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A study on soil characteristics in the JFM practiced degraded forests of north coastal districts of Andhra Pradesh

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Abstract

JFM works were taken up in the North Coastal Reserve forest (RF) of Andhra Pradesh for the regeneration of degraded forests. Soil samples were collected and analyzed from ten treatment practice number one and three treatment practices number seven areas. Pothavaram RF, Burna RF areas having fertile soils with high IVI value. Darakonda RF, Mallavaram RF areas having low micro and high macro elements concentration and having good number of diversity in one area and dominance in other area. Murari RF, Korra RF areas having slightly acidic soil nature and macro elements are in medium concentration and micro elements are in high concentration showing very poor growth of species. Baliagam RF, Maribanda RF areas having medium fertile soil conditions, but with less diversity. Shikargangii RF is having low microelements concentration and medium macro elements concentration with poor growth of species. The bamboo forest areas Tarlakota, Lammasanghi and Divanchervu RF areas having good fertile soils having good number of grown clumps. The study helps to improve the degraded forest areas by selecting the species suitable to the soil conditions and also helps to improve the soil characteristics by planting different species to improve the particular macro or micro element. The study also helped to identify the impact of the JFM works and also to identify the endemic and endangered species.

Key words: Forest management; Tropical forest; Soil characteristics.

Abbreviations: VSS - Vana Samrakshana Samithi; FD-Forest Department; TP-1-Treatment practice number one (Miscellaneous forest area); TP-7 - Treatment practice number seven (Bamboo forest); JFM - Joint forest management; RF - Reserve forest area; IVI= Importance value index.

Introduction

Forests are potentially renewable resources and the protective, productive and accessory functions are the major uses of fores1s. The degradation of tropical forests and destruction of habitat due to anthropogenic activities are the major causes of decline in the global biodiversity. Therefore in many areas the reconstruction of a disturbed ecosystem is being taken up on a priority basis, both for biodiversity conservation and for maintaining landscape productivity (Solbrig, 1991). Joint Forest Management (JFM) is Participatory action involving the Government and a local community for regeneration of degraded forests through effective protection, sharing of produce and improving the socio economic conditions of the forests communities. In this program various treatment practices (TP) like TP-1, TP-5 and TP-7 are the silvicultural works done under APFP (Andhra Pradesh Forestry Project). JFM works were taken up in the North Coastal Reserve forest (RF) of Andhra Pradesh for the regeneration of degraded forests. Sample plots were laid and soil samples collected and analyzed from ten treatment practice number one areas East Godavari (Pothavaram RF at Gokavaram Range, Mallavaram RF at Sudikonda Range, Gedhada RF at

Table 1: List of factors

Parameter	Method
pH	NEERI, 2001
Total Nitrogen	NEERI, 2001
Phosphorous	NEERI, 2001
Potassium	Page et al. 1982
Iron	Page et al. 1982
Manganese	Page et al. 1982
Copper	Page et al. 1982
Zinc	Page et al. 1982

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Table 2. Geo-Position Details of Study areas

S.No	Reserve Forest	Section	Range	Division	District	Type of the Forest and area	Geopositing system readings or Compartment number (C.No)
TREATMENT PRACTICE NO- ONE (TP-1)							
1	Pothavaram	Gokavaram	Gokavaram	Kakinada	East Godavari	Dry deciduous forest and mountainous area	1. 17^0 . 18' . 12.11'' N 81^0 . 44'. 47.32" E C.No : 688 A
2	Mallavaram	Mallavaram	Sudikonda	Kakinada	East Godavari	Northern dry mixed deciduous forest and plain area	1. 17^0 . 16' . 48.2" N 81^0. 59' . 15.5" E 2. 17^0 . 16' . 48.3" N 81^0 . 59' . 17.2" E 3. 17^0 . 16' .45.2" N 81^0 . 59' .17.5" E C.No : 491
3	Gedhada	Gedhada	Rampachodavaram	Kakinada	East Godavari	Moist mixed deciduous forest and Mountaneous area	C. No : 420
4	Murari	Divanchervu	Gokavaram	Kakinada	East Godavari	Dry deciduous forest and Plain area	C. No : 449
5	Burna	Veeragattam	Palakonda	Srikakulam	Srikakulam	Northern tropical dry mixed deciduous forest and mountaneous area	24*.30' N - E (Compass reading) C.No : 211
6	Baliagam	Mandasa	Kasibugga	Srikakulam	Srikakulam	Dry deciduous forest and mountaneous area	C.No : 218
7	Shikargangii	Bobbili	Parvathipuram	Vizainagaram	Vizainagaram	Dry deciduous forest and Plain area	34*.40' N – E (Compass reading) C.No : 336
8	Korra	Paderu	Paderu	Paderu	Visakhapatnam	Moist deciduous forest and mountaneous area	C.No : 492
9	Maribanda	Elamanchali	Elamanchali	Visakhapatnam	Visakhapatnam	Dry deciduous forest and Plain area	C.No : 665/666
10	Darakonda	Downoor	Narsipatnam	Narsipatnam	Visakhapatnam	Moist deciduous forest and mountaneous area	221 BB 170.5'' N - E (Compass reading)
TREATMENT PRACTICE NO- SEVEN (TP-7)							
11	Tarlakota	Baliagam	Kasibugga	Srikakulam	Srikakulam	Dry deciduous forest and mountaneous area	1. 8^0 .48 '. 53 .6" N 84^0.25'. 42.2" E 2. 8^0 49'. 03" N 4^0 . 25'. 43.8" E 3. 18^0. 49'. 5" N 4^0 . 25'. 44.9" E 4. 8^0. 49'. 9 " N 4^0. 25'. 46.7" E
12	Lammasanghii	Chintapalli	Chintapalli	Visakhapatnam	Visakhapatnam	Moist deciduous forest and mountaneous area	1. 17^0. 51'.43'. 8" N 82^0. 26'.12' .9" E 2. 17^0. 51'.18' .4" N 82^0 .25' .14 .6" E
13	Divancheruvu	Divancheruvu	Kakinada	Kakinada	East Godavari	Dry deciduous forest and Plain area	1. 17^0. 01'. 75.4" N 81^0. 49'. 07.2" E

Rampachodavaram Range and Murari RF at Gokavaram Range), Srikakulam (Burna RF at Palakonda Range and Baliagam RF at Kasibugga Range), Vizayanagaram (Shikargangii RF at Parvathipuram Range) and Visakhapatnam (Korra RF at Paderu Range, Maribanda RF at Elamanchali Range and Darakonda RF at Narsipatnam Range) districts and three treatment practices number seven (bamboo forest) areas Srikakulam (Tharlakota RF at Kasibugga Range), Visakhapatnam (Lammasangii RF at Chintapalli Range) and East Godavari (Divanchervu R.F at Kakinada Range) districts (Table 1 & 2).

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Soil fertility is very important for the growth of any plant. Many researchers studied the forest species along with the soil characteristics. Toko *et al.* (1999) measured the amount of the extractable Sulfate content in 12 Japanese forest soils. As a preliminary work he studied the sulfur dynamics in forest ecosystems. The two levels of sulfate contents in Japanese forest soils suggest that the sulfur dynamics are different in these soils.

Swati and Lodhiyal (2005) studied on the various aspects of soils and tree layer vegetation analysis in reserve forests in the Nainital district of Kumaon in central Himalaya in temperate region. The soil texture for coarse gravel ranged from 22.0-0.56.2 %, sand 33.9-56.7 %, silt 2.7-7.1 % and clay 5.9-14.2 % in the reserve forest. Soil bulk density varied from 0.95-1.20 gm cm3 however the soil porosity and pH ranged from 52.8-64.2 % and 5.5-6.5, respectively.

Varma *et al.* (2005) studied plant species diversity along with the soil characteristics. He studied in the degraded forest of Surajpur block (Barotiwala) of Kuthar Forest Range in Kunihar Forest Division of Himachal Pradesh. He studied the diversity of species in both the plantations and in dense forest. He also studied the soil characters of the both the areas. He found the soil under plantation forest has better fertility status in comparison to degraded forest.

Jumpei *et al*. (2008) studied on soil physical properties in three forest types in tropical lowland monsoon forests in central Cambodia under the same climatic conditions. The soils in the study area were generally sandy, a slight difference in clay content caused large variations in the vG parameters and K. It was hypothesized that the lower K in KH-E than AH-D at high matric potential, i.e., w[–10 kPa, was favorable for evergreen trees to retain the soil water for the transpiration in the dry season. Actually the evergreen forest soils showed relatively moist conditions throughout the year.

Methodology

The present investigation carried out by laying sample plots and collecting soil samples at different areas where Treatment practices are carried out for the improvement of degraded forests under APFP (Andhra Pradesh Forestry Project).

Laying of sample plots

One of the methods followed in laying sample plots was the stratified random sampling. In the present study, all the ten locations of TP-1 areas, sample plots of one hectare area were permanently demarcated with stones taking 100x100m in all the four sides. These one hectare plots were initially divided in to four quadrants and again in each quadrant one 10 m x 10 m sub plot were laid. Data on the name and number of the species and their basal girth (cm), girth at breast height (cm) and height (m) of the trees etc. was taken from each sub plot in the TP-1 areas. From the recorded data all the species are classified according to girth-height class wise. Species composition, Density, abundance and frequency of various species present in the plot were calculated using the following formulae (Government of Andhra Pradesh, 2002). Using the values of density, abundance and frequency, the relative frequency, relative density and relative dominance of the species and Importance value Index (IVI) of the species were calculated using the following formulae (Chandrashekera *et al*. 2002).

To study the impact of TP-7 operations, sample plots were laid in all the three selected bamboo forests. In all these forest areas base line of approximately one-kilometer was taken from the center of the plot. From the base line, grid lines perpendicularly were marked at 320 m a part. On the perpendicular line marked points for each 300 m, all these points become center of the sample plot (PSP) proposed. From the center of Permanent Sample plot, moved 22.36 m perpendicularly with the help of cross staff in all four directions and marked four points. These four points form the vertices of rhomboidal PSP having each side of 31.62 m. The total area of each PSP was approximately 0.1 ha (31.62 m X 31.62 m =

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Table 3. Height wise distribution of various species at different RF areas studied

S.No	Name of the RF	Height classification (m) ---------->									Total
		0-2 m	2-4 m	4-6 m	6-8 m	8-10m	10-12 m	12-14 m	14-16m	16-18 m	
1	Pothavaram RF	0	12	27	12	3	1	0	0	0	**55**
2	Mallavaram RF	20	26	20	1	5	0	0	0	0	**72**
3	Gedhada RF	0	8	22	16	0	1	0	0	0	**47**
4	Murari RF	15	44	13	0	0	0	0	0	0	**72**
5	Burna RF	7	39	27	25	9	7	0	0	0	**114**
6	Baliagam R	76	13	0	0	0	0	0	0	0	**89**
7	Shikargangii RF	106	2	0	0	0	0	0	0	0	**108**
8	Korra RF	44	11	4	0	0	0	0	0	0	**59**
9	Marribanda RF	31	39	25	0	0	0	0	0	0	**95**
10	Darakonda RF	15	46	27	18	8	2	1	1	1	**119**
	Total	**314**	**240**	**165**	**72**	**25**	**11**	**1**	**1**	**1**	**830**

998.824 m2) (Government of Andhra Pradesh, 2002). All the clumps in the permanent sample plot were counted. Four clumps out of every 100 clumps were counted for detailed count of number of culms and their size etc. This results in 4 % intensity of clump analysis. The data collected includes girth (cm) of the bamboo and height of the bamboo. After the data collection, all the bamboo culms were classified according to the girth and height.

Soil sample collection

Soil samples are collected using the standard scientific method. One meter pit is divided in to four parts and from each part soil sample was taken separately and mixed thoroughly. From this soil, one kg sample was collected using quartering technique. This soil sample is used for chemical analysis.

Soil analysis procedure

The soil samples collected in both miscellaneous forest and bamboo forest were analyzed for various soil characteristics as mentioned below.

Results

Over the ten areas studied, number of trees found in 0-2 m height class (314) followed by 2-4 m (240), 4-6 m (165) and 6-8 m (72). Only three trees found in height class of 12-18 m (Table 3). More number of trees found in Downoor RF (119) followed by Burna RF (114), Shikargangii RF (108) and Maribanda RF (95). Only 47 trees found in Gedhada RF. More number of trees found in 10-30 cm girth class (446) followed by 1-10 cm (274)

Table 4. The Girth wise distribution of various species at different RF areas studied

Girth classification	Pothavaram RF	Mallavaram RF	Gedhada RF	Murari RF	Burna RF	Baliagam RF	Shikargangii RF	Korra RF,	Marribanda RF	Darakonda RF	Total
1-10 cm	**0**	**0**	19	25	**0**	39	101	35	32	23	**274**
10-30 cm	31	62	25	44	85	44	7	16	59	73	**446**
30-50 cm	18	9	2	3	24	6	0	4	4	17	**87**
50-70 cm	5	1	1	0	4	0	0	2	0	5	**18**
70-90 cm	1	0	0	0	1	0	0	0	0	1	**3**
90-110cm	0	0	0	0	0	0	0	2	0	0	**2**
Total	**55**	**72**	**47**	**72**	**114**	**89**	**108**	**59**	**95**	**119**	**830**

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and 30-50 cm (87). Five trees found in girth class of 70-110 cm (Table 4).

Table 5. Information on Vegetation with respect to tree community at different RF areas studied

S.No	Location details	Total number of Individual species	H*	C*	R*
1	Pothavaram RF	16	3.458	0.133	2.1
2	Mallavaram RF	17	3.286	0.149	1.866
3	Gedhada RF	16	3.11	0.18	2.33
4	Murari RF	16	3.5	0.095	1.88
5	Burna RF	24	3.896	0.101	2.238
6	Baliagam RF	11	2.01	0.226	1.146
7	Shikargangii RF	14	2.69	0.229	1.347
8	Korra RF	20	4.461	0.08	2.6
9	Marribanda RF	16	3.03	0.16	1.641
10	Darakonda RF	26	3.6	0.09	2.38

Note: H* = Shannon's index of diversity, R*= Menhinick's index of Species richness and C*=Simpson's index of species dominance

Table 6. Status of bamboo at Tarlakota RF in TP-7 and control area during base year and after six months

S. No	Sample plot	Average No. of clumps		Average Total number of culms		Average No. of fresh recruits		Average No. of long bamboo (> 5 m)		Average No. of short bamboo (< 5 m)	
		I	F	I	F	I	F	I	F	I	F
1	TP-7 plot	3.7	3.7	72.3	70.3	3.3	0.3	30.7	32.7	41.7	37.7
2	Control plot	4	4	88	105	17	0	58	98	30	113

Note: I= Initial Data; F= Data after six months

Total numbers of individual varieties of species are more at Darakonda RF (26) and Burna RF (24), Korra RF (20) and very less number of species found at Baliagam RF (11). Shannon-Wiener index (H) of species diversity is more at Korra RF (4.461) and Burna RF (3.896) and is very less at Baliagam RF (2.01). Simpson's index of species dominance is more at Shikargangii RF (0.229), Mandasa RF (0.226) and is less at Korra RF (0.08). Menhinick's index of Species richness value is more at Korra RF (2.6), Darakonda RF (2.38) and is less at Baliagam RF (1.146) (Table 5).

Darakonda RF, Burna RF and Korra RF are having higher diversity and richness of the species. Species dominance is found to be high at Mallavaram RF where two to three species occupied major area. In Burna RF, Shannon's species diversity index (H) is higher (3.836) and Simpson's index of species (C) dominance lower (0.101) and Menhinick's index (R) of species richness is higher (2.238) than other locations indicating favorable balance of species.

Bamboo forest areas

At Tarlakota RF, numbers of culms were more or less same both in initial and final data in TP-7 plot (Table 6). Where as in control plot the number increased from 88 to 105 after six months. At Lammasangii RF, (Table7) number of culms increased after six months both in Treatment Practice No -7 (TP-7) (from 64 to 66.3 culms) and control plots (from 56 to 77 culms). The increase was more in control plot compared to TP-7. At Divancheruvu R.F, (Table 8) 55 % increment observed in total number of culms (582) after one year in the TP-7 treated plot and 42 % in control plot (290).

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Table 7. Status of bamboo at Lammasangii RF in TP-7 and control areas during base year and after six months

S. No	Sample plot	Average No. of clumps		Average Total number of culms		Average No. of fresh recruits		Average No. of long bamboo (> 5 m)		Average No. of short bamboo (< 5 m)	
		I	F	I	F	I	F	I	F	I	F
1.	TP-7 plot	4	4	64	66.3	5.5	0.5	57.5	60.5	6.5	8.5
2.	Control plot	4	4	56	77	1	0	28	37	28	36
Note:I= Initial Data; F= Data after six months											

Table 8. Status of bamboo at Divanchervu RF in TP-7 and control plots during base year and after one year

S.No	Area	Average No. of Clumps	Average No. of culms		Average clump diameter (cm)		Average height (m)		Average number of fresh recruits		Average inter nodal length (cm)	
			I	F	I	F	I	F	I	F	I	F
1	TP-7	30	14.7	19.4	5.6	5.6	6.6	6.6	2.5	4.9	20	20
2	Control plot	8	32.8	35	5.8	5.8	6.8	6.8	3.6	0	20.7	20.7
Note: I=Initial data; F=After one year data												

Soil characteristics of sample plots

Soil samples were collected from the selected TP-1 and TP-7 sample plots and analyzed for various characteristics (Table 9). Out of the thirteen areas studied the soil reaction of the soil samples are neutral and slightly neutral in many areas and found acidic only in Murari RF, Korra RF and Tarlakota RF areas. The macro element, the Total Nitrogen value is medium (250 to 400 kg/ha) in all the areas and it is low only in Shikargangii RF (128 kg/ha). The available Phosphorous value is high (32 kg/ha) in Pothavaram RF and medium in Murari (29 kg/ha) and Darakonda RF (22 kg/ha) and it is low in all the remaining areas (< 20). The available Potassium value is high in Pothavaram, Murari, Burna, Darakonda and Divanchervu RF areas (420, 360, 385, 390 &396 kg/ha) and it is medium (145-640 kg/ha) in all the remaining areas. Pothavaram RF, Murari RF, Darakonda RF and Divanchervu RF areas area having good macro elements values and in the rest of the areas one out of three having low value of macro element. Shikargangii RF is having very low macro elements value.

The micro element, the available Zinc value is high in Pothavaram, Mallavaram, Gedhada, Burana and Divanchervu RF areas (1.22, 0.9, 1.63, 0.9 & 0.8 ppm) and in the remaining area its value is low (< 0.6 ppm). The available Manganese value is high in all the thirteen areas. The available Iron value is medium in Gedhada, Baliagam, Maribanda and Tarlakota RF areas (7.5, 6.69, 6.67 & 7.12 ppm) and is high in all the remaining areas (above 8 ppm). The available Copper value is high in Mallavaram, Murari, Darakonda, Lammasangii and Divanchervu RF areas (26, 30, 2.15, 3.14 & 29 ppm) and medium in Pothavaram, Gedhada, Burna, Maribanda and Tarlakota RF areas (1.6, 0.64, 0.82, 0.9 & 0.66) and its value is low in Baliagam, Shikargangii and Korra RF areas (< 0.4). The four micro elements values recorded high only in Mallavaram and Divanchervu RF areas and except in Tarlakota and Baliagam RF areas the remaining RF areas are having medium concentration of micro elements.

Pothavaram RF is having good fertile soil. Mallavaram RF soil is having low micro and high macro elements concentration. Gedhada RF is having medium soil fertility. Murari RF is having slightly acidic nature and the macro elements are in medium concentrations and micro elements are in high concentration. Burna RF is having good soil fertility, all the macro and micro elements are high in concentration. Baliagam RF is having medium soil fertility. Shikargangii RF is having low microelements concentration and medium macro elements concentration. Korra RF area is having slightly acidic soil and except zinc and Iron micro elements all the other elements are in medium

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Table 9. Soil analysis report of different Reserve Forest areas of North Coastal districts of Andhra Pradesh

S.No	Reserve Forest	p^H	Total Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)	Available zinc (ppm)	Available Manganese (Mn) (ppm)	Available Iron (ppm)	Available Copper (ppm)
1	Pothavaram	6.5	360	32	420	1.22	18.12	8.3	1.6
2	Mallavaram	7	390	18	290	0.9	31.1	16	26
3	Gedhada	7.5	342	15	265	1.63	10.09	7.5	0.64
4	Murari	5.5	336	29	360	0.6	29.66	11	30
5	Burana	7	315	10	385	0.9	30.1	12.2	0.822
6	Baliagam	6.5	290	13	256	0.26	27.76	6.69	0.473
7	Shikargangii	6.5	128	15	230	0.33	29.93	10.87	0.276
8	Korra	5	278	11	312	0.5	28.56	10.8	0.27
9	Maribanda	7	322	17	242	0.42	18	6.67	0.9
10	Darakonda	7	260	22	390	0.41	21.5	9.13	2.15
11	Tarlakota	6	298	15	310	0.28	26.77	7.12	0.667
12	Lammasanghii	6.5	310	17	299	0.6	24.11	8.65	3.14
13	Divancheruvu	7	360	18	396	0.8	33.1	15	29

concentration. Maribanda RF soil is having moderate soil fertility. Darakonda RF is having low micro and high macro elements concentration. Tarlakota RF is low fertile area and Lammasangii is having moderate soil fertility. Divanchervu RF is having good fertile soil. In Pothavaram, Mallavaram, Burna and Divancervu RF areas many of the macro and micro elements values are in high concentration and are fertile areas.

Conclusion

The stability of the ecosystem depends upon its biodiversity which is sum total of all flora and fauna. Conservation of biodiversity is very important for the sustainable development of the ecosystem. Soil samples were collected and analyzed from thirteen reserve forest areas and in each and every location observed difference in both edaphically and climatically. Present study helped to understand the different soil characteristics in North Coastal districts of Andhra Pradesh. Laying of sample plots helps to understand the biodiversity variation in various regions. Forest growth difference between the managed forests and non managed forest areas were also estimated. The study helps to improve the degraded forest areas by selecting the species suitable to the soil conditions and also helps to improve the soil characteristics by planting different species to improve the particular macro or micro element. The study also helped to identify the impact of the JFM works and also to identify the endemic and endangered species.

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