Benefits of Shelterbelt Plantation in Saline Coastal Tracts of Gujarat

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ABSTRACT

Salinity is one of the most severe environmental factors limiting the productivity of fertile lands and degrading the water quality in coastal areas. Besides sea water ingress, the acute problem of salinization in these areas is attributed to land use conversion involving deforestation, poor drainage, flooding and use of brackish water for irrigation. In addition, the exposed coastal zones are always prone to strong winds. Damage from salt-laden air can affect plants up to one kilometre from the sea, depending on wind speed and direction. The severity of salt damage to plants and water bodies depends upon the amount and duration of exposure, and the concentration of salt. High levels of soluble salts cause changes to soil structure, resulting in compacted soils and land degradation that is not conducive for plant growth. Reclamation and management of salt affected soils requires costly salinity management technologies viz., chemical amendments in alkali soils and drainage and leaching of saline soils. Low cost techniques include reclamation of alkaline soils through the biological route. Shelterbelt plantation is an environmentally attractive method for significantly reducing both the direct and indirect adverse impact of salinity on plants and water resources. Shelterbelts act as barriers that diminish damage from salt-laden winds in coastal areas and provide shelter to coastal life. Shelterbelt plantation requires a sound strategy that combines agricultural and forestry technologies to create a diverse, productive, healthy and sustainable coastal land-use system. The study describes the need, strategy and positive impact of shelterbelt plantation on the crop production and economy of the region along the salinity affected Saurashtra coastal tract in the vicinity of Porbandar district, Gujarat, India.

Keywords: Shelterbelt, Salinity, Groundwater, Salt tolerance

INTRODUCTION

The coastal zones displaying a variety of complex environments have to live with salinity. The nature of salinity in different areas varies from one region to another. In coastal regions, groundwater and soil quality is generally degraded due to natural processes such as salt water intrusion, tidal effects, wind driven sea spray and marine aerosols deposited on the topsoil, evaporation, and interaction of groundwater with brines and geological formations. Coastal areas are always prone to strong winds, which is a strong stress factor for trees growing in these exposed areas. High levels of soluble salts cause changes in soil structure, resulting in compacted soils, so much so that the land becomes increasingly degraded and unsuitable for plants grown in that area. With the increase in concentration of soluble salts in soil, the living tissue in the leaves and tender shoots is adversely affected, with the result that the plant either is killed or very badly damaged.

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Small and unhealthy seedlings are also very much affected. Shelterbelt plantation has been widely recognized as a natural method to reduce both the direct and indirect impact of salinity on plants and water resources, by acting as barriers or first line of defence that can effectively reduce damage from salt-laden winds and the wave action of tropical cyclones and tsunamis in coastal areas and provide shelter to coastal life. It is an integrated approach of using the interactive benefits by combining trees and shrubs with crops. Other than plantation, structures such as sandy wall, brushwood fencing, and rock wall etc. constructed in coastal areas also serve as shelterbelt. These structures prevent the entry of wild animals in the cropped area and as plants provide rough surface to the winds thereby slowing down the wind speed at the base of the shelterbelt [1-10].

The study area comprises the Minsar river basin, a major portion of which falls in the Porbandar district of Coastal Saurashtra in Gujarat. Owing to its barrenness due to high levels of salinity, the coastal area along the Porbandar district is locally known as Sorthi Ghed area, located in western parts of Saurashtra region between latitudes $21^{o}0'$ and $22^{o}22'$ N and longitudes $71^{o}22'$ and $72^{o}22'$E. The climate of the region is semi-arid type with maximum temperature varying from 35^{0} C to 44^{0}C during summers and a minimum of around 8^{0}C to 20^{0}C during winters. In the study area, winds are generally light to moderate that builds up some strength during southwest monsoon season. In the mornings of winter (October to March), winds are mostly from directions between northwest and northeast while in summer and in the southwest monsoon period, winds are predominantly from the southwest or west directions. In the afternoons, the winds are mainly from directions between southwest and west throughout the year. Wind velocity at the Porbandar coast varies from 9-23kph throughout the year [11]. The region is characterized by mudflats (Kerly creek), where increasing salinity threatens the water resources and salt laden winds have adversely affected the land productivity in the coastal belt filled with barren patches. Viewing the need for shelterbelt protection along the coastline, the Junagadh Forest Division (Porbandar), Gujarat Forest Department, has been pursuing coastal border plantation which involves a process of restoration through re-vegetation and soil and moisture conservation measures. The plantations are done on sand dunes, which are barren sandy stretches, located along the coastal border in narrow broken strips of varying width.

MATERIALS AND METHODS

This study involves the integration of remote sensing techniques and survey (through questionnaire and interaction with local people) within a Geographical Information System (GIS) framework. Surveys were carried out to investigate the benefits of shelterbelt plantation introduced in the area both as a salinity prevention measure and on the socio-economic conditions of the local population and farmers in the coastal belt of Minsar Basin. Detailed survey was conducted with the help of structured schedule and personal interviews with the local people in the study area and Junagadh Forest Division at Porbandar.

RESULTS AND DISCUSSION

A high salt content in irrigation water causes an increase in the soil solution osmotic pressure. The salts, besides affecting the plant growth directly, also affect the soil structure, permeability and aeration, thus affecting the plant growth, indirectly as well. Choice of the type of trees to be used for shelterbelts depends on the topography, local climate and soil conditions of the area.

Accordingly as per the climatic conditions, Porbandar Forest Department has undertaken the development of shelterbelt plantation in 2011-12 and 2012-13 at selected location as shown in figure 1. Planting has been carried out as per following models: block planting, row planting and line planting. In row planting, about 50 - 100 rows of trees serve as shelterbelt, which reduces the

wind velocity to a great extent. Line planting in coastal islands helps in reducing the wind force and stabilising the sand dunes. Block planting is a method of planting varieties in separate blocks. Porbandar Forest Department prepared a block planting model (Figure 2) for all selected location along the coastal belt on the basis of surrounding conditions of that area (Table 1). Each block is represented by all varieties (Table 2).

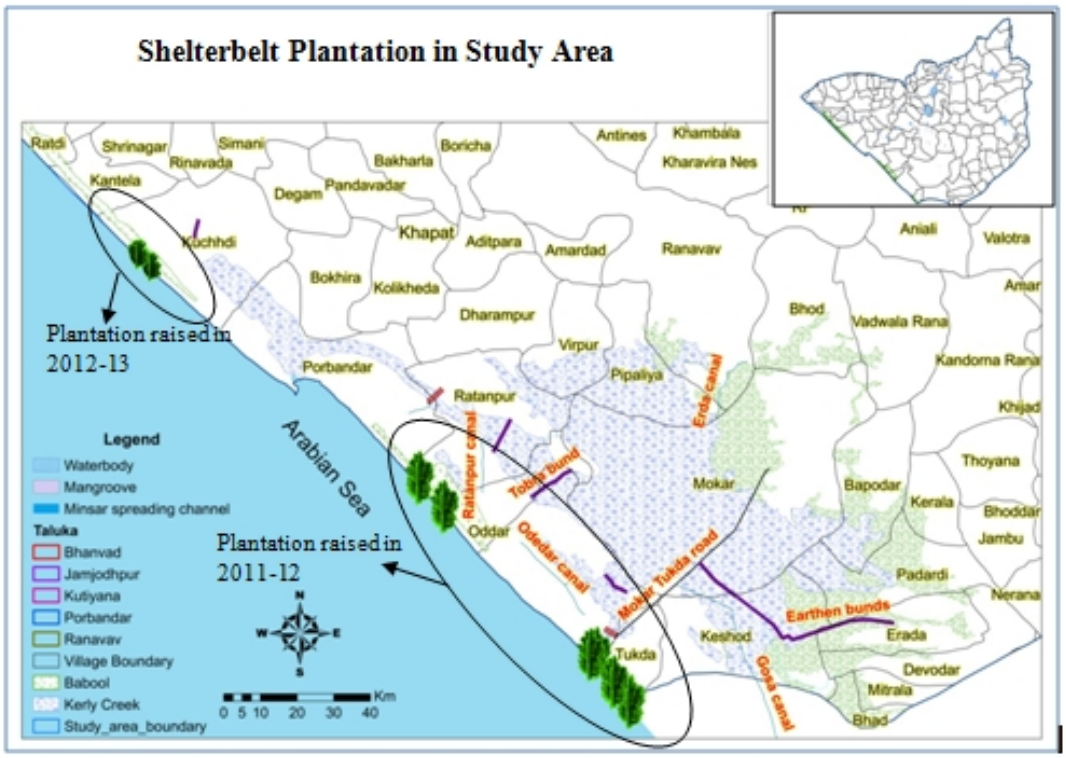

Figure 1. Location map of Shelterbelt Plantation in Study area.

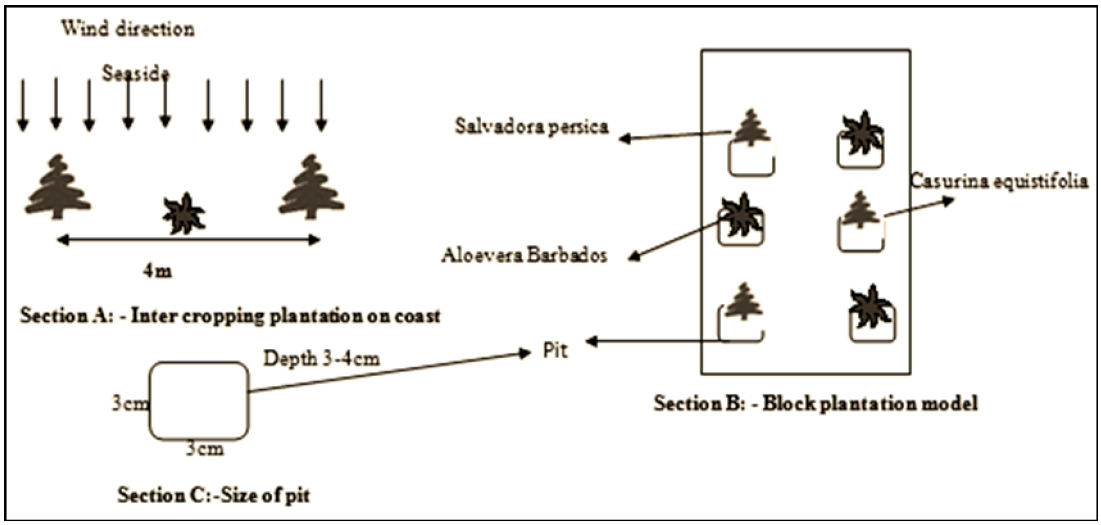

Figure 2. Plantation model adopted in Porbandar coastal region.

Table 1. Topographic, soil and local conditions of the area selected for plantation.

Category	Ratanpar	Tukda Gosa-A	Tukda Gosa-B	
	Block 1	Block 1	Block 1	Block 2 (Nursery Plantation)
Soil type	Sandy	Sandy	Sandy	saline soil (loamy)
Removal of cover soil	No	No	5 cm	45 cm
Land slope	Medium	Medium	Gentle	Gentle
Condition of soil prior to shelterbelt plantation	Poor fertility	Poor fertility	Poor fertility	Poor fertility
Grazing land/animals	Available/Blue bull, Cow, Buffalo	Available/Blue bull, Cow, Buffalo	Available/Blue bull, Cow, Buffalo	Available/Blue bull, Cow, Buffalo
Unauthorized cutting	possible cutting of babool	possible cutting of babool	possible cutting of babool	possible cutting of babool
Unauthorized cultivation	No	No	No	No
Possibility of damage due to Fire	May be possible		May be possible	
Type of tree proposed/planted	Babool, C. equistifolia	Babool, C. equistifolia	Babool, C. equistifolia	Babool, C. equistifolia
Total area used for planting (ha)	8 ha	7 ha	10 ha	5 ha

(Source: Porbandar Forest Department)

Forest Department raised medium category saline tolerant plants (as per FAO guidelines) viz. *Cassurina equistifolia* (tolerance EC 15-25 dS/m) and *Salvadora persica* (tolerance EC > 35 dS/m) as shelterbelt [9, 12]; both species were planted in rows at a spacing of 4 m. The department planted *Aloevera barbados* as an intercrop in between *C. equistifolia* and *S. persica* at Tukda Gosa to slow down wind at the base of the belt and have further plans to employ this planting technique in future at other locations also. Some other species that are planted include *Coconut* and *Prosopis Juliflora* (tolerate EC > 35 dS/m) [9,12].

The land selected for plantation is prepared by ploughing it thoroughly between April and May. Farmyard manure is applied during the last plough. Before the onset of rainy season, small pits (size 30 x 30 cm and 3-4 cm deep) are dug and filled with farmyard manure mixed with dug out soil. In sandy soils, irrigation is given to the plantation till the onset of monsoon, except in high rainfall areas. *P. Juliflora* is raised on the road side as a secondary wind strip shelterbelt.

Table 2. Quantity and category of plant species used in each block.

Type of work	Ratanpar	Tukda Gosa-A	Tukda Gosa-B	
	Block 1	Block 1	Block 1	Block 2
Type of plant	No. of plant species used			
Higher category Plantation	Not used			
Medium category Plantation				
a. *Casurina equistifolia*	4400	3850	6452	Not used
b. *Salvadora Persica*	4400	3850	4219	4400
c. *Babool*	Not used		1100	1100
d. *Aloevera barbadose*	Not used		329	329
Lower category Plantation	Not used			

(Source: Porbandar Forest Department)

Usually 60 cm tall seedlings establish better and grow well in plantations. Fertilizers (urea, DAP and cow dung) are added and watering is applied 12 times periodically after plantation, with no need of watering during monsoon season (Table 3). Weeding may be done periodically up to 3 years for better growth (1st year: three weedings; 2nd year: 2 weedings; 3rd year: 1 weeding). Ploughing may also be done in between the rows within 2 years to loosen the soil, which helps in percolating water and growth of plants.

Table 3. Measures taken for raising shelterbelt plantation.

Type of work	Ratanpar	Tukda Gosa-A	Tukda Gosa-B	
	Block 1	Block 1	Block 1	Block 2
Fertilizers Application				
a. Cow dung	3 tractor	2 tractor	Not used	
b. DAP	10 gm; 88 kg	10 gm; 77 kg		
c. Urea (2 Dose)	20gm; 176kg	20gm; 154kg	10gm	10gm
Pit sizes				
Small (3 x 3 x 3 cm)	8800	7700	11000	5500
Large	Not needed			
Medium				
Watering	12 times 8800 pits	12 times 7700 pits	12 times 7700 pits	12 times 7700 pits

(Source: Porbandar Forest Department)

Coastal shelterbelt plantation provides important ecological services and better livelihood opportunities for the local population that helps improve their quality of life. The findings in the region indicate that after shelterbelt plantation, the non-productive land became productive up to 70-80%. As per discussion with the farmers, 50-60% improvement on average was noted in the yield of Oreo crop, Castor and Gadap (Fodder) crop yield after 2-3 yrs of shelterbelt plantation. One of the major plantation activities along the coast is by private land owners who have employed *Casuarinas* and *Coconut* along with *Castor* and *Oreo* as cash crops at Tukda Gosa-B block. According to farmers, this approach has changed the economic scenario by increasing the land fertility due to which yield of crops (Castor and Oreo) increased up to a maximum of 80% in some locations which was 20-30% before this plantation 3-4 years ago. The problem of water logging and quality is also

reduced by up to 10-20%. To encourage shelterbelts in the region, the Forest Department also provided free seedlings of *Cassurina sps*. to farmers to conserve soil fertility and moisture of the area.

The Porbandar creek extends towards the land up to 2-3 km from the Arabian Sea. The area faces direct tidal currents from Arabian Sea. The creek has a scrubby patch of mangrove (*Avicennia marina*) with an average height of 1-3m. As per the 2007 assessment, a marginal increase to the extent of 0.21 km^2 was noticed. Out of 1.21 km^2 area of mangroves, 0.35 km^2 is dense mangroves and 0.86 is sparse mangroves [13]. Mangroves provide extra support against strong tidal fluctuation and induce sedimentation of soil particles at low tide.

Other than plantation, rock wall, sandy wall and brushwood fencing structures are also proposed along the seashore of Minsar basin as shelterbelt. As per local people and farmers, cultivated crops are susceptible to damage by wild animals in the region. These structures have been proposed by Porbandar Forest Department to prevent/reduce the entry of wild animals in the farm.

CONCLUSION

The findings indicate that shelterbelts plantation practices in coastal regions are profitable under a broad range of conditions and are therefore likely to be widely applicable. Shelterbelt plantation is a viable technique for significantly reducing both the direct and indirect adverse impacts of salinity on plants and water resources. The study of shelterbelts in the Porbandar region of Gujarat indicates that vegetation around the coastal area helps to reduce the water-logging conditions of coastal land and improve water quality by up to 10-20%, both of which have helped in increasing the production of Castor, Oreo and Gadap crop by up to 80%. The Forest Department Gujarat, Porbandar, plans to grow nursery plantation at more places in future near the coastline.

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