can be described</td> </tr> <tr> <td>3</td> <td>Nonsampled – None of the parameter is measured</td> </tr> </tbody> </table>	Code	Description	1	Sampled completely: all the components are measured	2	Partially sampled: partly inaccessible but the land features can be described	3	Nonsampled – None of the parameter is measured
Code	Description								
1	Sampled completely: all the components are measured								
2	Partially sampled: partly inaccessible but the land features can be described								
3	Nonsampled – None of the parameter is measured								

### 5. Record Subplot Data

#### SUBPLOT SLOPE (%)

Record the main slope present in the subplot.



#### SUBPLOT SLOPE ASPECT (DEG)

Record the aspect/ bearing across the subplot, to the nearest 1 degree. If the slope direction is variable, record the predominant slope direction.

#### SUBPLOT LEAF COVER (COUNT)



### 5. Record Subplot Data

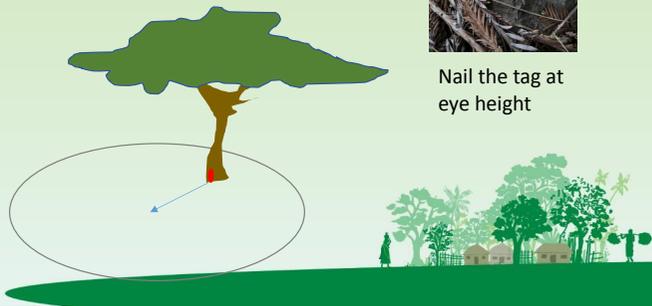
- WO RECORD NUMBER
- WITNESS OBJECT TYPE
- WO SPECIES
- WO DBH
- WO BEARING
- WO SLOPE DISTANCE
- TREE TAG NUMBER
- WO PICTURE
- WO NOTES



Tag the witness tree with paint



Nail the tag at eye height



**Chapter 7**  
**Land Feature Description**

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**Content**

1. What is a forest?
2. Recognition of Land Features Types
3. Describing land feature and objects
4. Land Feature Data Collection

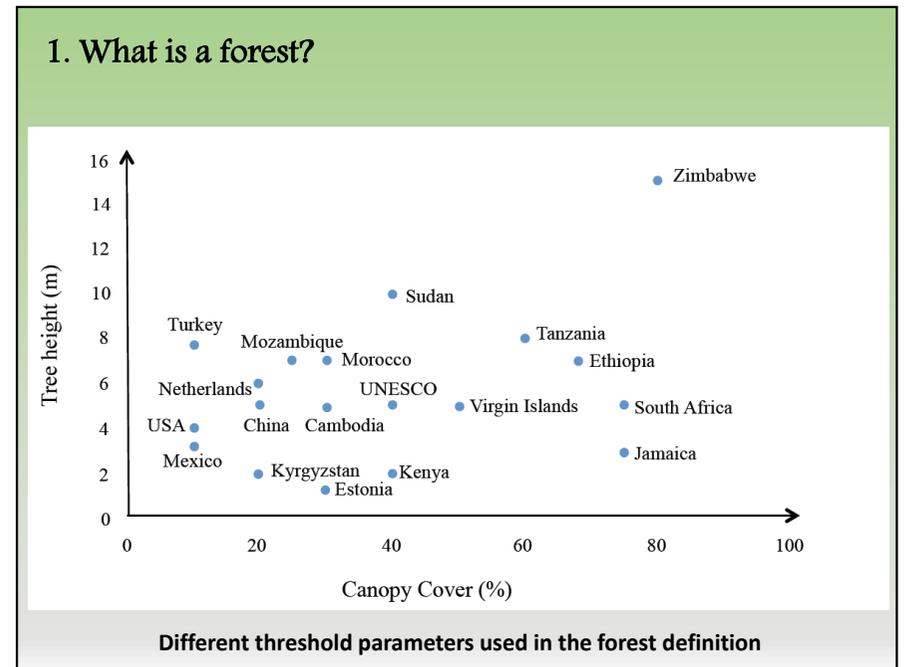
### 1. What is a forest?

**Definition in FRA 2015 Working Paper 180**  
Land spanning more than **0.5 hectares** with trees **higher than 5 meters** and a canopy cover of **more than 10 percent**, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use.

**Australia**  
Vegetation that has a height of **2 metres**, crown canopy cover of **at least 20%** and a minimum forest area of **0.2 hectares**.

**Natural Resources Canada**  
Ecosystem that generally covers a **large area** and is composed of woody vegetation dominated by **trees** growing in a relatively dense pattern.

**USDA Forest Service**  
**Forest land:** Land that has **at least 10 percent** crown cover by live tally trees of any size or has had **at least 10 percent** canopy cover of live tally species in the past, based on the presence of stumps, snags, or other evidence. To qualify, the area must be **at least 1.0 acre** in size and **120.0 feet** wide.



Is this a forest?



Yes!

NO



## 2. Recognition of Land Features Types

- Conventional system of land classes (such as forest land, cropland, grassland, etc.) that are assigned in the field.
- Descriptions are often vague or lacking appropriate definitions to allow their comparability with classification systems used in different maps
- Class names and definitions often changed over time to meet different priorities
- Hence, the BFI methodology **does not** rely on pre-defined land cover class names
- Instead a detailed description of the **physical attributes** identified within homogeneous land area are recorded

Describe what is in this picture without using the word forest, garden, orchard, paddy field, etc.?



Describe what is in this picture without using the word forest, garden, orchard, paddy, field etc.?



### 3. Describing land feature and objects

- Objects are the physical features of an area of land that is observed in the field at the time of data collection.
- The combination of objects within an homogeneous area of land constitutes a land feature.



### 3. Describing land feature and objects



#### What do we need to know?

- How many land feature are there?
- How big is it?
- Who owns/manages it?
- What is the crown cover range?
- Are there any environmental issues?
- What are the different objects you can see?
- What are the characteristics of those objects?

### 3. Describing land feature and objects



#### What do we need to know?

- How many land feature: **1**
- How big: **More than 0.5 ha**
- Crown cover: **0%**
- What are the different objects: **crop, water.**
- Characteristics of objects:
  - **Vegetated:** name, crop pattern, cultivation state, water supply, comments, etc.
  - **Water:** type, salinity, cover percentage, comments, etc.

### 3. Describing land feature and objects



#### What do we need to know?

- How many land feature: **1**
- How big: **More than 0.5 ha**
- Crown cover: **0-5%**
- What are the different objects: **tree, shrub, building, water.**
- Characteristics of objects:
  - **Vegetated:** object type, artificiality, object cover, growth form, management, comments, etc.
  - **Non-vegetated:** type, surface percentage, comments, etc.
  - **Water:** type, salinity, cover percentage, comments, etc.

### 3. Describing land feature and objects



- What do we need to know?**
- How many land feature: **2**
  - How big: **More than 0.5 ha (each)**
  - Crown cover: **40-50%, 0%**
  - What are the different objects: **tree, shrub, crop, etc.**
  - Characteristics of objects:
    - **Vegetated (land feature1):** object type, artificiality, object cover, growth form, management, comments, etc.
    - **Vegetated (land feature2):** name, crop pattern, cultivation state, water supply, comments, etc.

### 3. Describing land feature and objects



- What do we need to know?**
- How many land feature: **1**
  - How big: **More than 0.5 ha**
  - Crown cover: **40-50%**
  - What are the different objects: **tree, crop, etc..**
  - Characteristics of objects:
    - **Vegetated:** object type, artificiality, object cover, growth form, management, comments, etc.
    - **Vegetated:** name, crop pattern, cultivation state, water supply, comments, etc.

### 3. Describing land feature and objects



- What do we need to know?**
- How many land feature: **1**
  - How big: **More than 0.5 ha**
  - Crown cover: **60-80%**
  - What are the different objects: **tree, water, etc..**
  - Characteristics of objects:
    - **Vegetated:** object type, artificiality, object cover, growth form, management, comments, etc.
    - **Water:** type, salinity, cover percentage, comments, etc.

### 4. Land feature data collection

- Land Feature data is collected on all visited plots regardless of the presence of trees.
- Land Feature data are measured if the **PLOT\_STATUS <4**

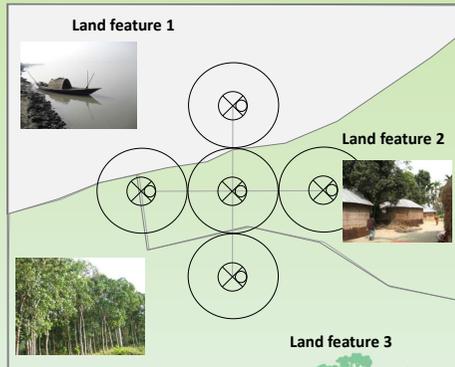
Plot_status	Description
1	Sampled completely (5 subplots accessible and measured)
2	Partially sampled (at least one subplot is measured)
3	Inaccessible plot but Land Feature parameters measured from distance
4	Not sampled – None of the parameter is measured



### 4. Land Feature Data Collection. Land feature details

#### 4.1 NUMBER OF LAND FEATURE

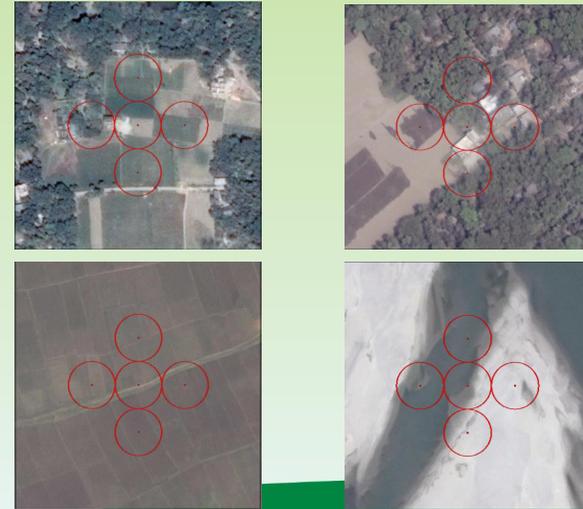
- The combination of objects within a homogeneous area of land constitutes a land feature.
- There may be more than one homogeneous land feature that falls across the plot.
- **At least one land feature** will be described for every visited plot regardless of the presence of trees.



### 4. Land Feature Data Collection. Land feature details

#### 4.1 NUMBER OF LAND FEATURE

Getting support from aerial photo of 200m by 200m

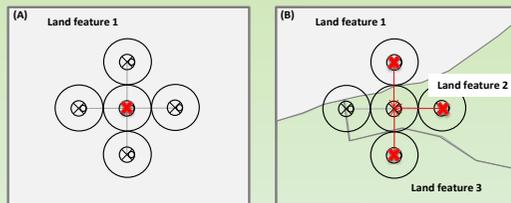


### 4. Land Feature Data Collection. Land feature details

#### 4.2 LAND FEATURE STATUS [If\_status]

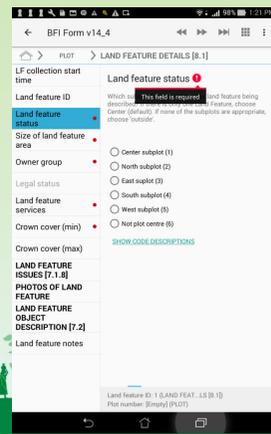
- A geographic reference point must be assigned for each Land Feature.
- This is used as a reference to link satellite imagery to the Land Feature type.

Two potential cases



Only one land feature: the plot center is used as the location by default

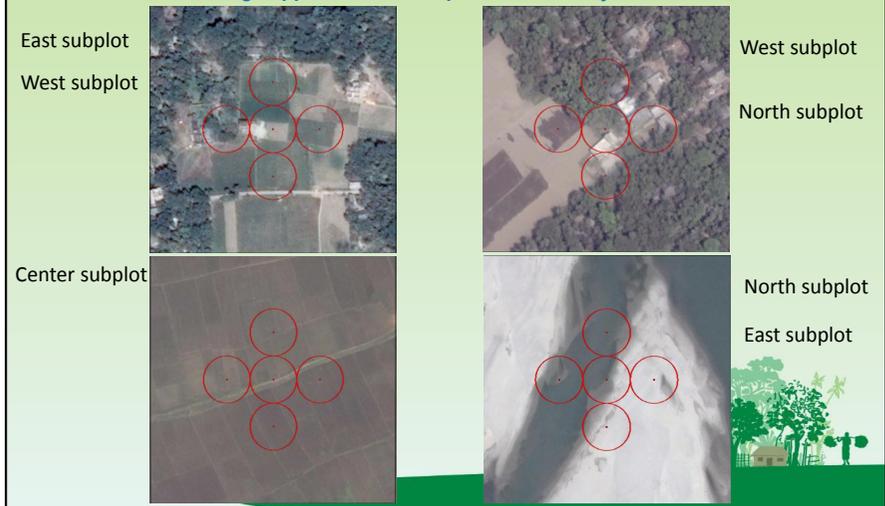
Multiple land features: indicate the selected subplot center (1 to 5) that best represents the land feature



### 4. Land Feature Data Collection. Land feature details

#### 4.2 LAND FEATURE STATUS [If\_status]

Getting support from aerial photo of 200m by 200m



#### 4. Land Feature Data Collection: Land feature details

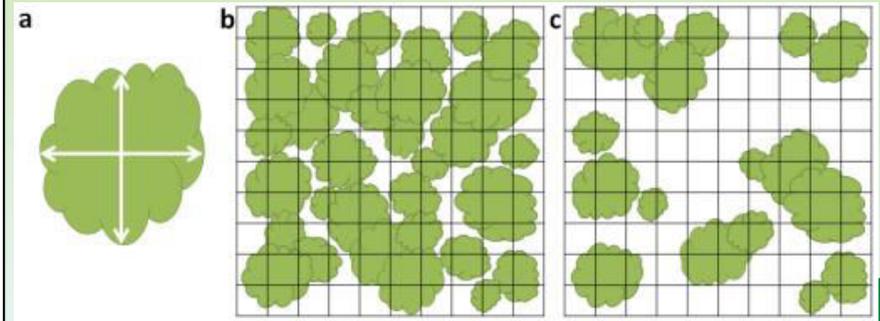
##### 4.3 LAND FEATURE VARIABLES

- 1 SIZE OF LAND FEATURE
- 2 OWNER GROUP
- 3 LEGAL STATUS
- 4 LAND FEATURE SERVICES
- 5 CROWN COVER
- 5.1 CROWN COVER %(MIN)
- 5.2 CROWN COVER %(MAX)
- 6 LAND FEATURE ISSUES

#### 4. Land Feature Data Collection: Land feature details

##### 4.4 CROWN COVER (MIN-MAX)

- The 'crown' is treated as a single area so the variability of leaf area is not considered.
- Crown cover considers the total area of crown where the crown is measured at its outer extremity (a).
- The CROWN COVER value should be representative of the entire land feature and is assigned as a range such as 80-100% (b) or 40-60% (c) based on expert judgment in the field.

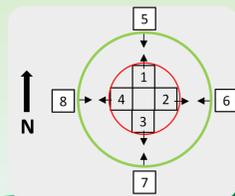


#### 4. Land Feature Data Collection: Land feature details

##### 4.5 PHOTO AND PHOTO POSITION

When collected  
Following each picture taken

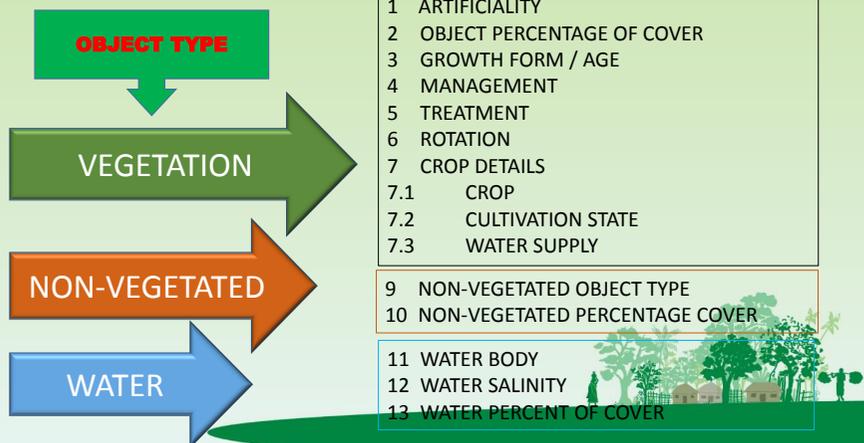
The aspect the photo is taken from should be recorded based on the diagram below. If you are inside of the land feature you have option numbers 1 to 4 indicating the direction of your position. If you are outside of the land feature the photo position will be 5 to 8.



#### 4. Land Feature Data Collection: Land feature details

##### 4.6 LAND FEATURE OBJECT DESCRIPTION

- Objects are the specific elements that together make up a land feature.
- Each land feature must have at least one object
- Multiple objects can be recorded based on observed layers from the field.



## 4. Land Feature Data Collection: Land feature details

### 4.7 SUBPLOT LAND FEATURE PROPORTIONING

- Count the number of complete squares in each land feature
- Number of complete squares in L plot 256
- Number of complete squares in M plot 44

English Forest Inventory FI - LAND FEATURE

Subplot: LAND FEATURE PROPORTIONING (LF)

LOCAL NUMBER OF SQUARES IN ONE SUBPLOT: 44

LOCAL NUMBER OF SQUARES IN ONE LAND FEATURE: 124

Subplot	LF	NUMBER OF SQUARES
1	M	44
2	L	256
3	L	256
4	L	256
5	L	256
6	L	256
7	L	256
8	L	256
9	L	256
10	L	256
11	L	256
12	L	256
13	L	256
14	L	256
15	L	256
16	L	256
17	L	256
18	L	256
19	L	256
20	L	256
21	L	256
22	L	256
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36	L	256
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85	L	256
86	L	256
87	L	256
88	L	256
89	L	256
90	L	256
91	L	256
92	L	256
93	L	256
94	L	256
95	L	256
96	L	256
97	L	256
98	L	256
99	L	256
100	L	256

Open the land feature boundaries over the subplot diagrams.  
If there is only one land feature, simply mark Land Feature 1 according to the form.  
Otherwise #1001 to #1020 are available on the form, where applicable.

M plot

L plot

Land Feature 1

Land Feature 2

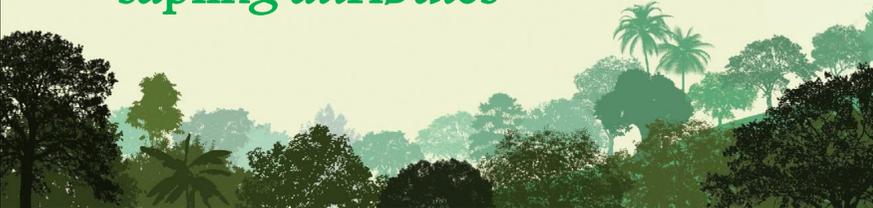
LF sketch form

- Trees of Land Feature 1
- Trees of Land Feature 2
- Withness object
- ⊗ Reference point
- - - Boundary between land feature 1 & 2
- Subplot boundary




## Chapter 8

# Measurement of tree and sapling attributes

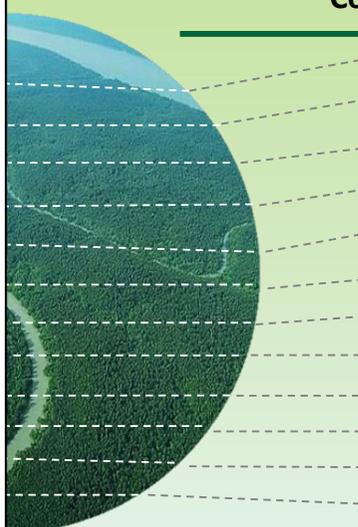







Food and Agriculture Organization of the United Nations

## Contents



1. Tree attributes for BFI
2. Tree status
3. Species
4. Measurement of tree bearing from plot center
5. Horizontal distance of tree from plot center
6. Diameter and height of stumps
7. Diameter at breast height
8. Tree height measurement
9. Crown position
10. Tree damage
11. Damage severity
12. Decay class



## 1. Tree attributes for BFI

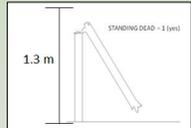
- The following attributes need to be assessed and measured during BFI
  - Tree status
  - Species
  - Bearing
  - Horizontal distance
  - Diameter of stumps
  - Diameter at breast height
  - Total height
  - Bole height
  - Crown height
  - Crown position
  - Tree damage
  - Damage severity
  - Decay class



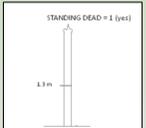
## 2. Tree status

**Record the present status of each targeted trees and stump (top diameter  $\geq 10$  cm) as following categories**

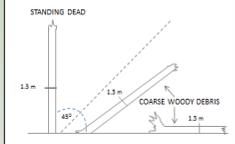
- **Live tree**
- **Dead standing tree:** The tree is standing above a 45 degree angle; a tree is dead when none of its parts are alive (leaves, buds, cambium) at 1.3m or above.
- **Stump (dead)**
- **Stump (alive)**



Broken and attached at below the 1.3 m height = stump

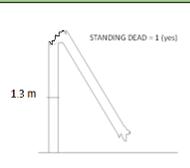


Standing dead tree



Coarse woody debris

Broken and attached less than 50% of the stem, consider the broken part as coarse wood debris and standing part as damaged standing tree



STANDING DEAD = 1 (yes)

1.3 m

Broken and attached more than 50% of the stem, consider as standing tree. Measure the length of the tree including the broken portion



STANDING DEAD = 1 (yes)

1.3 m

### 3. Species

- Record the appropriate species name from the drop down menu in open foris collect
- If the species is not in the drop down list, consider the following
  - Manual input of the species name
  - Try to know the local name
  - Use "UNK" for unknown species
  - Collect the specimen for identification
- If the species is known by another (local) name
  - Use "OTHER" or "UNK" for unknown species
  - List details in the space provided



### 4. Measurement of tree bearing from plot center

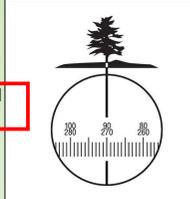
- Measure bearing of trees from the sub-plot center as follows
  - Measure bearing from the magnetic north of each trees using Suunto clinometer/Compass



Suunto clinometer

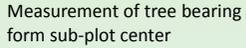


Targeted tree





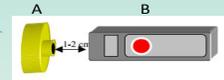
Compass



Measurement of tree bearing from sub-plot center

### 5. Horizontal distance of tree from plot center

- Measure the horizontal distance of the tree from the plot center using
  - Leaner measuring tape
  - Trupulse Laser Range Finder
  - DME



In case of sloping ground

$$\text{Horizontal distance} = \text{Slope distance} \times \text{Cos}(\sigma)$$

Where  $\sigma$  = slope angle in degrees

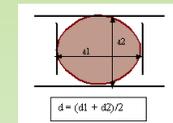
$$\text{Sloping distance} = \text{Horizontal distance} / \text{Cos}(\alpha)$$

Use of leaner measuring tape to measure horizontal distance from the sub-plot center to the tree



### 6. Diameter and height of stumps

- Diameter of live or dead stump should be taken whose height is less than 1.3 m
  - Live stumps with coppices will be measured twice
    - One for the stump and
    - Seedling, or sapling or tree in respective sub-plots
  - Diameter will be measured using
    - Diameter tape
    - Measuring tape or ruler: Measure the longest and shortest axes across the top of the stump and record the average of the two measurements
  - Height of stump
    - Measure the height of the diameter measuring point for stump



Different categories of stump

## 7. Diameter at breast height

- Tree diameter at breast height is commonly known as DBH, which is measured at **1.3 m** height from the ground level as recommended by FAO

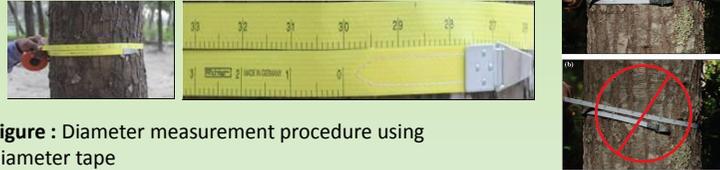
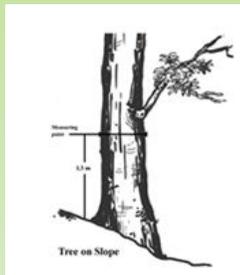


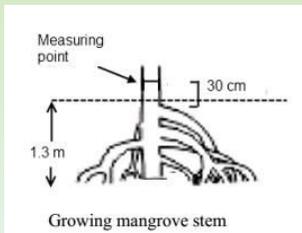
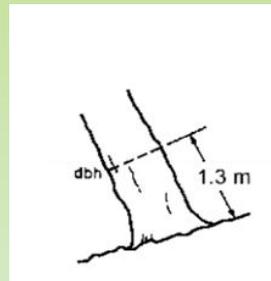
Figure : Diameter measurement procedure using diameter tape

Tape must be perpendicular to tree

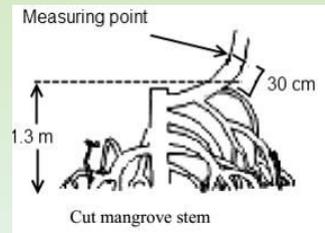
- Some of the exceptional situation usually arise in the field to measure DBH. These exceptional situation has been shown in the flowing slides



DBH measurement for trees on sloping ground



DBH measurement for trees with prop root and stilted roots



DBH measuring height

DBH measurement for Stump Sprout

DBH measurement at the edge

DBH measurement lean tree on level ground

DBH measurement for trees with prop root and stilted roots

DBH measurement for trees with abnormalities at 1.3 m height

Swelling at DBH

DBH measurement for trees with abnormalities at 1.3 m height

DBH measurement for trees forking below the 1.3 m height

### 8. Tree height measurement

- **Total height:** The height (or stem length) from ground line to the top of green terminal bud
- **Bole height:** The height between ground level and the crown point
- **Crown point:** Crown point is the position of the first crown forming live or dead branch

Different attributes of a tree

### • Height measurement using Suunto clinometer

- **Step 1:** Measure the horizontal distance of the targeted tree from the operator
- **Step 2:** Looking through the opening, line up the horizontal line with the top of the tree and read off the number from the percentage scale (ignore the sign)
- **Step 3:** Line up the horizontal line with the base of the tree and again read off the number from the percentage scale

### 10. Tree damage

- Record the damage type of trees
  - **None observed:** No damage observed at time of assessment
  - **Insect:** Defoliation caused by insect predation
  - **Disease:** Necrosis or other symptoms of ill health observed (usually on foliage)
  - **Fire:** Defoliation structural damage caused by fire
  - **Animal:** Over grazed
  - **Wind:** Affected by storms
  - **Suppression**
  - **Human:** Human-caused (cultural, logging, accidental, etc.)
  - **Other:** Unknown/not sure/other – includes death from human activity not related to silvicultural and land clearing activity (accidental, random, etc.), roots are undermined by erosion, hit by falling tree (include notes)

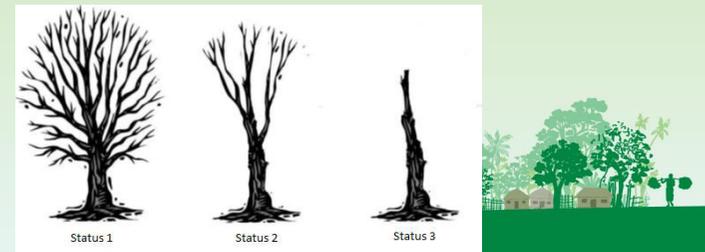
## 11. Damage severity

- Record the damage severity (if any) of the targeted tree
  - **Low:** Damage is less than 30% of the canopy or trunk; the tree is likely to recover from the damage; the damage is unlikely to affect the longevity of the tree.
  - **Moderate:** Damage is more than 50% of the tree canopy or trunk; the tree may make a partial recovery and the damage is likely to reduce the tree's natural life expectancy
  - **Severe:** Damage is up to 100% of the tree canopy or trunk; the tree is unlikely to recover from the damage; the trees longevity is significantly affected.



## 12. Decay class

- Record the decay class of the dead standing targeted tree
  - **Most branches present:** Original branch structure is present with many fine branches
  - **Few branches present:** Few limbs and no fine branches are present; sound at the base and decay is advancing at the upper bole
  - **No branches / few stumps only:** Predominantly a single trunk, minor stumps, significant decay in all parts of tree



**Chapter 9**  
**Bamboo Measurements**

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### Content

1. Bamboo Data
  - 1.1. Clump Record Number
  - 1.2. Bamboo Land Feature
  - 1.3. Bamboo Species
  - 1.4. Bamboo Bearing
  - 1.5. Bamboo Horizontal Distance
  - 1.6. Bamboo Length Measurement
  - 1.7. Bamboo Diameter
  - 1.8. Bamboo Stem Number

### 1 Bamboo data

**BAMBOO DATA:**  
Bamboo data will be recorded for **M Plot** (radius 8m) level

**1.1 CLUMP RECORD NUMBER**

- This is an auto generated number by Open foris application
- New clump number will be added for each new input



BAMBOO ATTRIBUTES	
Bamboo cl...d number: 1	• <input type="checkbox"/>
Bamboo cl...d number: 2	• <input type="checkbox"/>

**1.2 BAMBOO LAND FEATURE**

- In which Land feature the clump is found, that will be recorded here



**1.3 BAMBOO SPECIES**

- Mention the species name of the bamboo



### 1.4 BEARING

- Bearing will be measure from the subplot center to the center of the bamboo clump



### 1.5 HORIZONTAL DISTANCE

- Distance will be measured from the subplot center, to Bamboo clump center.



### 1.6 BAMBOO LENGTH

- This is one measurement that will represent the population average length.



### 1.7 BAMBOO DIAMETER

- Measure the DBH at 1.3 meter
- Measure 10 representative samples from the clump and make the average



### 1.8 BAMBOO STEM NUMBER

- Every individual number will be counted.

Bangladesh Forest Inventory	
SUBPLOT ATTRIBUTES > BAMBOO ATTRIBUTES	
Bamboo clump record number	Be
Bamboo Lf	Rec
Bamboo species	•
Bamboo maturity	•
Bamboo bearing	•
Bamboo horizontal distance	•
Bamboo height	•
Bamboo height method	•
Bamboo diameter	•
Bamboo stem number	•
Bamboo notes	





**Chapter 10**  
**Seedling Measurements**

### Content

1. What is 'seedling' as per BFI manual?
2. Where (L/M/S plots) to measure/ count the seedlings?
3. How to measure/ count the seedlings?
4. Identifying and recording the seedling species

### 1. What is 'seedling' as per BFI manual?

➤ Seedlings must be at least 10.0 cm in length and less than 2.0 cm at DBH in order to qualify for tallying

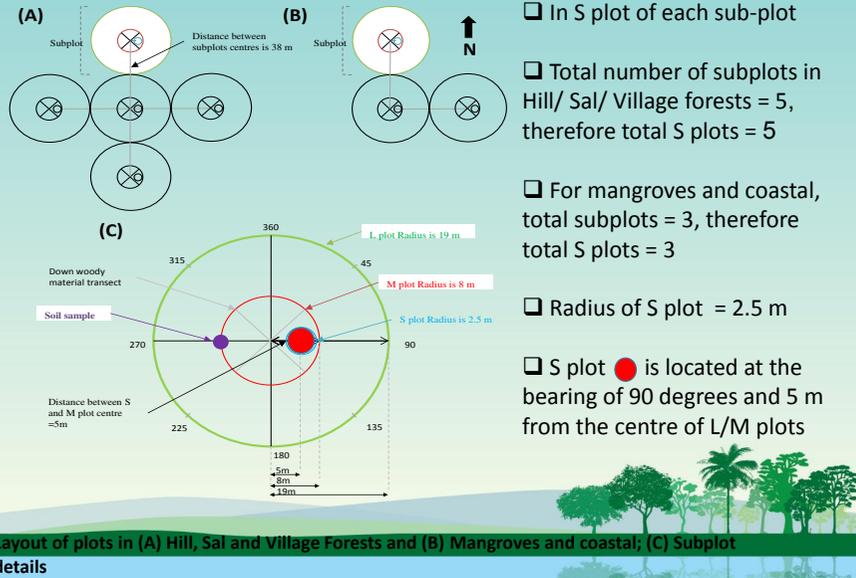


For a seedling to be counted it's total Height will be at least 10 cm and DBH will be less than 2 cm

Seedlings will be counted in S plot only

Fig. A seedling in the hill forest of Chittagong

## 2. Where (L/M/S plots) to measure/count the seedlings?



## 3. How to measure/count the seedlings?

- ❖ Seedlings information is obtained by counting live tree seedlings by species and land class
- ❖ All live seedlings that have their base inside the S Plot boundary regardless of vigor, damage should be counted
- ❖ In case of a clump of seedlings/coppices, only one seedling which is vigorous should be counted (a clump may consist of 3 or more live stems that sprouted from a common root base including stumps)
- ❖ *Nypa* will be recorded as a count

## 3. How to measure/count seedlings?.....cont'd

- ❖ Count all individual seedlings by species.
- ❖ When seedlings are distributed evenly on an S Plot, one way of estimating is to count the number of seedlings on one quarter of the S Plot and multiply by four (given that there is only one land feature on the S plot)- repeat for each species.

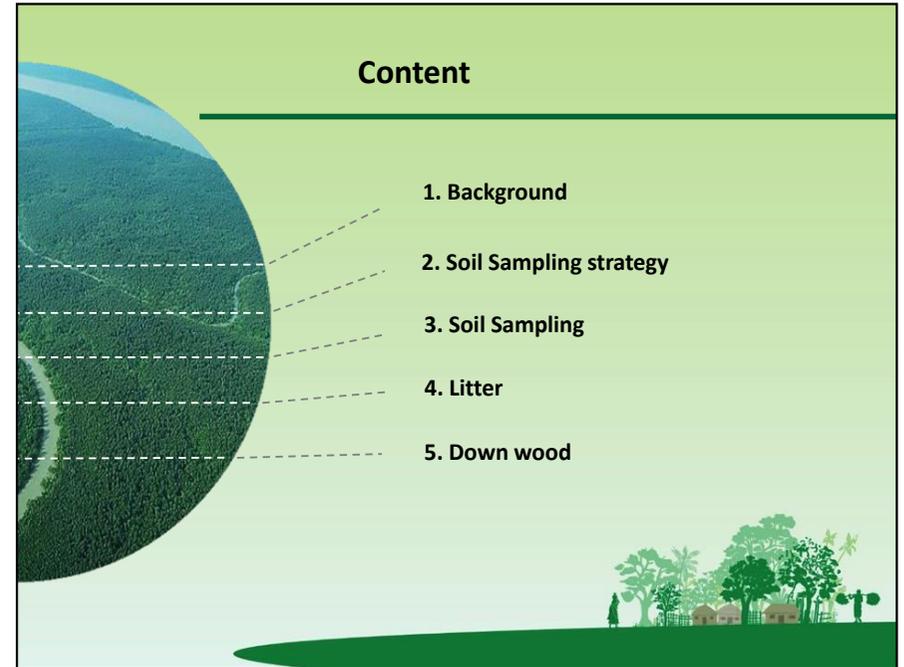
## 4. Identifying and recording the seedling species

- ❖ Record the SPECIES code from the Tree Species List
- ❖ Use the same procedures as the data item found in the Tree and Sapling data
- ❖ If the species cannot be determined in the field, tally the seedling, but bring branch samples, foliage, flowers, bark, etc. to the office for identification
- ❖ Make a note to correct the SPECIES code later



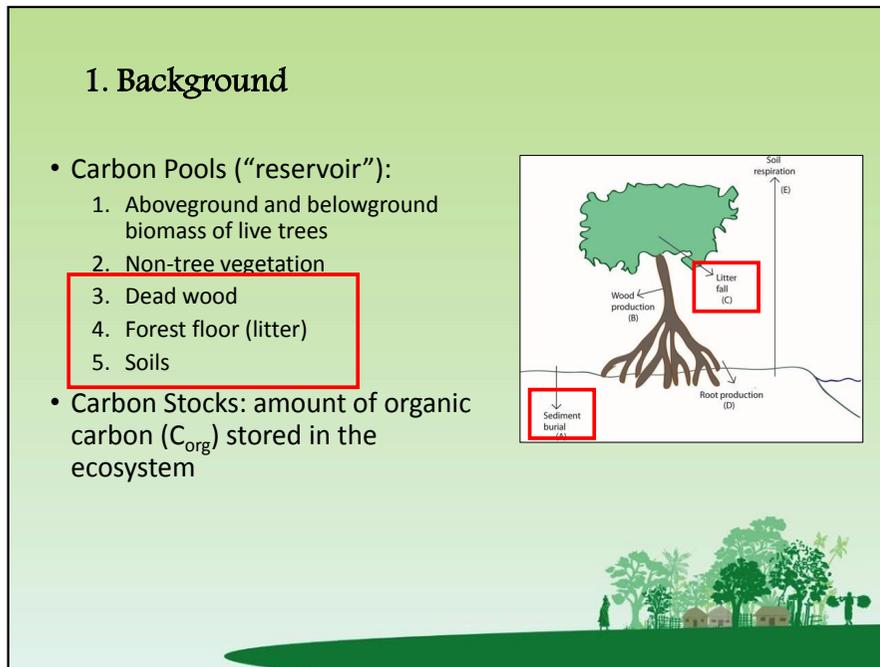
**Chapter 11**  
**Soil, Litter and Down wood Sampling**

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UN-REDD PROGRAMME  
FAO Food and Agriculture Organization of the United Nations



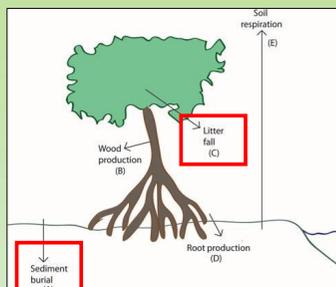
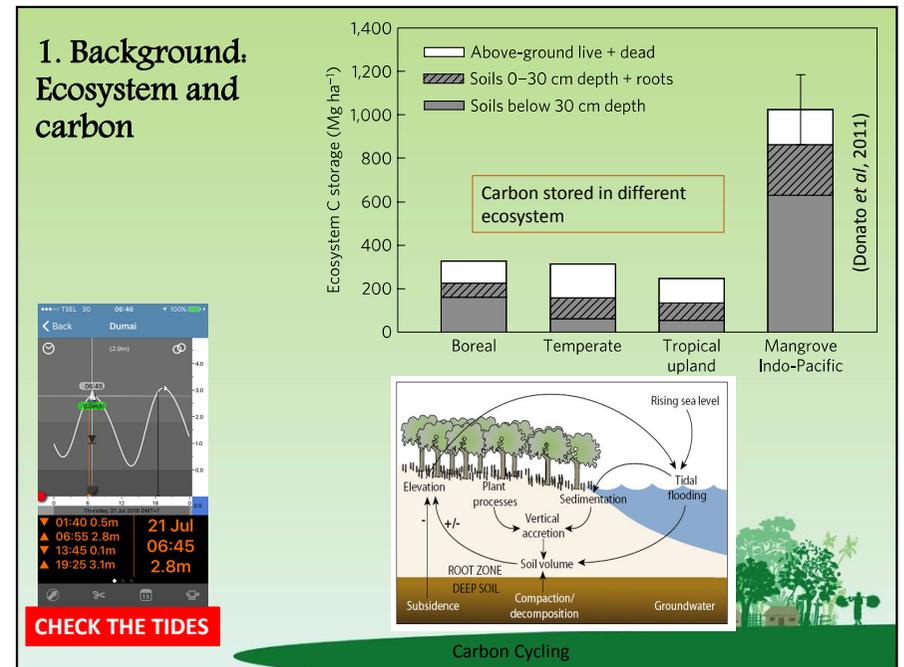
**Content**

1. Background
2. Soil Sampling strategy
3. Soil Sampling
4. Litter
5. Down wood

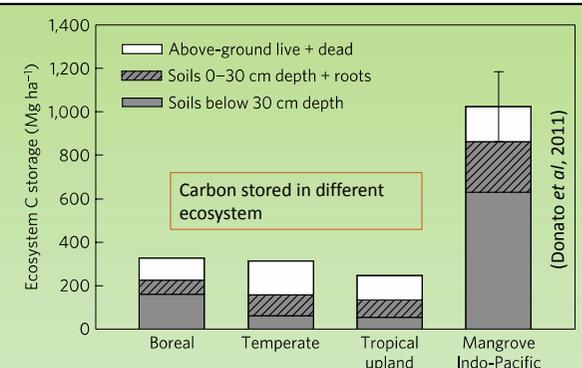


**1. Background**

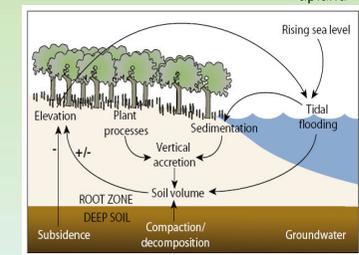
- Carbon Pools (“reservoir”):
  1. Aboveground and belowground biomass of live trees
  2. Non-tree vegetation
  3. Dead wood
  4. Forest floor (litter)
  5. Soils
- Carbon Stocks: amount of organic carbon ( $C_{org}$ ) stored in the ecosystem

**1. Background. Ecosystem and carbon**



Carbon stored in different ecosystem (Donato et al, 2011)



**CHECK THE TIDES**

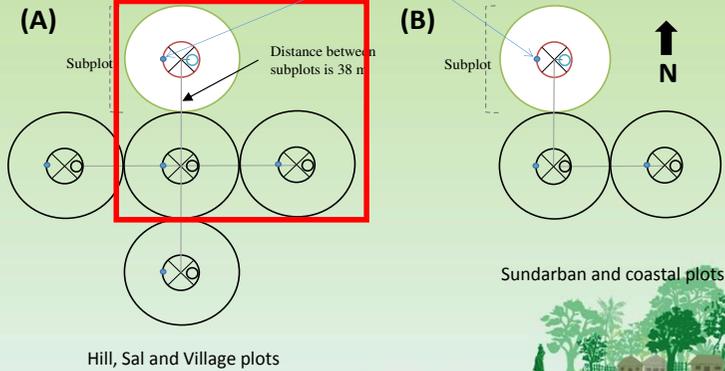
**Carbon Cycling**

## 2. Soil Sampling Strategy

Soil samples will be collected for first 3 sub plots only

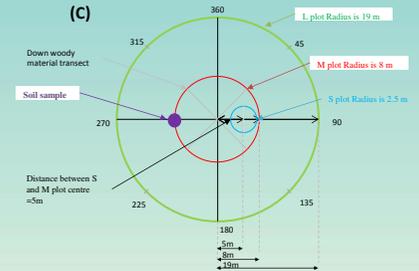
### Plot for Forest Inventory plot design

#### Plot for soil sampling



## 3. Soil Sampling

- Includes:
  - Soil information
  - Soil texture
  - Soil bulk density –organic carbon
- Try to find undisturbed plot in M plot



Complete layout of a Sab-plot (indicating soil sampling plot)

### a. Soil information

Take the information for each subplot:

- Soil condition (dry/moist/wet)
- Soil depth of dark colored horizon

#### Different Soil conditions



Dry soil

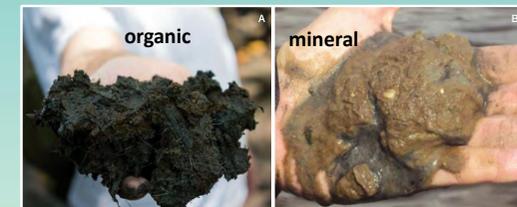
Moist soil

Wet soil

### Dark colored horizon : organic layer



Humuform: H&Tsp 1 Foto: Åke Nilsson

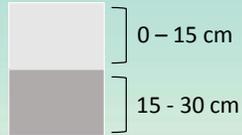


Can be obtained when collect the samples for soil texture (using auger)

### b. Soil Texture

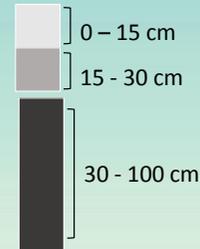
Non mangrove areas

- Core sampler (30 cm)
- Open pit for hard soil



### b. Soil Texture

- Mangrove forest : long auger (140 cm), sampling together with bulk density



Instead of discarding the soil of auger face, this soil part is used as sample of mangrove soil texture

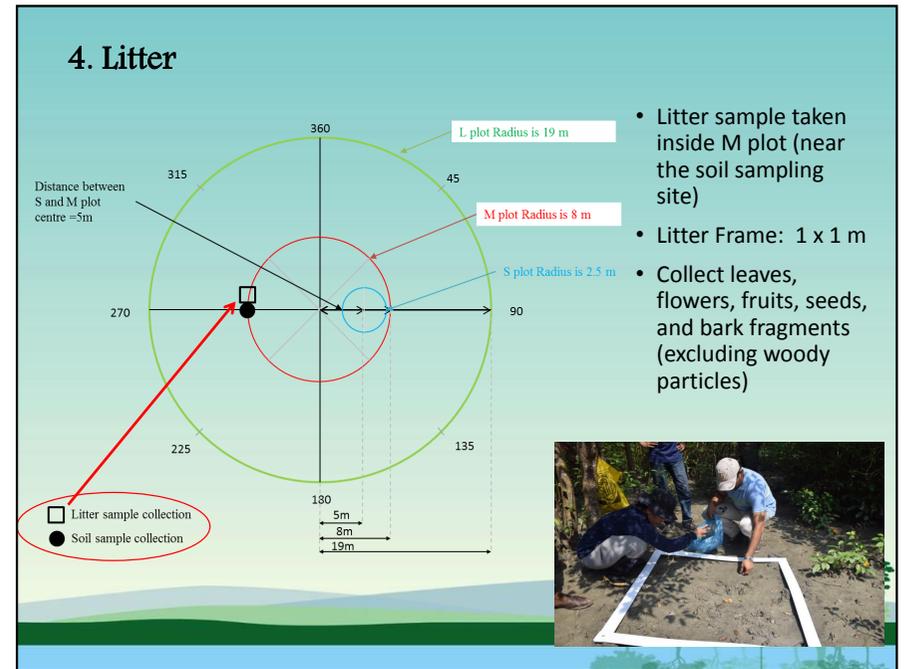
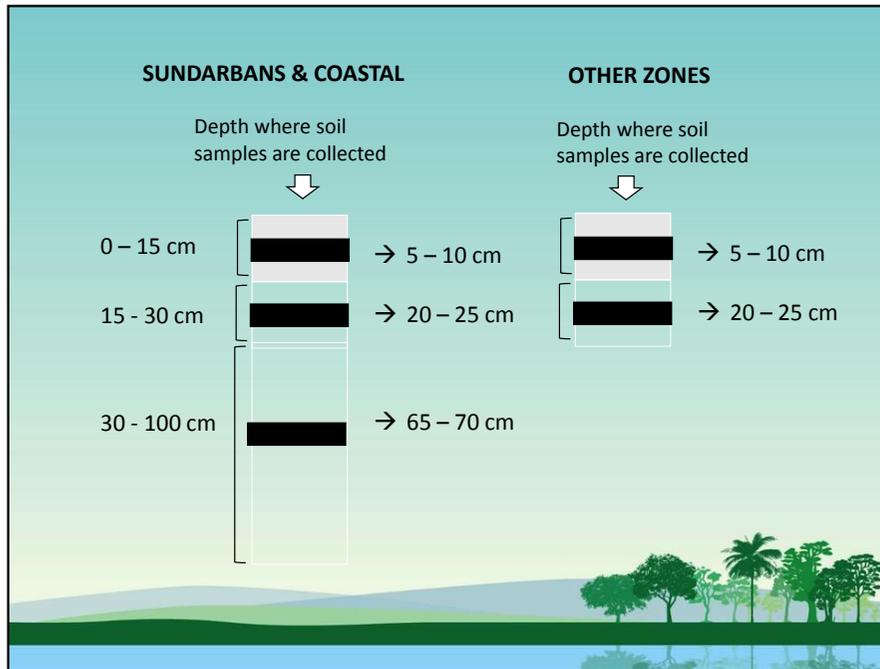
### c. Soil bulk density - $C_{org}$

- Mangrove forest : long auger (140 cm)
- Others : core sampler



### c. Soil bulk density - $C_{org}$

- Find the undisturbed site
- Steady and gently sample collection to avoid compaction
- When the soil is lack of cohesiveness, put the water after the auger insert into soil in order to consolidate the soil.
- Take the documentation
- Always clean the core/auger before collecting new sample



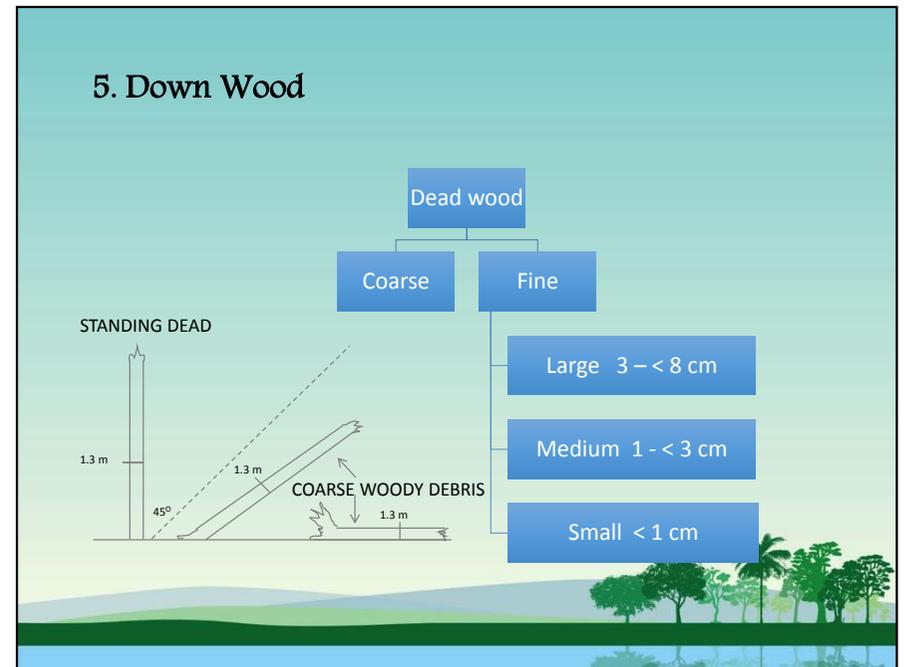
**EACH PLOT :**

**NON MANGROVES:**  
 6 soil texture samples (0 – 15 cm, 15 – 30 cm x 3)  
 6 soil BD-C samples (0 – 15 cm, 15 – 30 cm x 3)  
 3 litter sample bags

**MANGROVES:**  
 9 soil texture samples (0 – 15 cm, 15 – 30 cm, 30 – 100cm x 3)  
 9 soil BD-C samples (0 - 15 cm, 15 – 30 cm, 30 – 100cm x 3)  
 3 litter sample bags

**MAKE SURE THAT ALL SAMPLES ARE WELL LABELED**

DATE/PLOT/SUBPLOT/DEPTH/TYPE/LAND FEATURE



**Down wood measurement**

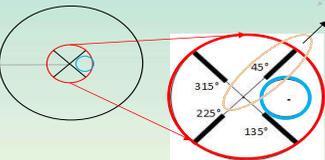
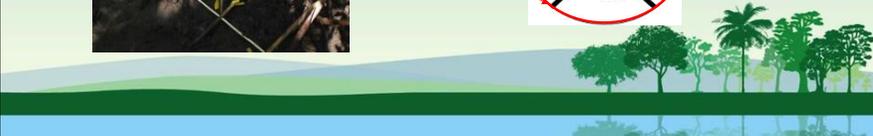
0 - 8 m (A)

Center of the subplot

5 - 8 m (B)



<b>A</b>	- All coarse woods (>8 cm diameter) - Large fine woods (3 – 8 cm diameter)
<b>B</b>	- Medium fine woods (1 – <3 cm diameter) - Small fine woods (< 1 cm diameter)

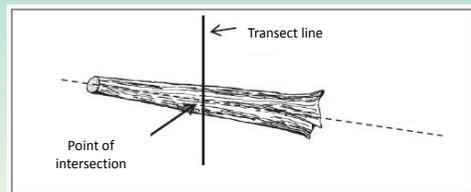
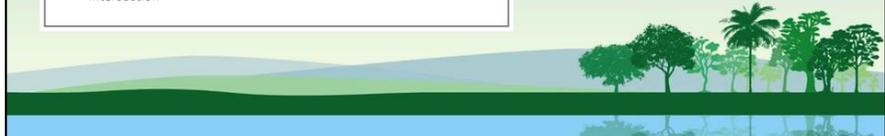



**Down wood measurement**

0 - 8 m (A)

Center of the subplot

5 - 8 m (B)

**Chapter 12**  
**Field data collection using**  
**Open Foris**

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UN-REDD PROGRAMME  
FAO Food and Agriculture Organization of the United Nations

### Content

1. Open Foris
2. Comparison to paper forms
3. How Does it Work?
4. Exporting the data
5. Backing up the data
6. Considerations

### 1. Open Foris

Free open-source solutions for environmental monitoring

What is openforis?

**Open Foris Collect-Mobile is a data collection application that runs on any Android.**

openforis COLLECT MOBILE

### 1. Open Foris

It is a free application  
Desktop collect version can be downloaded from : [www.openforis.org/tools/collect.html](http://www.openforis.org/tools/collect.html)  
Mobile collect version is available in Google play store.

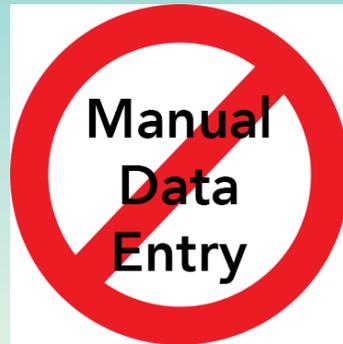
openforis COLLECT MOBILE

The application is still under development and should be periodically updated via Google Play

GET IT ON Google play

## 2. Comparison to Paper Forms

- Validation in the field
  - Error check
  - Required fields
  - Non-relevant fields
- Integrated code and species lists
- Remote data submission via Google Drive
- No secondary data entry required



## 3. How Does it Work?

OPENFORIS

### 3. How Does it Work?

Survey Designer : editing survey "bfi v10"

Survey language: English

Sampling Unit: plot

Form version: [dropdown]

Path: /plot/plot\_record/plot\_start\_time

View mode: Entry Form

Definitions

- plot\_id
- plot\_record
- plot\_date
- plot\_arriving\_from
- plot\_dep\_time
- plot\_do\_from
- plot\_start\_time
- location
- coordinate
- plot\_location
- forest\_admin
- plot\_forest\_div
- plot\_forest\_rang
- plot\_forest\_beat
- plot\_details
- plot\_crewnbr

Time attribute

General

Name: plot\_start\_time

ENTITY (Parent)

Relevant:  Always relevant  Only when expression is verified

ATTRIBUTE (Child)

Required:  Not required  Always required  Only when expression is verified

Dependent nodes

Labels and Tooltip

Label (en): [716] Start time on plot

Tooltip text (en): Record the time when the team arrived at the plot

Other labels

Versioning

Introduced in version: ---

Application version: 3.11.0

Logged as: admin

## 3. How Does it Work?

The format is reflected in the manual...

7.1.1 → PLOT-RECORD¶

[plot\_id]¶

Record the identification number for each plot, unique within a district. This ¶

When collected is	All-plots
Field-width is	3-digits
Tolerance is	No errors
Values is	001 to 2500

7.1.2 → INVENTORY-DATE¶

[plot\_date]¶

Record the year, month and day that the plot was completed. ¶

When collected is	All-plots
Field-width is	List
Tolerance is	No errors
Values is	15/10/2016 to 31/5/2018

7.1.3 → ARRIVING-FROM¶

[plot\_arriving\_from]¶

Record the location the crew is arriving from. If the crew is arriving from another plot (that has been measured/visited in the morning, select 2 and record the number of the previous plot visited in the other field. ¶

When collected is	All-plots
Field Width is	1-digit
Tolerance is	No errors
Values is	Code: Description
	1: FD-Field-Officers
	2: Another-plots
	3: Other

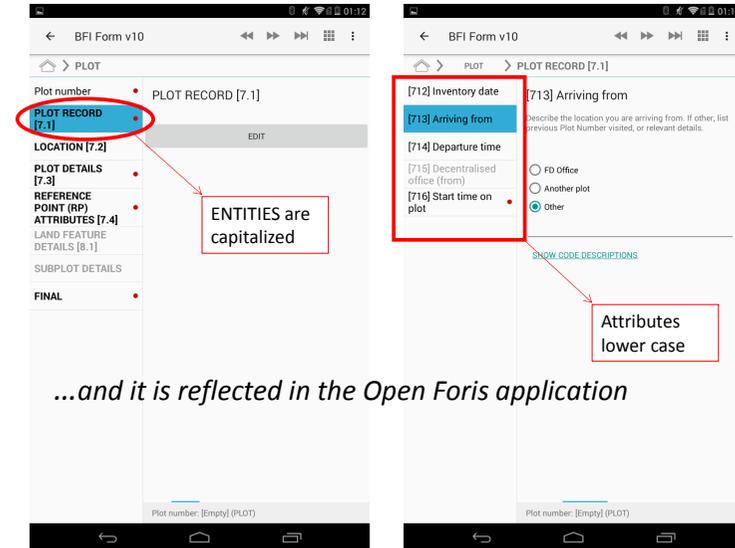
### 3. How Does it Work?

it is also reflected in the paper forms

Bangladesh Forest Inventory.....F1 - PLOT...1/2

PLOT-RECORD-(71)R			
PLOT-NUMBER-(711)R	R		
INVENTORY-DATE-(712)R	R	DEPARTURE-TIME-(714)R	R
ARRIVING-FROM-(713)R	1] FD Field-Office 2] Another-plot 3] Other:.....R		
FROM-DO-(715)R	R	PREVIOUS-PLOT-(725)R	R
START-TIME-(716)R	R	ENDING-TIME-(141)R	R
ADMINISTRATIVE-LOCATION-(72)R		FOREST-ADMINISTRATION-(73)R	
DIVISION-(721)R	R	FOREST-DIVISION-(731)R	R
DISTRICT-(722)R	R	FOREST-RANGE-(732)R	R
UPAZILA-(723)R	R	FOREST-BEAT/SFPC-(733)R	R
UNION-(724)R	R	ZONE-(734)R	R
PLOT-GPS-(74)R			
RP-GPS-NORTH-(741)R	R	RP-GPS-EAST-(742)R	R
CREW-DETAILS-(75)R			

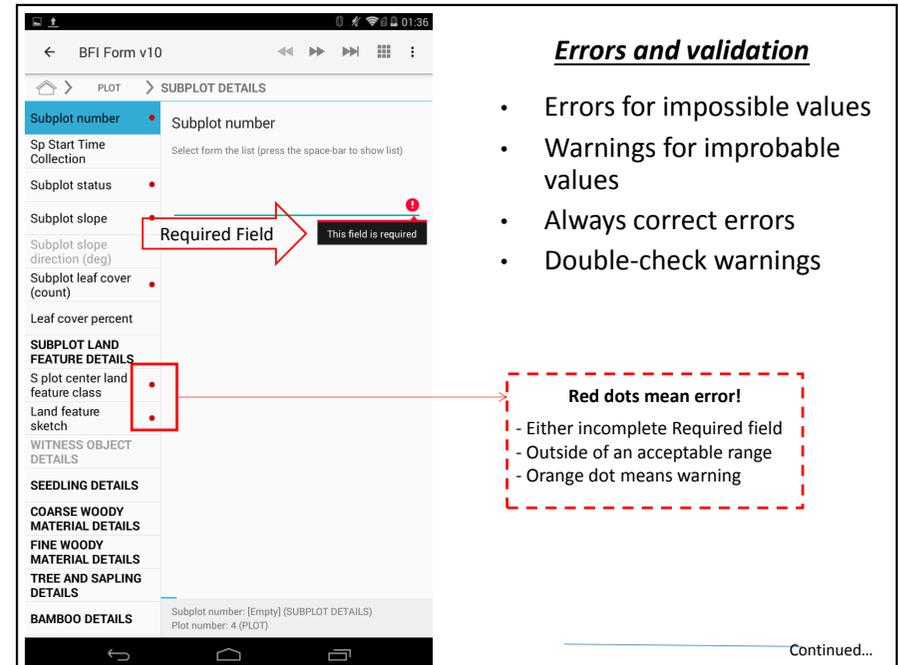
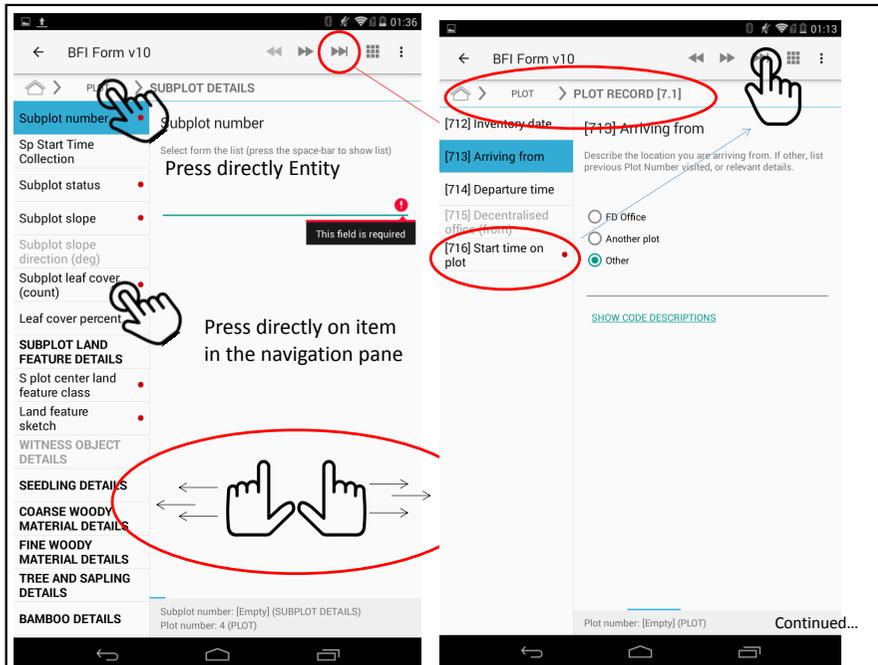
### 3. How Does it Work?



...and it is reflected in the Open Foris application

This has implication for navigating the application

Continued...



### Errors and validation

- Errors for impossible values
- Warnings for improbable values
- Always correct errors
- Double-check warnings

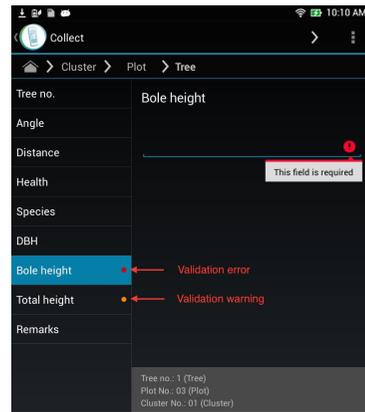
Red dots mean error!  
 - Either incomplete Required field  
 - Outside of an acceptable range  
 - Orange dot means warning

### 3. How Does it Work?

#### Constraint violations

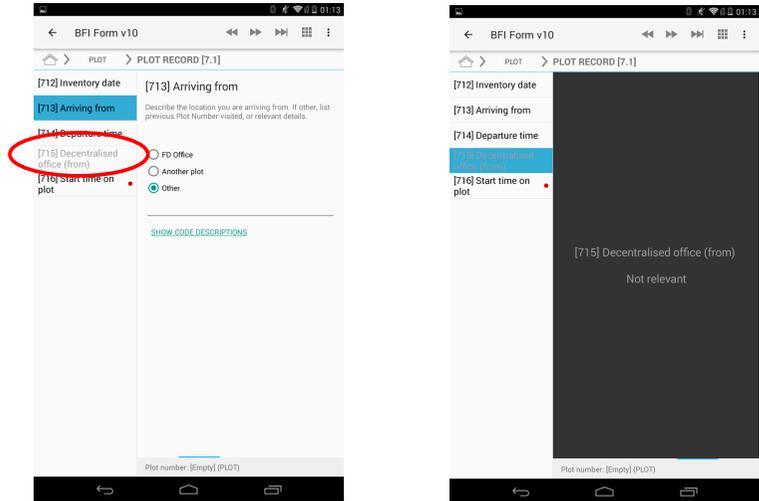
- Errors for impossible values
- Warnings for improbable values
- Always correct errors
- Double-check warnings

*At the end of the plot ensure there are no red dots and double check orange dots*



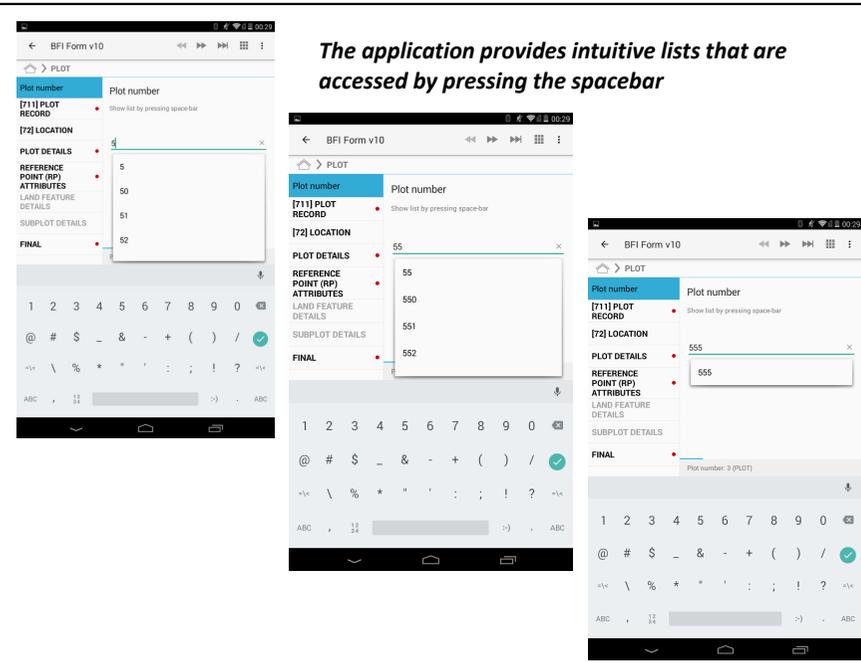
### 3. How Does it Work?

#### Relevance checks

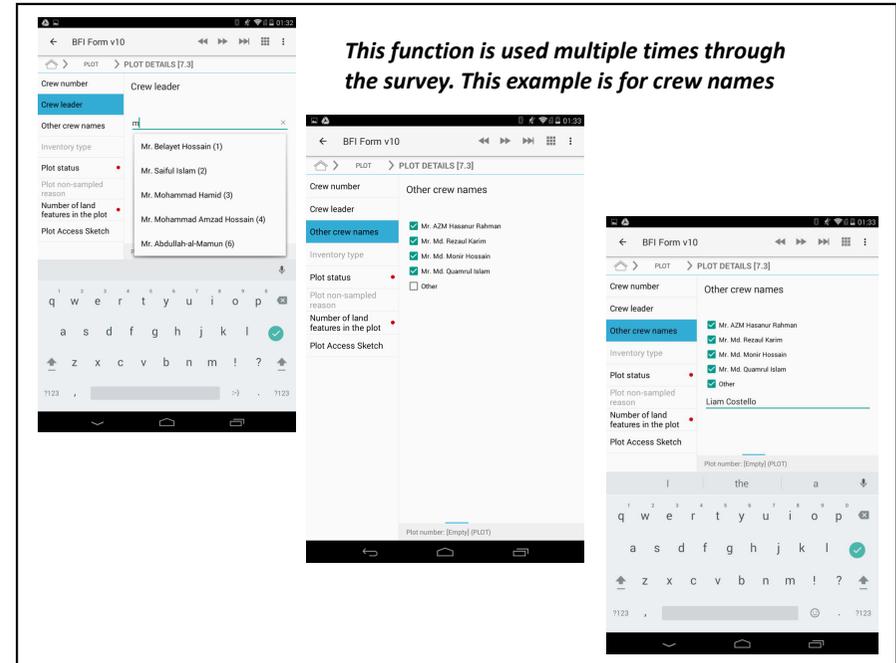


**Attributes are blacked-out when they are not relevant**

Continued...



**The application provides intuitive lists that are accessed by pressing the spacebar**



**This function is used multiple times through the survey. This example is for crew names**

### Entering species name

**1. Begin typing scientific or local name to see the options – consider spelling of local names!**

**2. If unknown type UNK or Other**

**3. Provide descriptive comments**

### 3. How Does it Work?

#### Types of input functions

**Select one**

**Select multiple**

**Attribute**

### 4. Exporting the data

**1. Access the settings via the three small dots on the top right**

**2. Select EXPORT**

**3. Select DRIVE**

**4. Select Add**

### 5. Backing up the data

Data backups are taken after every day's data collection

- Selecting the **Export** button accessed via the menu button
- In the pop-up window, select the “Save data in Download directory” box.
- Now plug a USB pen drive into the device.
- Open the “OI File Manager” manager and navigate to the “Downloads” folder which is located at the path Storage > Emulated > Legacy > Download. The file has a .collect-data file extension.
- Press and hold the file until the option to copy appears at the top of the screen. Press Copy.
- Navigate to the USB folder located at Storage > USB 1.
- Press paste.



## 6. Considerations

- Ensure there are no red dots at the end of the plot assessment
- Screen brightness
  - *During full sunlight the screen can be difficult to see*
- Battery life
  - *Batteries will last one full-day use*
  - *Must charge every night*
- Back up
  - *To be taken at the regional office*
- Removing data from the device
  - *Only to be done in coordination with the BFI unit*
- Protection
  - *To be kept clean, dry and safe*





Chapter 13  
Field data collection using  
Field Forms

USAID FROM THE AMERICAN PEOPLE  
SilvaCarbon  
UN-REDD PROGRAMME  
FAO Food and Agriculture Organization of the United Nations

### Content

1. Field data collection
2. Field Form
3. Structure of the Field Form
4. F1, F2, F3 - Plot
5. F4- Land Feature
6. F7- Subplot
7. F8 - Seedling
8. F9 - Coarse Woody Debris
9. F10 - Fine Woody Debris
10. F11 - Litter and soil
11. F12 - Tree and Sapling
12. F13- Bamboo
13. Conclusion

## 1. Field Data Collection



Very expensive  
Very time consuming  
Very costly

Make sure that the data are collected within the delimited time, in line with the manual and recommendations provided.

Any necessary additional measurements (because of errors/ mistakes) is not budgeted.

## 2. Field Form

Why using paper field form?

- Second data entry in case of technological failure
- Quality control
- To provide information that cannot be provided easily using the tablet
- Sometimes, there is nothing better than a paper and a pencil

### 3. Structure of the Field Form

**FIELD FORMS**

**APPROX. NUMBER OF FIELD FORMS**

- F1 – PLOT 1/3 - 1 per plot
- F2 – PLOT 2/3 - 1 per plot
- F3 – PLOT 3/3 - 1 per plot
- F4 – LAND FEATURE - 1 to 4 per plot
- F5 – LAND FEATURE - 1 to 4 per plot
- F6 – LAND FEATURE - 1 to 4 per plot
- F7 – SUBPLOT - 5 per plot
- F8 – SEEDLING - 1 per plot
- F9 – COARSE WOOD DEBRIS - 1 per plot
- F10 – FINE WOOD DEBRIS - 1 per plot
- F11 – LITTER AND SOIL - 1 per plot
- F12 – TREE AND SAPLING DATA - at least 1 per plot
- F13 – BAMBOO - 1 per plot
- F14 – SPECIMEN DATA - As required

Should be at least 11 field forms per plot. If no trees are found in one plot, you provide the form without data entry. Make sure the field forms are numbered.

### 4. F1 – Plot (1/3)

ON ALL FORMS, INDICATE THE PLOT NUMBER

All variables to have a code that corresponds to the number of the paragraph in the manual

- Multiple selection possible
- Single choice possible

Notes: provide comments here

Indicate in the RP note, if the RP is not taken in the subplot center, and any other information to help to find the RP

This is important!! Will allow you to well remember that particular plot

### 4. F2 – Plot (2/3)

Symbol	Code	Name
—●—	Ra	Road
—	R1	Highway: Road surface, more than two lanes, connected to secondary roads
---	R2	Secondary Road: Road surface, one lane, connected to R1
---	R3	Road: Loose surface, one lane, unopened
.....	R4	Provisional road: Loose surface
—+—	Rx	Railway
— —	W	Wall
—P—	Po	Open Ditch
—F—	Fo	Demarcated Forest Officer
—M—	Mo	Mosque, Church, Temple etc.
—R—	Rx	River Stream
—C—	C	Canal/Channel
—E—	Ep	Electric Pole
—F—	F	Field: Spine Field
—R—	Ra	Road Settlement: Cluster of houses
—M—	M	Market Area
—T—	T	Temporary Dissection

Important to help the team with the DGPS to find the plot location

Important to help any re-measurement process

### 4. F3 – Plot (3/3)

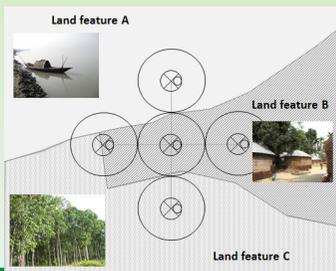
Include a record of conversations with a plot landowner/contact. While not a part of the official plot record, this information documents that permission was obtained.

### 5. F4- Land Feature

Bangladesh Forest Inventory F4 - LAND FEATURE /

PLOT NUMBER (611)	
LAND FEATURE DETAILS (71)	
LAND FEATURE (711)	LAND FEATURE STATUS (712)
SIZE OF LAND FEATURE (713)	OWNER GROUP (714)
LEGAL STATUS (715)	LAND FEATURE SERVICES (716)
MIN CROWN COVER (717)	MAX CROWN COVER (7172)
LAND FEATURE ISSUES (718)	FIRE (7181)
EROSION (7182)	IMPACT (7183)
LAND FEATURE PHOTOS (719)	PHOTO POSITION (7110)
RECOMMENDED CLASS NAME (7111)	

At least one land feature is described in each plot.



### 5. F5- Land Feature (Objects)

Each land feature must have at least one object assigned

Bangladesh Forest Inventory F5 - LAND FEATURE /

LAND FEATURE OBJECT DESCRIPTION (72)		PLOT NUMBER (611)	
OBJECT ID (721)	VEGETATION TYPE (7211)	ARTIFICIALITY (724)	OBJECT NO. OF COVER (725)
GROWTH FORM / AGE (726)		MANAGEMENT (727)	
TREATMENT (728)		ROTATION (729)	
CROP (7210)		CULTIVATION STATE (72102)	
WATER SUPPLY (72103)			
S4 NON-VEGETATED DETAILS		S5 WATER BODY DETAILS	
OBJECT ID (721)	NON-VEGETATED OBJECT TYPE (72111)	NON-VEG N COVER (7212)	WATER BODY (7213)
		WATER SALINITY (7214)	WATER N COVER (7215)
LAND FEATURE NOTES (7216)			

1 Vegetated object types: 1. Tree, 2. Shrub, 3. Herb  
 11 Natural or semi-natural; 2. Cultivated  
 11 Unopen age natural forest; 2. Unopen age semi-natural forest; 3. Unopen plantation; 4. Even age plantation; 5. Even age young plantation; 6. Even age mature plantation  
 10. None observed; 1. Rubber plantation; 2. Tea garden; 3. Sapling plantation; 4. Medicinal plantation; 5. NTFP plantation; 6. Woodlot plantation; 7. Central plantation; 8. Plantation (commercial); 9. Agroforestry system; 10. Orchard; 11. Copeland; 12. Turpin; 13. Urban parkland; 14. Bamboo grove on hill; 15. Village Common Forest; 16. Other  
 10. None observed; 1. Thinning; 2. Weeding; 3. Selective felling; 4. Group felling; 5. Strip felling; 6. Clear felling; 7. Sanitary cutting; 8. Prescribed burning; 9. Natural Regeneration; 10. Assisted Natural Regeneration; 11. Artificial regeneration; 12. Climber cutting; 16. Other; 19. Not known  
 11. Less than 10 years; 2. 10 to 20 years; 3. 20 to 30 years; 4. Greater than 30 years; 99. Unknown  
 11. Fallow; 2. Conventional tillage; 3. Reduced tillage; 4. No tillage; 5. Recently harvested  
 10. Not irrigated; 1. Irrigated; 2. New Flooding; 3. Rainfed; 4. Rainfed and Irrigated; 16. Other; 99. Unknown  
 1. Non-vegetated object types: 1. Soil; sand deposit; 2. Building Remains; 3. Road/Rail/Communication infrastructure; 4. Dump/old Excavation; 5. Salt pan; 6. Sand bar; 7. Beach; 8. River banks  
 1. Water body: 1. River; 2. Canal; 3. Pond; 4. Lake; 5. Stream; 6. Swamp; 7. Lake; 8. Stream; 9. Canal; 10. Other  
 = 1. Fresh; 2. Saline

### 5. F6- Land Feature

Bangladesh Forest Inventory F6 - LAND FEATURE

PLOT NUMBER (611)	
SUBPLOT DATA COLLECTION (6)	
SUBPLOT DETAILS (61)	
SUBPLOT STATUS (612)	
SUBPLOT SLOPE (613)	
SUBPLOT LEAF COVER (COUNT) (615)	
SUBPLOT NOTES (64)	
SUBPLOT WITNESS OBJECTS (65)	
WITNESS OBJECT TYPE (652)	
WITNESS OBJECT ID (653)	
WITNESS OBJECT DISTANCE (654)	
WITNESS OBJECT DISTANCE (655)	
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10m transect

### 6. F7- Subplot

Bangladesh Forest Inventory F7 - SUBPLOT /

PLOT NUMBER (611)		SUBPLOT NUMBER (61)	
SUBPLOT DATA COLLECTION (6)			
SUBPLOT DETAILS (61)			
SUBPLOT STATUS (612)			
SUBPLOT SLOPE (613)			
SUBPLOT LEAF COVER (COUNT) (615)			
SUBPLOT NOTES (64)			
SUBPLOT WITNESS OBJECTS (65)			
WITNESS OBJECT TYPE (652)		WITNESS OBJECT ID (653)	
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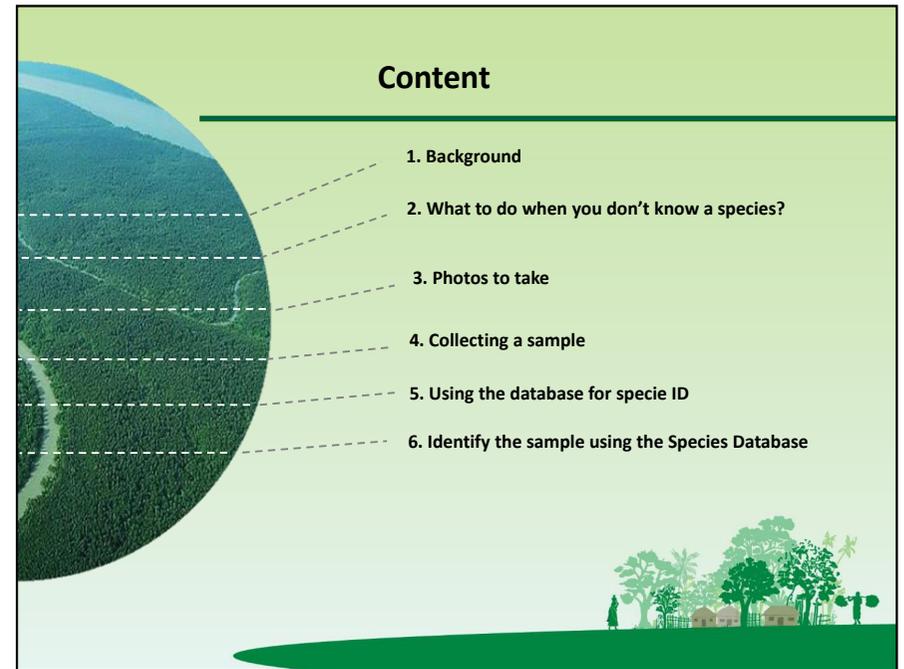
10m transect





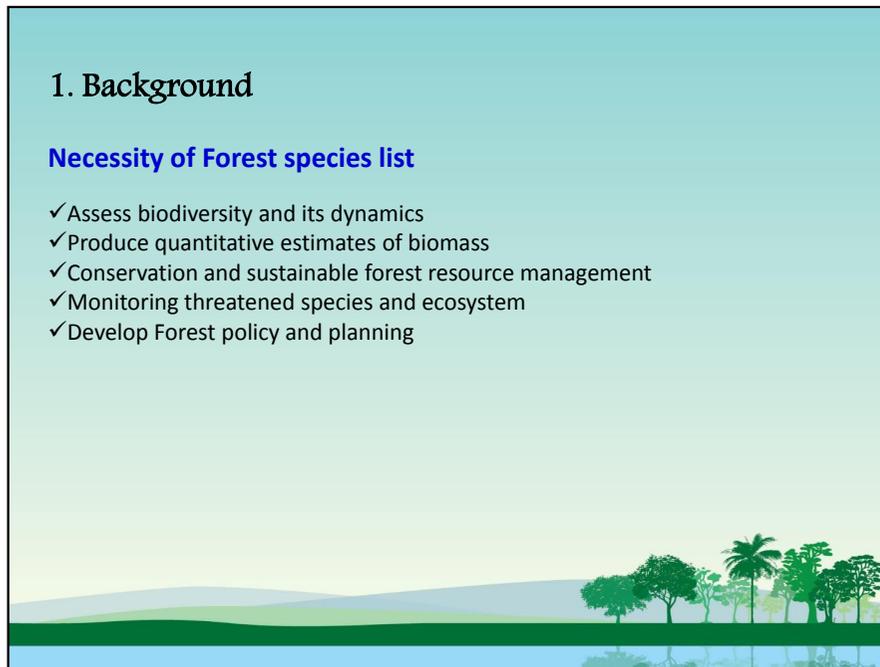


Chapter 14  
Specimen Collection – Botanical Identification

### Content

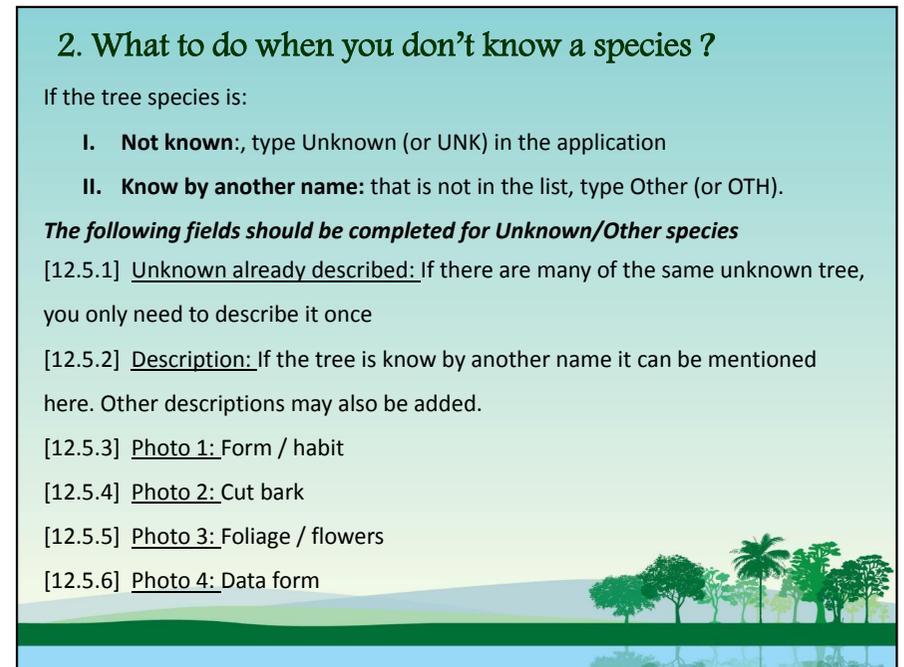
1. Background
2. What to do when you don't know a species?
3. Photos to take
4. Collecting a sample
5. Using the database for specie ID
6. Identify the sample using the Species Database



### 1. Background

#### Necessity of Forest species list

- ✓ Assess biodiversity and its dynamics
- ✓ Produce quantitative estimates of biomass
- ✓ Conservation and sustainable forest resource management
- ✓ Monitoring threatened species and ecosystem
- ✓ Develop Forest policy and planning



### 2. What to do when you don't know a species ?

If the tree species is:

- Not known:**, type Unknown (or UNK) in the application
- Know by another name:** that is not in the list, type Other (or OTH).

**The following fields should be completed for Unknown/Other species**

[12.5.1] Unknown already described: If there are many of the same unknown tree, you only need to describe it once

[12.5.2] Description: If the tree is know by another name it can be mentioned here. Other descriptions may also be added.

[12.5.3] Photo 1: Form / habit

[12.5.4] Photo 2: Cut bark

[12.5.5] Photo 3: Foliage / flowers

[12.5.6] Photo 4: Data form



#### 4. Collecting a Sample

##### WHAT TO COLLECT?

- Twigs with leaves, flowers and/or fruits
- Photographs
- Associated data



##### WHAT TO LOOK FOR IN A SPECIMEN?

- A healthy, mature plant
- Specimens in good condition
- Specimens representing the range of variation
- Plant in flowering and/or fruiting condition



#### 4. Collecting a Sample

##### Pressing of specimens

Specimens are laid evenly in folded newspaper between layers of blotter/newspaper and corrugated aluminum sheet. The larger specimen may be folded in V, N, M or W shapes.

##### Drying of the specimens

- The press is opened after 24 hour to change the blotters/newspaper for first time.
- The new pile of blotters and specimens is then locked up in the plant press and placed in the sun to dry.
- The process is repeated until the specimens are completely dried.



#### 5. Using the Database for Specie ID

**Bangladesh National Herbarium**  
Search Tree

search by Family    search by Genus    search by Species    search by local name

Habit:	Bark texture:	Bole:	Thorn:
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Leaf persistence:	Petiole:	Stipules:	Leaf type:
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Leaf arrangement:	Leaf venation:	Inflorescence:	Floral symmetry:
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Floral type:	Floral attachment:	Corolla aestivation:	Fruit:
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Sexual Reproductive Unit:	<input type="text"/>		
<input type="text"/>	<input type="text"/>		

#### 6. Identify the Sample using the Species Database

**Bangladesh National Herbarium**  
Tree Details

Family Name : Saurauia  
Genus : Saurauia  
Species : Saurauia rooiburghii  
Author Name : Wall.  
Synonyms : Saurauia thorallii auct. non Fin. & Gagnep., Saurau  
Vernacular Name:  
English Name:  
Description : A large shrub or small tree, up to 10 m tall, young stem and branches covered with ferruginous-tomentose hairs, mixed with minute acute scales. Leaves simple, alternate, 10-15 x 2.9 cm, elliptic-ovoblong, oblanceolate, base acute or cuneate, acute or shortly acuminate at the apex, margin obtusely or finely serrulate, glabrous above, tomentose beneath. Flowers in axillary cymes, thinly tomentose. Sepals 5, free, ovate to ovate-rounded, glabrous. Petals 5, white or pink, ovate, connate at the base, rounded at the apex, glabrous. Stamens numerous. Ovary ovoid, glabrous, styles 5, rarely 6, 1-2 mm long, connate below. Fruit a berry, sub-globose, fleshy, whitish. Seeds numerous, minute, brown.  
Fruits & Flowering Period : March-October  
Habitat : Edges of evergreen forests, often along streams.  
Distribution : Forests of Sylhet, Chittagong and Cox's Bazar dist  
Uses : Leaves are used as fodder and the wood for house

**Photographs :**

**BARK TYPES**



**1. EXFOLIATING**  
*Peels off in sheets leaving a mottled colour pattern*



**2. FISSURED**  
*Moderate to deep cracks and grooves in bark*



**3. FURROWED**  
*Shallow, vertical lines or grooves*



**4. PLATED**  
*Small, frequent segmented or tessellated pattern.*



**5. SHREDDY**  
*Peels off in shreds or string-like portions*



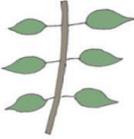
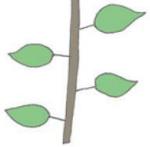
**6. SMOOTH**  
*Flat and smooth to the touch. Limited colour variation*

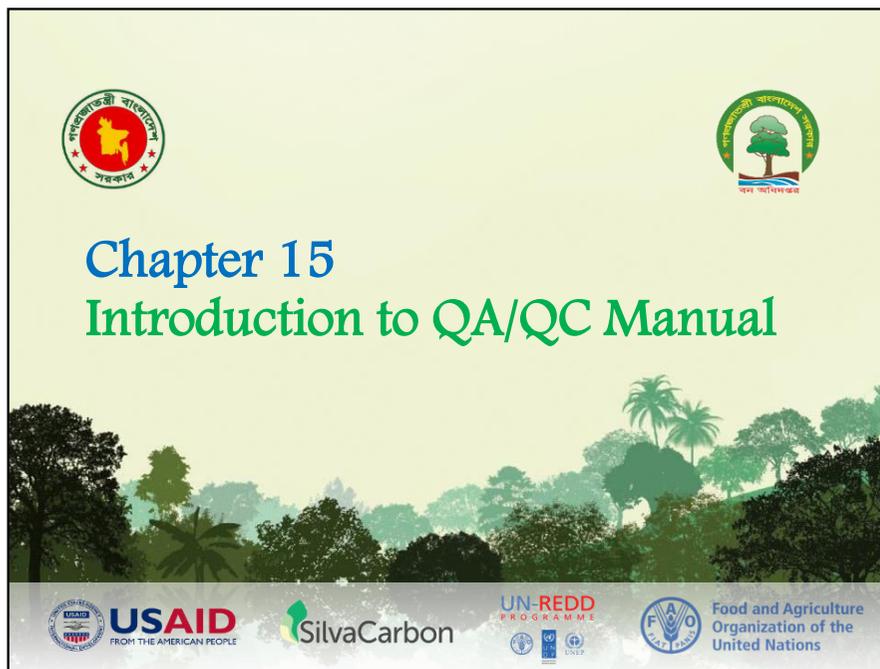


**7. WINGED**  
*Flattened woody protrusions attached to stems*



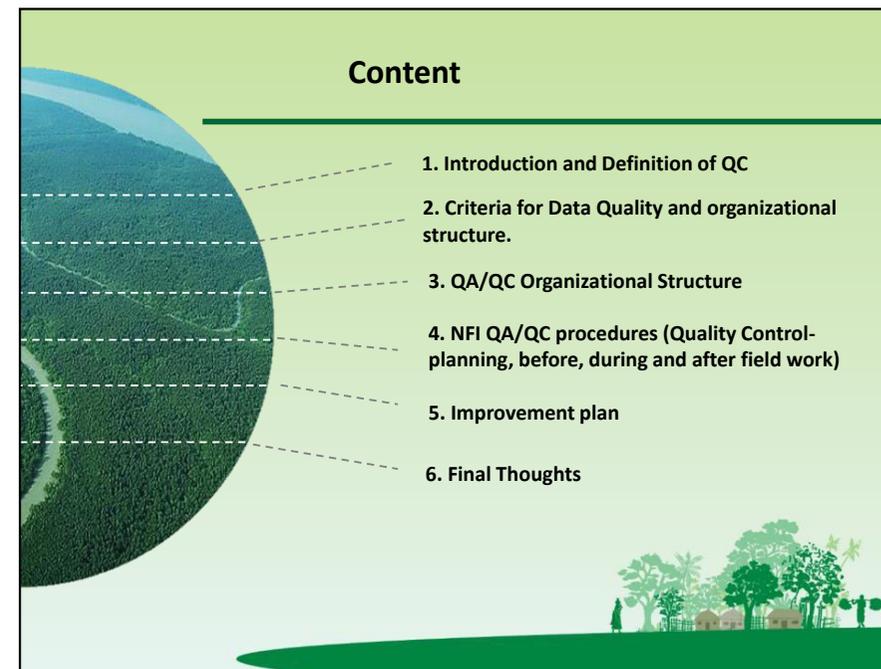
**8. SPIKEY**  
*Pointed spikes protrusions attached to stems*

Leaf Types		
		
Simple	Opposite	Alternate
		
Pinnate	Bipinnate	Tripinnate
		
Whorle	Palmate	Compound



Chapter 15  
Introduction to QA/QC Manual

USAID FROM THE AMERICAN PEOPLE  
SilvaCarbon  
UN-REDD PROGRAMME  
FAO Food and Agriculture Organization of the United Nations



### Content

1. Introduction and Definition of QC
2. Criteria for Data Quality and organizational structure.
3. QA/QC Organizational Structure
4. NFI QA/QC procedures (Quality Control-planning, before, during and after field work)
5. Improvement plan
6. Final Thoughts

### 1. Introduction and Definition of QC

Quality Control (QC) is a system of routine technical activities, to measure and control the quality of the inventory as it is being developed. The QC system is designed to:

- Provide routine and consistent checks to ensure data integrity, correctness, and completeness;
- Identify and address errors and omissions;
- Document and archive inventory material and record all QC activities.

From the IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories

### 2. Criteria for Data Quality

1. **Precision**—the ability of a method to reproduce the same value
2. **Accuracy**—the ability of a method to yield the “true” value
3. **Completeness**—the amount of valid, usable data produced by a method
4. **Comparability**—the ability to combine data collected in different locations, and by different data collectors

## 2. Criteria for Data Quality

Quality assurance and quality control (QA/QC) are fundamental for the Bangladesh Forest Inventory (BFI) to reach its objectives.

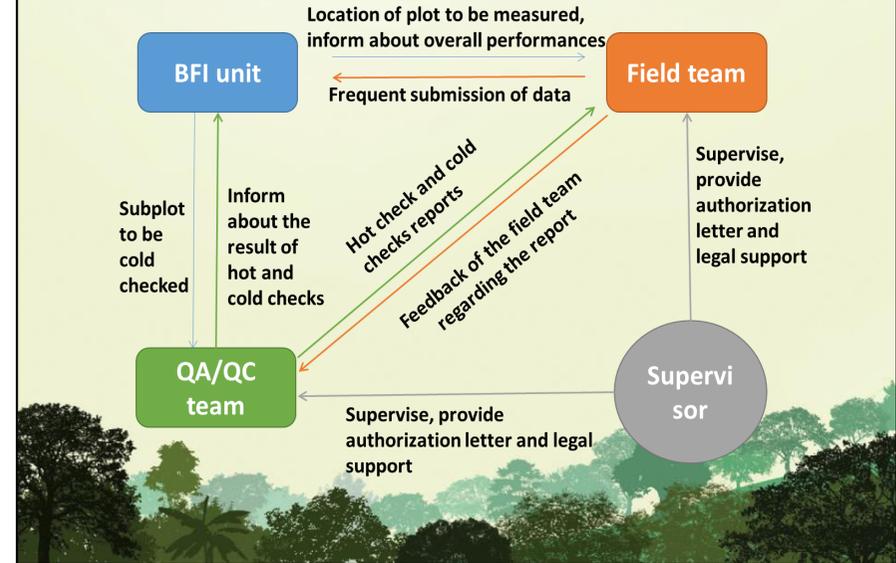
### Optimal situation



### Failure



## 3. QA/QC Organizational Structure



## 4. NFI QA/QC procedures

### QA Phases in the NFI:

1. Inventory planning phase
2. Before field work (pre-field)
3. During field work (including hot checks & cold checks)
4. After field work (post-field)



## 4.1 Quality Control. Inventory planning phase

1. Development of a field manual
2. Establishment of Measurement Quality Objectives (MQOs)
3. Designation of QA/QC specialists
4. Training and certification of field crews



## 4.1 Quality Control: Inventory planning phase

### Database validation rules

While designing the database a set of validation rules can be defined to check for correctness, consistency and accuracy of the data collected. Validation rules for the BFI includes:



- Data type validation
- Range checks and constraint validation
- Cross checks



## 4.2 Quality Control: before field work

Each variable has a Measurement Quality Objectives (MQOs) composed by 2 parts: (1) a **tolerance**, and (2) a **compliance standard**.

- (1) **Tolerance** is the maximum measurement error accepted, expressed in percentage on the real value, and
- (2) **Compliance standard** is the maximum number of errors accepted, expressed in percentage on the number of measured individuals.



### Examples:

For variable "DBH" (diameter at breast height):

**Tolerance** = 1. Tolerance =  $\pm 10\%$

**Compliance standard** = at least 90% of measurements



## 4.3 Quality Control : during field work

### Hot checks

- **Objective:** To assess the precision of the measurements of a Field crew, and provide immediate feedback that will improve the precision of future measurements.
  - A QA/QC team accompanies a field team to a plot. The QA/QC team observes how the regular team works paying attention to measurement techniques, communication, and efficiencies.

### Cold checks

- **Objective:** To assess the precision of the measurements of a field crew by re-measuring a plot after 2-4 weeks.
  - A QA/QC team measures a plot which has previously been measured by a field crew, compare the results and produce a scoring report



### Hot checks



Hot Checks are a great opportunity to:

- Offer comments and answer questions on an item by item basis
- Point out techniques to be used when conventional methodology does not work
- relate past experiences that have helped in future decision making
- Point out good work as well as areas for improvement

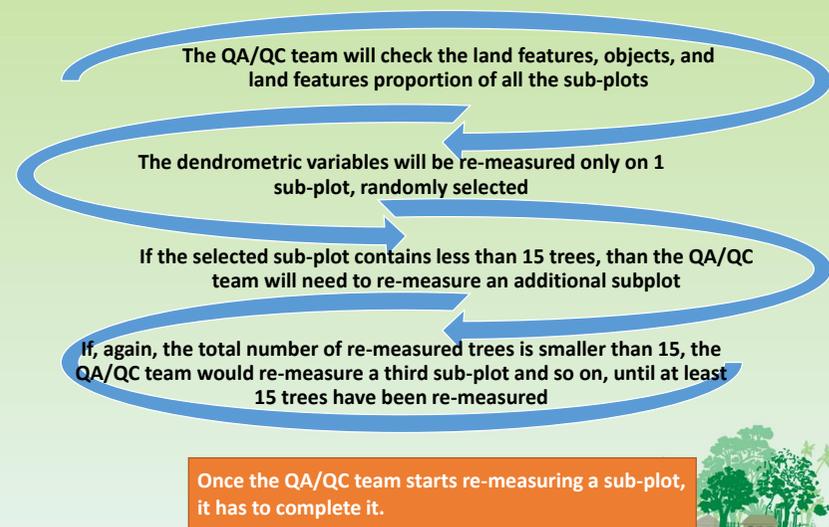


### Cold checks

- At the time of inspection, the QA/QC team has the completed data in hand so direct comparisons can be made in the field.
- Implemented such that the crews do not know when or if a given plot will be checked
  - With this, the field crew cannot alter their performance because of knowledge that the plot is a QC plot.

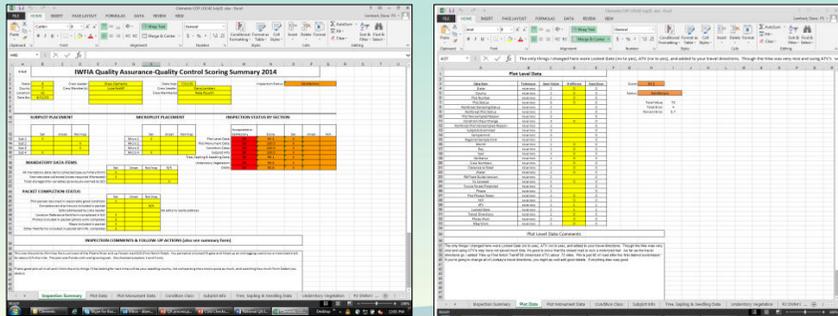


### Cold checks. What to measure?



### QA/QC evaluation form

- After the plot has been cold-checked, all the errors that have been identified by the QA/QC team have to be entered into the **cold-check score sheet**
- The score sheet, once filled, automatically provides a QA/QC score which can be used to assess the work of the field crew. A score of 100% means that no errors have been found, scores smaller than 85% are considered unsatisfactory



### QA/QC evaluation form

#### Appendix II. Cold Check Report Example

Based on the information contained in the score sheet, the QA/QC team compiles a cold-check report

636	Plot Quality Rating: 87.5%
Plot Completed: 9/12/12 dit: 9/21/12	
D. Coles, J. Williams Plot Cold Checked: 8/2/12 Feedback Provided: 8/4/12	

Location: Gifford Pinchot National Forest, Mount St. Helens National Volcanic Monument  
 Inspector: Cowlitz  
 Plots Measured: N1 and N3 were fully inspected; N2 and N4 were partially inspected.  
 Elevation: 2,966 ft.  
 Description: This plot was on the SW side of Mount St. Helens at the base of Goat Mountain and adjacent to Goat Marsh. It was an old growth mix of Western hemlock, Silver fir, Noble fir, Sub-alpine fir and Douglas-fir.  
 Summary: **VERY: Much of the plot was well done though there were a couple major errors that brought the score considerably. There was a missed and added tree as well as a missed and added seedling on a plot that had 1 seedling between all 4 microplots. Aside from that were just some minor errors described below.**

**JACKET and CONTENTS**

**Jacket**

**Inventory Contact Sheet:** N/A  
**Photos:** Good.  
**Plot Card:** Good.  
**Location & Description:** Directions were good but were missing the last mileage on FS rd. 0123 that leads up the trail head.  
**Site Map:** Good.

### 4.3 Quality Control : during field work



At least 7% of the plots are cold checked. It is also recommended to cold-check each field crew at least 3 times.



At least 3% of the plots are hot checked.

### 4.3 Quality Control : during field work



Tablets/androids

Check for errors in the field, during data collection

- **Objective:** To avoid unexpected, invalid, and missing values
- Use of **Portable Data Recorders (PDRs)** or other electronic devices is tremendously helpful to avoid data collection errors. PDRs can be pre-programmed with valid codes, ranges of values, and logical combinations of values; they can also be programmed to identify missing values.

Frequent transfer of field data to a central location for back-up

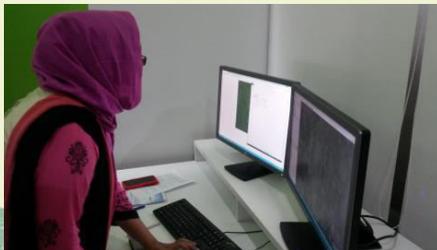
- **Objective:** To prevent loss of data due to lost or damaged PDRs or corrupted digital files, or due to lost field forms.

### 4.4 Quality Control : after field work

#### a) Check for errors in the office

- For example, check for unexpected values (e.g., unreasonably large values of DBH, height, etc., or tree species being recorded in unexpected locations).
- This is typically done by a central QC specialist and/or database specialist (with forestry expertise).

#### b) Transfer of all data, either before or after error-checking, to a central database.



## 5. Improvement plan



**Objective:** Identification of the necessary actions to improve the next national forest inventory cycle

**Definition:** To improve the quality of next inventory necessary actions needs to be inventories.

The improvement plan will be developed by the BFI unit.

The improvements areas will mainly center around three issues:

- (1) identifying source of errors,
- (2) coordination between institutions especially for data collection,
- (3) building capacity.

## 5.1 Improvement of the Data Quality

- Data collected provides feedback for realistic MQOs
- Revise methods to reduce errors
- Improve training
- Aid in interpretation of results



## 6. Final Thoughts

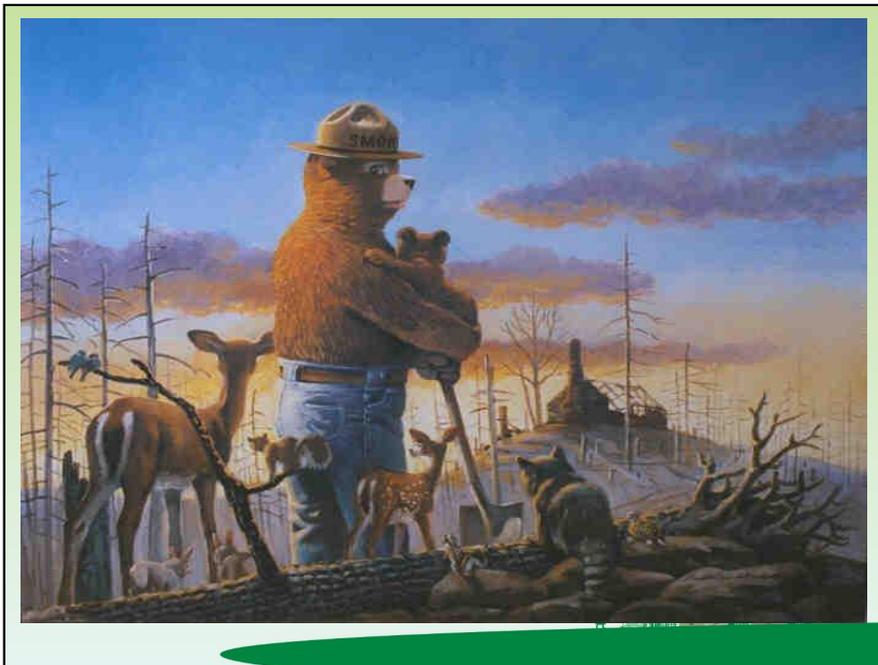
The QA crew should take care in evaluating errors.

- Differences in measurements are only considered “errors” when they are greater than the tolerance set for the variable in question.
- Measurements of the QA crew must be done very carefully to ensure that they are correct, before determining whether the field crew’s measurements were incorrect.

A minimum number of Hot and Cold checks should be done on every crew.

Take care on your Cold Check evaluations pointing out what the field crew should work on as well as pointing out positive aspects of their work

- Before making a determination of right or wrong, consider the field crew’s notes and look at the situation from their perspective.



ISBN: 978-984-34-2716-8