Introduction to salinity - workshop development guide for facilitator

T M. Lacey
Department of Agriculture, Western Australia

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INTRODUCTION TO SALINITY

WORKSHOP DEVELOPMENT GUIDE FOR FACILITATORS:

National DRYLAND SALINITY Program
Know-how to tackle salinity

GRDC
Grains Research & Development Corporation
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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Insert local picture onto the cover of the Participants Notes with details of cover picture below.

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PREFACE

This Facilitators Guide is designed for use in conjunction with Participants Notes and Presentation material.

Notes with suggestions for facilitators on the running of workshops (running sheet) and additional comments relevant to the information presented in the Participants Notes are highlighted in the boxes in this document.

All other material is set out as in the Participants Notes for easy reference.

The PowerPoint presentations illustrated here and in the Participants Notes are in separate files available from the Department of Agriculture, Western Australia. The Guide for Facilitators and the Notes for Participants are available in PDF format from the website (http://www.agric.wa.gov.au).

CDs of all workshop files are available in Microsoft Word format or in the case of the presentation material in PowerPoint by contacting Jo Brown at the Department of Agriculture on (08) 9368 3710. These files can then be cut and pasted to incorporate relevant local data or to modify in other ways to meet your specific needs. Workshop material produced from these notes should acknowledge the Department of Agriculture, Western Australia (DAWA), GRDC and the National Dryland Salinity Program funding, and the authors of specific material.

**Note:** It is strongly recommended that those designing workshops based on these guidelines tailor the presentation material and notes for each specific group with local examples and information where possible. The specific needs of a participating group may dictate that some sections of this workshop are expanded, reduced or modified in other ways. As a facilitator you need to have an understanding of the participants needs and modify material appropriately. Review the learning outcomes at both at the beginning and the end of the modification process to make sure that you are meeting all of your desired learning outcomes.

When customising the documents or the PowerPoint presentation to meet the needs of a specific group, check that references to page numbers and slide numbers remain valid and that slides in the Participants Notes are in correct presentation order so that participants can follow them without getting lost. This may necessitate changing page or slide numbers in the Participants and/or Facilitators Notes.

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. These notes are a record of your discussions and any conclusions developed out of this workshop.
INTRODUCTION

Benefits:
Participants will be able to recognise landscape components on their farm, which are at risk of salinity (current, imminent or future) and will be aware of a range of available options available to them to managing this risk.

POSSIBLE ADDITIONS TO THE FORMAT OF THE WORKSHOP

Linking the workshop to other relevant activities such as the release of local management strategies or the announcement of funding opportunities can add incentive for participants to adopt management options. Introducing a local perspective from a farmer that has recognised the significance of salinity and been working to manage it can create a sense of ownership of the issues within the group. This can include information on when salinity first occurred after clearing, where it occurred and what has been done (and to what effect) to try and manage the problem.

RESOURCE CHECKLIST

The following resources should be sourced for the local area where possible to help make the day relevant to participants and enabling change in texture of the information being presented to cater for a range learning styles. Staff working for both government agencies (such as the Department of Agriculture) and private industry in the area will often have local information and props that can be borrowed or utilised for the day. Having invited experts in specific areas to either present some topics or to provide technical backup on the day is particularly useful.

Notes and handouts:
- workshop notes, facilitators notes, planning worksheet;
- quiz questions, glossary and other appropriate tools.

Reconnaissance:
- local photos for PowerPoint and indicator species, aerial photos;
- Leakage Calculator, modelling results (Flowtube, AgET);
- RCA reports, Land Monitor maps, matrix - saltland capability, history of field site.

Equipment:
- pens, coloured permanent felt tip pens to mark map;
- heading on flip chart in advance of meeting;
- shovel, ruler, hand-held salinity meter, plopper, water samples collected from field,
Salinity Calculator, props such as piezometer tubes, and chip trays from drill holes;

- specimens and guide to indicator species (manual and/or handout).

**FACILITATION OUTLINE CHECKLIST**

**PRE-WORKSHOP ACTIVITY**

**Tailoring the workshop to the needs of the specific group (making it relevant)**

Local Intelligence (background information on the participants, age range, gender, farming area, farm enterprises and previous seasons etc) can be important. It is useful to send participants some pre-workshop material briefly outlining topics covered and including a questionnaire to gauge their expectations. Alternatively, if there are only a small number of participants, this information can be gathered through telephone calls or in person. Take notice of the participant expectations, as you will:

- discover what it is they want to learn and what problems they want to solve;
- realise what their needs are;
- become aware of what they don’t know and conscious of what they need to know;
- identify marketing that needs to be done with the group (managing their expectations);
- understand some of the social, economic and environmental dynamics of the group.

Identify, collect and collate necessary information and supporting resources. Adjust workshop approach and contents to suit needs of participants. Remember to:

- ensure the content is relevant for participants;
- make certain the real needs and problems of the participants are addressed;
- identify sites for field trips and determine mode of transport;
- brief any technical speakers, focussing them on your learning outcomes;
- research the contact details of local consultants and contractors.

If adjustments are made to the PowerPoint presentations, make sure that the corresponding sections in the Guide for Facilitators and Workshop Manual for Participants are also adjusted. In addition, the Guide for Facilitators includes references to page numbers in the Workshop Manual for Participants. Because of this, make sure all references to page numbers match the section that they are referring to.

**Setting up a field activity**

The selected sites may vary in line with the group’s knowledge of the catchment.

Choose a site:
• typical for the area or showing specific characteristics relating to course content;
• close to the workshop venue (limit travel time);
• where indicator species are present (ungrazed, or at least not heavily grazed);
• with existing shallow bores and associated bore logs (desirable);
• with identifiable landscape features shown on map or aerial photo of the site;
• with a good viewing point to gain an overall perspective of the catchment issues;
• that can be introduced as part of an indoor exercise (before going into the field).

Make sure Occupational Health and Safety (OH&S) hazards associated with undertaking a site visit are assessed for potential risks. Be aware of the need for safety and implement controls accordingly.

Setting up the workshop
Organise venue with appropriate facilities including:
• adequate ventilation, heating and/or cooling;
• space for projection screen;
• lighting (ability to dull lights or block out light for overhead presentations);
• fridge, power for kettle, lunch facilities, coffee mugs;
• toilet facilities.

Arrange seating to encourage participation and participants’ ability to see and hear presentations (e.g. close to front, informal etc.). Tables can be useful for activities throughout the day.

The venue may need to be a compromise choice to be close to the field sites. In this case, makeshift alterations to the facility may be needed, for example, blacking-out windows, additional seating, fans etc.

Remember to provide water for speakers and tea/coffee and other drinks, plus food for the participants.

Agenda/structure
This Guide for Facilitators only shows one option for the structure of the workshop. It is possible to change the timetable to suit the needs of the participants. It is up to the facilitator to decide on the time spent on the various sections and on the activities to be conducted.
INTRODUCTION TO THE WORKSHOP

Duration: 15-30 mins (Depends on number of participants)

Purpose
To introduce the workshop, context participants’ expectations and explore the topic.

Suggested approach
- Introduce yourself and other guests/presenters and context the workshop. Introduce the material being used such as Participant Notes and how they should be used to follow the day's presentations and activities etc.
- If you are not an ‘expert’ in this field, make sure that the participants know this. Tell them that you are knowledgeable in the workshop content, but if they need more technical information they should let you know and you will get back to them. Another option is to have an ‘expert’ in attendance for part of the workshop to answer questions, or use them to present a specific section that they are experienced with.
- Ask participants to introduce themselves and outline their expectations from the workshop.
- Document participants’ expectations.
- Outline what participants will take away from the workshop.

There is a range of ways to do this! Including an energiser activity to get participants firing and “break the ice” is a good way to start.

Rather than going around the tables with formal introductions inside, take participants outside, form a circle, introduce yourself and context the workshop, explaining what participants should take away. Then throw a ball to someone else in the circle who does their introduction etc. and continue until all participants have had a turn. Have someone making notes of what participant expectations are.

Often the mood created at the beginning of the day will flow through the following sessions and can “make” or “break” the day as a “learning experience” for the participants. Special effort in this session can be well worthwhile.

PowerPoint presentation
Use this as a brief reminder for participants. Slides should include the aims of the workshop, learning outcomes for participants and a timetable for the day.

It may also be useful to have the timetable on butcher’s paper that can be pinned up on a wall for reference by participants and the facilitator during the day.
Housekeeping

- Emergency exits, tea, coffee, toilets;
- Ground rules for discussion - It is important to make sure that all participants are encouraged to have their say and respect the rights of others and their opinions. This is also a good time to reinforce expectations of areas to be covered and those areas that won’t be covered;
- Mobile phones turned off.
1) **What is the major cause of new salinity in the wheatbelt of WA?**

   a) Flat landscape  
   b) Surface water run-off  
   c) Rainfall  
   d) Clearing  

   Most of the salt in the soil profiles within our landscapes has been deposited by rainfall. Changes in the hydrological balances as a result of clearing have lead to rising watertables and the development of secondary salinity.

2) **How much has leakage changed from pre-clearing native vegetation to post-clearing annual cereal crops in the WA wheatbelt?**

   a) pre 0 mm  
   b) pre 0.1–1 mm  
   c) pre 10 mm  

   post 2 mm  
   post 6–60 mm  
   post 100 mm  

   (1 mm = 1 L/m²)

   Before clearing, recharge was in equilibrium with discharge from the system to drainage lines and salt lakes etc. This would have been greater than zero (depending on the season) and generally less than 1 mm. Post-clearing recharge under well-grown cereal crops in the wheatbelt of WA will vary depending on soil types and season but is likely to be in the order of 10 to 60 mm (equivalent of 10 to 60 L/m² leakage). Note that leakage is not an exact measure and will vary depending on soil type, landscape, tillage practices, rotations and seasons. Data for 750–1250 mm rainfall area shows recharge increasing from between 50 mL and 3.7 L/m² to between 23 and 65 L/m². That is the change in recharge from pre-to post-clearing can range from as little at six times to as much as 1300 times more depending on all your factors. In 350 mm average rainfall (George 1992) recharge rates have increased from less than 1mm to at least 6-10 mm/year.

   Ref. Pages 71–72 and Figure 3.16 page 72 South West Hydrological Information Package, Bulletin 4488, Department of Agriculture.

3) **What is the average % of cleared land in the wheatbelt of WA affected by salinity?**

   a) 5%  
   b) 9%  
   c) 15%
There are a number of estimates of the percentage of cleared land in WA affected by salinity. These vary considerably, but the figure is likely to be in the order of 9%. AusStats survey of “Salinity on Australian Farms Estimates” suggests 1.24 million ha of salt-affected land in WA (estimated by surveyed farmers in 2002) as compared to that estimated by “experts” (1999) of approximately 1.8 million ha affected by salinity to some degree. Land Monitor estimates are around 860-960,000 ha and the omission of barley grass country in this figure is a major error. This would mean that the actual figure is significantly higher than Land Monitor predicts.

**Farmers’ estimates are likely to be on the low side and the experts’ figures on the high side. The reality is likely to be somewhere in between these two figures and depends on what you choose to report on as saline land.**

Expert estimates are probably based on intermediate scale interpretation of air photo and satellite imagery and probably a generous estimate. Estimates by farmers are probably under-estimates that omit salinised land that is not scalded or barley grass flats country i.e. areas that can still be productive for grazing purposes or intermediate levels of salinisation. Farmer estimates would not include some areas that are owned by the Commonwealth. Some farmers who perceived they only have small areas of salinity (say <10-20 ha) may not have responded to the original questionnaire and are therefore not included in these figures.

4) **What is the projected growth in total salinity area by 2050+ as a percentage of total cleared land?**
   a) 7%
   b) 20%
   c) 30%

This figure is now possibly slightly high but stick with it because it’s still used widely. Without significant changes to current land use, about 3 million hectares will be affected by salinity by 2010-15, and 6 million hectares or 30% of the South West of WA, by the time a new groundwater equilibrium is reached.

5) **What is the major origin of the salt causing secondary salinity?**
   a) Underground aquifers
   b) Rainfall
   c) Atmosphere

Others include mineralisation and marine sediments. However, there are no marine sediments in the wheatbelt (east of Darling Scarp).
6) In what part of the soil profile is most salt stored?
   a) Pallid (clay) zone
   b) Aquifers
   c) Soil surface

7) What are the respective amounts of salt deposited annually WA?
   a) coast 1000 kg/ha/yr   inland 40 kg/ha/yr
   b) coast 200 kg/ha/yr   inland 20 kg/ha/yr
   c) coast 30 kg/ha/yr   inland 10 kg/ha/yr

8) What percentage of a catchment needs planting to perennials to make a big
    difference to salinity in the wheatbelt?
   a) 25%
   b) 40%
   c) 60-80%

Some more responsive dissected catchments will only need 40% perennials but most
areas will need in the order of 60-80%. Note though that some catchments will be near
the new equilibrium and benefits from planting perennials may be minimal. Where to
plant perennials for greatest benefit needs to be outlined.

9) On average, how much salt per hectare is stored in the ground in the
    wheatbelt?
   a) 2-3 t/ha
   b) 20-30 t/ha
   c) 200–21,000 t/ha

It would take hundreds of year for this level of salt to leach away. In the wheatbelt,
McFarlane and George (1992) found salt stores of 210–2265 t/ha under hill-slopes,
1170-5750 t/ha under valley floors and up to 21,310 t/ha under flats adjacent to salt
lakes. The high salt storage in the profiles has led to the development of saline
watertables.
### QUIZ

Circle the correct answers for the following questions.

1) **What is the major cause of new salinity in the wheatbelt of WA?**
   - a) Flat landscape
   - b) Surface water run-off
   - c) Rainfall
   - d) Clearing

2) **How much has leakage changed from pre-clearing native vegetation to post-clearing annual cereal crops in the WA wheatbelt?**
   - a) pre 0 mm post 2 mm
   - b) pre 0.1–1.0 mm post 6–60 mm
   - c) pre 10 mm post 100 mm

3) **What is the average percentage of cleared land in the wheatbelt of WA affected by salinity?**
   - a) 5%
   - b) 9%
   - c) 15%

4) **What is the projected growth in total salinity area by 2050+ as a percentage of total cleared land?**
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   - c) coast 30 kg/ha/yr inland 10 kg/ha/yr

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### Slide 1.

**Introduction to salinity**

- National Dryland Salinity Program
- Grain Research & Development Corporation

### Slide 2.

**Housekeeping**

- Emergency exits
- Ground rules for discussion
- Tea, coffee
- Toilets etc.
- Mobile phones turned off
WORKSHOP DETAIL

Quiz

Purpose
To give farmers a general background to dryland salinity and its causes. This can be used to gauge the level of detail requires in the initial sessions on where salt comes from and what has caused salinity. This can also act to stimulate conversation as an “Ice breaker activity” at the beginning of the day.

Suggested Approach
The time spent on the introductory sections needs to meet the needs of the group based on their current knowledge levels and exposure to the issues.

A multiple-choice quiz is an option to give an overall scope of what constitutes salinity and the impact it is having. (Questions should be altered to represent area or State relevant to participants.)

Option 1. Hand out quiz and get individuals to fill in answers. Include answers in presentation to follow. Quiz may be done as individuals or as groups. Groups will encourage discussion and be less likely to intimidate some participants.

Option 2. Use quiz as part of the presentation getting participants to answer each question before moving on to explain the correct answer. This will encourage participation and interaction as part of the day.

This half dozen multiple-choice questions will provide an appreciation of the current understanding within the group. There may be an opportunity to gather information from the group to give benchmark information, which may be useful in later evaluation of the process.
AGENDA

Time
8:30  Energiser: Aims of workshop
9:30  How hydrology interacts with geomorphology to create salinity?
9:45  Activity - What characterises the local landscapes?
9:45  Salinity risk at a local landscape level (What is happening in my area?).
10:15 Model results from Flowtube and AgET and land monitor predictions.
10:30 Break: morning tea
10:50 What is the risk at the landscape level (land monitor)?
11:15 Soil types and landscapes with the greatest risk of salinisation?
11:25 Identify symptoms of current salinity and signs of potential salinity
11:30 How salinity is expressed in association with soil types and landforms
11:40 Landscape map analogy for PURSL
  What units are used to measure/describe salinity? Optional
12:00 Pre–field Activity
12:30 Field Trip  Including lunch on bus
14:00 The effect of salinity on farm production and profitability
14:05 Waterlogging salinity interactions
14:20 Assess the salinity risk for your farm land – Cost of doing nothing
14:45 Preliminary appraisal of major potential management options for your business
  Optional workshops - Introduction to the STEP Workshops,
Deep drainage – Is it for me? Surface water management – Is it for me?, Lucerne – Is it for me?, Perennial grasses – Are they for me?,
Grazing saline land – Is it for me?
14:55 Summary of day
15:00 Evaluation
15:10 Close – Where to from here?
1. Introduction

General

This is the first in 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 individual. Participants will determine their courses 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.

Outcomes for participants

By the end of this workshop, participants will have made an initial assessment of the risk of salinity to their farming business and be aware of some options available to manage that risk.

Participants will be able to:

- Understand of the broad cause and risk of salinity at a landscape level;
- Recognise symptoms of salinity and potential for salinity;
- Calculate of the potential effect of salinity on farm production and profitability;
- Assess the risk of salinity to the farm;
- Identify a number of potential management options.
- Understand the need to develop a transition strategy for adoption of new management options.
Slide 3.

Review options for managing salinity

- Introduction to Simulated Transitional Economic Planning as a tool to evaluate options
- Optional workshops being produced on key salinity management practices
- Assess the primary risk of salinity to your farming business and appraise the options available to manage this risk

Slide 4.

Outcomes for Participants

- Assessment of risk of salinity to farming business
- Awareness of some options to manage risk
  - Understand the cause and risk of salinity
  - Recognise symptoms and potential for salinity
  - Calculate implications to production and profitability
  - Assessment of risk of salinity to your farm business
  - Identify some potential management options
  - Understand the need to develop transition strategies
2. Understanding the cause of salinity

**Presentation - Where salt comes from**
- This section can be used to answer quiz questions or
- in answering the quiz and depending on the group’s understanding, this section may be briefly skipped over.

Before moving on (from the quiz) to the next section, ask how they went and if they need any further clarification in relation to questions and answers.

**Where does salt come from?**

**Salt store**
Salt store increases as you go east due to the low landscape relief, more sluggish drainage and greater depth of regolith.

- Pre-clearing recharge was in equilibrium with discharge from the system to drainage lines and salt lakes etc. This would have been greater than zero (depending on the season) and generally less than 1 mm. Post-clearing recharge under well-grown cereal crops in the wheatbelt of WA will vary depending on soil types and season but is likely to be in the order of 10-60 mm (equivalent of 10-60 L/m² leakage).
- Following clearing and the further expansion of groundwater systems, increasing recharge and rising watertables have dissolved this salt and concentrated it downstream.
- When saline watertables get to within 1–2 metres of the soil surface (depending on soil properties), capillary rise can transport the dissolved salts into the root zone affecting plant growth and leading to the development of salinity.
- A new equilibrium will be reached when the area of discharge from the watertable has expanded to compensate for the increased level of recharge to the system created by the change in vegetative cover etc.
Slide 5.

Where does salt come from?

1. Main source - deposited by rainfall over tens of thousands of years
   - 20–200 kg/ha/yr is deposited each year

2. Other sources are:
   - Weathering of minerals in the underlying bedrock
   - Salts in alluvium originating as marine sediments
     (not in wheatbelt)

Slide 6.

Equilibrium

[Diagram showing water movement and the watertable]
What causes secondary salinity?

Discussion or Presentation – What causes secondary salinity?
How changes in hydrology interact with salt store to cause salinity.
Impact of clearing on hydrology.
Use photos to generate discussion relating to the changes from pre- to post-clearing.
These are examples of photos showing natural vegetation pre-clearing vs cleared farmland. Local photos should be used if they are available or take your own.

Comparison of native vegetation to farming systems
Perennials are growing for 12 months of the year over a number of years.

- Summer growth provides the ability to utilise summer rainfall developing a soil moisture buffer prior to winter. The difference between the soil moisture following perennials 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 – Perennials grow for a number of seasons extending their roots down into the soil profile. This enables them to penetrate deeper, using more water from greater depth and creating a greater soil water buffer.

- Diversity – a range of species creating a canopy and understorey, providing 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 where as annuals’ leaf area index drops away to zero when the plants die off. Evaporation will 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, not to replace it. It is realised that replanting up to 80% of the landscape to trees is not a current option for profitable agriculture.

Mimicking the natural system
This includes being able to use water, preventing recharge and nitrate leaching (reducing development of acidity), preventing wind and water erosion and protecting soil structure.

To help manage watertables, we need management systems that can mimic the function of native vegetation without replanting it. Without high value plantation options available for most of the wheatbelt, planting large proportions (60–80%) of farms back to woody perennial vegetation is unrealistic. Profitable options that mimic some of the functions of the previous remnant vegetation are needed to enable farming to continue on the majority of land.
Western (high rainfall) areas generally receive greater than 450 mm annual rainfall. Eastern areas generally receive less than 350 mm annual rainfall. There will be a gradual decline in rainfall from west to east.

What causes secondary salinity?
- Salt stores in regolith - 200–21,000 t/ha
- Recharge increased dramatically after clearing
- Groundwater risen and saline areas have expanded
- It will take hundreds of years to flush salts from most cleared catchments
- New equilibrium
  - western areas 20-30 years after clearing
  - eastern areas 60-70 years after clearing
- Equilibrium - greater area of discharge compensates for recharge

What are the characteristics of native vegetation?

How have they changed with current farming systems?

Slide 8.

Causes of salinity

- Low recharge
  - Rainfall 750-1250 mm/yr
  - 350-400 mm/yr
  - Currently estimated that 9% of cleared land is saline and could double in next 20 years

- High recharge
  - 0.05-3.7 mm/yr
  - 0.01-1.0 mm/yr
  - 6-65 mm/yr

What were the causes of salinity?
- Salt stores in regolith - 200–21,000 t/ha
- Recharge increased dramatically after clearing
- Groundwater risen and saline areas have expanded
- It will take hundreds of years to flush salts from most cleared catchments
- New equilibrium
  - western areas 20-30 years after clearing
  - eastern areas 60-70 years after clearing
- Equilibrium - greater area of discharge compensates for recharge

Slide 9.

Mimic the function of native bush
- Water-use (prevention of recharge, nitrate leaching)
- Wind and water erosion prevention
- Soil structure
Local situation - vegetation remaining
The area of remnant vegetation in the WA wheatbelt is generally low, ranging from 5 to 10%. The vegetation remaining is generally fragmented and lacking genetic diversity. It is often found on hilltops or along drainage lines.

Leakage from crops and pastures compared to perennial vegetation

Generate discussion on the areas of remnant vegetation remaining in the area and back up with local figures.
Use the Leakage Calculator to illustrate the difference in water use from a range of crop and pasture rotations using local information on recharge is available as per the attached table.
Describe the Leakage Calculator, how to read it, how it can be used to evaluate the recharge for paddocks and the threat from leakage to rising watertables and potential salinity on the farm.

Note: The figures for leakage as a percentage of annual rainfall are only an indication based on an average season’s rainfall and standard soil and crop parameters. It is valid to look at the relativities between rotations and soils but the figures should not be treated as actual leakage. In low rainfall years leakage will be reduced and may be low even under pasture; in high rainfall years even the perennials can’t use all of the rainfall immediately.

The Leakage Calculator shows leakage (in mm/yr) for a range of land use options over a number of common soil types for the region. The level of leakage is indicated as being high, medium or low, based on total mm leakage and the permeability of the soil. If the drainage on a soil is low, a small amount of leakage will eventually fill it up whereas the same leakage on a more permeable soil will drain from the system. The total mm of drainage coming from different parts of the farming system are based on soil types and cropping rotations (calculated by AgET).

Note: The figures for leakage as a percentage of annual rainfall are only an indication based on average season’s rainfall and standard soil and crop parameters. It is valid to look at the relativities between rotations and soils but the figures should not be treated as actual leakage. In low rainfall years leakage will be reduced and may be low even under annuals; in high rainfall years even the perennials can’t use all of the rainfall immediately.

The main difference in leakage is between bare soil, annual crops or pasture, and perennials. The differences in water use between different annual crops and pastures are generally quite small in comparison and will vary from year to year. No one annual crop is likely to be significantly better or worse than another. However, failed crops and bare soil will have significantly higher leakage.
What is the area of remnant vegetation around Green Hills?

Slide 10.

Causes of salinity - vegetation

Remnant vegetation remaining:
- 5.1% West Mortlock (Goomalling-Dalwallinu)
- 4.8% East Mortlock (Meckering-Koorda)
- 2.7% Green Hills area.

Management options need to
- long-term sustainability
- Manage range of resource issues
- Integrated suite of options

Slide 11.

Equilibrium
Recharge = discharge

Slide 12.

Leakage from crops and pastures compared to perennial vegetation

Introduction to salinity - Facilitators Guide
Buffers created by perennials
When we refer to buffers in soil water created by perennials we are referring to the difference in soil water content under a perennial plant compared to the content under an annual crop or pasture. This buffer is the amount of extra water that can be accommodated before leakage below the plant roots will occur.

The following output sheet from LeBuM (Lucerne Buffer Model created by Phil Ward, CSIRO Floreat) shows the leakage under a number of soils based on Northam rainfall data (for the given input data listed below). This model calculates how long a particular buffer created by lucerne will last based on actual rainfall data, giving minimum, maximum and average periods (years) that the buffer will last.

The length of time that the buffer lasts is dependent on the soil type and the run of seasons. A buffer of 150 mm in the Northam Shire will last from as little as one year to as long as 18 years (with an average of five years) depending on the run of seasons and soil types.
It is important that the length of the cropping phase following three years of lucerne be modified to accommodate the run of seasons and specific soil types rather than cropping for a set period.

Worksheets
Introduce worksheets that participants will be using throughout the day to record the level of risk/threat salinity poses on their own farms. Participants should be given time and encouraged to fill these in for their own farms. This is designed to have the participants apply concepts learned, to their own situations. Worksheets will provide participants with a snapshot of their thinking throughout the workshop.
Slide 13.

**Central Wheatbelt Rotations**

Soil-Landscape Zone 258

**Bare soil**

Representative Location: Cunderdin

**Crop**

MAR (mm) 370

- P annual pasture
  - Serradella
  - Perennial grasses
  - Lucerne
  - Oil mallees
  - Salt bush

**Soil Type** & **Soil Group**

- **S1**: Poor sands
  - 446 42 12 14 10 6 2 0 2
- **S2**: Average sandplain
  - 464 38 10 11 8 4 2 0 1
- **S3**: Good sandplain
  - 303 29 4 5 4 1 0 0 1
- **S4**: Shallow duplex soil
  - 502 9 2 4 4 1 0 0 0
- **S5**: Medium heavy
  - 463 22 2 4 2 1 1 0 0
- **S6**: Heavy valley floors
  - 542 13 1 1 1 0 0 0 0
- **S7**: Sandy surfaced valleys
  - 402/404 19 4 5 5 0 0 0 0
- **S8**: Deep duplex soil
  - 407 21 2 4 4 1 1 0 1

High Leakage: greater than 5% of MAR or greater than 10% of MAR for permeable soils

Moderate Leakage: 2.5% to 5% of MAR or 5% to 10% of MAR for permeable soils

Low Leakage: less than 2.5% of MAR or less than 5% of MAR for permeable soils

---

Slide 14.

**Buffers created by Perennials**

**Input data**

- % of perennial (0-10)

**Max buffer developed by perennial (mm)**

- Average Leakage under annuals (mm)
  - 38.1
  - 37.7
  - 37.8
  - 36.7
  - 98.6

- Average Leakage under new rotation (mm)
  - 25.1
  - 19.9
  - 15.6
  - 13.5
  - 16.3

- Average years of crop before buffer is filled
  - 3.3
  - 3.5
  - 5.5
  - 2.2
  - 5.5

- Minimum years of crop before buffer is filled
  - 1.0
  - 1.0
  - 1.5
  - 1.0
  - 1.0

Source: Lucerne Buffer Model (LeBuM) developed by Phil Ward

---

Slide 15.

**Leakage on Farm**

Prioritise paddocks in relation to leakage “Risk”

**Paddock** & **Area (Ha)**

- Example Back paddock: 40

**Land Use** & **Main soil type**

- C, P, Lu, WP

**Rating Soil Type X Rotation** & **Priority Paddocks**

- H (21% leakage)

---

Farm details

What is your % of annuals?

What are your main rotations?

Would you class your farm in the High, Medium or Low Leakage category?

**Rotations:**

- C = crops (annual)
- P = pasture (annual)
- Lu = lucerne (perennial pastures)
- WP = woody perennials

---

Introduction to salinity - Facilitators Guide
Worksheet - Priority paddocks based on leakage
(Fill in some paddocks on your farm based on the Leakage Calculator output below).

<table>
<thead>
<tr>
<th>Paddock</th>
<th>Area (ha)</th>
<th>Rotation C, P, Lu, WP</th>
<th>Main soil type</th>
<th>Rating soil type X rotation</th>
<th>Priority paddocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example Back paddock</td>
<td>40</td>
<td>CP</td>
<td>Deep sand</td>
<td>H (21% leakage)</td>
<td>1</td>
</tr>
<tr>
<td>1 .................</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 .................</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 .................</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 .................</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

C=crop, P=pasture, Lu=lucerne, WP=woody perennials

Table 1. Leakage Calculator output

<table>
<thead>
<tr>
<th>Central Wheatbelt</th>
<th>Soil-Landscape Zone</th>
<th>Representative Location</th>
<th>MAR (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>258</td>
<td>Cunderdin</td>
<td>370</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Soil Group</th>
<th>B</th>
<th>C</th>
<th>P</th>
<th>Se</th>
<th>G</th>
<th>Lu</th>
<th>OM</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1 - Poor sands</td>
<td>446</td>
<td>42</td>
<td>12</td>
<td>14</td>
<td>10</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>S2 - Average sandplain</td>
<td>464</td>
<td>36</td>
<td>12</td>
<td>14</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>S3 - Good sandplain</td>
<td>303</td>
<td>29</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>S4 - Shallow duplex soil</td>
<td>502</td>
<td>9</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S5 - Medium heavy</td>
<td>463</td>
<td>22</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S6 - Heavy valley floors</td>
<td>542</td>
<td>13</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S7 - Sandy surfaced valleys</td>
<td>402/404</td>
<td>19</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S8 - Deep duplex soil</td>
<td>407</td>
<td>21</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

Summarise for the whole of farm!

What is your % CROP and PASTURE? Crop %, Pasture %

What are your main rotations?

What main soil types do you have?

What percentage of your farm would be High, Medium and Low leakage categories?

% High =

% Medium =

% Low =

---

Introduction to salinity - Facilitators Guide
### Slide 16.

**What factors control leakage on your property? Let’s work it out**

- **Central Wheatbelt**
  - **Soil-Landscape Zone** 258
  - **B bare soil**

#### Central Wheatbelt Rotations

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>% Area</th>
<th>Typical Area (ha)</th>
<th>Actual Area (ha)</th>
<th>Total Leakage (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S8 - Deep duplex soil</td>
<td>3.0%</td>
<td>3,000</td>
<td>4,000</td>
<td>1,000</td>
</tr>
<tr>
<td>S7 - Sandy surfaced valleys</td>
<td>8.5%</td>
<td>13,000</td>
<td>17,000</td>
<td>4,000</td>
</tr>
<tr>
<td>S6 - Heavy valley floors</td>
<td>17.8%</td>
<td>9,300</td>
<td>31,000</td>
<td>12,000</td>
</tr>
<tr>
<td>S5 - Medium heavy</td>
<td>12.5%</td>
<td>10,500</td>
<td>12,600</td>
<td>5,000</td>
</tr>
<tr>
<td>S4 - Shallow duplex soil</td>
<td>13.9%</td>
<td>27,000</td>
<td>0</td>
<td>6,000</td>
</tr>
<tr>
<td>S3 - Good sandplain</td>
<td>11.7%</td>
<td>45,500</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>S2 - Average sandplain</td>
<td>16.4%</td>
<td>129,500</td>
<td>18,000</td>
<td>4,800</td>
</tr>
<tr>
<td>S1 - Poor sands</td>
<td>16.2%</td>
<td>66,000</td>
<td>93,600</td>
<td>0</td>
</tr>
</tbody>
</table>

#### Working out leakage on your property

- **Option 2** - Areas input in hectares

#### The Leakage Calculator is available from the Department of Agriculture website.

- **Option 2** - Area input in hectares

#### What factors control leakage on your property? The Leakage Calculator works it out for you

- **Volumes of leakage in cubic metres**

#### Introduction to salinity - Facilitators Guide
How hydrology interacts with geomorphology to create salinity

Presentation
Purpose
To give farmers a general background to hydrology in the landscape.

Suggested approach
Present information on recharge, discharge and concepts of water movement and leakage. Props such as chip trays from drilling and piezometers can be used to give a hands-on component.

Relating the different common hydrology scenarios to specific sites within the catchment, highlighting them on a catchment map, or with photos and if applicable in relation to the field activity can again create a degree of ownership and the realisation of how the issues are affecting their catchment.

Piezometers and aquifers
A perched aquifer/groundwater is an unconfined aquifer (in a saturated condition) near the soil surface and separated from deeper groundwater by unsaturated materials. These are often shallow, thin and ephemeral (temporary) and sit on top of materials with low permeability.

An unconfined aquifer has no aquitard (barrier) above it. The watertable may rise or fall freely as water enters or leaves the aquifer.

A semi-confined aquifer is overlain by a layer that partly restricts the upward movement of water.

Landscape x hydrology - common scenarios

Valley floor - Lateral movement of water may be particularly slow depending on soil types, saprock (mm/yr).

Watertable rise will increase the area of shallow watertables and the potential for salinity. Shape of the valley will impact on the rate of spread of salinity.

Broad flat valley floors may have a mound in the watertable under them. This is thought to result from being cleared for longer (often the better soils that were cleared first) and the additional water received as run-on from other parts of the catchment. These areas also tend to have low hydraulic conductivity with lateral movement of water through them often only being in the order of several millimetres per year. Managing recharge on these at risk-areas (with watertables at depths of 3 to 5 m) is likely to significantly delay the development of salinity on them.

(See Reference: R.J. George et al.)

Break of slope - Water is often forced to the surface by a reduction in the slope of the watertable or through a constriction of the watertable (reduced thickness or transmissivity of the aquifer).

This area will often receive run-on from the slopes.

Geological constrictions - Where many structures are present, the catchment may be compartmentalised. The benefit/cost of treating compartments can often be considered separately. Where high value infrastructure is present the value from preventing watertable rise will be greatest. Structures may be seen by rock formations or by change in soil types.
Slide 19.

Aquifers and Piezometers

- Perched
- Unconfined
- Semi-confined
- Bedrock
- Saprock - insitu clay/quartz/rock
- Saprolite - insitu clay

20-30m

Slide 20.

How to interpret landscape by hydrology diagrams

- Topographic low discharge
- Discharge site
- Watertable
- Regolith
- Horizontal scale
- Vertical scale

Slide 21.

Causes of salinity

- Groundwater flows towards valleys
- Dissolves stored salts from the regolith profile
- Rises to within root zone or critical capillary depth salinity occurs
- Heavy clay (~ 2 m), sandy soils (~ 0.5 m)

Typical landscape x hydrology common scenarios

Valley floor

Introduction to salinity - Facilitators Guide
What characterises the local landscapes?

**Discussion and Presentation**

**Purpose**
To provide an overview of hydrology, hydrogeology, soils and recharge on them.

**Suggested approach**
Contact a local hydrologist for information and collect Rapid Catchment Appraisal (RCA), focus group reports, bore data etc. Understand the local situation in relation to hydrology and landscape. Maps of soil types, bore data on watertable rise, and structures such as dolerite dykes are useful.

Discussion - Relate local landscapes and hydrology to landscape diagrams.
Ask participants to identify the local landscapes. Take notes on whiteboard/flip pad.

Group discussion - What salinity processes are occurring?
Separate participants into small groups of approximately four. Have them discuss the salinity processes that are occurring in the local area. Allocate each group a relevant local landscapes to discuss.
Have groups present their thoughts and involve whole group in discussion.
Present (one or two overheads) diagrams to describe local situation as a brief summary to discussion. Locating examples on a catchment map can be useful.

**Worksheet 1 - Hydrology, hydrogeology, soils and recharge on them**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the magnitude of the salinity problem on your farm and in your local area?</td>
<td></td>
</tr>
<tr>
<td>Is it changing and at what rate?</td>
<td></td>
</tr>
<tr>
<td>Hill-sides:</td>
<td></td>
</tr>
<tr>
<td>Valleys:</td>
<td></td>
</tr>
<tr>
<td>How deep are the watertables?</td>
<td></td>
</tr>
<tr>
<td>Hillsides:</td>
<td></td>
</tr>
<tr>
<td>Valleys:</td>
<td></td>
</tr>
<tr>
<td>Are they rising and at what rate?</td>
<td></td>
</tr>
<tr>
<td>Hillsides:</td>
<td></td>
</tr>
<tr>
<td>Valleys:</td>
<td></td>
</tr>
<tr>
<td>How does this relate to the future development of salinity in the area?</td>
<td></td>
</tr>
<tr>
<td>List examples of salinity in the catchment that are associated with the various landscape scenarios?</td>
<td></td>
</tr>
</tbody>
</table>
Page 23 from Participants Notes

Slide 22.

**Causes of salinity**

- Groundwater flow is restricted by aquifer transmissivity (deep) or aquifer thinning (perched/sandplain) and expresses itself at the surface
- Many areas of salinity are caused by surface water problems (e.g. roads, small culverts, inundation from slopes without earthworks etc.)

**Break of slope - Reduced transmissivity or thinning of the aquifer.**

---

Slide 23.

**Causes of salinity**

- Groundwater is unable to flow past geological constriction and builds up until it nears the surface

**Geological constrictons.**

- Man-made structures such as roads may have an impact on hydrology.

---

Slide 24.

**Summary of causes of salinity**

- Recharge levels increase dramatically post-clearing
- Salt stores in regolith around 200–300 t/ha (increasing as you go east)
- Estimated to take hundreds of years to flush salts from most cleared catchments
- Groundwater risen and salinity expanded - recharge
- Equilibrium in western areas - 20-30 years, eastern areas 60-70 years (area of discharge is great enough to compensate for recharge)
3. Recognising salinity

Flow Tree for Evaluating the Risk of Salinity and Determining Management Options Available to Farmers

**Purpose**
To relate dryland salinity and its causes to local landscape so that farmers understand what is happening in their area.

**Suggested approach**

**Presentation and hands on - Introduce Salinity Options Flow Chart**
Refer to “Flow Tree” handout - for Evaluating the Risk of Salinity and Determining Management Options Available to Farmers.

**Emphasise** that this flow chart is a tool to help structure the process of identifying areas at risk from salinity on the farm. Hand out charts and take farmers through the chart in steps with them following through on their copies.

This salinity decision tree has been designed as a tool that can be used to help follow through a logical process when considering the on-farm risk of salinity and subsequent management options available. Before committing to management options it is important to review future objectives and priorities for the farm. *(See Flow Tree handout.)*

- How do you envisage your farm will look in the short (0-5 yr), medium (6–20 yr) and long-term (21+ yr)?
- What are your current objectives for the farm in regard to long-term sustainability (i.e. maintaining status quo, short-term profitability etc.)?
- What are the priority issues with regard to resource management on the farm? (wind erosion, water erosion, soil acidity, soil structure decline, waterlogging or salinity etc)?
- What is your current ability to invest in long-term objectives? (Are there short-term imperatives that need to be addressed as a high priority?)

The options listed are suggestions only and may not be suitable under all situations. More detailed information on all of the options is available through your local Department of Agriculture, private industry or some grower organisations - do your homework.

Not only is it important to look at “what” management option is suitable BUT also “how” it is introduced to the current farming system. How you introduce a new management option can significantly affect the profitability of the farm.
High salinity - Suited to highly salt tolerant species, including blue bush, puccinellia, salt bush. See soil and water salinity calculator.
Salinity risk at local landscape level (What is happening in my area?)

All bores shown in Figure 1 have rising trends with greatest rate of rise at the lower and mid-slopes where salinity is yet to develop. Slight reductions in piezometric heads will be measured following dry seasons. MO3D has no statistical correlation with either rainfall or time variables suggesting it is affected by local subsurface variables (e.g. preferred pathways or impermeable barriers).

Based on information from other catchments in the area, salinity in the deeper saprock aquifer is likely to vary from brackish to saline across the catchment, with valley floor salinity being highest. The slightly higher relief areas mainly form local flow systems that may have groundwater of suitable quality for most livestock purposes. Groundwater systems in the catchment can be categorised into local and intermediate flow systems, depending on their area of influence, recharge/discharge characteristics and the ease with which they can be perturbed by land management practices.

- Local flow systems are typically unconfined (perched) aquifers (principally in deep sands, shallow sands, sandy earths and deep and shallow sandy duplexes) or semi-confined (saprock) aquifers localised by geological structures such as bedrock highs or dolerite dykes. The intermediate flow systems comprise the deeper continuous saprock aquifer that extends over most of the catchment.
- Local flow systems are often linked to intermediate flow systems by both matrix and preferred pathway recharge mechanisms. Local flow systems are more apparent in the higher relief, more compartmentalised western catchment area. They are generally more responsive to strategies that attempt to remediate groundwater rise at a paddock scale than intermediate flow systems.

George and Conacher (1993) studied this linkage in a small hill-slope catchment 17 km WNW of Narrogin. They concluded that significant recharge occurs by preferred pathway flow (in macropore channels) following saturation of the A horizon (topsoil) after major rainfall events.

- Unconfined (perched) aquifers, particularly the shallow and deep sandy duplex soils in lower slope and valley floor landscape positions, contribute significantly to waterlogging. Most unconfined aquifers (except those with a base of competent rock) also contribute to recharge of intermediate semi-confined aquifers (George and Conacher 1993).
- In these local flow systems, rainfall primarily contributes to the unconfined (perched) aquifer of duplex soils and discharges further downslope in ephemeral streams. A portion of this unconfined water will contribute to the deeper semi-confined intermediate flow system via preferred pathway recharge.
- Significant elevation difference along a confined or semi-confined aquifer increases the groundwater pressure head of the lower sections of the aquifer. In artesian systems, the pressure head in the down-gradient section of the aquifer is above the ground surface, and a free flowing well may establish. Semi-confined aquifers, particularly in zones of groundwater convergence, can yield stock quality water between 50 and 250 m$^3$ per day (George 1991).
- Continued salinisation in the catchment will occur where:
1. Groundwater levels become sufficiently shallow enabling evaporation of the capillary fringe and salt concentration at the surface, as is the case in most valleys. The rate of capillary rise and height of the capillary fringe depend on soil type. Capillary rise may occur in fine-textured (heavy) soils when the water level is within 2 m of the surface (e.g. clays can have a 2 m capillary fringe). In coarse-textured soils, the capillary fringe is much thinner and so evaporation and salt concentration may only occur when the watertable is much shallower.

2. An area is seasonally inundated or becomes waterlogged. Over time, the reconcentration of fresh to brackish surface and soil water will lead to the accumulation of moderate to high levels of salt through evaporation.

3. Coarse-textured unconfined aquifers terminate over an impermeable layer (e.g. duplex subsoil) allowing water to seep to the surface and evaporate, leaving behind salts. Sandplain seeps will be more common in the west of the catchment.

4. Bedrock and geological structures (such as dykes) act as barriers to groundwater flow, resulting in groundwater accumulation and subsequent rise towards the surface.

General information for the South-West of Western Australia shows that shallow piezometers located near discharge zones typically have little variation in water levels due to evaporation and use by vegetation (equilibrium). Deep piezometers intercepting semi-confined aquifers in similar locations often display rates of rise in the order of 10 cm/year, possibly signifying the presence of an upward vertical hydraulic gradient that may ultimately increase discharge area. Upper and mid-slope catchment areas where recharge dominates usually have groundwater rise in the order of 30 cm/year. With the general exception of shallow piezometers located in discharge areas, seasonal fluctuations of 0.5 to 1 m over an average rainfall season across different landscape positions are common, indicating groundwater response to individual recharge events—(see Mackie River RCA Report).
Figure 1. Example of local groundwater trends.

Use local bore data or data from a comparable catchment to indicate the importance of monitoring, watertable levels and rates of watertable rise.
Slide 26.

Slide produced by: T Lacey

Slide 27.

Slide produced by: T Lacey

What's happening locally?

- Hydrology - general trends likely to be up based on other catchments, no data
- Recharge - increased since clearing. Highest on sandy, gravelly and shallow duplex soils
- Long period since clearing - 100+ years - new equilibrium may have been reached?
Model results from Flowtube, AgET and Land Monitor predictions

Present any model findings relating to risks (not output) – may include some detail in Participants Notes if thought to be relevant. Easy to get bogged down in detail and this will detract from the bigger picture.

It is important to note that altering farming systems to include some phased crop and perennial pasture rotations can significantly reduce recharge without major changes to the total area of crop and pasture. However, changing from continuous annual pasture to crop-annual pasture rotation or to continuous cropping will only reduce recharge slightly. The use of lucerne and woody perennials in farming systems is considered highly beneficial, as they use almost all of the annual rainfall. Surface water management and engineering options should be part of an integrated system developed for recharge management.

Note: Flowtube modelling cited in this report assumes a constant annual rate of recharge. It does not take into account episodic recharge (high rainfall/flood events which often results in watertables rising and not lowering to their previous, deeper levels). Another major assumption is that all strategies implemented take effect immediately with full potential e.g. lucerne is transpiring water at its full potential from the moment it is included in the program.

Recent modelling is suggesting
Specifically, farmers at most risk should not expect hill-slope recharge management to significantly influence the magnitude of their salinity risk. Valley farmers can provide their own in situ risk management, and “buy time” by recharge management. This provides a significant environmental and economic advantage to those at risk who currently have deep (say 3-5 m or more), but rising valley watertables.
Slide 28.

Tools available to evaluate problem

- Land Monitor maps - future and current salinity
- Flowtube modelling, AgET, Leakage Calculator
- Physical markers and local knowledge
- Vegetative indicators
- Soil test 1:5 EC
- Geophysics - EM38, EM31, magnetics, radiometrics
- Drilling/piezometers for groundwater

Slide 29.

Modelling - Flowtube, AgET (East Mortlock)

Four options for intervention

- Do nothing - Recharge under existing mix of rotations is estimated to be 11% of annual rainfall
- Low intervention - Reduce recharge to 9% of annual rainfall (perennials from 5 to 14% of catchment)
- Moderate intervention - Increase perennials to 19%, reduce recharge to 8% of annual rainfall
- High intervention - Recharge reduction of 50% could be achieved through widespread adoption of perennial pastures, alley farming, tagasaste and oil mallees

Slide 30.

Area of saltland in WA

Source: Land Monitor

Introduction to salinity - Facilitators Guide
What is the risk at the landscape level (Land Monitor)?

**Presentation and hands-on with Land Monitor maps - What is the risk at the landscape level**
This will including predictions for the future, extent, timing and severity and may be linked to catchment appraisal reports or regional strategy documents etc. Overheads showing Land Monitor for the area. Explanation of each of the various levels of risk at the generic level before introducing the satellite image etc.

**Introduction to Land Monitor - Salinity maps**
These maps show areas where salinity has reduced plant cover in the low-lying areas and valley floors. They indicate a comparison of the extent of salinity in the years 1987-92 and 1995-98. The method involves the processing of historic calibrated Landsat satellite imagery in conjunction with elevation data and ground information to identify areas of land that are salt-affected. They are not 100 per cent accurate, but are better than 90 per cent in the wheatbelt. There are two types of errors: saline areas with unusually dense vegetative cover, as in the higher rainfall areas and mid-slope seeps which are usually too small to be detected by remote sensing (omission errors); and non-saline areas are sometimes mapped as saline when they are located in valley floors and are consistently unproductive – examples are waterlogged, overgrazed, or somehow deficient soils (commission errors). So there are regular mistakes in the maps, but they give a reasonable view of where the main saline areas are. They probably shouldn’t be used at paddock/farm scale, but are useful at catchment scale – i.e. 1:50,000.

**Ortho-photos** - Aerial photos are rectified using digital elevation models to produce ortho-photos. Ortho-photos are suitable to produce maps down to 1:10,000 scale and in some cases 1:5,000 scale.

DLI (Department of Land Information) coverage of ortho-photography will be increased with new photography over the agricultural area from Land Monitor.

Land Monitor has identified valley floor areas where the risk from future shallow watertables is likely to be greatest by combining the location of current salinity, digital elevation model data and surface water accumulation models. These maps shouldn’t be used at paddock/farm scale, but are useful at catchment scale – i.e. 1:50,000, and indicate areas for further investigation. Areas mapped as being susceptible to a shallow watertable were done so by height above catchment water flowpaths. These areas accumulate water from the rest of the catchment. The lower sequence (0-0.5 m above flowpath) will be most vulnerable to a shallow watertable, followed in order by the rest of the sequence (Overhead 19). The area of upper catchment affected by shallow watertables caused by seepage, bedrock interaction and/or dykes is not included in the estimation.
Slide 31.

What's my risk? - Land Monitor

- Salinity in 1995-98
- Vegetation

Source: Land Monitor

Slide 32.

What's my risk? Land Monitor

Increasing area affected by shallow water table in 0.5 m increments above flowpath.

Source: S Ghauri

Slide 33.

What's my risk? Land Monitor

Valley floors - not a prediction of areas that will become saline in the future.

Blue areas on the map indicate valley floors but are not a prediction of areas that will become saline in the future.

Source: Land Monitor
Height above valley floor:
It is important to note that not all these areas will become saline, as soil variations and groundwater quality beneath these locations are critical factors in determining their susceptibility to salinity. For example, in some areas of the catchment, groundwater may be fresh and therefore pose no major threat. Also, areas mapped as at risk may have a deep sandy soil with minimal capillary fringe, thus preventing capillary rise from causing salinity, even over the longer term.

Valley hazard maps (Valley floor/low-lying area maps):
These are not “salinity risk maps”; nor do they identify areas with rising groundwater or watertables. They are topographical maps derived from digital elevation models (DEMs) and simply show low-lying areas. They show ‘valley floors’ where the country is reasonably dissected (so that surface water flowpaths can be identified), or where the country is so flat that it has basin drainage. Some of these valley floors/low-lying areas may become saline and/or waterlogged in the future, but that will be determined by a range of other hydrological factors. In many of the relatively stable parts of the wheatbelt, the groundwater may never rise close enough to the surface for salinity to express itself. By themselves, these maps are not a useful indicator of areas of hydrological risk, but when other layers of hydrological information are added, they can become a useful indicator. These maps are also useful in defining the general shape of the landscape, and showing where catchment divides occur (particularly in non-rejuvenated landscapes where slope-changes are difficult to determine by eye).

Group interpretation (small groups) of local Land Monitor information
Divide into groups of three or four farmers. Groups to present outcomes.

- How accurate are the salinity valley floor maps for their area?
- Are there significant areas at risk within the local area and at the farm level?

Interact with groups as they develop their ideas.
Allow 15 minutes for activity and 10 minutes presentations.
Fill in worksheet sections, for areas at risk on their individual farms. Reiterate scale and use of Land Monitor at different scales (guide only).
Figure 2. Example of valley hazard map

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

• Current salinity in red/orange from salinity maps

Source: Land Monitor
Slide 34.

Current salinity in red/orange from salinity maps. Valley floors at greatest risk in purple. Monitor groundwater levels in risk areas.

Slide 35.

Recharge on soil types

Look at maps
How accurate are the salinity valley floor maps for your area? Are there significant areas at risk within the local area and at the farm level?

Mark areas of high recharge on property photos
Identify symptoms of current salinity and signs of potential salinity

Presentation and Discussion

Purpose
Farmers able to recognise signs of salinity and potential salinity.

Suggested Approach
Present information on soil types and landscapes with the greatest risk of salinisation. Discuss land management units/soil categories and allocate salinity risk. Utilise soil maps to help identification of high recharge areas on farms. Have participants mark areas of valley floor and high recharge potential on their property photos. Participants to assess risk to farm from recharge and salinity - fill in worksheets.

How salinity is expressed in association with soil types and landforms
Examples:
- creek lines, valley floor pools
- position of the change of slope
- broad soil types and obvious management units.

Geological structures such as fault lines, dykes and bedrock highs have significant impact on the expression of salinity in Western Australia. They can act as either carriers or barriers to water movement through the landscape. From East Mortlock Catchment Appraisal, the patterns of salinity indicate that geological structures (e.g. faults, quartz veins) control much of the groundwater flow and salinity development. Pre-existing fault lines have, over time, been converted into drainage lines through preferential erosion, and along with their groundwater accumulation qualities, have made them obvious points for salinity development. A significant proportion of catchment salinity has already developed, especially in drainage lines, hence the moderate increase in areas of potentially shallow watertables.
Soil types and landscapes with the greatest risk of salinisation?

Presentation and Worksheet

Indications of how salinity is expressed in association with soil types and landforms. Use aerial photographs, diagrams, bore data and plant samples collected locally (or photos if not available) to indicate how salinity is expressed in relation to soil types and landforms. Refer to process to identify salinity and Salinity Decision Flow Tree?

The expression of salinity and waterlogging is often related to landscape features. Ask participants to list features that indicate a high risk of salinity or waterlogging.

Examples:
- Creek lines, valley floor pools
- Position of the change of slope
- Broad soil types and obvious management units.

Have participants record situations that apply to them in their workbook.

The following comments are taken from the East Mortlock Catchment Report and can be used as an example of the influence of soils and landscape on salinity. Identifying similar information relevant to participants is encouraged.

The following is an example of the influence of soils and landscape on salinity.

- Deep sands and ironstone gravels are major soils with high recharge potential. The best way to manage recharge on them is by planting permanent perennials (e.g. revegetation with natives, tagasaste, shelter belts etc.) and phase cropping with perennial pastures, or less effectively, deep-rooted annual pastures (e.g. serradella) or continuous cropping.

- Shallow sandy duplexes are major soils that contribute significantly to recharge via preferred pathways such as large cracks and root channels, particularly when the soil profile is saturated or waterlogged. Recharge will be reduced on this soil by improving surface water management (reducing waterlogging) and altering the farming system to increase perennials and improve crop and pasture water-use.
Fault traces and associated salinity development evident from aerial photo interpretation. Dashed lines are located just above fault traces (DOLA 1992).

Slide 37.

Reading the landscape

Slide produced by: EG Barrett-Lennard

Slide 38.

Reading the landscape

Slide produced by: EG Barrett-Lennard
General results show that middle and lower slopes are at risk of salinisation within 20 years and that the onset of salinity in middle slope areas can be delayed by many years, depending on the level of intervention. However, lower slope and valley areas must not be seen as being completely unproductive in the future, as many areas within salinised paddocks will remain highly productive for salt-tolerant pastures.

Areas with steeper slopes and shorter distances to discharge points will be less affected by salinisation because of higher groundwater gradients and less constrictive flow, thus reducing groundwater rise. Examples of such areas include stretches of Mortlock River East, particularly on the western flank of the catchment around the Dowerin-Meckering Road and south of Great Eastern Highway between Meckering and Cunderdin.

Participants will need to look for landscape features relating to the expression of salinity and waterlogging at field site. **Facilitators need to be aware of any major features at the site.**

**Landscape map analogy for PURSL**

Indicator species and where they grow. The matrix is used to build a picture of local indicator plants as well as improved species in relation to their salinity/waterlogging tolerance.

**Presentation and discussion**

Use the matrix below to identifying indicator species for saline and/or waterlogged land. The matrix is used to build a picture of local indicator plants as well as improved species in relation to their salinity/waterlogging tolerance.

Present a blank matrix and ask participants to add the local indicator plants into this matrix. Prompt by selecting two or three plants that would be known to the participants and inserting them into the matrix.

Open up the discussion to get people to contribute their thoughts onto the main matrix.
Salinity/waterlogging matrix

Q. Why does all this matter?
A. $$$.

List indicator species found locally?
What units are used to measure/describe salinity?

Treat this section as optional depending on the needs of the group

Discussion and demonstration
Ask the group what units they use to measure salinity. Discuss the different units used and the standard units. Hand out the WA Salinity Calculator and briefly demonstrate how to use it.

Optional - This can be used to initiate a discussion about the use of the ‘Electrical Conductivity of the 1:5 extract’ (EC$_{1:5}$) and the ‘Electrical Conductivity of the Saturation Extract’ (EC$_e$) to measure salinity. Most laboratories report results as EC$_{1:5}$ measurements because they are cheaper and simpler to do. However, results can be in either form so the principles of the measurement need to be explained.

The Department of Agriculture’s Salinity Calculator gives approximate conversions between EC$_a$ and EC$_e$ values for three soil textures. (These conversions assume a moist soil in spring.)

Hands-on experience in measuring the salinity of samples.
Provide samples and recording sheets for groups to practise the measurement of salinity. Practical exercise in groups. May be done as a component of the field activity if bores are present at the field site.

Ask who can recall the difference between piezometers and wells from earlier overhead. Discuss the difference between piezometers and wells and their advantages or disadvantages (overheads and Farmnotes).

The Department of Agriculture’s Salinity Calculator gives approximate conversions between EC$_a$ and EC$_e$ values for three soil textures. (These conversions assume a moist soil in spring.)

Measuring salinity of water or soil
Water: Electrical conductivity in water (EC$_w$)
Direct measurement with salinity meter. Hand-held salinity meters are available.

Soil: There are two options for measuring salinity of soils:
1. Mix soil with water and measure as a water sample based on how soil sample is prepared:
   A) EC$_e$ - Electrical conductivity (extraction)
   Saturation extract method. Soil mixed with distilled water into a paste, then filtered and measured. Most accurate for plant diagnostics but needs to be sent to an accredited laboratory.
   B) EC$_{1:5}$ - Electrical conductivity (1:5 suspension). 1 g soil suspended in 5 mL distilled water and shaken. Less accurate but quicker and can be done on the farm or by local Department of Agriculture office.
2. EC$_a$ - Electrical conductivity (apparent). Direct measurement with an electromagnetic induction meter (EM) e.g. EM38 and EM31. Can have full paddock surveys carried out by contractors. Useful to look at relative changes in salinity across a paddock/site. Needs calibration.
Depending on time available and resources such as salinity meters and EM38 you may like to demonstrate and/or have participants measure salinity of samples. Find out who carries out EM surveys.

(Reference: Dept of Agriculture Farmnote 59/2002 ‘Monitoring groundwater levels’.)
For further information on measuring salinity, refer to Farmnote 105/2001 ‘Measuring salinity on the farm’. The facilitator must have a copy of this Farmnote (or something similar from a different State) available for each participant.

To access Farmnotes, go to Dept of Agriculture website on www.agric.wa.gov.au. Look to the right hand side of the home page to a box that says ‘Series Publications’, and click directly on ‘Farmnotes’. Once in the Farmnotes section, enter the Farmnote number (e.g. 59/2002) into the ‘Search for’ box and enter. A summary of the relevant Farmnote will appear, and you need to click on the title for the full document (best to print the PDF format).
What units are used to measure salinity?

Units of measurement of salinity


Measure salinity

Water: - Electrical conductivity in water (ECw)
Direct measurement with salinity meter.

Soil: - 2 options
- Mix soil with water and measure as a water sample

- ECa - Electrical conductivity (apparent).

Soil and Water Salinity Calculator

4. **Pre-field activity**

Work in groups to plan a salinity management strategy based on information relating to the field site.

**Purpose**

To have participants look at the range of tools and information relating to a specific site that will be visited (if time allows) in the field.

**Suggested Approach**

It is often good to have a number of site scenarios for the group to look at. Small groups of three to four participants can be given the task of planning in relation to a specific scenario and reporting back to the whole group. Where time is limited this can be a good way of covering a number of scenarios fairly quickly without having to just skim over the issues.

Move around the small groups providing support for the activity. Make sure all groups clearly understand what they are being asked to do. Have any invited experts assist during the activities.

Have the owner of the land present to help provide back ground information on the site. Land Monitor, soil type, contours and watertable information etc will all help to build the picture.

Have a series of questions to ask in the field:

- What broad landscape features are influencing the site? (i.e. creek lines or change of slope, valley floors etc)?
- What are the soil types in the catchment?
- Are there any geological structures, such as dykes, bedrock highs or fault lines, influencing salinity?

Have a hand-out on history of the site or have farmer describe the site and answer questions for participants.

Be prepared to present a quick summary.

Describe how the diagnostic information can be used to indicate areas that are likely to develop future salinity.

Divide into groups of three to plan a management strategy for the site based on information available. Have groups present back to all participants before or after the field visit or both.
5. Field trip

**Purpose**
Farmers get to put theory into practice in the field (reinforcement of learning to date).

**Suggested approach**
The time allocated to the field visit should be adjusted according to the background of participants. Where participants generally have a poor understanding of the catchment and issues relating to salinity more time will be required to give the group a feeling for local issues. This may be as an extended field tour on the day or as a pre-workshop field tour to familiarise participants with general catchment issues.

Briefly describe the field activity before leaving including the tools being used in the field. The aim of this visit is to provide participants with an on-ground review of the information covered in the workshop. Refer back to the “Flow tree for evaluating the risk of salinity and the management options available to farmers”. Make sure participants take their notes in the field with them. Provide a Land Monitor map of the area indicating valley floors, new and old salt.

Participanst may monitor depth and salinity of groundwater themselves or watch a demonstration (this can be linked to a group activity to convert salinity measurement to a standard format).

Lead discussion and associated activities in the field through:
- identification of landscape and associated risk (use Land Monitor);
- soil types and risks (maps);
- indicator species;
- measurement of depth and salinity of watertables;
- measurement of soil salinity with EM38 Optional.

Have participants fill in the following section of the worksheet.

**Worksheet 2**

<table>
<thead>
<tr>
<th>What broad landscape features are influencing the site (i.e. creek, slope, valley)?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What are the soil types in the catchment?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Are there signs of geological structures such as dykes, bedrock highs?</th>
</tr>
</thead>
</table>
Some issues to consider in regard to any options that might be adopted include:

- Farmers’ long-term goals etc?

- Area of crop and pasture?

- Crop yields and areas affected by either salinity or waterlogging?

- Stocking enterprise (sheep, cattle, and meat production)?

- Area of salinity?

- Salinity of the area?

- Increases in salinity observed or indicator species (following wet years etc.)?

- Where are watertables? Shallow within 3 metres or deeper?

- Monitoring of watertables, either on the farm or in similar sites nearby?
6. The effect of salinity on farm production and profitability

**Presentation**

**Purpose**
To show how salinity affects plant growth and survival.

**Suggested approach**
Compare the level of reduction in production. Use photos and tables of plant response to salinity and or waterlogging and used examples discussed on field trip.

Plants can be broadly divided into three groups, halophytes (like river saltbush), tolerant non-halophytes (like barley) and sensitive non-halophytes (like beans). The relative difference between these groups is important.

**References**

**Growth response to salinity**
Halophytes grow better on mildly saline than non-saline sites. They are therefore key components of saltland pastures.
Non-halophytes vary in their tolerance to salt. The more tolerant species may be components of saltland pastures while the less tolerant species will almost certainly not be.

**Waterlogging and salinity interactions**

**Discussion and overheads**

**Suggested approach**
Ask participants to write down 2 to 3 effects of waterlogging on plant growth and crop production (1-2 minutes). Go around the group and list these on a flip chart and discuss (prepare heading on flip chart in advance of meeting). Put up on wall as a reference.
Participants could reflect on how badly crops germinate and emerge from waterlogged soils, how waterlogging causes the death of roots etc., how waterlogging causes plants to become nutrient-deficient, (especially nitrogen).

**Worksheet 3**
Write down 2 to 3 effects of waterlogging on plant growth and crop production
Slide 44.

List the effects of waterlogging on crop and pasture production?

- Decreases diffusion of oxygen into soil.
- Causes energy deficiency in roots.
- Breaks down salt exclusion.
- Adversely affects growth and survival.

Slide 45.

Salt/waterlogging interactions

Three broad groups of plants

River saltbush
Barley
Beans

Slide 46.

Waterlogging is a problem because ...

- Decreases diffusion of oxygen into soil.
- Causes energy deficiency in roots.
- Breaks down salt exclusion.
- Adversely affects growth and survival.
Waterlogging saturates the pores in the soil that are normally filled with gas, making them oxygen deficient. This affects the ability of roots to get energy for their metabolism and makes roots leaky to salt. If salt accumulates to a substantial degree in the shoots, plant growth and survival are affected. The following series of photos shows the effect of salinity and waterlogging on plants.

The four pots pictured in each photo are growing wheat. The two pots on the left are waterlogged while the two pots on the right are freely drained. The photos show the effects of waterlogging on wheat grown with (a) no salt, (b) salt equivalent to 4% sea water and (c) salt equivalent to 20% sea-water. The effect of salinity and waterlogging combined has a much harsher effect on plant growth than salinity on its own. This indicates the potential for removing the waterlogging from the system with surface water drainage. Raised beds are one option that can be used to remove the waterlogging (Barrett-Lennard 2003).
**Slide 47.**

**Salt in the leaves**

- 'low' salinity (2 dS/m) = $4 \times$
- 'moderate' salinity (12 dS/m) = $0.20 \times$

**Slide 48.**

**Sodium in leaves**

('moderate' salinity - 12 dS/m)

- Percent sodium (organic dry wt basis)
- 12
- 9
- 6
- 3
- 0

= drained
= waterlogged

**Slide 49.**

**Waterlogging and Salinity**

- Effects on Growth
- Zero salt
- 4\times
- 20% of seawater

(Photographs: Simon Eyres)
Impact of loss of productivity to profitability of the farm

Options include:
Do nothing (live with salinity) and continue farming with current system and accept that a percentage of land will be lost to salinity in the future. The risk associated with this depends on the area of the farm that is likely to be affected or lost. If you are nearing the new equilibrium where the discharge sites are adequate to deal with the recharge then the best option may be to do nothing, get more land etc. If however you have large areas of valley floors that are likely to go saline before the new equilibrium is reached then the cost to your farm will be greater. The land that goes saline will often be some of the most productive on the farm.

Contain the spread of salt-affected land. This will mean adopting a change in farming systems and mindset. There will be no “Silver Bullet” for managing salinity and a suite of profitable farming practices including perennial pastures, trees, saltland grazing systems and water management practices will need to be adopted. There will be a lag period in seeing results even if moving to 100% perennials, as there is already an excess of water in the groundwater system. Containment may not stop salinisation altogether but it may buy time. Recent modelling work is indicating that areas with broad valley floors (largely in the ancient drainage zones) will get the greatest response (buying time) from managing recharge in the valley floors themselves.

Recovery of salt-affected land. This is the most difficult and costly option to achieve. It will usually involve the continued use of engineering options.

Adaptation to saline areas. This involves the inclusion of alternative productive options on land that has gone saline. Grazing management of saline pastures utilising salt and waterlogging-tolerant species.

Presentation and discussion - Relate loss of productivity to the profitability of the farm. Profit = Returns - Cost
Remember that profit = returns (some of which may not have a $ figure attached to them) - costs (which include profit forgone).
Ask group to list the costs and benefits for the four options (Do nothing, containment, recovery and adaptation).

Cost of “Do Nothing” Scenario (for areas with broad flat valley floors)
Familiarise yourself with the cost of salinity spreadsheet. If there is interest from the group the spreadsheet can be used interactively. Enter average farm size, expected levels of salinity in the future, profit per hectare and relative profitability of management options. Be aware of management options that may be profitable in the general area.

STEP (Simulated Transitional Economic Planning)
Introduce the group to the concept of transitional planning. If this is an area that interests members there is the option of getting involved with specific STEP workshops in the future. Trying to cover STEP in any level of detail is unlikely to do it justice and will detract from the main focus of the introductory workshop.

There are many ways to move into new farming systems. The transitional period is critical to the profitability of the farm. STEP is one option that allows farmers to examine the implications of a range of transitional strategies.
Costs and benefits

Broad options

Do nothing - Cost of lost productive land and land value

Containment - Costs in moving to new profitable system, reduced loss of productive land, land value, feel good etc.

Recovery - Expensive with ongoing cost, disposal of saline water issues

Adaptation - Costs in moving to new profitable system, increased profitability of land

Decisions on management options

Need to be kept in context with overall farm objectives and goals

- Reasons for managing salt
- $ spent elsewhere etc.

Cost of “Do nothing” scenario

Assumptions: Broad flat valley floor landscapes

- 2000 ha property
- 20% total future salinity (by year 2075)
- Watertables are saline and rising, leading to the areas of salinity indicated in the scenario above

<table>
<thead>
<tr>
<th>Salinity level</th>
<th>% of potential (ha)</th>
<th>Area Ha</th>
<th>% of potential (ha)</th>
<th>Area Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% (unusable)</td>
<td>0%</td>
<td>0%</td>
<td>2025</td>
<td>2050</td>
</tr>
<tr>
<td>Low yield</td>
<td>25%</td>
<td>32</td>
<td>4%</td>
<td>80</td>
</tr>
<tr>
<td>MYSA (Barley)</td>
<td>40%</td>
<td>40</td>
<td>6%</td>
<td>120</td>
</tr>
<tr>
<td>HYSA (Barley)</td>
<td>65%</td>
<td>65</td>
<td>8%</td>
<td>160</td>
</tr>
<tr>
<td>Total Area</td>
<td>100%</td>
<td>100</td>
<td>100%</td>
<td>100</td>
</tr>
</tbody>
</table>
Cost of “No Change Scenario”
This spreadsheet looks at the cost if no attempts are made to adopt management practices to reduce recharge to the system. The spreadsheet is based upon “Broad Flat Valley Floors” where planting 40 to 50% of the area at risk of becoming saline to perennials may increase the time to salinity developing by 40 years (buying 40 years). The spreadsheet allows you to change farm area, future salinity area, current profit from non-saline land and how profitable the new management options are in comparison to current farm management.
Where management options putting 40% or area at risk into perennials is adopted the same final level of salinity is reached but instead of being reached in the year 2075 it is taking 40 years longer (final salinity levels reached in 2115). The average per year difference can be looked at over the periods of 2000 to 2025, 2000 to 2050, 2000 to 2075 or 2000 to 2115.

The profitability of the individual options for managing salinity are not considered here but are considered in the individual option workshops and can be looked at more closely for individual farms within the STEP workshops. When calculating the profitability of any of the options the period of transition and associated costs need to be taken into account. It is also useful to look at profit in terms of Net Present Value. This spreadsheet is available from the Department of Agriculture website or from Trevor Lacey, Department of Agriculture, Northam.
Slide 53.

Cost of “Do nothing” scenario

- Average profit from non-saline areas = $200/ha/yr

![Graph showing No Change - Costs of Lost Production]

Slide 54.

Cost of “40% Management” scenario

- Recharge management scenario buying 40 years

![Graph showing Cost of loss of productive land to salinity.]

Slide 55.

Comparison - Cumulative position

The value of delaying salinity by 40 years

![Graph comparing No Change vs delay by 40 years]

Comparison of "No Change" vs "Buying 40 Years"
7. Assess the salinity risk for your farmland

**Purpose**
Farmers put salinity into perspective for their farms and develop some long and medium term goals relating to salinity management.

**Suggested approach**
Context management of salinity in relation to overall farm objectives and goals.
- Reasons for managing salt
- $ spent elsewhere etc.
- Section to fill out in worksheet.

**Worksheet and discussion - Participants to identify the nature of their salinity problems**
Have farmers fill in worksheet sections for the estimated areas of both current and potential salinity. Estimate current value of production on this land (Value of protection) which represents the cost of the “No Change option”. Estimate social, environmental and possible off-site affects.
Summary of worksheets filled out through the day.

**What do I plan to do?**
Complete section at end of planning worksheets – what are my general medium and long-term goals in relation to salinity and recharge management?

**Worksheet 4.**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are your personal goals for the farm?</td>
<td></td>
</tr>
<tr>
<td>How do you rate the overall risk to your farm?</td>
<td></td>
</tr>
<tr>
<td>What is the value of production on land at risk from salinity?</td>
<td></td>
</tr>
<tr>
<td>What are my long-term goals in relation to salinity management?</td>
<td></td>
</tr>
</tbody>
</table>
Monitoring watertables

Treat as optional section depending on the needs of the group.

Presentation and discussion on how to monitor watertables and the use of piezometers

Discuss the differences between monitoring wells and piezometers and what is best to use to monitor different situations.

Must measure depth before salinity, as salinity requires the bore to be baled out. For salinity measurements, the bore must be baled out and ‘new’ water allowed to move in.

For information on installing and monitoring bores, refer to Department of Agriculture Farmnote 59/2002 ‘Monitoring groundwater levels’. The facilitator must have a copy of it before taking a sample. This is because evaporation can increase salinity concentrations in the bore water when left sitting for periods of time.

Department of Agriculture Farmnote 59/2002 ‘Monitoring groundwater levels’ provides good additional information.

- Ask participants if anyone has installed shallow monitoring bores on their farm?
- What do they show/tell you?
- How have they used the information?

Have a handout of local bore information graphed over time, preferably for the field site or local area.

The watertable should be monitored regularly on a monthly or quarterly basis for a number of years if trends are to be identified. If they are not monitored regularly they will only tell the depth of the watertable and the quality of the water but won’t tell you what the trend is in regard to groundwater movement.

The depth and salinity of shallow groundwater and its trend is over time is valuable information.

The depth to watertable over summer will determine the level of salinisation through surface evaporation and the risk of waterlogging. The shallower and more saline the watertable the greater the likelihood of topsoil salinisation through evaporation and capillary rise. Waterlogging, salinity and their interactions determine the effect on establishment and growth of plants.

The best way of monitoring depth and salinity of shallow groundwater over time is with shallow (to 2 m depth) bores. How deep is the water level beneath the soil surface? Measure depth to watertable in either an established shallow bore or a hole/soil pit dug to 2 m, using a ‘plopper’.

The watertable should be monitored regularly on a monthly or quarterly basis for a number of years if watertable trends are to be identified. If they are not monitored regularly they will only tell the depth of the watertable and the quality of the water but won’t tell you what the trend is in regards to groundwater movement.

Department of Agriculture Farmnote 59/2002 ‘Monitoring groundwater levels’ provides good additional information.
8. Preliminary appraisal of major potential management options for your business

Presentation with photos and samples of plant options
Preliminary awareness of major potential management options for your business
- Where the options are best suited?
- What benefits and limitations can the options have (agronomic/economic)?
- Environmental and social impact?
- PURSL – forages and trees
- Perennials - pastures, shrubs, trees, crops
- Annuals - summer crop, winter crop and pastures

Small Group Work to review the range of options for managing salinity, using planning worksheets. Groups to propose a list of possible options for consideration for their business and make a recommendation as to the best management options for their farm. Select one or two PowerPoint slides from the Million Hectares optional workshops to highlight some of the options that you think members of the group may be interested in.

Optional workshops available (on the Department of Agriculture web site)
- Simulated transitional economic planning (STEP) – Is it for me?
- Lucerne – Is it for me?
- Perennial grasses – Are they for me?
- Surface water management – Is it for me?
- Deep Drainage – Is it for me?
- Grazing saline land – Is it for me?

Options for managing salinity

Optional workshops - Preferred Pathway
- Recommended sequence of workshops: -
  - Introduction to salinity
  - STEP introduction half-day
  - STEP part 2 or other optional modules.

Introduction to the STEP Workshops
If you would like to know the financial implications of making changes to your farming system, then the STEP workshops may be for you. STEP (Simulated Transitional Economic Planning) is an economic decision tool which can be used by farm businesses to investigate the economic consequences of making changes to the current farming system.

Example:
Slide 56.

What's required

A change in mind-set regarding
- Phase farming
- Permanent perennial-based pastures
- Alley farming
- Block plantations, corridors etc.
- Integration of water management

Slide 57.

What does the decision tool STEP do?

- Used to investigate the economic consequences of moving from one enterprise mix to another
A group of 22 farmers in the Gillingarra area of the Northern Agricultural Region were interested in looking at alternative farming systems to reduce the future risk of salinity. A standard farm was designed specifically for the area following consultation with the Gillingarra farmer group. This farm was used to investigate the financial viability of different farming systems for the area and the process of changing from one farming system to another.

Details of the rotations and areas of both the current and future farms are shown. The current farm was an annual pasture-based system with Merino sheep. For the future farm, perennials replaced annual pasture on the less productive areas and cattle replaced sheep. STEP was first used to look at the 10-year cumulative profit of the current farm for different combinations of stocking rate, sheep price and flock structure as shown.

**Mixed flock** = ewes and wethers

**Sheep sale price**
- Low = $30 lambs, $20 ewes, $25 wethers and rams
- High = $65 lambs, $30 ewes, $35 wethers and rams

**Stocking rate (DSE)**
- Low = 2.9 winter, 2.1 summer
- High = 5 winter, 3.8 summer

The only combination showing a positive cumulative profit for the current system is the ewe flock with a high stocking rate and high sheep sale price.
Slide 58.

Comparing 10 year cumulative profits for current farm

-2 0 1 2

low SR mix flock
low price
low SR mix flock
high price
high SR mix flock
low price
high SR mix flock
low price
high SR mix flock
high price

Slide 59.

Current farm and future farm, 10 year cumulative profit

-2 0 1 2

current future

Farming System

-2 0 1

best case - ewe flock
high SR+price
worst case - wether flock low SR+price
high SR $600
low SR $600
high SR $650
low SR $650

Slide 60.

Current and future farm rotations and hectares

<table>
<thead>
<tr>
<th>Soil types</th>
<th>Area (ha)</th>
<th>Current rotation</th>
<th>Future rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>weak sand</td>
<td>500</td>
<td>blue lupins</td>
<td>tagasaste</td>
</tr>
<tr>
<td>yellow sand</td>
<td>400</td>
<td>Volunteer pasture</td>
<td>Volunteer pasture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved pasture</td>
<td>Improved pasture</td>
</tr>
<tr>
<td>sandy gravel</td>
<td>300</td>
<td>Volunteer pasture</td>
<td>Volunteer pasture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved pasture</td>
<td>Improved pasture</td>
</tr>
<tr>
<td>sand over gravel</td>
<td>100</td>
<td>Volunteer pasture</td>
<td>Volunteer pasture</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved pasture</td>
<td>Improved pasture</td>
</tr>
<tr>
<td>waterlogged</td>
<td>100</td>
<td>wet pasture</td>
<td>perennials</td>
</tr>
<tr>
<td>Total</td>
<td>1400</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Volunteer pasture = low stocking rate
Improved pasture = high stocking rate
The 10 year cumulative profit of the future farm was analysed for two different stocking rates and two cattle sale prices. The future farm was generally more profitable than the current farm. Only the future scenario with a low stocking rate and low cattle price ($600) was slightly less profitable than the best case scenario for the current farm.

As the financial viability of the future farm looked promising, the next step was to assess the financial viability of transition to the future system. This slide depicts the annual cumulative profit over a 10 year period for different transition strategies. For each transition strategy, lambs were sold each year and cattle gradually introduced into the system. This process occurred more rapidly for the shorter four-year transition than for the longer 10 year transition. The transitions are also compared at a high ($700) and low ($600) cattle sale price.

The graph shows that at a low cattle price of $600 a longer transition period of 10 years appears more financially viable than the shorter transition. However, at a higher cattle price of $700, the shorter transition is the more profitable.

**Conclusion**

If you are interested in using STEP to assess the economic consequences of changing your farm then the STEP workshops are for you. The first workshop is an introduction during which you will gain an understanding of how the STEP tool can be used to assess the financial potential of any proposed change to a farming system. If you wish to progress further with STEP there are a number of options available for other workshops:

1. You can use STEP to analyse your own farm.
2. Your facilitator can develop a representative farm for your group and either
   - you can use STEP to address questions using this farm or
   - the facilitator can do some analyses for your group and report the results.
Slide 61.

Cumulative profit for 4 and 10 year transition strategies for a mixed flock

Cumulative profit

- $200,000
- $0
- $200,000
- $400,000
- $600,000
- $800,000
- $1,000,000
- $1,200,000
- $1,400,000

Year

Slide produced by: C Peek

Slide 62.

Lucerne - best perennial option for phase farming currently available

Benefits from the lucerne phase
- herbicide resistance and weed management
- extended green feed (finishing stock out of season)
- reduced supplementary feeding
- reduced recharge and nitrate leaching

Greatest benefits on high recharge soils

Slide produced by: T Lacey

Slide 63.

A solution to the ‘problem with saltbush’ ...

Lowers watertables

Bulk of $s

Slide produced by: EG Barrett-Lennard

Introduction to salinity - Facilitators Guide
9. Where to next

**Group process - where to from here?**
This may be at the end of this workshop or after participants have had a chance to digest the information they have received.

**Suggested approach**
Run a session either directly following this workshop or within two to three weeks while the implications of the workshop are still fresh in the participants’ minds. Are they interested in another “A Million Hectares for the Future” workshop?
REFERENCES


