



Two-Week Training Programme for WPO/ACF/RFO
on
**“Preparation of Working Plan Forest Resource Assessment
using RS/GIS & Field Inventory Method ”**

Dated: 15-01-2024 to 25-01-2024

Demonstration of Data Processing App

Forest Survey of India,
Ministry of Environment, Forests and Climate
Change

Dehradun. www.fsi.nic.in

22nd January, 2024



Calculation Steps for Growing Stock

Steps to Calculate Estimated Stems & Volume

- Calculate individual tree volume using the State/ UTs wise Volume Equations.
- Calculate Crop Composition wise Vegetated Area.
- Calculate Crop Composition wise Stem & Volume per hectare and Estimated Trees and Volume.

Steps to Calculate Estimated Stems & Volume

Step 1: Extract the total number of Plots where inventory has been carried out.

Step 2: RFA Area of the Forest Division for processing.

Step 3: Extract the Forested Plots from the Plot Description Form (PDF) ; ie plots having all the Legal Status except 5 (LS <> 5)

Step 4: Extract the Vegetated Plots from the Plot Description Form (PDF) ; ie plots having all the Legal Status except 5 (LS <> 5) and Land Use code in 01,02,03.

Steps to Calculate Estimated Stems & Volume

Step 5: Derive the per plot area. **Area for processing / Vegetated plots gives per plot area.**

Note: If Crop Composition '00' ie Not reported exists in the PDF i.e. based on the condition Legal Status except 5 (LS \neq 5) and Land Use code in 01,02,03 and Crop Composition is equals to '00' then per plot area will be revised using [**Area for processing / (Vegetated plots –No. of plots where CC IS '00')**]

Step 6: Derive the Crop Composition (CC) wise number of vegetated plots bases on the condition Legal Status except 5 (LS \neq 5) and Land Use code in 01,02,03 and Crop Composition is not equals to '00'

Steps to Calculate Estimated Stems & Volume

Step 7: Derive the Crop Composition wise number of Net vegetated plots bases on the condition Legal Status except 5 (LS \neq 5) and Land Use code in 01,02,03 and Crop Composition is not equals to '00' and Plot Status in 1 & 5.

Step 8: Derive the CC wise Vegetated Area. **Step 6 multiply with step 5 gives the CC wise vegetated area.**

Step 9: Calculate the CC wise number of subplots and there area (in sq meter) with applying the slope correction factor (Subplot is 8 meter radius). Condition is Legal Status except 5 (LS \neq 5) and Land Use code in 01,02,03 and Crop Composition is not equals to '00' and Plot Status in 1 & 5 and SubPlot status in 1 & 4 and Species code < 2001

Steps to Calculate Estimated Stems & Volume

Step 10 : Calculate the CC wise number of trees and enumerated volume of the trees. Condition is Legal Status except 5 (LS \neq 5) and Land Use code in 01,02,03 and Crop Composition is not equals to '00' and Plot Status in 1 & 5 and SubPlot Status in 1 & 4 and Species code < 2001

Step 11: Calculate the cc wise stem and volume per ha. No of trees/ (Subplots Area from Step 9/10000) and Enumerated Volume / (Subplots Area from Step 9/10000)

Step 12: Calculate CC wise estimated trees and volume. Stems/ ha * Vegetated Area from Step 8 ; Volume/ ha * Vegetated Area from Step 8

Estimation for Vegetated Area

				LS <> 5	LS = 5	LS <> 5, LU(1, 2, 3)	LS <> 5, LU(1, 2, 3), CC=00	C/(H-I)			LS <> 5, LU(1, 2, 3), CC<>00	LS <> 5, LU(1, 2, 3), CC<>00, PS (1,5)		J*M
B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
State Name	Area (Sq Km)	No of Plots HQ	No of Plots	Forested Plots	Private Plots	Vegetated Plots	Vegetated Plots CC00	Area Factor	Crop Composition	Crop Composition	Vegetated Plots CC Wise	Net Vegetated Plots	Net Vegetated Plots CC Wise	Vegetated Area sq km
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	01	Fir	9	641	7	308.66
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	02	Spruce	2	641	2	68.59
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	03	Fir-spruce	3	641	3	102.89
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	04	Blue pine (Kail)	1	641	1	34.30
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	05	Deodar	8	641	6	274.37
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	06	Chir-pine	220	641	199	7,545.10
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	07	Mixed conifers	3	641	3	102.89
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	08	Oak-Rhododendron Forest	88	641	75	3,018.04
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	09	Up-land hardwoods	20	641	18	685.92
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	10	Teak	6	641	6	205.78
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	11	Sal	71	641	70	2,435.01
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	17	Khair forest	4	641	4	137.18
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	20	Teak with Misc	5	641	5	171.48
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	21	Sal with Misc	40	641	36	1,371.84
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	22	Mixed bamboo	1	641	1	34.30
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	25	Anogeissus pendula (Kardhai)	1	641	1	34.30
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	26	Teak mixed with Sal	1	641	1	34.30
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	27	Conifers mixed with hardwoods	4	641	3	137.18
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	28	Khair and Shisham	3	641	3	102.89
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	29	Oaks	87	641	82	2,983.75
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	30	Low land Hardwood	53	641	50	1,817.68
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	31	Miscellaneous forest	76	641	59	2,606.49
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	32	Eucalyptus	5	641	5	171.48
Uttarakhand	24,418.70	953	953	920	32	726	14	34.30	33	Eucalyptus with Miscellaneous	1	641	1	34.30
											712		641	

Estimation for Vegetated Area

L	LS <> 5, LU(1, 2, 3) , PS (1,5), SPS(1,4)		LS <> 5, LU(1, 2, 3) , PS (1,5), SPS(1,4) and Species Code<2001		S/(R/10000)	S/(T/10000)	U*P	V*P
	Q	R	S	T	U	V	W	X
Crop Composition	No of Sub Plots	Sub Plots Area (Sq Mt)	No. of Trees	Volume (cum)	Stems per Ha	Volume per Ha	Estimated Stems	Estimated Volume
Fir	27	4,758.89	139	175.22	292.08	368.19	90,15,586	1,13,64,812.92
Spruce	8	1,416.35	46	52.19	324.78	368.48	22,27,720	25,27,453.32
Fir-spruce	12	2,009.97	59	88.21	293.54	438.86	30,20,134	45,15,374.10
Blue pine (Kail)	4	655.61	13	2.41	198.29	36.73	6,80,051	1,25,957.63
Deodar	19	3,013.45	170	113.77	564.14	377.54	1,54,78,099	1,03,58,534.49
Chir-pine	724	1,18,770.25	3,750	1,596.32	315.74	134.40	23,82,25,817	10,14,09,505.77
Mixed conifers	11	1,831.93	123	36.63	671.42	199.94	69,08,133	20,57,112.81
Oak-Rhododendron Forest	293	49,494.03	3,197	1,016.42	645.94	205.36	19,49,46,320	6,19,79,312.60
Up-land hardwoods	71	12,221.01	603	230.56	493.41	188.66	3,38,44,077	1,29,40,541.82
Teak	24	4,519.87	176	76.22	389.39	168.63	80,12,731	34,70,036.54
Sal	273	50,525.35	1,868	1,435.40	369.72	284.09	9,00,26,098	6,91,77,320.94
Khair forest	16	2,948.02	58	39.61	196.74	134.36	26,98,983	18,43,185.64
Teak with Misc	20	4,017.04	202	77.84	502.86	193.78	86,22,987	33,22,974.86
Sal with Misc	137	24,837.08	864	453.08	347.87	182.42	4,77,21,686	2,50,25,202.56
Mixed bamboo	1	170.58	7	2.22	410.37	130.01	14,07,393	4,45,889.08
Anogeissus pendula (Kardhai)	4	652.45	31	4.70	475.13	72.02	16,29,502	2,47,015.96
Teak mixed with Sal	4	803.62	19	4.52	236.43	56.29	8,10,857	1,93,046.61
Conifers mixed with hardwoods	12	1,919.52	55	59.49	286.53	309.95	39,30,727	42,51,965.23
Khair and Shisham	12	2,411.82	36	9.20	149.27	38.16	15,35,756	3,92,603.98
Oaks	302	50,469.39	2,647	654.72	524.48	129.73	15,64,90,406	3,87,07,131.78
Low land Hardwood	176	31,109.62	930	311.73	298.94	100.20	5,43,38,379	1,82,13,918.64
Miscellaneous forest	223	40,805.25	1,276	433.00	312.70	106.11	8,15,06,226	2,76,58,389.23
Eucalyptus	20	4,017.31	116	27.10	288.75	67.47	49,51,477	11,56,905.52
Eucalyptus with Miscellaneous	4	804.02	5	0.35	62.19	4.32	2,13,278	14,826.19
	2,397	4,14,182	16,390	6,901			96,82,42,423.82	40,13,99,018.23

Estimation for Less Vegetated Area

			LS <> 5, LU(4, 6,8,9,10,12, 13,15)	LS <> 5, LU(4, 6,8,9,10,12, 13,15) and PS(1,5)	LS <> 5, LU (4, 6, 8, 9, 10, 12, 13 ,15) and PS(1,5) & SPS(1,4)			LS <> 5, LU (4, 6, 8, 9, 10, 12, 13, 15) and PS(1,5) & SPS(1,4) and Species Code<2001		I/(H/10000)	J/(H/10000)	K * C	L * C
A	B	C	D	E	F	G	H	I	J	K	L	M	N
State Code	State Name	Less Vegetated Area (Sq Km)	Less Vegetated Area (Plots)	Less Vegetated Area (Vegetated Plots)	Net Less Vegetated Plots	No of Sub Plots	Sub Plots Area (Sq. Mt.)	No. of Trees	Volume (cum)	Stems per Ha	Volume per Ha	Estimated Stems	Estimated Volume
05	Uttarakhand	183	18	11	6	36	6,564	7	5.51	10.66	8	1,95,142	1,53,612.06

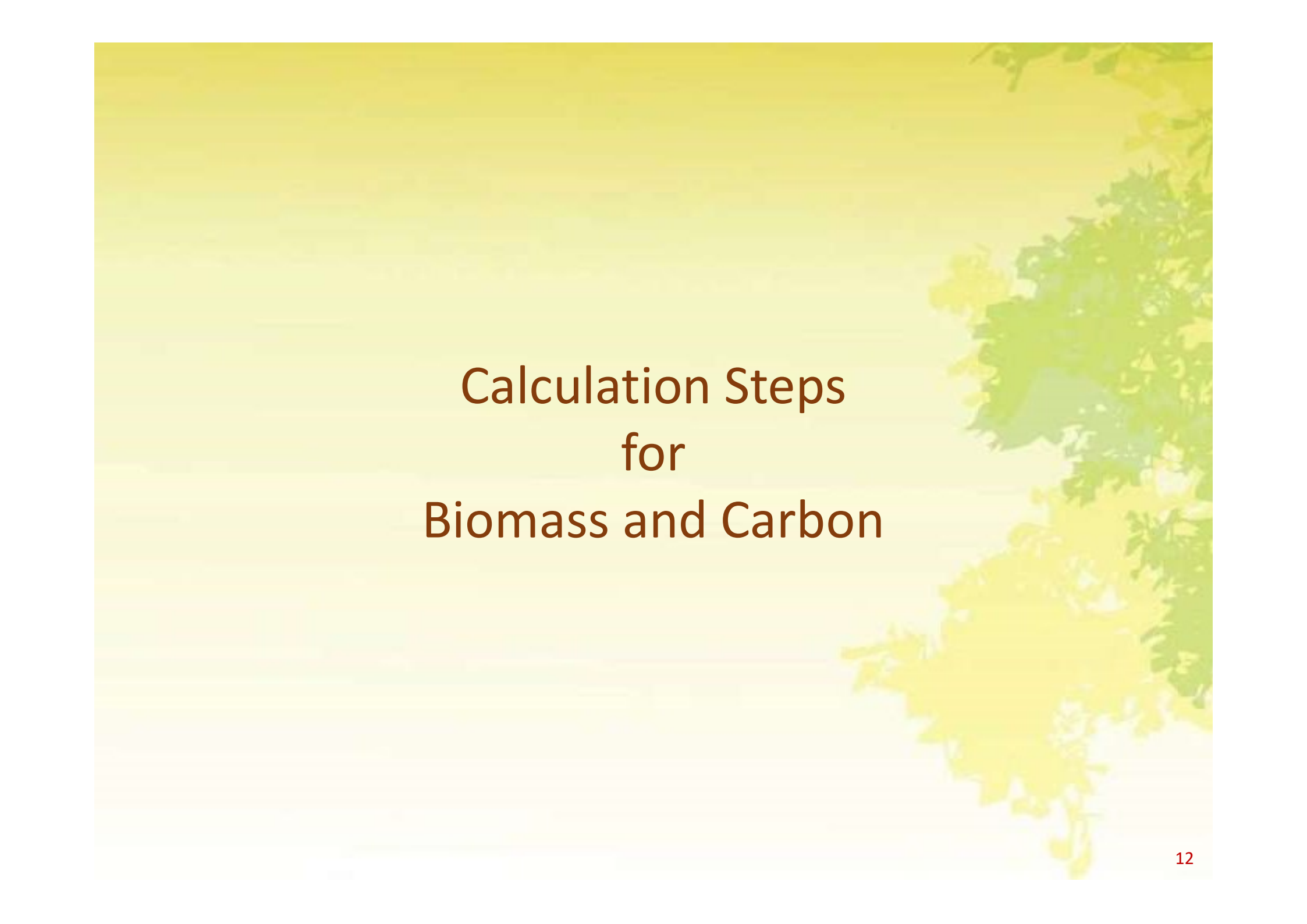
Total Estimated Stems (Nos)=

Vegetated Area (Estimated Stems) + Less Vegetated Area (Estimated Stems)

Total Estimated Volume (cum)=

Vegetated Area (Estimated Volume) + Less Vegetated Area (Estimated Volume)

State	StateName	Area for Processing (sq km)	No of Plots HQ	No of Plots	LS <> 5	LS = 5	LS <> 5, LU(1, 2, 3)	LS <> 5, LU(1, 2, 3), CC=00	C/(H-I)	CropComposition	CropCompositionDesc	LS <> 5, LU(1, 2, 3), CC<>00	LS <> 5, LU(1, 2, 3), CC<>00, PS (1,5)	Net Vegetated Plots CC Wise	Vegetated Area sq km	From PEF Data (Refer PEF_Master Sheet)		LS <> 5, LU(1, 2, 3), PS (1,5), SPS(1,4), SpeceisCode<20		S/(R/1000)	S/(T/1000)	U*P	V*P
					Forested Plots	Private Plots	Vegetated Plots	Vegetated Plots CC00	Area Factor			Vegetated Plots CC Wise	Net Vegetated Plots			NoofSub Plots	Area_SqM	Species_Count	Species_Vol	Stems perHa	Vol perHa	Estimated Stems	Estimated Volume
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	01	Fir	2	272	2	149.26	8	1,491.32	29	43.67	194.46	292.81	29,02,538	43,70,608.19
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	02	Spruce	7	272	5	522.42	20	3,386.83	116	197.17	342.50	582.17	1,78,93,043	3,04,13,788.94
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	03	Fir-spruce	1	272	1	74.63	4	638.19	4	7.09	62.68	111.09	4,67,771	8,29,058.73
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	05	Deodar	5	272	3	373.16	9	1,507.37	86	52.89	570.53	350.89	2,12,89,718	1,30,93,517.56
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	06	Chir-pine	90	272	73	6,716.82	263	44,756.36	1,362	607.19	304.31	135.67	20,44,02,560	9,11,24,357.33
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	07	Mixed conifers	1	272	1	74.63	3	512.28	11	10.11	214.73	197.39	16,02,527	14,73,183.67
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	08	Oak-Rhododendrom Fore	53	272	47	3,955.46	176	30,411.17	1,776	667.40	584.00	219.46	23,09,97,480	8,68,06,022.36
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	09	Up-land hardwoods	9	272	8	671.68	32	5,520.04	319	105.48	577.89	191.09	3,88,16,153	1,28,35,208.65
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	10	Teak	1	272	1	74.63	4	803.47	37	20.46	460.50	254.60	34,36,800	19,00,141.78
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	11	Sal	30	272	29	2,238.94	108	20,108.81	646	433.74	321.25	215.69	7,19,26,490	4,82,92,723.34
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	14	Garjan forest (Dipterocar	1	272	1	74.63	4	710.39	47	6.67	661.60	93.83	49,37,645	7,00,273.71
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	17	Khair forest	3	272	3	223.89	12	2,139.75	57	39.00	266.39	182.26	59,64,228	40,80,597.22
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	20	Teak with Misc	3	272	3	223.89	12	2,411.33	142	31.88	588.89	132.20	1,31,84,855	29,59,898.07
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	21	Sal with Misc	21	272	20	1,567.26	77	14,208.35	490	319.79	344.87	225.07	5,40,49,689	3,52,74,608.51
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	22	Mixed bamboo	2	272	2	149.26	5	973.19	12	6.15	123.31	63.15	18,40,496	9,42,644.07
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	25	Anogeissus pendula (Kard	3	272	1	223.89	4	652.45	31	4.70	475.13	72.02	1,06,37,883	16,12,594.73
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	26	Teak mixed with Sal	2	272	2	149.26	8	1,508.82	61	53.73	404.29	356.14	60,34,547	53,15,819.07
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	27	Conifers mixed with hard	1	272	1	74.63	4	630.82	11	8.05	174.38	127.61	13,01,402	9,52,336.88
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	28	Khair and Shisham	2	272	2	149.26	8	1,608.35	26	6.28	161.66	39.03	24,12,933	5,82,622.67
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	29	Oaks	31	272	26	2,313.57	94	15,839.17	695	201.73	438.79	127.36	10,15,16,245	2,94,66,630.95
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	30	Low land Hardwood	13	272	12	970.21	44	8,013.29	225	63.40	280.78	79.11	2,72,41,854	76,75,549.60
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	31	Miscellaneous forest	35	272	28	2,612.10	102	18,871.34	590	178.32	312.64	94.49	8,16,65,554	2,46,81,885.63
05	Uttarakhand	23,658.15	457	457	438	19	343	26	74.63	32	Eucalyptus	1	272	1	74.63	4	804.08	6	0.22	74.62	2.72	5,56,894	20,309.59
												317		272	23,658.15			6,779	3,065.10			90,50,79,304	40,54,04,381.26



Calculation Steps for Biomass and Carbon

BIOMASS EQUATIONS

- BE1:** biomass equation used to estimate biomass of small wood of trees having DBH 10cm or more
BE2: biomass equation used to estimate biomass of foliage of trees having DBH 10cm or more
BE3: biomass equation used to estimate biomass of small wood of trees having DBH less than 10cm
BE4: biomass equation used to estimate biomass of foliage of trees having DBH less than 10cm
D: diameter at breast height in meter; D_1 : diameter at breast height in cm; unit of biomass is kg

South Deccan

S.No.	Species Name	Equation
1	<i>Tectona grandis</i>	$BE_1 = 539.6789 D^2 - 91.0556 D + 27.1753$
	<i>Tectona grandis</i>	$BE_2 = 25.3092 D^2 + 0.7069 D + 0.5550$
	<i>Tectona grandis</i>	$BE_3 = 0.2044 D_1^2 + 1.0601 D_1 - 1.2801$
	<i>Tectona grandis</i>	$BE_4 = 0.0080 D_1^2 + 0.0186 D_1 + 0.0267$
2	<i>Anogeissus latifolia</i>	$BE_1 = 527.5528 D^2 + 190.9378 D - 6.3153$
	<i>Anogeissus latifolia</i>	$BE_2 = 1.8701 D^2 + 2.0075 D - 0.0042$
	<i>Anogeissus latifolia</i>	$BE_3 = 0.1675 D_1^2 + 0.5589 D_1 + 0.7879$
	<i>Anogeissus latifolia</i>	$BE_4 = 0.0025 D_1^2 + 0.0046 D_1 + 0.0086$
3	<i>Terminalia crenulata/tomentosa</i>	$BE_1 = 810.6925 D^2 - 139.3736 D + 36.0631$
	<i>Terminalia crenulata/tomentosa</i>	$BE_2 = 5.5404 D^2 + 2.6344 D + 0.0470$
	<i>Terminalia crenulata/tomentosa</i>	$BE_3 = 0.2952 D_1^2 - 0.5102 D_1 + 1.4387$
	<i>Terminalia crenulata/tomentosa</i>	$BE_4 = 0.0021 D_1^2 - 0.0009 D_1 + 0.0157$
4	<i>Albizzia amara</i>	$BE_1 = -31.5487 D^2 + 88.5829 D + 1.3364$
	<i>Albizzia amara</i>	$BE_2 = -0.6411 D^2 + 2.7919 D + 0.0396$
	<i>Albizzia amara</i>	$BE_3 = 0.0363 D_1^2 + 1.4877 D_1 - 0.7142$
	<i>Albizzia amara</i>	$BE_4 = 0.0012 D_1^2 + 0.0209 D_1 + 0.0161$
5	<i>Chloroxylon swietenia</i>	$BE_1 = 488.0505 D^2 + 33.6399 D + 15.4392$
	<i>Chloroxylon swietenia</i>	$BE_2 = 14.1500 D^2 - 0.9931 D + 0.4151$
	<i>Chloroxylon swietenia</i>	$BE_3 = 0.3823 D_1^2 - 1.2603 D_1 + 1.8184$
	<i>Chloroxylon swietenia</i>	$BE_4 = 0.0043 D_1^2 - 0.0183 D_1 + 0.0393$



Objective

Calculate biomass from different five Components of Plot Enumeration Form (Field Form No.-3)

1. Tree Volume
2. Bark Biomass
3. Woody Biomass
4. Small wood Biomass
5. Leaf biomass



Calculation Steps

1. Tree Volume(cum)

a. To calculate Volume, put dia in Tree Volume equation

2. Bark Volume, Biomass & Carbon(tonnes)

Bark volume is to be calculated as follows:

a) Calculate dia for Over Bark Volume [dia_cm+(DBT_MM/10)]

b) Calculate Over Bark Volume (OBV) using the same volume equation (use DBH as calculate in step 2(a))

c) Calculate Bark Volume (BV)=(OBV-Volume)*(1-VoidFactorBark)

d) Bark Biomass= BV *Bark Specific Gravity

e) Bark Carbon= Bark Biomass*(Carbon Content % for Wood/100)



Calculation Steps

3. Woody Biomass & Carbon(tonnes)

- a) Woody Biomass= Tree Volume*Woody Specific Gravity
- b) Woody Carbon= Woody Biomass* (Carbon Content % for Wood /100)

4. Small wood Biomass & Carbon (kg)

- a) Small Woody Biomass= Just Put DBH in Biomass Equation (BE_1)
- b) Small Woody Carbon= Small Woody Biomass* (Carbon Content % for Wood /100)

5. Leaf Biomass & Carbon (kg)

- a) Leaf Biomass= Just Put DBH in leaf Biomass Equation (BE_2)
- b) Leaf Carbon= Leaf Biomass*(Carbon Content % for Leaf/100)

Individual tree volume, biomass & carbon calculation having Dbh ≥ 10 cm Plot size 8 m radius

Species Name	Status of Tree	Dbh & DBT			Volume (Cum)			Biomass					Carbon				
		Dbh (Meters)	DBT (mm)	Dbh for Over Bark (Meters)	Vol (CUM)	Over Bark Vol (Cum))	Bark Vol (Cum))	Woody (Tonnes)	Bark (Tonnes)	Small Wood (Kg)	Leaf (Kg)	Total (Tonnes)	Woody (Tonnes)	Bark (Tonnes)	Small Wood (Kg)	Leaf (Kg)	Total (Tonnes)
Tectona grandis	Alive	0.2	16	0.216	0.290	0.350	0.053	0.161	0.028	31.974	3.733	0.225	0.080	0.014	15.958	2.397	0.112
Shorea robusta	Alive	0.2	18	0.218	0.193	0.246	0.040	0.132	0.021	35.367	2.849	0.191	0.060	0.010	16.173	1.847	0.088
Ficus religiosa	Dead	0.2	28	0.228	0.202	0.286	0.078	0.078	0.041	28.355	1.438	0.149	0.032	0.017	11.501	0.426	0.061
Zizyphus jujuba	Alive	0.2	18	0.218	0.112	0.136	0.020	0.067	0.011	28.355	1.438	0.108	0.028	0.005	11.745	0.470	0.045

Volume and Biomass equations

Species Name	Volume and Biomass Equation		
	Volume	Small Wood Biomass	Leaf Biomass
Tectona grandis	$(0.08847-1.46936*D+11.98979*(D^2)+1.970560*(D^3))$	$-56.4459*(D^2)+140.203*D+6.1908$	$-3.4159*(D^2)+18.133*D+0.2431$
Shorea robusta	$(0.16306+4.8991*D-1.57402*(D^0.5))^2$	$-218.765*(D^2)+252.6165*D-6.4059$	$-19.8692*(D^2)+21.2077*D-0.5973$
Ficus religiosa	$(0.03629+3.95389*D-0.84421*(D^0.5))^2$	$631.2*(D^2) + 51.49*D - 7.191$	$12.77*(D^2) + 6.048*D - 0.282$
Zizyphus jujuba	$(0.007602-0.033037*D+1.868567*(D^2)+4.483454*(D^3))$	$631.2*(D^2) + 51.49*D - 7.191$	$12.77*(D^2) + 6.048*D - 0.282$

Requirement of different factors for carbon estimation

Species Name	Factor requirements				
	Woody Specific Gravity	Bark Specific Gravity	Void factor bark	Carbon Content % for Wood	Carbon Content % for Leaf
Tectona grandis	0.555	0.53	0.125	49.91	64.22
Shorea robusta	0.684	0.53	0.25	45.73	64.82
Ficus religiosa	0.385	0.53	0.075	40.56	29.63
Zizyphus jujuba	0.600	0.53	0.175	41.42	32.70

Note: If a tree species is alive then it contributes in AGB and if it is dead then it contributes in Dead Wood component of Carbon Pools



Regeneration Form (Plot size 1.7 m radius)

Following information will be generated from regeneration form

1. **Woody biomass**
 - Small woody biomass
 - Established plants biomass
 - Un-established plants biomass
2. **Leaf biomass**
 - Small woody leaf biomass
 - Established plants leaf biomass
 - Un-established plants leaf biomass
 - Recruits plants leaf biomass
3. **Woody carbon**
4. **Leaf Carbon**



1. Woody biomass

- Small woody biomass (kg)
 - a) Small Woody Biomass= Just Put DBH in Biomass Equation [BE₃]
- Established plants biomass (kg) [i.e. if category of regeneration is 1]
 - b) Established plants Biomass= Just Put 3.5 cm DBH in Biomass Equation [BE₃] *
No. of plants in Category of regeneration-1 (Established plants)
- Un-established plants biomass (kg) [i.e. if category of regeneration is 2]
 - c) Unestablished plants Biomass= Just Put 1.5 cm DBH in Biomass Equation [BE₃]
* no of plants in Category of regeneration-2 (Un-established plants)
- Total woody biomass (kg)
 - d) Total Woody BioMass= a + b +c

2. Leaf biomass

- Small woody leaf biomass (kg)

e) Small Wood leaf Biomass= Just Put DBH in Leaf Biomass Equation [BE₄]

- Established plants leaf biomass (kg) [ie if category of regeneration is 1]

f) Established plants leaf Biomass= Just Put 3.5 cm DBH in Leaf Biomass Equation [BE₄] *
No of plants in Category of regeneration-1 (Established plants)

- Un-established plants leaf biomass (kg) [ie if category of regeneration is 2]

g) Unestablished plants Biomass= Just Put 1.5 cm DBH in Leaf Biomass Equation [BE₄] *
No. of plants in Category of regeneration-2 (Un-established plants)

- Recruit plants leaf biomass (kg) [ie if category of regeneration is 3]

h) Recruit plants Biomass= Just Put 0.5 cm DBH in Leaf Biomass Equation [BE₄] *
No. of plants in Category of regeneration-3 i.e. (Recruits plant)

- Total leaf biomass i) Total Leaf BioMass= e + f + g + h

Total Biomass = d + i

3. Woody carbon

- Small woody carbon (kg)

j) $\text{Small Woody carbon} = a \times (\text{Carbon Content \% for Wood}/100)$

- Established plants carbon (kg) [ie if category of regeneration is 1]

k) $\text{Established plants carbon} = b \times (\text{Carbon Content \% for Wood}/100)$

- Un-established plants carbon (kg) [ie if category of regeneration is 2]

l) $\text{Un-established plants carbon} = c \times (\text{Carbon Content \% for Wood}/100)$

- Total woody carbon (in kg)

m) $\text{Total carbon} = j + k + l$



4. Leaf carbon

- Small woody leaf carbon (kg)

n) Small Wood leaf carbon = $e \times (\text{Carbon Content \% for Leaf} / 100)$

- Established plants leaf carbon (kg) [ie if category of regeneration is 1]

o) Established plants leaf carbon = $f \times (\text{Carbon Content \% for Leaf} / 100)$

- Un-established plants leaf carbon (kg) [ie if category of regeneration is 2]

p) Unestablished plants carbon = $g \times (\text{Carbon Content \% for Leaf} / 100)$

- Recruit plants leaf carbon (kg) [ie if category of regeneration is 3]

q) Recruit plants carbon = $h \times (\text{Carbon Content \% for Leaf} / 100)$

- Total leaf carbon (in kg)

r) Total leaf carbon = $n + o + p + q$

Total Carbon = m + r

Individual tree plant biomass & carbon calculation having Dbh ≥ 5 cm and ≤ 9 cm

Plot size 1.7 m radius

Species Name	Dbh & No of Plants in Category of Regeneration				Biomass (Kg)										Carbon (Kg)									
	Dbh (cm)	Established	Un-established	Recruit	Small Wood	Established Plants Wood	Un-established Plants Wood	Total Wood	Leaf	Established Plants Leaf	Un-established Plants Leaf	Recruit Plants Leaf	Total Leaf	Total	Small Wood	Established Plants Wood	Un-established Plants Wood	Total Wood	Leaf	Established Plants Leaf	Un-established Plants Leaf	Recruit Plants Leaf	Total Leaf	Total
Tectona grandis	7	0	0	0	7.448	0.000	0.000	7.448	0.469	0.000	0.000	0.000	0.469	7.917	3.717	0.000	0.000	3.717	0.301	0.000	0.000	0.000	0.301	4.018
Shorea robusta	9	0	0	0	15.095	0.000	0.000	15.095	2.051	0.000	0.000	0.000	2.051	17.146	6.903	0.000	0.000	6.903	1.329	0.000	0.000	0.000	1.329	8.232
Ficus religiosa	8	0	0	0	11.336	0.000	0.000	11.336	0.437	0.000	0.000	0.000	0.437	11.773	4.598	0.000	0.000	4.598	0.129	0.000	0.000	0.000	0.129	4.727
Zizyphus jujuba	0	2	4	21	0.000	5.488	6.076	11.564	0.000	0.430	0.468	1.428	2.326	13.890	0.000	2.273	2.517	4.790	0.000	0.141	0.153	0.467	0.761	5.551

Biomass equations

Species Name	Biomass Equation	
	Small Wood	Leaf
Tectona grandis	$0.1189*(D^2)+0.1503*D+0.5695$	$0.0103*(D^2)-0.0272*D+0.1544$
Shorea robusta	$0.1094*(D^2)+0.7826*D-0.8099$	$0.0204*(D^2)+0.0470*D-0.0245$
Ficus religiosa	$0.1995*(D^2)-0.3849*D+1.6476$	$0.0493*D+0.0429$
Zizyphus jujuba	$0.1995*(D^2)-0.3849*D+1.6476$	$0.0493*D+0.0429$

Requirement of different factors for carbon estimation

Species Name	Factor requirements	
	Carbon Content % for Wood	Carbon Content % for Leaf
Tectona grandis	49.91	64.22
Shorea robusta	45.73	64.82
Ficus religiosa	40.56	29.63
Zizyphus jujuba	41.42	32.70

Note: it contributes in AGB component of a Carbon Pools

Forest Floor Carbon (tonnes) [Plot Size – 1 m X 1 m]: Data of fresh and partially undecomposed leaves and twigs and in addition fully decomposed leaves, twigs and branches are collected and its weight is recorded in grams from 3 microplots. Total area of 3 microplots is 3m². It contributes in the **Litter** component of the **Carbon pools**.

Step 1 : Weight of Forest Floor in gms ie for Plot1, Plot2 & Plot3.

Step 2 : Weight (kg) = Weight of (Plot1 + Plot2 + Plot3)

Step 3 : biomass kg per ha (d) = (Weight)/(3 / 10,000) * ((Forest Floor Weight Percentage at 65 degree centigrade)/100)

Step 4 : biomass (tonnes/ha) e = d/1,000

Step 5 : Carbon (tonnes/ha) f = e * ((Forest Floor Organic Carbon Content Percentage)/100)

Soil Organic Carbon (tonnes): A pit of 30cm x 30cm x 30cm in each microplots and collect the soil sample of 50 grams after mixing thoroughly. Thereafter sent the sample to laboratory to get the organic carbon content of soil. It contributes in the **Soil Organic Carbon** component of the **Carbon pools**.

Step 1 : Calculate carbon content in soil

say(CC_Soil) = Soil Organic Carbon Content Percentage /100

Step 2 : Carbon (tonnes/ha) Say (SOC) = CC_Soil *(Proportion Of Soil/100) * (40,00,000/1,000)

Stump Information (Plot Size- 2.8 m radius): The base of a tree and its root left in the ground after felling.

Step 1 : Volume(in cum)=(22/7) * {Dia(m)/2}² * {(Height(m))}

Step 2 : Biomass (in tonnes) = Volume * [Specific Gravity of a species]

Step 3 : Carbon (in tonnes) = Biomass * (Carbon content percentage of a species /100)

Note: If a Stump species is alive then it contributes in AGB and if it is dead then it contributes in Dead Wood component of Carbon Pools.

Dead Wood (Plot Size- 2.8 m radius)): Woody material of tree having diameter more than 5 cm, which is not part of a live tree, laying on the ground.

Step 1 : Volume(in cum)=(22/7) * {Dia(m)/2}² * {(Height(m))}

Step 2 : Biomass (in tonnes) = Volume * [Specific Gravity of a species]

Step 3 : Carbon (in tonnes) = Biomass * (Carbon content percentage of a species /100)

Note: It contributes in Dead Wood component of Carbon Pools

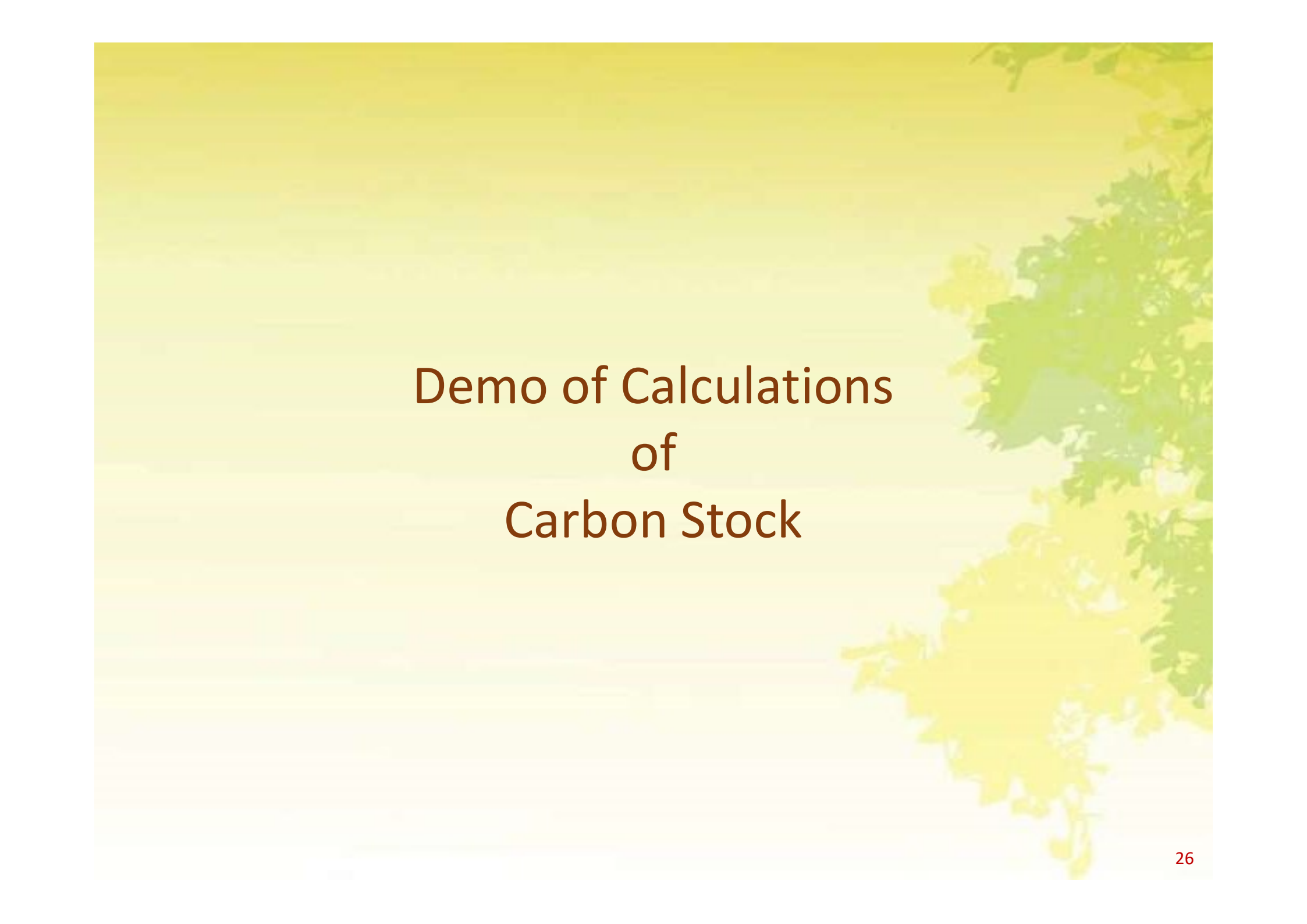
Woody Litter (Plot Size- 1.7 m radius): Woody material of tree having diameter less than 5 cm, which is not decomposed.

Step 1 : Weight of woody litter is recorded in Kg upto 2 decimal places say(weight)

Step 2 : Biomass (in tonnes) = weight/1,000

Step 3 : Carbon (in tonnes) = Biomass * (a)

Note: Carbon content percentage is 0.46 say(a). It contributes in Litter component of Carbon Pools



Demo of Calculations of Carbon Stock



Thanks