Financial Analysis of *Eucalyptus camaldulensis* Plantations in Bangladesh

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Abstract

The paper compares the economic performance of *Eucalyptus camaldulensis* plantations of different ages. The price of sawn timber per cubic metre was found to be Tk. 4,076 to 8,828 (1 US$ = 48.71 Tk.). The fuelwood was usually sold at a price ranging from Tk. 915 to 1,677 per ton. The staking, felling and logging costs were Tk. 864, 686 and 1,431 per hectare respectively. The IRRs were 22.87, 20.66, 20.57, 39.13, 27.58, 12.67 and 59.81% for Dinajpur (rural Charkai), Dinajpur (urban Charkai), Sylhet (Chawtali), Sylhet (Lawachara), Tangail (Charaljani), Mymemsingh (Santoshpur) and Cox's Bazar (Chainda) respectively at 10 years rotations. For Dinajpur and Tangail, the NPVs were found to be negative for the 5th, 6th and 7th rotation ages.

সারসংক্ষেপ

এ প্রবন্ধে বিভিন্ন বয়সের *Eucalyptus camaldulensis* বাগানের অর্থনৈতিক অবস্থার তুলনামূলক বিশ্লেষণ করা হয় । এতে দেখা যায়, প্রতি ঘন মিটার কাঠের মূল্য ৪,০৭৬ থেকে ৮,৮২৮ টাকা এবং প্রতি টন জ্বালানি কাঠের মূল্য ৯১৫ থেকে ১,৬৭৭ টাকা । ট্যাকিং, ফেলিং ও লগিং খরচ হেক্টর প্রতি যথাক্রমে ৮৬৪, ৬৮৬ ও ১,৪৩১ টাকা । দিনাজপুর (চরকাই পল্লী এলাকা), দিনাজপুর (চরকাই পৌর এলাকা), সিলেট (চাউতলী), সিলেট (লাউয়াছড়া), টাঙ্গাইল (চারালজানি), ময়মনসিংহ (সন্তোষপুর) ও কক্সবাজার (চাইন্দা)-এর দশ বছর আবর্তনকালের বাগানের আই. আর. আর. যথাক্রমে ২২.৮৭, ২০.৬৬, ২০.৫৭, ৩৯.১৩, ২৭.৫৮, ১২.৬৭ ও ৫৯.৮১% । দিনাজপুর ও টাঙ্গাইলের ৫ম, ৬ষ্ঠ ও ৭ম বছর আবর্তনকালের এন. পি. ভি. ঋণাত্বক দেখা গেছে।

Key words : Biomass, financial rotation, internal rate of return, net present value, plantation cost, timber production

Introduction

Until a decade ago, eucalypts were of little interest in Bangladesh. Probably in the 1930's *Eucalyptus citriodora* was haphazardly introduced in the tea estates of eastern Bangladesh as an ornamental tree (Davidson and Das 1985). But *E. camaldulensis* is now widespread in the country specially in the districts of Rajshahi, Dinajpur, Mymensingh, Sylhet and Cox's Bazar. This is largely because of its fast growth and suitability for various purposes such as fuelwood, pole, pulpwood and timber (Davidson and Das 1985). This would also minimize the gap between demand and supply of fuelwood by utilising vast tracts where native species are not promising (Davidson and Das 1985). Eucalypts are also being largely utilized in India as poles particularly in rural areas (Tewari 1992). Bangladesh has not yet seen any commercial felling of the species. As a result eucalypt poles are not found in the market. However, shortage and high prices of conventional and better timber press the rural people to use *E. camaldulensis* as timber.

Studies specially regarding economic performance of *E. camaldulensis* plantations in Bangladesh are of great importance. The present study tries to find out the economic performance of *E. camaldulensis* of different ages growing under various site conditions.

Materials and methods

Data on the costs of raising nursuries and plantations, harvesting and marketing, yield and volume, expected prices when sold as fuelwood, timber and pole were collected from seven locations under five forest divisions *viz.* Dinajpur, Mymensingh, Tangail, Sylhet and Cox's Bazar, taking two plantation years from each of Dinajpur and Sylhet and one plantation year from each of Tangail, Mymensingh and Cox's Bazar.

Only direct costs of plantation establishment were considered. Indirect costs (overheads) including those of administration, supervision, etc. were not taken into account (Ohlin 1995).

The main determinant costs were of seed collection, nursury operation including site preparation, cleaning, raising seedlings in polybags, planting, tending, harvesting and marketing (Gunter and Harry 1984). Some costs were available from the commercial plantations of the Forest Department. In these cases, the costs of different phases were collected from the offices of Divisional Forest Offices of the sample locations. The harvesting cost was extracted from the harvesting records of other plantations with approximately similar girthclass distribution. Existing market price was used in valuating inputs and outputs of the experiments.

According to Islam (undated), direct costs of plantation establishment arising from various operations were as follows :

Seedling raising (per 100)	:	Tk. 1.25
Site preparation (per hectare)	:	30 man-days
Jungle cutting	:	30 man-days
Debris collection, burning and reburning	:	22 man-days
Field planting (per hectare)		
Marking the planting position and stacking	:	18 man-days
Marking pit (30 cm x 30 cm x 30 cm)	:	70 man-days
Seedling carrying from nursery to planting site	:	12 man-days
Seedling planting	:	40 man-days

Five weedings were done in the first two years-three in the first and two in the second year. The average costs of the first year weeding, brushing and cleaning in Dinajpur (rural Charkai), Dinajpur (urban Charkai), Sylhet (Chawtali), Sylhet (Lawachara), Tangail (Charaljani), Mymensingh (Santoshpur) and Cox's Bazar (Chainda) were Tk. 20,000, 14,250, 11,549, 2,200, 1,627, 6,400 and 15,000 respectively and those for second year were Tk. 28,250, 12,500, 10,387, 8,128, 882, 3,961 and 12,500 respectively (1 US$ = 48.71 Tk.).

There was no thinning cost because no thinning was carried out. The cost of land was not taken into account because Forest Department owned the land. The optimum rotation period was determined by the method of maximum Land Expectation Value (LEV) and maximum Internal Rate of Return (IRR). Sensitivity analysis referring

price changes of timber was included (Ohlin 1995). The analysis assumed a timber recovery rate of 40% stem and fuelwood taken togather 82% of total biomass and air dried main stem biomass 53% of stem biomass (Latif 1988).

The mathematical statements of the financial value of plantations depends at a given bank rate on the following economic determinants :

i) Benefit-cost ratio (B/C) = $\dfrac{\sum \dfrac{B_t}{(1+i)^t}}{\sum \dfrac{C_t}{(1+i)^t}}$

ii) Net present value (NPV) = $\sum \dfrac{B_t - C_t}{(1+i)^t}$

iii) Internal rate of return (IRR) = $\sum \dfrac{B_t - C_t}{(1+i)^t} = 0$

(Gittinger 1974)

where,

Bt = Benefit at time t
Ct = Cost at time t

i = Interest rate (10%)
t = 1, 2, 3 .... n years

Results and discussion

The resutls are based on the latest yield data and operation costs that were avaiable. The basic information of the sample plantations is shown in Table 1.

The stocking density in Dinajpur (Charkai), Sylhet (Chawtali), Tangail (Charaljani) and Mymensingh (Santoshpur) was 2,990 trees/ha with 6' x 6' spacing but in Sylhet (Lawachara) and Cox's Bazar (Chainda) they were 1,330 trees/ha with 9' x 9' spacing and 4,324 trees/ha with 5' x 5' spacing respectively. The yields were found to be 9.05, 13.68, 16.30, 20.10 and 34.70 m³/ha for the site index 8, 9, 10, 12 and 15 respectively. The price of sawn timber per cubic metre varied from Tk. 4,076 to 8,828. Fuelwood were usually sold at a price ranging from Tk. 915 to 1,677/ton.

Table 1. Basic information on *E. camaldulensis* plantations for financial analysis.

Location	Area (ha)	Planting year	Initial seed-ling/ha	Spacing	Rotation	Site index	Yield (m³/ha)	Market price (Tk.) Timber/ m³	Market price (Tk.) Fuel/ Ton
Dinaipur									
Charkai (rural)	20.24	1987	2,990	6' x 6'	7	9	14.48	6,606	1,170
Charkai (urban)	40.49	1986	2,990	6' x 6'	7	9	13.68	6,606	1,170
Sylhet									
Chawtali	14.17	1987	2,990	6' x 6'	6	10	16.30	6,095	999
Lawachara	08.90	1983	1,330	9' x 9'	12	10	16.30	4,076	1,677
Tangail									
Charaljani	01.22	1987	2,990	6' x 6'	7	15	34.70	8,117	915
Mymensingh									
Santoshpur	04.86	1987	2,990	6' x 6'	7	8	9.05	8,828	1,540
Cox's Bazar									
Chainda	21.00	1988	4,324	5' x 5'	6	12	20.10	6,745	1,154

Table 2. Different operation costs of *E. camaldulensis*.

Locations	Area (ha)	Cost (Tk.)				
		Felling	Logging	Staking	Transportation	Marketing
Dinajpur	20.24	13,600	28,000	16,000	17,250	5,750⁻
Sylhet	08.90	7,650	15,850	9,500	7,680	2,560
Tangail	01.22	1,000	2,100	1,250	3,650	1,137
Mymensingh	04.86	2,320	4,880	2,920	10,000	2,430
Cox's Bazar	21.00	14,000	29,600	17,920	18,120	6,040
Total	56.22	38,570	80,430	47,590	56,700	17,917

Table 2 shows the costs of harvesting, transportation, marketing and prices of fuelwood and timber. The average man-days/ha required for felling, logging and staking were about 16, 34 and 20 respectively and the corresponding felling, logging and staking costs were Tk. 686, 1,431 and 846 per hectare at an average labour cost of Tk. 42/man-day. The average marketing and transportation costs were Tk. 319 and 1,009 per hectare respectively.

The total main stem air-dry biomass productions and revenue yield at seven locations of Dinajpur, Sylhet, Tangail, Mymensingh and Cox' Bazar at stand ages 5, 6 and 7 years are shown in Table 3. The value yield was estimated by multiplying the corresponding main stem biomass by the market price. The total main stem air-dry biomass at age 5 were 4,350, 4,972, 8,079, 13,673 and 21,752 kg/ha for site indices 8, 9, 10, 12 and 15 respectively.

Table 3. Total main stem air-dry biomass and value yield of *E. camaldulensis*.

Locations	Site index	Stem biomass (kg/ha) Rotation age			Value yield (Tk.) Rotation age		
		5	6	7	5	6	7
Dinajpur							
Charkai (rural)	9	4,972	7,599	7,767	10,0633	1,53,804	1,57,204
Charkai (urban)	9	4,972	7,599	7,767	2,01,316	3,07,684	3,14,486
Sylhet							
Chawtali	10	8,079	8,184	12,210	1,14,479	1,59,667	1,73,016
Lawachara	10	8,079	8,184	12,210	71,903	72,838	1,08,669
Tangail							
Charaljani	15	21,752	26,889	33,854	26,537	32,805	41,302
Mymensingh							
Santoshpur	8	4,350	4,676	7,215	66,141	72,725	85,065
Cox's Bazar							
Chainda	12	13,673	17,536	17,759	2,87,133	3,68,256	3,75,939

Table 4. Revenue yield of *E. camaldulensis* plantations at different rotations ages.

| Locations | Stem biomass (kg/ha) | | | | Value yield (Tk.) | | | |
| | Rotation age (year) | | | | Rotation age (year) | | | |
	10	12	14	16	10	12	14	16
Dinajpur								
Charkai (rural)	166	194	218	240	10,96,596	12,81,564	14,40,108	15,85,440
Charkai (urban)	332	387	436	480	12,93,192	25,56,522	28,80,216	31,70,880
Sylhet								
Chawtali	152	176	198	218	6,19,552	7,17,376	8,07,048	8,88,568
Lawachara	95	111	125	137	5,79,025	6,76,545	7,61,875	8,35,015
Tangail								
Charaljani	29	33	37	40	2,35,393	2,67,861	3,00,329	3,24,680
Mymensingh								
Santoshpur	28	33	38	41	2,47,184	2,91,324	3,35,464	3,61,948
Cox's Bazar								
Chainda	335	387	434	475	22,54,575	26,10,315	29,27,330	32,03,875

The total revenue at different rotations are shown in Table 4. There was gradual increase in total yield and revenue as the age increased. The increase in total yield from 10th year to 12th year was 8% and to 16th year was 6.34% in Dinajpur indicating a decreasing trend. The estimated total revenues were Tk. 10,96,596, 12,93,192, 5,79,025, 6,19,552, 2,35,393, 2,47,184 and 22,54,575 for Dinajpur (rural Charkai), Dinajpur (urban Charkai), Sylhet (Lawachra), Sylhet (Chawtali), Tangail (Charaljani), Mymensingh (Santoshpur) and Cox's Bazar (Chainda) respectively at the age of 10 years.

Table 5. Economic indicators of *E. camaldulensis* plantations in Bangladesh (discount rate 10%).

| Locations | Rotation age (year) | | | | | | | | |
| | 5th | | | 6th | | | 7th | | |
	NPV	B/C	IRR	NPV	B/C	IRR	NPV	B/C	IRR
Dinajpur									
Charkai (rural)	-65412	0.52	-	-36942	0.73	-	-44135	0.68	-
Charkai (urban)	-165005	0.47	-	-108058	0.65	-	-122446	0.61	-
Sylhet									
Chawtali	10644	1.31	22.61	6589	1.19	15.83	2904	1.08	12.08
Lawachara	13690	0.12	14.99	45632	1.43	21.30	43379	1.41	18.31
Tangail									
Charaljani	-7974	0.65	-	-6107	0.73	-	-3657	0.84	-
Mymensingh									
Santoshpur	-1504	0.97	-	-1530	0.97	-	2475	1.03	10.66
Cox's Bazar									
Chainda	167847	2.53	47.50	213816	2.95	44.11	188187	2.75	34.44

Table 6. Economic indicators of *E. camaldulensis* plantations in Bangladesh.

| Locations | Rotation age (year) | | | | | | | | | | | |
| | 10th | | | 12th | | | 14th | | | 16th | | |
	NPV (10%)	B/C (10%)	IRR	NPV (10%)	B/C (10%)	IRR	NPV (10%)	B/C (10%)	IRR	NPV (10%)	B/C (10%)	IRR
Dinajpur												
Charkai (rural)	2,53,190	2.49	22.87	2,44,144	2.48	20.50	2,19,481	2.37	18.24	1,88,977	2.21	16.37
Charkai (urban)	4,65,966	2.22	20.66	4,34,983	2.14	18.83	3,78,847	1.99	15.99	3,10,472	1.81	14.60
Sylhet												
Chawtali	1,06,796	1.80	20.57	1,01,116	1.79	17.93	88,866	1.71	15.93	72,870	1.60	14.35
Lawachara	1,72,614	4.40	39.13	1,67,836	4.51	32.39	1,55,286	4.42	27.61	1,38,360	4.19	24.03
Tangail												
Charaljani	64,180	3.41	27.58	59,387	3.28	21.89	83,629	3.10	20.73	45,620	2.82	18.58
Mymensingh												
Santoshpur	21,857	1.29	12.67	20,891	1.29	12.81	17,651	1.24	12.09	9,114	1.13	10.95
Cox's Bazar												
Chainda	20,34,391	15.30	59.81	19,43,905	15.24	49.71	17,94,401	13.98	39.90	16,14,924	13.64	34.85

Table 7. Sensitivity analysis of *E. camaldulensis* plantations in Bangladesh.

| Locations | IRR at different rotation age (year) | | | | IRR after 20% decrease in price | | | | % change in IRR | | | |
	10	12	14	16	10	12	14	16	10	12	14	16
Dinajpur												
Charkai (rural)	22.87	20.57	18.24	16.37	19.64	17.70	15.97	14.53	14.12	13.95	12.45	11.24
Charkai (urban)	20.66	18.83	15.94	14.60	14.10	13.51	12.34	11.40	30.06	27.93	22.58	22.92
Sylhet												
Chawtali	20.57	17.97	15.93	14.35	16.53	14.90	13.89	12.29	19.64	16.90	12.81	14.36
Lawachara	39.13	32.39	27.61	24.03	34.94	29.20	25.05	21.90	10.73	09.85	07.64	08.86
Tangail												
Charaljani	27.58	21.89	20.73	18.58	23.82	20.66	18.35	16.39	13.63	05.02	11.48	11.79
Mymensingh												
Santoshpur	12.67	12.84	12.09	10.95	10.50	10.35	10.00	09.22	17.13	19.20	17.29	15.80
Cox's Bazar												
Chainda	59.81	49.71	39.90	34.85	37.16	30.89	26.49	23.98	37.87	37.86	38.61	31.19

Table 5 shows the various economic indicators such as B/C ratio, NPV and IRR at different rotations. For Dinajpur and Tangail the NPV's were found to be negative at the 5th, 6th and 7th rotation ages. The IRR's were less than 10%. For Mymensingh (Santoshpur) the NPV's were also ngative at the rotation ages of 5 and 6 years but positive at the rotation age of 7 at 10% discount

rate. The B/C ratio was 1.03 and IRR 10.66%. The NPV's were also positive for Sylhet (Lawachara), Sylhet (Chawtali) and Cox's Bazar (Chainda) respectively.

However, at 10 years rotation the Forest Rent and NPV attained the highest levels (Table 6). The IRR's decreased with the increase in rotation age. For Dinajpur (Charkai) the NPV's at 10% discount rate were Tk. 2,53,190, 2,44,144, 2,19,481 and 1,88,977 at rotation ages of 10, 12, 14 and 16 years respectively. The corresponding B/C ratios were 2.49, 2.48, 2.37 and 2.21. Similar results were found for plantations of Sylhet, Tangail, Mymensingh and Cox's Bazar.

The sensitivity analysis as given in Table 7 compares the effect of changes in production costs and market prices. A 20% decrease in price of sawn timber caused IRR's to decrease by about 14, 30, 11, 20, 14, 17 and 38% in Dinajpur (rural Charkai), Dinajpur (urban Charkai), Sylhet (Lawachara), Sylhet (Chawtali), Tangail (Charaljani), Mymensingh (Santoshpur) and Cox's Bazar (Chainda) respectively at 10 years rotation showing much more sensitivity in Dinajpur (urban Charkai) and Cox's Bazar (Chainda) locations.

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