LECTURE-5

LEARNING OBJECTIVES: ENERGY PLANTATION, CHARACTERISTICS OF TREE SPP. FOR ENERGY PLANTATION, DIFFERENT ENERGY PLANTATION SPECIES & ADVANTAGES OF ENERGY PLANTATION

Introduction

- India is one of the world's 2nd largest populated country.
- India has huge human population of 125 crore.
- Most of the population (75%) residing in rural area which totally depends upon forest to meet out their energy requirement.
- The demand for fuelwood in India is increasing day by day.
- India's current firewood consumption is more than 133 million tonnes; most of it is being used in cooking. To cook 1 kg of food 1.2 kg of firewood is required.
- It clearly indicates that India should produce more wood than food if it is to be cooked before it is consumed. The electricity can also be generated by dried wood.
- According to estimate 400 million tonnes of cattle dung equivalent to about 60 million tonnes of fuelwood are burnt annually in our country.
- If this much quantity of cattle dung is incorporated into the soil then it could increase soil productivity.
- Similarly fuelwood is the most significant reason for tree cutting.
- To save forests from degradation, fuel wood tree growing should become part of agriculture through agroforestry in blocks in order to meet out their demands of fuelwood improve the microclimate by means of saving trees in natural forests.
- An energy plantation is one that is grown purely for plant material for their fuel than for fibre content.

Criteria of tree spp. planted for energy plantation

- Tree species should be fast growing with high photosynthetic efficiency which results into high yields.
- Tree species should have high coppicing and pollarding capacity.
- Tree species selected to energy plantation should be conical or cylindrical in shape.
- Tree species should have wood of high calorific value, high wood density, dry weight and burns without sparks or toxic smoke.

- Tree species should be able to tolerate incidences of insects, pests and diseases.
- Tree species should have ability in them to reduce transpiration loss in arid areas.
- Tree species should have ability to fix nitrogen, if possible, that can improve soil fertility without having much competition with main crop for soil moisture, sunlight, etc.
- Tree species should be multiple in nature.

Plate 5.1 *Eucalyplus* Wood Lot

Plate 5.2 *Casuarina equisetifolia* wood lot

SUITABLE SPECIES FOR FIREWOOD/FUELWOOD/ ENERGY PLANTATION FOR DIFFERENT REGIONS

Tropical dry region: *Acacia catechu, Acacia modesta, Acacia nilotica, Acacia Senegal, Acacia tortilis, Anogeissus pendula, Albizia lebbek, Azadirachta indica, Cassia siamea, Cordia rothii, Dalbergia sissoo, Emblica officinalis, Eucalyptus camaldulensis, Erythrina superb, Gmelina arborea, Parkinsonia aculeate, Peltophorum ferrugineum, Pongamia pinnata, Prosopis cineraria, Prosopis juliflora, Tamarindus indica, Tamarix troupe, Tecomella undulate, Zizyphus maurtiana* etc.

Tropical humid region: *Adina cordifolia, Acacia auriculiformis, Acacia catechu, Acacia nilotica, Albizia procera, Azadirachta indica, Cassia siamea, Casuarina equisetifolia, Dalbergia sissoo, Dendrocalamus strictus, Ficus spp., Eucalyptus spp., Kydia calycina, Leucaena leucocephala, Madhuca indica, Melia azedarach, Morus alba, Salix tetrasperma, Syzygium cuminii, Tamarindus indica, Trewia nudiflora, Gliricidia sepium* and *Gmelina arborea.*

Sub-tropical region: *Acacia catechu, Acacia melanoxylon, Acacia nilotica, Aesculus indica, Ailanthus excels, Celtis australis, Grevillea robusta, Michelia champaca, Populus deltoids, Populus nigra, Robinia pseudoacacia, Salix alba* and *Toona ciliate.*

Temperate climate: *Acer spp., Aesculus indica, Alnus nepalensis, Alnus nitida, Celtis australis, Populus ciliate, Quercus semecarpifolia, Salix alba* and *Toona serrata*

- The direct use of firewood in densely populated area should be avoided as it causes environmental pollution.
- Some firewoods on burning give toxic and irritating smoke, and foul odour.
- The firewood may be converted into charcoal which is more efficient.

Charcoal:

- Charcoal is an ideal smokeless fuel for cooking. 1 kg of charcoal has a replacement value of 2.38 kg of firewood or more.
- The combustion efficiency of charcoal is about 28 per cent.
- Thus, conversion of firewood into charcoal for use as a fuel will be better than firewood as such.

- Charcoal is also useful as a reductant in electrometallurgical industries
- Manufacture of calcium carbide, carbon-disulphide and active carbon.
- It does not contain sulphur. The following are a few important trees species for energy plantation: (charcoal making)

Charcoal making: *Acacia nilotica*, *Adina cordifolia*, *Anogeissus latifolia*, *Casuarina equisetifolia*, *Pinus roxburghi*, *Quercus leucotrichophora, Quercus semecarpifolia, Tamarindus indica, Terminalia arjuna, Terminalia bellerica, Terminalia chebula* and *Terminalia catappa*

Shrubs for energy plantation: *Atlantia monophylla, Crewia latifolia, Clerodendron inerme, Dodonaea viscose, Jatropha glandulifera, Jatropha curcas, Tecoma gracilis* and *Ipomoea camea* etc.

- Besides firewood and charcoal plants also provide exudates and extractives.
- Such plant species are energy rich and may be exploited as renewable sources of energy.
- These species are known as 'petro-crops', since they can serve as substitutes for supplement to petro chemicals.

Extractive plants: Based on exudates and extractives, plants are classified as those bearing:

i) Latex
ii) Vegetable oil and waxes
iii) Resins
iv) Essential oils
v) Tannins and phenolic compounds bearing plants

Latex yielding plant species:

- Plant species yielding latex belong to Family Apocynaceae, Asclepiadaceae, Euphorbiaceae, Moraceae and Sapotaceae.
- Potential petro-crops are: *Euphorbia antisyphilitica, E. tirucalli, E. lathyris, Pedilanthes tithymaloides, Calotropis procera, Asclepias curassavica* and *Parthenium argentatum.*

Vegetable oils:

- Vegetable oils have great potential to be used as liquid fuel or as a source of hydrocarbons.
- Some of them can be mixed in diesel.
- The non-edible seed bearing oil tree species can be cultivated on poor, marginal and wastelands.
- Important species are
- **Seed-oil bearing plants** *Antinodaphe hookeri, Aleurites triloba, Anacardium occidentale, Aphanamixis polystachya, Azadirachta indica, Calophyllum inophyllum, Cocos nucifera, Croton tiglium, Garcinia indica, Hydnocarpus wightiana, Jatropha curcas, Madhuca indica, Madhuca longifolia, Melia azedarach, Mesua ferrea, Mimusops elengi, Pongamia pinnata, Pittosporum resiniferum, Ricinus communis, Salvadora oleoides, Sapium sebiferum, Schleichera oleosa, Samecarpus anacardium, Shorea robusta, Simmondsia chinesis, Strychnos nux-vomica* and *Vateria indica* etc.

Resins:

- Resins are collected mainly from members of family Pinaceae.
- These are volatile oils (turpentine) and non volatile resins (rosin).
- The resins are main source for synthetic rubber and other polymers.
- Turpines are highly combustible and they can be used in various formulations of fuel for automobiles.

Calorific value:

- The amount of heat produced when 1 g of fuel is completely burnt in excess of air or oxygen.
- If one gram of carbon is burned completely, it produces about 30,000J or 30 KJ/g of heat.
- Therefore, the calorific value of carbon is 30 KJ/g and fuel having high calorific value is regarded as good fuel.
- CV of hydrogen is 150 KJ/g. However, it is not commonly used fuel because of highly combustible nature and difficulty in its handling.

ADVANTAGES OF ENERGY PLANTATIONS

- Emit little or no sulphur and less nitrogen dioxide than fossil fuel
- Helps in rehabilitation of degraded lands
- Provide rural employment
- Alive and active growing forest and other plant biomass absorb the green house gas in quantities broadly equivalent to amount emitted when plant material decay or burned. They are thus called as "Carbon neutral" fuel sources
- Growing energy crops creates a "carbon sink" which includes storing carbon underground through the tree root system
- Lower energy cost per unit area as lower inputs are require as compared to agriculture crops.
- Energy plantations are thought to remove the entire nutrient from soil. However, by use of thermo chemical process of biomass conversion it is feasible to recover all nutrients as ash which can be returned to the plantation sites
- Dependable & renewable source of energy along with afforestation of marginal lands & employment generation.
- Aesthetic value, Windbreak and Shelterbelts.
- Fodder, NTFP etc.
- Handling & disposal of by products is safe.
- Energy plantations are both ecologically as well as sociologically much sounder investments

Table 5.1 A few species used in energy plantations with their respective calorific value and specific gravity

Sr. No.	Species	Sp. gravity	Calorific value K cal/kg
1.	*Acacia auriculiformis*	0.60-0.78	4800-4900
2.	*Acacia catechu*	1.00	5142-5244
3.	*Acacia dealbata*	0.70-0.85	3500-4000
4.	*Acacia leucophloea*	0.78	4899-4886
5.	*Acacia mearnsii*	0.70-0.85	3500-4000
6.	*Acacia nilotica*	0.67-0.68	4800-4950
7.	*Acacia senegal*	-	3200
8.	*Acacia tortilis*	-	4400
9.	*Adina cordifolia*	-	3855
10.	*Aegle marmelos*	0.91	4495
11.	*Albizia lebbek*	0.55-0.64	5163-5166
12.	*Albizia odoratissima*	0.73	5131-5266
13.	*Albizia procera*	0.68	4870-4865
14.	*Alnus nepalensis*	0.32-0.37	4600
15.	*Anogeissus latifolia*	0.94	4948

16.	*Anogeissus pendula*	0.94	4900
17.	*Anthocephalus cadamba*	0.94-0.53	4800
18.	*Artocarpus heterophyllus*	0.51	5318
19.	*Azadirachta indica*	0.75	-
20.	*Baringtonia acutangula*	0.58	5078
21.	*Bauhinia retusa*	0.72	5027
22.	*Bauhinia variegata*	-	4800
23.	*Butea monosperma*	0.54	4909
24.	*Bischofia javanica*	0.74	5162
25.	*Cajanus cajan*	-	4594
26.	*Cassia siamea*	0.60-0.80	-
27.	*Casuarina equisetifolia*	0.80-1.2	4950
28.	*Cedrela toona*	0.57	5113-5168
29.	*Chloroxylon swietenia*	-	4759
30.	*Dalbergia sissoo*	0.75-0.80	4908-5181
31.	*Diospyros melanoxylon*	0.79-0.87	4957-5030
32.	*Diospyros montana*	0.70-0.80	5125
33.	*Dodonaea viscosa*	1.20-1.28	5035-4939
34.	*Emblica offcinalis*	0.70-0.80	5200
35.	*Eucalyptus camaldulensis*	0.6	4800
36.	*Eucalyptus globulus*	0.80-1.00	4800
37.	*Eucalyptus grandis*	0.40-0.70	4900
38.	*Eucalyptus tereticornis*	0.70	4800
39.	*Gmelina arborea*	0.42-0.64	4763-4800
40.	*Grevillea robusta*	0.57	4904-4914
41.	*Grewia spp.*	0.67	5292
42.	*Hardwickia binata*	1.08	4891-4952
43.	*Holoptelia integrifolia*	0.63	5228
44.	*Lannea coromandelica*	0.55	4933
45.	*Leucaena leucocephala*	0.55-0.70	4200-4600
46.	*Madhuca longifolia*	0.56	5043-5156
47.	*Mangifera indica*	0.58	4610
48.	*Melia azedarach*	0.56	5043-5176
49.	*Morus alba*	0.63	4371-4773
50.	*Michelia champaca*	0.45	5068
51.	*Ougeinia oojeinensis*	0.85	5178
52.	*Pithecellobium dulce*	0.64	5177-5600
53.	*Pongamia pinnata*	0.75	4600
54.	*Populus euphratica*	0.48	5008-5019
55.	*Prosopis chilensis*	0.80-0.92	5000-5500

56.	*Prosopis cineraria*	0.77-0.94	5000
57.	*Prosopis juliflora*	0.70	4800
58.	*Pterocarpus marsupium*	0.79	4904-5141
59.	*Pterygota alata*	0.25-0.62	5160
60.	*Quercus leucotrichophora*	0.74	4633
61.	*Schleichera oleosa*	0.91-1.08	4928-4950
62.	*Sesbania grandiflora*	0.55	4407
63.	*Shorea robusta*	0.68-0.82	5095-5433
64.	*Syzygium cuminii*	0.67-0.78	4834
65.	*Tamarindus indica*	0.91-1.28	4909-4969
66.	*Tamarix aphylla*	0.60-0.75	4835
67.	*Tectona grandis*	0.55-0.70	4989-5535
68.	*Terminalia alata*	0.71-0.94	5047-5373
69.	*Terminalia arjuna*	0.74-0.82	5030-5128
70.	*Terminalia chebula*	0.77	3967
71.	*Trema orientalis*	0.48	3095
72.	*Xylia xylocarpa*	0.92	4975-5044
73.	*Zizyphus mauritiana*	0.93	4900