EUCALYPTUS PULPWOOD PRODUCTION POTENTIAL OF SALINE AND WATERLOGGED AREAS IN PAKISTAN

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Abstract

Pulpwood production potential of eucalyptus, grown on saline and waterlogged lands in Pakistan was studied in consideration to mean annual increment, wood basic density and yield of pulp. The results revealed that about 30.2 million cubic metre of eucalyptus pulpwood can be produced annually from plantations raised on saline and waterlogged lands in Pakistan per year. This supply of pulpwood is sufficient for the sustained production of 1.225, million tonnes/annum of kraft pulp. After meeting the domestic demand, about 0.625 million tonnes/annum, pulp in surplus would be available for export to earn foreign exchange of about 15.112 billion rupees. Additional benefits like land reclamation, employment generation, import substitution and environmental protection will also accrue from afforestation of saline and waterlogged areas with eucalyptus.

Introduction

Pakistan has an area of about 6.3 million hectares of fertile land rendered unsuitable for agriculture and tree growth through water logging and salinity (Ijaz and Davidson, 1997, Hussain and Gul, 1991). This problem arose due to defective irrigation (Marcar and Debra, 1991). It is widely acknowledged that by land-use change, such marginal areas could be used for the production of timber, pulpwood, fuel wood and forage by planting with suitable tree, shrub and grass species (Marcar *et al.*, 1991).

Afforestation offers an opportunity of both utilization and amelioration of these degraded lands (Sheikh, 1974; Malik and Sheikh, 1983) under tree based land management strategy. With this approach, a number of tree species were tried on waterlogged and saline areas in different parts of the country. Out of exotic and indigenous tree species tested, eucalyptus (*Eucalyptus*

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camaldulensis) in terms of its survival and growth, proved to be the best species (Hussain and Gul, 1991). Besides production of wood, a *E.camaldulensis* tree of 6 years age may use 1400 mm water annually (Rehman *et al.*, 2003) and thus helps to reduce water table without any cost. In addition, eucalyptus also has the advantage of subsequent regeneration through coppicing.

The study was therefore, conceived to estimate the eucalyptus pulpwood and pulp productivity potential of saline and waterlogged lands in Pakistan on the basis of mean annual increment, wood density and yield of pulp. This may also motivate the farmers to raise eucalyptus plantations for pulpwood production, coupled with land reclamation and other economic and environmental benefits.

Material and Methods

In this study both primary and secondary data were used. The mean annual increment (MAI) per tree, wood volume and green wood weight was estimated from the eucalyptus plantations raised on saline and waterlogged lands in Faisalabad (Punjab).

Basic density of eucalyptus wood from 6 years old trees was calculated as the ratio between green wood volume and oven dry weight. From the basic density (BD) and kraft pulp yield (Y) the potential of saline and waterlogged lands to produce wood and wood pulp was estimated by the Baldis (1991) method. Surplus pulp production and prices in the international market were used to project export potential.

Results and Discussion

Results showed that the Mean Annual Increment (MAI) of eucalyptus plantations raised on saline and waterlogged lands in Faisalabad (Punjab) was estimated in the range of 7-8 m^3 /ha /year. Per tree volume of eucalyptus was estimated at about 0.032 m^3 and green weight of 23 kg. However, at moderately saline lands (EC 8-15 ds/m) per tree volume was recorded at about 0.04 m^3 with a green weight of about 28 kg. These figures of MAI are very low as compared to MAI of eucalyptus raised on normal soils (*about 17 m^3/ha/year*). Slow growth of eucalyptus on saline and waterlogged areas is the main reason for this big difference in MAI.

Basic density of wood (Oven dry weight/ green volume) is an important parameter used to estimate pulpwood productivity of a stand as the green volume of wood can directly be converted to oven dry weight. Basic density of

eucalyptus wood from 6 years old trees was estimated as 540 -550 kg/m^3.

Pulpwood production

The data analyses (Appendix-I) show that from six years old eucalyptus plantations raised on waterlogged and saline site can generate about 181.4 million m^3 of eucalyptus pulpwood per annum on sustainable basis. This supply of pulpwood is sufficient for the production 1.225 million tonnes/annum of kraft pulp. This pulp production is surplus than the domestic needs by about 0.656 million tonnes which can be exported to foreign countries against an earning of about 15.112 billion rupees.

Surplus eucalyptus kraft pulp could be marketed in the Middle East. It is estimated that League of Arab States import about 0.433 million tonnes of different types of pulp annually at a cost of about US $ 221.300 million for paper making (FAO, 1999). Although, it is a small market in the world's perspective but it may be a very attractive market for Pakistan for export of pulp. Furthermore, eucalyptus pulp could also be exported to European Union pulp and paper markets. Members of the European Union spend annually about U.S $ 7,056.4 million on the import of about 13.25 million tonnes of pulp for paper manufacture. European Union is net importer of pulp and its imports are 38 percent of the world total on the basis of import value (FAO, 1999). Appendix-II describes the estimated eucalyptus pulpwood availability per hectare of saline and waterlogged areas at different growth rates and Appendix-III shows the returns from poorly managed eucalyptus plantations on moderately saline and waterlogged areas at 50% survival rate.

Additional benefits of Eucalyptus plantations

Besides wood production, additional benefits like land reclamation, employment generation, import substitution and environmental protection etc, will also accrue from afforestation of saline and waterlogged areas with eucalyptus which are briefly described as under:

Eucalyptus is well known for growing on waterlogged and saline lands. It grows fast, tolerates salt and consumes large quantity of available water. After two or three rotations of eucalyptus, the land can be used for growing agricultural crops. Farmers can earn additional income by planting eucalyptus on such unproductive lands. This may help to alleviate the poverty in the farming communities. This increase in income could be a motive for planting trees of eucalyptus because of its early maturity and low maintenance cost.

Pakistan imports hardwood and softwood pulps in order to meet it is

domestic demands. Domestic production of eucalyptus pulp may substitute for the 70 percent of the imported pulp in Pakistan. Establishment of the pulp industry in eucalyptus producing areas may result in creating additional jobs in local communities. Eucalyptus utilization may bring socio-economic changes in the growing areas.

Manufacturing of pulp or paper from eucalyptus wood increases the value of wood. Wire (1990) a US pulp and paper consultant estimated that value of eucalyptus wood can be increased up to ten times (about 200-240 dollars per tonne) in Pakistan. Other uses of eucalyptus such as fuel wood or charcoal manufacturing do not increase the value as much as pulp and paper industry. Pakistan can not only save, but also earn foreign exchange by exporting eucalyptus wood chips or pulp to the world markets. Exports of eucalyptus wood or chips is only possible if Pakistan concentrates heavily on increasing its eucalyptus resources. The quality of paper products manufactured in Pakistan is not up to the world standard. Eucalyptus pulp may be blended with non-wood pulps to improve the quality of existing paper products. Eucalyptus pulps are used worldwide to improve the quality of tissue paper, writing and printing paper.

By raising the industrial plantation of fast growing tree species like eucalyptus and Poplar, Pakistan may help in reducing the pressure on softwood forests (coniferous species), allowing them to be managed for their environmental value and for growing long rotation high value timber. Presently softwood trees in Pakistan have low growth rates, and consequently a longer rotation period. Using hardwood pulp from eucalyptus trees may reduce the pressure on agricultural wheat straw which is used as fodder for livestock. Over-harvesting of slow growing softwood trees have created a number of environmental problems. By protecting the softwood resources in the hilly areas, Pakistan can reduce the degradation of its fragile watershed ecosystem.

Conclusion

Water logging and salinity is one of the biggest menace faced by the agriculture sector in the country, which has adversely affected the economy of the country. Biological rehabilitation of such degraded lands is the only economically viable solution. *Eucalyptus camaldulensis* is the best species for planting in such areas. The vast land area affected with waterlogging and salinity has a great potential to produce pulpwood, leading to establishment of pulp industry and bringing a substantial economic activity in the country. In addition to this, a good support to amelioration of the environment would be available.

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APPENDIX-I
Pulpwood production

The calculation of saline and waterlogged land available for planting of eucalyptus and wood volume production is given as under:

i. estimated saline and waterlogged area in Pakistan=6.3 million ha
ii. Area available for pulpwood plantations (leaving 40% for other alternate land uses) =3.78 million ha
iii. Area for sustainable supply/annum at 6 years rotation basis 3.78/6 =0.63 million ha
iv. Mean Annual Increment (MAI) of pulpwood plantations 8 m^3/ha/annum
v: Anticipated volume production at the end of rotation (6 years)3.78 x 8 x 6 =181.44 million m^3
vi. Pulpwood availability (PWA) =MAI x BD /1000 tones /ha/annum. = 8x.540/1000 =4.32 tonnes/ha/annum
vii Total pulpwood availability from 0.630 million hectares. = 0.630x4.32= 2.723 million tones/annum.

Pulp productivity (PP) potential is the weight of pulp which can be produced from one cubic metre of wood. PP depends on basic density (BD) of wood and yield (Y) of pulp by particular pulping process . In the present study, possibility of manufacturing kraft unbleached pulp has been considered for calculation, on the basis of 45 % pulp yield from 6 years old eucalyptus plantation.

a. Eucalyptus Pulp Productivity (PP) = BD x Y/100 (kg/m^3) 540 x 45/100 =243 kg/m^3 pulp.
b. Pulp Productivity Potential (PPP) of Eucalyptus= PP x MAI x Rotation / 1000 (tonnes/ha/year)
Taking into consideration MAI =8m^3/ha/year, Rotation =6 years
=243 x 8 x 6/ 1000 (tonnes/ha/ for 6year =11.664 tonnes /ha /for 6 years.
c. Quantity of pulp which may be manufactured from 0.630 million hectare of eucalyptus plantation raised on saline and waterlogged lands (Tonnes) =0.63 X Basic Density X Yields X MAI/1000.=0.63 X 540 X 0.45 X 8/1000 = 1.225 million tonnes/ year.
d. Total national annual demand for wood pulp (Total Demand)= 0.600 million tonnes.
e. Surplus quantity of pulp per year=1.225 – 0.600 =0.625 million tonnes
f. Value of the surplus pulp (unbleached) = Rs. 15112.5 million (pulp in the world market = Rs. 15.112 billion @ Rs 24180 /ton)

APPENDIX- II

Estimated eucalyptus pulpwood availability per hectare of saline and waterlogged areas at different growth rates

MAI m^3/ha/ yr	BD Kg/ m^3	PWA tones/ ha/yr	Rotation (R) Years	TPWP(OD) tonnes/ ha	TPWP (G) (tones /ha)	Value of pulpwood*
7	540	3.78	6	22.68	38.55	53,970
8	540	4.32	6	25.92	44.06	61,684
9	540	4.86	6	29.16	49.57	69,400
10	540	5.40	6	32.40	55.08	77,112

* Value of pulpwood @ Rs.56/ 40 kg

MAI = Mean annual increment.
BD = Basic density
PWA = Pulpwood availability.
TPWP (OD) = Total pulpwood production.
TPWP (G) = Total pulpwood production.
OD = Oven dry
G = Green

Appendix- III

Estimated return per hectare from poorly managed eucalyptus plantations on moderately saline and waterlogged areas with a survival rate of 50%

End use	Thinning	Harvest
Spacing before removal (m)	1.8 x 1.8	3.6x1.8
Removal age (years)	3	6
Average Diameter (cm)	6.4	12.7
Trees / ha removed	772	772
Volume of wood per tree (m^3)	1	5
Weight per tree (kg)	20	100
Total weight (tonnes /ha)	15.44	77.20
Farm price (Rs/40kg)	56	56
Total value (Rs)	21,616	108,080
Annual Cost (Rs)	1000	1000
Total Cost	9,000	3,000
Net income (Rs)	12,616	105,080