Biomass Production and nutrient removal from tropical pines

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Introduction

All the major paper mills and other wood based industries require large quantities of raw materials both to meet existing installed capacities and contemplated expension programme. Due to the technological improvement the major paper mills have since started utilisation of mixed hardwoods from natural forests besides the conventional long fibre raw material such as *Bomboo*. The long fibre bamboo resources have become scarce due to over use and requirement of the weaker section. This has caused for the search of alternative source of raw material for paper and pulp industry. It is very well known that there is a wide gap between the industrial wood requirement and supply. To abridge the gap between demand and supply, the state forest department took mass scale plantation of Tropical pines on marginal, degraded and waste land during 1960-1970.

Tropical pines by their quick growing nature and high yield and long fibre dimension are considered to be an excellent source for paper and pulp. The suitability of these species for paper and pulpmaking is being recommended by Singh and Sharma 1982.

Site, spacing and stand age have pronounced effect on biomass production and productivity of tropical pines. The intensive management of these plantations will significantly increase biomass production and on harvest nutrient removal. It has been observed that the nutrient removal during short rotation forestry approaches to that of agronomic crops. thus fertilization must be an integral part of intensive management.

The paper summarised results on biomass and nutrient distribution in Tropical pines from the studies carried out in the different part of the country on different speices of tropical viz. *Pinus patula* (Sharma and Srivastava 1984, Singh 1982, George et. al 1982, Sharma et, al. 1982. Bhartari 1986). *Pinue kesiya* (Das and Ram Krishanan 1987, Pande et. al. 1987). *Pinus roxburahii* (Kaul et. al. 1981) *Pinus ellottii* 1987 and *Pinus caribaea* (un published)

RESULT AND DISCUSSION

Biomass and Productivity

Biomass production generally increases with the increase of stand age. But the MAP (Mean annul production) ceases after attaining certain age, which varies at different site for same species; it is very clear by examining the Table 1 and Table 2. Though there is a increasing trend in biomass accumulation in case of *P. patula* growing in Tamilnadu and West Bengal, the MAP attains its peak in the early age (9-10 years) and thereafter either become constant or start declining. The MAP for *P.patula* growing in West Bengal reaches to its peak in the latter ages. It clearly indicates that the hillslopes of Palni and Nilgiris are better suited for plantations of tropical pines compared to the slopes of Darjeeling, because favourable climatic edaphic and topographic conditions. Similarly *P. kesiya* attains the highest productivity at the age of 7 Meghalaya compared to *P. kesiya* growing in Orrissa. In case of *P. ellottii* though the maximum biomass is produced at the age 40 years but the productivity start declining after 10 years of age.

Tree spacing has a pronounced effect on biomass production. Closer spacings generally have the greatest MAP during the early years of growth. For *P. carebaea* growing at four different spacings, the maximum biomass production and MAP was obtained at closer spacing (2× ×2m) Table 2. However it has been observed that these plantations with the increasing age

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Table—1

Distributions of above Ground Biomass (t/ha) in Different Tropical Pines.

Species	Location	Age	No. of tree/ha	Foliage	twig	Branch	Bark	Bole	Total	Productivity
P. Patula	T.N.	3	644	1.90	1.35	1.14	4.36	1.35	10.10	3.36
		5	967	4.98	3.47	3.45	9.25	4.02	25.17	5.03
		9	1167	10.81	9.08	20.87	8.58	97.72	147.06	16.34
		11	960	8.08	8.48	13.38	9.49	69.25	108.68	9.88
		13	1033	14.05	13.45	20.50	10.49	70.69	129.18	9.94
P. Patula	T.N.	6	1125	4.48	3.04	2.47	1.48	6.62	18.09	3.01
		8	1000	7.75	7.67	10.13	5.00	35.92	66.47	8.31
		10	856	13.10	14.46	16.66	9.00	81.77	134.99	13.50
		12	922	14.40	13.53	16.70	9.31	96.65	150.59	12.55
		14	1222	19.08	16.36	19.19	11.23	129.38	195.22	13.94
P. Patula	T.N. Site I	6	100	10.50	2.28	16.32	5.24	34.03	68.37	11.40
		8	980	13.30	2.25	45.20	9.21	59.85	129.81	16.22
		9	980	14.34	2.65	29.60	11.70	85.29	143.58	15.95
	Site II	6	100	5.63	—	5.40	1.86	4.46	17.35	2 89
		9	987	13.00	—	34.04	10.19	64.50	121.73	13.52
P. Patula	W.B.	4	2100	6.78	3.03	5.40	1.58	10.67	26.46	6.87
		6	1289	6.48	2.22	5.81	1.59	11.79	27.89	4.65
		8	1022	5.26	3.40	6.56	2.16	18.45	35 83	4.47
		10	1422	4.92	2.70	4.34	2.33	12.64	26.93	2.69
		12	533	8.80	10.20	18.31	7.41	60.65	105.37	8.78
		14	350	7.29	6.37	20.38	8.23	57.59	99.86	7.13
P. Patula	W.B.	8	900	2.56	—	3.03	1.71	10.40	17.70	2.21
		10	1275	7.48	—	12.41	4.42	26.90	51.21	5.12
		12	630	3.57	—	8.06	3.56	21.63	36.82	3.07
		17	530	7.09	—	20.33	8.92	54.18	90.52	5.32
		25	655	13.11	—	19.44	23.82	144.77	201.14	8.05
		34	640	10.89	—	39.00	45.88	278.81	374.58	11.02
P. Kesiya	Meghalaya	1	28300	1.55	—	—	0.44	0.50	2.49	2.49
		2	28200	2.04	—	0.74	0.74	0.84	4.36	2.18
		3	24020	3.89	—	2.16	2.27	2.57	10.89	3.63
		4	23500	4.68	—	6.14	4.21	4.75	19.78	4 95
		5	21800	5.86	—	10.56	3.74	10.29	30.45	6.09
		7	10800	6.16	—	24.03	16.64	45.71	92.54	13.22
		12	6880	6.40	—	28.62	15.59	68.12	118.73	9.89
		15	2520	6.59	—	42.58	19.91	108.78	177.86	11.86
		22	2080	7.04	—	59.52	37.22	203.41	307.19	13.96

Species	Location	Age	No. of tree/ha	Foliage	twig	Branch	Bark	Bole	Total	Productiv ity
P. Kesiya	Orissa	4	700	1.38	0.78	0.76	1.72	5.45	—	1.36
		6	2220	4.11	2.09	4.15	2.62	9.81	22.78	3.80
		8	670	6.23	3.10	8.78	4.5	22.89	45.50	5.69
		12	630	5.86	4.94	10.53	8.68	62.86	92.87	7.74
		14	340	4.83	5.43	6.85	8.24	53.26	78.61	5.62
Pinus elliottii	U.P.	10	1568	25.55	14.10	18.95	18.54	5.981	136.95	13.70
		20	912	13.30	9.90	20.58	22.09	122.94	188.81	9.44
		30	479	12.20	13.79	42.46	22.63	141.3	232.46	7.75
		40	676	20.58	25.01	67.44	37.58	297.3	447.96	11.20
Pinus roxburghii		40	278	5.37	3.37	19.00	10.82	106.59	145.15	3.63
Pinus caribaea		15								
	2×2m		2146	24.26	8.19	19.45	28.61	167.45	247.96	16.53
	2.5×2.5m		1233	13.89	7.10	12.43	15.16	87.12	135.70	9.05
	3 × 3m		909	12.43	7.57	11.25	18.86	113.60	163.71	10.91
	3.5×3.5m		611	13.15	4.36	7.42	15.01	88.10	128.04	8.54

occupy the site fully and the MAP gradually and mass in the wider spacings also. The higher biomass production and higher MAP in closer spacing of *P. caribaea* can be explained that in young stands which do not have fully close canopy, leaf biomass is larger; and the higher leaf biomass resulted in the higher production.

Partitioning of Biomass

Partitioning of biomass proportion for all species (Table 3)followed the order of bole> branch>foliage> bark> twig, However the maximum bole biomass is being partitioned in *Pinus roxburghii* and the leaf in *Pinus ellottii* with regard to the partitioning of bole biomass in *Pinus patula*, *Pinus kesiya* and *Pinus caribaea* varied between 53-68%. Similarly partitioning of utilizable biomass (bole+branch+twig) in all the three species, viz. *Pinus patula*, *Pinus kesiya* and *Pinus caribaea* is almost same and flucuate in between 78 to 82%. Further, the partitioning of utilisable biomass in *Pinus roxburghii* is 89% and *Pinus ellottii* is 68%, Thus, *Pinus caribaea* and *Pinus patula* can be efficient for energy captures under Indian conditions.

Nutrient Removal and Nutrient use efficiency

Pinus species often occur on nutrient defecient and highly leached soils. They can be successfully planted in such habitats because their sclerophyllous needless act to conserve nutrients,being long wood and resistant to leaching, insects attack and decay (Monk 1966). It is evident from Table 4 that the nitrogen, potassium, calcium are lost significantly during the harvest of latitisable biomass. However, there losses can be mitigated by adding the non-utilisable biomass(needles and barks) to the lowest site.

Nutrient use efficiency is an important management consideration because forests are frequently restrictd to the soil of low fertility. The tropical pines are the most efficient user of the nutrients. One kilogram of phosphorous is necessary to produce 1125 kg of biomass in the deciduous forest covers and 7460 kg. of biomass in tropical pines. (Table 5). The moderately high biomass production of tropical pines coupled with efficient use of nutrients make the tropical pine forests most suitable for intensive forest management. In contrary to above deciduous forests of tropics and subtropics are not efficient user of nutrient indicating.

Table—2
Biomass and productivity in Tropical pines at different locations

Location	Age	Stand density Tree/ha	Foliage Biomass t/ha	Above ground Biomass t/ha	Productivity (t/ha/Yr)
			1. Pinus patula		
TAMIL NADU					
KODAIKANAL	9	1116	10.81	147.06	16.34
KODAIKANAL	9	980	14.34	143 58	15.95
OOTAKMUND	10	856	13.10	134 99	13.50
WEST BENGAL	12	533	8.80	105.37	8.78
WEST BENGAL	25	655	13.11	201.14	8.05
			2. Pinus Kesiya		
MEGHALAYA	7	10800	6.16	92.54	13.22
ORISSA	12	630	5.86	92.87	7.74
			3. Pinus ellottii		
U.P.	10	1568	25.55	136 95	13.70
	20	912	13.30	188.81	9.44
	30	479	12.20	232.46	7.75
	40	676	20.58	447.96	11.20
			4. Pinus roxburghii		
U.P.	40	278	5.37	145.15	3.63
			5. Pinus carebaea		
U.P. (2×2m)	15	2146	24.26	247.96	16.53
(2.5×2.5m)	15	1233	13.89	135.70	9.05
(3×3m)	15	909	12.43	163.71	10.91
(3.5×3.5m)	15	611	13.15	128.04	8.51

Table—3
Comparative Proportion of Biomass Components in Tropical Pinus at Different Locations.

Species	Locations	Stand age	% of Biomass component Foliage	Twig	Branch	Bark	Bole
Pinus Patula	Tamil Nadu	9	10.6	7.6	17.2	7.8	56.8
	West Bengal	9	12.2	8.6	18.9	7.2	53.1
Pinus kesiya	Meghalaya	8	5.6	24.8	12.8	56.8	
	Orissa	9	9.2	6.7	12.7	9.9	61.7
Pinus ellottii	U P.	10	18.7	10.3	13.8	13.5	43.7
Pinus caribaea	U.P.	15					
		(2×2m)	9.8	3.4	7.8	11.5	67.5
		(2.5×2.5m)	10.2	5.2	9.2	11.2	64.2
		(3×3m)	7.6	4.6	6.9	11.5	69.4
		(3.5×3.5m)	10.2	3.4	5.8	11.7	68.9
Pinus roxburghii		40	3.7	2.3	13.0	7.5	73.4

Table—4

Nutrient Removal of Utilisable (Bole + Branch + Twig) and Nonutilisable (Leaf + Bark) in Different Tropical Pines

Species	Stend age	Biomass components	Biomass (t/ha)	Nutrient (kg/ha) N	P	K	Ca	Mg
Pinus patula (Kodai kanal)	9	UTI	127.67	258.4	45.14	142.5	118.7	34.2
		Non UTI	19.39	76.5	19.40	85.4	64.4	25.3
		Total	147.06	334.9	64.54	227.9	183.1	59.2
Pinus patula (Ootacmund)	12	UTI	126.88	701.20	1.40	86.0	75.1	205.8
		Non UTI	23.71	291.80	2.70	76.9	66.7	54.4
		Total	150.59	993.00	4.10	162.9	141.8	259.2
Pinus patula (West Bengal)	12	UTI	89.2	134.0	12.8	94.9	98.9	64.5
		Non UTI	16.2	169.0	16.4	83.4	52.4	20.0
		Total	105.4	303.0	29.2	178.3	151.3	84.5
Pinus kesiya (Orissa)	12	UTI	78.3	129.0	21.2	73.2	38.0	52.2
		Non UTI	14.6	69.4	14.4	49.0	16.9	43.0
		Total	92.9	198.4	35.6	122.2	54.9	95.2
Pinus kesiya (Orissa)	15	UTI	151.4	423.8	106.0	348.1	272.5	90.8
		Non UTI	26.5	74.2	18.6	61.0	47.7	15.9
		Total	177.9	508.0	124.6	409.1	320.2	106.7
Pinus roxburghii	40	UTI	129.0	206.0	16.0	95.0	193.0	55.0
		Non UTI	16.2	130.0	13.0	66.0	95.0	31.0
		Total	145.2	336.0	29.0	161.0	288.0	86.0
Pinus caribaea	15	UTI	106.7	277.3	44.8	103.1	355.5	42.7
		Non UTI	29.0	184.3	22.4	88.3	136 3	26.9
		Total	135.7	361.6	67.2	191.4	491.8	69.6

Table 5

Nutrient use Efficiency (Biomass in kg./kg. of Nutrients) of major forest cover.

Forest Covers	N	P	K	Ca	Mg	Source
Broad leaved (Deciduous)	278	1125	291	147	703	Negi & Sharma (1990)
Evergreen (Eucalyptus)	347	4236	758	241	1117	—do—
Tropical pines	326	7460	692	614	1049	Derived From Table 4

thereby that substantial amount of nutrients will be lost from the ecosystem on harvesting. As stated already, that a high proportion of the total nutrient capital in subtropical deciduous forest is tied up in the forest biomass. Thus maintaining the site productivity following clear cutting, will be most difficult in humid tropics and subtropics.

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