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PROPAGATION AND ESTABLISHMENT OF SPINIFEX (*SPINIFEX SERICEUS*) - A VISIT TO NURSERIES AND SAND DUNE REVEGETATION SITES, AUSTRALIA, JUNE 1993

AUTHOR(S):

D. O. BERGIN

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ABSTRACT*

An NZ FRI scientist visited research stations, nurseries and revegetation projects in New South Wales and Queensland in June 1993 to learn latest propagation and establishment techniques for spinifex (*Spinifex sericeus*), which is native to both New Zealand and Australia. Spinifex is widely used in Australia for rehabilitation of dunelands that have been modified and subject to erosion due to a number of causes, usually uncontrolled recreational use, sand mining and other commercial coastal development. Methods for establishing spinifex on dunelands include direct sowing of seed and transplanting of cuttings taken from existing plants nearby. Fast release high nitrogen fertilisers top-dressed over existing spinifex colonies is a highly successful technique for increasing plant vigour and cover. Successful techniques developed in Australia for revegetating sand dunes with spinifex need to be evaluated for their effectiveness in New Zealand conditions. A summary of these methods is listed and should be considered in any future spinifex research programmes.

* Note: This material is unpublished and must not be cited as a literature reference.

PROPAGATION AND ESTABLISHMENT OF SPINIFEX (*SPINIFEX SERICEUS*)
- A VISIT TO NURSERIES AND SAND DUNE REVEGETATION SITES,
AUSTRALIA, JUNE 1993

D. O. Bergin
New Zealand Forest Research Institute
Rotorua

1993

1. INTRODUCTION

I visited Australia for 12 days during late May 1993 to inspect nurseries and sand dune revegetation sites along the coast of New South Wales and part of Queensland for the purpose of learning latest propagation and establishment techniques for spinifex (*Spinifex sericeus*).

This report documents techniques used to revegetate sand dunes with spinifex at each of the main sites visited in Australia. Other notes of interest on management of beaches and the use of other species are also included.

2. USE OF SPINIFEX IN NZ AND AUSTRALIA

Spinifex is native to both Australia and New Zealand and is the dominant sand binding species on nearly all sandy beaches throughout New Zealand. It has been widely used by coastal agencies in several Australian states for major rehabilitation programmes to revegetate large areas of coastal dunes that have been mined for minerals. It has also been used for stabilising dunes that are highly modified by recreational use and where inward movement of sand is threatening coastal resorts and settlements. Similar problems on a smaller scale, including local erosion of fore dunes, occurs in New Zealand. However, spinifex has never been used on a management scale in New Zealand despite its potential. A review of the use of spinifex in both countries (Bergin & Shaw 1991) concluded that for New Zealand, revegetation of dunelands using spinifex is a feasible option for many disturbed sites but comprehensive planting and fertiliser trials were required to determine appropriate techniques and treatments.

The Indigenous Forest Management group have been working with indigenous sand binding species in several North Island localities for the past 5 years. This work is well supported by the Foundation for Research, Science and Technology, and the Department of Conservation. Support from Regional Councils is also highly likely in future with the development of the Dune Care movement.

Seed and cuttings of spinifex have been collected over the last two years and seedlings are being raised at the NZ FRI Nursery. Pilot planting trials were established on Bay of Plenty and Coromandel beaches in the last 2 years. Results are generally encouraging. However, there are continuing problems with raising large numbers of healthy stock and maintaining vigour of seedlings for planting. Major planting, direct seeding and fertiliser trials using spinifex are planned for the next 2-3 years by NZ FRI. It was therefore, timely to visit Australia to gain first hand knowledge of both nursery and field planting trials and to evaluate the role that fertilisers can have with revegetation of dunes so that an appropriate research programme can be developed for New Zealand dunelands.

3. ITINERARY AND CONTACTS

Appropriate contacts and sites to visit in Australia were determined from published literature and from earlier visits made by coastal managers in the Department of

Conservation and the Waikato Regional Council. Travel within Australia was by rental car. The itinerary was as follows:

24 May

- Travel Auckland to Sydney

25 May

- Travel from Sydney south to Nowra
- Meet staff at Conservation and Land Management Department (CALM) office at Nowra (Contacts - Gary Druett, Noel Kesby)
- Inspect CALM Nursery south of Nowra (Contact - Nursery Manager, Dirk deJonge)
- Visit local sand dune problem sites and revegetation projects including Shoalhaven Heads, Seven Mile Beach, Kiama Downs and Jones Beach

26 May

- Travel from Nowra north to The Entrance (central coast NSW)

27 May

- Inspect beach erosion and revegetation along coast north of The Entrance
- Meet Roger Stanley from the CALM office, Kempsey, at Harrington
- Visit dune repair work at Harrington

28 May

- Inspect several recent and older revegetation sites north of Harrington including Crowdy Head, North Haven, Lighthouse Beach, Hat Head National Park, Smoky Beach.
- Travel north through Kempsey to Grafton
- Contact Bronwyn Scott, Dune Care Co-ordinator, Banagar, northern NSW

29 May

- Travel northwards through Gold Coast to Brisbane
- Inspect beach revegetation and management schemes in northern NSW including Lighthouse Beach at Ballina, Lennox Head, Suffock Park, Kingscliff

30 May

- Visit high recreation-use beaches and revegetation programmes along Queensland coast south of Brisbane including Kirra Beach, Gold Coast

31 May

- Travel to South Stradbroke Island with Beach Protection Authority Queensland staff, Department of Environment and Heritage (Contacts - Sel Sultmann, Jim MacKenzie)
- Inspect South Stradbroke Island Nursery (Contact - Nursery Manager, Bob Hurley)
- Visit numerous planting, seeding and fertiliser trials of duneland species on South Stradbroke Island beaches including the Nerang River Entrance Stabilisation Project
- Inspect recent sand nourishment and revegetation projects at Surfers Paradise and North Kirra Beaches along the Gold Coast

1 June

- Visit Beach Protection Authority Queensland Head Office, Brisbane, for further discussions, collection of reports, papers, etc.

2 June

- Travel Brisbane to Auckland

4. RESEARCH AND MANAGEMENT OF SAND DUNE VEGETATION IN NSW

4.1 CALM Nursery, Nowra

- Large quantities of spinifex seed are collected and stored in hessian bags for up to several months before sowing. Seed is used for direct seeding of dunes. Stored seed attracts rodents so control is essential, usually rat poison. Each bag is approximately 900 mm x 600 mm and holds 2 kg of loosely packed spikes (Plate 1).
- Spinifex seed can be stored for up to 2 years but there is some loss of viability.
- Nursery raises a range of secondary and tertiary coastal plants including coastal tea tree (*Leptospermum laevigatum*), horsetail she-oak (*Casuarina equisetifolia* var. *incana*) and coastal banksia or coastal honeysuckle (*Banksia integrifolia*). Spinifex seedlings are not propagated.
- Secondary and tertiary species raised from seed in 150 mm deep, narrow diameter plastic disposable tubes in a 3:1 river sand:peat moss mix. Seed sown directly or small plants transplanted into tubes. Tubes kept in polystyrene holders on benches under 30-50% shade cloth.

4.2 Sand dune revegetation and management, Nowra

- On exposed sites, spinifex seed is often sown amongst marram grass (*Ammophila arenaria*) culms which provide some immediate sand surface protection. Marram grass is used as temporary cover while spinifex seed germinates and plants establish. In mid to upper parts of NSW, marram eventually dies out (at lower latitudes with longer day length and cooler temperatures, marram usually persists).
- Spinifex is established on dunes by hand sowing of whole spikes. 2-4 seedheads are placed into 150 mm deep holes dug by spade at a 600 mm x 600 mm grid without marram or interplanted with marram at 1200 mm x 1200 mm grid. 7 bags of seed heads are required per ha with marram or 26 bags per ha where only spinifex is sown.
- Planting and sowing generally done in late autumn and early spring. N fertiliser (eg, "Starter 18") is applied about 2 weeks after sowing of spinifex with further applications twice annually for the duration of the revegetation project.
- At Jones Beach, Kiama Downs, marram culms planted 8 months previously (October) were now 250 mm high, appeared vigorous. 20 or more spinifex seedlings had germinated in many clumps from sown seedheads with seedlings 150 mm high and occasional edge seedlings up to 250 mm high (Plate 2). Revegetated areas fenced off with minimum of 3 wire post fence, with rail fences and board and chain accessways near high use areas.

4.3 Sand dune revegetation and management, northern NSW

- Good examples of the effects of restricted and unrestricted recreational use on dunes observed at The Entrance. Fenced accessways with board and chain clearly preferable to fenced accessways without board and chain (Plates 3 & 4).
- A reconstructed dune at Harrington was revegetated with some marram planting but mainly sowing of spinifex seed. Seed processed by a Hannaford Resilient Tapered Thresher Model L. T. Mk II. 11% of seed damaged. Contact for seed cleaning: Doug Waterhouse, CALM, Plant Materials Centre, P. O. Box 445, Cowra, NSW 2794.
- Revegetation projects for extensive exposed sites need to be initiated on the windward side to reduce burial of planted and sown material by sand.

- Brush matting, broad leaved paper bark (*Melaleuca quinquenervia*), provided protection for areas sown with spinifex by trapping sand and reducing winds. Brush matting preferred to latex applications which do not reduce wind whipping sand across surface.
- Fertiliser improves growth of spinifex and hence sand stability. Fertiliser used at Harrington was "Starter 18" (N:P:K 18:18:0) twice per year for the first two years or until sufficient cover attained. Fertiliser broadcast by hand or spinners used. Then secondary tree and shrub species established including coastal wattle, coastal tea tree and coastal banksia with natural regeneration on dunes (e.g., angular pigface (*Carpobrotus glaucescens*) in foredunes) now taking place 10 years later.
- The native *Festuca littoralis* has been planted on experimental basis. Has been used with spinifex in areas of high conservation value and responds to fertiliser (could have similarities to *Austrofestuca littoralis*, an uncommon NZ indigenous sand binder).
- Dense stands of the large sprawling shrub bitou bush (*Chrysanthemoides monilifera* ssp. *rotundata*), have invaded many coastal areas of NSW and has become a major weed problem. Birds distribute seed and new colonies establish around bird perches such as fence posts along dunes. Biological control is being considered. Boneseed (*Chrysanthemoides monilifera* ssp. *moniliferum*), is less common occurring on coastal and inland sites.
- At Crowdy Head sand was dumped from dredging of the Crowdy Bay Harbour 12 months previously and the new dune revegetated with spinifex and coastal wattle (*Acacia sophorae*). Spinifex heads were sown at 600 mm centres with coastal wattle broadcast sown. Brush layed down with heavier stem ends facing into prevailing wind and stem dug into sand. Fertiliser broadcast over site at planting (Plate 5).
- 12 months after sowing clumps of spinifex throughout new dune at Crowdy Head with several plants per clump, usually one becoming dominant. 6 m long runners on largest spinifex 12 months after sowing (Plate 5).
- At North Haven marram grass was planted and spinifex seed sown (using a hand sowing machine) 5 years previously on dumped dredge material. A good example of marram being used as a temporary nurse for spinifex. Marram gave good cover for 1-2 years while spinifex establishing. 5 years later all marram had died and area now covered in spinifex and rear dune in coastal wattle from broadcast sown seed (Plate 6).
- A reformed dune at Lighthouse Beach currently being planted in secondary species 4 years after its formation was initially planted with marram and sown with spinifex. This was typical of many blow outs along the NSW coast caused by large scale sand mining or high recreational use. N fertiliser applied each year has resulted in dense healthy stands of spinifex on foredune. Pogo stick used to allow planting of secondary species (eg, coastal banksia) with brush matting to provide surface protection (Plates 7 & 8). Large truckloads of brush collected locally from coastal tea tree stands by cutting branches of shrubby vegetation. Cut vegetation recovers quickly.
- A precision garden seeder was used to sow cleaned spinifex seed at Smokey Beach. Seeds sown 50 mm apart. 6 months after sowing seedlings up to 100 mm high.
- Numerous examples of fenced off dunes in high use areas from Ballina to the NSW northern border. Included fenced and boarded accessways and signs indicating local Dune Care Group involvement in managing use of dunes and revegetation projects (Plates 9).
- Revegetation is more effective in building a gradual dune than the more expensive sand trapping fences (Plate 10). Build up of sand along shade cloth fences necessitates periodic lifting so they remain effective sand traps and to prevent a beach hazard.

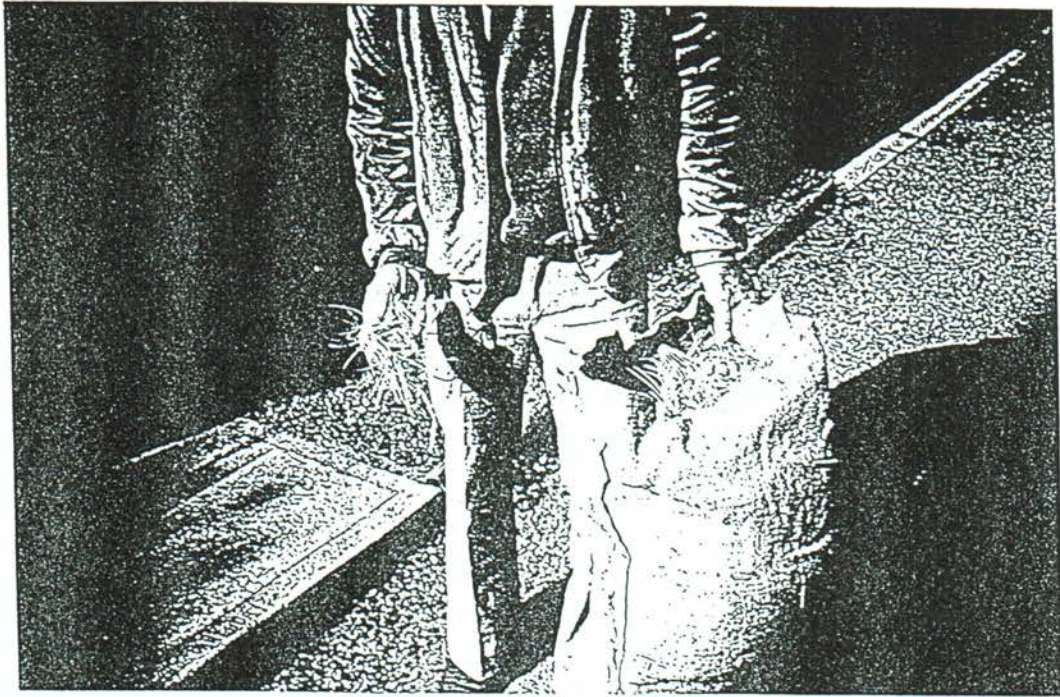


Plate 1: Spinifex seed is stored in hessian bags and kept in cool, dark conditions for several months. Control of rodents is essential. Although seed can be stored for up to 2 years, viability decreases significantly.

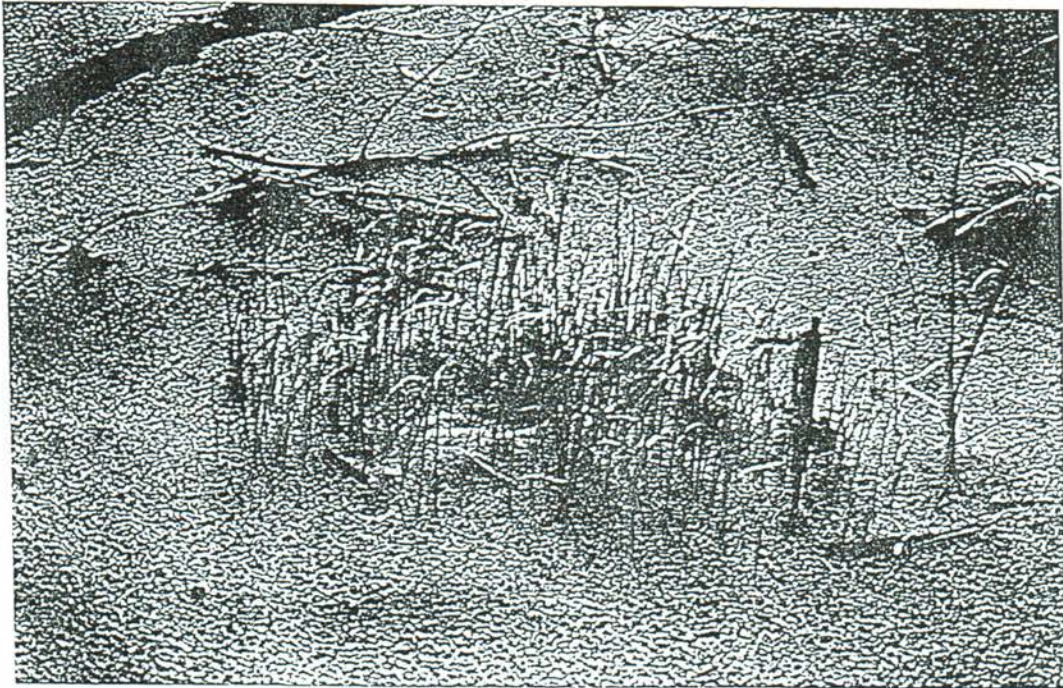


Plate 2: In NSW, the preferred technique for revegetating sand dunes with spinifex is to sow seedheads into holes dug by spade. A handful of seedheads (approximately 2-4 seedheads) is placed in each 150 mm deep hole. Fertiliser is applied 2 weeks after sowing. On this site at Jones Beach, Kiama Downs, seedlings have germinated in dense clusters and are 150 mm high, with occasional seedlings on the edge of groups up to 250 mm high, 8 months after sowing in spring.

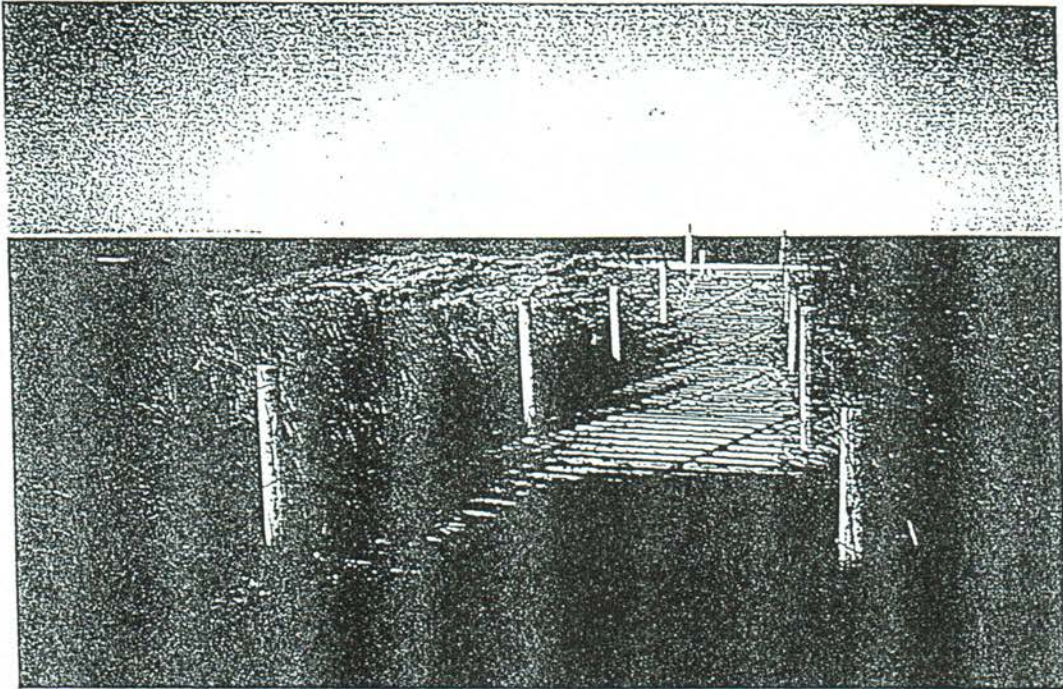


Plate 3: Revegetation projects in areas of high recreational use are fenced off with accessways constructed to encourage beach users to keep off vegetation. Pedestrian and vehicular accessways usually consist of boards attached to galvanised chain, which not only provide a solid base for access, but can be lifted periodically as sand level increases.

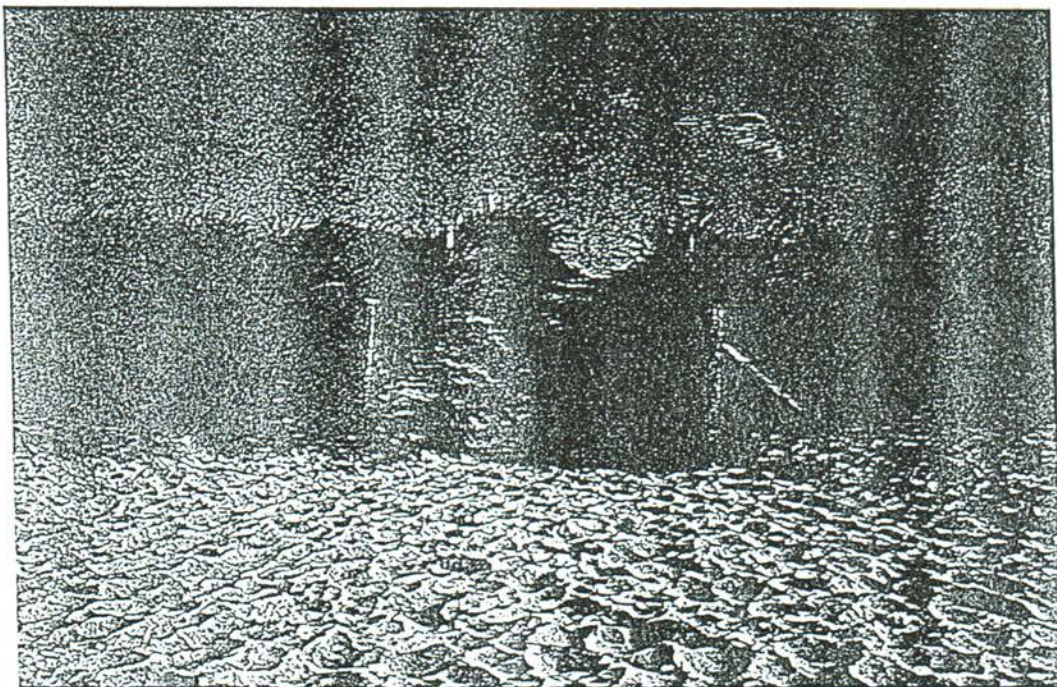


Plate 4: Revegetated dunelands require continual monitoring and maintenance particularly where there is high recreational use. Along part of the beach north of The Entrance, NSW, although revegetation has been generally successful, fencing and accessways have not been maintained. A build up of sand on either side of this accessway and heavy traffic use has increased the risk of sand erosion at this point. A board and chain base as well as curved accessways reduces wind tunnelling and sand erosion at such sites.



Plate 5: Bare sand dredged from nearby Crowdy Bay Harbour, near Kempsey, NSW, was sown with spinifex seedheads at 600 mm centres along with coastal wattle seed broadcast over the site. Brush matting was laid over the site after sowing. About 12 months after sowing, and with the addition of N fertiliser at planting, spinifex seedlings have runners up to 6 m long. Other vegetation is coastal wattle and goats foot convolvulus. Roger Stanley (CALM, Kempsey), holding the extended runner, has been involved with dune revegetation projects for many years along the northern NSW coast.



Plate 6: Along the central and northern NSW coast, marram grass culms (trucked in from Victoria) are often interplanted as a temporary cover crop to provide shelter amongst sown spinifex seedheads while spinifex seedlings become established. Although marram grows initially, it is unsuited to the shorter day lengths at these latitudes and as seen at North Haven Beach 5 years after planting, has died out. This allows spinifex and goats foot convolvulus to take over on once bare foredunes.



Plate 7: Brush matting is the preferred technique in NSW for providing recently sown and/or planted dunes protection from wind and accelerated sand erosion or deposition. Cut ends are placed facing into the prevailing wind. There are often stands of low height coastal tea tree close to revegetation projects where branches are cut from shrubs to provide adequate volumes of matting.



Plate 8: Secondary species such as coastal wattle grown in long thin containers are planted in deep holes made with a "pogo stick" (on right). Deep planting ensures root systems are within the moist sand zone and this improves survival and growth.

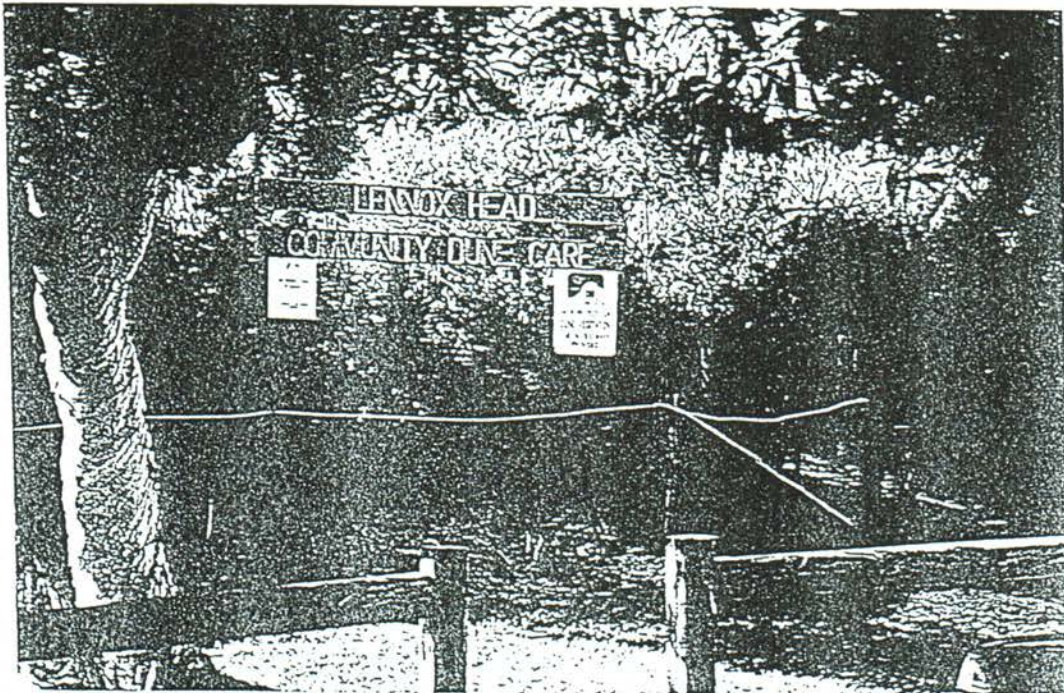


Plate 9: The Community Dune Care concept which involves active participation of local communities with support from State and Local Government agencies has been highly effective at increasing public awareness of the need for sustainable management of sand dunes to enhance their value as a coastal buffer, yet allow continued access for beach users. Local community projects are well signposted, as seen at Lennox Head, northern NSW, informing users of the need for well managed dunes and to encourage use of accessways.

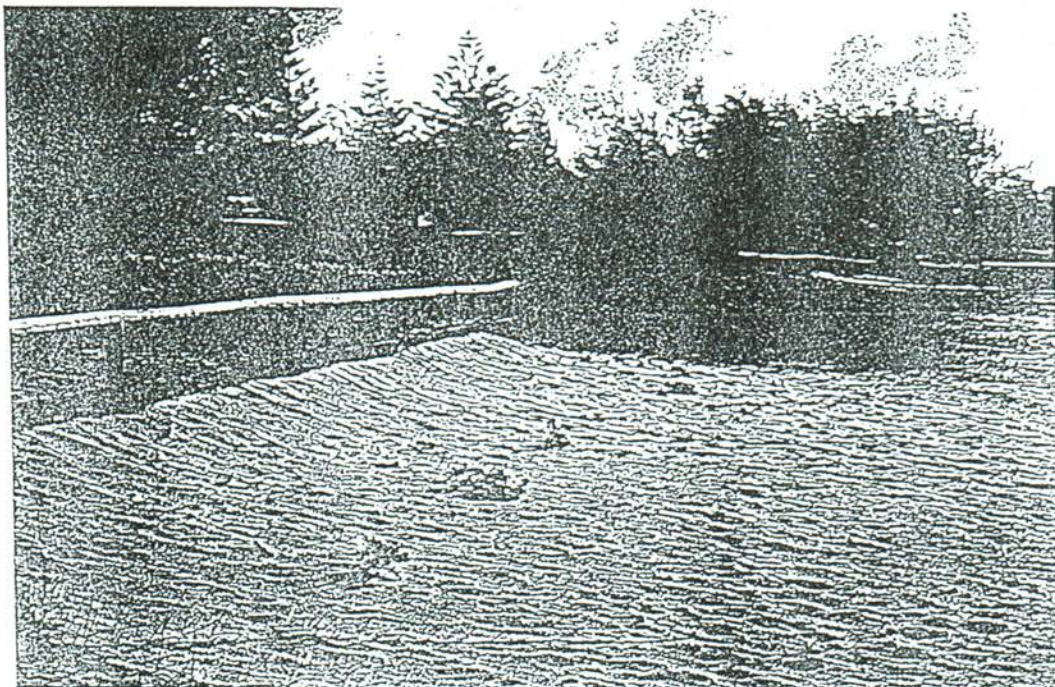


Plate 10: Both spinifex and sand trapping fences are used at Kingscliff beach, northern NSW to trap sand. However, spinifex has created an even cover of dense vegetation whereas the shade cloth fence has created a mound of sand on the seaward side with no vegetation cover. This mound is still subject to movement by wind and the fence will need continual maintenance including lifting as the mound of sand increases in height to remain effective in trapping sand. Clearly, the establishment and maintenance of a dense spinifex sward is the more aesthetically pleasing and the least expensive option.

5. RESEARCH AND MANAGEMENT OF SAND DUNE VEGETATION IN QUEENSLAND

5.1 Beach Protection Authority Queensland Nursery, South Stradbroke Island

- The Beach Protection Authority Queensland maintain a nursery, field station and numerous dune trials on South Stradbroke Island south of Brisbane (Plate 11). The function of the nursery is to provide trees for a State funded free tree programme, carry out research on dune revegetation, and to provide seedlings for setting up demonstration areas for local councils where dune revegetation is required.
- They use tall containers (eg, surplus plastic cotton spools), for raising seedlings of a range of species for dune planting (Plate 12). Tall containers enable deep planting within the moist sand zone. Root-trainers not favoured as dead seedlings result in wasted space and vigorous roots between plugs make separation difficult. Potting mix is 50% sand, 25% peat moss, 12.5% vermiculite, 12.5% perlite with a slow release fertiliser (eg, Osmocote). Species raised include coastal banksia, coastal tea-tree, horsetail she-oak. Horsetail she-oaks are not given N to encourage nodule formulation on roots. Coastal banksia forms dense, fine root system near soil surface very efficient at sieving nutrients.
- Spinifex sometimes raised from tip cuttings off runners in tall paper pots (approx. 200 mm x 50 mm) in 3:1 sand:peat for establishing in very exposed areas where seeding, cover crops or sprig transplants will fail. Aim is to keep stock hardy for planting onto dunes. On difficult sites spinifex plants from seeding can take 6 months or longer but the advantage of cuttings set in the nursery is that seedlings are established in 3-4 months. Nursery raised spinifex seedlings are however, expensive compared to direct seeding and transplanting of cuttings.

5.2 Sand dune research, South Stradbroke Island

- Spinifex best established directly on dunes by direct sowing of seed or transplanting cuttings. A modified mechanical vegetable seed sower/planter attached to tractor is used to sow separated seed and plant tip cuttings directly onto dunes.
- Spinifex seed threshed using peg tooth drum machine, resulting in a small degree of damaged seed. Threshed seed contains a large quantity of seedhead debris (Plate 13). Seeding in May usually with cover crop, eg, cereal rye (*Secale cereale*) at 4:1 cover crop:spinifex. Spinifex sowing can be left for 6-12 months after cover crop sown when it is certain the cover crop has succeeded. Cover crop sown in rows 30 cm apart using a standard disc sower with spinifex sown using modified vegetable sower (Plate 14).
- Two methods of selecting cuttings:
 - 1) Runner cuttings - 600 mm tip or stolon cuttings with at least 3 nodes (any roots will die off) taken from nearby established colonies are placed in 200 mm deep trenches with 75 mm of tip exposed (Plate 15). Expect 50% survival in direct transplanting with best results in cool damp weather.
 - 2) Sprigs - a single division, taken from mature clumps on back dunes (Plate 16). Sprigs are characterised by 3-5 growing points (nodes) at close spacing along the stem from which new roots can develop. Sprigs are planted into deep holes dug in sand. May preferred month as weather showery. Survival usually about 50% depending on weather.
- On established spinifex colonies, trials indicate N fertilisers applied at high rates (200-400 kg N/ha/annum) boost growth significantly. Ideally require a small amount of rainfall after/during fertiliser application. 2-4 split applications over the year

spread risk of no rain or too much rain after application. Split applications are not necessarily equal quantities of fertiliser.

- "Nitram" (Ammonium nitrate - 34% N - quick release) is the most widely used fertiliser for broadcasting over spinifex stands on dunes. Results from beach fertiliser trials indicate NPK fertilisers may increase weed species. N lost from sand quickly but P can be tied up for some years. pH in shelly beach is often high (8-8.5) so need to be careful with some fertilisers. Therefore important to check substrate type and pH of sand before applying fertiliser. Urea not favoured as organic matter is too low in sand dunes for it to be effective.
- Typical fertiliser trial design of natural spinifex stands has 5 x10 m plots with 2 m wide buffers. % ground cover assessed using a 1m x 1m point sampling frame using 40 points per plot. Green leaf and dead leaf material are recorded separately.
- Complete NPK fertiliser ("Cropking") significantly boosts growth of secondary species. Fertiliser applied to surface surrounding each tree in band 30 cm diameter. Fertilisers currently trialed include granulated and tablet forms.

5.3 Sand dune revegetation and management, Gold Coast

- Fertilising of naturally occurring plants and colonies the most successful method of extending vegetation on dunes. On foredune spinifex and goats foot convolvulus (*Ipomoea pes-caprae*) respond quickly to fertiliser. Small spinifex colonies and the leading 1 m wide edge of larger colonies are fertilised at least twice annually for 2-3 years to encourage rapid expansion and eventually joining up of colonies (Plates 17 & 18).
- North Kirra Beach is the site of the biggest sand nourishment project in the southern hemisphere with 3.5 million cubic meters of sand dredged from off-shore and placed on beach (Plate 19). The Beach Protection Authority are in the midst of a 2 year programme to revegetate bare sand. The installation of training walls at the mouth of the Tweed River across the border in NSW has temporarily interrupted the northward drift of sand to North Kirra resulting in the depletion of sand from this area. Consideration is now given to maintaining the longshore drift in more recent coastal works; eg, sand pumping stations, such as the one recently installed at South Stradbroke Island where the Nerang River has been diverted through an artificial channel, ensures the northward longshore drift of sand continues up the Queensland coast.
- Techniques developed for maintaining spinifex on dunes are used along the very high use areas of the Gold Coast including application of fertilisers and controlling access to vegetated areas (Plate 20). Development of high rise buildings and roads along beach fronts have left virtually no effective dune to act as a buffer during major storms.



Plate 11: A major Sand Dune Research Station of the Beach Protection Authority Queensland (Department of Environment and Heritage) is situated on South Stradbroke Island just off the coast between Brisbane and Surfers Paradise. The station comprises a research nursery and a field base from which numerous dune revegetation trials located on the island are monitored. From left to right: Jim MacKenzie, Senior Dune Conservationist; Sel Sultmann, Dune Conservationist; Bob Hurley, Research Station Manager.



Plate 12: As in NSW, deep containers are preferred for raising spinifex and secondary species for planting on dunes. Spinifex is raised in the nursery in small numbers for difficult sites usually from tip cuttings off runners in a 3:1 sand:peat mix. The containers are used plastic cotton reels which are held in polystyrene boxes. Pictured are horsetail she-oaks, one of the major indigenous tree species raised for planting on sand dunes.

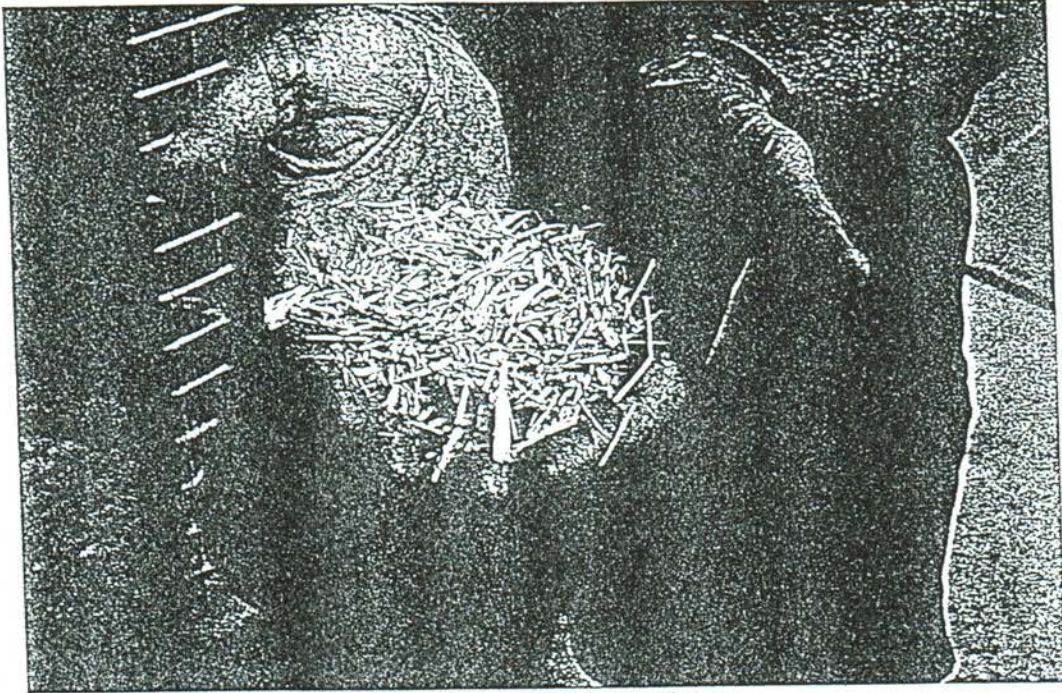


Plate 13: In Queensland, spinnifex seedheads are usually threshed in a peg tooth drum thresher for direct sowing by tractor drawn sowing machines directly onto dunes. Threshed seed, which contains a large proportion of seedhead debris, is stored in large drums or sacks with rodent control.



Plate 14: Direct seeding spinnifex is the most common method of propagating spinnifex on fresh dune surfaces in Queensland. On this stable trial site on South Stradbroke Island, spinnifex seed was sown by machine 7 years ago with a cover crop of rye. Fertiliser was applied at planting. The persistent single plants of spinnifex is a result of relatively little sand movement and no post-sowing fertiliser applications. An application of fertiliser would considerably boost vigour and ground cover.



Plate 15: An effective method of vegetative propagation of *spinifex* is transplanting of runners directly onto bare dune surfaces. As indicated by Sel Sultmann, runners need to be 600 mm long and placed into 200 mm deep trenches with 75 mm of tip left above ground. About 50% survival can be expected using runners.

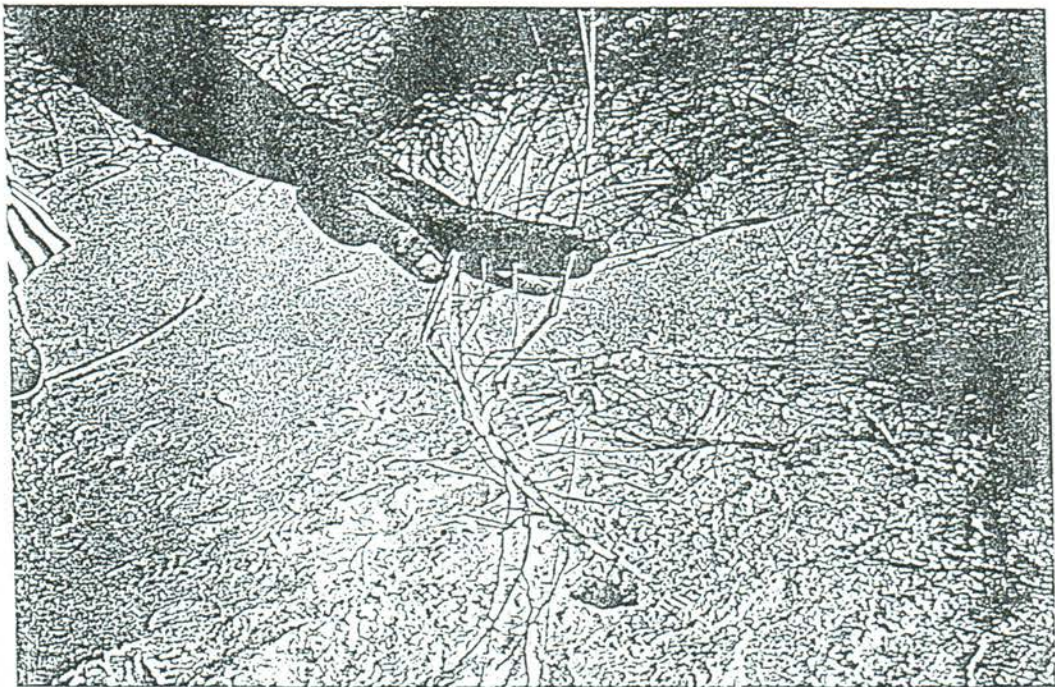


Plate 16: An alternative vegetative method is transplanting of sprigs taken from established plants on back dunes. Sprigs are characterised by 3-5 growing points or nodes at close spacing from which new roots will grow. Sprigs are transplanted directly onto dunes in deep planting holes. As with runner cuttings, sprigs are best transplanted in autumn.

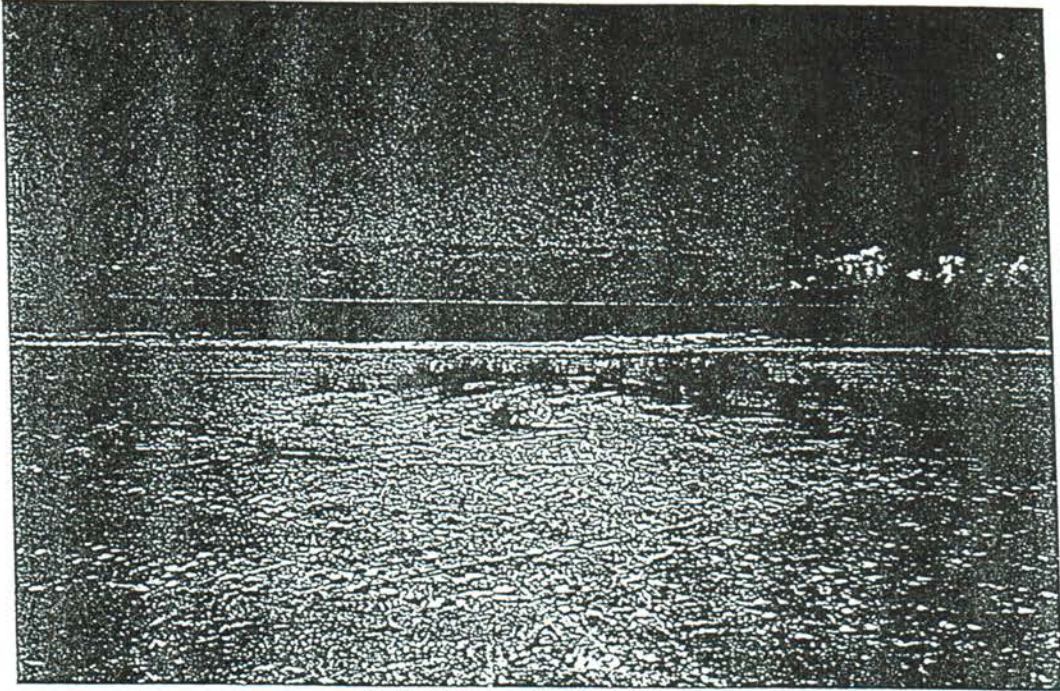


Plate 17: The Beach Protection Authority of Queensland encourages the enhancement of any existing spinifex on sites requiring revegetation rather than the more expensive options of seeding and transplanting. The most effective tool to extend existing spinifex and increase vigour is to broadcast high rates of N fertiliser (usually "Nitram" - ammonium nitrate, 34% N) over isolated spinifex plants. This small colony of spinifex on an incipient dune near Surfers Paradise was fertilised with a total of 400 kg N/ha over the past year in several split applications resulting in a dramatic increase in size of the colony.

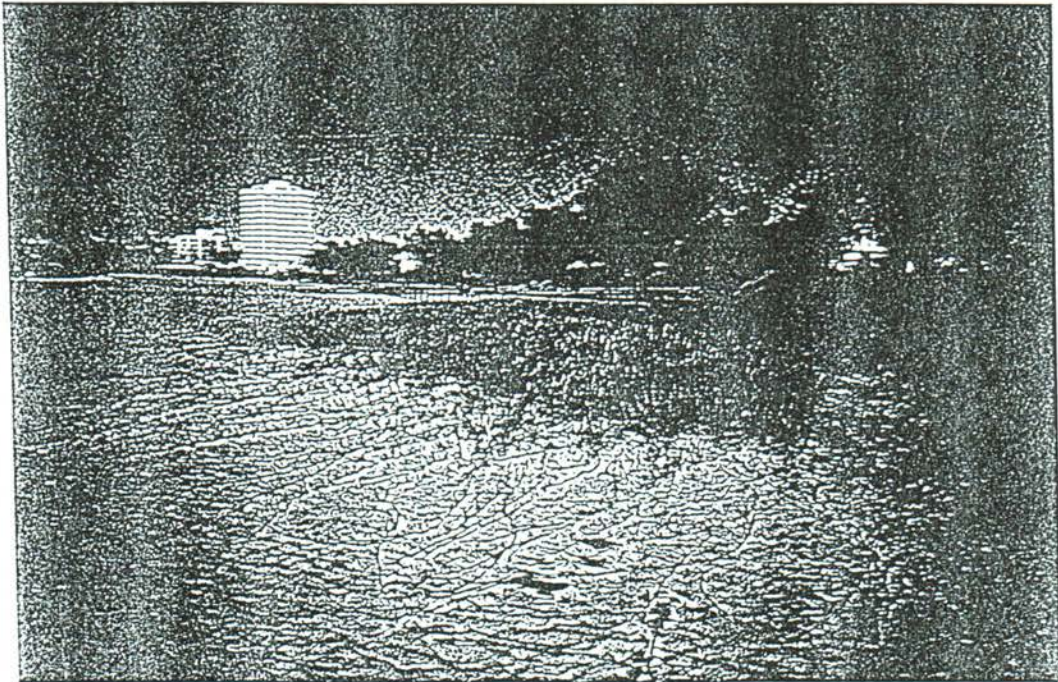


Plate 18: Similarly, large colonies of spinifex can be extended to new sites by broadcasting N fertiliser only along the leading margins of the colony. Growth of runners have been recorded as high as 15 m in Queensland within a year where there are long growing seasons at these latitudes. The best response occurs when fertiliser is applied during or just before a shower of rain. Split applications increases the chance of at least some of the fertilising occurring during showery weather.

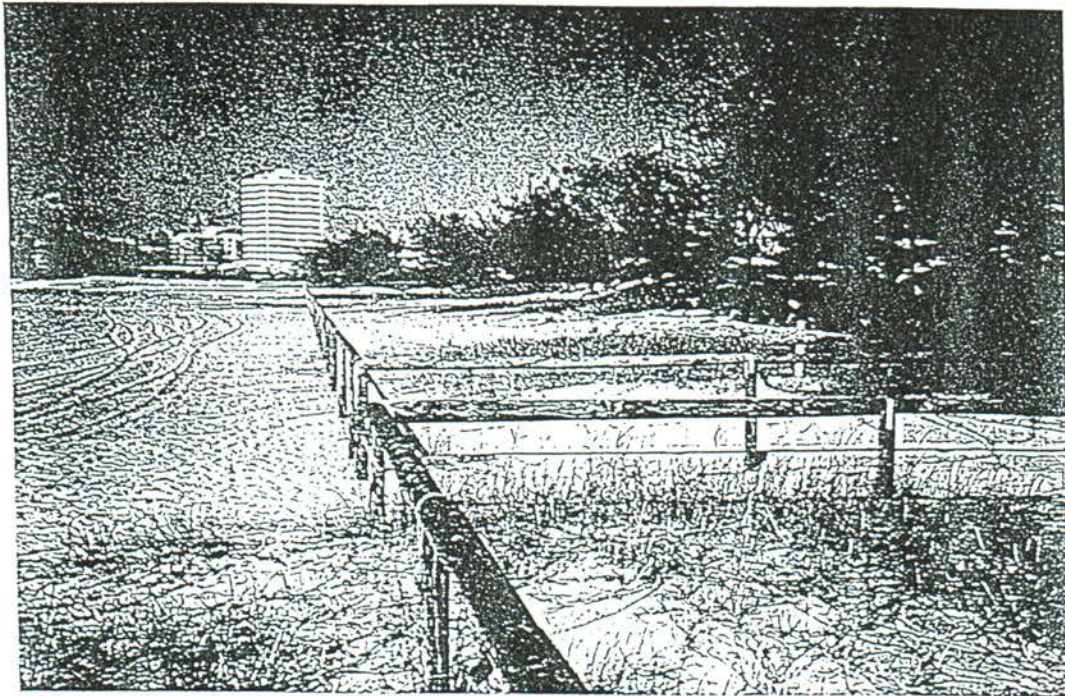


Plate 19: At North Kirra Beach, south of Surfers Paradise, the largest sand nourishment project in the southern hemisphere is in progress. The SA16 million project involved dredging of 3.5 million cubic meters of sand from 1 km off-shore to create a new beach along the coastline which was previously protected by a rock wall. The uppermost portion of this wall is still visible in parts (on right under trees). The Beach Protection Authority is in the midst of a 2 year revegetation programme to prevent removal of sand using spinifex seeding and vegetative propagation methods to stabilise the foredune.

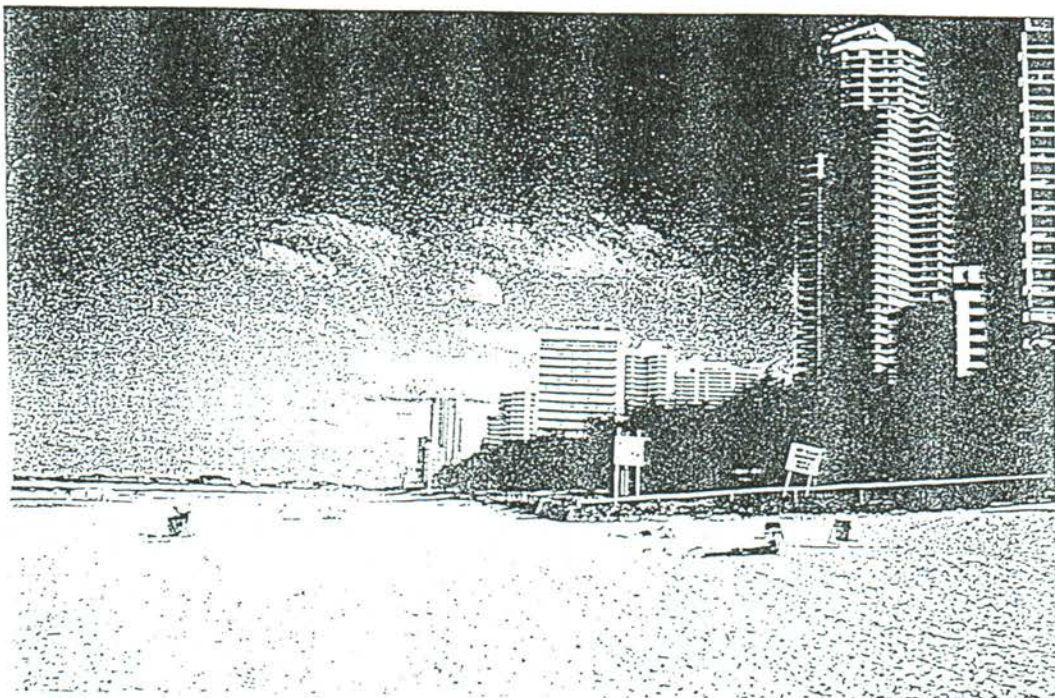


Plate 20: In the heart of the Gold Coast at Surfers Paradise, dense spinifex colonies are maintained by fertilising and by the strict control of beach users by fencing, signposting and board and chain walkways. Horsetail she-oaks are planted along the backdunes. In such heavily used areas, sand that is not fenced off does not support any vegetation at all. High rise buildings are located on the dune allowing little buffer during storms. Further development of the road and pavements between buildings and the beach is using up more of what little dune remains.

6. MAIN POINTS RELEVANT TO NEW ZEALAND SPINIFEX RESEARCH

Successful techniques developed in Australia for revegetating sand dunes with spinifex need to be evaluated for their effectiveness in New Zealand conditions. The following summary of successful methods used in Australia need to be considered in any future New Zealand spinifex research programmes.

Spinifex seed collection and handling

- Seed to be stored in hessian bags and kept in cool dark conditions with rodents controlled.
- Spikes either threshed by machine or left whole depending on sowing method. Threshing destroys some seed.

Nursery raising of spinifex

- Difficult to raise seedlings so should only be considered for very exposed sites where other revegetation methods would fail.
- Seedlings raised in 3:1 sand:peat mix using tall containers to enable deep planting.
- Preferred method is to raise seedlings from tip cuttings of runners, not from seed.
- Use slow release fertilisers in potting mixes.

Establishing spinifex on bare sand surfaces

- Directly sow seed by hand or machine depending on site and scale of revegetation, or transplant cuttings onto sand dunes in preference to planting nursery-raised seedlings.
- On very exposed sites establish a temporary cover crop before or when spinifex is sown or transplanted or place brush (small branches of tea tree) over area once sown.
- Planting and sowing to be done in late autumn or early spring. N fertilisers to be broadcast sown after sowing/planting (probably at least 2 weeks after sowing).
- Two methods for direct sowing seed on dunes:
 - (a) Place 2-4 spikes (handful) into 100 mm deep holes at 600 mm centres.
 - (b) Sow threshed seed (with debris/chaff) into furrows using hand or tractor drawn seed sowers.
- Two methods for establishing cuttings on dunes:
 - (a) Cut 600 mm long runners or stolon including the growing tip off existing plants nearby and place into 200 mm deep trenches with 75 mm of tip left exposed.
 - (b) Take sprigs from mature plants in back dunes which have 3-5 nodes at close spacing and plant into deep holes.

Fertilising spinifex

- Fertilising existing spinifex plants and colonies is the most effective way of improving dune vegetation cover where plants occur.
- Broadcast high rates of high N fertiliser (200-400 kg N/ha/annum) over small colonies on fore dunes or the leading 1 m wide edge of large colonies.
- Apply fertilisers at least twice annually and for up to 3 years. Fertilising is only beneficial when applied during or just before some rain occurs. Too much rain will leach fertiliser through sand beyond spinifex roots. Hence, split applications reduces the risk of no or too much rain after each fertilising.

Research with fertilising spinifex

- Determine the substrate type and pH level before deciding on fertiliser formulation.

- Fertiliser plots to be at least 5 x 10 m with buffers.
- Assess % ground cover vegetation using a point sampling frame recording separately green leaf material and dead vegetation.

7. USEFUL REFERENCE MATERIAL

The following major items of material acquired during the Australian visit is held by Indigenous Forest Management section, NZ FRI:

Beach Protection Authority Queensland, 1980: Dune stabilisation and management programme. Vol. 1. Government Printer, Queensland. 120p.

Beach Protection Authority Queensland, 1983: Dune stabilisation and management programme. Vol. 2. Government Printer, Queensland. 135p.

Beach Protection Authority Queensland, 1987: Dune stabilisation and management programme. Vol. 3. Government Printer, Queensland. 130p.

Beach Protection Authority Queensland, 1990: Dune stabilisation and management programme. Vol. 4. Government Printer, Queensland. 132p.

Beach Protection Authority Queensland, 1981: Coastal dune management manual. Series of leaflets - "Coastal sand dunes - their vegetation and management".

New South Wales Government, 1990: Coastline management manual. NSW Government. 50p, 4 appendices.

Soil Conservation Service of NSW, 1990: Coastal dune management. Soil Conservation Service of NSW, Sydney. 76p.

A range of other publications were also acquired including papers, articles, reports on specific coastal projects, annual reports, posters, stickers and other promotional material.

8. REFERENCE

Bergin, D. O. ; Shaw, W. B. 1991: Propagation and establishment of *Spinifex sericeus* - a review. FRI Contract Report FWE 91/27 (Unpubl.). 18p.