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# Progress in Coastal Sand Dune Reclamation in Queensland, Australia

by
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## INTRODUCTION

The State of Queensland is located between latitudes 10° and 29°S and longitudes 138° and 154° E. The coastline is about 5, 200 km in length, and contains a high percentage of sandy beaches, the sand consisting either of silica or calcareous material, the latter frequently in the Barrier Reef area.

The coastal climate is subtropical to tropical, and rainfall is of summer incidence. Tropical cyclones occur on the average three times per year and are associated with heavy rain, and high winds sometimes over 100 knots. High seas whipped up by these cyclones cause rapid recession of the coastline followed by slow accretion during calm periods. When tropical cyclones cross the coast structural damage occurs as a result of wind and heavy seas. An example of this was Cyclone Althea which caused $A 2 million worth of damage at Townsville in 1972.

Over 75% of Queensland's population of nearly two million people live within 40 km of the coast and there is intense development of parts of the coastal areas. There is therefore great pressure on coastal areas, not only by direct human developments such as towns, industry, and recreation, but also by indirect human agencies such as grazing and burning of dunal vegetation.

The Beach Protection Act of Queensland (1968-70) set up an Authority to investigate erosion of the coast and recognised the importance of the coastal dunes by requiring landholders to control wind erosion on their property in declared Beach Erosion Control Districts. Requirements were to establish or preserve vegetation to prevent the scouring action of the wind.

The Delft Hydraulics Laboratory (1970) further stressed the need for stable coastal dunes and stated that 'part of the sand nourishment must be used to form dunes, and these should be stabilized by proper vegetation. The upper part of the beaches should be protected against wind erosion by the installation of sand-catching fences. The use of the frontal dune area and the beaches for building activities must in general be prohibited.' Similar statements are made in five other sections of the Delft Report.

The Beach Protection Authority of Queensland, as part of its function of investigating coastal erosion, adopted a Research Programme into the stabilization and preservation of coastal sand dunes. An Experimental Area was set up on South Stradbroke Island, and five Field Trial Areas were established in Southern Queensland. Experimental work started at the end of 1970, and this paper gives a brief review of progress to date.

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## THE RESEARCH PROGRAMME

THE PLANT ECOLOGY OF UNDISTURBED AREAS. In southern Queensland the coastal dune system is threatened by real estate development, mining, and by the high concentration of people. Dune vegetation is being destroyed by uncontrolled pedestrian access through the dunes and the ever increasing use of dune buggies and trail bikes. Grazing is an important factor in many areas.

It is necessary to carry out a stocktaking of the plant communities on coastal dune systems while there are still some of them left. These studies will indicate the means by which damaged dunal areas can be repaired when the phase of coastal exploitation is completed.

This project consists of detailed studies of coastal plant communities, their floristic composition, pattern, and structure, and their relationship to one another. Information is being sought on the soil nutrient status, topographic relationships, microclimate, and the natural recolonisation of dunes following damage from burning, mining, or other causes. Minimum standards for revegetation are being developed for the use of authorities administering heavy mineral mining.

An undisturbed dunal area 100 km north of Brisbane has been selected for initial studies, and detailed vegetation and topographic surveys are at present being carried out. Quadrats will be set up to measure changes in ground and canopy cover, and recovery from a damaged condition.

A DETAILED STUDY OF BEACH SPINIFEX GRASS. Beach spinifex grass (SPINIFEX HIRSUTUS Labill.) has been recognised as the most widespread and important primary coloniser of coastal sand dunes in eastern Australia. It is distributed from Cape Bedford (Lat. 15° S) in the north to Tasmania in the south.

DESCRIPTION. It is an extremely hardy species, resistant to sand and salt drift, and capable of growing through accumulated sand drifts, thus tying down moving dunes. Black (1955) described beach spinifex as 'a sand binding grass with stout creeping stems; leaves silvery-silky, sheaths loose, blades long; long, hairy, straw coloured lanceolate bracts at base of each male and female spikelet. Fertile heads about 20 cm diameter and forming a bristly globular head, which falls off the peduncle when ripe and is blown along the sands by the wind.'

INVESTIGATIONS. The primary objective of the study of beach spinifex grass is to increase the knowledge of the species so that it could be more effectively, efficiently, and reliably utilised in sand dune reclamation projects. Studies are in progress on the habit of growth, seed setting and harvest, establishment from seed and vegetative material, and the nutritional requirements of the species.

Laboratory trials have shown that the best germination occurs at a depth of 3.75 cm, and at alternating 20-35°C temperatures (Tables 1 and 2). Germination under no light conditions was 27.7% compared with 9.4% under lighted conditions (Harty and McDonald, 1972).

TABLE 1. Effect of depth of sowing on germination of beach spinifex grass (Harty and McDonald, 1972).

| Depth of sowing, cm | Percentage germination, % |
|---|---|
| 1.25 | 24.4 |
| 2.5 | 49.9 |
| 3.75 | 53.4 |
| 5.0 | 17.3 |
| 6.25 | 26.5 |
| 7.5 | 27.9 |
| 8.75 | 4.9 |



TABLE 2. Effect of temperature regimes on the germination of beach spinifex grass (Harty and McDonald, 1972).

| Temperature, °C | Percentage germination, % |
|---|---|
| 25 | 37.2 |
| 30 | 28.0 |
| 15-35 alternating | 57.0 |
| 20-35 alternating | 57.3 |

Pot trials indicated that 56 kg of nitrogen/ha and 120 kg of phosphorus/ha increased yields of dry matter of beach spinifex grass by approximately ten times over a four month period. In the field stolon elongations of 50 cm/week were obtained by using 450 kg/ha of a mixed fertilizer, at 3-4 monthly intervals.

A STUDY OF THE COASTAL CLIMATE OF QUEENSLAND. The climate of coastal Queensland changes markedly from the south to the north, a distance of 2,300 km, and these changes are reflected in a change in the pattern of vegetation on dunal areas. Information is being collected on various climatic aspects, such as rainfall, temperatures, evaporation, wind, and the occurrence of tropical cyclones.

On proceeding north the degree of winter drought increases markedly, with only 5% of the total rain (1,661 mm) falling from May to October at Thursday Island (Lat. 10°S) as compared with 35% of a total of 1,344 mm falling in the same period at Southport (Lat. 28°S). Average maximum temperatures at Thursday Island are 6°C higher than at Southport, and average minimum temperatures about 10°C higher.

The effect of cyclones is greater in northern parts of the state, with accompanying effects on rainfall, wind, and wave erosion of coastal dune areas.

EVALUATION OF PLANT SPECIES FOR THE STABILIZATION OF COASTAL SAND DUNES. As coastal sand dune stabilization and preservation is based on the use of vegetation, it is necessary to make the best use of available species if dune stabilization is to be most effective. A collection is being made of seed or vegetative material of plant species of possible use for sand dune reclamation projects. These species will be established in the field under varying degrees of exposure. Regular observations and measurements will enable conclusions to be reached about the use of various species.

The initial trials will include SPINIFEX HIRSUTUS, AMMOPHILA ARENARIA, CHLORIS GAYANA, VITEX TRIFOLIA, VITEX OVATA, CASUARINA EQUISETIFOLIA, CANAVALIA MARITIMA, and CANTHIUM COPROSMOIDES. This project will continue initially over a period of three years.

TRIALS OF DUNE FORMING (SAND DRIFT) FENCES. Semi-permeable fences are commonly used to trap sand blowing off beaches and to initiate re-building of eroded frontal dune systems. A trial was designed and installed incorporating three different types of drift fence - spaced slats, moulded polyethylene material, and woven polyethylene fabric.

Costs of the fences including material and erection costs were 1.21 $A/m for spaced slats, 1.67 $A/m for moulded polyethylene, and 1.28 $A/m for woven polyethylene. Considerable variations in unit costs occur depending on costs of materials, methods of attachment of the material to the fence, and the type of fence to which the material is attached.

The results of surveys indicated that there was no difference between the rate of sand accumulation against the different types of fence, except that the higher

fences eventually accumulated more sand than the lower fences. Approximately 9,000 $m^3$ of sand accumulation per km length of fence occurred over a period of twelve months.

A decision on the type of drift fence to use in any one area is likely to be made on cost considerations and resistance to vandalism, which was not tested in this trial.

EVALUATION OF SURFACE MULCHING TREATMENTS. Organic mulches such as brush, hay, and straw are commonly used to prevent wind erosion on bare sandy surfaces. On the east coast of Australia a technique called 'brush matting' is widely used in conjunction with vegetation, for stabilizing the most exposed areas. In this method a single complete layer of young trees or branches of trees is laid over the bare sand in which grass seeds have been planted and fertilizer applied. The method is exceptionally effective but is costly and limited to areas where brush is readily available. Other mulching and spraying methods appear to offer alternatives to brush matting, dependent on their effectiveness in stabilizing sand under very exposed conditions, their ability to allow vegetation to establish, and their cost.

A trial was installed to investigate the relative effectiveness of six mulching treatments, viz. brush mat, straw mulch, bitumen emulsion, PVA, straw mulch and bitumen emulsion, and straw mulch and PVA. These treatments were applied to small plots which had previously been sown with seed of marram grass, beach spinifex grass, sorghum, Rhodes grass, sand plain lupin, and cereal rye, and fertilized. The plots were laid out in a complete randomised block design with four replications. Seedlings were counted when they germinated, and ground cover was measured at intervals. Summaries of these results are shown in Tables 3 and 4.

TABLE 3. Number of seedlings per $m^2$ under the various treatments one month after sowing. Note complete failure of beach spinifex due to cold conditions

| Treatment Species | 1 Brush Mat | 2 Straw Mulch | 3 Bitumen Emulsion | 4 PVA | 5 Straw + Bitumen | 6 Straw+ PVA |
|---|---|---|---|---|---|---|
| Marram grass | - | 0.7 | 1.0 | 2.7 | - | - |
| Beach spinifex | - | - | - | - | - | - |
| Sorghum | 13 | 10 | 12 | 17 | 9 | 6 |
| Rhodes grass | 3.2 | 0.1 | 0.3 | - | - | - |
| Lupin | 1.8 | 1.7 | 1.3 | 1.6 | 2.3 | 2.1 |
| Cereal rye | 64 | 105 | 56 | 75 | 118 | 132 |
| Totals | 82 | 117.5 | 70.6 | 96.3 | 129.3 | 140.1 |

Although initial germination of annual species was excellent on treatments 6, 5, and 2 (Table 3), ground cover after 10 months on the bursh matted plots was two and a half times that under the next best treatment (Table 4). This is apparently due to the extra protection provided for young establishing perennial species under brush mat. Strong winds associated with recurring cyclones occurred about seven months after the trial was laid out, and these severely affected the vegetation on all plots except the brush matted plots.



TABLE 4. Percentage ground cover of plants at intervals after application of different mulching or spraying treatments

| Treatments | Months after treatment application | | | |
|---|---|---|---|---|
| | 1 | 2 | 5 | 10 |
| Brush mat | 1.6 | 7.2 | 7.9 | 58.7 |
| Bitumen | 2.1 | 6.2 | 6.7 | 22.4 |
| Straw mulch | 2.6 | 7.3 | 4.9 | 18.8 |
| Straw mulch + Bitumen | 1.8 | 10.3 | 7.3 | 12.6 |
| Straw mulch + PVA | 2.2 | 9.2 | 10.9 | 6.5 |
| PVA | 1.3 | 5.8 | 7.5 | 4.7 |

## CONCLUSIONS

Advances have been made in the methods of rapid establishment and growth of the major primary colonising species SPINIFEX HIRSUTUS (Beach spinifex grass).

Comparisons have been made between three different types of sand drift or dune forming fences all of which effectively built-up sand dunes.

Trials have indicated the superiority of the brush matting technique over other types of surface mulching methods to produce stability under very exposed conditions.

Work has been commenced on the plant ecology of undisturbed dunal areas and climatological studies are also under way. Species evaluation trials will commence at the end of 1972.

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