

11.7

GOA

11.7.1 Introduction

Goa, became a Union Territory of India in 1961 and attained statehood in 1987. It is located along the Arabian Sea and has an area of 3,702 sq km which is 0.11% of the geographical area of the country and is bordered by Maharashtra in the North & East and Karnataka in the South. The State lies between 14°53' N to 15°40' N latitude and 73°40' E to 74°21' E longitudes. The State has two distinct physiographic regions, namely Western Ghats and coastal plains. Goa has a tropical monsoon climate. The average annual rainfall is 3,800 mm and the average annual temperature ranges between 16°C to 37°C. The State is drained by a number of rivers, the important rivers being Mandovi and Zuari. The State has two districts, none of which are classified as hill or tribal districts. As per the 2011 census, Goa has a population of 1.46 million accounting to 0.91% of India's population. The urban and rural population is 62.17% and 37.83% respectively. The Tribal population is 10.23%. The average population density of the State is 394 persons per sq km which is slightly higher than the national average. The 19th Livestock census 2012 has reported a total livestock population of 0.14 million.

TABLE 11.7.1 Land Use Pattern

Land Use Types	Area (in 000' ha)	Percentage
Geographical Area	370	
Reporting area for land utilization	361	100.00
Forests	125	34.75
Not available for land cultivation	37	10.28
Permanent pastures and other grazing lands	1	0.36
Land under misc. tree crops and groves	1	0.16
Culturable wasteland	53	14.55
Fallow land other than current fallows	0	0.00
Current fallows	15	4.11
Net area sown	129	35.79

Source: Land Use Statistics, Ministry of Agriculture, GOI, (2014-15)

11.7.1.1 A Brief Overview of Forestry Scenario

The forests of Goa are rich in diversity due to the variations in altitude, aspect, soil characters, slope etc. As per Champion and Seth Classification of Forest Types (1968), the forests of Goa have five Forest Type Groups which are further divided into five Forest Types. Major portion of the vegetation in Goa belongs to plateau vegetation along undulating terrain and hills. Goa has 16 mangrove species including *Rhizophora* spp, *Bruguiera* spp, *Ceriops tagal*, *Kandelia* spp, *Avicennia* spp, *Sonneratia* spp, *Acrostichum* spp, *Aegiceras* spp, *Excoecaria* spp, *Lumnitzera* spp.

Goa Forest Department implements various schemes like Rehabilitation of Degraded Forests, Western Ghats Development Programme, Development of Gardens, Parks and Fountains, Social and Urban Forestry etc.

Recorded Forest Area (RFA) in the State is 1,225 sq km of which 253 sq km is Reserved Forest and 972 sq km is Unclassed Forests. In Goa, during the period 1st January 2015 to 5th February 2019, a total of 42.75 hectares of forest land was diverted for non-forestry purposes under the Forest Conservation Act, 1980 (MoEF&CC, 2019). As per the information received from the State 140 ha of plantations have been raised in the State in the last two years.

One National Park and six Wildlife Sanctuaries constitute the Protected Area network of the State covering 5.33% of its geographical area.

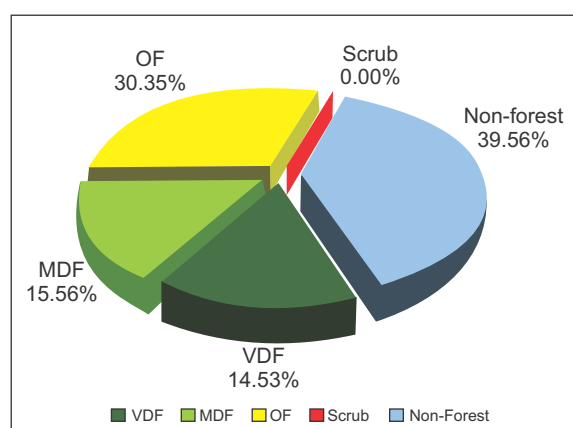
11.7.2 Forest Cover

Based on the interpretation of IRS Resourcesat-2 LISS III satellite data period of Dec 2017, the Forest Cover in the State is 2,237.49 sq km which is 60.44% of the State's geographical area. In terms of forest canopy density classes, the State has 538.00 sq km under Very Dense Forest (VDF), 576.09 sq km under Moderately Dense Forest (MDF) and 1,123.40 sq km under Open Forest (OF). Forest Cover in the State has increased by 8.49 sq km as compared to the previous assessment reported in ISFR 2017.

TABLE 11.7.2 Forest Cover of Goa
(in sq km)

Class	Area	% of GA
VDF	538.00	14.53
MDF	576.09	15.56
OF	1,123.40	30.35
Total	2,237.49	60.44
Scrub	0.00	0.00

FIGURE 11.7.1 Forest Cover of Goa



11.7.2.1 Forest Cover inside and outside Recorded Forest Area (or Green Wash)

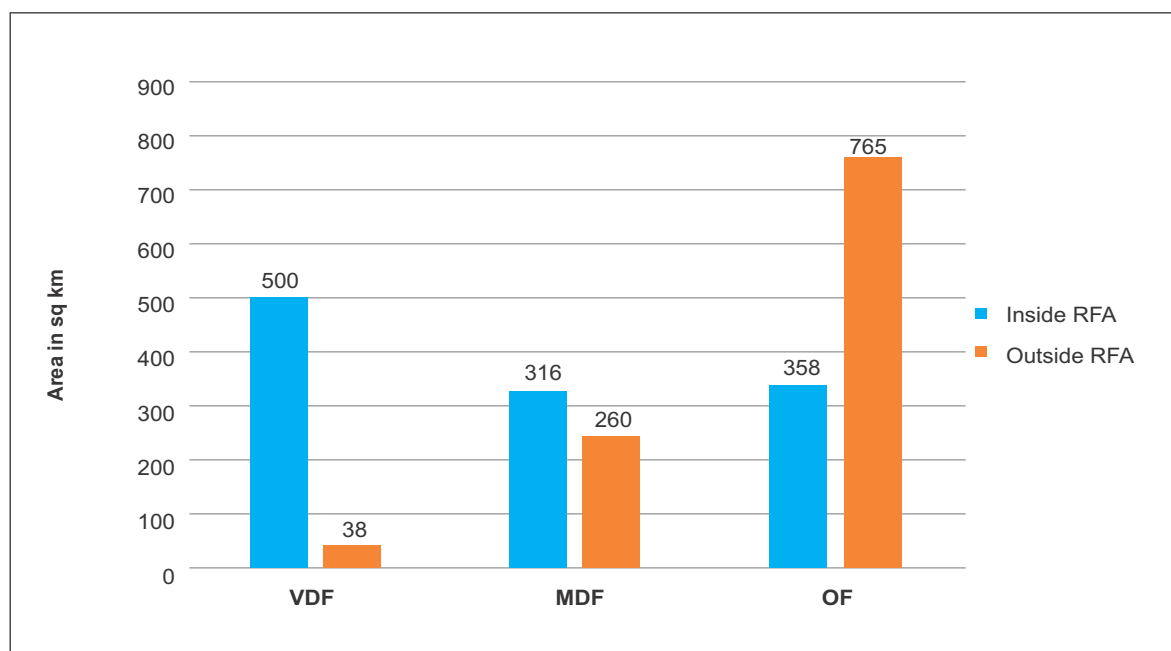
The State has reported extent of recorded forest area (RFA) 1,225 sq km which is 33.09% of its geographical area. The reserved and unclassified forests are 20.65% and 79.35% of the recorded forest area in the State respectively. However, as the digitized boundary of recorded forest area from the State covers 1,309.00 sq km, the analysis of forest cover inside and outside this area is given below.

TABLE 11.7.3 Forest Cover inside and outside Recorded Forest Area or (Green Wash) in Goa

(in sq km)

Forest Cover inside the Recorded Forest Area (or Green Wash)				Forest Cover outside the Recorded Forest Area (or Green Wash)			
VDF	MDF	OF	Total	VDF	MDF	OF	Total
500	316	358	1,174	38	260	765	1,063
42.59%	26.92%	30.49%		3.57%	24.46%	71.97%	

*in case of Goa RFA, boundaries have been used.

FIGURE 11.7.2 Forest Cover inside and outside RFA in Goa**TABLE 11.7.4** District-wise Forest Cover in Goa

(in sq km)

District	Geographical Area (GA)	2019 Assessment				% of GA	Change wrt 2017 assessment	Scrub
		Very Dense Forest	Mod. Dense Forest	Open Forest	Total			
North Goa	1,736	127.00	231.15	574.76	932.91	53.74	5.91	0.00
South Goa	1,966	411.00	344.94	548.64	1,304.58	66.36	2.58	0.00
Grand Total	3,702	538.00	576.09	1,123.40	2,237.49	60.44	8.49	0.00

TABLE 11.7.5 Forest Cover Change Matrix for Goa

(in sq km)

Class	2019 Assessment					Total ISFR 2017
	VDF	MDF	OF	Scrub	NF	
Very Dense Forest	538	0	0	0	0	538
Moderately Dense Forest	0	576	0	0	0	576
Open Forest	0	0	1,115	0	0	1,115
Scrub	0	0	0	0	0	0
Non Forest	0	0	8	0	1,465	1,473
Total ISFR 2019	538	576	1,123	0	1,465	3,702
Net Change	0	0	8	0	-8	

Main reasons for the increase in forest cover in the State are plantation and conservation activities.

TABLE 11.7.6 Altitude-wise Forest Cover in Goa

(in sq km)

Altitude Zone (m)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-500	3,549	442	556	1,095	2,093 (93.56 %)	0
500-1000	153	96	20	28	144 (6.44 %)	0
Total	3,702	538	576	1,123	2,237	0

(based on SRTM, Digital Elevation Model, 30 m, 2016)

TABLE 11.7.7 Forest Cover in different slope classes in Goa

(in sq km)

Slope (in degrees)	Geographical Area	VDF	MDF	OF	Total	Scrub
0-5	1,918	100	212	502	814 (36.39 %)	0
5-10	795	122	148	283	553 (24.72 %)	0
10-15	463	118	104	162	384 (17.17 %)	0
15-20	273	92	64	90	246 (11.00 %)	0
20-25	136	55	29	44	128 (5.72 %)	0
25-30	64	28	12	22	62 (2.77 %)	0
>30	53	23	7	20	50 (2.23 %)	0
Total	3,702	538	576	1,123	2,237	0

(based on SRTM, Digital Elevation Model, 30 m, 2016)



FIGURE 11.7.3 Forest Cover Map of Goa

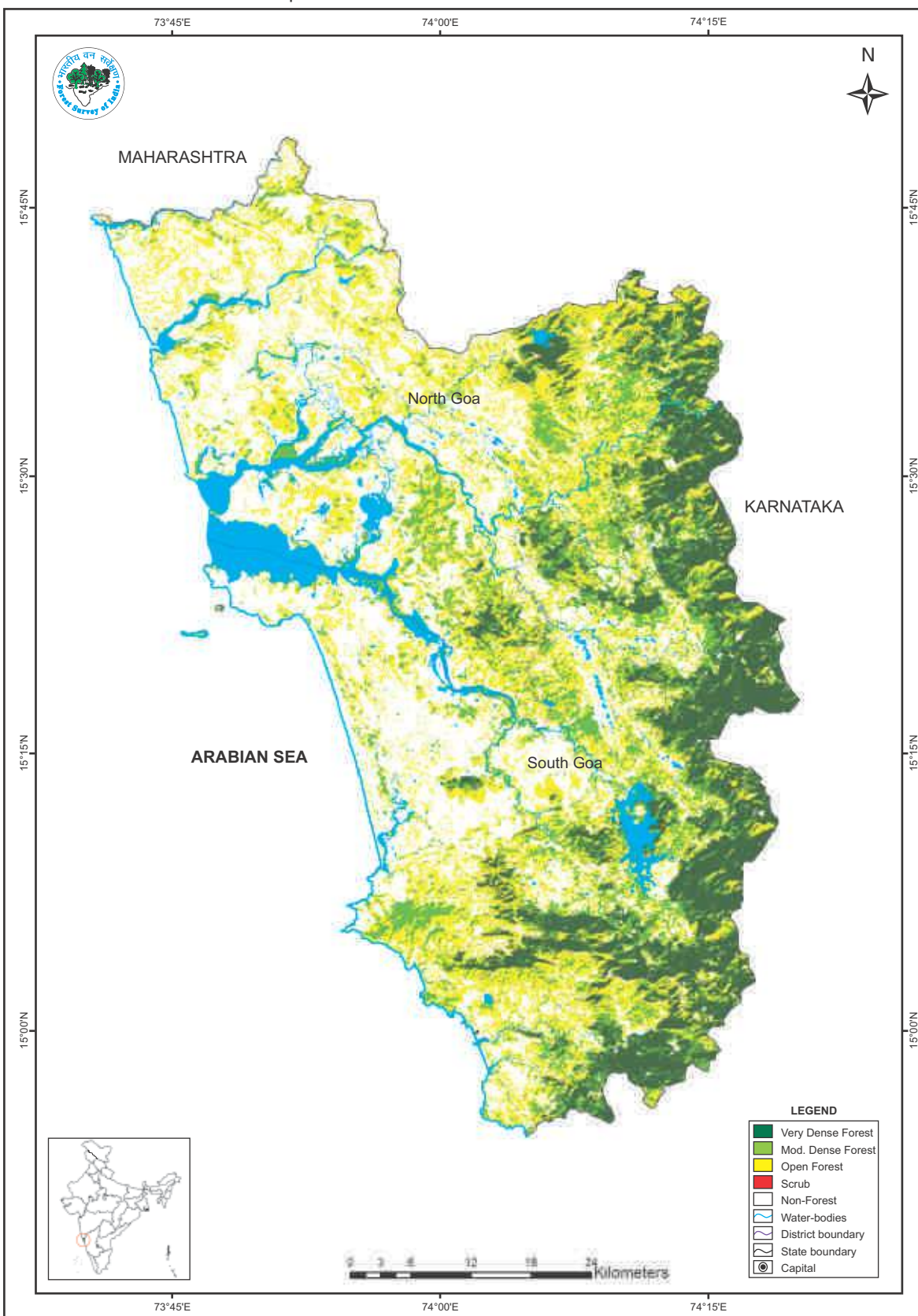


TABLE 11.7.8 Wetlands inside the Recorded Forest Area (or Green Wash) in Goa

(in ha)

Wetland Category	No. of Wetlands	Total Wetland Area
Inland Wetlands - Natural		
Lake/Pond	3	33
Ox-bow lake/Cut-off meander	1	6
River/Stream	11	488
Sub - Total	15	527
Inland Wetlands - Man-made		
Reservoir/Barrage	2	134
Tank/Pond	22	92
Sub - Total	24	226
Coastal Wetlands – Natural		
Sand/Beach	3	2
Mangrove	2	243
Sub -Total	5	245
Wetlands (<2.25 ha)	27	27
Total	71	1,025
Total Recorded Forest (or Green Wash) Area (in ha)		1,30,900
% of Wetland area inside Recorded Forest (or Green Wash) Area		0.78%

*(analysis based on the National Wetland Atlas: India, 2011)***11.7.3 Forest Types & Biodiversity**

Forest Type Maps of 2011 have been refined in the recently completed exercise by FSI. Percentage area under different forest types of Goa as per the Champion & Seth classification (1968), according to the latest exercise are presented in the following table.

TABLE 11.7.9 Percentage area under different Forest Types of Goa

Sl.No.	Forest Type	% of Forest cover
1.	1A/C4 West Coast Tropical Evergreen Forest	22.40
2.	2A/C2 West Coast Semi-Evergreen Forest	21.35
3.	3B/C2 Southern Moist Mixed Deciduous Forest	42.55
4.	4B/TS2 Mangrove Forest	1.08
5.	5/E7 Laterite Thorn Forest	0.02
6.	Plantation/ TOF	12.60
	Total	100.00

11.7.3.1 Assessment of Biodiversity in Goa

Findings of the rapid assessment of Biodiversity carried out at the national level for natural forests during September 2018 to May 2019 as part of the forest type mapping exercise is summarized below in table 11.7.10 and table 11.7.11 in respect of Goa.

TABLE 11.7.10 No. of species observed during the rapid assessment

Plant Type	Number of Species
Tree	118
Shrub	50
Herb	38

TABLE 11.7.11 Shannon-Wiener Index of Tree, Shrub and Herb species in different Type Groups of Goa

Sl.No.	Forest Type Group	Shannon-Wiener Index		
		Tree	Shrub	Herb
1.	Group 1- Tropical Wet Evergreen Forests	2.86	2.54	2.61
2.	Group 2- Tropical Semi-Evergreen Forests	3.14	2.16	2.28
3.	Group 3- Tropical Moist Deciduous Forests	3.13	2.65	1.83
4.	Group 4- Littoral and Swamp Forests	*	0.23	0.67
5.	Group 5- Tropical Dry Deciduous Forests	*	1.23	0.41

*adequate number of sample plots were not available

11.7.4 Fire Prone Forest Areas

Geographical area under different classes of forest fire proneness are given in the following table.

TABLE 11.7.12 Forest Fire Prone Classes (in sq km)

Sl. No.	Forest Fire Prone Classes	Geographical Area	% of Total forest cover
1.	Extremely fire prone	-	0.00
2.	Very highly fire prone	-	0.00
3.	Highly fire prone	-	0.00
4.	Moderately fire prone	1.10	0.05
5.	Less fire prone	3,589.82	99.95
	Total	3,590.92	100.00

11.7.5 Tree Cover

Forest cover presented in the section 11.7.2 accounts for tree patches of size 1 ha and more having canopy density more than 10%. However, trees occurring in patches of size less than 1 ha including scattered trees are assessed through sampling based methodology. Tree cover in Goa has been estimated as given in table 11.7.13.

TABLE 11.7.13 Tree Cover in Goa (in sq km)

Tree Cover	Area
	272

Tree cover of Goa has decreased by 51 sq km as compared to the previous assessment reported in ISFR 2017.



11.7.6 Extent of Trees Outside Forest (TOF)

Trees outside Forests (TOF) refer to tree resources found outside the forests as defined in the Government records. FSI maps forest cover using satellite data and assesses tree cover outside forests using sampling based method. Forest Cover outside the recorded forest area is derived using boundaries of RFA or Green Wash. Extent of TOF therefore may be estimated as the sum of extent of forest cover outside the recorded forest areas (RFA) and tree cover as given in the preceding section.

TABLE 11.7.14 Extent of TOF in Goa (in sq km)

Forest Cover outside the RFA/GW	Tree Cover	Extent of TOF
1,063	272	1,335

11.7.7 Growing Stock in Forest

Growing stock in the recorded forest areas (RFA) in Goa is given in the table 11.7.15. Diameter class-wise distribution of top 5 species in numbers derived from the forest inventory data is presented in the table 11.7.16

TABLE 11.7.15 Growing Stock in Goa (in m cum)

Growing Stock (GS)		% of Country's GS
Growing Stock in Recorded Forest Area	11.16	0.26
Growing Stock in TOF	4.03	0.25

TABLE 11.7.16 Diameter class distribution of top five species inside RFA in Goa (in '000)

Sl.No.	Species	Dia class (cm)		
		10-30	30-60	>60
1.	<i>Terminalia paniculata</i>	5,698	1,771	161
2.	<i>Terminalia tomentosa</i>	2,235	544	0
3.	<i>Xylia xylocarpa</i>	2,617	483	0
4.	<i>Careya arborea</i>	1,570	181	0
5.	<i>Anacardium occidentale</i>	3,463	282	0

11.7.8 Carbon Stock in Forest

The total Carbon stock of forests in the State including the TOF patches which are more than 1 ha in size 25.34 million tonnes (92.91 million tonnes of CO₂ equivalent) which is 0.36% of total forest carbon of the country. Pool wise forest carbon in Goa is given in the following table

TABLE 11.7.17 Forest Carbon in Goa in different pools (in '000 tonnes)

AGB	BGB	Dead wood	Litter	SOC	Total
9,010	2,617	172	665	12,874	25,338

11.7.9 Growing Stock of Bamboo

Bamboo bearing area and growing stock inside the recorded forest area (RFA)/ Green Wash in the State which include culms of 1 year age and above are given in the table 11.7.18

TABLE 11.7.18 Growing Stock of Bamboo in Goa

Growing Stock (GS)		% of Country's GS of Bamboo
Bamboo bearing area inside RFA/Green Wash (in sq km)	418	0.26
Total number of culms (in millions)	30	0.08
Total equivalent green weight (in 000' tonnes)	202	0.07

11.7.10 Dominant tree species in Trees Outside Forests (TOF)

Top five species in numbers in Trees Outside Forests in Goa in rural and urban areas are given in the table 11.7.19 and table 11.7.20 respectively.

TABLE 11.7.19 Top five tree species in TOF (Rural) in Goa

Sl. No.	Species	Relative Abundance (%)
1.	<i>Areca triandra</i>	28.58
2.	<i>Cocos nucifera</i>	22.42
3.	<i>Anacardium occidentale</i>	6.33
4.	<i>Acacia auriculiformis</i>	6.17
5.	<i>Areca catechu</i>	3.71

TABLE 11.7.20 Top five tree species in TOF (Urban) in Goa

Sl. No.	Species	Relative Abundance (%)
1.	<i>Cocos nucifera</i>	38.17
2.	<i>Mangifera indica</i>	10.18
3.	<i>Acacia auriculiformis</i>	4.14
4.	<i>Anacardium occidentale</i>	3.76
5.	<i>Artocarpus heterophyllus</i>	3.73

11.7.11 Major Invasive Species

Major invasive species as assessed from forest inventory data are presented in the table 11.7.21.

TABLE 11.7.21 Major invasive species in the State inside the RFA/Green Wash in Goa (in sq km)

Sl. No.	Species	Estimated Extent
1.	<i>Chromolaena odorata</i>	60
2.	<i>Cassia tora</i>	13
3.	<i>Ageratina adenophora</i>	3
4.	<i>Triumfetta rhomboidea</i>	1
5.	<i>Acacia farnesiana</i>	1

Major invasive species are given in terms of their estimated extent.

11.7.12 Quantified estimation of Dependence of People living in forest fringe villages on forests in Goa

Through a nation-wide study, FSI has done estimation of dependence of people living in the villages close to forest for fuel wood, fodder, small timber and bamboo in quantified terms for each State & UT of the country (Please refer to Chapter 10 in Vol. I for details). The estimated quantities of the four produce for Goa is given in the table 11.7.22.

TABLE 11.7.22 Estimation of Dependence of People in Forest Fringe Villages on Forests in Goa

Fuelwood (tonnes)	Fodder (tonnes)	Bamboo (tonnes)	Small Timber (cum)
30,285	34,852	312	2,699