

# Survival and Growth Performance of Some Mangrove Species Planted in the Sundarbans of Bangladesh

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## Abstract

Survival, establishment and early growth of six major and economically important mangrove plant species, namely sundri (*Heritiera fomes*), gewa (*Excoecaria agallocha*), goran (*Ceriops decandra*), passur (*Xylocarpus mekongensis*), kankra (*Bruguiera* sp.) and baen (*Avicennia officinalis*) were studied in two salinity zones (moderate and strong saline) of the Sundarbans mangrove forests of Bangladesh at the age of five years after planting. The objective of the study was to enrich the vacant and poorly regenerated areas of the Sundarbans for its sustainable production and management.

The percentages of planted seedling's survival and establishment by fencing at moderate saline zone were 84.9, 74.3, 63.5, 60.6, 40.6 and 38.9 for gewa, goran, sundri, kankra, passur and baen respectively. The average height growths of these species were 1.94 m, 1.04 m, 0.90 m, 1.18 m, 1.71 m and 2.90 m respectively. Except gewa and goran all the seedlings of other four species died due to deer browsing when planted in unfenced condition.

## সারসংক্ষেপ

বাংলাদেশের সুন্দরবন ম্যানগ্রোভ বনের দু'টি লবণাক্ত এলাকায় (মধ্যম লবণাক্ত এবং অতিরিক্ত লবণাক্ত) অর্থনৈতিক গুরুত্বসম্পন্ন প্রধান ছয়টি ম্যানগ্রোভ প্রজাতির (গেওয়া, গরান, সুন্দরী, কাকড়া, পশুর এবং বাইন) পরীক্ষামূলক বাগান উত্তোলন করে পাঁচ বছর বয়সে প্রজাতিসমূহের বেঁচে থাকার হার এবং প্রাথমিক বৃদ্ধি পর্যবেক্ষণ করা হয়। সুন্দরবনের ফাঁকা এবং প্রাকৃতিকভাবে কম চারা জন্মে এমন এলাকায় বাগান সৃষ্টির মাধ্যমে বনের উন্নয়ন এবং টেকসই উৎপাদন সাধনই ছিল এই গবেষণার উদ্দেশ্য।

মধ্যম লবণাক্ত এলাকায় বেড়া দিয়ে উত্তোলিত বাগানে চারা বেঁচে থাকার হার হচ্ছে গেওয়া ৮৪.৯%, গরান ৭৪.৩%, সুন্দরী ৬৩.৫%, কাকড়া ৬০.৬%, পশুর ৪০.৬%, এবং বাইন ৩৮.৯%। এ সকল প্রজাতির গড় উচ্চতা বৃদ্ধি ছিল যথাক্রমে ১.৯৪ মিঃ, ১.০৪ মিঃ, ০.৯০ মিঃ, ১.১৮ মিঃ, ১.৭১ মিঃ এবং ২.৯০ মিঃ। গবেষণায় দেখা যায় যে, উন্মুক্ত স্থানে উত্তোলিত বাগানে হরিণে খাওয়ার ফলে গেওয়া এবং গরান ব্যতীত অন্যান্য চারটি প্রজাতির সকল চারাই মারা যায়।

**Key words :** Deer browse, height growth, mangrove plantation, regeneration, Sundarbans, survival, sustainable production

## Introduction

The Sundarbans is a natural mangrove forest consisting of 245 genera and 334 species of trees, herbs, shrubs, bryophytes and pteridophytes (Prain 1903). Chaffey *et al.* (1985) listed 66 plant species from the Sundarbans. The most important tree species in the Sundarbans are sundri (*Heritiera*

*fomes*) constituting 73% of the growing stock followed by gewa (*Excoecaria agallocha*) constituting 16% (Forestal 1960). Other major plant species are goran (*Ceriops decandra*), passur (*Xylocarpus mekongensis*), baen (*Avicennia officinalis*), keora (*Sonneratia apetala*), kankra (*Bruguiera* sp.), golpata (*Nypa fruticans*), khalsi (*Aegicerus corniculatum*), hantal (*Phoenix paludosa*), etc.

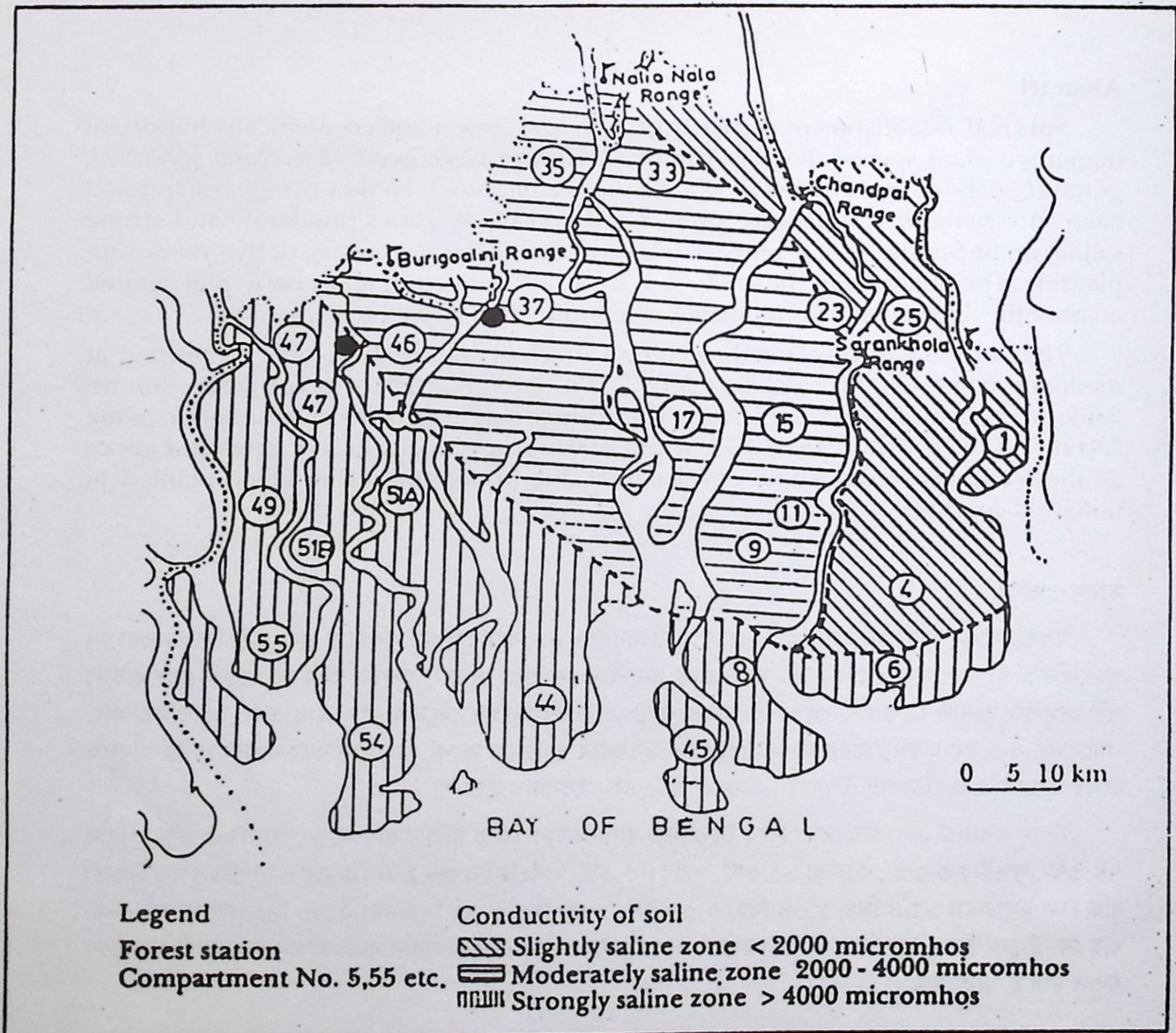


Figure 1. Map of the Sundarbans showing locations of the experimental plots (●) and three salinity zones.

According to salinity and species composition the forest is divided into three ecological zones *viz.* slightly saline, moderately saline and strongly saline zone (Curtis 1933, Choudhury 1968, Chaffey *et al.* 1985). The zonation of the Sundarbans is defined by the distributions of the three species—sundri, gewa and goran. All these three occur throughout the Sundarbans but in different proportions depending on salinity. Sundri is the characteristic species of the slightly saline zone, gewa of the moderately saline zone and goran of the strongly saline zone (Chaffey *et al.* 1985). Faizuddin *et al.* (1996) also found sundri as the dominant species in the less saline zone, gewa in the moderate saline zone and goran in the strong saline zone. The zonation is shown in Fig. 1.

The productivity of the Sundarbans is very low which is only 1.12 m<sup>3</sup>/ha/year (Davidson 1984). The merchantable growing stock of the major species *viz.* sundri and gewa have been depleted by 40% and 45% respectively within a period from 1969 to 1984 (Chaffey *et al.* 1985). This may further be depleted by inadequate regeneration in some parts of the forest (Siddiqi *et al.* 1994). Shafi (1982) claimed that regeneration of the Sundarbans has decreased by 100% in 1981 as compared to that of 1959-60. Moreover, failure to survive and establish the recruited seedlings was a serious problem for ensuring a rich stocking (Siddiqi 1992).

A survey conducted in 1960 revealed that 7% of the forest was under non-commercial cover (NCC) while in 1985 it was reported to be 2%

(Chaffey *et al.* 1985). The NCC area (174000 ha) of the Sundarbans was covered by some climbers or non-commercial species.

Salinity is an important factor regulating growth, survival and zonation of mangroves (Bowman 1917, Karim 1994). Wild animals also play an important role on the establishment of the regeneration mainly through their feeding habits (Blasco 1977, Chai and Lai 1984, Siddiqi and Hossain 1994).

Very little information is available on the survival and growth performance of the mangrove species in the Sunderbans. So, trial plantations of the six major and economically important mangrove tree species, namely sundri, gewa, goran, passur, kankra and baen were established in the two salinity zones of the Sundarbans with a view to study the survival, establishment and growth of these mangrove species for sustainable production and management.

## Materials and methods

The study was carried out in the Sundarbans natural mangrove forest. The Sundarbans is the largest single tract mangrove in the world covering an area of 10,000 km<sup>2</sup> of which 62% falls within the territory of Bangladesh. The Sundarbans of Bangladesh lies between the latitudes 21<sup>0</sup> 30' and 22<sup>0</sup> 30' N and between the longitudes 89<sup>0</sup> and 89<sup>0</sup>.55'E. The experiment was conducted in the moderate and strong saline zones where regeneration is scanty or not available (Fig. 1).

Table 1. Site characteristics of the experimental plots.

Year of plantation	Location		Soil condition			Tidal inundation	Water salinity	Initial vegetation
	Compt. no.	Zone	Texture	pH	Salinity			
1990	37	MS	Silty clay	7.8	2.6-5.0 m. mohs/cm	Inundated by all tides in monsoon; seldom in non-monsoon	7-27 ppt.	Sporadic <i>C. decandra</i> , <i>E. agallocha</i> and <i>Tamarix indica</i>
1990	46	SS	Silty clay	7.8	2.7-5.3 m. mohs/cm	Inundated by all tides in monsoon; seldom in non-monsoon	9-28 ppt	Sporadic <i>E. agallocha</i> , <i>X. mekongensis</i> , <i>A. officinalis</i> and <i>A. aureum</i> .

Note : MS = Moderately saline, SS = Strongly saline.

### Raising and maintenance of nursery

Seedlings were raised in polybags at Bogi Research Station in 1989. The mature seed/propagules of sundri (*Heritiera fomes*), gewa (*Excoecaria agallocha*), goran (*Ceriops decandra*), passur (*Xylocarpus mekongensis*), kankra (*Bruguiera* sp.) and baen (*Avicennia officinalis*) were collected from healthy mother trees/forest floor of the Sundarbans.

The nursery was fenced with barbed wire to prevent entrance of the deer. The seedlings were raised in polybags (15 cm x 25 cm) staked on the polythene sheet to check entrance of the roots to the ground. The bags were shifted over the sheet to check root growth. Shade over the seedlings was given initially. Subsequently the shade was removed to allow the seedlings for hardening. The seedlings in the nursery were maintained for about 10-12 months. Regular watering and weeding in the nursery were made.

### Experimental design and planting

The experiment was laid out in a Randomised Complete Block Design. Six species were planted at two locations with two treatments (fenced and unfenced) in three blocks. So, the number of plots were 18 (3 x 6) at each location for a single treatment. The size of two plots for fenced areas was 0.2 ha. Each of these was planted with 2510 seedlings at 0.9 m x 0.9 m spacing. The size of the plots in the unfenced areas was also 0.2 ha. Planting was carried out in June, 1990 with the onset of monsoon. Three weeding were done in the first year and two weeding in the subsequent years.

### Data collection and analysis

Data on survival and growth were collected at three months intervals. Final collection of data

were made at the age of five years. Data were analysed to determine significant variations in survival and height growth between the fenced and unfenced areas by paired T-test and also between the species by F-test.

### Results and discussion

The experimental plantations were raised at two locations, one at moderate saline zone and another at strong saline zone. At both the locations, seedlings were planted in fenced and unfenced conditions. But unfortunately, the fencing materials of the strong saline zone plantation were stolen one year after plantations by some miscreants. So, the effect of fencing was not reflected properly in that location. Results of that location were only tabulated but not analysed. Data recorded from the uninterrupted plot i.e. data at moderately saline zone were tabulated and analysed.

In the experimental plantation of the moderately saline zone, it was observed that except gewa and goran all the seedlings of the other four species planted in unfenced condition were browsed by deer. Subsequently the seedlings died. After five years of planting survival and height growth of the surviving two species in the unfenced condition were 62.2% and 1.84 m and 61.4% and 1.02 m for gewa and goran respectively. In the fenced condition survival of gewa, goran, sundri, kankra, passur and baen were 84.9%, 74.3%, 63.5%, 60.6%, 40.6% and 38.9% respectively and their heights were 1.94 m, 1.04 m, 0.90 m, 1.18 m, 1.17 m and 2.9 m respectively (Table 2). A significant difference (at 1% level) was observed among the species in their survival and height growth performance. A very high significant difference was also found for survival and height growth between fenced and unfenced conditions. But for gewa and goran the differences were found insignificant.

**Table 2.** Survival and height growth performance of six mangrove species planted in moderately saline zone of the Sundarbans at the age of five years.

Species	Survival (%)			Average height (m)		
	Fenced	Unfenced	Difference	Fenced	Unfenced	Difference
Sundri	63.5	Nil	**	0.90	Nil	**
Gewa	84.9	62.2	NS	1.94	1.84	NS
Goran	74.3	61.4	NS	1.04	1.02	NS
Passur	40.6	Nil	**	1.71	Nil	**
Baen	38.9	Nil	**	2.90	Nil	**
Kankra	60.6	Nil	**	1.18	Nil	**
For species F 5,27 = 14.5377 ** For condition F 1,27 = 60.3946** (fenced-unfenced)				For species F 5,27, = 5.3062* For condition F 1,27 = 34.9132* (fenced-unfenced)		

Note : Each value is the mean of three replicates, \* = Significant at 5% level, \*\* = Significant at 1% level, NS = Non-significant

**Table 3.** Survival and height growth performance of six mangrove species planted in strong saline zone of the Sundarbans at the age of five years.

Species	Survival (%)		Average height (m)	
	Fenced	Unfenced	Fenced	Unfenced
Sundri	Nil	Nil	-	-
Gewa	74.4	69.6	1.99	2.4
Goran	44.0	18.5	1.15	0.94
Passur	Nil	Nil	-	-
Baen	Nil	Nil	-	-
Kankra	Nil	Nil	-	-

Note : Each value is the mean of three replicates. The fencing materials were stolen one year after planting. So, the effect of fencing was not reflected.

In the experimental plantation of strong saline zone, as said earlier, the fencing materials were stolen one year after planting. So, the seedlings planted in the fenced condition were affected by deer browsing. Except gewa and goran all the seedlings of the other four species died in both the conditions. Survival percentages of gewa

and goran were 74.4 and 44.0 respectively in fenced condition and 69.6 and 18.5 in unfenced condition. The average heights were 1.99 m and 2.4 m for gewa and 1.15 m and 0.94 m for goran in fenced and unfenced conditions respectively (Table 3).

From the experiments made at two locations it was observed that except gewa and goran all the

seedlings of the other four species were browsed by deer when planted in the unfenced condition. Siddiqui and Husain (1994) reported that leaves of *Bruguiera* spp. *Xylocarpus mekongensis* and *Avicennia officinalis* appeared to be highly palatable to deer causing significant damage to the new seedlings of these species. They also noticed that the deer was not found to affect the natural regeneration of *Heritiera fomes*, *Excoecaria agallocha* and *Ceriops decandra*. The present observation revealed that though the deer did not show any significant effect on the survival and height growth of *E. agallocha* and *C. decandra*, they were found to browse the seedlings of *H. fomes* effectively when planted in the unfenced condition.

The highest survival was observed in gewa (84.9%) followed by goran, sundri, kankra, passur and baen. On the other hand the highest average height growth was seen in baen (2.90 m) followed by gewa, passur, kankra, goran and sundri (Table 2). Performance of gewa and goran were found satisfactory in both fenced and unfenced conditions at both locations. Baen and passur though showed better growth in fenced condition at moderate saline zone, their survivals were found un-

satisfactory. Though survived satisfactorily in fenced areas, sundri's height growth was found very poor. Troup (1921), Das and Siddiqui (1985), Saenger (1986) and Siddiqui and Khan (1990) also mentioned that sundri preferred a lower level of salinity, and growth of this tree species is very much stunted in the high saline areas.

## Conclusion

Studies on survival, establishment and initial growth of six mangrove species such as sundri, gewa, goran, passur, baen and kankra in the plantation of poorly regenerated areas of the Sundarbans revealed that deer browsing is a serious problem for the seedlings. Except gewa and goran all other four species died due to deer browsing within one year after planting when planted in the unfenced condition. Productivity of the Sundarbans can be improved by raising successful plantation with gewa and goran in the poorly regenerated areas without fencing. It is also suggested to raise plantation with other four species such as sundri, baen, passur and kankra by fencing.

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