Perennial grasses - are they for me? Workshop manual for participants

Department of Agriculture and Food, WA
Grains Research and Development Corporation

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PERENNIAL GRASSES - ARE THEY FOR ME?

WORKSHOP MANUAL FOR PARTICIPANTS
Acknowledgments

This workshop has been developed as part of the GRDC/NDSP-funded “A Million Hectares for the Future” Project with support and input from key personnel from the Department of Agriculture, Western Australia (DAWA). Thankyou also to the farmers who participated in the pilot workshops, providing valuable feedback on structure and content.

Developed and compiled by Trevor Lacey, Department of Agriculture, Northam WA.

January 2005

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Cover Picture

Setaria grass at Sustainable Grazing on Saline Lands (SGSL) site east of Beverley 2004.

These Participants Notes cover all of the topics discussed and overheads presented within the workshop, with space to add your own comments. Worksheets provide space for answering questions relating to activities carried out. These notes are a record of your discussions and any conclusions developed out of this workshop.
Contents

AGENDA (SAMPLE) .......................................................................................................................... 4

1. INTRODUCTION .......................................................................................................................... 6
  1.1. GENERAL ............................................................................................................................... 6
  1.2. OUTCOMES FOR PARTICIPANTS ......................................................................................... 6

2. PERENNIAL GRASSES FROM A RESOURCE MANAGEMENT PERSPECTIVE ................. 8
  2.1. REVIEW OF PERENNIALS FROM INTRODUCTORY WORKSHOP ...................................... 8

3. RANGE OF SPECIES AND VARIETIES AVAILABLE ............................................................... 11

4. IDENTIFY ENVIRONMENT, LANDSCAPE AND SOIL LIMITATIONS .................................... 17
  4.1. CRITICAL MANAGEMENT FACTORS ................................................................................ 17

5. UNDERSTAND PERENNIAL GRASSES IN FARMING SYSTEMS .......................................... 21
  5.1. TIPS FOR SUCCESSFUL SUB-TROPICAL GRASS ESTABLISHMENT .............................. 22
  5.2. GRAZING SYSTEM ............................................................................................................. 26

6. COSTS AND BENEFITS .............................................................................................................. 31

7. PRE-FIELD ACTIVITY ................................................................................................................ 35

8. FIELD ACTIVITY ....................................................................................................................... 35
**AGENDA (SAMPLE)**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 – 9:10</td>
<td>Introduction</td>
</tr>
<tr>
<td>9:10 - 9:20</td>
<td>Review of “Introduction to salinity” workshop</td>
</tr>
<tr>
<td>9:20 – 9:40</td>
<td>Species</td>
</tr>
<tr>
<td>9:40 – 9:50</td>
<td>Roles of perennial grasses</td>
</tr>
<tr>
<td>9:50 – 10:05</td>
<td>Management factors</td>
</tr>
<tr>
<td>10:05 – 10:20</td>
<td>Economics</td>
</tr>
<tr>
<td>10:20 – 10:40</td>
<td>Activity</td>
</tr>
<tr>
<td>10:40 – 10:45</td>
<td>Describe Field Activity</td>
</tr>
<tr>
<td>10:45 – 10:55</td>
<td>Travel to site</td>
</tr>
<tr>
<td>10:55 – 11:20</td>
<td>Farmers perspective, What, Why, Plans for the future</td>
</tr>
<tr>
<td>11:20 – 11:45</td>
<td>Plant species distribution, What has established best and Where</td>
</tr>
<tr>
<td>11:45 - 12:00</td>
<td>Return to hall</td>
</tr>
<tr>
<td>12:00 – 12:10</td>
<td>Summary</td>
</tr>
<tr>
<td>12:10 – 12:30</td>
<td>Participants Review</td>
</tr>
<tr>
<td>12:30 – 1:00</td>
<td>Lunch provided</td>
</tr>
</tbody>
</table>
Slide 1.

Perennial Grasses:

Slide 2.

House keeping

- Emergency exits
- Ground rules for discussion
- Tea coffee
- Toilets etc
- Mobile Phones turned off

Slide 3.

Structure of Workshop

- Introductions
- Brief review of salinity
- Perennial grass options available
- Climate and environment requirements
- Part of the system
- Management
- $$
- Field Trip (Deane and Sarah Aynsley)
- BBQ Lunch
1. Introduction

1.1. General

This workshop is part of a series of workshops looking at dryland salinity and options to manage it. These ‘Million hectares’ workshops have the common themes of environmental improvement. They provide information to help participants identify the risks within the catchment and at a farm level, assess both the likelihood of the risk occurring and consequences if the risk is not managed and determine the best course of action for individuals. This perennial grass workshop builds on information and understanding developed from other Million hectares workshops. Participants will determine their course of action based on their specific circumstances and goals. There is no one recipe that is suited to all participants.

The Participants Notes when completed should provide a documented record of the risks, their likely impact and planned activities to manage their risk.

1.2. Outcomes for participants

By the end of the day participants will have developed an initial strategy for perennial grasses on a farm.

This will be developed in this workshop through the:

- understanding of the role of perennials grasses from a resource management perspective;
- appreciation for the range of species and varieties available;
- knowledge of where (environment, landscape and soil limitations) and how (rotations, companion species, seasonal patterns of growth & quality) perennial grasses might fit within their farming system;
- understanding of critical management factors (establishment, nutrition, weed and pest control, grazing management etc.) for success with perennial grasses;
- basic understanding of the costs and benefits associated with perennial grasses;
- identification of some additional sources of information on perennial grasses.
Slide 4.

Causes of salinity

Low Recharge, High Recharge

Current estimated that 9% of cleared land saline and could double in next 20 years.

Slide 5.

Tools - Leakage Calculator

Leakage Calculator showing leakage under annuals vs. perennials

Slide 6.

Tools - Monitoring

Rising watertables resulting from leakage and the change from native system to annual cropping system

Perennial Grasses – Participants Notes
2. Perennial Grasses from a resource management perspective

2.1. Review of perennials from introductory workshop

Benefits from perennials:

- **Perenniality** - perennials are growing for 12 months of the year and for a number of years.
- Summer and winter growth provides the ability to utilise summer rainfall and enables the soil moisture buffer in the soil prior to winter. The difference between the soil moisture following perennials as compared to annual species is the size of the buffer. The soil can hold this additional amount of moisture before leakage to the groundwater system occurs.
- Deep-rooted – as perennials live for a number of seasons they have more time to extend their roots within the soil profile. This enables them to penetrate deeper and consequently, they have the ability to use deeper water and create a greater soil-water buffer.
- Diversity – a greater range of species creating a canopy and understorey etc. providing for greater interception of both light and rainfall.
- High leaf area index (LAI) year-round - this is basically the size of the pump that drives the water extraction from the soil profile by the roots. The greater the leaf area index the greater the pump. Perennials maintain their LAI throughout the year whereas annuals’ leaf area index drops away to zero when the plants die off. It should be noted that evaporation would continue to remove moisture from the soil in summer, through capillary rise providing there is moisture to the surface. Once the surface layers dry out capillary action will cease.
- High water-using systems aim to mimic features of native vegetation rather than replace it. It is realised that replanting up to 80% of the landscape with native vegetation is not an option for profitable agriculture.
Tools to help determine what options may be available and to identify additional information that might be required.

Valley floors at greatest risk in purple Monitor groundwater in risk areas

Current salinity in red/orange from salinity maps

Perennial Grasses – Participants Notes  Page 9
Slide 10.

Waterlogging and Salinity

Effects on Growth

zero salt

4 ×

20% of Seawater

Slide produced by: EG Barrett-Lennard

Slide 11.

Integrated systems

Lowers watertables

Bulk of $s

Bulk of $s

Slide produced by: EG Barrett-Lennard
3. **Range of species and varieties available**

Activity: Identification of grass species

<table>
<thead>
<tr>
<th>Couch</th>
<th>Paspalum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green panic</td>
<td>Rhodes grass</td>
</tr>
<tr>
<td>Kikuyu</td>
<td>Setaria</td>
</tr>
<tr>
<td>Lovegrass</td>
<td>Signal grass</td>
</tr>
<tr>
<td>Windmill grass</td>
<td>Curly windmill grass</td>
</tr>
<tr>
<td>Phalaris</td>
<td>Tall wheat grass</td>
</tr>
<tr>
<td>Puccinellia</td>
<td>Ryegrass</td>
</tr>
<tr>
<td>Bambatsi panic</td>
<td></td>
</tr>
</tbody>
</table>

Match each of the samples to one of the perennial grass species listed above.

<table>
<thead>
<tr>
<th>Sample Number</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pot Number 1</td>
<td></td>
</tr>
<tr>
<td>Pot Number 2</td>
<td></td>
</tr>
<tr>
<td>Pot Number 3</td>
<td></td>
</tr>
<tr>
<td>Pot Number 4</td>
<td></td>
</tr>
<tr>
<td>Pot Number 5</td>
<td></td>
</tr>
<tr>
<td>Pot Number 6</td>
<td></td>
</tr>
<tr>
<td>Pot Number 7</td>
<td></td>
</tr>
<tr>
<td>Pot Number 8</td>
<td></td>
</tr>
<tr>
<td>Pot Number 9</td>
<td></td>
</tr>
</tbody>
</table>
Slide 12.

Perennial Grass Species

- Potted plant identification
- Perennial Rules of Thumb
- Perennial Grass Growth Characteristics
- Perennial Species for Out of Season Production
- Perennial Pastures CD (Tim Wiley)
- Fact sheets NSW and QLD DPI

Slide 14.

Species of Perennial Grasses

<table>
<thead>
<tr>
<th>Sub-tropical perennial grasses</th>
<th>Temperate Perennial grasses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bana / Elephant grass</td>
<td>Cocksfoot</td>
</tr>
<tr>
<td>Blue panic</td>
<td>Festucet</td>
</tr>
<tr>
<td>Buffel grass</td>
<td>Phalaris</td>
</tr>
<tr>
<td>Couch</td>
<td>Puccinella</td>
</tr>
<tr>
<td>Creeping blue grass</td>
<td>Puygrass</td>
</tr>
<tr>
<td>Digit grass</td>
<td>Ryegrass</td>
</tr>
<tr>
<td>Green panic</td>
<td>Tall wheat grass</td>
</tr>
<tr>
<td>Jarra grass</td>
<td></td>
</tr>
<tr>
<td>Kikuyu</td>
<td></td>
</tr>
<tr>
<td>Lovegrass</td>
<td></td>
</tr>
<tr>
<td>Para grass</td>
<td></td>
</tr>
<tr>
<td>Paspalum</td>
<td></td>
</tr>
<tr>
<td>Purple pigeon grass</td>
<td></td>
</tr>
<tr>
<td>Rhodes grass</td>
<td></td>
</tr>
<tr>
<td>Setaria</td>
<td></td>
</tr>
<tr>
<td>Signal grass</td>
<td></td>
</tr>
</tbody>
</table>

Native Grasses: (many others)
- Windmill grass
- Curly windmill grass
- Kangaroo grass

Native Grasses: (many others)
- Spear grass
- Wallaby grass

Perennial Grasses – Participants Notes
Slide 15.

**Species ID**

<table>
<thead>
<tr>
<th>Species</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Couch <em>Paspalum</em></td>
<td>Identification of grass species</td>
</tr>
<tr>
<td>Green <em>Panicum</em></td>
<td></td>
</tr>
<tr>
<td>Rhodes <em>Cynodon</em></td>
<td></td>
</tr>
<tr>
<td>Kikuyu <em>Sesleria</em></td>
<td></td>
</tr>
<tr>
<td>Lovegrass <em>Sorghum</em></td>
<td></td>
</tr>
<tr>
<td>Signal grass <em>Pennisetum</em></td>
<td></td>
</tr>
<tr>
<td>Windmill grass <em>Setaria</em></td>
<td></td>
</tr>
<tr>
<td>Curly windmill grass <em>Echinochloa</em></td>
<td></td>
</tr>
<tr>
<td>Phalaris <em>Phalaris</em></td>
<td></td>
</tr>
<tr>
<td>Tall wheat grass <em>Poa</em></td>
<td></td>
</tr>
<tr>
<td>Ryegrass <em>Poa</em></td>
<td></td>
</tr>
<tr>
<td>Blue panic <em>Panicum</em></td>
<td></td>
</tr>
</tbody>
</table>

Match each of the samples to one of the perennial grass species listed above.

Sample Number  | Species
----------------|------------------
Pot Number 1    |                 |
Pot Number 2    |                 |
Pot Number 3    |                 |
Pot Number 4    |                 |
Pot Number 5    |                 |
Pot Number 6    |                 |
Pot Number 7    |                 |
Pot Number 8    |                 |
Pot Number 9    |                 |

Slide 16.

**Rhodes Grass**

- Callide (most productive in WA)
- Katambora (good salt tolerance)
- Fine cut (selection out of Katambora with more leaf)
- Top cut (selection out of Katambora with more leaf)
- Pioneer (least productive)
- Prostrate and spreads readily from above ground runners.
- Seed head resembles an open hand.
- Grows up to 1.5 meters tall.

Photo: Tim Wile

Slide 17.

**Signal Grass**

- Paspalum like seedheads
- Pointy leaves
- Shiny leaves
- Leaves light green in colour.

Photo: Tim Wile

Photo: Kate Robinson
Slide 18.

**Gatton, Green Panic**

- A bunch grass that tillers from the base.
- Does not have runners or stolons.
- Grows up to 1.5 m tall.
- The seed is held in feathery seed heads.

Photo: Tim Wiley

Slide 19.

**Setaria**

- A bunch grass that tillers from the base.
- Does not have runners or stolons.
- The seed is held in cigar shaped seed heads that sit on tall stalks.
- Grows up to 1.5 m tall.

Photo: Kate Robinson

Photo: Tim Wiley

Slide 20.

**Bambatsi, Blue Panic**

- A bunch grass that tillers from the base.
- Bluish coloration.
- Does not have runners or stolons.
- Grows up to 1.5 m tall.
- The seed is held in feathery seed heads.

Photo: Kate Robinson
Slide 21.

**Tall Wheat Grass**

- Up right tufted perennial grass
- Grows up to 1.8 m tall
- Leaves greyish or bluish green.
- Leaves 4–8 mm broad
- Seed head similar in structure to annual ryegrass

Photo: Kate Robinson

Slide produced by: T. Lacey

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Slide 22.

**Puccinellia**

- Leaves greyish green
- Leaves 1 to 4 mm wide, hairless and up to 35 cm long
- Loose open seed heads on ridged branches

Photo: Kate Robinson

Slide produced by: T. Lacey

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Slide 23.

**Cocksfoot**

- Bunch grass to 1.2 m
- Winter active summer dormant
- Well drained and moderately fertile
- Requires 450 mm rain and mild summers

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Perennial Grasses – Participants Notes
Slide 24.

**Tall Fescue**

- Tussock forming.
- Up to 2 meters tall

Photo: Tim Wile

Slide produced by: T. Lacey

Slide 25.

**Phalaris**

- Bunch grass
- Up to 1.8 m tall

Photo: Tim Wile

Slide produced by: T. Lacey

Slide 26.

**Other Species sown on site**

- Wavy leaf saltbush
- Acacia Saligna, Puccinellia grass

Photo: Kate Veronesi

Photo: Kate Veronesi

Slide produced by: T. Lacey
4. Identify environment, landscape and soil limitations

4.1. Critical Management Factors

Extract from Perennial Pasture CD prepared by Tim Wiley, Department of Agriculture, Geraldton

Soil type is not a major factor in determining which sub-tropical perennial grasses can grow where. Most species will grow on poor sands through to clays. However some species perform better on certain soil types.

**Soil texture** - On the poor sands the green panic appears to be one of the best performing grasses. Rhodes grass and setaria have also been very productive. It is perhaps only the species that require plenty of water like para grass, which may not persist on the deep dry sands. The main challenge on the sands is in getting good germination and establishment due the soil surface being non-wetting. Perennials growing on heavy soils will show signs of moisture stress earlier in summer than perennials growing on other soil types. Bambatsi panic seems to be the grass which shows the least drought effects on the heavier soils over summer. Lotononis has performed well on clay at New Norcia.

**Soil depth** - Shallow soils that have a physical or chemical barrier to root growth will be less suitable for perennial grasses. Generally the deeper the soil and the easier for roots to penetrate, the better the production will be for the perennials.

**pH** - Most sub-tropical perennial grasses seem to be reasonably well adapted to variations in soil pH. However there is little data in the literature on optimum pH ranges for most species. Also there have not yet been any trials looking at soil pH or lime applications in WA.

**Salinity** - The salt tolerance of the perennial grasses varies considerably between species. Puccinellia and tall wheatgrass are the most salt tolerant perennial grasses. Rhodes grass also has reasonable salt tolerance. However we have discovered that there is considerable variation in salt tolerance between Rhodes grass cultivars. Callide is usually the most productive variety of Rhodes grass. But Katambora has much better salt tolerance. Selections out of Katambora such as 'Fine cut' and 'Top cut' also seem to have reasonable salt tolerance. A researcher in the Eastern States is currently selecting super salt tolerant lines of Rhodes grass.

Para grass and Bambatsi panic may also have some useful tolerance to salinity.
Slide 27.

Environment, landscape and soil limitations

- Soil texture
- Soil depth
- pH
- Salinity
- Perched water tables
- Climate

Slide 28.

Differences between C3 and C4 Plants

C3 and C4 refer to carbon fixation in the photosynthetic pathways

C3
- Higher respiration rates (at high light / heat intensity)
- Higher requirement for Nitrogen (Rubisco enzyme)
- Suited to temperate areas
- Active in the cooler winter and spring months
- Biomass production is high
- Potential transpiration relatively low.
- Don’t leave the soil as dry.

C4
- More water efficient
- More nitrogen efficient
- Hot dry environments
- Poorer soil types
- Cost in terms of energy
- C4 plants dominate in lower latitudes (tropics)
- Hotter, drier summer months in more temperate areas
- Most active spring summer and autumn

Neither C3 nor C4 are able to strike a balance between production and soil water and soil nitrate use.

Slide 29.

Climatic Influences

[Graph showing climatic influences with annotations]

- Rainfall
- Highest Max Temp
- Mean Daily Max Temp
- Mean Daily Min Temp
- Lowest Daily Min Temp

Perennial Grasses – Participants Notes Page 18
**Perched watertables** - The best production comes from soils where there are perched watertables within reach of the roots. There is some variation in rooting depth between perennial grasses but most seem to be able to put roots down 3 to 4 metres.

**Climate** - Recommendations on pasture species are usually based around total annual rainfall. However this does not seem to be a reliable indicator for perennial grasses in WA. Certainly the amount of rain that falls will influence the amount of production from perennial grasses. However the persistence of perennial grasses seemed to be strongly influenced by summer temperatures and humidity levels. The C3 or temperate perennial grasses have not persisted north of Gingin even through summers when there has been a lot of rain (e.g. 300 mm of summer rain), or near the coast where total average rainfall is around 700 mm.

The sub-tropical perennials have been shown to survive right out to the edge of the northern wheatbelt. A range of sub-tropical grasses survived the 2002 drought at Wubin when there was only 120 mm of rain in 18 months.

Climatic factors like temperature and humidity can also influence where some species will persist in the landscape. On the south coast kikuyu will grow over most parts of the landscape. But in the northern agricultural region kikuyu only persists where there are shallow perched fresh watertables. Veldt grass also behaves differently between the south coast and the northern sandplain. In the West Midlands the veldt grass exhibits strong alleopathic characteristics in that it kills out all other species. It is not possible to establish trees or tagasaste if veldt grass is present. However on the south coast veldt grass paddocks usually include a healthy mix of other species including annual legumes.

The growth of sub-tropical perennial grasses is limited by the cold weather in winter. Again there are differences between species with the panics and setaria giving the best winter growth. In southern regions the sub-tropical species will become also completely dormant in winter.

Frost burns the leaves of the sub-tropical species. However frost will not kill the sub-tropical grasses. In central Queensland where sub-tropical perennials are the major component of the pastures, winter temperatures regularly drop to -6°C.
Slide 30.

**C3 and C4 Plant Activity**

- Temperature Requirement for productivity
  - C3 0 – 35 deg optimum 25 Deg
  - C4 15 – 45 Deg Optimum 35Deg

High growth

Low growth

Slide 31.

**Characteristics of perennial grasses.**

<table>
<thead>
<tr>
<th>Characteristics of Perennial Grasses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Growth habit</strong></td>
</tr>
<tr>
<td><strong>seed</strong></td>
</tr>
<tr>
<td><strong>Rhizomes</strong></td>
</tr>
<tr>
<td><strong>Runners</strong></td>
</tr>
<tr>
<td><strong>Seed</strong></td>
</tr>
<tr>
<td><strong>Seed rates kg/ha</strong></td>
</tr>
<tr>
<td><strong>Waterlogging tolerance</strong></td>
</tr>
<tr>
<td><strong>Frost tolerance</strong></td>
</tr>
<tr>
<td><strong>Inundation tolerance</strong></td>
</tr>
<tr>
<td><strong>Salt tolerance</strong></td>
</tr>
<tr>
<td><strong>Fertility</strong></td>
</tr>
<tr>
<td><strong>Comments</strong></td>
</tr>
</tbody>
</table>

Slide 32.

**Characteristics of perennial grasses - continued**

- Temperature Requirement for productivity
  - C3 0 – 35 deg optimum 25 Deg
  - C4 15 – 45 Deg Optimum 35Deg

High growth

Low growth
5. Understand perennial grasses in farming systems

Most perennial grasses will form the basis of permanent or semi-permanent pastures. They have the ability to mimic to an extent the function of the native bush in regards to water use (particularly the summer-active species) leaving the soil moisture profile depleted prior to the beginning of the winter months. Perennial grasses are not usually grown in short rotations with crops as they are hard to remove, may be host for some diseases and pests of cereal crops and make seeding operations difficult. They are either sown in areas that will be permanent or semi-permanent pasture. Although not commonly practised there is some interest in and may be some potential for over-cropping with both native and introduced winter-dormant perennial grasses. This is an area where little work has been done.

Over-cropping is where annual crops are sown over a perennial pasture using virtually normal crop management practices, herbicides etc.
### 5.1. Tips for successful sub-tropical grass establishment

**Extract from Perennial Pasture CD prepared by Tim Wiley, Department of Agriculture, Geraldton**

<table>
<thead>
<tr>
<th><strong>Weed control</strong></th>
<th>Good weed control is essential. Even slight competition during establishment can greatly affect the establishment of the stand.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time of sowing</strong></td>
<td>The best time to sow seems to be from mid-August through to mid-September. These plants need at least one rainfall event after sowing to initiate germination. If you sow too early the plants will germinate but develop slowly due to cold conditions. Subsequent weed germinations could then put added competition pressure on the grass seedlings.</td>
</tr>
<tr>
<td><strong>Seeding depth</strong></td>
<td>Seed needs to be sown SHALLOW - no deeper than 0.5 cm.</td>
</tr>
<tr>
<td><strong>Pressing</strong></td>
<td>Sub-tropical grasses need to be firmly pressed into the soil at seeding. Vast improvements in establishment have been obtained through firm pressing.</td>
</tr>
<tr>
<td><strong>Seeding rate</strong></td>
<td>The recommended rate for a mixture is 3–4 kg/ha. With accurate seed placement and press wheels this can be reduced to 2 kg/ha.</td>
</tr>
<tr>
<td><strong>Grazing</strong></td>
<td>Pasture should be rotationally grazed as set stocking will thin the stand. The first grazing also needs to be timed carefully as grazing too early can destroy the stand. These plants need to develop their secondary root systems in order to anchor them to the ground before grazing. If this has not occurred and they are grazed, the stock will pull the whole plant out of the ground. Secondary root development can occur anytime between six weeks and six months after germination, depending on rainfall.</td>
</tr>
<tr>
<td><strong>Germination testing</strong></td>
<td>Germination testing should be carried out on seed prior to purchasing to ensure successful establishment.</td>
</tr>
</tbody>
</table>
Slide 33.

**Understand the role of perennial grasses in farming systems**

- Rotations.
- Companion species
- Seasonal patterns of growth
- Quality
- Grazing system

Slide 34.

**Understand the role of perennial grasses in farming systems**

- Rotations.
- Companion species
- Seasonal patterns of growth
- Quality
- Grazing system

Slide 35.

**Salt tolerance vs Waterlogging Matrix**

Salt vs Waterlogging Matrix

- Salt tolerant species
- Waterlogging tolerant species
- Salt water tolerance
- Waterlogging tolerance

---

**Adapted from Barrett-Lennard EG., (2003). Saltland Pastures in Australia.**
Establishing sub tropical perennial grasses
Tim Wiley, Ken Angell, Dave Rogers, Nadine Morgan, Department of Agriculture, and Phil Barrett-Lennard, Evergreen Farming

Sub-tropical perennial grass can be established by sowing in spring. The method of sowing will depend on the machinery available to a farmer. However, there are some principles that must be followed to ensure effective establishment.

Total weed control
It is essential that all the existing pasture is killed before sowing perennials. Perennial grass seedlings are not very vigorous and do not compete with established annual pasture plants. Even newly germinated annual plants will be very competitive against the perennial seedlings. However, annual seedlings that germinate after the perennial seedlings should not prevent establishment. It is the annual seedlings that germinate before the perennials that do the most damage. By killing the annual pasture in early spring, moisture will be conserved at the surface and in the profile. This will improve perennial grass germination. Under these conditions there can even be an adequate germination without rain. If the soil profile is fully wetted up and there are no established annuals present, then there will be enough moisture for sub-tropical perennials to survive the first summer without rain. With a very dry summer the sub-tropical grass may not grow much over the summer but because of their exceptional drought tolerance they will at least survive.

Killing annual pastures
Paddocks to be sown to perennials in spring should be hard grazed to utilise the feed available and to set the pasture up to be killed. By grazing heavily in late winter it also means that other paddocks can get away. This means that there should be little loss of grazing over the whole farm from killing the spring flush of annual pastures in just one paddock. Experience suggests that it is best to kill the annual pasture about four weeks prior to sowing. The reason for this is unclear but it could be a disease break effect from a short fallow. Starting the control of the annual pasture early also means there is an opportunity for a second weed kill on newly germinating annual pasture plants. For example, for the Moora region, the annual pasture should be killed in mid August for a mid September perennial germination. In southern regions germination is not likely till late September or early October.

Herbicides
Established pastures can be killed using higher rates of knock down herbicides. Ideally, a hard grazed paddock should be spelled for two weeks following 15 mm or more of rain prior to spraying with knockdowns. This allows the plants to freshen up and have more new leaf for chemical uptake. The double knock method is preferred for killing well established pastures. The pasture is sprayed with Glyphosate first and followed up with Spray.Seed® five days later. Use at least 2 L/ha Glyphosate on pastures in spring. Increase the Glyphosate rate in areas close to horticulture, because it may be unsafe to use Spray.Seed® as a second knock. Avoid using soil residual herbicides such as Atrazine as it will affect some sub-tropical species. Add 100 mL of Le-Mat® per hectare in the second spray for redlegged earth mite control to set the paddock up for over-sowing annual legumes in the following year.

**Time of sowing**
Sub-tropical grasses have a mechanism to prevent seed from germinating when the soil is too cold. The exact temperature for germination varies slightly between species. There will also be some variations between plants within any line of seed. The soils on south facing slopes will not warm up as quickly as soils on north facing slopes. The colour of the soil surface can also influence soil temperatures. Areas that are waterlogged can take much longer to warm up due to the effect of evaporation off the soil surface. These wet areas can take up to 6 weeks longer to reach the critical temperature than other soils. Sowing too early on wet areas has not given good establishment.

**Sowing method**
Sub-tropical grasses can be sown with most machinery. However usually it is necessary to mix the seed with fertiliser or some other carrier to get the seed to flow through the seed box and tubes. For very fluffy seeds like Rhodes grass it takes a minimum ratio of 25 kg of fertiliser mixed with 1 kg seed to get it to flow easily. Pelleted seeds are not as big a problem for flow.
5.2. Grazing system

A range of models (MIDAS and others) have over the years indicated that good quality green feed available over the “feed gap” in summer and autumn can be worth as much as 10 times the value of feed in spring. The timing of the feed gap and its size will differ depending on the type of enterprises being run on particular farms. The requirements for feed will be different for wool producing merino enterprises and meat production enterprises and will vary for time of lambing or calving (late lambing enterprises will have a feed gap in late spring and early summer where as an early lambing flock will have the feed gap in autumn and early winter).

Perennial grasses can provide good quality green feed that can help to fill these feed gaps. Many wheatbelt farms have a range of soil types and landscape positions, which will often result in niche areas on farms that are suitable for perennial grass production. It is estimated that having perennials that provide out of season feed on approximately 10% of the farm area will be most profitable (this will generally fill those feed gaps but will vary for each farming enterprise). Areas such as sandplain seeps, change of slope or other areas with shallow watertables and wet or waterlogged or marginally saline areas may not be large but if fenced and established to perennial species can have a significant impact on the grazing system on farms.
**Slide 36.**

**Companion Species - Mixes**

<table>
<thead>
<tr>
<th>Dryland Mix</th>
<th>Wetland Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow at 2 kg/ha (if unsure of your ability to maintain accurate depth control, use a seeding rate of 3 – 4 kg/ha).</td>
<td>Sow at 4 – 5 kg/ha</td>
</tr>
<tr>
<td>Rhodes Grass 20%</td>
<td>Bambatsi 20%</td>
</tr>
<tr>
<td>Green Panic 20%</td>
<td>Setaria 20%</td>
</tr>
<tr>
<td>Setaria 20%</td>
<td>Tall Wheat Grass 30%</td>
</tr>
<tr>
<td>Signal Grass 20%</td>
<td>Puccinella 10%</td>
</tr>
<tr>
<td>Bambatsi 10%</td>
<td>Signal Grass 10%</td>
</tr>
<tr>
<td>Premier Digit Grass 4%</td>
<td>Rhodes Grass 10%</td>
</tr>
<tr>
<td>Creeping Bluegrass 4%</td>
<td></td>
</tr>
<tr>
<td>Jarra Digit Grass 2%</td>
<td></td>
</tr>
</tbody>
</table>

**Slide 37.**

**Grazing System**

- Feed Budgeting
- "Feed Gap" in summer and Autumn
- Rotational Grazing
- Green Feed provides Vitamin E

**Slide 38.**

**Quality**

On areas with shallow water tables the summer production can be spectacular. Results from the 1995/6 summer Cataby.

Stock were excluded from the site until after the dry matter cuts were taken. Seeded 10 October 1995, germinated – 10 November 1995, dry matter cuts 13 February 1996 (95 days from germination).

<table>
<thead>
<tr>
<th>Species</th>
<th>Nandi setaria</th>
<th>Green Panic</th>
<th>Kikuyu</th>
<th>Hymenachne</th>
<th>Gatton panic</th>
<th>Kazangula setaria</th>
<th>Punta cheneyi</th>
<th>Cudil Rhode</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM kg/ha</td>
<td>5.0</td>
<td>11.1</td>
<td>5.7</td>
<td>4.4</td>
<td>8.8</td>
<td>12.1</td>
<td>4.3</td>
<td>7.0</td>
</tr>
<tr>
<td>DM digestibility %</td>
<td>77</td>
<td>64</td>
<td>71</td>
<td>63</td>
<td>64</td>
<td>85</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Protein %</td>
<td>9.1</td>
<td>6.1</td>
<td>8.3</td>
<td>8.4</td>
<td>8.0</td>
<td>12.1</td>
<td>11.1</td>
<td></td>
</tr>
<tr>
<td>Energy MJ/kg</td>
<td>10.2</td>
<td>9.0</td>
<td>10.0</td>
<td>8.9</td>
<td>9.0</td>
<td>12.3</td>
<td>9.7</td>
<td></td>
</tr>
<tr>
<td>Growth rate kg/ha/day</td>
<td>53</td>
<td>117</td>
<td>66</td>
<td>48</td>
<td>93</td>
<td>127</td>
<td>45</td>
<td>74</td>
</tr>
</tbody>
</table>
Grazing management

The following is a draft of a Farmnote which will be published soon.

Whole farm grazing and feed budgeting
Tim Wiley, Department of Agriculture, Jurien Bay CAC

Whole farm feed budgeting is a planned approach to where stock will be grazing on the farm for a given length of time. As with a financial budgets, this requires estimates of inputs (i.e. feed supply) and outputs (i.e. feed consumption). The budgeting allows managers to see if there is likely to be an imbalance between inputs and outputs, and make adjustments accordingly. As with all future prediction, forward budgets never work out exactly right. But by continuously monitoring the budgets, deviations from the plan are picked up early and adjustments made so that small problems don’t become big problems.

Feed budgeting - A feed budget is a prediction of how much paddock feed will be available and how much feed a given group of livestock will eat. The aim is to balance the budget so that stock don't run out of feed, or that feed is wasted.

Feed budgets can be done for individual paddocks. In this case stock numbers on the paddock, and/or the length of time the paddock is grazed for, is adjusted to match the amount of pasture. This can be a very useful tool particularly for farmers who want to manage weeds by grazing. With individual paddock budgets stock movements on the rest of the farm are not taken into account. Adjusting the stock numbers in one paddock inevitably means that the grazing on other parts of the farm will change. These unplanned changes in other paddocks may not be the most appropriate. A whole farm feed budget is required to best manage the whole farm’s pasture base.

Learning how to do a one paddock feed budget is a good place to start developing the skills of feed budgeting. Farmers can learn these skills by doing the ‘Prograze’ course. Prograze has 8 half-day units and is delivered to groups of farmers by Edge network trainers spread across the State. Prograze covers measuring Feed On Offer (FOO), assessing botanical composition of pastures, estimating pasture digestibility, animal feed requirements and animal feed intake.

Whole farm grazing planning
A whole farm grazing plan is based on estimates of the total farm feed supply and total animal feed requirements. Each paddock is assessed for the amount of feed in the paddock at the start of the budgeting period and the likely amount to be grown. The feed requirement of each mob of animals is also estimated. Farmers then use this information to fill out a grazing chart. A grazing chart is a grid with paddocks listed down the table and time in days listed across the table.

A grazing chart lists every paddock on the farm and the area of each. From this the total amount of feed in each paddock can be shown. The times when paddocks need to be locked up are marked on the grazing chart. Paddocks may be locked up for activities such as cropping, hay cutting, deferred grazing after the break, or to allow pastures to set seed. Specific management practices such as weaning, shearing, spray topping or Timerite can also be marked on the grazing plan. This means that not only are individual paddocks managed appropriately, but it also gives an overview of farm labour requirements over the season.

A plan is then developed of where the individual mobs will be grazing over time. Individual mobs can be marked in different colours. Pencils are used so that adjustments to the plan can be made later if required. Simple calculations are done to indicate how long a given mob can stay in a specific paddock. This is based on the total amount of feed in a paddock and the total feed consumption of the mob to be grazing it. The finished grazing plan will show where all mobs will be grazing over the budgeting period.

The grazing plan then is put up in a prominent spot in the farmer’s office. As mobs are shifted their movements are marked on the plan with pens. Sometimes mobs may be moved out of a paddock sooner than the grazing plan indicates as the feed supply does not last as long as predicted. Or stock may be in a paddock longer than planned. Small variations will not have a significant effect on the grazing plan. However by recording actual stock movements on the grazing chart it will quickly become evident when adjustments to the plan are needed.

In poor seasons farmers will pick up potential feed shortages earlier. The farmer can then make decisions about reducing stock numbers and/or increasing supplementary feed supplies. Feed shortages are detected before neighbours realise that there will be a problem. The planning process allows farmers to accurately calculate how many stock they need to get rid of or how much extra fodder they will need.

When seasons are better than predicted grazing planning also allows farmers to better utilise the extra feed grown. They can accurately predict how many extra stock to buy or how much land to take out of grazing. These spare paddocks can then either be cropped
or cut for fodder conservation.
Perhaps the biggest benefit to farmers from whole farm feed budgeting is a reduction in their own levels of stress. Farmers using this system consistently report that that their stress levels are greatly reduced. This is because they pick up potential problems much earlier and can make plans to do something about it. Grazing planning gives them a level of control that they did not have with traditional approaches to deciding on stock movements.

Extract from Perennial Pasture CD prepared by Tim Wiley, Department of Agriculture, Geraldton

As yet there have been limited trials on the fertiliser requirements of sub-tropical grasses in WA. A summary of the work done so far suggests

- No responses to fertiliser sown with the seed, though farmers may need to have 50 kg/ha Superphosphate or another carrier to get Rhodes grass seed to physically flow through seeding machines.
- Established perennials respond to high rates of nitrogen fertiliser.
- Response to nitrogen has been around 20 kg dry matter/kg of nitrogen applied, which is typical for annual grasses.
- No responses to phosphorus or potassium in established Rhodes grass (see the results below from the one trial conducted so far).
- Standard fertiliser applications should be targeted at the annual legume component of a mixed pasture to maximise the nitrogen production to drive the perennial grass component of the pasture.
- Nitrogen, either from fertilisers or companion legumes, makes perennial grasses grow more and also makes them more tolerant of drought.
- Theories suggest that perennials may reduce the overall requirement for fertilisers by recovering nutrients from depth and by speeding up organic nutrient cycling, but conversely may increase the requirement through increased carrying capacities and better economic returns to nutrients applied. This issue has not been studied in WA yet.
6. Costs and benefits

Slide 39.

Identify costs and benefits

Slide 40.

Identify costs and benefits
Slide 41.

**Economics of introducing perennial pastures into the farming system**

This presentation details results from the Moore River North standard farm

Slide 42.

**Location**

Two scenarios were run on the standard farm

- a current, or do nothing scenario, (standard practice annual rotations)
- a strategic high water use scenario (strategic use of perennial pastures on non cropping type country)
Slide 44.

**Composition of the current and perennial farms**

- Current: 4000
- Perennial: 2000

<table>
<thead>
<tr>
<th>Ha crop</th>
<th>ha annual pasture</th>
<th>ha perennial pasture</th>
<th>winter DSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>1000</td>
<td>2500</td>
<td>4000</td>
</tr>
</tbody>
</table>

Slide 45.

**Current and Future Rotations**

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Ha</th>
<th>Current System</th>
<th>Perennial System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lx Saline</td>
<td>100</td>
<td>B/2 annual pastures</td>
<td>Perennial trees and annual legume pasture</td>
</tr>
<tr>
<td>Mod Saline</td>
<td>220</td>
<td>Vol pasture</td>
<td>Saltland Pasture</td>
</tr>
<tr>
<td>Hi Saline</td>
<td>100</td>
<td>Volaneters/bare</td>
<td>Fenced samphire</td>
</tr>
<tr>
<td>S/Duplex</td>
<td>490</td>
<td>W/L/W/Vol/DM/L</td>
<td>W/L/W/C/DM/L</td>
</tr>
<tr>
<td>L/Duplex</td>
<td>245</td>
<td>W/B/W/CP</td>
<td>W/B/W/CP</td>
</tr>
<tr>
<td>S/Earth</td>
<td>700</td>
<td>W/L</td>
<td>W/L</td>
</tr>
<tr>
<td>Gravels</td>
<td>280</td>
<td>W/C/B/annual pastures</td>
<td>W/C/B/annual pastures</td>
</tr>
<tr>
<td>L/Earth</td>
<td>350</td>
<td>W/B/2 annual pastures</td>
<td>W/B/2annual pastures</td>
</tr>
<tr>
<td>Deep Sand</td>
<td>1015</td>
<td>W/L/W/VolPasture</td>
<td>W/L/Mod</td>
</tr>
<tr>
<td>Total</td>
<td>3500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Slide 46.

**Standard Farm 3500ha**

- Economics run over a 10 year period
- Average yields, prices, costs.
- Crop yields increasing at 2% pa
- Costs increasing at 3% pa
- Returns increasing at 2% pa
- Average % of different soil types in catchment
Slide 47.

**Annual capital and fixed costs both farms**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overheads/fixed costs</td>
<td>$59,500</td>
</tr>
<tr>
<td>Machinery depreciation</td>
<td>$52,500</td>
</tr>
<tr>
<td>Annual loan repayments</td>
<td>$40,000</td>
</tr>
<tr>
<td>Capital development for crops</td>
<td>$10,000</td>
</tr>
<tr>
<td>Capital development for stock</td>
<td>$4,000</td>
</tr>
<tr>
<td>Personal drawings</td>
<td>$80,000</td>
</tr>
<tr>
<td>Labour</td>
<td>$26,000</td>
</tr>
</tbody>
</table>

Slide 48.

**Cumulative profit for each system**

- Increased stocking rate 0.5%
- 320 ha sown
- 100 ha sown 5% increase lambing and $5 per lamb

**Transition**

**Perennial**

**Current**

![Graph showing cumulative profit over years]

Capital $30,000 over 10 years

Slide 49.

**Water balance - AgEt, CATCHER and FLOWTUBE models.**

A water balance analysis was carried out on the two scenarios to assess the impact on recharge and on the potential area affected by saline water tables on farm.

<table>
<thead>
<tr>
<th>Current salinity</th>
<th>50 year salinity current farm</th>
<th>50 year salinity perennial farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.7%</td>
<td>27.9%</td>
<td>19.7%</td>
</tr>
</tbody>
</table>
7. **Pre-field Activity**

Work in groups to plan a perennial grass strategy based on information relating to the field site.

8. **Field Activity**

**Hydrology Report**
**Morbinning Catchment Group – Deane Aynsley**

**GEOLOGY**
The area is composed of clays, silts and sands within stream channels and adjacent valley flats, with extensive reworking of valley flat alluvium by the present drainage system. To the west of the site laterite hills overlie deeply weathered bedrock. Bedrock geology consists of migmatite, adamellite and granodiorite (Chin 1986).

**HYDROLOGY**
The property is located within the bounds of the Transitional Drainage Zone (Ghauri 2004). Hydrological processes at this location are dominated by:

- Proximity to drainage line and shallow watertable (<0.5-1 m)
- *In situ* recharge from rainfall
- Sluggish surface/groundwater flows from surrounding catchment areas.

Groundwater quality was measured in two piezometers immediately adjacent to the site on a neighbour’s property on October 2003. Both deep and shallow groundwaters are saline measuring 2200 and 2000 mS/m, respectively, with near neutral pH.

Secondary salinisation is the product of evaporation of surface water and shallow groundwater via capillary action. A small upward vertical gradient is present and this also explains rapid salinisation of the site (10 cm piezometric differential – piezometer construction unknown but gradient will be very small). The property owner indicated that major salinity onset occurred after the wet years of 1998-2000, when salts stored in the profile had been mobilised upwards during profile saturation. The profile saturation effect
can be seen below a dam on the southern section of the site where elevated EM is measured.

Airphoto (March 2001) and EM31/38 surveys reveal salinity is aligned with drainage lines that flow to the south of the site. Surrounding areas are less saline because of the marginal elevation difference and possibly due to sandier soil.

Two piezometer locations (Figure 1) have been discussed with the landholder (no pegs installed). The first is to be located within a lucerne-sown area at the northern end of the paddock to assess drawdown impact. It has been located far away enough from the drainage line for a comparison to be made with another existing piezometer. The second piezometer is located in an area that is to be planted to saltbush alleys to assess the effect of alleys on the watertable at the site. Again, an existing piezometer can be used as a control.

Figure 1. Approximate positions of existing piezometer (triangles) and 2 new piezometer sites (circles).

REFERENCES


Slide 50.

**Develop plan - Field Activity**

- Hydrological Report
- Ortho photo
- Contours
- EM38 and 31 maps

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Slide 51.

**HYDROLOGY**

- Proximity to drainage line and shallow watertable (<0.5-1m).
- *In situ* recharge from rainfall
- Sluggish surface/groundwater flows from surrounding catchment areas.

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Slide 52.

**What would you do in this paddock?**
Slide 53.

• Colours match salinity classes

Source: Deane Aynsley’s SGSL site.

Slide 54.

• Colours Don’t match salinity classes.

Source: Deane Aynsley’s SGSL site.
**What is the SGSL WA Producer Network all about?**

The Sustainable Grazing on Saline Lands (SGSL) producer network is a joint initiative between Australian Wool Innovation Limited, Land and Water Australia, Meat and Livestock Australia and the Western Australian Department of Agriculture. Under the principles of “Participatory R&D”, farmer groups have an opportunity to apply for funding from SGSL and technical support from the Department of Agriculture to conduct trials which aim to increase livestock production from land affected by waterlogging and salinity. Since May 2002, over 60 producer groups have submitted applications to host trials and their projects have been approved by a coordinating committee consisting of farmers and representatives from CSIRO, Department of Agriculture and other groups.

**Details of the Morbinning Catchment Group Trial**

**Objective**

Demonstrate a grazing system that while alleviating the threat of salinity to productive land, will give the best liveweight growth rates and wool growth rates of merino weaners throughout the autumn feed gap.

**Treatments**

- Unimproved annual pasture control (ryegrass, barley grass and capeweed dominant)
- Lucerne (established in 2003 and funded by Deane)
- Mixture of saltbush, acacias, perennial grasses (sub-tropical and temperate) and balansa clover
- Sub-tropical perennial grasses only

**Measurements**

- **Pasture**: Feed on Offer, Pasture Quality of all species present, plant establishment counts, pasture composition, vigour of perennials, % of bare ground
- **Livestock**: (of tagged sub-sample) Weight, Condition Score, Staple strength, length, fibre diameter and yield
- **Groundwater**: Quarterly depth to watertable and an initial and final water quality reading
- **Soil**: EM survey, soil survey (soil types, horizons and nutrient analysis) and ongoing EC1:5 and pH1:5 (water) samples

**Initial outcomes**

- Lucerne establishment has been poor using a zero-till disc drill
- Prior cultivation resulted in much improved establishment of sub-tropical perennial grasses
- Acacia has selectively germinated in the fresher parts of the paddock while saltbush has selected the saltier areas.
- Acacia germination in alleys has been good
- Saltbush germination has been poor. Mainly due to lack of rainfall.
- Germination of sub-tropical perennial grasses has been excellent. Rhodes grass and gatton panic the most dominant species.
New publications currently being developed.

- Perennial Rules of Thumb, Department of Agriculture WA and Meat and Livestock Australia.
- Perennial, Pasture Species for out of Season Production, Department of Agriculture WA and Meat and Livestock Australia
- Tim Wiley - Draft Perennial Pastures CD, Department of Agriculture, Geraldton WA.