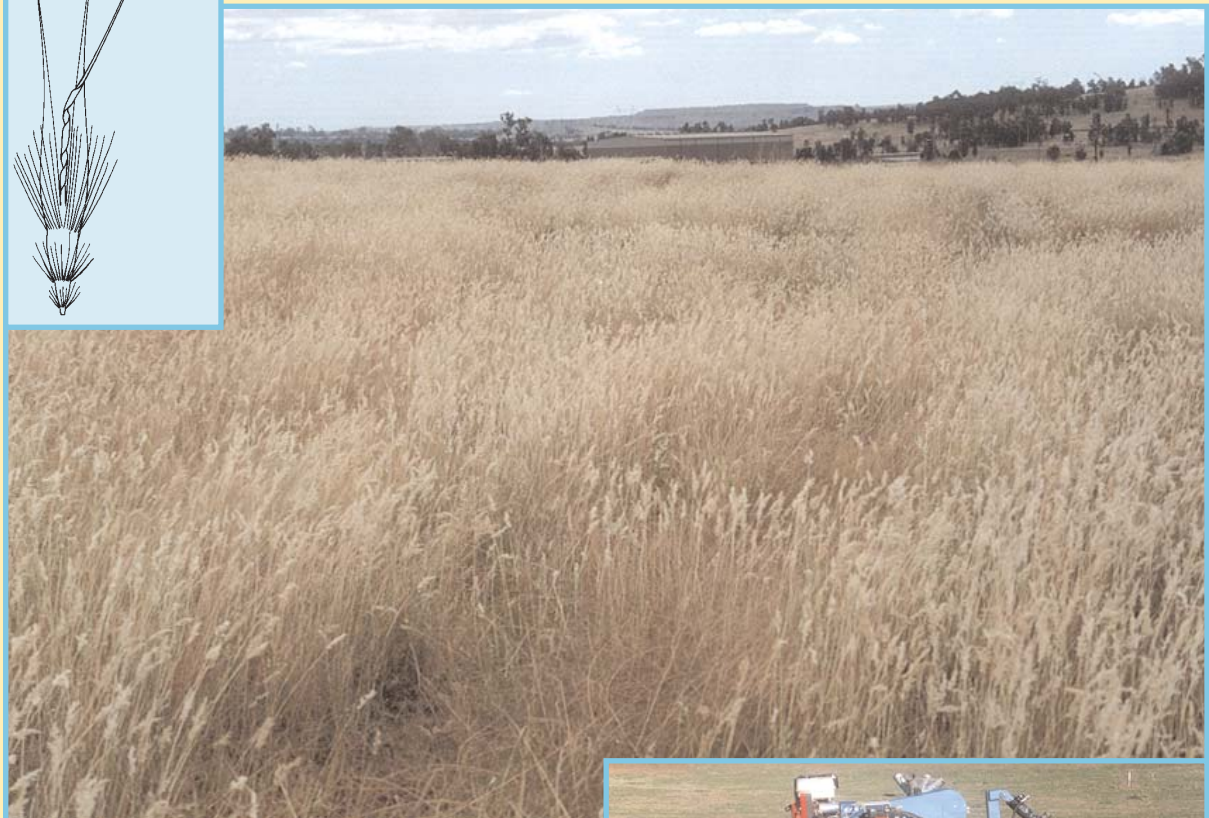
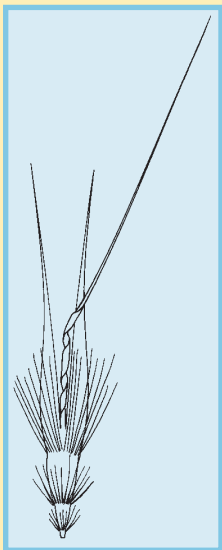


Rehabilitation of open cut coal mines using native grasses: Management guidelines

Prepared by Charles Huxtable



Department of Sustainable Natural Resources

Cover illustrations, from left to right:

- **The spikelet of the native pasture grass, *Austrodanthonia setacea*.**
- **A good stand of Taranna wallaby grass (*Austrodanthonia richardsonii*) at Ravensworth mine, 1 year after sowing.**
- **A brush harvester for native grass seed built for the rehabilitation trials, and designed by J. Ryan of Cooma.**

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INTRODUCTION

These guidelines provide a brief summary of the species of Australian native grasses and their management that are recommended for rehabilitation of open cut coal mines in the Hunter Valley. The information is based on the results of 5 years of research carried out on mine sites during 1994–1999.

WHY USE NATIVE GRASSES?

Native grasses are a diverse group of plants with a range of attributes which make them important components of vegetation in the landscape. Because of their diversity, native grasses play an important role in mine rehabilitation as components of reconstructed vegetation communities and for a range of post-mining landuses. Native grasses are environmentally friendly, contribute to overall biodiversity and can be grown in association with native trees, shrubs and forbs (small broad-leaved plants) on minesites.

Some native grasses have a high forage value for livestock and can tolerate low soil fertility and drought. These attributes make them a desirable choice where land is intended for grazing after mining.

Introduced pasture species have been used for mine rehabilitation in the past, but compared to native grasses they have the following disadvantages:

- They can be costly to maintain.
- They tend to need more fertile soil and to be less drought tolerant.
- A pasture containing only Rhodes grass tends to develop when introduced pastures (which usually include Rhodes grass) are not managed properly.



A trial of mixed species at Howick mine, 2 years after sowing. After 1 year, 17 native grasses and 7 native forbs were established at this site.

OPTIONS FOR VEGETATION INCLUDING NATIVE GRASSES

To rehabilitate land, native grasses can be grown alone or with trees and/or shrubs. Native forbs can also be included in pastures containing native grasses.

WHERE TO USE NATIVE GRASSES

- On topsoil that has been taken from pre-strip areas dominated by native grasses.
- On areas with raw spoil, where topsoil is not available.
- On areas of low fertility topsoil that contains few seeds from introduced plants.

These situations give native grasses a competitive advantage because the soil has one or more of the following features:

- few seeds of introduced plants
- many seeds of native plants
- low fertility.

Where there is a risk of soil erosion, other soil conservation measures may be necessary.



Although it was not sown, the native species blown grass (*Lachnagrostis filiformis*), was growing on a trial site at Ravensworth mine, in the spring of 1998. Native grasses can establish from reserves of seed in topsoil used for a rehabilitation site.

CHOOSING SUITABLE NATIVE GRASSES

Native grasses should be selected mainly for their ability to survive the local soil and climatic conditions on the mine sites. Species that originally grew locally are desirable, but are not essential.

Recommended species

Table 1 lists recommended species, their seasonal growth patterns, recommended sowing times and special attributes.

As many suitable species as possible should be sown, with a minimum of three warm season perennial (WSP) species and two year-long green perennial (YGP) species. Cool season perennial (CSP) and cool season annual (CSA) species can be added if they are available.

For raw spoil, the best YGP species are wallaby grasses and plains grass. The best WSP species is windmill grass. (Table 1 lists the scientific names.)

For saline, alkaline dispersible topsoil, the best YGP variety is Taranna wallaby grass; the best WSP species are Queensland bluegrass, native millet, windmill grass and couch.

For better quality topsoil (loam to loamy clays with slightly acid to neutral pH and low salinity), the best YGP species are wallaby grasses and plains grass. The best WSP species are Queensland bluegrass, pitted bluegrass, native millet, windmill grass, blown grass, umbrella grass and early spring grass.

For highly acidic, sodic loamy sand, the best WSP species are wiregrass, pitted bluegrass, couch, slender rat's tail and tall windmill grass.



Yanganbil grass (*Austrostipa bigeniculata*), a native, growing on raw spoil at Howick mine, 2 years after sowing.



Windmill grass (*Chloris truncata*) growing at Ravensworth mine, showing the level of groundcover 4½ years after sowing.

SELECTING AND SOWING SEED

When selecting and sowing native grass seed, consider:

- dormancy
- viability
- form of seed sown (degree of cleaning)
- sowing depth
- soil moisture
- temperature.



Taranna wallaby grass growing on good topsoil at Ravensworth mine.



Preparation of a rehabilitation site at Howick Mine, October 1997.



Pitted bluegrass (*Bothriochloa decipiens*) seed in its uncleaned form, as harvested by a brush harvester.



Diamond harrows were used to rake in wallaby grass seed after sowing at Howick mine.

To maximise establishment, consider:

- seed source and quality
- sowing rate
- sowing technique
- multi-phase sowings and species diversity
- fertiliser application at the time of sowing.

CONTROLLING WEEDS

Weed control is absolutely essential during the first year, and probably later also.

A herbicide with the active ingredients picloram and triclopyr (for example Grazon®*) can be used to control galenia, because that type of herbicide has little adverse effect on native grasses. Competition from Rhodes grass and couch is a major threat to establishment of sown native grasses. These plants can be spot sprayed with a post-emergent herbicide containing the active ingredients glyphosate, diuron or atrazine (for example Roundup®) or another post-emergent herbicide.

* Other suitable herbicides include 4Farmers Tri-Pick®, Generex Trichloram®, Picker® and Grass-Up®. Mention of the product names given in this brochure is not intended to imply endorsement of one product over another equivalent product. Herbicides should be used only as instructed by the directions on the container label.

Table 1. Recommended species for rehabilitation of coal mine spoil in the Hunter Valley

Common name	Scientific name#	Growth pattern	Special features
Bunderra wallaby grass*	<i>Austrodanthonia</i>	YGP	Good coloniser, tolerates raw spoil, good forage value, prefers heavier soils, tolerates grazing.
ringed wallaby grass*	<i>A. caespitosa</i>	YGP	Good coloniser, tolerates raw spoil, good forage value, tolerates grazing.
Hume wallaby grass*	<i>A. richardsonii</i> cv. Hume	YGP	Good coloniser, tolerates raw spoil, good forage value, tolerates grazing.
Taranna wallaby grass*	<i>A. richardsonii</i> cv. Taranna	YGP	Good coloniser, wide soil tolerance, tolerates raw spoil, good forage value, tolerates grazing.
smallflower wallaby grass*	<i>A. setacea</i>	YGP	Good coloniser, tolerates raw spoil, good forage value, tolerates grazing.
plains grass*	<i>Austrostipa aristiglumis</i> or <i>A. bigeniculata</i>	YGP	Good coloniser, tolerates alkalinity and raw spoil, moderate forage value, tolerates grazing.
speargrass	<i>A. scabra</i>	YGP	Good forage value when in green leaf, drought tolerant, tolerates grazing.
slender bamboo grass	<i>A. verticillata</i>	YGP	Good forage value when in green leaf, drought tolerant, tolerates grazing.
shorthair plumegrass	<i>Dichelachne micrantha</i>	CSP	Good forage value, germinates from topsoil seed bank.
common wheatgrass	<i>Elymus scaber</i>	CSP	Very high forage value, germinates from topsoil seed bank.
blown grass	<i>Lachnagrostis filiformis</i>	CSA	Good coloniser, good forage value, germinates from topsoil seed bank.
wiregrass*	<i>Aristida ramosa</i>	WSP	Prefers low fertility soils, poor forage value, drought tolerant, good coloniser.
redgrass/pitted bluegrass*	<i>Bothriochloa macra/decipiens</i>	WSP	Good coloniser, small plant basal area but survives drought well.
windmill grass*	<i>Chloris truncata</i>	WSP	Good coloniser, low forage value, drought tolerant, tolerant of very poor topsoil and raw spoil, short-lived perennial.
tall windmill grass*	<i>Chloris ventricosa</i>	WSP	Good coloniser, low forage value, drought tolerant, tolerant of very poor topsoil and raw spoil, long-lived perennial.
barbed wire grass	<i>Cymbopogon refractus</i>	WSP	Prefers poor soils, low forage value, sensitive to grazing, very drought tolerant.

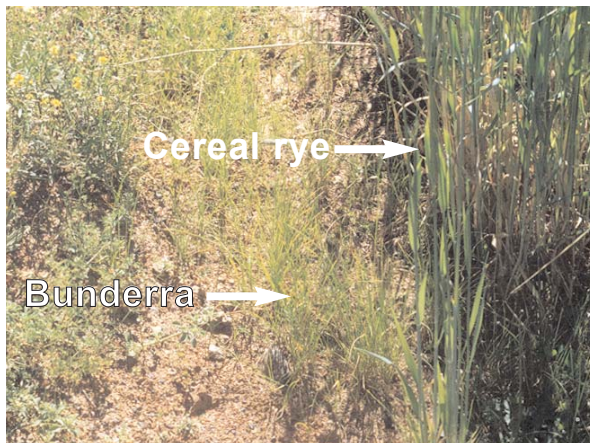
Queensland bluegrass*	<i>Dichanthium sericeum</i>	WSP	Requires better quality topsoil, prefers heavier black soils, moderate forage value, drought tolerant.
cotton panic grass	<i>Digitaria brownii</i>	WSP	Good forage value, prefers better soils, germinates from topsoil seed bank.
umbrella grass	<i>Digitaria divaricatissima</i>	WSP	Moderate forage value, prefers better soils, germinates from topsoil seed bank.
early spring grass	<i>Eriochloa pseudocacotricha</i>	WSP	Naturally colonises topsoil and raw spoil from seedbank or surrounds. May be salt-tolerant. Can form extensive stands with good groundcover and good forage value.
native millet	<i>Panicum decompositum</i>	WSP	Moderate forage value, prefers heavier soils, may be salt tolerant.
hairy panic	<i>Panicum effusum</i>	WSP	Good forage value, germinates from topsoil seed bank.
# Scientific plant names according to Wheeler, Jacobs and Whalley 2002.			
CSP	= cool season perennial. Most growth and seeding occurs during cool months. The plant lives for more than 1 year.		
YGP	= year-long green perennial. Most growth and seeding occurs in the cooler months, but the plant grows throughout the year, in response to rain. The plant lives for more than 1 year.		
CSA	= cool season annual. The plant germinates, grows, seeds and dies during the cooler months. It lives for only 1 year.		
WSP	= warm season perennial. Most growth and seeding occurs during warm months. The plant lives for more than 1 year.		
An asterisk (*) indicates species which were sown during these projects.			
Cool season perennials, year-long green perennials and cool season annuals should be sown in early to mid-autumn (March to April).			
Warm season perennials should be sown in early to mid-autumn (March to April) or early spring (September).			

MANAGING NATIVE GRASSES ON REHABILITATION SITES

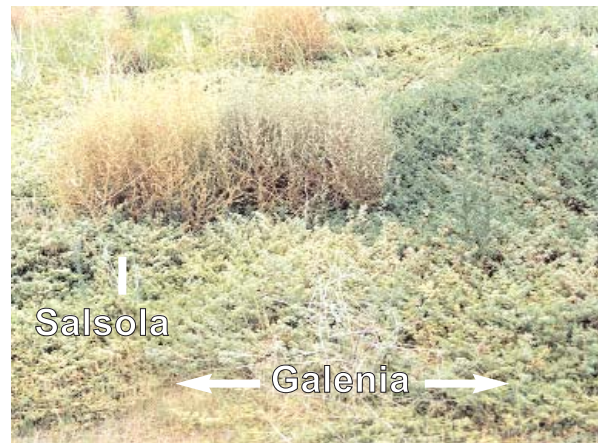
Different species of native grasses respond differently to a variety of management techniques. Grazing, slashing burning and fertiliser application can be used to maintain the desired pasture composition and diversity, and minimise invasion by weeds and exotic grasses.

Grazing favours some species such as redgrass, Queensland bluegrass and wallaby grasses. However, grazing is harmful to other grasses such as barbed wire grass, kangaroo grass and native sorghum. High intensity grazing for short periods (such as in time-control cell grazing) provides the most uniform defoliation, forcing animals to eat both palatable and unpalatable species.

Slashing has similar effects, but lacks the selectivity of low intensity grazing. Compared to grazing, slashing also lacks the effects of addition of urine and manure, and soil disturbance by hoofs.



Bunderra wallaby grass 6 months after it was sown with a cover crop of cereal rye at Rix's Creek mine.



A severe infestation of the weeds galenia (*Galenia pubescens*) and soft roly poly (*Salsola tragus*) at a rehabilitation trial site.



Burning was one of the methods used to control Rhodes grass (*Chloris gayana*) before native grasses were sown in a rehabilitation trial at Warkworth mine in October 1998.



Some native grasses are able to compete with vigorous introduced grasses such as this self-sown slender bamboo grass (*Austrostipa verticillata*) growing amongst phalaris and Rhodes grass sown at Howick mine 5 years earlier.

Low intensity burning benefits kangaroo grass by reducing the amount of dead material and stimulating new leaf growth and seed germination.

FURTHER READING

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