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POTENTIAL OF FOREST BIOMASS FOR ENERGY CONVERSION

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ABSTRACT

Forest is one of the important sources of fuelwood and has been meeting energy requirement of most the rural poor. Due to continued depletion of forest cover and density, the sustainability of fuelwood is questioned. The ever increasing demand and poor return of the forest has to be catered with innovative technology and judicious use of fuelwood. Biomass can be converted into useful energy by way of thermal, chemical and biochemical conversion, depending on the composition of the fuel and the desired energy carrier product. However woody biomass is still in the early stages of energy production. The paper is basically discussing the potential of tropical forest in producing biomass and envisaged technological intervention so that the forests can be managed sustainably.

KEYWORDS: Biomass Resource, Forest Survey, Fuelwood

INTRODUCTION

Background

Biomass or biological material of living things is often referred to as plant material. These renewable resources are huge and are being directly used to meet the energy demand. Biomass is a renewable source that accounts for nearly 33% of a developing country's energy needs. In India, it meets about 75% of the rural energy needs and the rural population constitutes 70% of the total population. Bio-fuel is indirect use of biomass by converting into another kind of energy products i.e. electrical/ heat energy, transport fuel, chemical feedstock (McKendry, 2002). Biomass has become a popular alternative to satisfy expanding energy demand and as a substitute for fossil fuels and has phased out nuclear energy in Europe (Lundmark R., 2006).

As per Ramachandra et al (2007), annually, 62-310 Mt of wood could be generated in India from the surplus land, after meeting all the conventional requirements of biomass, such as domestic fuel wood, industrial wood and sawn wood, with an investment of Rs. 168-780 billion. The annual energy potential of plantation biomass is estimated to vary from 930 to 4,650 PJ. It is projected that the energy consumption in 2010 will be 19,200 PJ; thus an estimate show that plantation biomass could supply about 5-24% of projected total energy consumption in 2010 (Sudha et al, 2003). The estimation of the biomass and the carbon contained in biomass of Indian forests, using species-wise volume inventories for all forest strata in various states indicate that the aboveground biomass densities ranged from 14 to 210 Mg/ha, with a mean of 67.4 Mg/ha, which equals around 34 MgC/ha (Haripriya, 2000).

Most of the world’s biomass is in the form of woody forest materials (Klass D, 2004). It is true for the developing nations; woody biomass remains the largest biomass energy source even today. It is important for us to improve our knowledge about biomass composition and chemical properties, which will help us to choose appropriate technology and feed stock. From the following table it is obvious that the tree species has the highest biomass component in meeting the energy.

Table 1: Biomass Composition and Chemical Properties (Source Klass D, 2004)

Biomass Component	Bermuda Grass (Herbaceous) (% Mass)	Poplar (Woody) (% Mass)	Pine (Woody) (% Mass)	Refuse Fuel (Waste) (% Mass)	Carbon Content (% Mass)	Higher Heating Value (MJ/Kg)
Cellulose	32	41	40	66	40-44	17
Hemicellulose	40	33	25	25	40-44	17
Lignin	4	26	35	3	63	25
Protein	12	2	1	4	53	24
Ash	5	1	1	17	0	0

Among all forest produces, production of wood is important for the country's economic development. The growing stock of the country for the year 2011 was 6,047.15 million cubic meter comprising of 4498.73 million cubic meters corresponding to the forest cover and 1548.42 million cubic meters corresponding to the tree cover. Average growing stock in the recorded forest area per hectare was 59.79 cubic meter. However, in 2005, the growing stock under tree cover was 1,616 million cubic meter and for forest cover was 4,602 million cubic meter. The proportion of growing stock for tree cover as compared to that for forest cover is 35.12% and 34.14% in 2005 and 2003 respectively (FSI, 2005, 2008). As per the CSO, fuelwood contributes highest i.e. 85% of the total reported output from the forests.

One obstacle to the adoption of woody biomass for energy production is accurate data on sustainable supply. There are few site specific studies available for discussion. Study conducted in Eastern Ghats of Tamil Nadu, India by Ramachandran et al (2007). The study estimated Growing stock, biomass. As per the study estimate, evergreen forests volume m^3/ ha is 428.229, followed by deciduous 316.06 m^3/ha. Whereas secondary deciduous biomass volume of 216.673 m^3/ha, southern thorn forest with volume of 73.025 m^3/ha and euphorbia 52.72 m^3/ha. As per the estimates about 36 percent of the biomass per ha is in the form of branch and foliage, stumps and root. These are considered as sustainable source of bio-energy conversion.

Table 2: Biomass, Volume, Total Biomass Assessment

Forest Type	Volume (m^3/ha)	Timber Biomass (Tons/ha)	Branch and Foliage (Tons/ha)	Stumps and Root (Tons/ ha)	Biomass (Tons/ha)	Area of Each Forest (ha)	Total Biomass (M tons)
Evergreen	428.229	196.988	47.277	63.036	307.302	3962.23	1.22
Deciduous	316.06	161.316	38.716	51.621	252.653	12684.74	3.19
Secondary deciduous	216.673	154.983	37.196	49.595	241.773	2960.28	0.72
Southern thorn	73.025	42.282	10.148	13.530	65.960	6676.15	0.44
Euphorbia scrub	52.72	36.859	8.846	11.795	57.5	304.4	0.02
Total	**1086.707**	**592.428**	**142.183**	**189.577**	**924.188**	**26587.80**	**5.58**

Plantation forests including Tree Resources outside Forests (TOF) have higher potential for biofuel sources, which constitute 5.07% of the total tree biomass. Plantation forests of short rotation tree species with regular leaf shedding have more capacity of carbon sequestration. Fast growing conifers like Chir Pine produce litter (Pine needles), which can be converted into char and char bricket. Species like eucalyptus is ideal for salt affected wastelands and increase the biomass in such land also. Estimated rates of C flux in selected planted forests in India is tabulated below (Raizada et al, 2003):

Table 3

Tree Species	Area (000 ha), FSI, 1999)	Av. Litter Production (t/ha/yr)	C Flux (Mt. C/yr)	Total C Flux in the Planted Area (Mt C/yr)
Eucalyptus spp.	1360.91	4.50	2.03	27.5
Tectona grandis	1330.09	3.60	1.62	21.5
Acacia auriculiformis	564.67	3.03	1.36	7.7

Table 3: Contd.,

Pinus roxburghii	318.54	4.94	2.22	7.1
Dalbergia sissoo	266.58	3.03	1.36	3.6
Shorea robusta	250.28	11.27	5.07	1.3
Gmelina arborea	148.01	2.17	0.97	1.4
Gmelina arborea	148.01	2.17	0.97	1.4
Casuarina equisetifolia	134	3.15	1.41	1.9
Populus deltoids	47.48	3.71	1.66	0.8
Bombax ceiba	37.97	1.30	0.58	0.2

Study on Biomass Assessment

Under current research, authors tried to assess the biomass to document the potential of tropical dry deciduous forests in Central India. The study area was Bilaspur district, Chhattisgarh State. Total geographic area of the district is 6377 km^2 and 30.21 percent of its geographic area is occupied forest and Tree cover (FSI, 2011). Bilaspur district has been managed under two forest divisions namely, Bilaspur and Marwahi. Sub-tropical climate of the district is experiencing hot & humid summer and moderate winter weather. Annual average rainfall of the district is about 1375 mm and is unevenly distributed, i.e. decreases form south-east to Southwest. About 80percent of the total rainfall is received during July to September months.

The study framework followed step wise approach. The first step consisted of forest cover classification and mapping, within Bilaspur Forest Divison. In a second step, estimated the total forest biomass of the division and in the third step, quantified fuelwood demand in villages, which is within the vicinity forest.

To calculate woody biomass, it was necessary to identify and classify forest cover, as well as to characterize forest stand structure. There is total 71837.65 ha forests in Bilaspur forest division and forests are classified into Reserved Forests, Protected Forests and un-classed or orange (forest fringe) area with 67189.74, 4033.43 and 614.58 ha respectively. As per the division records, forests of the division falls in the site quality of IV and III and conventionally forests of the division have been categorized into Sal, Mixed forest with area of 152.58 km^2, 400 km^2 respectively.

Bamboo forest is II/III quality and of middle class density, which is highly degraded due to heavy pressure. As per the division level data, in the forests there are average number of trees at 375.76/ha with avergae tree volume of 69.79 cu.m/ha.

As per the satellite data (2009) of the Bilaspur forest division, forest cover estimated at 131109.9 ha (i.e. 22.63% of total geographic area) and scrubs 19888.81 ha (3.43%) with Dense Forest cover (> 60%) 24percent, Moderately Dense Forest (40 - 60%) 42percent and open canopy forest (< 40%) 34 percent. Another 6464.63 ha (1.12%) land was under other tree resources classified as Tree resources outside Forest. Satellite data of 10 years interval (i.e. year 2000 and 2009) was used to assess the changes in the forest canopy status in the forest division.

As per the study there is a shift of sum of area of one class to other class and vice-vice. About 126.37 ha of dense forest have been converted to moderately dense forest and 25.11 ha into open forest. Similarly about 409.13 ha moderately dense forest and 77.82 ha open forest has been converted to dense forest and recorded a net increase in the dense forest. There is a considerable change in moderately dense forest to open forest with 2157.24 ha, which is compensated by conversion of 1257.24 ha open forest into dense forest cover. There is also a shift from degraded forest with 1479.05 ha to open density forest.

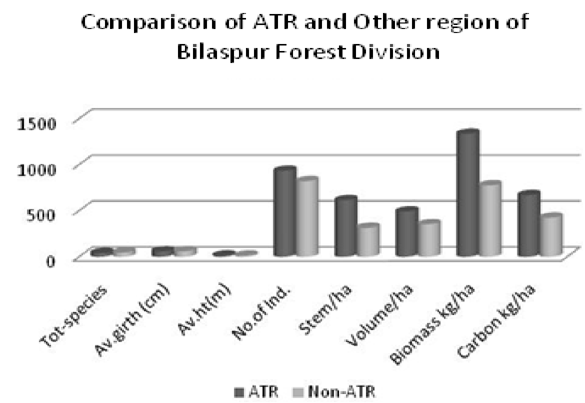

Figure 1

Assessment of available biomass the total forest area of division is divided in to tow sub-region namely Achanakmar Tiger Reserve (ATR) i.e. managed under Protected Area Network and other forest area. The Biomass form ATR region is not available for any commercial use. Available biomass from rest of the regions (Non-ATR) of the division, there were 46 species from 2.6 ha sampled area with 820 individuals. Average CBH and height was 59.44 cm and 12.65 m respectively. Other calculated parameters are stem/ha, volume/ ha, biomass kg/ha and carbon kg/ha were 314.280, 351.65, 774.41 kg and 425.1 kg respectively.

FUELWOOD CONSUMPTION

In the study villages, majority of the household uses forest woody biomass as Fuelwood for fulfillment of energy need. As per the study, the average consumption of fuelwood at households of vicinity villages' was 200 to 300 kg per month, whereas as the consumption of households in villages located inside the dense forest of ATR is much higher at 500 kg fuelwood per month. This is due non-availability of other energy means like kerosene, LPG and agriculture residue.

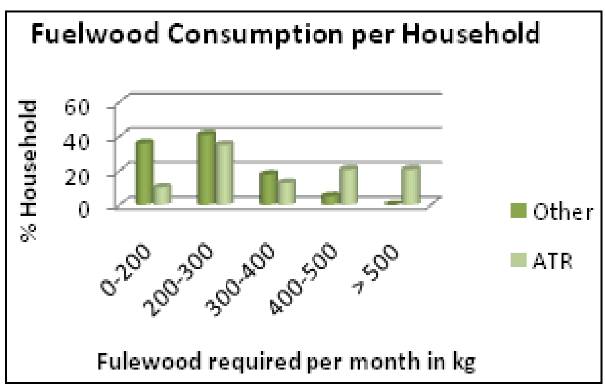

Figure 2

CONCLUSIONS

There are emerging opportunities to increase the forest biomass and they are National Afforestation Program (NAP) and Green India Mission. These centrally sponsored programs support the natural and aided regeneration of forests with the cooperation of Joint Forest Management Committees. About 10 m ha forest land has been developed under this program in the country. Another 5 m ha of forest land is going to be stocked under Green India Mission by way of plantation schemes. The mission also envisages bringing another 5 mil ha land outside forests under tree cover with the help of community. This program is envisages to achieve the target in next ten years. The mission also promotes renewable energy programs.

A critical knowledge gap is how potential edge effects of growing crop trees may influence habitat quality of intercropped stands. Although biomass intercropping may increase diversity by adding predominantly grass components to intensively managed forest landscapes, predictions about biodiversity response are not possible until more research is done.

The ability to produce and economically source hundreds of thousands of tons of woody feedstock annually and economically will require additional technological advancements that enhance the recovery, use, and marketing of these stocks while reducing the cost of handling. Modifications and/or advancements in the way this feedstock is harvested, collected, stored and transported will also have to be achieved, if financial success is paramount. There is huge availability of herbaceous and non-perennial woody biomass in Indian Forests. These resources need specific approach to meet the energy need of those remote villages of the country, which are more than 80000 in number in the country.

Based on the study it can be assessed that the energy requirement per family would be 1.05 Mkcal per month or 12.6 Mkcal per year, which can not only be met from forests. Looking to the fuelwood consumption, status of forests and available biomass in the central tropical forests there is a need of technological interventions to enhance the energy efficiency. The emerging technologies like bio- briquette, char and char briquette making with the cooperation of the Joint Forest Management committee may be effective in the region. The perennial and non-perennial shrubs and other invasive species like lantana can be harvested annually from the open forests as feed stock for char briquette or bio-briquettes. These units can be run by the local community institutions (JFMCs).

REFERENCES

1. Demirbas A (2001) Biomass resource facilities and biomass conversion processing for fuels and chemicals. Energy Conver. Manage 42:1357–1378
2. FSI. 2005. State of Forest Report, 2003. Forest Survey of India, Ministry of Environment and Forests Government of India, Dehra Dun, India.
3. FSI. 2008. State of Forest Report, 2005. Forest Survey of India, Ministry of Environment and Forests Government of India, Dehra Dun, India
4. FSI. 2011. State of Forest Report, 2009. Forest Survey of India, Ministry of Environment and Forests Government of India, Dehra Dun, India
5. Haripriya G. S. (2000), "Estimates of biomass in Indian forests", Biomass and Bioenergy, Vol. 19, No. 4, pp. 245-258.
6. Klass D. Biomass for renewable energy and fuels. Encyclopedia of Energy. Oxford: Elsevier Inc.; 2004.
7. Lundmark Robert (2006). Cost structure of and competition for forest-based biomass, Scandinavian Journal of Forest Research, 2006; 21: 272 -280
8. McKendry Peter (2002), Energy production from biomass (part 1): overview of biomass. Bioresource Technology 83 (2002) 37–46
9. Md. Bedarul Alam, Reino Pulkki, and Chander Shahi (2012), Woody biomass availability for bioenergy production using forest depletion spatial data in northwestern Ontario. Can. J. For. Res. 42: 506–516 (2012).
10. Md. Danesh Miah,, Masao Koike, Man Yong Shin, Shalina Akther (2011), Forest biomass and bioenergy production and the role of CDM in Bangladesh, New Forests (2011) 42:63–84 DOI 10.1007/s11056-010-9238-4

11. Nair C.T.S. (2012), Forests and Forestry in a changing society: challenges and possible responses, 4th. Kamta Prasad Sagreiya Memoria Lecture, State Forest Research Institute, Jabalpur, 2012.
12. P. Sudha, H. I. Somashekhar, S. Rao and N. H. Ravindranath (2003), "Sustainable biomass production for energy in India", Biomass and bioenergy, Vol. 25, No. 5, pp. 501-515.
13. Raizada A., Parandiyal A.K. and Ghosh B.N. (2003), Estimation of Carbon Flux through litter fall in forest plantations of India. Indian Forester, 129 (7): 881-894
14. Ramachandran A., Jayakumar S., Haroon R. M., Bhaskaran A. and Arockiasamy D. I. (2007). Carbon sequestration: estimation of carbon stock in natural forests using geospatial technology in the Eastern Ghats of Tamil Nadu, India, Current Science, Vol. 92, No.3, 10.
15. Ramachandra T. V. (2007). Geospatial Mapping of Bioenergy Potential in Karnataka, India, Journal of Energy & Environment, Vol. 6, 28-44.