

# National Forest Inventory in India



## Introduction : Forest Survey of India

- A National Organization under the Ministry of Environment and Forests, Government of India
- Devoted to Forest Resource Assessment at the National Level
- In service of the Nation since 1965





# Introduction : Evolution of the Organisation

1965

PISFR

- Assess availability of raw material for establishment of wood based industries in selected forest rich regions (FAO/UNDP/GOI project)

NCA Report, 1976

1981

FSI

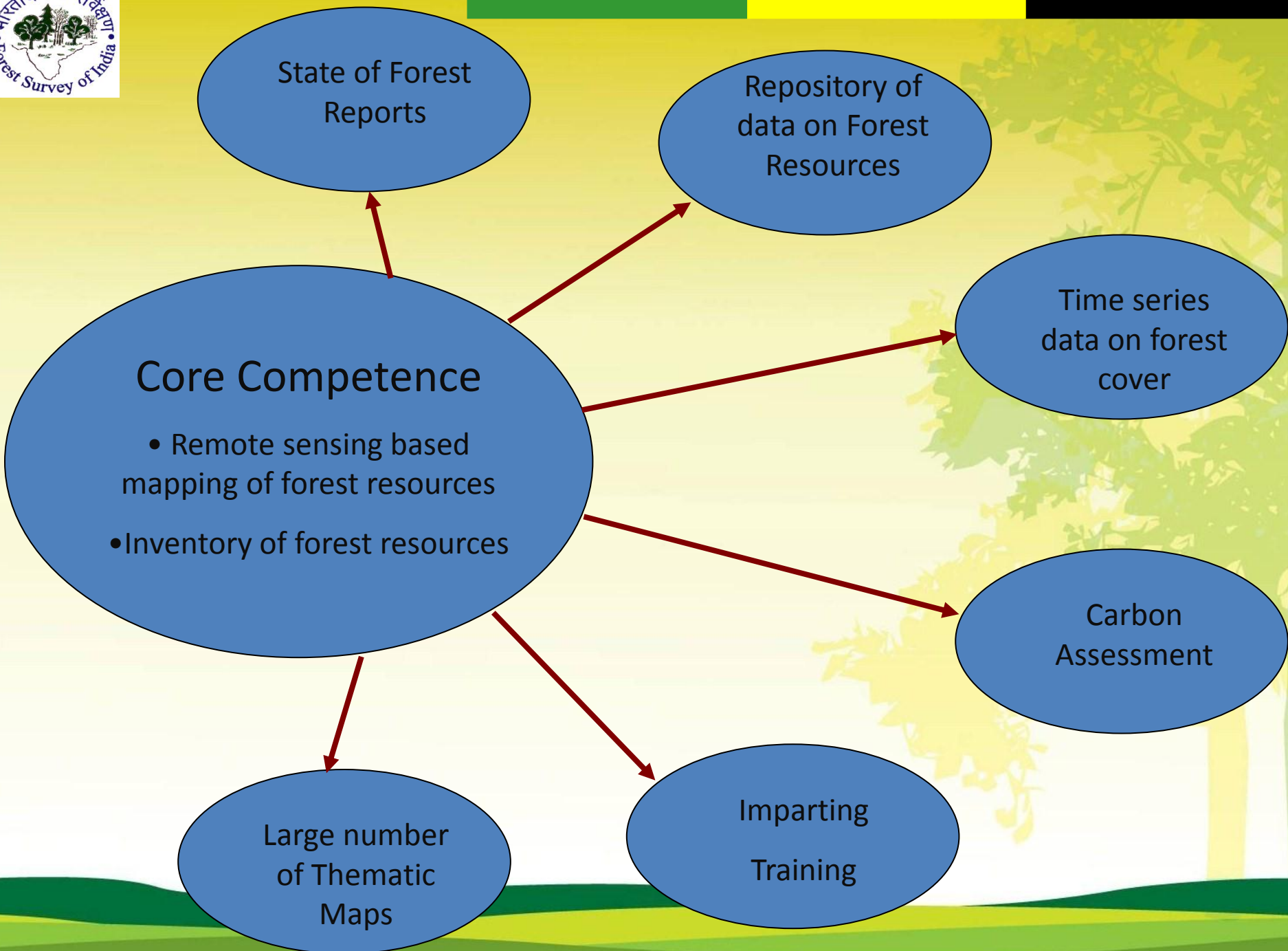
- Periodic monitoring of the forest resources
- Serve the data needs of development planning
- Serve as nucleus for the technological advancement and consultancy in the field of forest mapping and inventory
- Training of forestry personnel
- Provide institutional base for international cooperation and training

NRSA Report, 1984

1986

FSI – New Mandate

- Biennial forest cover mapping & preparation of SFR
- field inventory of forests and trees outside forests
- impart training to forestry personnel in modern forest survey and inventory techniques
- support and oversee techniques/inventory work undertaken by State/UT forest department.
- undertake project based activities of the State Forest Departments and central government organizations.





# Forest Inventory – Objectives

## 1. Quantitative Information

- Stratum wise growing stock
- Species wise growing stock
- Diameter class wise distribution
- Regeneration status etc.

## 2. Qualitative Information

- Legal status
- Land use
- Biotic influence
- Fire incidence
- Grazing incidence etc.

## Brief background

### From 1965 to 1981

Field inventory of unexplored forest areas started after launch of a FAO/UNDP/GOI project named as Pre-Investment Survey of Forest Resources (PISFR) in 1965 which led foundation of NFI

- Forest Inventory confined to certain project areas for setting up wood based industries
- Sampling design adopted as per prevailing condition of areas

## Brief background

### From 1981 to 2001

- PISFR was renamed as FSI, a fully Govt of India organization in 1981
- Inventory was continued as before with a uniform sampling design. The project areas was divided into grids of 2½' x 2½' and Systematic sampling followed by taking two plots of 0.1 ha in each grid
- Each year only selected districts covered due to limitation of manpower and districts/state level reports produced
- About three fourth of forested area of country could be inventorised in 20 years
- About 140 reports have been published on forest inventory.

## Brief background

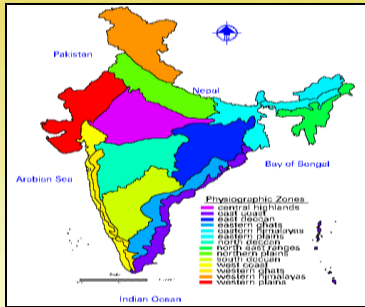
### From 2002 onwards

- Since all earlier inventory work was carried out in different parts of the country at different time, it was not possible to generate national estimates of growing stock for forest and TOF.
- Therefore, sampling design was modified in 2002 to have a national level estimates of GS both for forest and TOF.
- Thus from 2002 onwards, NFI has three components:
  - Inventory of Forests mainly inside the recorded forest area
  - Inventory of TOF (Rural): outside the recorded forest area in rural areas
  - Inventory of TOF (Urban): outside the recorded forest area in urban areas.

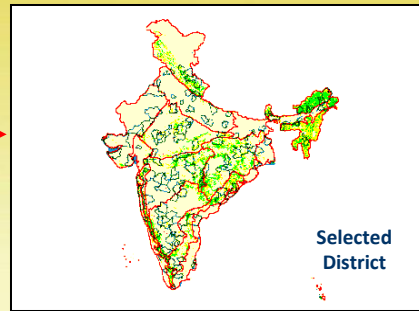


# NFI Methodology since 2002

Stratified country into 14 physiographic zones



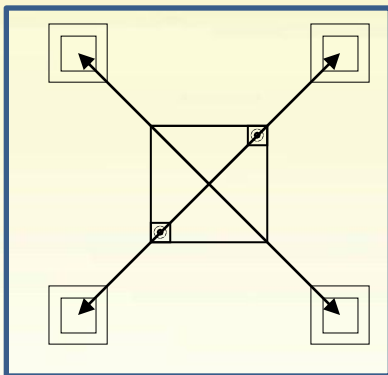
60 districts are selected randomly for inventory in a cycle of 2 yrs



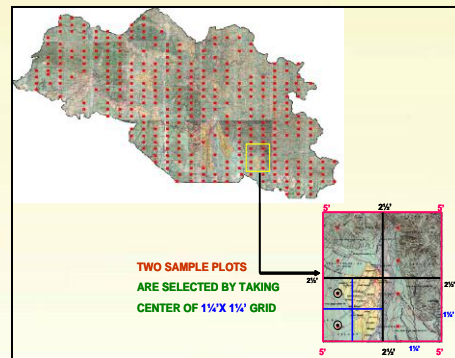
District are divided into grid of  $2\frac{1}{2}' \times 2\frac{1}{2}'$ .



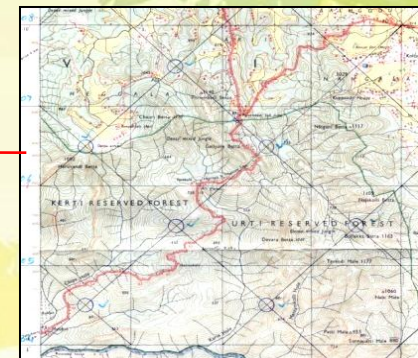
A square sample plot of size 0.1 ha is laid out at the centre of each selected forest sub-grid.



two sub-grids of  $1\frac{1}{4}' \times 1\frac{1}{4}'$  are selected randomly.



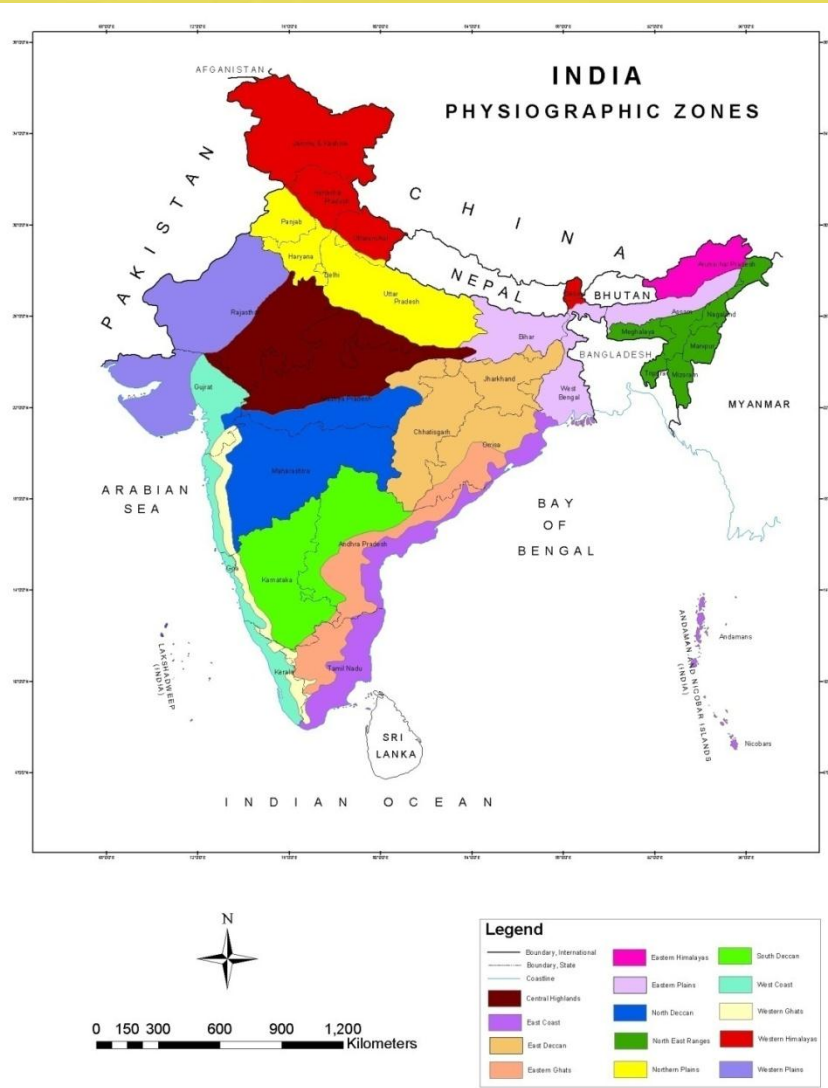
Each grid of  $2\frac{1}{2}' \times 2\frac{1}{2}'$  are divided into four sub-grids of  $1\frac{1}{4}' \times 1\frac{1}{4}'$ .



dbh of all tree over 10 cm recorded, litter and soil sample collected, regeneration status, bamboo, land use, legal status, crop composition, etc are recorded.

inconsistency check of sample data is done through software and then processed for generating different estimates

# Physiographic Zones of India



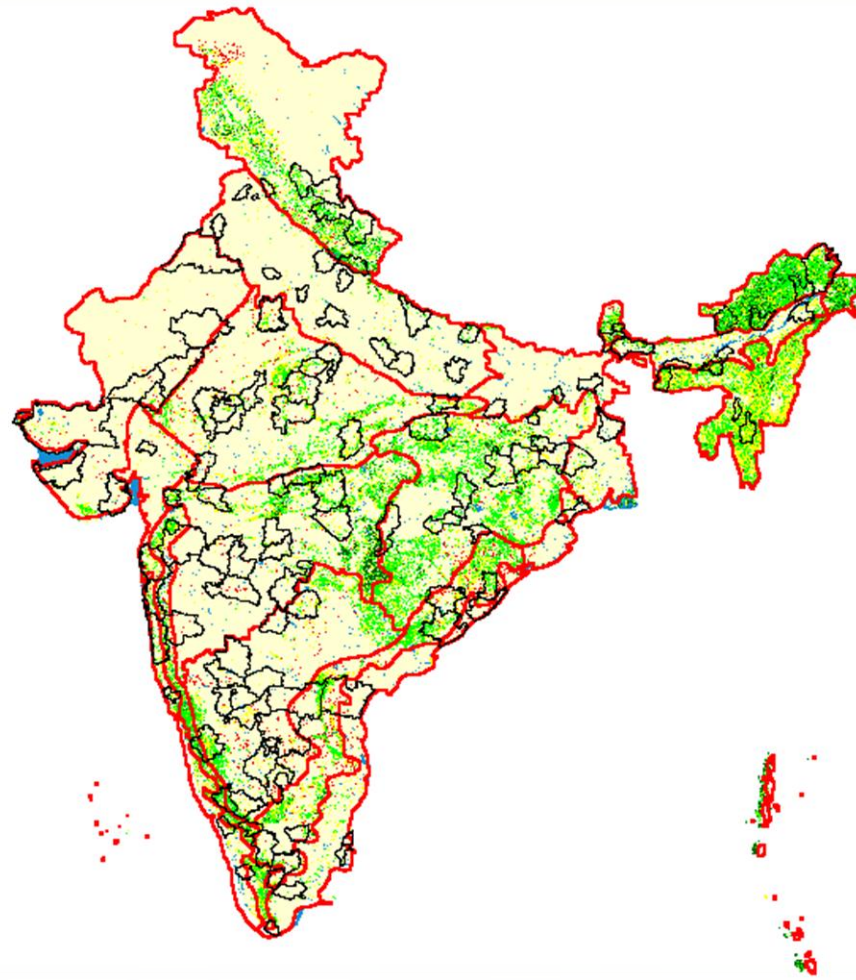
➤ **14 Physiographic Zones**

➤ **Based on**

- ✓ **Physiography**
- ✓ **Climate**
- ✓ **Vegetation**



# Randomly selected 60 districts



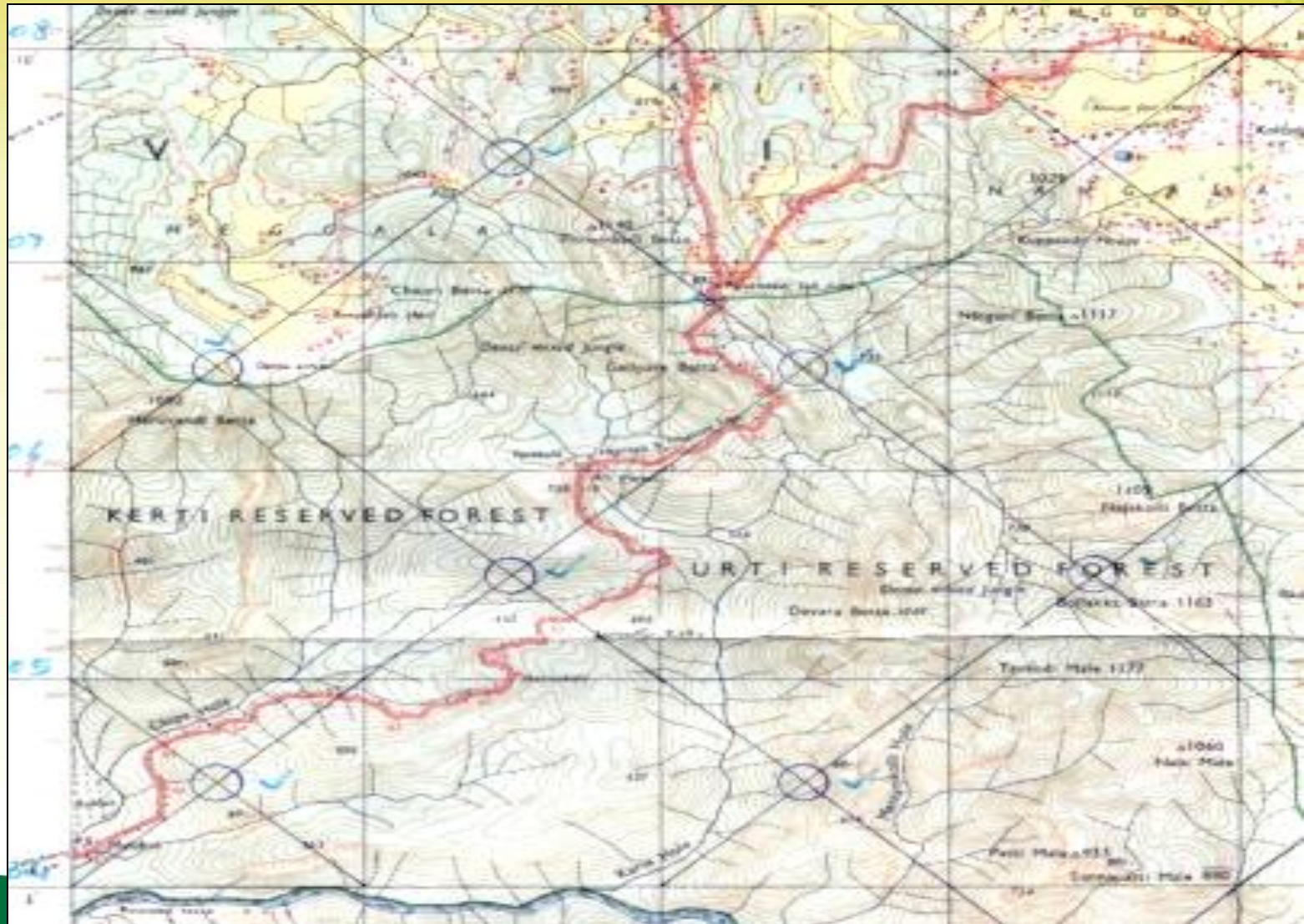


# Laying out of grids on topographic sheet of 1:50,000 scale in the office



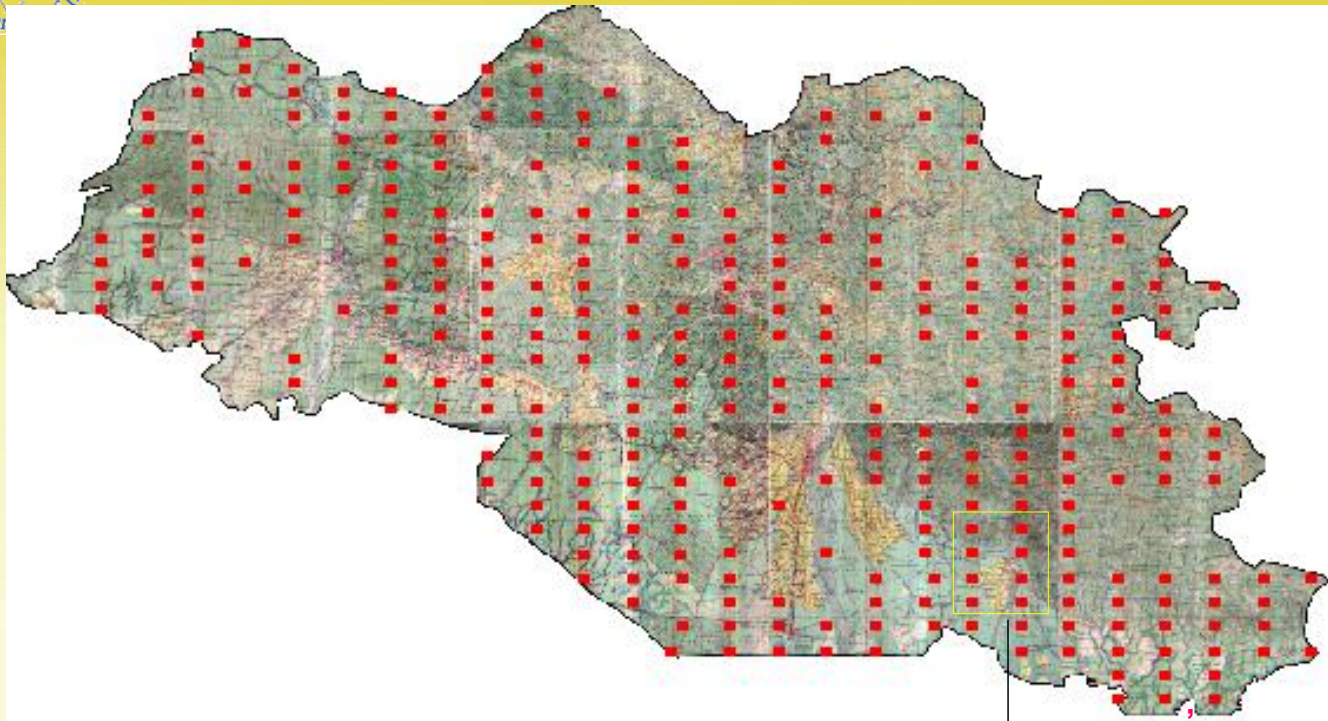


# Marking of grids on toposheets

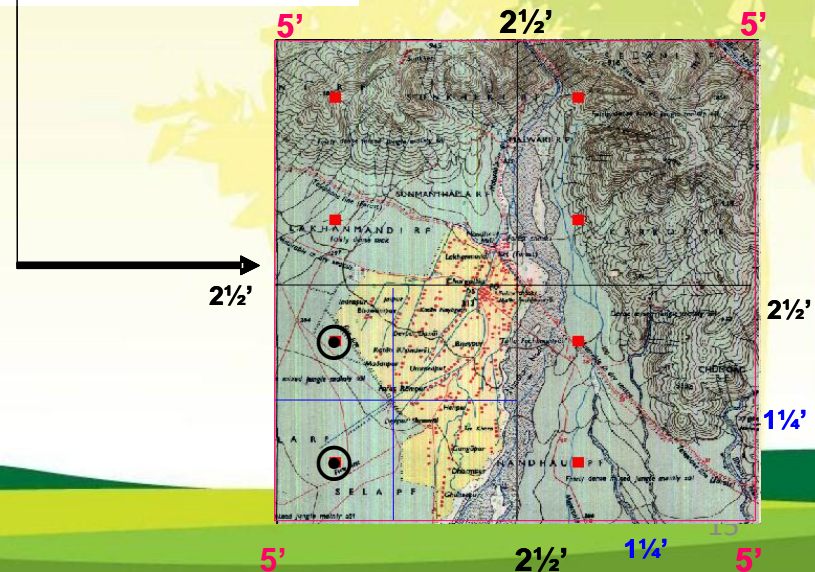




# Distribution of sample plots in a District



Two sample plots are randomly selected. Thereafter, every alternate  $1\frac{1}{4}' \times 1\frac{1}{4}'$  GRID is systematically selected to form two systematic samples. At center of selected  $1\frac{1}{4}' \times 1\frac{1}{4}'$  SUB GRID, sample plots of 0.1 ha is laid out.



# Sample plots

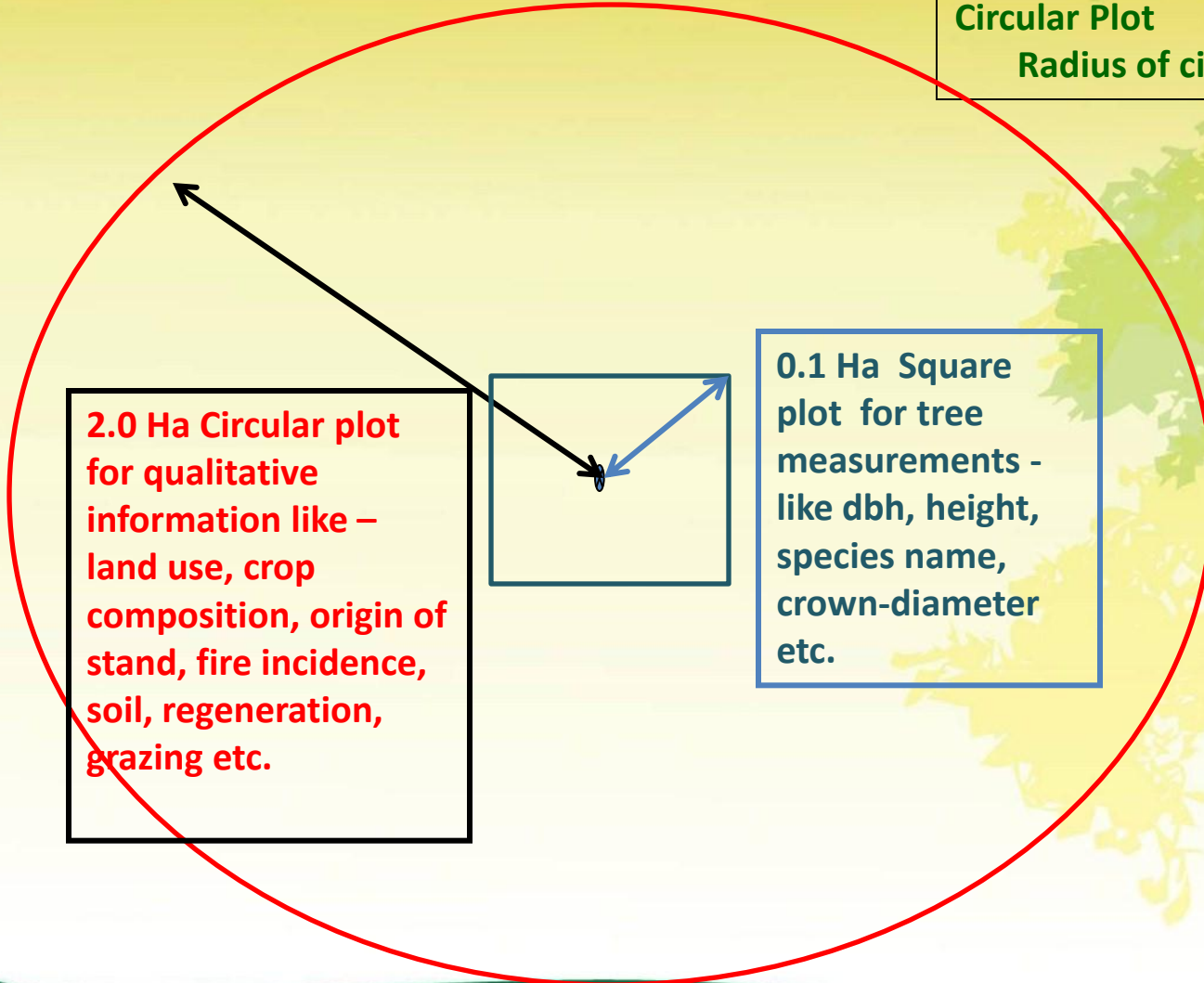
## Square Plot

Length of diagonal = 44.8 M

Length of side = 31.6 M

## Circular Plot

Radius of circle = 80 M



**2.0 Ha Circular plot for qualitative information like – land use, crop composition, origin of stand, fire incidence, soil, regeneration, grazing etc.**

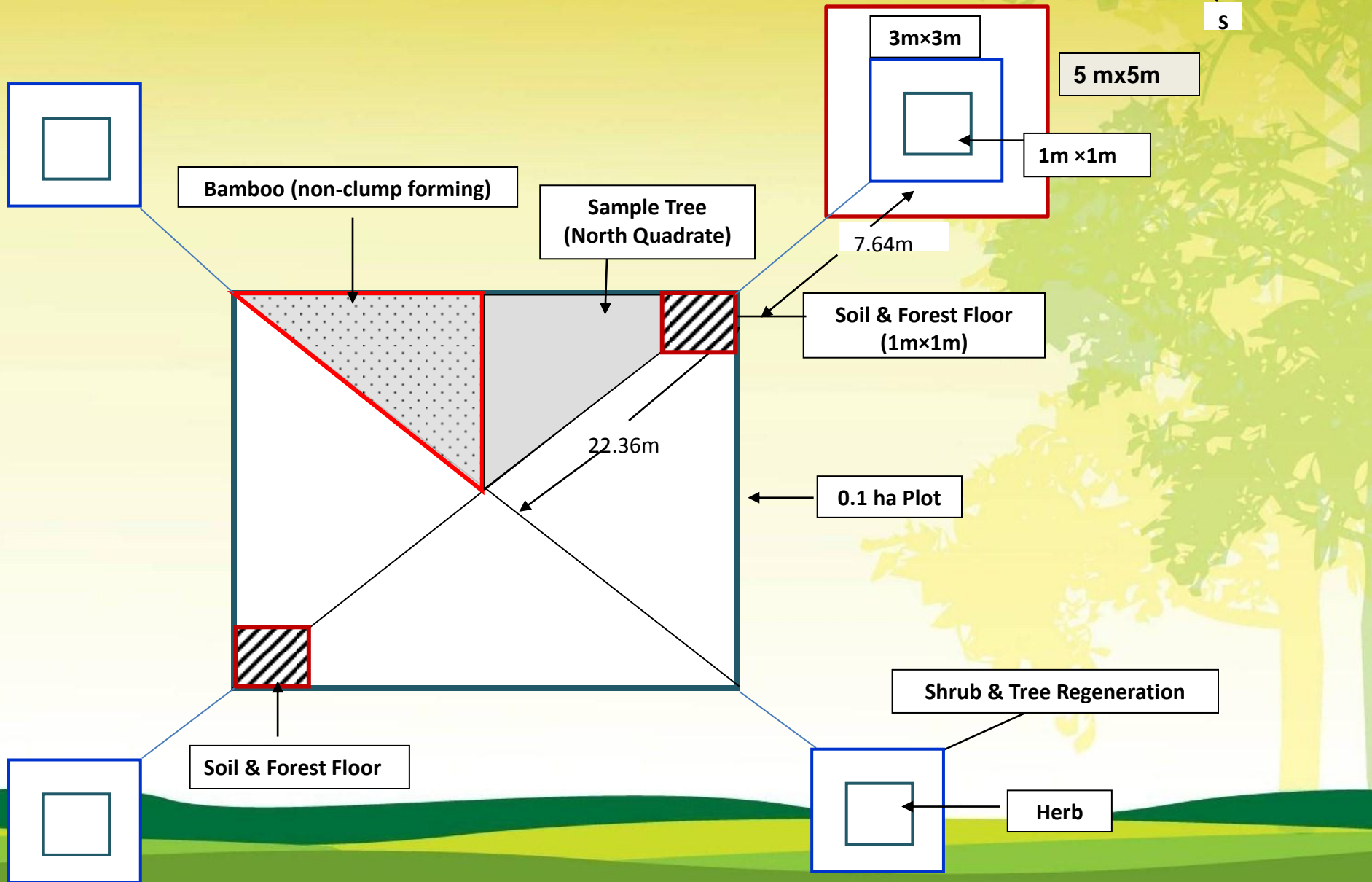
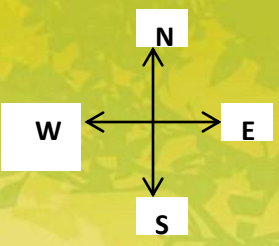
**0.1 Ha Square plot for tree measurements - like dbh, height, species name, crown-diameter etc.**

- Soil depth
- Rockiness
- Humus
- Origin of stand
- Crop Composition
- Bamboo density
- Bamboo quality
- Plantation potential
- Size class
- Biotic influence

- Area under different land use classes
- Intensity of regeneration
- Incidence of fire
- Injuries to crop
- Grazing
- Presence of weeds
- Presence of grass
- Soil erosion



# Sample Point & Attached plots





# Fields Forms

Field Form No.	Item	Description
1.	Plot Approach Form	The information recorded in this field form describes how the plot was approached
2.	Plot Description Form	The information recorded in this field form pertains to the general description of forest on an area of 2 ha i.e. 80m radius around the centre of the plot.
3.	Plot Enumeration Form	In this form data of trees above 10cm dbh and bamboo clumps are recorded which are found in 0.1 ha plot.
4.	Sample Tree Form	In this form data on dominance of trees of 10cm and above, double bark thickness, tree height and crown width of trees are recorded from north quadrant (one-fourth area) of the plot.
5.	Bamboo Clump Analysis Form	In this form data of each individual culms occurring in certain selected clumps in the plot is recorded.
6.	Bamboo Enumeration and Analysis Form (non-clump forming)	In this form information is collected for non-clump forming bamboos occurring in the sample plot..
7.	Bamboo Weight Form	For determining correlation between green and dry weights of utilisable bamboo culm length, data collected in this form.
8.	Herbs, Shrubs and Regeneration Form	The data regarding herbs are collected from four square sub-plots of 1mx1m laid out at the distance of 30m from the centre of main plot. Similarly, the data regarding shrubs and regeneration are collected from four square plots of 3mx3m laid out at a distance of 30m from the centre of the main plots.
9.	Soil and Forest Floor Carbon Form	For forest floor data fresh, partially and fully decomposed leaves, twigs and branches are collected from two sub-plots of 1mx1m laid out at north-east and south-west corners of the main plot. For collection of soil sample data pits of 30cmx30cmx30cm in the above two plots are dug out and a composite sample of 200gms is collected for estimating soil carbon.

# Field Form No.1: Plot Approach Form

- This form gives following details:
  - Mode of Travel up to the reference point
  - Conspicuous features observed during the journey
  - Bearing from the reference point
  - Distance from the reference point to the nearest plot centre
  - Time of starting from camp, arrival at reference point, arrival at the plot leaving the plot and returning to camp
- The above information are required for revisiting the plot

## Field Form No.2: Plot Description Form

- This form is filled up for every plot laid out on the ground
- The information in this form is filled up from an area of about 2ha (80m radius) around the centre of the plot
- It describes completely the plot through various qualitative parameters as given below:
  - Legal status
  - Land use
  - General topography
  - Slope

# Field Form No.2: Plot Description Form

- Position on slope
- Altitude
- Aspect
- Rockiness
- Soil data
- Humus
- Soil colour
- Soil consistency
- Soil texture
- Coarse fragment
- Soil depth





# Field Form No.2: Plot Description Form

- Soil erosion
- Origin of Stand
- Crop composition
- Canopy layer or storey
- Top height
- Size class
- Intensity of regeneration
- Species under regeneration
- Injuries to Crop
- Fire incidence
- Grazing incidence



# Field Form No.2: Plot Description Form

- Presence of weeds
- Presence of grass
- Bamboo density
- Bamboo quality
- Bamboo flowering
- Bamboo regeneration
- Plantation potential
- Biotic influence
- Natural calamities



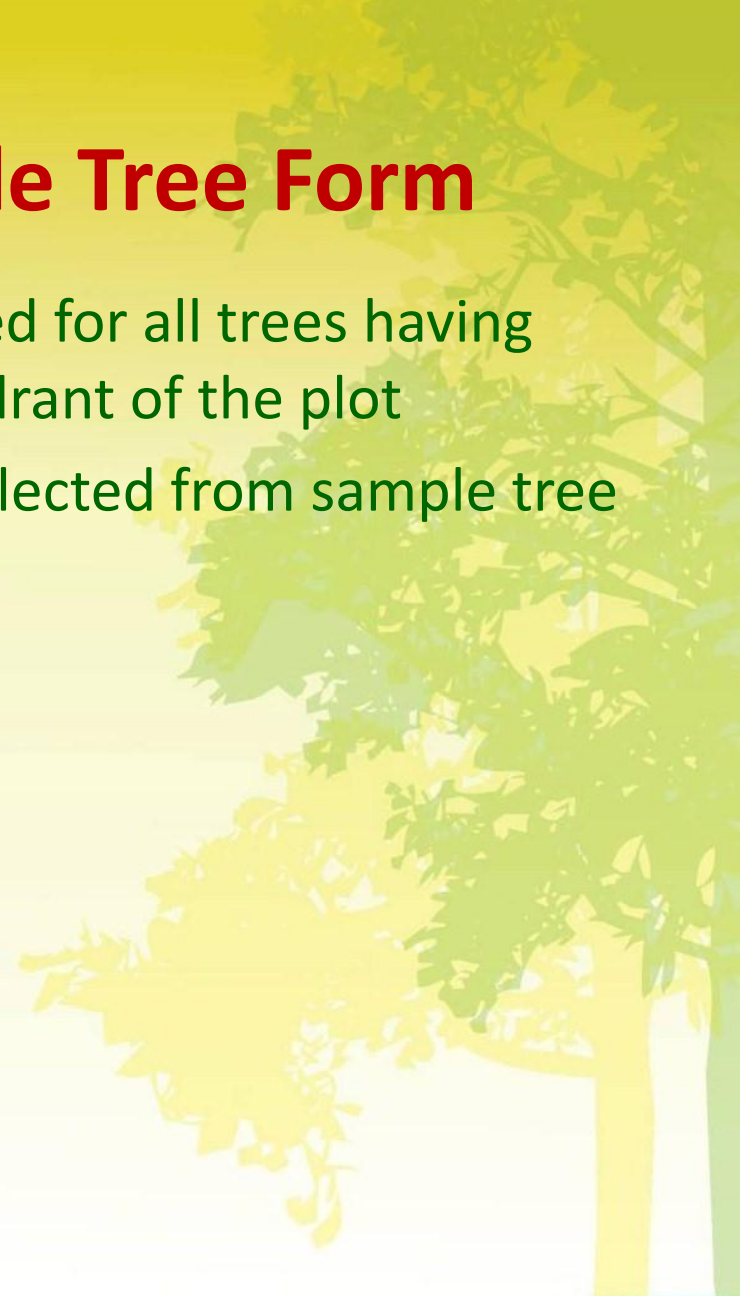
## Field Form No.3: Plot Enumeration Form

- The data in this form is recorded from the plot of 0.1 ha.
- This form is filled up for each plot separately
- The dbh and the name of the species are recorded for all trees above 10 cm diameter



# Field Form No.4: Sample Tree Form

- The information in this form is recorded for all trees having dbh 10 cm and above from north quadrant of the plot
- Following additional information is collected from sample tree form
  - Dominance
  - DBH over bark
  - Double bark thickness
  - Tree height
  - Crown width



## Field Form No.5: Bamboo Clump Analysis Form

- In this form data of each individual culms occurring in certain selected clumps in the plot is recorded
- In addition following information are recorded
  - Species name
  - Clump diameter
  - Clumps size
  - Average culm height
  - Bamboo quality

## Field Form No.6: Bamboo Enumeration and Analysis Form

- In this form information is collected for non-clump forming bamboos occurring in the sample plot
- For this purpose only one-eighth area of the plot is considered
- All culms are counted and categorised as follows:
  - Green sound
  - Green damaged
  - Dry sound
  - Dry damaged
  - Decayed



## Field Form No.7: Bamboo Weight Form

- For determining correlation between green and dry weights of utilizable bamboo culm length data is recorded in this form
- The data is collected for different diameter class
- Air dry weight is recorded for different diameter class

## Field Form No.8: Herb, Shrubs & Regeneration Form

- The data in this form is collected from three concentric plot at all four corners of 0.1 ha plot at a distance of 30m from the plot centre
- The size of plot for different parameters is as follows:
  - Herbs: 1m x 1m
  - Shrubs: 3m x 3m
  - Regeneration: 3m x 3m

## Field Form No.9: Soil and Forest Floor Carbon Form

- This data is collected from NE & SW corners within the plot of 0.1 ha
- For forest floor data, fresh, partially and fully decomposed leaves, twigs and branches is collected from a plot of size 1m x 1m and a composite sample of 200 gm is taken for laboratory
- For soil data, a pit of 30cm x 30cm x 30cm is dug out and a composite sample of 200 gm is taken for laboratory



# Data Collection Crew

- Data Collection is done by the trained **technical staff** of FSI's zonal offices at Shimla, Bangalore, Kolkata and Nagpur
- Each Crew consists of :

✓ Crew Leader	01
✓ Skilled Person	02
✓ Unskilled Person	01
✓ Cook cum Camp Attendant	01
✓ Driver	01
- About 7500 plots are laid out in forest and 10, 000 sample plots are laid out in TOF in every cycle.

**Output**



## Physiographic Zone wise growing stock

Physiographic Zone	Areas of Phy. Zone (km <sup>2</sup> )	Recorded Forest Area (km <sup>2</sup> )	Growing Stock		
			In Forest	In TOF	Total
			Volume (m. cum)	Volume (m. cum)	Volume (m. cum)
West. Himalayas	329,255	91,073	1,029.374	191.09	1,220.46
Eastern Himalayas	74,618	47,965	473.201	69.35	542.55
North East Ranges	133,990	79,431	341.142	102.85	443.99
Northern Plains	295,780	14,230	142.603	104.27	246.87
Eastern Plains	223,339	31,709	240.532	97.43	337.96
Western Plains	319,098	13,666	7.928	74.36	82.29
Central Highlands	373,675	80,665	109.371	110.86	220.23
North Deccan	355,988	87,260	281.074	83.47	364.54
East Deccan	336,289	128,757	622.183	198.74	820.92
South Deccan	292,416	49,459	224.422	134.28	358.70
Western Ghats	72,381	32,399	461.777	118.68	580.46
Eastern Ghats	191,698	74,418	360.651	75.26	435.91
West Coast	121,242	20,765	106.214	147.87	254.08
East Coast	167,494	17,826	68.336	91.06	159.40
<b>TOTAL</b>	<b>3,287,263</b>	<b>769,621</b>	<b>4,468.808</b>	<b>1,599.57</b>	<b>6,068.38</b>



# Statewise GS in forest and TOF

## State/UT wise Growing Stock

State/UT	Geographic Area (km <sup>2</sup> )	Recorded Forest Area (km <sup>2</sup> )	(m.cum)		
			Forests	TOF	Total
Andhra Pradesh	275,069	63,814	242.39	122.76	365.15
Arunachal Pradesh	83,743	51,540	492.54	79.20	571.73
Assam	78,438	26,832	174.11	42.44	216.55
Bihar	94,163	6,473	34.83	45.13	79.96
Chhatisgarh	135,191	59,772	335.47	72.64	408.11
Delhi	1,483	85	1.74	1.15	2.89
Goa	3,702	1,224	7.39	4.00	11.39
Gujarat	196,022	18,927	48.28	122.12	170.4
Haryana	44,212	1,559	4.89	15.58	20.47
Himachal Pradesh	55,673	37,033	322.4	21.23	343.63
Jammu & Kashmir	222,236	20,230	255.12	149.46	404.59
Jharkhand	79,714	23,605	103.78	53.32	157.11
Karnataka	191,791	38,284	314.57	105.26	419.83
Kerala	38,863	11,265	142.72	50.05	192.77
Madhya Pradesh	308,245	94,689	249.66	86.49	336.15
Maharashtra	307,713	61,939	294.17	151.40	445.58
Manipur	22,327	17,418	69.24	9.61	78.85

# Statewise GS in forest and TOF

## State/UT wise Growing Stock

State/UT	Geographic Area (km <sup>2</sup> )	Recorded Forest Area (km <sup>2</sup> )	(m.cum)		
			Forests	TOF	Total
Meghalaya	22,429	9,496	44.97	23.47	68.45
Mizoram	21,081	16,717	69.35	9.51	78.86
Nagaland	16,579	9,222	41.15	13.93	55.08
Orissa	155,707	58,136	285.32	77.21	362.53
Punjab	50,362	3,058	13.73	19.39	33.12
Rajasthan	342,239	32,639	34.64	90.46	125.1
Sikkim	7,096	5,841	19.82	2.53	22.35
Tamil Nadu	130,058	22,877	142.38	73.36	215.73
Tripura	10,486	6,294	22.21	8.04	30.25
Uttar Pradesh	240,928	16,583	122.96	83.44	206.4
Uttaranchal	53,483	34,651	459.26	19.34	478.6
West Bengal	88,752	11,879	92.46	44.85	137.31
Andaman & Nicobar	8,249	7,171	52.8	0.73	53.53
Chandigarh	114	34	0.29	0.10	0.39
Dadra & Nagar Haveli	491	204	3.93	0.85	4.79
Daman & Diu	112	8	0.01	0.11	0.11
Lakshadweep	32	0	0	0.05	0.05
Pondicherry	480	13	0.08	0.33	0.41
<b>Total</b>	<b>3,287,263</b>	<b>769,512</b>	<b>4498.66</b>	<b>1599.57</b>	<b>6098.22</b>

# Estimated stems by species and diameter class in forest

S. No.	Species Name	10-30	30-50	50 +	Total	Percentage
1	<i>Acacia catechu</i>	175,416	5,533	98	181,047	1.44
2	<i>Albizia amara</i>	60,406	4,705	550	65,660	0.52
3	<i>Anogeissus latifolia</i>	382,220	32,570	2,209	416,998	3.31
4	<i>Anogeissus pendula</i>	93,707	1,688	24	95,419	0.76
5	<i>Boswellia serrata</i>	110,686	36,234	3,174	150,094	1.19
6	<i>Buchanania latifolia</i>	207,283	4,549	326	212,159	1.69
7	<i>Butea monosperma</i>	168,133	14,055	683	182,872	1.45
8	<i>Castanopsis species</i>	153,105	36,465	11,903	201,473	1.60
9	<i>Chloroxylon swietenia</i>	214,251	9,320	746	224,317	1.78
10	<i>Cleistanthus collinus</i>	191,109	2,615	206	193,930	1.54
11	<i>Diospyros melanoxylon</i>	217,380	23,663	2,462	243,505	1.94
12	<i>Eucalyptus species</i>	58,849	3,380	268	62,497	0.50
13	<i>Gmelina arborea</i>	65,905	6,568	2,583	75,056	0.60
14	<i>Lagerstroemia parviflora</i>	241,025	10,157	477	251,659	2.00
15	<i>Lannea coromandelica</i>	281,271	31,271	1,208	313,750	2.49
16	<i>Lyonia ovalifolia</i>	77,062	9,034	1,289	87,384	0.69
17	<i>Macaranga species</i>	100,196	2,121	41	102,358	0.81



# Estimated stems by species and diameter class in forest

18	<i>Madhuca latifolia</i>	103,311	27,351	8,719	139,381	1.11
19	<i>Mallotus philippinensis</i>	84,490	2,409	75	86,975	0.69
20	<i>Pinus roxburghii</i>	111,095	59,179	21,013	191,287	1.52
21	<i>Pterocarpus marsupium</i>	82,840	13,610	2,605	99,055	0.79
22	<i>Quercus incana</i>	138,323	29,072	9,636	177,031	1.41
23	<i>Quercus semecarpifolia</i>	65,748	23,911	15,258	104,916	0.83
24	<i>Quercus species</i>	49,363	27,234	12,586	89,183	0.71
25	<i>Rhododendron arboreum</i>	126,247	16,119	3,140	145,506	1.16
26	<i>Schima wallichii</i>	124,700	32,394	8,022	165,116	1.31
27	<i>Shorea robusta</i>	903,632	124,616	30,830	1,059,079	8.42
28	<i>Syzygium cumini</i>	94,500	22,879	5,489	122,868	0.98
29	<i>Tectona grandis</i>	700,909	83,696	9,326	793,931	6.31
30	<i>Terminalia crenulata</i>	362,782	57,936	8,152	428,870	3.41
31	<i>Terminalia paniculata</i>	52,577	12,222	4,514	69,314	0.55
32	<i>Wrightia tinctoria</i>	65,241	1,386	160	66,786	0.53
33	<i>Xylia xylocarpus</i>	68,876	11,753	1,515	82,144	0.65
34	Rest of Species	4,689,714	754,614	254,545	5,698,873	45.30
	Total	10,622,355	1,534,308	423,830	12,580,493	99.99

# Estimated Volume by species and dia in forest

S. No.	Species Name	10-30	30-50	50 +	Total	Percentage
1	<i>Abies densa</i>	1.852	5.364	21.404	28.620	0.62
2	<i>Abies pindrow</i>	5.018	15.938	68.447	89.402	1.94
3	<i>Abies smithiana</i>	2.549	8.206	100.896	111.651	2.43
4	<i>Anogeissus latifolia</i>	73.250	32.791	6.434	112.475	2.44
5	<i>Boswellia serrata</i>	20.553	30.044	13.886	64.483	1.4
6	<i>Buchanania latifolia</i>	16.388	2.508	5.564	24.459	0.53
7	<i>Butea monosperma</i>	13.589	9.750	1.616	24.956	0.54
8	<i>Castanopsis species</i>	19.928	29.173	32.050	81.151	1.76
9	<i>Cedrus deodara</i>	6.872	29.061	40.670	76.603	1.66
10	<i>Diospyros melanoxylon</i>	21.085	19.393	6.995	47.473	1.03
11	<i>Gmelina arborea</i>	12.426	6.227	4.570	23.222	0.5
12	<i>Lagerstroemia parviflora</i>	29.403	9.075	2.296	40.774	0.89
13	<i>Lannea coromandelica</i>	36.647	23.482	3.059	63.187	1.37
14	<i>Madhuca latifolia</i>	13.942	21.342	25.829	61.113	1.33
15	<i>Pinus wallichiana</i>	6.016	18.101	35.546	59.663	1.3



# Thanks for your time

[prakash\\_293@rediffmail.com](mailto:prakash_293@rediffmail.com)

please visit us at  
[www.fsi.nic.in](http://www.fsi.nic.in)