

Financial Analysis of Keora (*Sonneratia apetala*) Plantations in Bangladesh

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ABSTRACT

An attempt has been taken to compare economic performance of different ages of keora (*Sonneratia apetala*) Plantations in coastal zone in this paper. The main objective was to find out financial rotation and profitability of keora plantation. The existing market price of round wood per cubic meter and fuel wood per ton were found to be Tk. 2650 to Tk. 3530 and Tk. 670 to Tk. 940 respectively near plantation area in 2003. The harvesting and processing costs were estimated as 20% and 10% of the standing value of the trees. The value of IRR and other economic determinants for timber were varied among Coastal Afforestation Divisions mainly due to different rates of siltation, salinity and other factors involved on the forest floor in coastal zone. However, applying the economic determinants throughout coastal zone, financially remarkable rotation age for timber was found to be within 14th to 16th year of plantation and rotation age for fuel wood as 9th year of plantation. Applying the same economic determinants keora plantation was also found as profitable in coastal zone in Bangladesh.

Keywords: Keora; Plantation; Determinants; Profitable

1. Introduction

Keora is one of the main and pioneer planting species along the coastal belt of Bangladesh. Nowhere else in the world, mangrove plantation has been raised with such a large scale keora plantation along the coastal belt in Bangladesh [1]. The species is highly suitable in newly formed muddy land in coastal belt. The massive Afforestation programme was under taken along the coastal belt and offshore islands of Chittagong, Noakhali, Bhola, Barisal and Patuakhali. Coastal afforestation programme was first initiated along the coastal belt of Bangladesh in 1966 and it is still going on [2]. The spacings were applied from (1.02 m × 1.20 m) to (1.80 m × 1.80 m) where planted seedlings were 6945 to 3085 per hectare respectively. There were mono and mixed types of plantations in the coastal afforestation programme. The other species in the mixed plantation are kankra (*Bru-guiedoa Sexuangulara*), baen (*Avicennia officinalis*), gewa (*Excecaria agallocha*) etc. Though the initial year of plantation was 1966 but most of the successful plantations were found physically from 1980.

The objective of starting coastal Afforestation programme in the country was primarily to stabilize accreted land and protecting destruction, losses of assets and lives in

coastal areas against natural disasters like cyclone, tidal bore, etc. The secondary objective was to develop natural land management system and uplifting the socio-economic condition of the people through multiple benefits of forest resources in coastal areas. Timber and fuel wood production of the species, its use in different types of industries and creation of employment opportunities were also the ultimate objectives of the Forest Department [1]. So the production of the species recommends to make hardboard, pulpwood, packing boxes, bobbins, joinery, doors, windows, etc. Many plantations of the species of different areas have become older in coastal zone.

Unfortunately, a severe stem borer attack was first reported in keora plantations in all coastal areas [3]. Later on Bangladesh Forest Research Institute conducted a sample survey and the percentage of overall infestation was estimated at 59% [4]. Infested trees were suggested to remove and mixed plantations of keora with acceptable species was recommended. Later on keora plantations were found successful in all coastal zones.

But no financial analysis was done for this valuable plantation. Determination of acceptable rotation age and profitability of this plantation is absolutely necessary. So, an attempt has been taken to find out financial rotation age and profitability of keora plantation in coastal zones through applying economic determinants.

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2. Materials and Method

A study was done on the financial analysis of keora plantations in three Coastal Plantation Divisions. A sampling design was prepared for almost all the Coastal Afforestation Divisions. The site of the survey was included the plantations from each Coastal Afforestation Division established in Chittagong, Barisal and Patuakhali from 1980 to 1996. A samples of 3 plots from each plantation year and each plot size (10 m × 10 m) of 0.01 ha was considered for the selected keora plantation of every Coastal Afforestation Division. Collection of data and analysis were performed separately for all administrative Coastal Afforestation Division except Noakhali due to unfavorable situation of institutional team work. The plantations were identified with the help of the local forest staff. The ages of the plantations were confirmed by consulting the plantation journals kept in the respective Forest Range Offices. Height and diameter at breast height (DBH) of the stands were measured from each selected plot by Haga Altimeter and Diameter tape respectively. Information regarding physical and financial (direct cost) aspects on keora plantation was collected from two different locations of each (coastal) division. Indirect cost including those of administration, supervision, etc. were not taken into account [5]. Data on the costs of the raising nursery plantations and other maintenance operations were collected from plantation journal of the local range office. The particular harvesting and processing costs were deducted in a certain percentage from standing value of the trees [6]. The mode of marketing and market price of sawn wood, round wood and fuel wood of keora was collected from the nearest local market of the study area. Existing market price was considered to evaluate the input costs and returns of the species. The cost of land and thinning were not considered because of ownership of Forest Department and no thinning opera-

tion was done in the plantation.

The determinants are Net Present Value (NPV), Internal Rate of Return (IRR), Benefit Cost Ratio (B/C), Efficiency Index (EI), Land Expectation value (Le) and Equal Annual Equivalent (EAE) interms of the Le and NPV those were applied to find out the economically right rotation period and profitability of the species. The mathematical approach to the financial analysis of plantations depends on a certain interest rate on the following economic determinants.

$$1) \text{ NPV (Net Present Value)} = \sum \frac{R_n}{(1+i)^n} - \sum \frac{C_n}{(1+i)^n}$$

$$2) \text{ IRR (Internal Rate of Return)} = \sum \frac{R_n}{(1+i)} - \sum \frac{C_n}{(1+i)^n} = 0$$

$$3) \text{ Benefit Cost Ratio (B/C)} = \frac{\sum \frac{R_n}{(1+i)^n}}{\sum \frac{C_n}{(1+i)^n}}$$

where,

R_n = Returns at every n year

C_n = Cost at every n year

n = Number of years

i = Interest Rate

$$\text{EAE} = \text{NPV} \left[\frac{i(1+i)^t}{(1+i)^t - 1} \right]$$

where,

EAE = Equal Annual Equivalent

NPV = Net Present Value

i = Interest Rate

t = Rotation Period (1, ..., n)

$$\text{Le} = \frac{Yr + Tb(1+i)^{r-b} + 1 \left[\frac{(1+i)^r - 1}{i} \right] - Cc(1+i)^{r-c} - e(1+i)^r - 1}{(1+i)^r - 1}$$

where,

Y = Net yield at rotation age

T = Net value of intermediate cuttings

b = Age at which revenue is received

I = Annual income

C = Net value of intermediate cost

c = Age at which cost is incurred

e = annual expenses

r = Rotation

i = Interest rate

Equation for estimating volume over bark (Vob) of three different coastal divisions [5].

$$\text{InVob} = -8.66152 + 1.58656 \times \text{InD} + 0.77152 \times \text{InH}$$

for Chittagong.

$$\text{InVob} = -9.23507 + 1.69673 \times \text{InD} + 0.92309 \times \text{InH}$$

for Barisal.

$$\text{InVob} = -8.75215 + 1.75034 \times \text{InD} + 0.64233 \times \text{InH}$$

for Patuakhali.

3. Result and Discussion

Raised plantations have tremendous contribution directly as tangible and intangible benefits in coastal areas. Intangible benefits are considered as protecting lives, properties environments and socio-cultural welfare of the people living in the coastal zone [7]. So it is very tough

to quantify the value to benefits of protecting lives, assets and other uncountable welfare of population and contributions to acceleration of newly land formation and development of land suitable for agricultural activities. Therefore, no financial values were considered other than the fuel and timber yield per hectare of keora plantation [8]. Assessment relating to financial approach depending on market survey and estimated present stocking yield of standing trees per hectare were done in coastal zone in 2010. The average market prices of sawn wood, round wood and fuel wood were estimated to be Tk. 5093 /m³, Tk. 3050 /m³ and Tk. 30 /m³ respectively. The values of round wood and fuel wood of market price were mainly considered for the study.

The maximum height and DBH were found in the plantation of the year 1980-1981 in Barisal and Patuakhali Coastal Afforestation Divisions [9] and lowest in the year 1989-1990 in Chittagong Coastal Afforestation Division (**Table 1**). Measurement of one to five feet bottom part of the trees was not possible due to sedimentation in forest floor of the plantation. Sedimentation rate was observed highest in areas of Chittagong Coastal Afforestation Division.

The maximum number of trees per hectare was found

in the plantation of the year 1989-1990, 1990-1991 and 1995-1996 in Chittagong, Barisal and Patuakhali Coastal Division respectively. Highest yield was found in the year 1986-1987, 1983-1984 and 1980-1981 in these divisions because of size of the trees (**Table 2**). The elimination rate among the coastal zones was the highest in Barisal in year 1995-1996 and the lowest in Chittagong in the year 1986-1987 and 1989-1990 (**Table 3**).

Considering the age 9th year and less than 9th year of plantations for fuel wood, the values of economic determinants were found maximum in 9th of plantations through the coastal zones [10]. All parametric values of different economic determinants of timber were varied within the coastal divisions. Ranking on different economic determinants the optimum financial rotation for Barisal (**Table 4**), Chittagong (**Table 5**) and Patuakhali (**Table 6**) were as timber 16th to 18th year, 15th to 16th year and 11th to 13th year of plantation. However, overall results of all coastal division showed that determinants like Net Present Value (NPV), Internal Rate of Return (IRR), Land Expectation Value (LE) and Equal Annual Equivalent (EAE) in terms of Le and NPV were found highest in the 11th year of plantation (**Table 7**). Besides, Benefits Cost Ratio and Efficiency Index were found maximum in the 16th year

Table 1. Average DBH and height of trees in different plantation years.

Plantation Year	Chittagong		Barisal		Patuakhali	
	DBH cm	Height m	DBH cm	Height m	DBH cm	Height m
1980-1981			29.91	21.53	25.05	22.29
1981-1982	12.13	12.16	20.04	17.70	23.93	22.24
1982-1983	13.13	11.73	22.96	20.05	23.89	21.23
1983-1984	12.37	11.03	25.00	14.30	22.25	16.82
1984-1985	12.40	12.78			21.77	14.70
1985-1986	12.56	12.67	23.67			
1986-1987	12.07	13.35	17.98	17.20		
1987-1988	13.62	11.97				
1988-1989	9.56	8.10				
1989-1990	8.66	7.87	12.16	13.02	18.98	18.11
1990-1991			12.74	12.88	14.68	16.49
1991-1992			13.25	12.57	13.26	15.09
1992-1993			12.34	12.19	10.90	15.27
1993-1994						
1994-1995					11.24	12.64
1995-1996			10.37	8.40	9.51	9.20
1996-1997			8.43	9.11		

Table 2. Stocking of tree and yield in different plantation years.

Plantation Year	Chittagong		Barisal		Patuakhali	
	Stocking	Yield	Stocking	Yield	Stocking	Yield
	(No/ha)	(m ³ /ha)	(No/ha)	(m ³ /ha)	(No/ha)	(m ³ /ha)
1980-1981			600	325.49	967	328.34
1981-1982	1700	120.29	1167	276.07	900	280.40
1982-1983	1725	125.96	1100	361.86	933	279.06
1983-1984	1825	116.28	1500	441.57	1167	281.64
1984-1985	1950	132.54			967	195.46
1985-1986						
1986-1987	2767	209.40	1733	325.80		
1987-1988	2250	185.11				
1988-1989	2550	89.70				
1989-1990	2900	80.27	2067	173.45	1167	221.11
1990-1991			2167	188.11	1500	167.57
1991-1992			1933	183.67	2167	208.72
1992-1993			1900	139.37	2233	141.70
1993-1994	2980	81.43	1930	140.30	2156	141.10
1994-1995					2067	128.36
1995-1996			2033	79.54	2433	89.44
1996-1997			2067	61.64		

Table 3. Elimination of percentage of trees in different plantation years.

Plantation Year	Chittagong	Barisal	Patuakhali
1980-1981		10%	10%
1981-1982	5%	8%	9%
1982-1983	5%	9%	9%
1983-1984	6%	24%	9%
1984-1985	6%		10%
1985-1986	5%	25%	10%
1986-1987	3%	32%	
1987-1988	4%		
1988-1989	4%		
1989-1990	3%	18%	10%
1990-1991		6%	8%
1991-1992		7%	6%
1992-1993		3%	6%
1993-1994		5%	
1994-1995		4%	9%
1995-1996		50%	8%
1996-1997		50%	

Note: Blank space indicates trees harvested or not plated at all.

plantation (Table 7). So the optimum rotation can be chosen within the age of 14th to 16th year of plantation considering other intangible benefit than benefit of plantation production. On the other hand, it is observed in Table 4, Table 5 and Table 6 that there is no such difference in the values of NPV, IRR, B/C ratio, EI, Le, EAE_{Le} and EAE_{NPV} among 11th year to 22nd year of plantations in all Coastal Afforestation Divisions expect a few exceptions. All these determinants show acceptable

results indicating profitability of keora plantations. A few years plantations from 5th year to 10th year indicated small values in comparison with 11th year to 22nd year plantations in Barisal and Patuakhali Coastal Afforestation Divisions. The small values of the determinants are due to young aged plantation [11]. These plantations are now also profitable and may be more profitable after 10th year. However, overall results of the determinants show the same indication that coastal plantation of keora is profitable.

Table 4. Results of economic determinants in different ages in Barisal.

Age	NPV	IRR	B/C	EI	Le	EAE _{Le}	EAE _{NPV}
22	67770	36%	2.78	1.78	9491	1082	7726
21	62005	34%	2.68	1.68	9688	1120	7169
20	91429	39%	2.79	1.79	15963	1875	10739
19	122328	42%	2.77	1.77	23911	2859	14624
18	120835	44%	2.76	1.76	28554	3551	14939
17	107574	42%	2.60	1.60	29640	3831	13721
16	119341	46%	2.74	1.74	33197	4243	15254
15	94313	40%	2.45	1.45	30725	4110	12504
14	93305	39%	2.42	1.42	36943	5222	13025
13	69285	33%	2.15	1.15	28253	3977	9754
12	92297	38%	2.39	1.39	43161	6334	13546
11	107157	61%	2.69	1.69	57825	8903	16498
10	88668	62%	2.65	1.65	55635	9054	14430
9	44852	38%	1.89	0.89	28363	4639	7321
8	22943	27%	1.52	0.52	14727	2432	3767
7	1035	15%	1.14	0.14	1091	224	213
6	384	13%	1.06	0.06	498	114	88
5	11989	21%	1.33	0.33	7909	1328	1990

Table 5. Results of economic determinants in different ages in Chittagong.

Age	NPV	IRR	B/C	EI	Le	EAE _{Le}	EAE _{NPV}
21	35277	30%	2.60	1.60	5512	637	4079
20	41072	32%	2.64	1.64	7171	842	4824
19	41603	34%	2.63	1.63	8132	972	4974
18	52876	37%	2.68	1.68	11596	1414	6447
17	77664	42%	2.71	1.71	20047	2528	9771
16	102452	47%	2.75	1.75	28499	3643	13095
15	100074	53%	3.05	1.95	27837	3558	12791
14	51754	45%	2.64	1.64	18500	2511	7025

Table 6. Results of economic determinants in different ages in Patuakhali.

Age	NPV	IRR	B/C	EI	Le	EAE _{Le}	EAE _{NPV}
22	79660	39%	2.78	1.78	13908	1634	9357
19	76496	34%	2.72	1.72	10713	1221	8721
21	72009	36%	2.73	1.73	11251	1301	8326
20	87942	40%	2.75	1.75	17190	2055	10513
18	66770	39%	2.73	1.73	14643	1785	8141
17	94256	47%	2.73	1.73	32144	4387	12640
16	97652	54%	2.72	1.72	39699	5661	13735
15	118014	59%	2.71	1.71	57185	8579	17520
14	109634	61%	2.66	1.66	60359	9459	16999
13	121741	55%	2.73	1.73	49644	6989	17138
12	101049	60%	2.71	1.71	47254	6935	14830
11	138376	65%	2.71	1.71	74672	11497	21305
10	101254	63%	2.62	1.62	63532	10340	16479
9	52494	42%	1.98	0.98	33399	5476	8589
8	3734	20%	1.35	0.35	3265	612	700
7	957	14%	1.10	0.10	1008	207	197

Table 7. Results of economic determinants in different ages of plantations in costal zone.

Year	NPV	IRR	B/C	EI	Le	EAE _{Le}	EAE _{NPV}
22	59848	34%	2.70	1.70	8572	980	6842
21	58362	34%	2.68	1.68	9370	1088	6773
20	70897	37%	2.73	1.73	12668	1494	8357
19	87715	39%	2.73	1.73	17566	2109	10528
18	88473	42%	2.73	1.73	21081	2621	10950
17	101427	45%	2.70	1.70	30094	3953	13152
16	105689	51%	2.84	1.80	33578	4487	13927
15	88027	48%	2.60	1.60	35470	5067	12350
14	101470	50%	2.54	1.54	48651	7341	15012
13	95513	44%	2.44	1.44	38949	5483	13446
12	96673	49%	2.55	1.55	45208	6635	14188
11	122767	63%	2.70	1.70	66249	10200	18902
10	94961	63%	2.63	1.63	59584	9697	15454
9	48673	40%	1.94	0.94	30881	5058	7955
8	13339	24%	1.43	0.43	8996	1522	2233
7	996	14%	1.12	0.12	1050	216	205
6	384	13%	1.06	0.06	498	114	88
5	11989	21%	1.33	0.33	7909	1328	1990

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