Dryland Salinity R&D Foresighting Analysis

Application of foresighting to develop options for the future management of, and research and development into, dryland salinity in Australia

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Report outline

This report comprises:

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- Executive summary
- Chapter 1 Background
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- Chapter 3 Results
- Chapter 4 Comparison with the CIE foresighting process
- Chapter 5 Outcomes of the foresighting analysis
- Chapter 6 Evaluation of the foresighting analysis

Readers interested in a quick overview of the dryland salinity foresighting project:

For a quick overview of the outcomes of the project, read Key Findings and Recommendations, the Executive Summary, and the summary page that precedes each chapter (13 pages).

Readers interested in a comprehensive review of foresighting and its application to dryland salinity:

Each chapter is supported with diagrams and tables that help to explain the methodology and results of the dryland salinity foresighting project. Detailed appendices are included for those readers interested in following the customised process used in this study.

Readers are also referred to companion documents for background reading:

(1) Report by the Centre for International Economics [CIE, (1997)]. Using Foresighting to Identify R&D Priorities for LWRRDC. LWRRDC Occasional Paper No. 10/97. Centre for International Economics; in conjunction with CSIRO.

(2) Report by VCG Australia, [1997]. An Assessment of the National Dryland Salinity R,D&E Program. LWRRDC Occasional Paper No. 16/97.

National Dryland Salinity R,D&E Program (NDSP)—Reader's note

Throughout this work, references to the NDSP are to Phase I of that program, unless otherwise indicated. In July 1998 Phase I concluded and Phase II commenced. The second phase has expanded scope and objectives which do not necessarily equate to 'the current situation' as referred to in this text.

Key findings and recommendations

Key findings (KF)

Against the specific objectives of the dryland salinity foresighting exercise, ie. to:

1. **Examine likely scenarios of the future extent and cost of dryland salinity across Australia;**
2. **Identify appropriate research and development priorities for support under the National Dryland Salinity R,D&E Program (NDSP).**

and key (focal) decisions for future dryland salinity management (Box 1):

Box 1
Dryland salinity project—focal decisions

- What blockages need to be removed?
- Who should be involved?
- What level of intervention is required?
- Who should pay and how much?

we have concluded that:

KF 1 Scenarios and driving forces

Plausible dryland salinity scenarios can be developed from the list of 50 critical uncertainties (driving forces that shape the future) identified by the foresighting process. We developed 10 plausible scenarios throughout the course of this project. They serve to create stories, from the critical uncertainties, that people involved in dryland salinity can readily relate to.

KF 2 Strategic R&D directions

While the scenarios fall short of examining the extent and cost of dryland salinity in specific terms, from the analysis of critical uncertainties (driving forces) used to develop the scenarios, we have clearly identified strategic research and development priorities that will have an impact on extent and cost, for support under the NDSP (Box 2).

KF 3 Emphasis on motivating factors

The strategic R&D directions (foresighting process) emphasise the identification of the motivating factors necessary to significantly change the way dryland salinity is currently being managed. This requires quantification of salinity impacts on the quality of life of affected communities and environments as well as the impacts being experienced by individual landusers.

KF 4 Implications for future action and decision-making

Many of the perceived future needs can be summarised as a requirement for a convincing model(s) that describes the economic, financial, physical, social and ecological benefits of implementing remedial actions to overcome dryland salinity.

Our analysis of gaps in knowledge and technology associated with the R&D directions suggests the following types of model are required:

- salt balance (input/output) at three different levels (regional, catchment and property);
- (financial) production models at the property level; and
- off-site salinity impact/cost models, including impacts on the natural environment.

Box 2
Summary of 14 strategic R&D directions

FD1 Blockages

1.1 Quality of life and human health impacts

1.2 Incentives necessary to encourage coordinated landuser activity

FD2 Involvement

2.1 Limit of individual responsibility

2.2 Operating environment for landholder internalisation of salinity impacts.

FD3 Intervention

3.1 Catchment Management Committees implement effective, coordinated catchment plans

3.2 Changes of industry structure to bring together benchmarking, self-regulation, quality assurance, marketing and R&D

3.3 Scope of regulations to meet changing landuse regimes

3.4 Effect of regulatory market quality criteria on production methods, such as ISO9000.

3.5 Appropriateness of COAG land management targets and incentives, in effectiveness programs.

FD4 Who pays/How much?

4.1 Inequities in 'who pays'—on-farm and off-farm.

4.2 'Triggers' landusers require to liberate capital.

4.3 Information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources.

4.4 'Polluter pays' philosophy impact on individuals implementing remedial action.

4.5 Government environmental restoration programs—restricting landuser access to national funds

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At the catchment level, credible models are required for the community as a whole to understand the escalating risks of dryland salinity. At the property level credible models are also required to provide landusers with a clear indication of the land degradation and financial risks they face in the future.

The *credibility* of the models is one of the cornerstones of a future integrated R&D program. To achieve the necessary level of integrity, data needed to run the models must be upgraded/completed to provide consistent results and must be readily updated (in real time). Output from the models can then be used to support decision-making on priority works, appropriate institutional arrangements, responsibility for action, and who pays.

KF 5 Focus of increased R&D emphasis

Comparison of the foresight strategic R&D directions with R&D priorities identified under current and proposed NDSP initiatives indicate that LWRRDC should consider placing more R&D emphasis on:

- the apportionment of on-site and off-site costs caused by dryland salinity;
- the 'triggers' and incentives necessary to ensure landuser action (individually and collectively);
- the possible effects of government regulation and market quality demands; and
- readily understood information systems to help landusers decide whether remedial action is financially advantageous.

KF 6 Assessed benefits of R&D

According to foresighting workshop participants, the greatest net benefit is expected to arise from incentives for coordinated landuser activity, coordinated catchment management plans, identifying inequities in who pays (on-farm/off-farm), and identifying the 'triggers' landusers require to liberate capital. This should be substantiated with other stakeholder groups.

KF 7 Applicability of foresighting to environmental management

We believe that the dryland salinity foresighting process is suitable for application to environmental management programs in general. It can be effectively run with a disparate group of experts; it is completely transparent and therefore suitable for reassessment by other groups; it yields numerous scenarios that are both plausible and logical; and it is a low cost option to establish strategic directions for all LWRRDC-managed R&D programs.

KF 8 Applicability of foresighting to dryland salinity management

The value of applying a foresighting process to dryland salinity management has also been confirmed. It will provide LWRRDC with additional insight into which R,D&E programs require greater funding emphasis, the timing of strategic R,D&E initiatives, and the likelihood of a successful outcome. With this information, LWRRDC should be in a better position to make R,D&E investment decisions.

KF 9 Requirement for a integrated national R&D program

The dependencies between the 14 strategic R&D directions identified in this study indicate that R&D for individual strategies may be of limited value.

Although outside the scope of this study, part of the requirement for an integrated national R&D program is an effective information infrastructure operating at the state and regional level to be in a position to assess the benefits of such R&D.

Recommendations

We recommend:

R 1 Foresighting workshops should be conducted with the National Dryland Salinity Technical Committee and a catchment management group.

The driving forces identified at the national scenario planning workshop should be re-evaluated by other stakeholder groups. We recommend conducting short workshops with at least the National Dryland Salinity Technical Committee and a catchment management group to confirm strategic directions identified from the national forum. (LWRRDC would then be in a position to confidently develop an R&D agenda endorsed by its major stakeholders).

R 2 Establish a national information infrastructure for dryland salinity R&D reporting and impact assessment.

It has been established in this study that better and more timely information is one of the keys to communities and individuals acting to combat dryland salinity. It is critical that R&D results are communicated to all stakeholders. Establishing priorities for information at the state, regional and local level to support the strategic R&D directions is fundamental to their successful implementation.

Conclusion

The emphasis must shift from decision-making on R,D&E based mainly on technical merit (given that no two catchments are hydrologically the same), to decision making framed from an institutional, social, economic and financial perspective which provide incentives at the landuser level.

Executive summary

This report describes the application of foresighting techniques to assist LWRRDC to:

- examine critical driving forces and likely scenarios for the future extent and cost of dryland salinity across Australia; and
- identify appropriate research and development priorities to be supported under the National Dryland Salinity R,D&E Program (NDSP).

It also includes:

- a report on the outcome of the dryland salinity foresighting exercise against the above objectives [Chapter 5]; and the efficacy of the process to environmental management in general and dryland salinity management in particular [Chapter 6]; and
- a review of the general foresighting scenario process undertaken by the CIE (1997).

A foresighting process modified from Schwartz (1991), was used to identify 14 strategic research and development (R&D) directions for the future management of dryland salinity in Australia. An overview of the steps in the foresighting process used in this project is shown in Figure 2 on page 16. The methodology involves a pre-workshop phase (preparation of an issues paper and seeding scenarios for workshop participants), a scenario planning workshop and a post-workshop review and analysis phase.

National perspective

Dryland salinity presently costs the agricultural industry about $300 million per annum or about 1.2% of gross agricultural production; and now affects approximately 2.5 million hectares of agricultural land (1996 estimate). Possibly more significant costs are incurred off-site by industry and the community as a whole—through a range of economic, social, political and technological impacts.

In January 1998, a broad group of stakeholders in the dryland salinity problem attended a national workshop to identify the major driving forces likely to shape the future, and to develop scenarios describing a range of plausible outcomes to the year 2020 and beyond. The results included in this foresighting project are based on an analysis of their input to the process.

National priorities

This study addressed four key (focal) decisions for national dryland salinity management (from Box 1):

- what blockages need to be removed?
- who should be involved?
- what level of intervention is required?
- who should pay and how much?

We have used the foresighting process to identify a robust, integrated program of social, economic, political, technical and biophysical R&D needed to address dryland salinity. At this stage we have not differentiated between R&D for public or private good.

The 14 strategic R&D directions (from Box 2, reproduced below) identified by the foresighting process, and in response to the focal decisions, emphasise the need to *convince* landusers that it is in their financial interest and the community's interest to invest in dryland salinity remedial actions. This requires quantification of salinity impacts on the quality of life of affected communities and environments as well as the impacts being experienced by individual landusers.

FD1 Blockages

1.1 Quality of life and human health impacts

1.2 Incentives necessary to encourage coordinated landuser activity

FD2 Involvement

2.1 Limit of individual responsibility

2.2 Operating environment for landholder internalisation of salinity impacts.

FD3 Intervention

3.1 Catchment Management Committees implement effective, coordinated catchment plans

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4.1 Inequities in 'who pays'—on-farm and off-farm.

4.2 'Triggers' landusers require to liberate capital.

4.3 Information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources.

4.4 'Polluter pays' philosophy impact on individuals implementing remedial action.

4.5 Government environmental restoration programs—restricting landuser access to national funds

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At the catchment level, credible models need to be developed to allow the community as a whole to understand the escalating risks of dryland salinity. At the property level credible models are also required to provide landusers with a clear indication of the land degradation and financial risks they face in the future.

The *credibility* of the models is considered to be one of the cornerstones of a future R&D program. To achieve the necessary level of integrity, data needed to run the models must be upgraded/completed to provide consistent results and must be readily updated (in real time).

Output from the models can then be used to support decision-making on:

- priority works (based on sound cost–benefit information);
- appropriate national, state, regional and local institutional arrangements;
- responsibility for action; and
- who pays.

It could be expected that many of strategic R&D directions determined in this study would need to be implemented under an integrated national salinity infrastructure program. A fragmented approach is unlikely to be effective in achieving the magnitude of change required at the landuser level.

Potential benefits of investing in strategic R&D Directions

Results of a survey in which workshop participants were asked to rate the 14 R&D strategic directions according to their chance of success, magnitude of benefits, likelihood of adoption and longevity of benefits, indicated that the highest ranked strategies included:

- determining incentives for landusers to work together;
- coordinated catchment management models;
- identifying inequities in who pays for dryland salinity impacts; and
- defining the 'triggers' required for landusers to liberate capital for dryland salinity management.

Our analysis of the physical challenges of dryland salinity; and gaps in knowledge and technology required to address these challenges (Chapter 5), further supported the need for improved models (economic, financial and environmental); and the need for better accounting of impacts, benchmarking, completion of the information base and identification of the true costs and benefits of remedial action.

LWRRDC-managed R&D programs

Comparison of the focus of the LWRRDC-managed dryland salinity R,D&E program (Phase I) with the intent of the 14 strategic R&D directions identified by the foresighting exercise shows the present program places considerable emphasis on the biophysical attributes of dryland salinity, quantification of internal and external costs; and impediments to the adoption of policies and programs for dealing with dryland salinity. However there do not appear to be any projects associated with the apportionment of on-site and off-site costs; the 'triggers' and incentives necessary to ensure landuser action (individually and collectively); the possible effects of government regulation and market quality demands; or readily understood information systems to help landusers decide whether remedial action is financially advantageous.

Value of the foresighting process to LWRRDC

Application of foresighting techniques to LWRRDC-managed programs has both process and outcome benefits. It has been shown that the modified Schwartz approach is robust and transparent. It could be repeated very cost effectively over time with different groups (eg. NDSP technical committee and regional landuser groups). The outcome of the foresighting exercise (14 strategic R&D directions and an assessment of the overall net benefit of each strategic direction, to establish a sense of priority), leaves little doubt that NDSP must become more responsive to the information needs of individual landusers.

Present technological research indicates that (given present forms of landuse) there is no general panacea with respect to dryland salinity control as each catchment differs hydrologically from another. The best that can be expected is that techniques for characterising and monitoring individual catchments will become simpler and cheaper in the future. Hence if significant advances are to be made in the implementation of dryland salinity control then more emphasis will need to be placed on those 'drivers of the future' concerned with individual landuser incentives, as part of an overall program of (public and private benefit) R&D identified by the foresighting process.

The dryland salinity foresighting project also confirms the more subjective assessment of critical knowledge gaps identified by Hayes (1997), in a review of progress in managing dryland salinity. Clearly these two studies have independently arrived at a conclusion that a different focus is required to dryland salinity management in the future.

Review of the CIE report

Under the Terms of Reference for this project (see Appendix 1), we were also required to review the outcomes of the general foresighting scenario process undertaken by the CIE(1997).

The CIE report provides an example of how extensive statistical analysis and modeling can be used as part of the foresighting process to explore possible futures. It is a level of forecasting to perhaps aspire to rather than a level of analysis that could be routinely and cost effectively achieved for all LWRRDC-managed programs, given the dearth of regionally consistent data. The two methodologies and scope of each problem addressed by the respective foresighting exercises are compared in Chapter 4.

A lack of statistical data for on-site/off-site salinity impacts precludes logically extending the CIE foresighting results to determine the likely impacts of increased agricultural production targets on the regional extent of dryland salinity.

Conclusion

The general conclusion from this study is that NDSP (Phase I) is intuitively addressing many of the key components of an integrated strategy, albeit it is apparently seeking narrower outcomes than is the suggested focus of strategic R&D identified by the foresighting exercise.

The dryland salinity foresighting project has provided LWRRDC with additional insight into which R,D&E programs require greater funding emphasis, the timing of strategic R,D&E initiatives; and the likelihood of a successful outcome.

With this information, LWRRDC should be in a better position to make R,D&E investment decisions.

The emphasis must shift from decision-making on R,D&E based mainly on technical merit (given that no two catchments are hydrologically the same), to decision making framed from an institutional, social, economic and financial perspective which provide incentives at the landuser level.

Synopsis of Chapter 1
Background

Dryland salinity is recognised as a national problem with significant on-site and off-site impacts on agriculture, industry and the community.

Current systems appear to be supporting incremental improvements rather than major achievements in halting the spread of dryland salinity.

Foresighting challenges stakeholders in the problem to 'think outside the square'—move out of their comfort zone to consider a future that is profoundly different to the recent past.

Through the identification of driving forces and the development of scenarios, we will be in a position to develop robust R&D strategies that cover a range of possible futures; and be better prepared to recognise the warning signals of adverse change to understand which path we are likely to be travelling down. Corrective action can then be taken through the development of appropriate policies and objectives to shape a preferred future.

Chapter 1 overviews the:

- background to this project
- purpose of this report
- outcome sought from the study
- current dryland salinity situation
- scope of the dryland salinity problem
- applicability of the foresighting process to environmental management

The dryland salinity foresighting project objectives are:

- to use a foresighting process to examine likely scenarios of the future extent and cost of dryland salinity across Australia
- to identify appropriate research and development priorities for support under the National Dryland Salinity R,D&E Program.

LWRRDC needs to better understand the critical uncertainties (driving forces) likely to shape the future, to identify research and development required as a catalyst to support preferred outcomes in the Year 2020 and beyond. New possibilities are required that present the landuser with a range of opportunities that encompass not only technical solutions but also the social, economic, political and ecologically sustainable implications of any such research.

Both *process* and *outcome* goals of a foresighting exercise are discussed.

This foresighting project is the first of a number of consultative exercises recommended with different stakeholder groups to achieve a national consensus on dryland salinity issues; identify a range of possible R&D programs to address physical challenges; and assist LWRRDC to develop short-, medium- and long-term dryland salinity R&D strategies.

CHAPTER 1

Background

In September 1997, LWRRDC commissioned foresighting studies to assist in planning and managing future expenditures on research and development for three national programs;

— dryland salinity;

— river health; and

— irrigation research and development.

This followed an evaluation of the usefulness of foresighting techniques by the Centre for International Economics (CIE); [Using Foresighting to Identify R&D priorities for LWRRDC; Occasional Paper 10/97 (July 1997)].

The specific objectives of the dryland salinity foresighting exercise are to:

1. Examine likely scenarios of the future extent and cost of dryland salinity across Australia;
2. Identify appropriate research and development priorities for support under the National Dryland Salinity R,D&E Program.

The dryland salinity foresighting project was an exploratory exercise ('toe in the water') to trial the usefulness of the technique to LWRRDC-managed R&D programs. In this study, it was necessary to address issues from a broad national perspective rather than attempt to account for regional variability in dryland salinity.

The main emphasis of the dryland salinity foresighting exercise was to expose the critical uncertainties (driving forces) that shape the future and, which without research and development, may lead to unexpected on-site and off-site consequences. However, in gaining a consensus for future coordinated action, the 'process' benefits of involving stakeholders in a foresighting exercise should not be overlooked.

Purpose of this report

The purpose of this report is to:

1. Outline the foresighting methodology and process used to:
    - examine likely scenarios for the future extent and cost of dryland salinity across Australia; [Chapter 2] and,
    - identify appropriate R&D priorities for support under the National Dryland Salinity R,D&E Program [Chapter 3];
2. Review the outcomes of the general foresighting scenario process undertaken by the CIE (1997) [Chapter 4]; and
3. Report on the outcomes of the dryland salinity foresighting exercise against:
    - the objectives [Chapter 5]; and
    - the efficacy of the process to environmental management in general and dryland salinity management in particular [Chapter 6].

Outcomes

LWRRDC required scenarios to be developed to represent a range of plausible alternative future environments in 2020. These were to be based on issues critical to the success of ecologically sustainable development (ESD) and dryland salinity management in particular.

Related outputs of a foresighting process suggested in the CIE Report (1997) include:

- identification of physical challenges for each scenario; and
- gaps in knowledge and technological solutions to address these challenges.

Such analyses further assist to identify and prioritise R&D options.

This foresighting project is the first of a number of consultative exercises required with different stakeholder groups to:

- over time, achieve a national consensus on dryland salinity issues;
- identify a range of possible R&D programs to address physical challenges; and
- assist LWRRDC to develop short-, medium- and long-term dryland salinity R&D strategies.

Current situation

A criticism of present efforts to manage dryland salinity is that the technologies used for ameliorating the problem are based upon existing industries, management paradigms and institutional perspectives. The present system appears to be producing incremental improvements rather than major achievements in halting the spread of dryland salinity (Scenario Planning Workshop Opening Address, Appendix 9—Campbell (1998)). The dryland salinity foresighting project challenged participants to 'think outside the square'; ie. to move out of their comfort zone to consider a profoundly different future to the recent past.

Foresighting techniques are very appropriate to develop a range of plausible futures, given that land managers of the future could be expected to face significant changes in landuse, management practices, property ownership, enterprise mix, industry options and access to market information. Landusers may also be confronted with vastly different regulatory and international trade environments that introduce new competitive forces. These are just a few of many potential drivers of change that could be expected to shape the future over the next 20 years.

Growing political and public concern about the environment and the sustainable use of our natural resources is challenging both government and industry to review the appropriateness of past policies and objectives, particularly with a view to enforcing stricter regulation of non-ecologically sustainable practices. The debate over future cost sharing arrangements between government and industry continues to grow over who benefits and who should pay for better land management or reversal of current land degradation, in the absence of convincing economic and environmental models.

It should be noted that present land management options within Australia are currently being questioned on the basis that they may never be appropriate to our environmental conditions, and that incremental changes from current research efforts are unlikely to achieve long-term ecological sustainability. If this is the case, future LWRRDC R&D needs to address new possibilities that present the landuser with a range of opportunities including access to convincing models that encompass not only technical solutions but also the social, economic, political and ecological implications associated with various options.

Existing industry paradigms and policy frameworks appear to place emphasis on 'improving on the past' rather than strategies based on 'what is appropriate for the future'. Hence understanding of the likely future environment for dealing with dryland salinity is required to define what strategies are needed, and what processes are necessary to ensure their successful development, communication, implementation, uptake and support; (Scenario Planning Workshop Opening Address, Appendix 9—Campbell (1998)).

Scope of the dryland salinity problem

Dryland salinity presently costs the agricultural industry about $300 million per annum or about 1.2% of gross agricultural production. Possibly more significant costs are incurred off-site by industry and the community as a whole; through a range of economic, social, political and technological impacts. Dryland salinity now affects approximately 2.5 million ha of agricultural land and at the present rate of increase is likely to affect about 3.6 million ha by the year 2050; and could eventually increase to around 12 million ha (Robertson, 1996)*.

Technological advances and changed landuse practices within the agricultural industry are making gradual improvements to salinity control in some regions, but on the whole they tend to be relatively small incremental gains. Off-site industries affected by salinity may well be tackling this problem in a variety of ways not known to the agricultural industry, or to Research and Development Corporations. Their solutions could possibly stimulate new approaches to dryland salinity control and hence result in major gains in ameliorating the problem.

Applicability of the foresighting process

From a LWRRDC perspective, the foresighting process involves identifying uncertainties and developing scenarios to lead to a better understanding of the forces likely to shape the future, and therefore the technologies required as a catalyst to support preferred outcomes. This includes 'how', 'when' and 'where' they are likely to be most needed. Figure 1 shows the potential for foresighting to assist LWRRDC's strategic planning process.

There are three simplistic future dryland salinity scenarios; better, worse and no change. However, by using a foresighting process to examine the issues that apply to a range of plausible scenarios, we can be prepared to recognise the warning signals of adverse change, and understand which path we are likely to be travelling down. Corrective action can then be taken through the development of appropriate policies and objectives to shape a preferred future.

As indicated in the CIE (1997) Report, application of foresighting techniques may place emphasis on process, or on the information generated by the foresighting process.

In the dryland salinity exercise, both outcomes are relevant. From a process perspective, the project has:

- facilitated extensive interaction between representatives of different industry sectors and State and Commonwealth governments, through a national workshop; and
- exposed foresighting as a process to promote lateral thinking about traditional problems.

From an information perspective, it has achieved (for the Workshop group):

- a consensus on the critical issues and their relative importance to the future management of dryland salinity; and
- an assessment of the potential for success of R&D directed towards gaining a better understanding of the critical issues likely to have a major impact on the future state of dryland salinity in Australia.

The foresighting process was tested on a limited group of national representatives, selected to deliberately take a higher level perspective of the problem. To reinforce 'process and information' outcomes, the next step is to involve (in separate exercises), State and regional groups to achieve over time a full consensus on the recommended strategies developed from this study.

Although many of the recommended strategies may have been addressed in the past, this study provides new insight into where, and in which sequence R&D funding emphasis should be placed in order to make a significant impact on dryland salinity.

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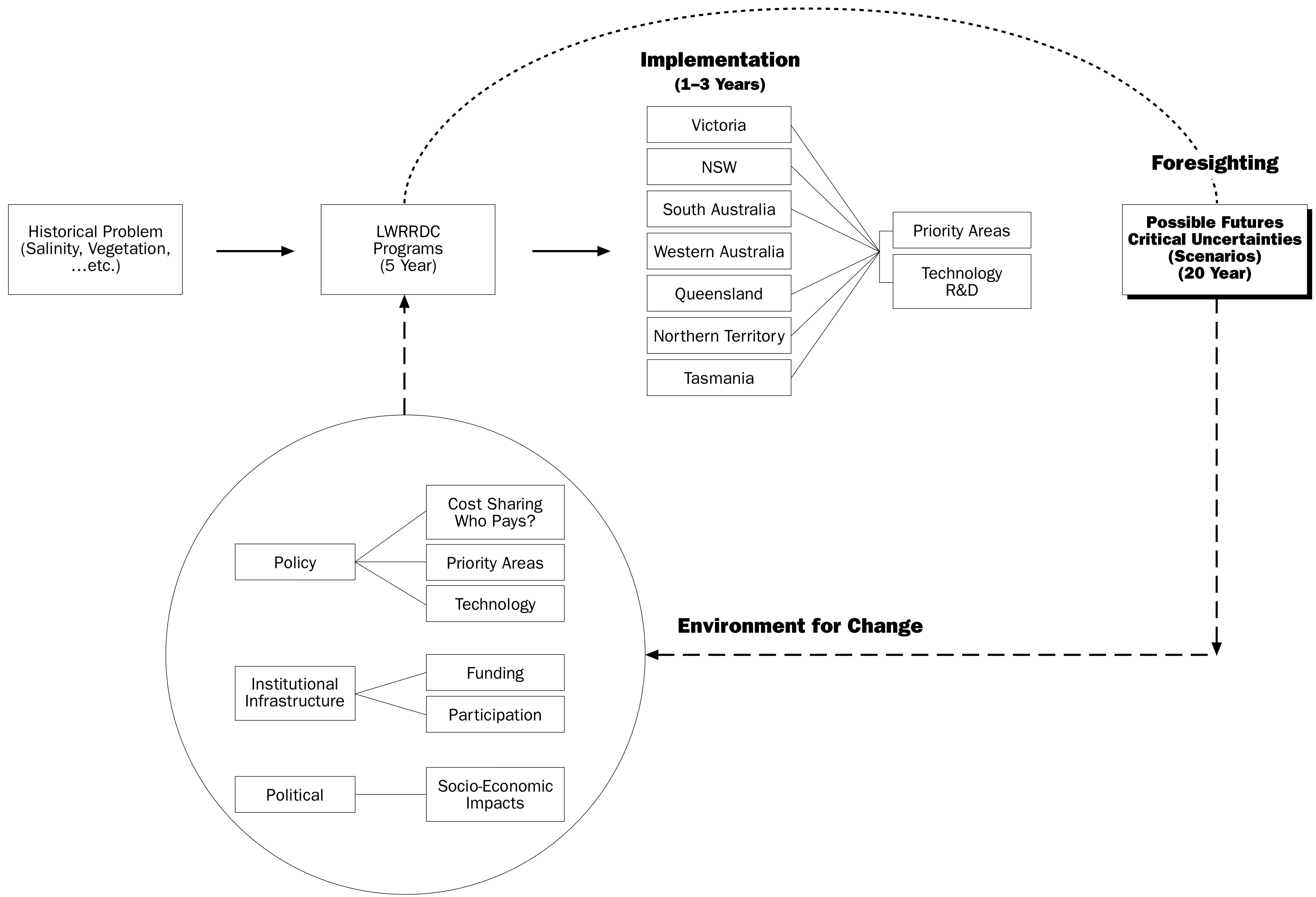
* Figures emerging from recent work indicate the potential extent of land that could ultimately be affected by dryland salinity is in excess of 15 million ha (Murray–Darling Basin Commission, in publication).

Figure 1
The role of foresighting in LWRRDC's strategic planning process



Synopsis of Chapter 2
Methodology

In this chapter, we discuss:

- a definition of foresighting
- the dryland salinity foresighting methodology
- foresighting process—phase I (Issues paper, seeding scenarios)
- foresighting process—phase II (Workshop, driving forces, scenarios, strategic analysis)
- 'axes of uncertainty'
- quadrants of uncertainty

The dryland salinity foresighting methodology used in this study is based on a process described by Schwartz, (1991). It involves clearly identifying the focal decisions, driving forces (subset into predetermined and uncertainties), critical uncertainties, axes of uncertainty and then scenario development. It is driven by an understanding of the forces shaping the long-term future which should be taken into account in policy formulation, planning and decision-making.

The focal decisions (FDs) in this study relate to key issues identified in 'An Assessment of the National Dryland Salinity R,D&E Program'; Occasional Paper No. 16/97, ie.

FD1 What blockages need to be removed to improve on the current situation?

FD2 Who should be involved?

FD3 What level of intervention is required?

FD4 Who should pay; and how much are they prepared to pay?

The objective was to identify the driving forces shaping the future most likely to have the greatest impact on dryland salinity and ecologically sustainable development in general; and hence provide a focus for LWRRDC's long-term R&D programs.

Two phases of the process are discussed. Phase I (pre-workshop) established the current situation through an Issues Paper, developed seeding scenarios; and the basis for selecting participants for a national scenario planning workshop. Phase II covered the identification of driving forces at a national scenario planning workshop; and development of three scenarios about the future status and extent of dryland salinity; (Institutional, Technological and Market driven futures).

Post workshop analysis showed how 150 driving forces were reduced to 50 critical uncertainties. These uncertainties were used to create axes of uncertainty, using an approach to define principal orthogonal axes; with each quadrant representing a logical future. The critical uncertainties became key points in developing scenarios (stories) about the future.

It is stressed that scenarios are not predictions (to be judged right or wrong, but are intended to raise awareness of the issues that if not addressed, may result in unwanted outcomes). A further set of scenarios is presented to reflect the axes of uncertainty analysed post-workshop.

Methodology

Although many foresighting techniques are described in the literature, we have favoured using a scenario planning approach described by Schwartz, 1991, because it is closely aligned with our existing information planning methodology, and provides a transparent, stepwise approach (Figure 2), to what may otherwise be regarded as a speculative process.

What is foresighting?

Foresighting exercises can combine a number of methods to develop pictures of the future including scenario planning, the Delphi, expert panels and other methodologies.

A useful general definition of foresighting is provided by Martin and Irvine, (1989).

> *Foresight is a process by which one comes to a fuller understanding of the forces shaping the long-term future which should be taken into account in policy formulation, planning and decision-making . . . Foresighting involves qualitative and quantitative means for monitoring clues and indicators of evolving trends and developments and is best and most useful when directly linked to the analysis of policy implications . . . Foresighting is not planning—merely a step in planning.*

From the LWRRDC perspective, it should involve "systematic attempts to look at the longer term future of science, technology, economy and society with a view to identifying emerging generic technologies likely to yield the greatest economic and/or social benefits" (OECD, 1996).

Scenario planning

A dearth of historical data on the extent and cost impacts of dryland salinity favoured scenario planning as the most appropriate approach for this project. Schwartz describes a scenario as a tool for ordering one's perceptions about alternative future environments in which today's decisions might be played out. According to Schwartz, (1991);

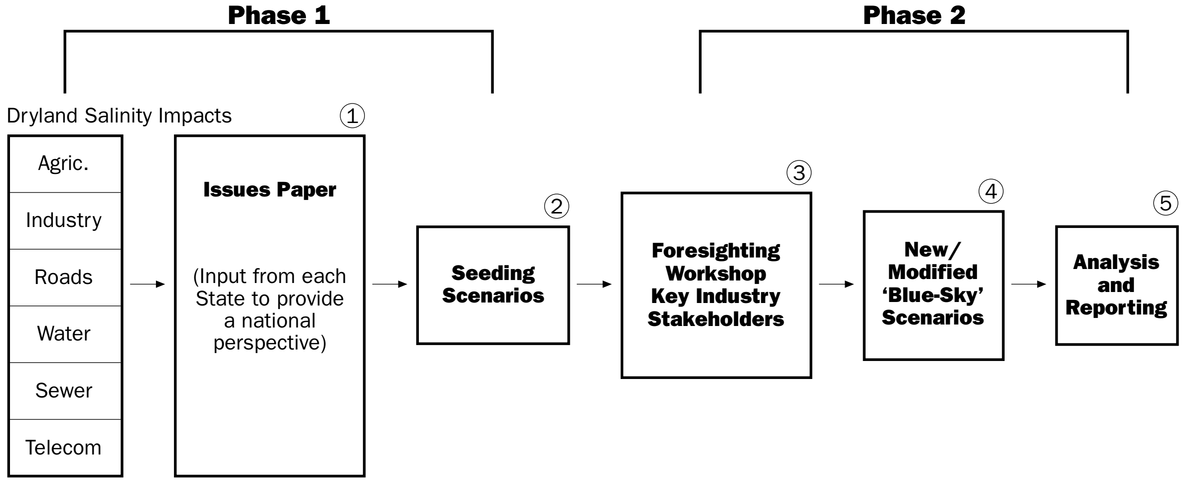
> *"The test of a good scenario is not whether it portrays the future accurately, but whether it enables an organisation to learn and adapt". ….."Scenarios also embrace qualitative perspectives and the potential for sharp discontinuities that econometric models exclude. Consequently, creating scenarios requires decision-makers to question their broadest assumptions about the way the world works so they can foresee decisions that might be missed or denied."… "Using scenarios is rehearsing the future; by recognising the warning signs and drama that is unfolding one can avoid surprises, adapt and act effectively". … "Ultimately, the end result of scenario planning is not a more accurate picture of tomorrow but better decisions about the future".*

Overview of the dryland salinity foresighting methodology

A typical foresighting process requires a number of iterations with the opportunity for input at all levels. The objective of this foresighting exercise is to achieve over time a national consensus on broad strategic R&D directions to assist in prioritising funding initiatives for dryland salinity over the next five years, and in the longer term. This may require the process to be repeated at approximately 18 month intervals (as perceptions may change over time), with the same and/or different stakeholder groups.

Figure 2 illustrates the steps followed in the dryland salinity foresighting process and is further described in Table 1.

Figure 2
Overview of steps in the foresighting process



In the dryland salinity foresighting exercise, three levels of consultation are recommended:

Tier 1 Consultation	National Workshop
Tier 2 Consultation	National Dryland Salinity Committee
Tier 3 Consultation	Landusers/representatives from selected Catchment Management Committees.

Tier 1 level consultation occurred through a national workshop held in Adelaide in January 1998, attended by approximately 20 industry leaders and experts from a range of backgrounds likely to be affected by dryland salinity over the next 20 years. They were given the initial opportunity to develop a range of plausible dryland salinity scenarios.

Consultation on the results of the foresighting exercise with Tier 2 and 3 representatives is outside the scope of this study but should take place as soon as possible following the completion of this project. It is suggested that the process of prioritising driving forces and R&D priorities is re-run with representatives of the National Dryland Salinity Technical Committee; as well as a regional/catchment management group, to confirm results from the National Workshop.

Foresighting process—Phase I

To establish an appropriate framework for foresighting and subsequent scenario development, the Schwartz methodology requires agreement on the focal issue or decision that will be used as a test of relevance for all subsequent work in the scenario planning process.

Focal decisions/issues

The dryland salinity foresighting process addressed the need for decisions to be made (focal decisions) in relation to a number of key issues identified in 'An Assessment of the National Dryland Salinity R,D&E Program'; LWRRDC Occasional Paper No. 16/97.

Table 1
Dryland salinity foresighting process (modified from the Schwartz method)[1]

Phase I (input on Issues from State dryland salinity experts)	
1	Clarify the problem; identify the Focal Decision(s)/Issues to be addressed by the foresighting process.
2	Develop an Issues Paper related to the Focal Decision(s)/Issues.
3	Determine driving forces
4	Develop 'Seeding' Scenarios (3 prepared)
5	Use outputs as background material for a national industry sector representatives workshop.
Phase II (National Industry Representatives Scenario Planning Workshop)	
6	Review and further development of the driving forces (and confirm focal decisions; outputs from Phase I)
7	Identify and prioritise the pre-determined (or inevitable) events and uncertainties; as well as the critical uncertainties (those that have a major impact on the Focal Decision).
7A[2]	*Use the driving forces to develop axes of uncertainty; and hence quadrants of uncertainty defined by the intersection of two orthogonal axes. (Each of the far corners of the quadrants represents a logical future; critical uncertainties become points in each scenario).*
8[3]	Use the driving forces to develop scenarios within these four quadrants.
9	Analyse the implications of these scenarios; to identify strategic R&D opportunities.
Phase 3 (Review of R&D Directions)[4]	
11	Circulate R&D directions to Expert Group, National Representatives and LWRRDC R&D institutions
12	Report and communicate results to LWRRDC for national awareness and action.

1 (Peter Schwartz 'The Art of the Long View' (Doubleday Currency, 1991))

2 Due to the limited duration of the Workshop, this step was not formally completed within the time available. It was subsequently analysed and is included in this report to show the ideal sequence of steps in the foresighting process.

3 A preliminary review of the driving forces identified by workshop participants indicated three likely scenario topics that could play a major role in the future management of dryland salinity: ie. a future driven by technical; institutional or economic market forces (or combinations of these forces). These scenarios have been positioned on axes of uncertainty, as shown later in this report.

4 Phase 3 to be undertaken following the release of this report.

The key (focal) decisions considered to be important for the optimal management of dryland salinity (from Box 1);

- What blockages need to be removed to improve on the current situation?
- Who should be involved?
- What level of intervention is required?
- Who should pay; and how much are they prepared to pay?

and the issues and key factors (Table 2) that relate to these decisions are listed below.

Table 2
Dryland salinity—issues/key factors

1. **National significance of dryland salinity**
   - Extent
   - Off-site Effects (Ecological: Financial)
   - Costs
2. **Causes of current failure to manage dryland salinity**
   - Failure to implement
   - Regulation
   - Motivation
3. **The most likely forms of intervention required to manage dryland salinity**
   - Market Forces
   - Political Intervention
   - Community Conscience
4. **Constraints preventing better management of dryland salinity**
   - Incentive
   - Knowledge
   - Relative importance (to other forms of degradation)
5. **Possible returns from future investment and institutional changes**
   - Institutional change
   - Socio-economic research
   - Technical Research

Source: LWRRDC Occasional Paper No. 16/97

Development of issues paper (current state of knowledge)

To provide background information for participants attending the national scenario planning workshop, a brief Issues Paper (Appendix 7) was compiled on the current state of knowledge about dryland salinity, including an initial list of issues and likely outcomes facing industry, infrastructure and the community (Alexander Tomlinson Associates, 1997). Social, economic, political, technological, and ecological driving forces currently influencing change were also identified. The Issues Paper reflects a comprehensive literature review; with input from State salinity committee experts.

Although dryland salinity impacts are not well quantified in the literature, they are widespread across industry, infrastructure and the community, as well as in the agricultural industry. Most of the statistics on the potential spread and impact of dryland salinity found in the Issues Paper have been extrapolated from historical trend data.

Development of seeding scenarios

From the Issues paper, sets of seeding scenarios or specially constructed stories about the future were developed to acquaint workshop participants with the scenario planning process prior to attending the national workshop. Each scenario (Appendix 8), modelled a distinct and plausible world in the year 2020.

Selection of workshop participants for a National Dryland Salinity Scenario Planning Workshop

To identify potential stakeholders affected by dryland salinity, components of an ecologically sustainable development model (Figure 3) were reviewed to target industry and community sectors listed in Table 3.

Figure 3
Ecologically sustainable development model

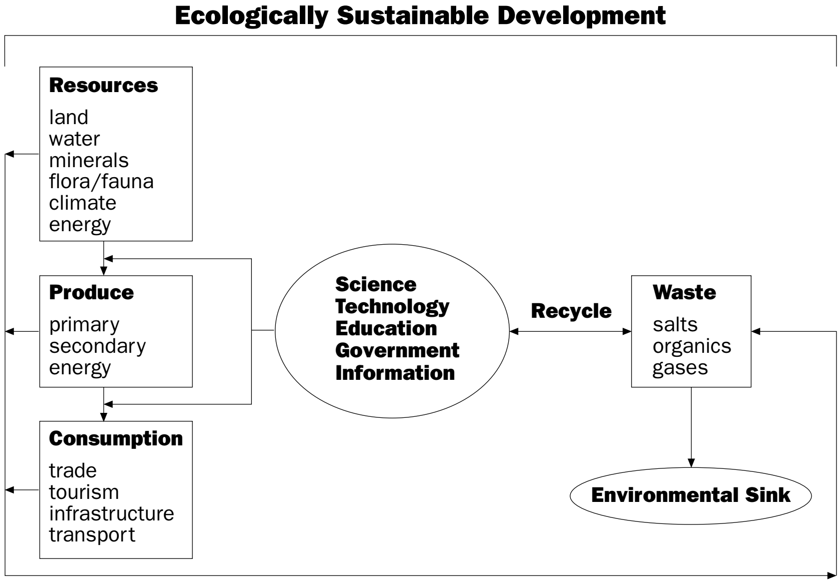


Table 3
Sectors relevant to the ecologically sustainable development model

Resources

1. Natural Resources (land, water, vegetation, fauna)
2. Energy
3. Climate

Produce

4. Production Economics/Genetics (agriculture/tolerant species etc)
5. Industry (Heavy industry dependent on water resources)
6. Finance

Consumption

7. Trade
8. Infrastructure—Local Government (urban, roads, railways)
9. Transport
10. Tourism (ecological impacts)

Waste

11. Wastewater/Recycling/Desalination
12. Land Rehabilitation

Science/Technology/Government/Education

13. Science and Technology
14. Information Technology and Communications
15. Education and Awareness
16. Government and Regional Development (incl. Rural Adjustment)
17. Indigenous Population

Ideally, candidates attending a national scenario planning workshop would include representatives from industry and community sectors likely to be affected by dryland salinity over the next 20 years; and experts working on dryland salinity impacts (social, economic, technical, political; biophysical). Although not all sectors identified in Table 3 were available for the national scenario planning workshop held in January 1998, those sectors represented are listed in Table 4.

Table 4
National foresighting workshop—sectors represented

Scenario planning workshop—Broad areas of representation

- Industry/Industry Commission
- Research Institutions (CRC; Land and Water; Economic)
- State Government (Salinity; Roads/Infrastructure; Natural Resource Management; Rural Adjustment; Extension Services)
- Commonwealth Government (Primary Industries, AGSO; CSIRO)
- Associations (National Farmers' Federation)
- Environmental Consultants/Academic Institutions

Foresighting process—Phase II
Scenario planning

The dryland salinity scenario planning process (refer to Table 1 on page 17) is described in two parts:

Part 1 reflects the process undertaken at the national workshop in which time constraints dictated that participants had to move directly from driver identification to scenario development without explicitly analysing the critical uncertainties and axes of uncertainty.

Part 2 describes the process which built on the workshop list of driving forces using the comprehensive foresighting methodology described by Schwartz. Ideally this would have been carried out explicitly at the workshop.

Part 1—Workshop scenario development process

Driving forces

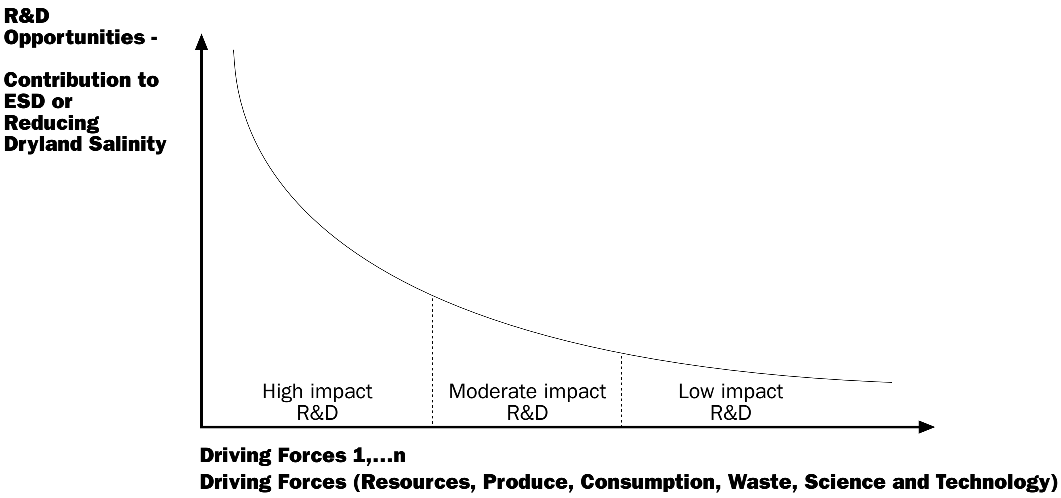
Through the use of foresighting techniques, the objectives of this study were to understand which of the driving forces shaping the future were likely to have the greatest impact on dryland salinity and ecologically sustainable development in general, and hence provide a focus for LWRRDC's long-term R&D programs (Figure 4).

As a prelude to developing scenarios, 150 long-term driving forces (Appendix 2), expected to influence the focal decisions and resolution of dryland salinity issues over the next 20 years, were identified and discussed during the national scenario planning workshop. (By identifying driving forces, it is contended that we will be better prepared to recognise symptoms of change, and make better decisions today).

Scenario development

The process of developing scenarios contributes significantly towards achieving a stakeholder consensus about the future. From a LWRRDC technology R&D perspective, the foresighting process was tested to establish its value for identifying R&D opportunities; to work towards achieving ecologically sustainable development (ESD); and specifically, to mitigate the impacts of dryland salinity on industry, infrastructure, the community and environment.

Figure 4
Use of foresighting to identify R&D opportunities (prioritised according to their impact on ESD or reduction in dryland salinity)



The dryland salinity foresighting exercise used focal decisions (see page 17) and key issues from Table 2 (see page 18) to establish an appropriate framework for scenario development. This framework was subsequently used to test the relevance of all subsequent work carried out during the scenario planning process.

Workshop participants used focal decisions, critical uncertainties and driving forces discussed during the plenary session and in scenario planning groups to develop a range of scenarios reflecting a technical, institutional and market driven future.

The scenarios developed at the national dryland salinity scenario planning workshop are presented below.

SCENARIO 1
MAD MAX 4 (TECHNICAL FOCUS)

In the year 2020, due to continuing rising watertables, 5 million ha is affected by dryland salinity. There has been extensive loss of quality in many ecosystems. Current biologically-based strategies are not sufficient to control the rate of increase. A quantum change is expected from recently implemented engineering solutions.

The combination of increased river salinity and high water prices has pushed rural urban communities to develop groundwater supplies, aquifer storage systems and grey water re-use treatment systems. There is tension between further allocation for environmental flows and new development opportunities and in-catchment water sharing.

Catchment governance processes demand risk assessment as a primary tool with respect to natural resources in all decisions on changed land and water use. The national catchment priortisation process developed at the turn of the millennium has been extensively used to ensure maximum return on investment in these decisions and R&D support. This has created a large demand for skills and information, particularly on evaluation criteria and processes.

Increased global population has kept wheat prices up. This, combined with unacceptable pressure on current urban areas, leads State and Federal governments to re-evaluate their policies on support to rural Australia. Following a recent landslide election victory the Government is implementing inland resettlement schemes. In doing so, it is finding new land management systems. The number of land management system options has increased dramatically through improvements to technology, such as genetic engineering.

SCENARIO 2

PADDY'S MARKET RULES (MARKET RULES FOCUS)

Global climate change remains a key uncertainty. The global community addresses this issue by introducing market instruments such as global emission trading options. International compliance has strong implications for the use of Australian resources and those of competing countries.

The trend to a green economy and ESD, in conjunction with a desire for smaller government, has lead to greater use of market processes in the management of natural resources (eg. eco-labelling). This in turn has lead to higher economic values being placed on environmental resources and better sustainable management.

The introduction of market processes into the management of natural resources has lead to greater returns from technological developments aimed at ESD, including non-market returns. Social Cost Benefit Analysis is applied to allocate greater private and public R&D investment in this area. A preference by society for reclamation and use of salt-affected lands has encouraged the development of new technologies such as the introduction of salt-tolerant plants developed from bio-technologies.

The trend to using market processes and the failure of past institutions has lead to their rationalisation, with fewer government and more private (both profit and non-profit) institutions. Government involvement is mainly in terms of established property rights, etc so that markets can work more appropriately. There is greater transparency in the actions of these institutions. Governments have moved from providers of services to funders. Government institutions are limited to areas where market failure justifies their involvement.

Following on the explosion of the information age, a strong information market has developed. New information relevant to dryland salinity is provided more by private market companies. Government only provides information that private markets do not supply and society demands. Information is more relevant, provided more conveniently and at a lower cost than in the past. A better educated community makes more appropriate use of this information in the management of natural resources.

Globilisation has had a number of effects. Individual economies are now more interconnected, for example through FDI, and problems in one can easily spill over to others. It is now a more variable world economic environment. Strong pressures are introduced to remove impediments to structural adjustment and optimal use of resources in the battle to survive in this global economy. Both macro and micro changes take place in light of this environment, for example large trading blocks like an expanded EU are formed and there is greater vertical integration between raw and processed food producers. There is a strong trend towards corporate farms using outside capital, for example to grow trees on farms.

A continuation of significant changes in tastes, diets and lifestyles has lead to a strong demand for 'clean green' foods. Increasing urbanisation world wide has seen a continuing trend towards convenience processed foods. These trends are reinforced by increasing incomes in some large developing countries.

Market policies are to the fore, including in the natural resources area with a heavy emphasis on the allocation of property rights, etc. Traditional service industries such as the water industry are now privatised and increasingly owned by large global corporations. Price has become the key determinant in the allocation of scarce resources such as land and water. Principles such as user and beneficiary pays are more in force. The establishment of these markets has lead to greater product choice in terms of quality and quantity, as well as lower cost systems. Regulations such as those in the environmental area have been replaced by market-oriented policies. Courts have become less involved in resource management issues.

Market forces continue to provide sufficient resources such as energy at reasonable prices and the world economy continues to grow strongly. Markets are established on previously under-valued resources such as water and these resources have become more appropriately priced and used, including in environmental uses.

SCENARIO 3
REPUBLIC OF OCEANIA (INSTITUTIONAL FOCUS)

Under the new 'Republic of Oceania', State governments no longer exist as they have been replaced by 'Regional' governments.

These governments rely on defined property rights to raise revenue for natural resource management. This attracts co-financing from private sector industry and the 'Oceania Consortium'.

Accelerated rural structural adjustment has resulted in large, efficient private sector resource users who are now willing to pay for what they use.

These resource users are subject to centrally managed 'quality assurance' processes linked to property management planning/ integrated catchment management/regional development, and, to comply with environmental audit requirements 'quality assurance' systems are used to secure a competitive edge in the global market and to attract a risk premium from financial markets.

Demographic shifts, combined with IT, have resulted in information access, serviced by cheaper diagnostics allowing implementation of 'state of art' technologies for the use of saline land and water.

In order to be at the cutting edge of productive resource use and to manage declining resource quality and quantity, resource users will invest in R&D to identify new technologies, opportunities and maintenance of core commercial sectors.

Major shifts in landuse have also occurred from agricultural to non-agricultural purposes. Greater intensification occurs—especially in the peri-urban areas.

Infrastructure design and maintenance integrates the costs of increased salinity and passes costs on to infrastructure users.

Part 2—post workshop analysis: Schwartz methodology (post workshop)

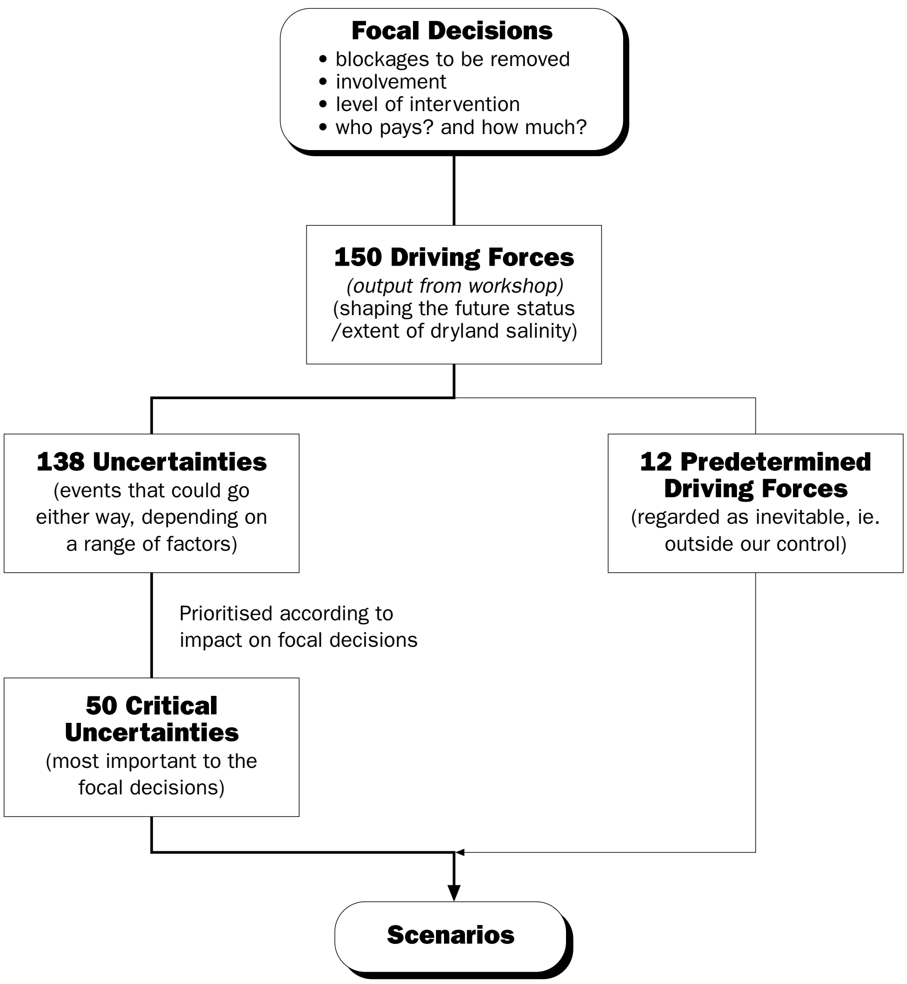
The following sections outline latter components of the application of the Schwartz scenario planning methodology used to enhance the results of the national scenario planning workshop.

Prioritisation of driving forces

Driving forces identified by participants at the national scenario planning workshop (Appendix 2), were subsequently grouped into categories of social, economic, technical, political and biophysical forces.

Through a questionnaire, workshop participants were requested to classify the 150 driving forces identified as either 'pre-determined', or 'uncertainties'. The pre-determined forces (those outside our control and likely to form a part of any of the developed scenarios) were then separated, leaving a list of 138 uncertainties (Figure 5), (as practically all drivers were listed as an uncertainty by one or more workshop participants).

Figure 5
Prioritisation of driving forces



Critical uncertainties

Critical uncertainties are driving forces most important to the focal decisions; and the most difficult to predict. They were selected and ranked in a systematic manner (Appendix 3) from the score of 'importance of the uncertainty to the focal decisions', assigned by workshop participants. After the uncertainties had been ranked, the driving forces were reduced from 138 to 50 critical uncertainties.

Axes of uncertainty

The next step in the process was to group 'like' sets of critical uncertainties (bundles of uncertainties with a degree of commonality) to a single spectrum, or axis of uncertainty. eg. the 'authority-regulation' to 'knowledge-incentive' axis shown in Figure 6.

By creating two orthogonal axes of uncertainty, we were able to identify four different but plausible quadrants (a matrix) of uncertainty, each very different from the other, with the extremes of each quadrant representing a logical future. The driving forces used to create the axes then became key points in developing plausible scenarios (or stories) concerning the future (refer to Figures 6–8).

At this stage of the process, there is significant potential for different analysts to identify tens of different axes of uncertainty that may be variants of the same underlying principal drivers. Scenario planning is not a 'precise science', bearing in mind that we are attempting to identify a set of axes and related scenarios which are plausible with respect to the focal decisions. The development of scenarios serves to create a 'story' from the critical uncertainties that we can relate to. The scenarios are not predictions (to be judged right or wrong), but simply a means of raising awareness of the issues that if not addressed, may result in unwanted outcomes. It could be argued that once the critical uncertainties are identified and accepted by stakeholders, the scenarios contribute little to the final analysis of strategic directions and priorities.

Various techniques can be used to group 'like' uncertainties. In the axes developed below, we have used 'Key Words' in examples 1 and 3; and a more holistic 'bundling technique' to develop axes in example 2. All axes are valid and serve to illustrate that we were attempting to identify a set of axes that would allow us to fully explore the influence of the identified critical uncertainties.

To illustrate the process, example 1 is discussed in more detail. Sorting key words in the critical uncertainties identified by participants at the Adelaide Workshop, led to a natural grouping of [*'Individual Landuser'*], [*'Government and Community'*], [*'Knowledge/Incentive/Education/Technology/R&D'*], and [*'Regulation'*]. These four groups are sufficient to create one example of a set of principal orthogonal axes representing future uncertainties of dryland salinity management in Australia (Figure 6).

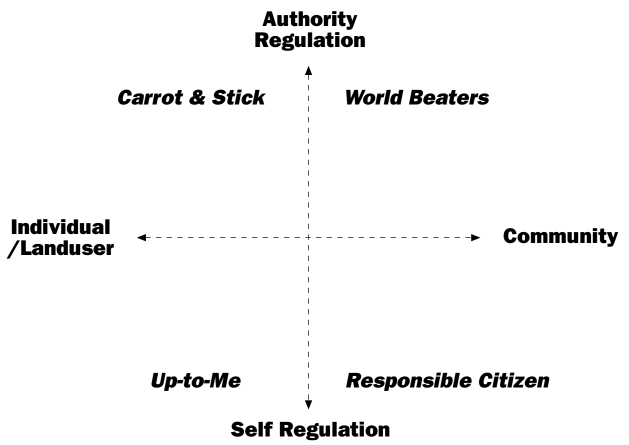
With the right framework (set of orthogonal axes), compatible with the focal decisions and driving forces, it is feasible to explore in a two dimensional way, all of the important driving forces in a 200–300 word scenario (the critical uncertainties being the key points in each scenario).

It should be emphasised that other axes of uncertainty could be devised, each generating four very different logical futures to be explored through constructed scenarios. Perhaps in a future foresighting exercise other options should be explored.

It would be difficult to ignore the *'Individual Landuser vs Government/Community* axis but there are a range of possibilities for the other axis: eg. a *'Motivation/Incentive'* spread over a *'self-motivated vs regulated'* axis (Figure 7);

Figure 6
Axes of uncertainty—example 1

Figure 7
Axes of uncertainty—example 2



or an *'Information/Knowledge'* axis that ranges from a low confidence to a high degree of confidence in our understanding of dryland salinity (Figure 8).

Workshop scenarios positioned on axes of uncertainty (example 1)

Although national workshop participants did not have explicit axes available to them, they were deliberately organised into groups (Institutional, Technical, Market Forces); that ensured important axes were given some focus. Each group derived their focal decisions and developed three future scenarios on the basis of the driving forces discussed or developed at the workshop.

Figure 9 shows that the choice of workshop groups and consideration of background information on focal decisions and driving forces prior to scenario planning allowed the three workshop scenarios described in 'Scenario Development' to be referenced to the axes of uncertainty presented in Figure 6.

Figure 8
Axes of uncertainty—example 3

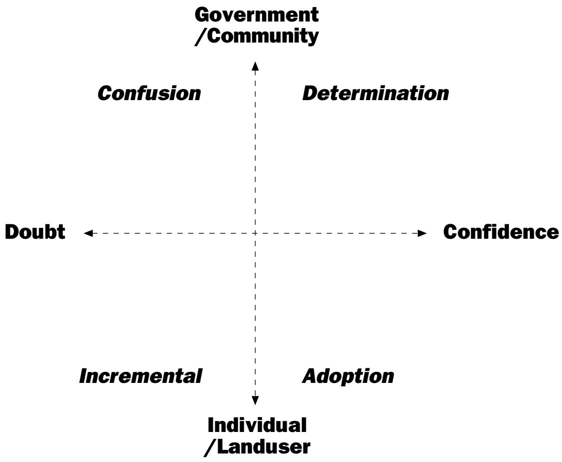
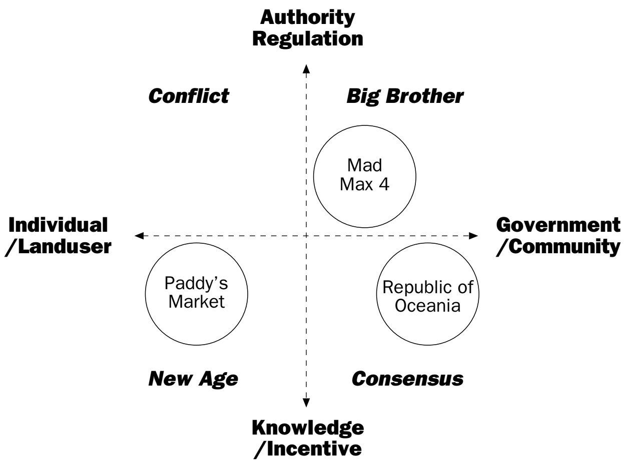


Figure 9
Dryland salinity workshop scenarios/axes of uncertainty



Scenarios developed by workshop participants reflect many of the characteristics of each quadrant explained in the next section. They are not predictions, but serve to highlight the forces that push the future in different directions.

Explanation of the axes of uncertainty (Figure 6)

Decisions relating to critical uncertainties that play out in all four quadrants are those which need to be addressed most urgently by future R&D plans and strategies. For those uncertainties appearing in only one or two quadrants, we need to identify the early warning signs that indicate that other scenarios are beginning to unfold. In this way we can prepare or 'rehearse' our strategies to influence the possible futures. The axes are interpreted as follows:

HORIZONTAL AXIS: GOVERNMENT/COMMUNITY – INDIVIDUAL/LANDUSER AXIS

The *horizontal axis* of uncertainty contrasts individual landuser management of dryland salinity with a government and community approach to the problem. Some landusers do not have a salinity problem; some are successfully implementing control measures; some are largely ignoring the problem. Landusers traditionally make all of the management decisions with respect to their land and tend to resent outside interference with those decisions.

Dryland salinity also impacts on governments (Federal, State, Local) as well as the community at large. Their views and actions with respect to this problem can be rather different to those of the individual landuser as they are driven by such salinity impacts as damage to infrastructure, water quality, and environmental degradation. Governments are in the position of being able to find solutions to dryland salinity through fostering research and education and/or by imposing various positive and negative incentives upon landusers.

VERTICAL AXIS: AUTHORITY/REGULATION – KNOWLEDGE/INCENTIVE

The *vertical axis* represents two extremes of action with respect to dryland salinity. One extreme represents total regulation via predetermined forms of land management together with various 'carrot and stick' incentives, while the other represents self-regulation that is generated through knowledge and the certainty of higher financial rewards.

Explanation of the quadrants of uncertainty (Figure 6)

The axes of uncertainty give rise to *four quadrants of uncertainty* which contain a large number of 'real life' situations. The attitudes likely to prevail in each quadrant are characterised as 'Big Brother'; 'Conflict'; 'Consensus' and 'New Age', described below.

AXES QUADRANT 1—BIG BROTHER

The *Big Brother* quadrant represents the confidence that governments and the community have in the information concerning the causes, effects, required control measures and costs of dryland salinity to the nation. It also reflects their unified determination to see the problem controlled or eliminated.

In the extreme situation the government (with the concurrence of community opinion) would simply say *"This is a national problem. We know how to fix it and so for the good of the community and environment we will implement those measures, regardless of individual landuser opinion"*. It could also involve such measures as a compulsory co-payment by landusers that could only be avoided by implementing certain prescribed land management practices.

Less extreme actions, dictated by political realities, would contain a whole raft of incentives, disincentives, education programs, demonstration areas and research.

AXES QUADRANT 2—CONFLICT

The *Conflict* quadrant represents a 'battle of wills' between governments and individual landusers. The government does not have overwhelming support from the community; nor does it have complete confidence in the information being provided by its various research and development initiatives. However it is determined to see that 'something is done' to fix up the salinity problem.

Economic rationalists push the scenarios towards the extreme corner of the quadrant regardless of whether techniques exist for determining the 'fairness' of the actions to individual landusers. They would probably institute a blanket 'polluter pays' tax that makes no allowance for the wide range of biophysical situations to which it is applied.

The more moderate (or politically wise) legislators might soften the regulations with tax concessions to those seen to be implementing recommended landuse practices. This might be welcomed by the 30% of agricultural producers to whom it would make a significant financial contribution but not to the remaining majority. It would be unlikely to make significant gains against the spread and severity of dryland salinity.

Naturally, individual landusers would resent such action and in the extreme situation such regulations would be ignored completely. The attitude of *'no-one is going to tell me how to run my farm'* would be prevalent in many areas. Forced property sales would only serve to heighten tensions, increase social security payments, and result in a marked decrease in agricultural production. Environmental groups in the community would probably give tacit political support to the government action whilst at the same time demand more funding for environmental protection and restoration.

AXES QUADRANT 3—CONSENSUS

The *Consensus quadrant* represents a more pragmatic approach by governments, community and individual landusers. Everyone knows there is a problem and that it is not going to be fixed overnight. However all parties are confident that given sufficient research effort and education programs; individual landusers will change their land management practices. There are plenty of examples of success in the battle against the white giant but without the whole-hearted support of all landusers the advances are *incremental* rather than substantial.

In the extreme sector of this quadrant governments provide positive assistance to community groups to implement remedial work on public lands but still largely resist on-farm assistance. Closer to the vertical axis governments do make some concession to individual landusers in the form of work-experience programs for the long-term unemployed. These people plant trees, remove noxious weeds and carry out other short-term forms of environmental work and receive the approval of the community for their efforts.

Landcare thrives in this sector as it involves a reasonable number of individual landusers, community groups with an environmental conscience and government employees engaged in environmental education, communications, whole farm plans, land and water management plans etc.

AXES QUADRANT 4—NEW AGE

The *New Age quadrant* is characterised by individual landusers having ready and affordable access to good quality research information—not only in the dryland salinity area but in other forms of land degradation, alternative crops, markets, economic models etc. They would be confident that tackling dryland salinity was a worthwhile financial exercise and that they were contributing to restoring the environment.

The extreme lower corner of the quadrant would be occupied by the highly motivated individual who gets on with the job with little government influence (they *choose* to do it!) other than through the provision of easy-to-follow, real-time information. Since success breeds success this landuser's self esteem is restored and his/her standing in the community increases markedly. The New Age landuser becomes a leader in innovative approaches to achieving ecologically sustainable production and drags the neighbours along by example and enthusiasm.

The most likely starters in this quadrant are those who have a low debt commitment in the first place and who treat their holdings as a business first and a way-of-life second. The land is their 'bank' and they are determined to improve it's capital value, yet achieve a good return on their investment at the same time.

Companies controlling numbers of properties are also likely to flourish as they spread their risks and liabilities by using contract labour and machinery wherever possible. Their philosophy is 'if there is an environmental problem that is affecting production—then fix it up'.

Looking at these quadrants collectively it is clear that they provide not just a 'single' story but a whole set of plausible chapters in a book of 'possible futures'. The next chapter describes how to condense those 'plausible chapters' into a practical set of actions.

Synopsis of Chapter 3
Results

In this chapter we discuss:

- from critical uncertainties to a dryland salinity R&D strategy
- evaluation of the net benefits of strategic R&D directions
- dryland salinity program—performance targets (dateline 2020)
- reverse history analysis

When the critical uncertainties identified in Chapter 2 were analysed in relation to the axes of uncertainty, 14 critical uncertainties common to all four quadrants were identified. This led to the identification of R&D topics which were assigned to the four focal decisions.

14 Strategic R&D directions identified by the foresighting process

FD1 Blockages

1.1 Quality of life and human health impacts

1.2 Incentives necessary to encourage coordinated landuser activity

FD2 Involvement

2.1 Limit of individual responsibility

2.2 Operating environment for landholder internalisation of salinity impacts.

FD3 Intervention

3.1 Catchment Management Committees implement effective, coordinated catchment plans

3.2 Changes of industry structure to bring together benchmarking, self-regulation, quality assurance, marketing and R&D

3.3 Scope of regulations to meet changing landuse regimes

3.4 Effect of regulatory market quality criteria on production methods, such as ISO9000.

3.5 Appropriateness of COAG land management targets and incentives, in effectiveness programs.

FD4 Who pays/How much?

4.1 Inequities in 'who pays'—on-farm and off-farm.

4.2 'Triggers' landusers require to liberate capital.

4.3 Information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources.

4.4 'Polluter pays' philosophy impact on individuals implementing remedial action.

4.5 Government environmental restoration programs—restricting landuser access to national funds

Net benefits of the strategic R&D directions were analysed based on values assigned by workshop participants. The greatest net benefit is expected to arise from incentives for coordinated landuser activity, coordinated catchment management plans; identifying inequities in who pays (on-farm/off-farm); and the 'triggers' landusers require to liberate capital.

CHAPTER 3

Results

From critical uncertainties to a dryland salinity R&D strategy

The characteristics of each quadrant described on page 28 can potentially lead to numerous specific scenarios about the future status of dryland salinity. However, remembering that the objective of scenario planning is not to predict future events, but to highlight large scale forces that push the future in different directions, many of these scenarios will be similar in terms of key underlying characteristics.

In pursuit of a robust strategy to combat dryland salinity and more specifically, to develop the R&D component of such a strategy, we need to identify critical uncertainties that feature in several possible futures. A robust R&D strategy can then be developed to cover these possible futures.

Using the Schwartz approach, we can reduce the large number of critical uncertainties identified by workshop participants to a specific set of uncertainties common to all quadrants.

Critical uncertainties occurring in only one or two quadrants are not immediate priorities under this strategy, but at the same time, they should not be ignored. There may come a time when they have a strong influence on combating dryland salinity; and one should always be on the lookout for early warning signs of their increasing prominence.

In this respect, consider the potential benefits of a foresighting exercise prior to the Asian economic crisis (crash). While such events are usually difficult to forecast, foresighting analysis could have assisted the region to be strategically prepared, and alert to the early warning signals of a pending economic downturn. (Such events that occur 'without warning' are commonly referred to as 'long fuse, big bang problems').

The real value of the current foresighting exercise at this stage is in having identified potentially the most important driving forces (critical uncertainties) that will shape the success of future dryland salinity programs. They should feature prominently in any future strategy.

In this foresighting exercise, 50 of the 138 driving forces identified by Workshop participants were identified as critical uncertainties (refer to Figure 5 on page 24 and Appendix 3; Table 22 on pages 74–75). When these uncertainties are examined in terms of the axes of uncertainty shown in Figure 6 on page 26 (ie. [Authority/Regulation – Knowledge/Incentive]; [Government/Community – Individual/Landuser], there are 14 critical uncertainties common to all four quadrants (Table 5 and Appendix 4). These critical uncertainties should then become a focus of a dryland salinity management strategy in general, and an R&D investment strategy in particular.

Reviewing the focal decisions of the dryland salinity foresighting exercise (from Box 1):

FD1 Blockages

FD2 Involvement

FD3 Intervention

FD4 Who pays/how much?

the 14 critical uncertainties led to the identification of R&D topics, which were assigned to each of the four Focal Decisions (Box 2).

Box 2
Broad strategic R&D categories that address focal decisions about the future management of dryland salinity

FD1 Blockages

R&D Topic 1.1	Determine the potential effects of dryland salinity on the quality of life and human health over the next 20 years.
R&D Topic 1.2	Determine the incentives necessary to encourage landusers to work together in overcoming to dryland salinity.

FD2 Involvement

R&D Topic 2.1	Define the limit of individual responsibility for dryland salinity management.
R&D Topic 2.2	Determine what operating environment will be necessary for landholders to accept internalisation of salinity impacts.

FD3 Intervention

R&D Topic 3.1	Determine how empowered Catchment Management Committees might best be able to implement effective, coordinated catchment plans for dryland salinity management.
R&D Topic 3.2	Define what changes of industry structure will be necessary to bring together benchmarking, self-regulation, quality assurance, marketing and R&D
R&D Topic 3.3	Determine the scope of appropriate regulations to meet possible changing landuse regimes in the twenty-first century
R&D Topic 3.4	Determine whether regulatory market quality criteria, such as ISO9000, will have any effect on production methods in areas affected by dryland salinity.
R&D Topic 3.5	Determine the appropriateness of land management targets and incentives, devised by COAG, in changing the effectiveness of dryland salinity management programs.

FD4 Who pays/how much?

R&D Topic 4.1	Identify inequities in 'who pays' for dryland salinity impacts—both on-farm and off-farm.
R&D Topic 4.2	Define the 'triggers' landusers require to liberate capital for dryland salinity management.
R&D Topic 4.3	Determine the information individual landusers require to be able to make informed investment decisions and set priorities in the face of limited financial resources.
R&D Topic 4.4	Determine whether the 'polluter pays' philosophy is likely to lead to individuals implementing remedial action.
R&D Topic 4.5	Determine whether government environmental restoration programs (revegetation, increased protection of biodiversity) are restricting landuser access to national funds for overcoming dryland salinity.

The 14 strategic directions have a strong bias towards social, economic and institutional implications of dryland salinity, with particular emphasis on the role of the individual landuser.

The Hayes (1997) review of the LWRRDC-managed National Dryland Salinity R,D&E Program also highlighted a need for emphasis on economic and institutional issues for any future NDSP. The major finding from that study was *"that land managers currently lack the incentives to change practices and that successful management of dryland salinity (and other resource management issues) will require changes to the operating environment in which land management decisions are being made"*. It also indicated governments will need to act to bring about change based on better information about the benefits and costs to society of reducing dryland salinity. This would require R,D&E to provide better information and to improve the range of technical, economic and social tools to support dryland salinity management at least cost to society.

Evaluation of the benefits of strategic R&D directions

The 14 dryland salinity strategic R&D directions identified by the foresighting exercise, were distributed to workshop participants for their evaluation. They were asked to score the strategies as **H**igh (3), **M**edium (2) or **L**ow (1) according to:

- the chance of success of that strategy;
- the magnitude of benefits that could be expected by implementation of the strategy;
- the likelihood that the strategy would be adopted;
- the likely longevity of the benefits arising from implementation; and
- the likelihood of leakage of the benefits.

All results were normalised based on the total number of answers received to a particular question.

The results are shown as histograms in Figures A1 to A6 (Appendix 5) with a 'high' rating having a value of greater than 0.7, a 'moderate' rating between 0.5 and 0.7, and a 'low' rating at values less than 0.5.

Chance of success of R&D strategies

Only five of the 14 strategies were rated as having a high chance of success with the remainder having a moderate chance.

The highest scores were assigned to strategies directed towards 'blockages to the uptake of remedial actions':

- Catchment Management intervention;
- Inequities with respect to who pays for dryland salinity damage; and
- Determining the 'triggers' necessary to induce farmers to adopt remedial actions.

The lowest scores were for strategies involving:

- Market quality criteria; and
- Competition for national funding for implementing dryland salinity management strategies.

The latter is an interesting comment in the sense that a major complaint of landusers is that national money is rarely spent on privately owned lands.

Magnitude of benefits

Most of the strategic R&D directions were rated as having a high or moderate benefit. The least benefit was seen to be associated with 'market quality criteria'. Clearly this was not seen by workshop participants as a major incentive for landholders to implement dryland salinity management techniques.

Different responses to the 'magnitude of benefits' may be expected from different stakeholder groups so there would be considerable benefit in designing independent foresighting exercises to cover all affected parties.

Likelihood of adoption

Respondents were not particularly convinced that any of the R&D strategies would be embraced by landusers in the future—although they did consider that Catchment Management Committees would be willing to act if given the authority to do so.

It is possible that landuser representatives would have scored this question more positively but until that thesis is tested LWRRDC could not be confident that they were promoting the right strategies.

The question of implementation is obviously the key to all proposed strategies and raises the question of what incentives are necessary to induce landholders to adopt remedial measures. The answer might well be to simply 'ask them' in the next stage of foresighting, for comparison with the views of 'off-farm' interests.

Responses in this category, and the others to a perhaps lesser extent, have something to say about knowledge of and the selling of the results from LWRRDC R&D activities.

Longevity of benefits

On the whole all strategies were seen to have moderate to high long-term benefits—if implemented. It is possible that landuser representatives would hold a less positive view on longevity of benefits based on the 'feasibility of implementation'.

Leakage of benefits

Responses to this question were probably influenced by different interpretations of what was meant by 'leakage of benefits'.

Leakage of benefits refers to where techniques devised in the LWRRDC R&D program are exported or adopted by other countries and diminish the gains to Australia from the innovation. Regardless of the understanding of the question, the large majority of respondents saw the leakage of the benefits being low, as might have been expected in relation to resource related R&D, as distinct from commodity R&D.

Overall expected net benefits

To ascertain the overall expected net benefits of the 14 dryland salinity strategic R&D directions identified by the foresighting exercise, the normalised scores for the component questions need to be aggregated.

In this aggregation, the first three components (chance of success, magnitude of benefits, likelihood of adoption) should take the same weighting. This is because, say a high score in each component would be equally important in the overall benefit—a high benefit would be diminished unless the chance of success and likelihood of adoption were also high.

The fourth component (longevity of benefits) differs from the first three components in that a linear relationship would not be expected between the High, Medium and Low responses. Discounting over time means benefits realised for say 10 years will not be twice the benefits realised for five years. (The (normalised) weights used were obtained by discounting with the long-term bond rate of 5.7% and taking a Medium response as corresponding to five years, the time frame for LWRRDC work program).

The benefit leakage was not used in the aggregation as, from the response to this question, it would appear to have little impact on R&D in the land and water resources area.

Evaluation summary

All results are summarised in Table 5 with the highest rating represented by dark shading—low rating, no shading.

Table 5
Prioritisation of dryland salinity strategic R&D directions

Dryland Salinity Strategic R&D Directions	Chance of Success	Magnitude of Benefits	Likelihood of Adoption	Benefit Longevity	Benefit Leakage	Net Benefits
R&D 1.1						
R&D 1.2						
R&D 2.1						
R&D 2.2						
R&D 3.1						
R&D 3.2						
R&D 3.3						
R&D 3.4						
R&D 3.5						
R&D 4.1						
R&D 4.2						
R&D 4.3						
R&D 4.4						
R&D 4.5						

Synopsis of Chapter 4
Comparison with the CIE foresighting process

In this chapter we discuss:

- context of the dryland salinity and Centre for International Economics (CIE) foresighting exercise
- implications of the CIE report
- CIE outcomes applicable to the dryland salinity foresighting process
- conclusions drawn from the CIE report

The CIE report provides an example of how extensive statistical analysis and modelling can be used as part of the foresighting process to explore possible futures. It is a level of forecasting to perhaps aspire to rather than a level of analysis that could be routinely and cost effectively achieved for all LWRRDC-managed R&D programs, given the dearth of regionally consistent data.

The two methodologies and scope of each problem addressed by the respective foresighting exercises are compared (Figure 10 and Table 6).

A lack of statistical data for on-site/off-site salinity impacts precludes logically extending the CIE foresighting results to determine the likely impacts of increased agricultural production targets on the regional extent of dryland salinity.

The approach we have devised takes into account the less than ideal base of information on which to begin a meaningful foresighting exercise; and LWRRDC's requirements that foresighting should be carried out with a clearly defined range of actionable steps as an endpoint, ie. specific advice on R&D options to assist in mitigating the impacts of dryland salinity.

To carry out a similar level of statistically based analysis on commodity projections to support a dryland salinity foresighting exercise, we would require:

- commodity projections at a regional and catchment level;
- statistical information on the extent and cost of on-site and off-site salinity impacts at a regional and catchment level;
- models to determine salinity equilibrium states in each region/catchment; and
- the predictive capability to model the impacts of increased production demands/management options on land, water and yield.

These information and technology gaps are addressed by strategic R&D directions identified by the foresighting process.

Once the additional statistical analysis and modelling shortfalls at a regional and catchment level have been addressed, it would be possible to carry out more detailed foresighting exercises incorporating aspects of the CIE example.

Comparison with the CIE foresighting process

Summary of assessment

The CIE application of foresighting incorporates a level of forecasting to perhaps aspire to rather than a level of analysis that could be routinely and cost effectively achieved for all LWRRDC-managed R&D programs. It provides an example of how extensive statistical analysis and modeling can be used as part of the foresighting process to explore possible futures, albeit ones that concentrate on commodities and ignore key outlying events from a resources perspective, such as droughts. Unfortunately the wealth of aggregated statistical information at the global and national level is not available on a disaggregated regional basis required to address LWRRDC-managed R&D programs.

The dryland salinity foresighting methodology has provided the strategic insight needed to carry out more detailed foresighting exercises incorporating aspects of the CIE example, once the additional statistical analysis and modelling shortfalls at a regional and catchment level have been addressed.

Context of the dryland salinity and CIE foresighting exercises

A requirement under the dryland salinity foresighting terms of reference was that the implications of the CIE approach for this present exercise should be examined. Figure 10 presents schematically, the scenarios and focal decisions for both foresighting projects. Table 6 shows the national significance of each issue, to provide context and scope; and to assist in comparing methodologies used in each case.

Figure 10
Dryland salinity/CIE foresighting projects

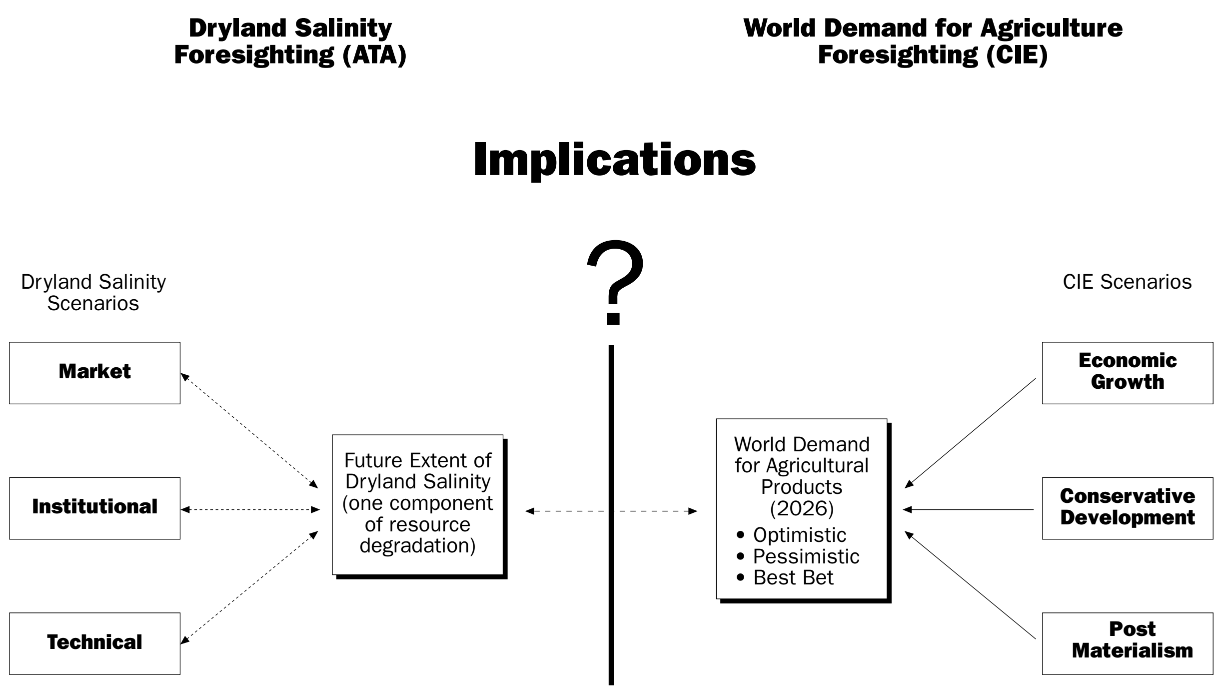


Table 6
Comparison of foresighting exercises

	Dryland Salinity (ATA)	World Agricultural Demand (CIE)
• Production—potential impacts	Current impact $300 million pa. lost production. (1.5%)	Current Australian production $22 billion pa.
• Current productive area/ impacted area	Current productive area impacted is 2.5 million ha—or 4.5% cultivated land. (Potential to increase to 12 million ha.)	Current productive agricultural area 50 million ha.
• Increase in Area (to meet 2026 World Agricultural Production targets.	Potential additional area of salt impact—500,000 ha	8 million ha increase in Cropping Area to meet 2026 demands.
• Driving Forces	1. quality of life/human health 2. benefits of catchment coordination 3. lower risks 4. landuser incentives 5. investment 'triggers'. 6. competition for limited funds	1. demand 2. physical constraints — land — water — yield 3. extent environmental costs are internalised

The CIE foresighting exercise addressed the potential for Australia's agricultural sector to meet demand projections, given potential supply constraints of the resource base under three scenarios: *economic growth*; *conservative development* and *post-materialistic;* CIE, (1997). Three main drivers were considered to be *demand*, *physical constraints* and the *extent that environmental costs are internalised.*

Currently, national agricultural production is valued at $22 billion pa. over a productive area of 50 million hectares. The implications of the CIE report are that an additional 8 million ha. of cropping area would be required to meet the likely increase in demand for agricultural products by 2026.

The dryland salinity foresighting exercise addresses the likely extent and management of dryland salinity with a view to identifying strategic R&D directions. Possible futures under three scenarios are considered (Figure 10 on page 37); a market driven future which is similar to the economic growth scenario developed by the CIE; a technology dominated future; and a future which is heavily influenced by institutional forces.

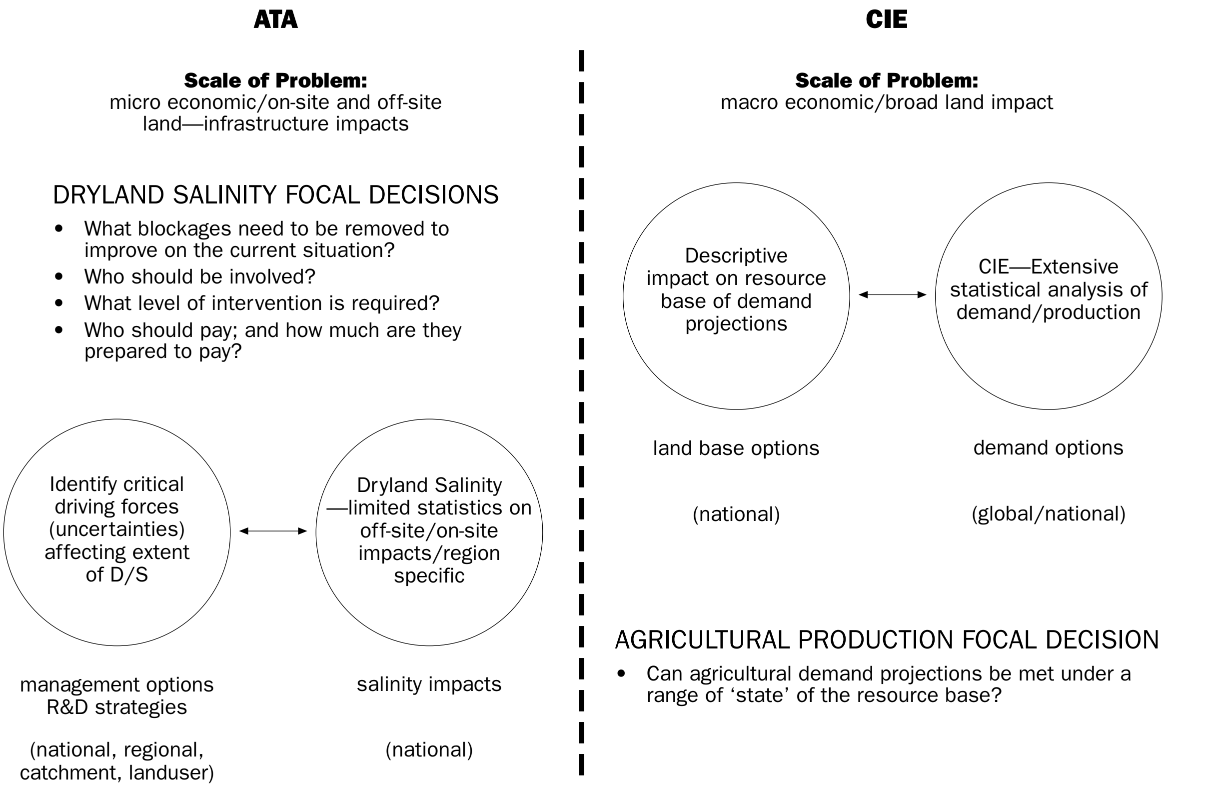
The foresighting analysis indicates that some of the most important driving forces likely to affect the extent of dryland salinity in the long-term are; quantification of quality of life and human health impacts; empowered Catchment Management Committees implementing effective, coordinated catchment plans; the availability of information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources; incentives to encourage coordinated landuser activity; identification of the 'triggers' landusers require to liberate capital; and assessment of the effects of competition for government environmental restoration programs drawing funding away from salinity management on private land.

Dryland salinity affects an estimated area of 2.5 million ha. (approximately 4.5% of the productive area) and is costing in the order of $300 million in lost production or 1.5% of total production value (CIE, 1997; Robertson, 1996). However, the off-site costs could be significantly higher. At equilibrium, it has been estimated (Robertson, 1996) that the potential area of salt affected land across the nation could reach 12 million ha.

Given these figures, it could be contended that dryland salinity does not yet rate as a problem of national significance. However, it should be remembered that dryland salinity is only one cost component of a larger land degradation problem that must be addressed by the nation and that there is considerable uncertainty associated with the above estimates of affected land.

Figure 11 shows how a lack of statistical data for on-site/off-site salinity impacts precludes logically extending the CIE foresighting results to determine the likely impacts of increased agricultural production targets on the regional extent of dryland salinity. (Significant data collection is required well beyond the scope of this project, which is very much an exploratory exercise).

Figure 11
Scale and focus of foresighting exercises



It is apparent that while increased global demand for Australian agricultural production has the potential to lead to an increase in the area of salt affected land, relatively speaking dryland salinity, (although not explicitly considered by the CIE), would appear to be only a minor impediment to the achievement of CIE estimated production targets to the year 2026.

In the dryland salinity foresighting exercise, we have therefore set out to address the focal decisions for the future management of dryland salinity (Box 1) addressed in 'An Assessment of the National Dryland Salinity R,D&E Program'—LWRRDC Occasional Paper 16/97.

1. What blockages need to be removed to improve on the current situation?
2. Who should be involved?
3. What level of intervention is required?
4. Who should pay; and how much are they prepared to pay?

It has been necessary to first address the problem broadly at this level, and then to identify LWRRDC strategic research and development needs that specifically relate to the management and extent of dryland salinity; (which is the objective of the foresighting exercise).

The issues relevant to these decisions include (Source: LWRRDC Occasional Paper No. 16/97):

1. National significance of dryland salinity
   - Extent
   - Off-site Effects (Ecological: Financial)
   - Costs
2. Causes of current failure to manage dryland salinity
   - Failure to implement
   - Regulation
   - Motivation
3. The most likely forms of intervention required to manage dryland salinity. (Market Forces; Political Intervention; Community Conscience).
4. Constraints preventing better management of dryland salinity. (Incentive; Knowledge; Relative importance; to other forms of degradation)
5. Possible returns from future investment and institutional changes. (Institutional change; Socio-economic research; Technical Research).

Implications of the CIE report

The CIE report is a useful presentation of the general foresighting process. In particular, Figure 1—Summary of the Foresighting Exercise; and Figure 4—Steps in a Foresighting Exercise; are succinct presentations of key parts of a general foresighting process.

However, given that the CIE's task was to focus on presenting a general process, details on specific approaches within these general processes are neglected. For example, Figure 1 of the CIE Report presents options for various steps in a general foresighting process, such as choosing between scenario building, the Delphi and other methodologies. However, few details are given on the individual phases required in scenario building (of which there are many and varied in the literature), including the methodology chosen for the dryland salinity foresighting exercise.

The focus of CIE Scenarios—demand-based projections for Australian agricultural production influenced by a range of changes in natural resource management, reflects a far more statistically supported problem than the impacts of dryland salinity (and most other problems addressed by LWRRDC-managed R&D programs). The availability of historical data for various commodities facilitated extensive evaluation of Australia's capability to meet demand projections under three different scenarios (economic growth, conservative, post-materialistic). The pull of global economic drivers reflected in CIE's current and projected demands provides a framework to evaluate impacts based on the three chosen scenarios. In comparison, statistics on dryland salinity impacts are extremely poor and not regionally specific. Hence projections for the extent and location of dryland salinity cannot easily be made from gross national statistics.

It is therefore difficult to envisage the CIE statistical approach being routinely applied at the LWRRDC R&D program level given the dearth of regionally consistent data. The approach we have devised takes into account the less than ideal base of information on which to begin a meaningful foresighting exercise. Still, a meaningful foresighting exercise needs to step outside historical data as illustrated by such events as the current Asian crisis where historical relationships have little relevance.

We are also concerned that LWRRDC requires foresighting to be carried out with a clearly defined range of actionable steps as an endpoint. It is therefore extremely important to establish the focal decisions expected to be addressed before conducting the foresighting exercise. In the case of the CIE foresighting study, it has provided an indication of potential movements required in the commodity base in response to world demands and different local production conditions in general terms. This will allow the real situation to be monitored over the coming years to see which path we may be moving down (ie. is it possible to meet demand?).

The CIE result is more a high level, passive outcome than is required by LWRRDC at the program level, which requires advice on R&D options to assist in mitigating the impacts of a specific problem; such as dryland salinity. The tightness and transparency of the Schwartz approach used in the dryland salinity foresighting exercise (Schwartz, 1991, The Art of the Long View), uses statistical analysis to identify driving forces with the greatest uncertainty; and the potential to have the greatest impact in the long-term future. The CIE foresighting exercise appears to have used an approach that does not differentiate the priorities or sequence of future action.

Schwartz describes in detail the specific approach chosen to develop scenarios and its key phases such as isolating the key decisions, identifying the driving forces, predetermined elements and critical uncertainties. The Schwartz methodology is extremely rigorous, logical and places more emphasis on making the driving forces visible than on the actual scenarios. The scenarios represent a convenient way of gaining 'buy-in' from stakeholders as they construct plausible futures based on the dominance of identified driving forces. Schwartz stresses that scenarios are not intended to be judgemental but to make the driving forces visible through a plausible range of stories about the future.

The CIE report provides no indication of how the critical uncertainties have been determined or the scenarios developed to address the focal decision, although the key issues and drivers are obviously well addressed throughout the report.

CIE outcomes applicable to the dryland salinity foresighting process

The treatment of outliers such as droughts, in the CIE scenarios is one outcome of that foresighting process that should be of direct relevance to LWRRDC-managed R&D program foresighting exercises.

In the supply constraints on which the scenarios in the CIE report are mainly based (demand differing little), such outliers are smoothed out with optimistic, best bet and pessimistic estimates presented. Yet these events are likely to have major and possibly long lasting effects on land resources. Such events would be key land degradation drivers in scenarios relevant to issues such as dryland salinity.

Other problems in extending the results of the CIE scenarios to land resource based foresighting exercises, such as on dryland salinity, include:

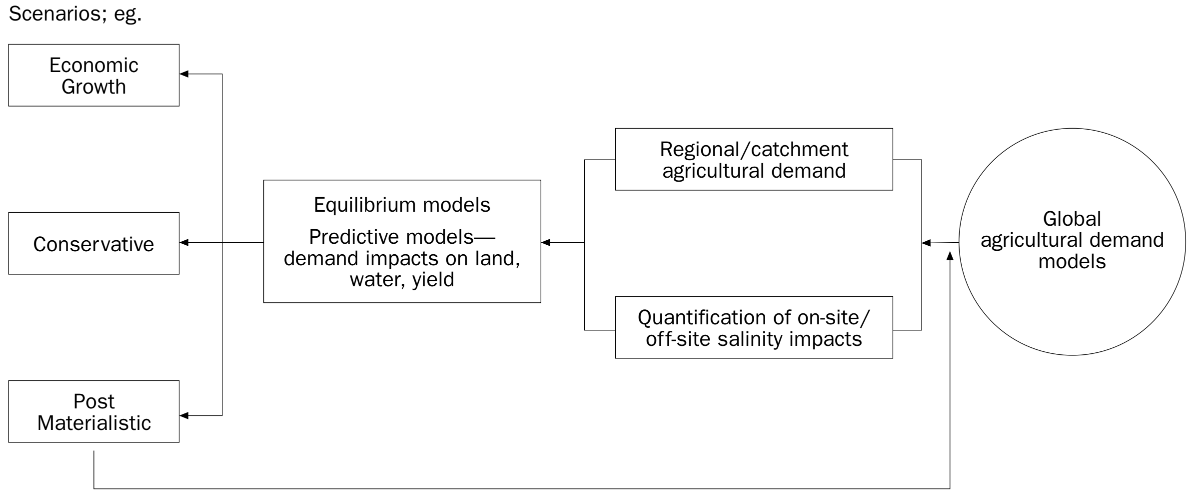
- the scenarios in the CIE report are presented mainly in terms of commodity impacts, taking no account of land resource implications such as in the case where wheat may need to be grown on marginal lands.
- the scenarios appear to assume economic growth cannot occur sustainably. (High/moderate/low land and water resource demands might have been a better spectrum of scenarios).
- some of the assumptions underlying the scenarios in the CIE report are debatable; and this uncertainty should enter the scenarios. For example, constant population growth is assumed whereas the World Bank states this will be affected by income growth and other factors that differ under the various scenarios. Similarly, it is assumed that developing countries will 'catch up' to developed countries within this period.

Conclusions drawn from the CIE report

Unfortunately the wealth of aggregated statistical information at the global and national level is not available on a disaggregated regional basis required to address LWRRDC-managed R&D programs. At this point in time, the CIE example is more a level of forecasting to perhaps aspire to as part of a foresighting process, than a level of analysis that could be routinely and cost effectively achieved for all LWRRDC-managed R&D programs.

To carry out a similar level of statistically based analysis on commodity projections to support a dryland salinity foresighting exercise, we would require (Figure 12):

Figure 12
Model components required for the statistical analysis of commodities impacts on dryland salinity at regional/catchment level



- commodity projections at a regional and catchment level
- statistical information on the extent and cost of on-site and off-site salinity impacts at a regional and catchment level
- models to determine salinity equilibrium states in each region/catchment; and
- the predictive capability to model the impacts of increased production demands/management options on land, water and yield.

These information and technology gaps are addressed by strategic R&D directions 1.1 and 3.1 identified in the dryland salinity foresighting exercise ie.

R&D Topic 1.1 Determine the potential effects of dryland salinity on the Quality of Life and Human Health over the next 20 years.

R&D Topic 3.1 Determine how empowered Catchment Management Committees might best be able to implement effective, coordinated catchment plans for dryland salinity management.

Once the additional statistical analysis and modelling shortfalls at a regional and catchment level have been addressed, it would be possible to carry out more detailed foresighting exercises incorporating aspects of the CIE example.

CIE's recommended outcomes from a foresighting process

The CIE report recommended a number of outcomes should flow from a foresighting process including:

1. scenarios (descriptions) of the resource base in 2020.
2. issues/physical challenges for scenarios/driving forces.
3. identification of gaps in knowledge to address physical challenges and gaps in technological solutions.
4. consensus on the issues and range of possible solutions to address physical challenges.
5. probability estimates assigned to scenario components/critical uncertainties.
6. recommendations for action.
7. comparison with existing LWRRDC R&D agenda.
8. mechanism for evaluating the foresighting exercise.

In the next chapter, we extend the dryland salinity foresighting process to address these suggested outcomes.

Synopsis of Chapter 5
Outcome of the foresighting analysis

In this chapter we discuss:

the outcome of the foresighting process against a checklist of outputs/outcomes suggested for such a process in the CIE (1997) Report.

1. scenarios (descriptions) of the resource base in 2020.
2. issues/physical challenges for scenarios/driving forces.
3. identification of gaps in knowledge to address physical challenges and gaps in technological solutions.
4. consensus on the issues and range of possible solutions to address physical challenges.
5. probability estimates assigned to scenario components/critical uncertainties.
6. recommendations for action.
7. comparison with existing LWRRDC R&D agenda.
8. mechanism for evaluating the foresighting exercise.

Critical knowledge gaps identified through the foresighting exercise are compared with those identified by Hayes, (1997), NDSP Review (Tables 10 and 11). Both studies have independently concluded that a markedly different approach is required to dryland salinity management. NDSP Phase II R&D options (AACM International, 1998), are also reviewed. The foresighting results indicate that existing R&D programs could be strengthened with additional research topics; and that current programs could be more sharply focused towards some focal decisions.

The foresighting R&D directions emphasise an integrated plan of action including:

- identification of the motivating factors required to result in a significant change in the way dryland salinity is currently being managed. (Requires quantification of salinity impacts on the quality of life of affected communities and environments and the impacts being experienced by individual landusers).
- credible catchment level models are required for the community as a whole to understand the escalating risks of dryland salinity. At the property level credible models are also required to provide landusers with a clear indication of the land degradation and financial risks they face in the future.

The types of model required are:

- salt balance (input/output) at three different levels (regional, catchment and property);
- (financial) production models at the property level; and
- off-site salinity impact/cost models, including impacts on the natural environment.

The *credibility* of the models is considered to be one of the cornerstones of a future integrated R&D program. To achieve the necessary level of integrity, data needed to run the models must be upgraded/completed to provide consistent results and must be readily updated (in real time). Output from the models can then be used to support decision-making on priority works, appropriate institutional arrangements, responsibility for action and who pays.

Many of these perceived future needs can be summarised as a requirement for a convincing model(s) that describes the economic, financial, physical, social and ecological benefits of implementing remedial actions to overcome dryland salinity.

The foresighting strategic R&D directions show that they contribute strongly to sixteen Year 2020 performance targets for dryland salinity management, identified by workshop participants.

Reverse history analysis suggests a sequence of implementing the 14 strategic R&D directions (Table 5 on page 35), taking into account the desired outcome by the year 2020.

The three current dryland salinity sub-programs are assigned to the focal decisions and strategic R&D directions (Table 16 on page 59). The table shows some significant differences between the existing focus of LWRRDC-managed sub-programs and identified foresight strategic directions.

In this foresighting exercise, there is no mistaking the general thrust that we still are not addressing effectively the need for site-specific demonstrations (models) that will convince landusers that it is in their *financial* interest to invest in dryland salinity remedial actions.

CHAPTER 5

Outcome of the foresighting analysis

The purpose of this chapter is to present the results of dryland salinity foresighting against the CIE's checklist of suggested outputs/outcomes for a successful foresighting exercise. These requirements include:

1. A range of descriptions of the resource base in 2020; (preferred; expected; possible scenarios).
2. A range of issues/physical challenges for each scenario (problems agreed, needs identified, priorities assigned)/possible solutions leading to a prioritised list. (Ownership/Commitment).
3. Identification of gaps in knowledge to address physical challenges and gaps in technological solutions.
4. Consensus on the issues and range of possible solutions to address physical challenges, leading to a plan of action and description of potential impacts of such action. (Ownership/Commitment).
5. Probability estimates assigned to scenario components.
6. Recommendations for action (possible technologies—well defined/appropriate; and supporting strategic planning and policy development).
7. Comparison with existing LWRRDC Research and Development agenda, of newly identified actions/ impacts.
8. Mechanism for evaluating the foresighting exercise (process/outcomes)—(periodic reviews; update planning).

While the Terms of Reference for this study (Appendix 1) are narrower in scope than the list of CIE suggested outcomes, we have been able to address most of them through the course of this project. Each of the eight outcomes is discussed below.

Range of descriptions of the resource base in 2020

It was possible to include only general descriptions of the resource base in pre-workshop, workshop and post workshop scenarios, given the dearth of regionally specific data, and LWRRDC's desire to treat this project as a 'toe in the water' foresighting exercise. As discussed previously, using the Schwartz (1991) method, we have placed greater emphasis on identifying the critical uncertainties (driving forces) that shape the future than on the scenarios.

Range of issues

The 14 R&D strategic directions identified by the foresighting process (Box 2) address four major decision areas which will influence the long-term success of the dryland salinity management program (Box 1).

The 150 driving forces identified by participants at the scenario planning workshop were sorted and prioritised generating a list of 50 high priority 'uncertain' driving forces, which were further reduced to 14 critical uncertainties; and which became the basis for the strategic R&D directions

Identification of physical challenges: gaps in knowledge and gaps in technology

An assessment of the main physical challenges, the gaps in knowledge and the gaps in technology (Appendix 6), is summarised in Tables 7 to 12.

Although 14 critical uncertainties were eventually identified from the quadrants of uncertainty as having a high priority with respect to strategic R&D directions the remaining 36 critical uncertainties should not be ignored. It is possible that at least some of them may become important in the future. Hence all 50 of them have been examined in terms of the 'physical challenges' they may present, the 'gaps in knowledge' and the 'gaps in technical solutions' presently available.

Table 7
Summary of physical challenges—50 high priority uncertainties

- **Financial resources of the landuser**
  — focus on survival
  — management of risk to minimise losses/impacts
- **Accessibility of a knowledge base**
  — consolidated information/landuser awareness of information resource
  — access to information
  — relevance
  — volume of information to be processed
- **Cost of works**
  — tools
  — regulations
  — diversity of technology
  — pay-off period
- **Community need for a solution**
  — motivation
  — attitude
  — inclination to work together
  — opposition to controls
  — awareness
- **Condition of the land base**
  — land capability
  — land liabilities
- **Landuser attitude**
  — skills
  — incentives
- **Industry incentives**
  — costs
  — cost of production
  — competitiveness of products

The most important gaps in knowledge and technology to address the identified physical challenges are included in Tables 8 and 9.

Table 8
Summary of gaps in knowledge—50 high priority uncertainties

- **Impact accounting**
  — extent of dryland salinity damage
  — property—off-site impacts and long-term projections
- **Benchmarks**
  — quality of Life
  — health/viable rural communities
  — land condition
  — current practice—salt outputs
  — salt input/output (balance)
- **Completeness of information base**
  — consistent comparable information
  — quality of information
  — consistency of advice
- **True costs**
  — cost of compliance
  — non market costs
  — upgrade cost
  — implementation costs
  — cost, versus risk
- **Benefits**
  — evidence of improved outcomes
  — long-term (sustainable benefits)
  — landuser financial benefits
  — industry benefits
  — benefits of real-time information

Table 9
Summary of gaps in technology—50 high priority uncertainties

- **Sustainable catchment model**
  — salt-balance models at property level (funding, priorities, regulation)
- **Monitoring program**
  — quality of life
  — catchment level (indicators, benchmarks)
  — salt balance
  — real-time groundwater level/salinity information
- **Socio-economic model**
  — risk model (depletion of physical resources)
  — financial model of investment options/benefits

The critical gaps identified above have a lot in common with the 'major tasks' identified by Hayes (1997) viz.

1. Identifying risk and establishing causes.
2. Identifying the possible solutions.
3. Identifying the costs and benefits of alternative approaches and their distribution.
4. Arranging cost sharing.
5. Implementing onground activities or works.

A subjective assessment has been made (Hayes (1997), Figure 2, page 21), of the progress towards achieving these key tasks, and the critical knowledge gaps remaining as constraints in each task area. We have compared the Hayes results with the critical knowledge gaps identified for the dryland salinity foresighting exercise (Tables 10 and 11 following).

Table 10
Critical knowledge gaps in managing dryland salinity—Hayes (1997)

Establishing Causes	Identifying Solutions	Identifying Costs and Benefits	Arranging Cost Sharing	Implementing on ground Works
• Cost	• Cost	• No common basis	• Cost basis	• Consultation process
• Technical Resources	• Technical Resources	• Non-market costs—including costs to the environment	• Policies	• Coordination of disciplines
• Time	• Modelling Database	• Distribution of costs and benefits	• Negotiation	• Responsibilities
• Communication Techniques	• Catchment classification	• Means of extrapolation	• Government Views	• Coordination of agencies
• Hazard Assessment	• Estimates of Time Scales	• Consideration of policy options including regulation	• Links with other resource issues	• Relationship to other issues
• Detailed Mapping and Data	• Catchment Specific Recommendations	• Links with other resource issues		• Role of regulatory framework • Feasibility of economic instruments • Attitudes to land retirement • Linkages with structural adjustment

Table 11
Critical knowledge gaps in managing dryland salinity ATA foresighting project (1998)

Establishing Causes	Identifying Solutions	Identifying Costs and Benefits	Arranging Cost Sharing	Implementing on ground Works
• Impact accounting	• Availability of knowledge base	• Benefits of improved outcomes/ landuser – industry.	• Types of incentives; 'triggers'; appropriateness of targets	• Community knowledge, skill level; awareness
• Benchmarks—Quality of life/ land/salt output	• Classification of landuser community			
• Completion of quality information base	• Best practice ESD			
• True costs—compliance; non-market costs; implementation.	• Change required in production methods			
• Indicators—resources; investment; institutional performance.	• Innovation with potential for greatest impact			

Issues consensus/range of possible solutions/leading to a plan of action (ownership/commitment)

While it could not be expected that one national workshop would lead to a national issues consensus, ownership and commitment to solutions and actions, clear directions have emerged through the foresighting process.

The strategic directions place a strong emphasis on identifying the motivating factors required to result in a significant change in the way dryland salinity is currently being managed. This requires quantification of salinity impacts on the quality of life of affected communities and environments as well as the impacts being experienced by individual landusers.

At the catchment level, credible models need to be developed to allow the community as a whole to understand the escalating risks of dryland salinity. At the property level credible models are also required to provide landusers with a clear indication of the land degradation and financial risks they face in the future.

The types of model required are:

- salt balance (input/output) at three different levels (regional, catchment and property);
- financial production models at the property level—with variables to reflect the cost impacts of different salinity levels and treatment options and the related benefits of the required investment. The model should also allow projections to be made on long-term production levels in the event that no action is taken; and
- off-site salinity impact/cost models, including impacts on the natural environment.

The *credibility* of the models is one of the cornerstones of a future coordinated R&D program. To achieve the necessary level of integrity, data needed to run the models must be upgraded/completed to provide consistent results and must be readily updated (in real time).

Output from the models can then be used to support decision-making on:

- priority works (based on sound cost–benefit information);
- appropriate institutional arrangements;
- responsibility for action; and
- who pays.

Many of these perceived future needs can be summarised as a requirement for a convincing model(s) that describes the economic, financial, physical, social and ecological benefits of implementing remedial actions to overcome dryland salinity.

Once governments, catchment management bodies, communities and landusers are confronted with imperative argument in this form then there would probably be a significant improvement in action. But since dryland salinity is just one factor in a number of serious land degradation processes it may be the case that no significant action, with respect to salinity, is achieved until most or all are tackled collectively as a 'National Land Degradation Strategy'.

Clearly the Hayes analysis (Table 10) and dryland salinity foresighting analysis have independently arrived at a conclusion that is markedly different to a '**more of the same**' approach to dryland salinity.

In some ways it is a 'Catch-22' situation. Economic models certainly have been attempted in the past but are, as yet, not highly convincing as they depend on good technical information for their success. However if we are to wait for all desirable technical information to become available then it may be too late to retrieve the salinity situation.

An alternative approach may be to concentrate on those examples where landholders have implemented remedial action and analyse the benefits that have resulted. As discussed previously in one of the 'scenarios'—success breeds success.

Existing focal catchments may well provide the basis for evaluating the effectiveness of the strategic R&D directions identified in this study.

Dryland salinity R&D program—performance targets—dateline 2020

(What would constitute a successful salinity management program outcome?)

Table 12 lists sixteen dryland salinity Year 2020 performance targets identified by participants at the national dryland salinity scenario planning workshop. Strategic R&D directions (identified from the foresighting process) were assigned to each of these targets; according to their potential to assist in achieving the target outcome.

Table 12
Potential for strategic R&D to contribute to the 2020 performance targets of the National Dryland Salinity R,D&E Program (used to develop Figure 13)

	Desired Performance Targets to be Achieved by the Year 2020	R&D Topic Contributing to 2020 Performance Targets
Technological		
T-1	Lower equilibrium level (salt affected area), than the 1998 forecast	**3.1; 1.2**
T-2	Demonstrable change in patterns of landuse	**3.1; 3.3; 3.4; 4.2; 4.3**
T-3	Productive use of salinised land	**3.1**
T-4	Landusers have sufficient knowledge to resolve/avoid salinity problems	**3.1; 3.3; 4.3**
Social		
T-5	Behavioural change in landusers	**1.1; 1.2; 2.1; 2.2; 3.1; 3.2; 3.5; 4.3; 4.4**
T-6	Landuser and community attitudinal change	**1.1; 1.2; 4.2; 4.3 4.4**
T-7	Community is inspired to act.	**1.1; 1.2; 4.1; 4.3**
T-8	Existence of a 'decision making environment',—for communities to adopt an appropriate level of risk management. (ie. communities are in control of the level of salinity impact)	**1.1; 4.3**
Economic		
T-9	Costs to make a measurable impact on salinity are well understood.	**1.1; 4.1; 4.2; 4.3 4.5**
T-10	Community consumership (buy in across the community) of salt costs	**1.1; 1.2; 2.2; 4.1; 4.4**
T-11	Landusers have resources to make change	**4.2; 4.5**
T-12	Landusers have increased (production) options	**3.1; 3.2**
Political		
T-13	Demonstrable change in policies	**1.1; 1.2; 4.1; 4.4; 4.5**
Biophysical		
T-14	Dryland salinity is managed to a level appropriate to its impacts, and action takes place within appropriate time scales.	**1.1; 3.1; 3.5; 4.2; 4.3**
T-15	Stabilisation of watertables and landscapes	**1.1; 3.1; 3.5; 4.5**
T-16	Revegetation programs have increased biodiversity	**3.1; 3.5; 4.5**

Legend to Table 12

FD1	**Blockages**
1.1	Quality of life and human health impacts
1.2	Incentives necessary to encourage coordinated landuser activity
FD2	**Involvement**
2.1	Limit of individual responsibility
2.2	Operating environment for landholder internalisation of salinity impacts.
FD3	**Intervention**
3.1	Catchment Management Committees implement effective, coordinated catchment plans
3.2	Changes of industry structure to bring together benchmarking, self-regulation, quality assurance, marketing and R&D
3.3	Scope of regulations to meet changing landuse regimes
3.4	Effect of regulatory market quality criteria on production methods, such as ISO9000.
3.5	Appropriateness of COAG land management targets and incentives, in effectiveness programs.
FD4	**Who pays/how much?**
4.1	Inequities in 'who pays'—on-farm and off-farm.
4.2	'Triggers' landusers require to liberate capital.
4.3	Information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources.
4.4	'Polluter pays' philosophy impact on individuals implementing remedial action.
4.5	Government environmental restoration programs—restricting landuser access to national funds. Table 12 indicates that the 14 strategic R&D directions identified by the foresighting process strongly contribute to performance targets related to landuser incentives and changing community attitudes, based on an understanding of the true costs of dryland salinity.

Table 13 shows the frequency with which each strategic R&D topic contributes to the 16 Year 2020 performance targets in Table 12.

From Table 13, based on key frequencies with which R&D directions contribute to performance targets the strategic R&D directions listed in Table 14 have the potential to make a significant contribution to dryland salinity decision-making.

Reverse history analysis

Using the assignment of R&D directions to performance targets (Table 12 on page 51) to undertake reverse history analysis, one interpretation of the dependencies, sequencing and timing of strategic R&D initiatives to contribute to 2020 dryland salinity performance targets is shown in Figure 13.

Table 13
Contribution of strategic R&D directions to performance targets

Dryland Salinity Strategic R&D Directions		Frequency R&D Topic Contributes to 2020 Performance Targets (out of 16 Performance Targets)
FD1 Blockages		
R&D Topic 1.1	Quality of life and human health impacts	9
R&D Topic 1.2	Incentives for coordinated landuser activity	6
FD2 Involvement		
R&D Topic 2.1	Limit of individual responsibility	1
R&D Topic 2.2	Operating environment for landholder internalisation of salinity impacts.	2
FD3 Intervention		
R&D Topic 3.1	Catchment Management Committees implement effective, coordinated catchment plans	9
R&D Topic 3.2	Changes of industry structure to bring together benchmarking, self-regulation, quality assurance, marketing and R&D	2
R&D Topic 3.3	Scope of regulations to meet changing landuse regimes	2
R&D Topic 3.4	Effect of regulatory market quality criteria on production methods, such as ISO9000.	1
R&D Topic 3.5	Appropriateness of COAG land management targets and incentives, in effectiveness programs.	4
FD4 Who pays/how much?		
R&D Topic 4.1	Inequities in 'who pays'—on-farm and off-farm.	4
R&D Topic 4.2	'Triggers' landusers require to liberate capital.	5
R&D Topic 4.3	Information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources.	8
R&D Topic 4.4	Impact of 'Polluter pays' philosophy—impact on individuals implementing remedial action.	4
R&D Topic 4.5	Government environmental restoration programs—restricting landuser access to national funds	5

Table 14
Key R&D directions contributing to performance targets

Dryland Salinity Strategic R&D Directions		Frequency R&D Topic Contributes to 16 Performance Targets
R&D Topic 1.1	Quality of life and human health impacts	**(9/16)**
R&D Topic 3.1	Catchment Management Committees implement effective, coordinated catchment plans	**(9/16)**
R&D Topic 4.3	Information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources	**(8/16)**
R&D Topic 1.2	Incentives necessary for coordinated landuser activity	**(6/16)**
R&D Topic 4.2	'Triggers' landusers require to liberate capital	**(5/16)**
R&D Topic 4.5	Government environmental restoration programs—restricting landuser access to national funds	**(5/16)**

The diagram illustrates the recommended R&D should take place in the following suggested sequence in order to achieve the preferred outcomes in 2020:

1. Demonstrably change policies → Landuser and community attitudinal change

Key Strategies: *Determine*
- 1.1 salinity impacts on quality of life/health
- 1.2 incentives for change
- 4.2 'triggers' required for landusers to liberate capital
- 4.3 landuser information requirements for risk management
- 4.1 who pays (on-farm/off-farm)
- 4.4 impacts of a 'polluter pays' policy
- 4.5 impacts of other funding programs

2. Behavioural change (building on 1 above)

Key Strategies: *Determine*
- 2.1 limit of individual responsibility
- 2.2 operating environment for internalisation of costs
- 3.1 how empowered CMCs can best implement catchment plans
- 3.2 changes in industry structure to encourage self-regulation
- 3.5 appropriate COAG land management targets

3. Landuser knowledge (building on 1 and 2 above)

Key Strategies: *Determine*
- 4.3 landuser information requirements for risk management
- 3.1 how empowered CMCs can best implement catchment plans
- 3.3 regulations to support changed landuse regimes

4. Demonstrable change in landuse

Key Strategies: *Determine*
- 3.4 impact of ISO 9000 on production methods.

5. Lower equilibrium level (watertable and salt-affected area)

Key Strategies: *Determine*
- 3.1 how empowered CMCs can best implement catchment plans
- 1.2 incentives for change

Probability estimates assigned to strategic R&D directions

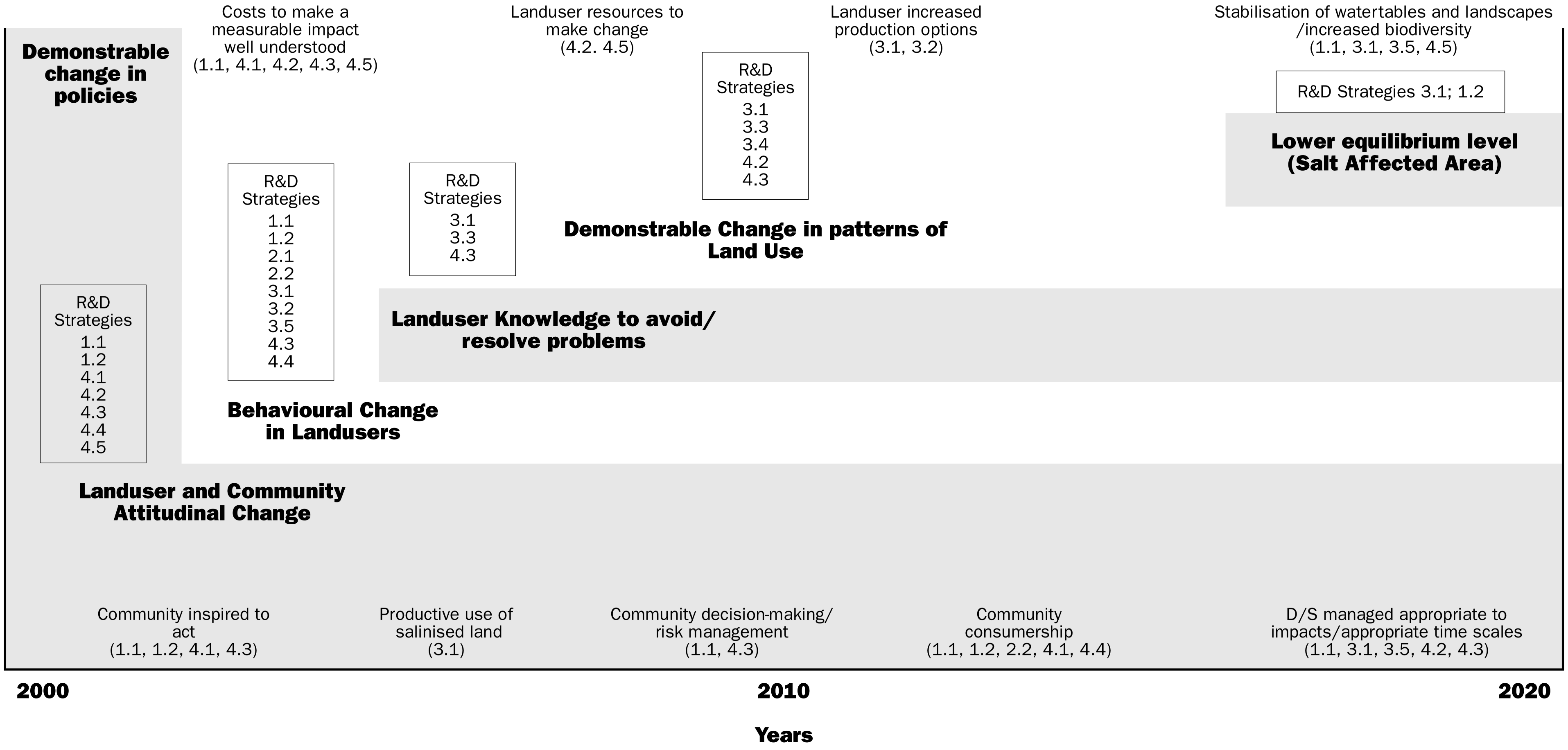
Probability estimates with respect to chance of success, potential magnitude of benefits, longevity of benefits and leakage of benefits for each of the 14 strategic R&D directions is discussed on pages 33–34.

The greatest net benefit is expected to arise from incentives for coordinated landuser activity, coordinated catchment management plans; identifying inequities in who pays (on-farm/off-farm); and the 'triggers' landusers require to liberate capital.

Recommendations for action

It is recommended that the 14 strategic R&D directions should be confirmed by different stakeholder groups. It is suggested that the Dryland Salinity Committee Technical Committee and a regional catchment group should participate in separate exercises to prioritise driving forces to arrive at a comparable set of critical uncertainties.

Figure 13
Timing of strategic R&D to achieve 2020 dryland salinity performance targets



Comparison with the existing LWRRDC R&D agenda

Dryland salinity R,D&E program

The goal of the National Dryland Salinity R,D&E Program (Phase 1) is to generate integrated techniques and approaches for optimal management of dryland salinity in Australia. Key principles of the program include:

- an integrated catchment management approach involving the community;
- formulation and application of models for collaborative and multi-disciplinary R,D&E;
- investigation and application of techniques to manage dryland salinity impacts;
- investigation of the potential to improve sustainable income from salt affected land; and
- ensuring program outcomes (information, techniques, approaches) are incorporated into national and state dryland salinity management programs.

The National Dryland Salinity R,D&E Program is directing resources to combat dryland salinity through three sub programs:

Sub-Program 1: Mapping and monitoring

Aimed at identifying the current extent of dryland salinity and the land at risk of salinisation.

Project 1: Mapping Dryland Salinity

Involves using Landsat TM to identify and map occurrences of salinity in three of the five focus catchments identified for the program.

Project 2: Land Condition Monitoring

Involves the use of TM data to distinguish between land in persistently poor condition due to salinity and land on which shorter term decreases in productivity are due to other factors.

Project 3: Predicting Areas at Risk from Salinity

Development of methods for predicting salinity in the landscape by integrating remotely sensed data with other spatial data sets. Determination of indicators for land at future risk.

Sub-Program 2: Social and economic assessment

Intended to provide information on the costs of the full impact of dryland salinity (including non-market valued benefits and costs) to assist in investment and policy decision-making.

Project 1: Quantification of the Full Range of Costs of Dryland Salinity

Surveys to obtain information on the direct and indirect impacts of salinisation (shires, rural communities, government agencies); to develop a methodology for rigorous assessment of catchment-wide costs.

Project 2: Non-Market Valuation Techniques:

Investigates ways of valuing the costs of dryland salinity and the benefits from investment in R&D where a monetary value cannot be assigned.

Project 3: Identifying Social, Economic and Environmental Impediments to the Adoption of New Policies and Programs/Developing Management Options and Strategies to Overcome Impediments

Investigates impediments to the adoption of policies and programs for dealing with dryland salinity.

Sub-Program 3: Soil/water/plant interactions

Reflects the need to consider salinisation as an outcome of a combination of biological and physical factors operating from scales from the paddock to the catchment.

Project 1: Native Perennial Grasses for Sustainable Productive Pastures

Investigations to identify a native grass that has a potential to reduce soil water to at least the same extent as phalaris, supports sheep or cattle growth and can be readily commercialised.

Project 2: Measurement and Modelling Techniques for Comparing Deep Drainage Under Current and Alternative Farming Systems.

Identification and recommendation of best practice agricultural strategies, appropriate to land units that will minimise deep drainage and maximise water use and productivity through an approach that is hydrologically sound and economically sustainable.

Project 3: Improve Dryland Salinity Management Through Integrated Catchment Scale Modelling.

Involves defining key data sets to achieve sensible catchment descriptions, and the required level of data accuracy required to answer current dryland salinity problems. It also seeks to link biophysical and economic data to assess through time and space, the effects of land management practices on ecologically sustainable development. A specific output product will be a decision-support tool with which the local community can test the outcomes of 'what if' scenarios against agreed catchment goals.

It would appear from the foregoing that NDSP is already addressing many of the strategic R&D directions indicated by the foresighting exercise. However using the same focal questions (Box 1) of:

- Blockages.
- Involvement.
- Intervention.
- Who pays/how much?

it becomes apparent from Table 15 that there are some significant differences between the existing focus of LWRRDC-managed R&D programs and identified (foresight) strategic directions.

In particular, the present NDSP projects place considerable emphasis on:

- the biophysical attributes of dryland salinity (quantification and modelling);
- quantification of internal and external costs; and
- impediments to the adoption of policies and programs for dealing with dryland salinity.

However there do not appear to be any projects associated with:

- the apportionment of on-site and off-site costs;
- the 'triggers' and incentives necessary to ensure landuser action (individually and collectively);
- the possible effects of government regulation and market quality demands; or
- readily understood information systems to help landusers decide whether remedial action is financially advantageous.

Undoubtedly there is scope for argument about the precise meaning of the 14 strategic R&D directives arrived at in the foresighting exercise but there is no mistaking the general thrust that we still are not addressing effectively the need for site-specific demonstrations (models) that will convince landusers that it is in their **financial** interest to invest in dryland salinity remedial actions.

As indicated in the scenarios associated with the quadrants of uncertainty (Chapter 2) some landusers will allocate financial resources towards overcoming salinity problems either due to a socio-environmental conscience or to a perceived financial gain. But the large proportion of landusers are yet to be convinced that it is a worthwhile exercise for either reason.

Table 15
NDSP Phase I R,D&E projects classified against foresighting R&D strategic directions

		NDSP R,D&E Project
FD1 Blockages		
R&D Topic 1.1	Quality of life and human health impacts	Quantification of Costs (2.1) Non-Market Valuation (2.2) Impediments to Policy Adoption (2.3)
R&D Topic 1.2	Incentives necessary to encourage coordinated landuser activity	
FD2 Involvement		
R&D Topic 2.1	Limit of individual responsibility	
R&D Topic 2.2	Operating environment for landholder internalisation of salinity impacts.	
FD3 Intervention		
R&D Topic 3.1	Catchment Management Committees implement effective, coordinated catchment plans	Mapping Dryland Salinity (1.1) Land Condition Monitoring (1.2) Predicting Areas at Risk (1.3) Native Perennial Pastures (3.1) Measurement and Modelling—Deep Drainage (3.2) Integrated Catchment Modelling (3.3)
R&D Topic 3.2	Changes of industry structure to bring together benchmarking, self-regulation, quality assurance, marketing and R&D	
R&D Topic 3.3	Scope of regulations to meet changing landuse regimes	
R&D Topic 3.4	Effect of regulatory market quality criteria on production methods, such as ISO9000.	
R&D Topic 3.5	Appropriateness of COAG land management targets and incentives, in effectiveness programs.	
FD4 Who pays/how much?		
R&D Topic 4.1	Inequities in 'who pays'—on-farm and off-farm.	
R&D Topic 4.2	'Triggers' landusers require to liberate capital.	
R&D Topic 4.3	Information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources.	
R&D Topic 4.4	'Polluter pays' philosophy impact on individuals implementing remedial action.	
R&D Topic 4.5	Government environmental restoration programs—restricting landuser access to national fundsPresent technological research indicates that (given present forms of landuse) there is no general panacea with respect to dryland salinity control as each catchment differs hydrologically from another. The best that can be expected is that techniques for characterising and monitoring individual catchments will become simpler and cheaper in the future. Hence if significant advances are to be made in the implementation of dryland salinity control then more emphasis will need to be placed on those 'drivers of the future' concerned with individual landuser incentives.	

Comparison of priority research needs—other NDSP initiatives

The NDSP Phase II Options Paper (AACM International, February 1998), lists priority research needs developed through consultation with stakeholders during:

- the review of Phase I NDSP program;
- recent activities conducted by the NDSP communication coordinators;
- output from the national dryland salinity scenario planning workshop; and
- initial meetings conducted for the design of NDSP II.

Table 16 shows the frequency with which 31 R,D&E opportunities identified in the Options Paper for the National Dryland Salinity R,D&E Program Phase II address the 14 strategic R&D directions identified by the foresighting project.

Potential R&D opportunities (research, development and extension projects), were matched to 10 of the 14 R&D strategic directions identified by the foresighting process. However, Table 16 indicates that NDSP respondents indicated a preference for catchment, community and environment R&D to address dryland salinity, compared to a broader set of strategies suggested by the foresighting exercise. This can probably be attributed to the different background of participants in the two exercises; coupled with the fact that traditional assessment techniques may miss requirements identified by a foresighting exercise.

Of particular interest is the fact that no NDSP II R,D&E projects have been listed for FD1.1–1.2; (limit of individual responsibility; operating environment for landholder internalisation of salinity impacts): and FD4.3–4.4 (information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources; the impact of a 'polluter pays' philosophy on individuals implementing remedial action).

Table 16
NDSP Phase II R,D&E opportunities classified against foresighting R&D strategic directions

		No. of NDSP R&D Options
FD1 Blockages		
R&D Topic 1.1	Quality of life and human health impacts	7
R&D Topic 1.2	Incentives necessary to encourage coordinated landuser activity	1
FD2 Involvement		
R&D Topic 2.1	Limit of individual responsibility	—
R&D Topic 2.2	Operating environment for landholder internalisation of salinity impacts	—
FD3 Intervention		
R&D Topic 3.1	Catchment Management Committees implement effective, coordinated catchment plans	12
R&D Topic 3.2	Changes of industry structure to bring together benchmarking, self-regulation, quality assurance, marketing and R&D	1
R&D Topic 3.3	Scope of regulations to meet changing landuse regimes	1
R&D Topic 3.4	Effect of regulatory market quality criteria on production methods, such as ISO9000.	1
R&D Topic 3.5	Appropriateness of COAG land management targets and incentives, in effectiveness programs.	1
FD4 Who pays/how much?		
R&D Topic 4.1	Inequities in 'who pays'—on-farm and off-farm.	1
R&D Topic 4.2	'Triggers' landusers require to liberate capital.	2
R&D Topic 4.3	Information required by landusers to make informed investment decisions and set priorities in the face of limited financial resources.	—
R&D Topic 4.4	'Polluter pays' philosophy impact on individuals implementing remedial action.	—
R&D Topic 4.5	Government environmental restoration programs—restricting landuser access to national funds	4

Table 16 also indicates that NDSP II R&D options identified to date reflect a similar weighting towards several of the foresighting R&D topics listed above, viz.

- quality of life impacts;
- catchment management; and
- landuser access to national funds; but

that there are gaps in potentially high priority R&D in the following areas:

(4.3) Information required by landusers to make informed investment decisions and set priorities.

(1.1) Limit of individual responsibility.

(1.2) Incentives necessary for coordinated landuser activity.

(4.2) 'Triggers' required for landusers to liberate capital (for dryland salinity mitigation).

(4.4) 'Polluter pays' impact on individuals.

(4.1) Inequities in who pays (on-farm/off-farm).

(3.5) Appropriateness of COAG land management targets and incentives.

Mechanism for evaluating the foresighting exercise

Process/outcome

The foresighting process should be repeated at regular intervals of 18 months or less, progressively involving different stakeholder groups. Over time, this will eventually lead to a consensus of critical uncertainties and strategic R&D directions. Outcomes associated with the recommended strategic R&D should be monitored at six monthly intervals according to a standard set of performance indicators, designed specifically for each of the 14 strategic R&D directions.

Periodic reviews/update planning

A standardised information infrastructure is required to support information management associated with the 14 strategic R&D directions. This will facilitate comparable reporting and review across all states. Consideration should be given to incorporating salinity information as a component of the Australian Spatial Data Infrastructure (ASDI). A short-term objective must be to incorporate updated salinity management plans into state and local government planning. The ASDI offers potential to assist LWRRDC to achieve this objective.

Synopsis of Chapter 6
Evaluation of the foresighting analysis

In this chapter we discuss:

- the general applicability of foresighting to environmental management programs
- the applicability of foresighting to dryland salinity management
- comments on the foresighting process (successes and shortfalls)

We believe that the dryland salinity foresighting process is suitable for general application to environmental management programs, given that:

- a disparate group of experts were able to produce a clear-cut set of drivers, scenarios and R&D priorities, critical to the future management of a major, national socio-economic/environmental issue;
- each step of the process is completely transparent and capable of reassessment by other groups interested in the problem;
- it demonstrated (through the axes and quadrants of uncertainty) that it is possible to devise scenarios for the future that are both plausible and logical; and
- a low cost foresighting methodology to establish strategic directions for all LWRRDC programs could be applied over a six month consultation period, using a national support network of experts and industry leaders.

The value of applying a foresighting process to dryland salinity management has also been confirmed. The final 14 strategic R&D directions resulting from the consultation are perhaps not what might have been expected from such a group—but the process dictates that 'intuitive' results were not being sought.

We recommend repeating the workshop phase with at least the National Dryland Salinity Technical Committee, and a catchment management group to confirm strategic directions identified from the national forum. LWRRDC would then be in a position confidently develop an R&D agenda endorsed by its major stakeholders.

Although the initial LWRRDC contract called for the production of future dryland salinity scenarios it became clear (at least to the authors) that specific scenarios are not the most important aspect of this type of foresighting exercise. The quadrants of uncertainty can be used to produce a large number of possible, and plausible scenarios all based on the same specific critical uncertainties (driving forces), but their real value is in condensing down a number of uncertainties into specific strategic R&D directions.

Scenario building (using the same or updated list of drivers) should be revisited at regular intervals in order to monitor how the future is starting to play out while there is still time to react in a rational manner. It also helps to lift decision makers 'out of the square' of current thinking and so make them more prepared for an ever-changing future.

CHAPTER 6

Evaluation of the foresighting analysis

The purpose of this chapter is to review the efficacy of the foresighting process for environmental management in general; and dryland salinity management in particular.

Applicability of foresighting to environmental management programs

We believe that the dryland salinity foresighting exercise demonstrated a number of strengths that make it suitable for general application to environmental management programs; in the sense that:

- a very disparate group of experts were accommodated in the discussion and they were able to produce a clear-cut set of drivers, critical to the future management of a major, national socio-economic/environmental issue (in this case, dryland salinity in Australia);
- each step of the process is completely transparent and capable of reassessment by other groups interested in the problem;
- it demonstrated (through the axes and quadrants of uncertainty) that it is possible to devise scenarios for the future that are both plausible and logical; and
- a low cost foresighting methodology could be applied to establish strategic directions for all LWRRDC-managed R&D programs over a six month consultation period, using a national support network of experts and industry leaders.

There are many different approaches to foresighting. As indicated in the CIE (1997) Report, "the best practice methodology depends on the goals of the foresighting process (process/outcome)". We have customised a foresighting approach that is well suited to a range of environmental management applications.

Application of foresighting to dryland salinity management

LWRRDC required this study to be a 'toe in the water' exploratory exercise, a trial of the usefulness of the technique to LWRRDC-managed R&D programs. Resources limited the study to one national workshop thus diminishing the potential at this early stage for State 'buy-in' to the process or outcome, or to impart a regional perspective.

Given the diverse backgrounds of the national dryland salinity scenario planning group and the complexity of the problem, we believe that for this particular case, the outcome of the dryland salinity foresighting exercise has been of greater importance than the process (although both process and confirmation of outcome would be the objective in re-running the exercise with State committees and landusers).

For this reason, we strongly recommend repeating the workshop phase with at least the National Dryland Salinity Technical Committee, and a catchment management group to confirm strategic directions identified from the national forum. (More frequent, shorter foresighting exercises across national, state and regional stakeholder groups would assist LWRRDC to meet process goals for all of its R&D programs).

The final 14 strategic R&D directions resulting from the consultation are perhaps not what might have been expected from such a group—but the process dictates that 'intuitive' results were not being sought.

Although the initial LWRRDC contract called for the production of future dryland salinity scenarios it became clear (at least to the authors) that specific scenarios are not the most important aspect of this type of foresighting exercise. The quadrants of uncertainty can be used to produce a large number of possible and plausible scenarios to help lift decision makers 'out of the square' of current thinking and so make them more prepared for an ever-changing future. But their real value is in condensing down a number of uncertainties into specific strategic R&D directions. Scenario building (using the same or updated list of drivers) should be revisited at regular intervals in order to monitor how the future is starting to play out while there is still time to react in a rational manner.

Comments on the foresight process (successes and shortfalls)

Involvement of state salinity experts in the process

'Buy-in' to the foresighting project from outside the immediate group of workshop participants proved to be extremely difficult. The email reference group covering all states (Appendix 10), established to create awareness of the project and receive feedback on the issues paper had little success.

National workshop

Participants

Using a diverse group for the initial stage of dryland salinity foresighting probably has a lot to recommend it as it resulted in a wide range of 'drivers for the future'. These could well be used as the starting point for other groups (eg. Dryland Salinity Committees, representatives from Catchment Management Committees, farmer organisations etc.) to impose their more focused knowledge on the eventual outcome of the analysis.

Greatest value from workshop participants is likely to come from the second round of scenario planning workshops that they attend; ie. with a degree of experience and self discipline not to 'over indulge' in any stage of the process.

Timing

Maintaining a schedule for each stage of the foresighting workshop process presented a major challenge. There is a fine balance between curbing discussion to ensure that each part of the process is successfully completed and allowing brainstorming and 'blue sky' scenarios about the future to develop, with a chance that innovation may result. Most participants came with different levels of understanding of the foresighting process; many with pre-conceived ideas about how it should be run.

The logistics of the exercise were less than ideal in the sense that there was insufficient time available at the Adelaide meeting to explicitly re-order 150 drivers, assess their 'uncertainty' and 'importance' (in relation to the four focal points), reduce these to 50 critical uncertainties, use key words or bundling to arrive at a set of possible axes of uncertainty, and to write scenarios arising from the quadrants of uncertainty.

The minimum time requirement for those actions would be two full days and a night of data processing. As it was, a considerable part of the exercise was carried out by e-mailed questionnaires—a procedure that resulted in only a 50% response once participants returned to their daily duties.

APPENDIX 1

Dryland salinity foresighting project Terms of Reference

The Terms of Reference for the Dryland Salinity Study are to:

(i) review the outcomes of the general foresighting scenario process undertaken by the CIE.

(ii) propose an appropriate methodology and process for the foresighting exercise to assist to:

- examine likely scenarios for the future extent and cost of dryland salinity across Australia; and
- identify appropriate R&D priorities for support under the National Dryland Salinity R,D&E Program.

(iii) provide guidance on the selection of appropriate participants to be involved in the foresighting process.

(iv) document the outcomes of the exercise against:

- the objectives; and
- the efficacy of the process to environmental management in general and dryland salinity management.

APPENDIX 2

Driving forces: dryland salinity foresighting process

These driving forces were identified by participants at the Adelaide Dryland Salinity Scenario Planning Workshop in response to the Focal Decisions and Issues facing Dryland Salinity Management in Australia.

Social dynamics

Table 17
Driving forces that relate to the focal decisions

Social Dynamics (Drivers in italics)

- Will *increased levels of understanding* of the extent of intervention required (across all sectors of government and community) change the current resourcing of the problem (large input costs required by the landuser)?
- Will *increased levels of national public awareness* of the severity of dryland salinity cause the community to take action?
- Will *dominance of broader issues* (health and education; or other environmental issues) prevail over salinity as the main problems of national significance.
- Will *individual property and land values be affected severely* in 20 years?
- Will the spread of dryland salinity change *the structure of rural communities* by 2020?
- Will the *community perception/expectation for action* on dryland salinity change the severity of off-site impacts
- Will *inequities and tensions over who pays* for dryland salinity impacts be dealt with in the community?
- Might *knowledge of the magnitude of true costs* change the national perception of the problem?
- Might the *social impacts of dryland salinity* facilitate landuser action to maintain the environment?
- Might *shared goals and collaboration* facilitate uniform land stewardship?
- What form should a *sustainable land management program* take? (compared to new frontier assistance programs over the last 150 years). (avoid perpetuating the 'sacred cow' status of landusers)
- What is the *consistency of message required* to avoid landusers 'sitting on the fence'?
- Will *urban community attitudes* be influential in creating regulatory changes?
- Might the *gulf be reduced* between the impact of regulations; and the farmers' believed rights?
- Will *education on the benefits of regulatory impacts* change the landuser's appreciation of what regulation can do?
- Will *peer pressure and sense of community values* motivate landusers to initiate appropriate salinity management action?
- Will *'information awareness'* affect the way landusers manage salinity?
- Might *environmental change/environmental costs* affect community attitudes to dryland salinity by 2020?
- Will *loss of valued assets* affect community perceptions of dryland salinity?
- Might a *critical mass of landusers with the desire to act* on dryland salinity affect trends in status and extent? (ie. positive coercion versus regulation)
- Will *marketing of salinity impacts on the community* manipulate community conscience to 'buy-in' to the dryland salinity problem?
- Might *reactionary community attitudes* bring unwanted (off-target) impacts?
- Might *environmental and social disasters* associated with dryland salinity affect community attitudes?
- Might the *quality of life/ human health change* over the next 20 years as a result of dryland salinity impacts?
- Will *community education programs* affect community responsiveness to dryland salinity?
- Will the *media be influential in changing community perceptions* about dryland salinity? (image perception)
- Might *emergence of strong leadership in the community* affect community involvement in dryland salinity?
- Will *landusers short-term focus change* over the next 20 years?
- Will *'do nothing' managers be motivated in the near future?*
- Will *access to a knowledge base* affect management of dryland salinity? (changing nature of knowledge ownership)

- Will community/catchment *agreement be reached on a socially acceptable level of salinity?*
- Will dryland salinity be *recognised as national priority relative to national issues*?
- Will the community continue to perceive dryland salinity as a new problem? (hence not in need of urgent attention)
- Would an *expanded scope of socio-economic research beyond current socio-economic problems* affect the community in 20 years?
- Would *adverse findings of socio-economic research* change attitudes of rural communities to dryland salinity management?
- Will the landuser *adversely react to too much science and discipline* imposed by dryland salinity management programs? (or become a sophisticated client)
- Is there a necessary *required 'process' skill level of community groups,* to bring about their own reversal in the extent of dryland salinity? (ie. capacity building for community groups)

Economic

Table 18
Driving forces that relate to the focal decisions

Economic (Drivers in italics)

- Will *increased production costs/reduced profitability* over an increased areas of Australia justify salinity as a problem of national significance?
- Will *new trade agreements* (non-tariff trade barriers) be introduced, causing landusers and politicians to regard dryland salinity as a problem of national significance
- Will *economic attractiveness of continuing with incompatible landuse practices* (ie. practices unsuited to the nation's natural resource base), be favoured over more suitable/costly (ESD) practices?
- *Will dryland salinity increase the costs of goods and services* significantly and how sensitive is the community (price sensitivity) to changing costs?
- Might *quantifying the incremental expression of cost* (ie. per unit increase in EC); threshold cost, and cumulative cost, affect the timing and magnitude of national resources committed to managing dryland salinity
- Will *the national cost of dryland salinity* change substantially if we don't treat the problem?
- What is the *significance of non-market costs* in the total account of salinity impact?
- Might *national dryland salinity related water treatment costs* per capita change by 2020?
- Might the *magnitude (annual cost) of lost opportunities* caused by dryland salinity impacts change significantly, by 2020
- Might *costs of infrastructure damage* change significantly by 2020?
- Will *landusers value longer term benefits* (including intangibles and externalities) of early salinity management action? (Tradeoff between discounted future benefits against today's real costs).
- Are the *'triggers' landusers require to liberate capital* for dryland salinity management known?
- What is the *information required to make informed investment decisions/*prioritise given shortage of funds?
- Might *quantification of reduced risks to landusers* increase the attractiveness of dryland salinity management solutions?
- What might constitute *incentives for landusers* to work together?
- Will *'polluter pays'* lead to self-regulation?
- Will *market forces replace regulations* compelling landusers to undertake salinity management plans?
- Will *demonstration of due diligence on property transactions* (ie. liabilities such as dryland salinity valued against the property) protect new owners from unforeseen debt?
- Will farm (micro)-*economic impacts of dryland salinity* affect capital investment in on-farm salinity management? (ie. increased water use leading to increased production costs, reduced asset value of property, limited range of production)
- Will *international production standards* requiring certification that products are sourced from sustainable landuse systems, affect capital investment in on-farm salinity management?
- Will *tied funding arrangements* affect the success of catchment management plans?
- Will *property values* be impacted severely by watertables and salinity?
- Will *non market issues restrict markets* for Australian production from unsustainable landuse systems?

- Will other forms of *economic instruments* (eg. recharge credits) affect off-site impacts of dryland salinity?
- Will landusers *overcome the fear* associated with uncertainty of the economic impact of dryland salinity on their livelihood?
- Might accounting to identify the *true costs of dryland salinity impacts* affect resourcing decisions?
- Will *collective, coordinated financing* address dryland salinity management problems more cost effectively?
- Might *landuser awareness of $ benefits* of dryland salinity management encourage better management?
- Might *dryland salinity impacts on individuals* be collectively managed more cost effectively for the individual?
- Would a demonstrated *link between strong business performance and responsible land management* affect land management incentives?
- Is there a *critical mass of investment $* required for dryland salinity management to have an impact at catchment level?
- Will we be able to *demonstrate that costs* associated with dryland salinity *are preventable*?
- Will *landusers pay for knowledge?* (creating a market value for knowledge)
- Will *salinised land be managed to maximise its value; productiveness and attractiveness?*
- Will *increased public scrutiny of $ invested in dryland salinity* programs affect the way these funds are allocated?
- Will *increased accountability for outcomes* at the program level affect the way dryland salinity funds are allocated?
- Are there *new analysis tools* that could bring socio-economic aspects into consideration in salinity management programs? (currently a poor selection of tools are available, particularly in economic analysis; and those that are available are poorly used)
- Will *salinity risk* be dealt with at range of scales?
- Will *international markets* drive technical R&D options?
- Would *improved credibility of economic models* change the national perspective of dryland salinity?

Political

Table 19
Driving forces that relate to the focal decisions

Political (Drivers in italics)

- What operating environment is required to *internalise external salinity impacts*?
- How to *simultaneously manage multi-dimensional aspects* of dryland salinity? (dryland salinity is not a unidirectional problem)
- Will regulations need to be changed to meet the *changed landuse regimes* of the twenty first century?
- Is the *limit of individual responsibility* for dryland salinity management able to be defined?
- Will *regulations that require the landuser to improve or maintain* property values, change the value of the property right?
- Will *compulsory 'buyer beware' property report* required by lending authorities before purchase, need regulations to enforce?
- What *degree of dryland salinity impact* must be recognised before regulations are imposed?
- What *Local Government environmental responsibility* is appropriate to assist in mitigating the impacts of dryland salinity?
- Will the *risk of litigation* over undisclosed salt affected land increase Local Government's role in salinity management (eg. building approvals on salt affected land)?
- Will *political understanding of the status and potential extent* of dryland salinity affect the resourcing of dryland salinity management?
- Who will be the next *eco-political champion* of dryland salinity management?
- Will *international treaties* affect the landuser's approach to managing dryland salinity?
- Might *local government politics* affect dryland salinity management?
- Will *'green terrorism'* be influential in 20 years.
- Will *'brown reactiveness'* be influential in 20 years
- Will dryland salinity *gain votes in the electorate* over the next 20 years?
- Will *minor parties be in control of both upper and lower houses* of Parliament over the next 20 years?
- Will *governments be pressured to maintain viable rural communities*?

- Might *authorities empowered to implement coordinated catchment plans*, change the effectiveness of dryland salinity management?
- Might the *focus of structures/regulatory bodies/institutions change from production to resource management*?
- Is there one body competent to make *decisions about the relative importance of impacts of dryland salinity*?
- Is there a particular *structure and location of organisation best equipped to manage dryland salinity*? (eg. regionalised, government or private?).
- Will a *multi-organisation; multi-disciplinary approach* to address R&D problems on a large (regional/national) scale change the effectiveness of current dryland salinity management programs?
- Will *the structure of industry change to bring together benchmarking, self-regulation, quality assurance; marketing and R&D?*
- Will *establishment of coordinated management structures* focus thought on a systematic approach to tackling dryland salinity?
- Will *existing institutional frameworks change* to deliver salinity management outcomes?
- *Is there a particular focus that LWRRDC*, GRDC etc should adopt to achieve salinity management outcomes? (eg. focus on evaluation of program performance)

Technological

Table 20
Driving forces that relate to the focal decisions

Technological (Drivers in italics)

- Will we be able *develop technology* to minimise infrastructure damage caused by dryland salinity
- Will *monitoring systems facilitate trace-back* from resource decline to source of discharge?
- Loss of flexibility and development opportunities
- Might a *balanced on-farm water budgeting* be achieved with affordable, property based water treatment technology?
- What *scale and scope of mechanisms* is required by landusers to address dryland salinity?
- Will *increased confidence in causes and effects of dryland salinity* lead to more thorough enforcement of regulatory practices?
- Will *salt impacts on urban roads and engineering* be significant in 20 years?
- Will *market quality criteria* affect production methods? (ie. product and process quality-ISO9000; and environmental assurance)?
- Will *knowledge of what to do and where to* do it affect resourcing of dryland salinity works implementation?
- Will the *knowledge base be segmented to key stakeholders*? (eg. responsibility assigned based on monetary impacts, particularly to local government).
- Would *real-time information* change management practices?
- Will *knowledge be delivered to all landusers*? (given the changing nature of land ownership)
- Is there a particular *level of management required* to keep dryland salinity under control?
- Would *treatment of dryland salinity as part of a complex set of interactions/impacts* change outcomes? (compared to treatment of salinity as an isolated problem)
- Is technological *innovation likely to be a significant factor in overcoming historical constraints associated with mitigation of dryland salinity impacts*?
- Can *integrated salinity management solutions* (involving socio-economic research) change the performance of current technology based salinity management programs?
- Will *new landuse opportunities* change socio-economic status in rural communities?
- Are there *productive options* for salt impacted land?
- Would *simpler, less expensive, flexible, technical packages* change the uptake of salinity management technology?
- Would an *information service for landusers* (collection, interpretation, feedback) change the uptake of salinity management technology?
- Would *improved risk assessment techniques and skills training* in natural resource management change the way landusers view technology to combat dryland salinity?
- Would *improved user interfaces* change the uptake of salinity management technology? (demand for R&D on ‘solutions’ side ie. user interfaces)

- Will *technical research based on systems* change the effectiveness of salinity management programs?
- Would application of *technical processes add value* to salinity management programs?
- Will technical *research funding directed at 'blue sky' options* pay-off?
- Will *new tools/technology* be influential in mitigating dryland salinity impacts over the next 20 years
- Can present technology be used to address *external impacts of dryland salinity,* in analysing on-site salinity problems?
- Would *knowledge of most appropriate areas* to apply tools/achieve benefits/remedial impacts change the focus of salinity management programs?

Biophysical

Table 21
Driving forces that relate to the focal decisions

Biophysical (Drivers in italics)
• Will *severity of dryland salinity impacts* on the landscape be more severe than other land degradation impacts?
• Will dryland salinity lead to a *decline in water quality* that will seriously impact on regional biodiversity; human health; treatment costs; infrastructure/engineering costs.
• Will *habitat be affected* severely by 2020?
• Will *benefits of environmental restoration* (revegetation programs) and increased biodiversity allow landusers to compete for alternative forms of national support (larger funding pool).
• Will *the significance of dryland salinity* in 20 years be greater than other forms of degradation? (salinity impacts on water quality; waterlogging; off-site effects)
• Will *incentives to meet land management targets* set by COAG change the performance of dryland salinity management programs?

Critical uncertainties: dryland salinity foresighting process

Critical uncertainties were identified based on a questionnaire in which Adelaide Scenario Planning Workshop participants were asked to score each of the driving forces in terms of its importance to the focal decisions.

Process to identify critical uncertainties (driving forces)

Workshop participants identified 150 drivers of the future with respect to dryland salinity. In a subsequent questionnaire participants were asked their opinion of which drivers would be considered as 'predetermined' (or 'inevitable') and which were 'uncertainties'. They were also asked to score the importance of all drivers—using a value of '1' for relatively low importance and '3' for relatively high importance.

The answers to the questionnaire have been plotted in the following histograms (Figures 14 to 18) to show the frequency of choice for 'uncertain' drivers. Since there were only nine replies to the questionnaire (approx. 40% response rate) the maximum value is '9' and the minimum, '0'. Where the respondent was uncertain a value of '0.5' was used. Included on the same figures is the 'normalised' importance rating allocated to each uncertainty. Again, where a respondent was uncertain whether a driver was relatively 'important' or 'unimportant' a score of '2' was used.

Given the diverse backgrounds of the participants it was not surprising that 138 of the original 150 drivers were identified as being 'uncertainties' by one or more of the respondents. A more 'salinity focused' group (eg. the LWRRDC Dryland Salinity Committee) might well have resulted in fewer uncertainties.

In order to identify the *critical* uncertainties only drivers having a frequency of '5' or above (simple majority) and a normalised importance rating of '0.67' ($2/3^{rd}$) were used in subsequent analyses. These cut-off values are arbitrary but resulted in 50 drivers being of major importance (Table 22).

Figure 14
Importance of social dynamic drivers

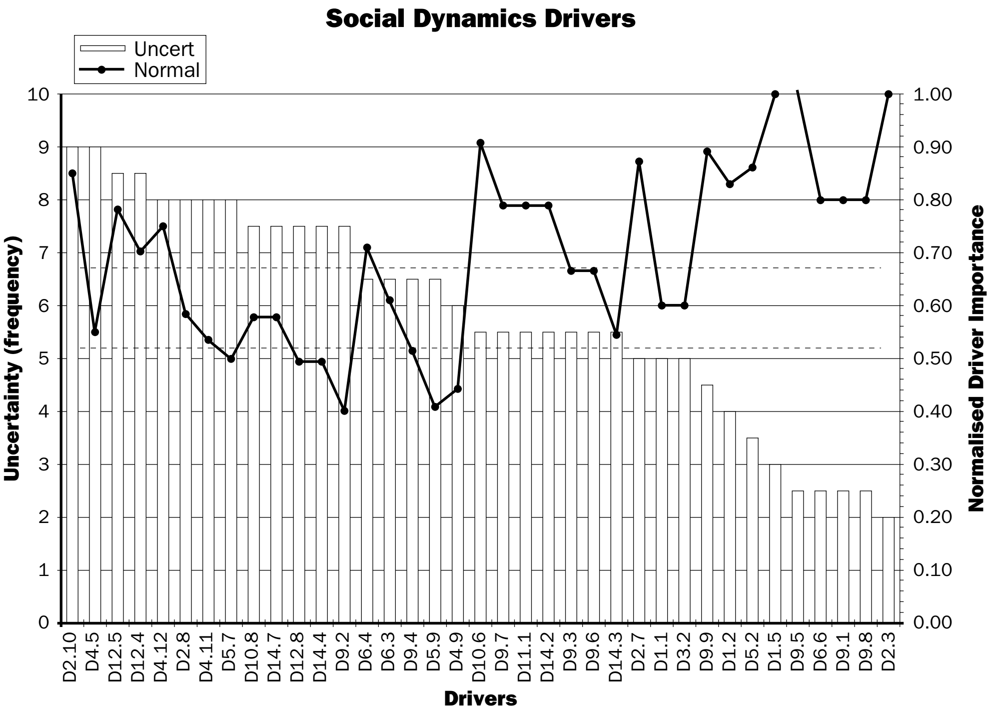


Figure 15
Importance of economic drivers

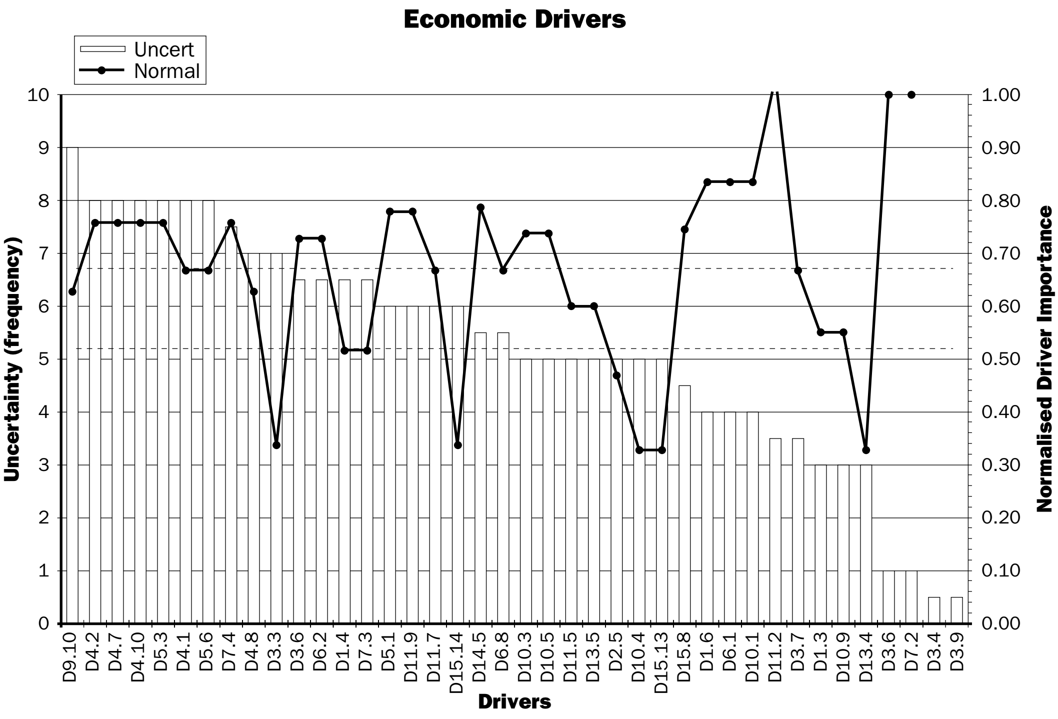


Figure 16
Importance of political drivers

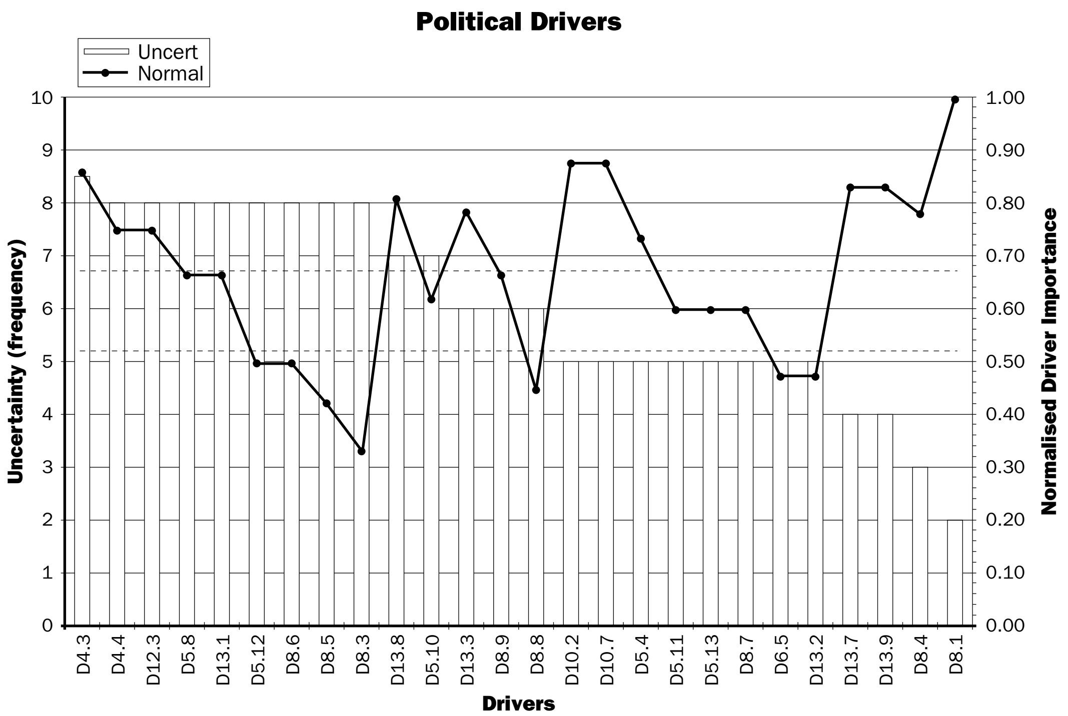


Figure 17
Importance of technical drivers

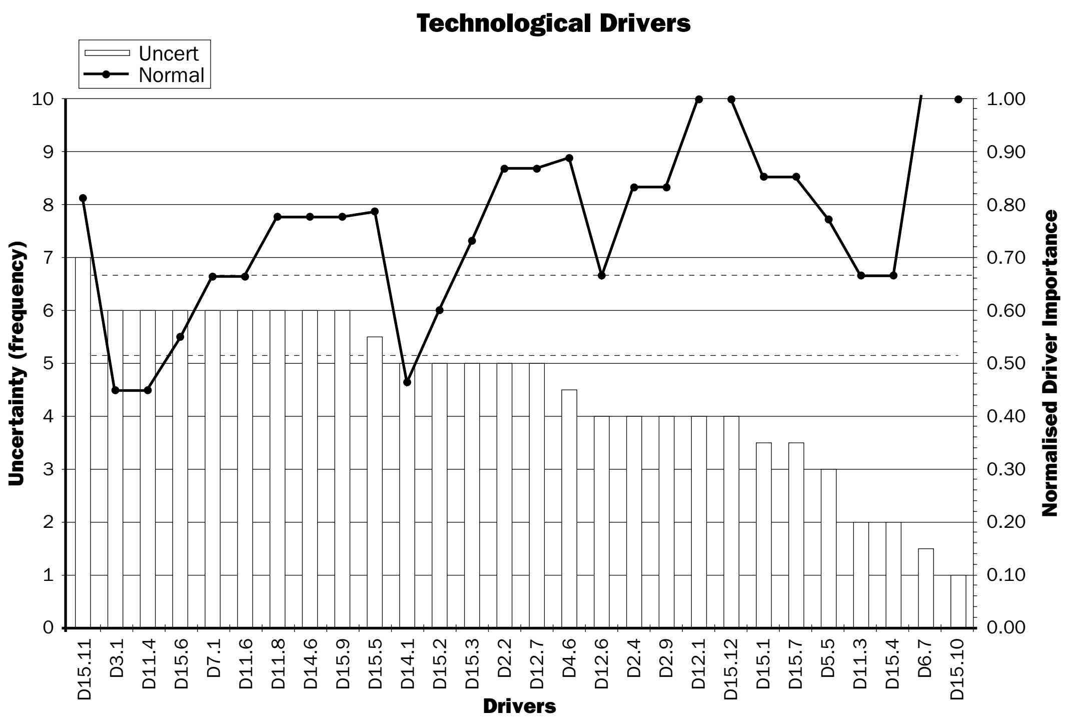
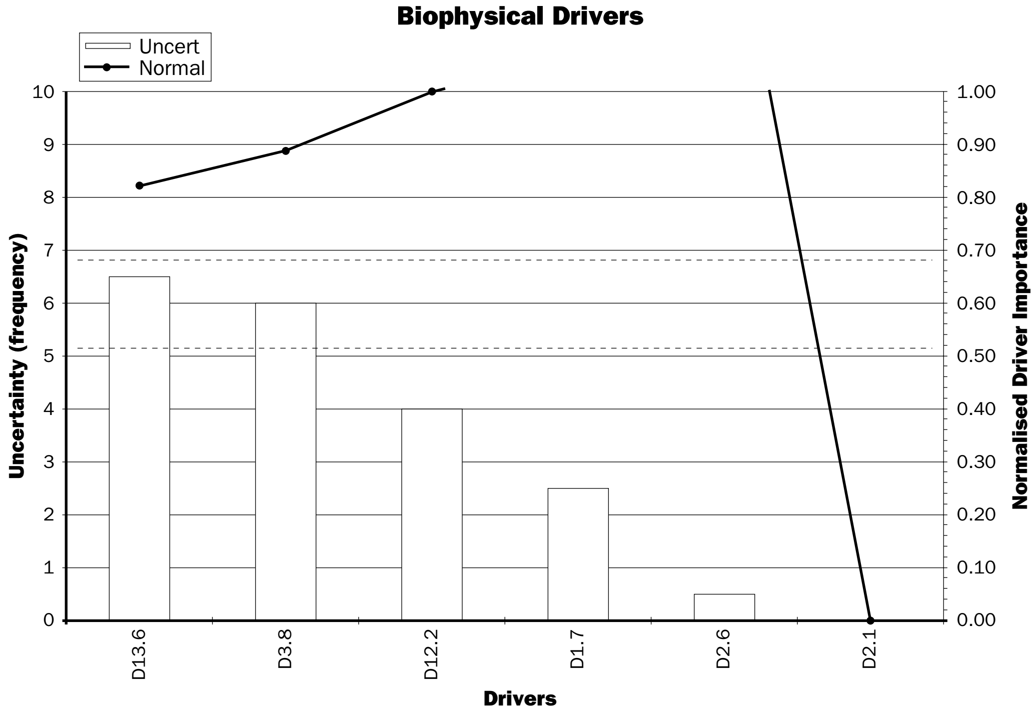


Figure 18
Importance of biophysical drivers



Critical uncertainties

Driving forces scoring above the cut-off score described in the previous section are included in Table 22.

Table 22
Critical uncertainties (identified by national workshop participants)

Social

- Will inequities and tensions over *who pays for dryland salinity* impacts be dealt with in the community?
- What is the *consistency of message required* to avoid landusers 'sitting on the fence'?
- Will *marketing of salinity impacts on the community* manipulate community conscience to 'buy-in' to the dryland salinity problem?
- Might the *quality of life/ human health change* over the next 20 years as a result of dryland salinity impacts?
- Will *community education programs* affect community responsiveness to dryland salinity
- Will landusers use *short-term focus* change over the next 20 years?
- Will *access to a knowledge base* affect management of dryland salinity (changing nature of knowledge ownership)
- Will community/catchment *agreement be reached on a socially acceptable level of salinity?*
- Will dryland salinity be *recognised as a national priority* relative to national issues?
- Will *'information awareness'* affect the way landusers manage salinity?
- Is there a necessary *required 'process' skill level of community groups,* to bring about their own reversal in the extent of dryland salinity? (ie. capacity building for community groups)

Economic

- What is the *significance of non market costs* in the total account of salinity impact
- Are the *'triggers'* landusers require to liberate capital for dryland salinity management known?
- What is the *information required to make informed investment decisions/* prioritise; given shortage of funds?
- What might constitute *incentives for landusers to work* together (with respect to dryland salinity)?
- Will *landusers value longer term benefits* (including intangibles and externalities) of early salinity management action? (Tradeoff between discounted future benefits against today's real costs).
- Will *'polluter pays'* lead to self-regulation
- Will *demonstration of due diligence on property transactions* (ie. liabilities such as dryland salinity valued against the property) protect new owners from unforeseen debt?
- Will *market forces replace regulations* compelling landusers to undertake salinity management plans?
- Will *international production standards* requiring certification that products are sourced from sustainable landuse systems affect capital investment in on-farm salinity management
- Will *tied funding arrangements* affect the success of catchment management plans
- Will *other forms of economic instruments (*eg. recharge credits) affect off-site effects of dryland salinity
- Will *collective, coordinated financing* address dryland salinity management problems more cost effectively
- Might *landuser awareness of $ benefits* of dryland salinity management encourage better management?
- Will *landusers pay for knowledge?* (creating a market value for knowledge)
- Will *salinised land be managed to maximise its value,* productiveness and attractiveness?
- Are there *new analysis tools* that could bring socio-economic aspects into consideration in salinity management programs? (currently a poor selection of tools are available, particularly in economic analysis, and those that are available are used poorly)

Political

- What *operating environment* is required to internalise salinity impacts?
- How to *simultaneously manage multi-dimensional aspects of dryland salinity*? (dryland salinity is not a uni-directional problem)
- Will *regulations need to be changed* to meet the changed landuse regimes of the twenty-first century?
- Is the *limit of individual responsibility* for dryland salinity management able to be defined?
- Will the *structure of industry change* to bring together benchmarking, self-regulation, quality assurance, marketing and R&D?
- Might *authorities empowered to implement coordinated catchment plans* change the effectiveness of dryland salinity management?
- Might the *focus of* structures/regulatory bodies/institutions *change from production to resource management*?
- Will existing *institutional frameworks* change to deliver salinity management outcomes?
- Is there one body competent to make decisions about the *relative importance of impacts* of dryland salinity
- Will *governments be pressured* to maintain viable rural communities
- Is there a particular *structure and location of organisation best equipped to manage dryland salinity*? (eg. regionalised, government or private?)

Technology

- Will we be able to *develop technology to minimise infrastructure damage* caused by dryland salinity?
- Will *market quality criteria affect production methods*? (ie. product and process quality-ISO9000; and environmental assurance)
- Would *real-time information* change management practices?
- Will *knowledge be delivered to all landusers*? (given the changing nature of land ownership)
- Is *technological innovation* likely to be a significant factor in overcoming historical constraints associated with mitigation of dryland salinity impacts?
- Will *new landuse opportunities* change socio-economic status in rural communities?
- Would an *information service for landholders* (collection, interpretation, feedback) change the uptake of salinity management technology?
- Would *improved user interfaces* change the uptake of salinity management technology? (demand for R&D on 'solutions' side ie. user interfaces)
- Can *present technology be used to address external impacts* of dryland salinity in analysing on-site salinity problems?
- Will *technical research funding* directed at 'blue sky' options pay off?

Biophysical

- Will *benefits of environmental restoration* (revegetation programs) and increased biodiversity allow landusers to compete for alternative forms of national support (larger funding pool)?
- Will *incentives to meet land management targets* set by COAG change the performance of dryland salinity management programs?

APPENDIX 4

Determining R&D priorities from the critical uncertainties

There are five steps in the process to identify R&D priorities from critical uncertainties:

1. Identify key words for each of the social, economic, political, technical and biophysical critical uncertainties;
2. Use frequency analysis to classify key words;
3. Develop axes of uncertainty;
4. Identify uncertainties that feature in all quadrants; and
5. Determine the R&D implications of uncertainties featuring in all quadrants.

Identification of key words

In order to further reduce the critical uncertainties to one or more pairs of orthogonal axes each was examined to determine what 'key words' were implicit in the stated driver. eg.

D2.10 Will inequities and tensions over who pays for dryland salinity impacts be dealt with in the community?

implies issues concerning *individuals, community, costs, regulation, and conflict.*

The identification of key words has been completed for the 50 critical uncertainties, under five categories; social, economic, political, technical and biophysical driving forces.

Social dynamic driving forces

D2.10 Will inequities and tensions over who pays for dryland salinity impacts be dealt with in the community?
(individual, community, costs, knowledge, regulation)

D4.12 What is the *consistency of message required* to avoid landusers 'sitting on the fence'?
(individual, information, motivation, government)

D9.3 Will *marketing of salinity impacts on the community* manipulate community conscience to 'buy-in' to the dryland salinity problem?
(community, market forces, motivation, individual)

D9.6 Might the *quality of life/ human health change* over the next 20 years as a result of dryland salinity impacts?
(community, well-being, individual, knowledge, regulation)

D9.7 Will community education programs affect community responsiveness to dryland salinity?
(community, education, individual)

D10.6 Will landusers use short-term focus change over the next 20 years?
(individual, motive)

D11.1 Will access to a knowledge base affect management of dryland salinity (changing nature of knowledge ownership)?
(individual, community, knowledge)

D12.4 Will community/catchment *agreement be reached on a socially acceptable level of salinity?*
(community, government, individual, knowledge)

D12.5 Will dryland salinity be recognised as a national priority relative to national issues?
(national, individual, knowledge)

D6.4 Will *'information awareness'* affect the way landusers manage salinity?
(individual, information, government)

D14.2 Is there a necessary *required 'process' skill level of community groups,* to bring about their own reversal in the extent of dryland salinity? (ie. capacity building for community groups)
(community, education, individual)

Economic driving forces

D3.5 What is the significance of non market costs in the total account of salinity impact?
(market forces, government, regulation)

D4.2 Are the 'triggers' landusers require to liberate capital for dryland salinity management known?
(individual, key knowledge, incentive, government, regulation)

D4.7 What is the information required to make informed investment decisions/prioritise given shortage of funds?
(information, individual, government, regulation)

D4.10 What might constitute incentives for landusers to work together (with respect to dryland salinity)?
(individual, incentive, government, regulation)

D4.11 Will *landusers value longer term benefits* (including intangibles and externalities) of early salinity management action? (Tradeoff between discounted future benefits against today's real costs).
(individual, incentive, government)

D5.1 Will 'polluter pays' lead to self-regulation?
(individual, regulation, knowledge, government)

D5.3 Will demonstration of due diligence on property transactions (ie. liabilities such as dryland salinity valued against the property) protect new owners from unforeseen debt?
(individual, regulation, knowledge)

D5.6 Will market forces replace regulations compelling landusers to undertake salinity management plans?
(individual, market forces, regulation, government)

D6.2 Will international production standards requiring certification that products are sourced from sustainable landuse systems affect capital investment in on-farm salinity management?
(regulation, incentive, individual)

D6.8 Will tied funding arrangements affect the success of catchment management plans?
(government, regulation)

D7.4 Will other forms of economic instruments (eg. recharge credits) affect off-site effects of dryland salinity?
(incentives, off-site impact, government, regulation)

D10.3 Will collective, coordinated financing address dryland salinity management problems more cost effectively?
(community, costs, regulation)

D10.5 Might landuser awareness of $ benefits of dryland salinity management encourage better management?
(individual, financial knowledge, government)

D11.7 Will *landusers pay for knowledge?* (creating a market value for knowledge)
(individual, knowledge, costs, government)

D11.9 Will salinised land be managed to maximise its value, productiveness and attractiveness?
(individual, incentive, government)

D14.5 Are there new analysis tools that could bring socio-economic aspects into consideration in salinity management programs? (currently a poor selection of tools are available, particularly in economic analysis, and those that are available are used poorly)
(tools, socio-economic knowledge, government)

Political driving forces

D4.3 What operating environment is required to internalise salinity impacts?
(government, regulation, costs, knowledge)

D4.4 How to simultaneously manage multi-dimensional aspects of dryland salinity? (dryland salinity is not a uni-directional problem)
(land degradation, knowledge, individual, government)

D5.4 Will regulations need to be changed to meet the changed landuse regimes of the twentyfirst century?
(government regulation, individual, knowledge)

D5.8 Is the limit of individual responsibility for dryland salinity management able to be defined?
(individual, recognition, government, regulation)

D13.3 Will the structure of industry change to bring together benchmarking, self-regulation, quality assurance, marketing and R&D?
(R&D, regulation, individual, standards, industry, government)

D10.2 Might authorities empowered to implement coordinated catchment plans change the effectiveness of dryland salinity management?
(government, regulation, individual, knowledge)

D10.7 Might the focus of structures/regulatory bodies/institutions change from production to resource management?
(government, regulation, objectives)

D13.8 Will existing institutional frameworks change to deliver salinity management outcomes?
(government, regulation, knowledge)

D12.3 Is there one body competent to make decisions about the relative importance of impacts of dryland salinity?
(government, knowledge, regulation)

D8.9 Will governments be pressured to maintain viable rural communities?
(government, motivation, regulation)

D13.1 Is there a particular *structure and location of organisation best equipped to manage dryland salinity*? (eg. regionalised, government or private?)
(government, regulation, knowledge)

Technological driving forces

D2.2 Will we be able to develop technology to minimise infrastructure damage caused by dryland salinity?
(technology, off-site, government)

D7.1 Will market quality criteria affect production methods? (ie. product and process quality-ISO9000; and environmental assurance)
(markets, regulation, individual, government, knowledge)

D11.6 Would real-time information change management practices?
(technology, information, incentive, individual, government)

D11.8 Will knowledge be delivered to all landusers? (given the changing nature of land ownership)
(information, individual, government)

D12.7 Is technological innovation likely to be a significant factor in overcoming historical constraints associated with mitigation of dryland salinity impacts?
(technology, individual, government)

D14.6 Will new landuse opportunities change socio-economic status in rural communities?
(socio-economic, technology, government, individual)

D15.3 Would an information service for landholders (collection, interpretation, feedback) change the uptake of salinity management technology?
(information, individual, technology)

D15.5 Would *improved user interfaces* change the uptake of salinity management technology? (demand for R&D on 'solutions' side ie. user interfaces)
(individual, information, technology, government)

D15.9 Can present technology be used to address external impacts of dryland salinity in analysing on-site salinity problems?
(technology, external impacts, individual, government)

D15.11 Will technical research funding directed at 'blue sky' options pay off?
(R&D, opportunity, government)

Biophysical driving forces

D3.8 Will benefits of environmental restoration (revegetation programs) and increased biodiversity allow landusers to compete for alternative forms of national support (larger funding pool)?
(technology, incentives, individuals, government, regulation)

D13.6 Will incentives to meet land management targets set by COAG change the performance of dryland salinity management programs?
(government, incentives, individuals, regulation)

Frequency analysis to classify key words

Collecting all key words together resulted in the following frequencies:

Table 23
Critical uncertainties—key words/frequencies

Key Words	Frequency	Key Words	Frequency
individual	35	motivation/incentive	14
community	12	regulation/ agreement	20
government	31	market forces	4
national	1	costs	5
information/ knowledge	24	R&D	2
technology/ education	9		

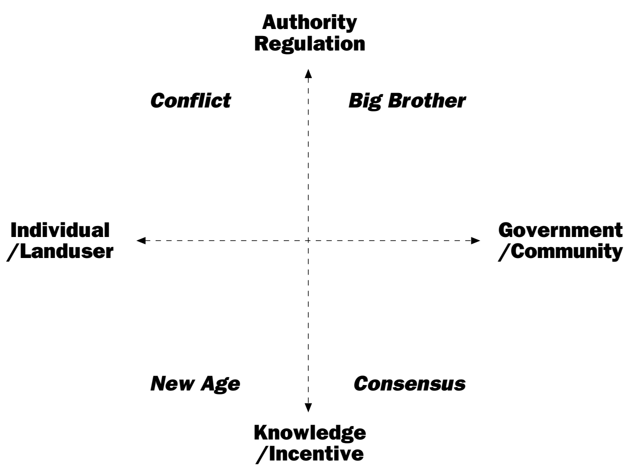
plus scores of 1 or 2 for *socially acceptable, community wellbeing, socio-economic status, community conscience, financial resources, financial regulation, off-site impact, land degradation, recognition, standards, industry, opportunity, objectives and response.*

Developing axes of uncertainty

The key words show natural groupings concerning [*'individual landuser'], ['government and community'], ['regulation'], ['information/ knowledge'], ['technology/ education'], and ['motivation/incentive'].*

Various sets of orthogonal axes of uncertainty may be derived from the list although it would be difficult to ignore one axis involving ['*individual landuser']* versus ['*government and community']* (Figure 19).

Figure 19
Axes of uncertainty

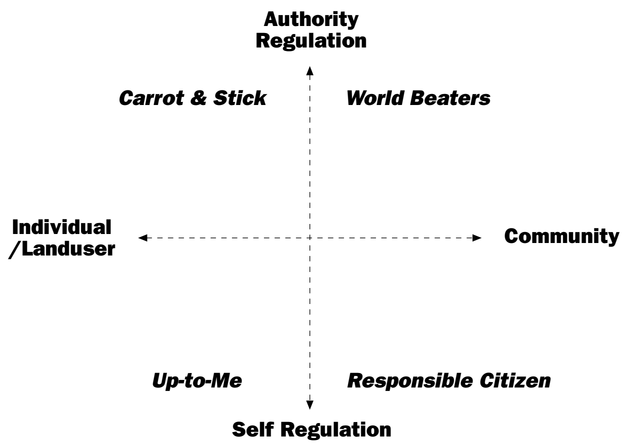


It should be emphasised that other axes of uncertainty could have been devised—and perhaps in future assessment of this foresighting technique that option should be explored. It would be difficult to ignore the *'Individual Landholder vs Government/ Community* axis but there are other possibilities for the other. eg. an *'Information/ Knowledge'* axis that ranges from a low confidence to a high degree of confidence in our understanding of dryland salinity, or *'Motivation/ Incentive'* spread over a *'self-motivated vs regulated'* axis.

An alternative approach—intuitive bundling

This technique relies on the 'feeling' generated during the consultation process. In this case a considerable amount of discussion centred around *'individual regulation and incentives'* and *'government/ community generated regulation'*. Hence individual uncertainties can be intuitively bundled together as in Figure 20.

Figure 20
Axes of uncertainty—bundling process



Those uncertainties that do not fit immediately on to the chosen axes are not lost to the analysis but rather remain as a conglomerate of issues that require future monitoring.

The intuitive approach is not dissimilar to that already used in the NDSP review where people who are very familiar with dryland salinity management issues have been coming to a consensus of those issues that should be addressed in the near future. A possible disadvantage could be an individual or group bias towards one point of view and a consequent loss of hard-won individual views for the future.

Summary

There are no set rules for reducing a list of critical uncertainties to a set of orthogonal axes.

The frequency/importance graphs followed by key word analysis was devised to demonstrate an objective approach that readily permits re-analysis of the data by other interest groups. For example the present set of drivers could easily be used as a starting point with another group of people (Dryland Salinity Committee, farmers group, local governments affected by off-site/urban salinity) who would then impose their own particular perspectives on the driver set.

Similarly, if 50 critical uncertainties were thought to be too many, more stringent cut-off values for 'frequency' and 'normalised importance' could be used to sharpen the focus with little extra effort. It may or may not affect the final axes of uncertainty generated but would almost certainly reduce the number of dryland salinity strategy issues identified.

The intuitive 'bundling' approach would probably best be carried out by a group of like-minded participants. It does not result in any loss of data but relies quite heavily on the 'feeling' generated by discussion at the meeting where the original drivers were recorded. It does not readily lend itself to 'sharpening focus' in any easily understood manner.

Identifying strategic R&D uncertainties that feature in all quadrants

Many scenarios could be developed for each quadrant in the axes of uncertainty shown in Figure 19 (page 80). The descriptions in Chapter 2 represent only a small fraction of the numerous scenarios that occur presently or which may occur in the future. The question is how to drive the system in the required direction when there are so many unknowns. Schwartz (1991), points out that this is achieved by immediately concentrating on those **critical uncertainties** that are common to all quadrants at this point in time. That is, the critical uncertainties become the strategic R&D directions.

Those uncertainties that occur in only one or two quadrants are not immediate priorities but at the same time they should not be ignored. There may come a time when they have a large influence on combating dryland salinity and one should always be on the lookout for early signs of them becoming activated. The real value of the foresighting exercise at this stage is in having identified them as potential players—and as such they should not be discarded.

Driving the axes of uncertainty

In this exercise 50 of the 138 drivers were identified as being of most importance to most of the group who answered their questionnaires (Appendix 3, Table 22). When these are examined in terms of the axes shown in Figure 19 on page 80 there are 14 (Tables 24–28) that are common to all four quadrants.

Table 24
Selection of critical uncertainties—social drivers

Driver	Individual Landuser	Government/ Community	Knowledge/ Incentive	Authority/ Regulation
2.10	x	x	x	x
12.5	x	x	x	
12.4	x	x	x	
11.1	x	x	x	
9.7	x	x	x	
10.6	x		x	
4.12	x	x	x	
6.4	x	x	x	
14.2	x	x	x	
9.3	x	x	x	
9.6	x	x	x	x

Table 25
Selection of critical uncertainties—economic drivers

Driver	Individual Landuser	Government/ Community	Knowledge/ Incentive	Authority/ Regulation
4.2	x	x	x	x
4.7	x	x	x	x
5.3	x		x	x
4.10	x	x	x	x
5.6	x	x		x
7.4		x	x	x
10.5	x	x	x	
11.9	x	x	x	
14.5		x	x	
3.5		x	x	x
6.2	x		x	x
5.1	x	x	x	x
6.8		x		x
10.3		x		x
4.11	x	x	x	
11.7	x	x	x	

Table 26
Selection of critical uncertainties—political drivers

Driver	Individual Landuser	Government/ Community	Knowledge/ Incentive	Authority/ Regulation
4.3	x	x	x	x
4.4	x	x	x	
5.4	x	x	x	x
5.8	x	*	x	x
13.3	x	x	x	x
10.2	x	x	x	x
10.7		x	x	x
13.8		x	x	x
12.3		x	x	x
8.9		x	x	x
13.1		x	x	x

Table 27
Selection of critical uncertainties—technical drivers

Driver	Individual Landuser	Government/ Community	Knowledge/ Incentive	Authority/ Regulation
2.2		x	x	
11.8	x	x	x	
7.1	x	x	x	x
15.11		x	x	
14.6	x	x	x	
15.9	x	x	x	
11.6	x	x	x	
12.7	x	x	x	
15.3	x	x	x	
15.5	x	x	x	

Table 28
Selection of critical uncertainties—biophysical drivers

Driver	Individual Landuser	Government/ Community	Knowledge/ Incentive	Authority/ Regulation
3.8	x	x	x	x
13.6	x	x	x	x

Implications for dryland salinity R&D—determining the R&D implications of uncertainties featuring in all quadrants

Referring to the bolded critical uncertainties in Tables A4.2–A4.6 above, the immediate priorities for LWRRDC, according to this technique, are the critical uncertainties shown as occurring in all quadrants; viz:

D2.10 Solving possible inequities in the payment of dryland salinity impacts—both on-farm and off-farm.

D9.6 Determining the effects of dryland salinity impacts on the quality of life and human health over the next 20 years.

D4.2 Defining the 'triggers' landusers require to liberate capital for dryland salinity management.

D4.7 Determining the information individual landusers require to be able to make informed investment decisions and priorities in the face of limited financial resources.

D4.10 Determining the incentives necessary to encourage landusers to work together in overcoming to dryland salinity.

D5.1 Determining whether the 'polluter pays' philosophy is likely to lead to individuals implementing remedial action.

D4.3 Determining what operating environment will be necessary for landholders to accept internalisation of salinity impacts.

D5.4 Determining appropriate regulations to meet possible changing landuse regimes in the twenty first century.

D5.8 Defining the limit of individual responsibility for dryland salinity management.

D13.3 Defining what changes of industry structure will be necessary to bring together benchmarking, self-regulation, quality assurance, marketing and R&D.

D10.2 Determining how empowered Catchment Management Committees might best be able to implement effective, coordinated catchment plans for dryland salinity management.

D7.1 Determining whether regulatory market quality criteria, such as ISO9000, will have any effect on production methods in areas affected by dryland salinity.

D3.8 Determine whether government environmental restoration programs (revegetation, increased protection of biodiversity) are restricting landuser access to national funds for overcoming dryland salinity.

D13.6 Determine the appropriateness of land management targets and incentives, devised by COAG, in changing the effectiveness of dryland salinity management programs.

APPENDIX 5

Analysis of benefits of strategic R&D directions

The 14 dryland salinity strategic R&D directions identified by the foresighting exercise, were distributed to workshop participants for their evaluation. They were asked to score the strategies as **H**igh, **M**edium or **L**ow according to:

- the chance of success of that strategy;
- the magnitude of benefits that could be expected by implementation of the strategy;
- the likelihood that the strategy would be adopted;
- the likely longevity of the benefits arising from implementation; and
- the likelihood of leakage of the benefits.

Nine replies were received and the results were averaged by assigning numerical values of 1, 3 and 5 to the Low, Medium and High classes. Where the answer was listed as a L/M, a value of 2 was used.

In some instances the respondent was apparently unable to make any decision (this was particularly so for the 'leakage of benefits' question) so all results were normalised based on the total number of answers received to a particular question.

The results are shown as histograms in Figures 21 to 25 with a 'high' rating having a value of greater than 0.7, a 'moderate' rating between 0.5 and 0.7, and a 'low' rating at values less than 0.5.

Figure 21
Chance of success of proposed R&D strategic directions

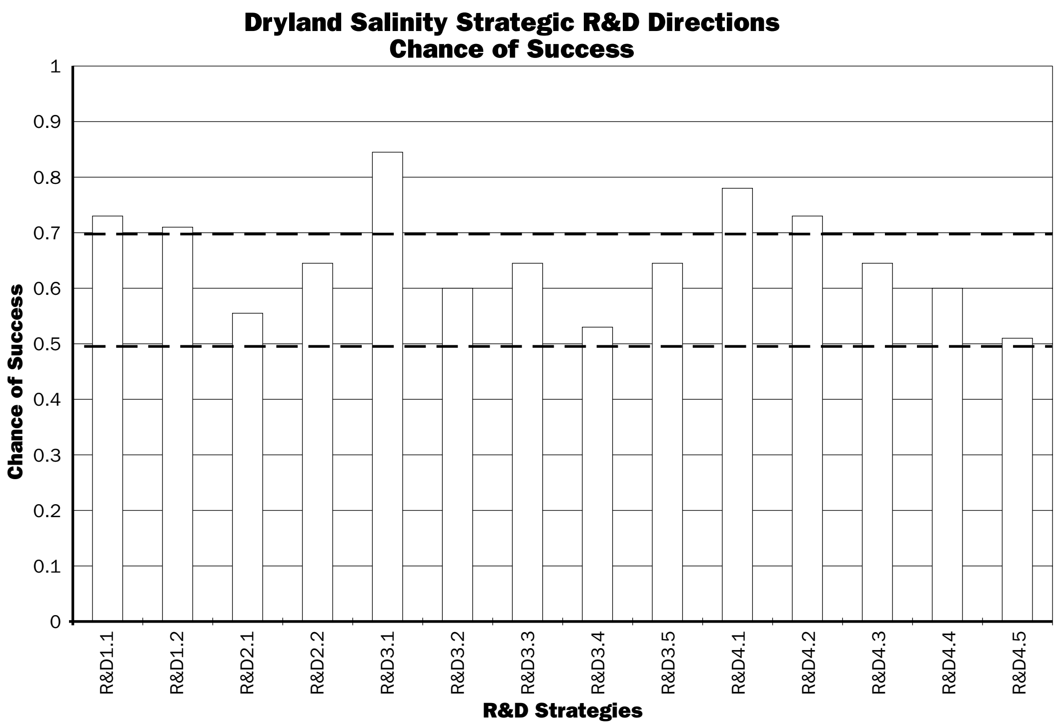


Figure 22
Magnitude of benefits expected by implementation of the strategy

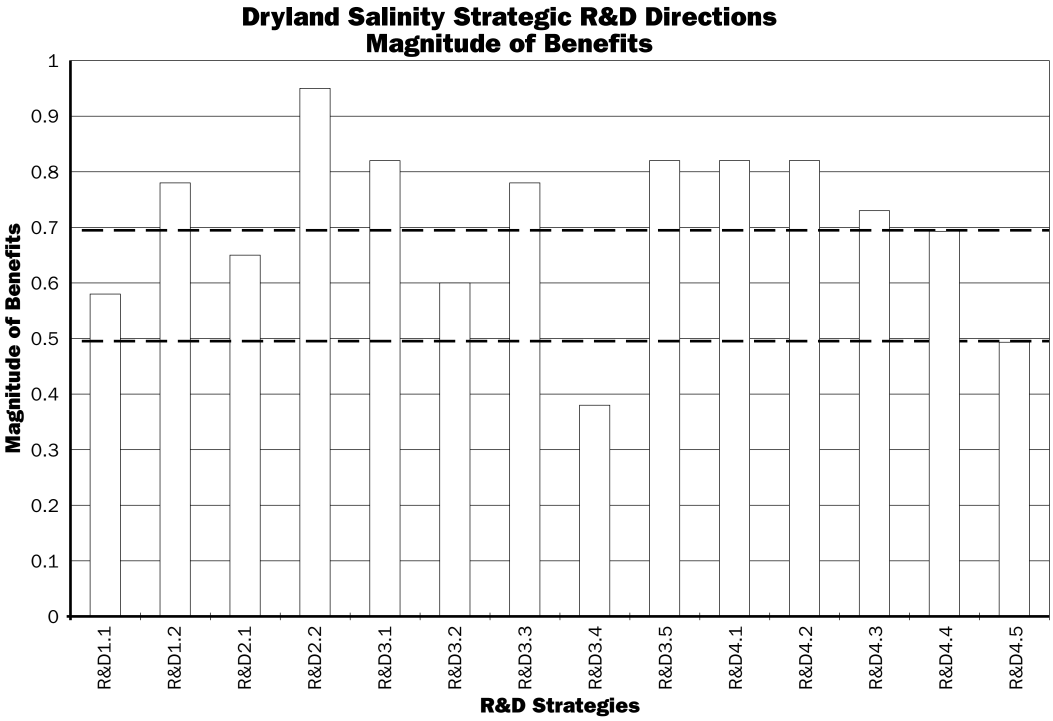


Figure 23
Likelihood that the strategy would be adopted

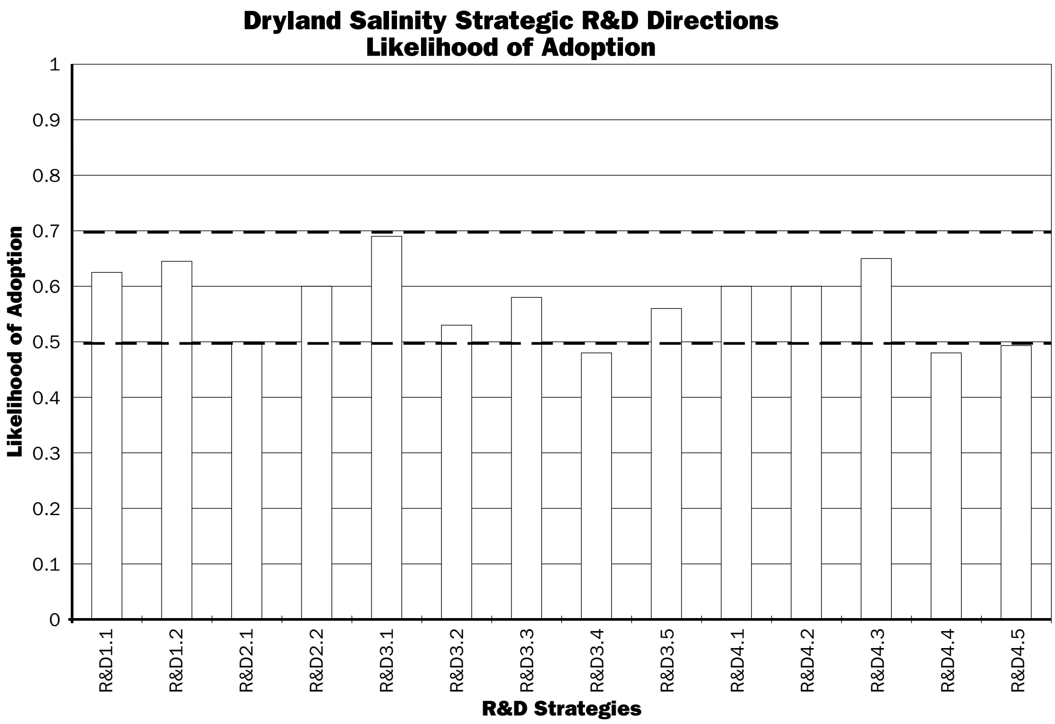


Figure 24
Longevity of benefits arising from implementation

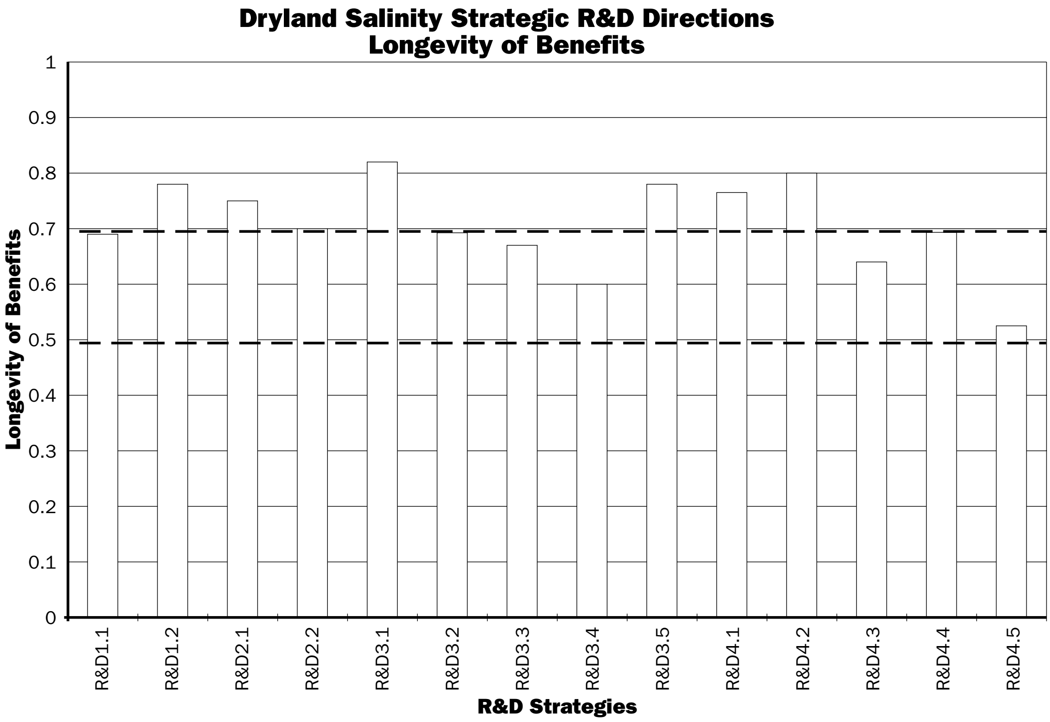


Figure 25
Likelihood of leakage of benefits

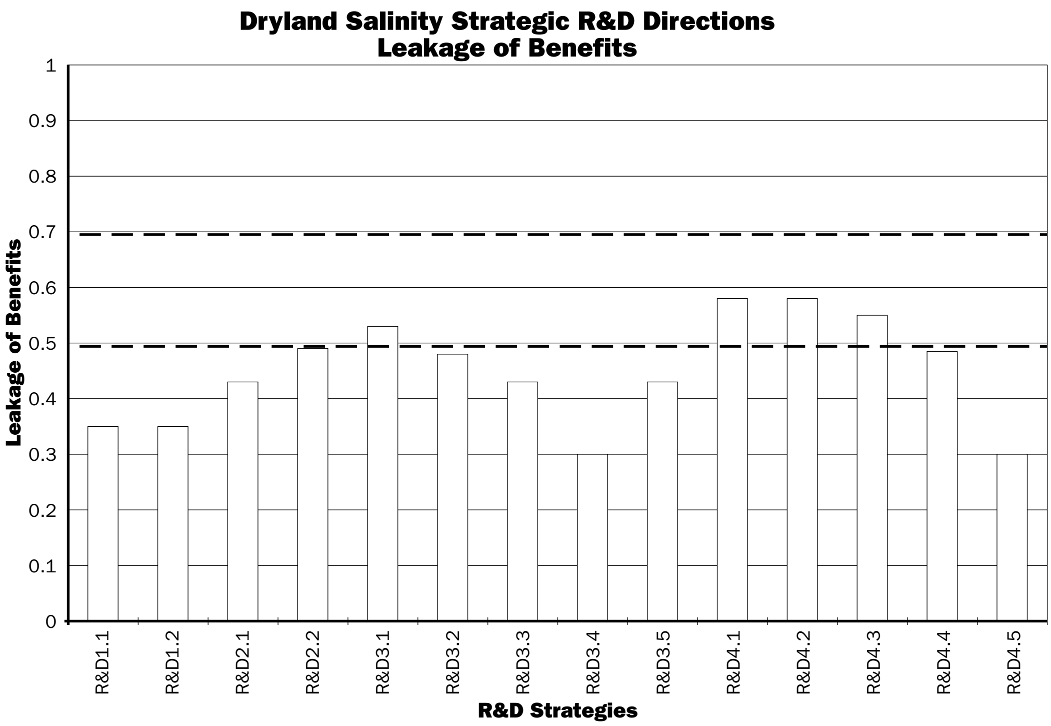
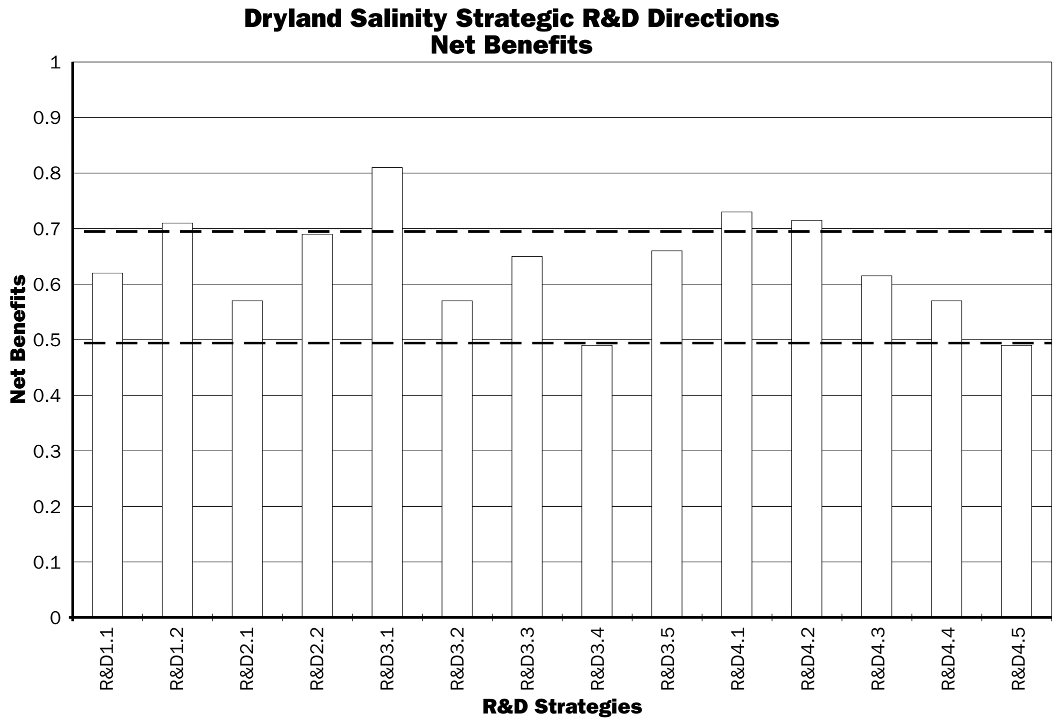


Figure 26
Net benefits of suggested strategic R&D directions



APPENDIX 6

Physical challenges: gaps in knowledge and gaps in technical solutions

Table 29
Social driving forces

Future Uncertainties	Physical challenges	Gaps in Knowledge	Gaps in Technical Solutions
• Quality of life (QOL)/ change in people's health status	• Condition of the land, water and environmental base. • Potential for wealth generation	• No QOL/health benchmarks • Potential value of production	• QOL/health monitoring program • Techniques to reach production potential
• Who pays for dryland salinity?	• Potential for rehabilitation costs to be beyond resources of landuser • combined action required	• True costs not known	• Accounting for impacts • Sustainable economic model
• Consistency of message required for action	• Agreeing on principles to combat dryland salinity	• Quantified impacts,—in different geoclimatic zones	• simple catchment monitoring program/ indicators
• Marketing of salinity impacts on the community to achieve buy-in	• Understanding community needs/ understanding/ motivation	• Quantifying community impacts.	• Accounting for impacts • Marketing techniques
• Community education programs improved response	• Understanding community needs/ understanding/ motivation	• Measuring present level of knowledge	• Type of education
• Short-term focus replaced by long-term outlook	• Landuser focus on survival on the land from year to year	• Number of landusers in a financial position to consider long-term options	• Convincing risk model to analyse short/long-term options.
• Access to a knowledge base—impact on salinity management	• Availability of a consolidated knowledge base	• Inconsistent/incomplete coverage of information base/impacts	• Agreed format and content
• Agreement on a socially acceptable level of salinity?	• Condition of the land base/awareness of current level of impact.	• No benchmarks	• Convincing risk model to analyse short/long impacts at various salinity levels
• Recognition as a national priority	• Awareness of environmental/ infrastructure damage.	• Extent and real cost of damage	• Convincing economic analysis
• 'Information awareness' effect on salinity management	• Availability and delivery of consolidated information resource/distribution network	• Present level of awareness	• Type of information required
• Required 'process' skill level of community groups.	• Landuser attitude to formal procedures/ coordinated action	• Present skill level	• Required skill level

Table 30
Economic driving forces

Future Uncertainties	Physical challenges	Gaps in Knowledge	Gaps in Technical Solutions
• ‘Triggers’ to liberate capital	• Financial status of landuser • Understanding real cost	• Landusers in a position to liberate capital • ‘Triggers’	• Convincing risk model to analyse short/long-term investment options.
• Information required to make informed investment decisions	• Landusers ability/ inclination to interpret information	• Key investment indicators • Input/output benchmarks	• Convincing risk model to analyse short/long-term investment options.
• Synergies from landusers working together	• Incentives/inclination for landusers to work together	• Evidence of improved outcomes	• Sustainable catchment model—process deterioration
• ‘Polluter pays’ leads to self-regulation	• Financial status of landuser acceptance of regulations	• Accounting for off-site impacts; to an individual landuser	• Ability to monitor salt input/output (farm models)for differing geoclimatic zones
• International production standards requiring landuser certification	• Number of landusers servicing international markets	• Cost of compliance versus non compliance	• Convincing risk model to analyse short/long-term investment options.
• Significance of non market costs	• Community knowledge of non-market costs	• Quantification of non market costs	• Convincing economic analysis
• Landusers value longer term benefits	• Landuser focus on survival on the land from year to year	• Evidence of long-term benefits	• Convincing risk model to analyse short/long-term benefits.
• Demonstration of due diligence on property transactions	• Landuser acceptance/ declaration of land liabilities	• Benchmarks on which to base a property ‘condition’ statement	• Affordable on-farm salinity assessment
• Market forces replace regulations re: salinity management plans	• Number of landusers/ financial status to respond to market forces	• Cost of compliance versus non compliance	• Convincing risk model to analyse short/long-term investment options.
• Tied funding arrangements—catchment management plans (CMPs)	• Landuser acceptance of whole of catchment approach	• Lack of consistent comparable information across catchments	• Sustainable catchment models; leading to identification of funding priorities.
• Effect of other forms of economic instruments (eg. recharge credits) on off-site impact	• Cost/feasibility of implementing an on-site monitoring program	• Estimated benefits/ impact; versus cost of implementation.	• Salt balance model at catchment level
• Cost effectiveness of collective, coordinated financing of works	• Landuser acceptance of community schemes	• Estimated benefits/impact	• Sustainable catchment models; leading to identification of funding priorities.
• Landuser awareness of $ benefits on dryland salinity management plans	• Number of landusers implementing plans/ financial status to have an impact	• Estimated benefits/impact	• Sustainable catchment models; property management plans (PMPs) leading to identification of priority activities
• Landusers pay for knowledge	• Value placed on knowledge given focus is on survival on the land from year to year	• Availability and accessibility of knowledge base applicable at the landuser level	• Sustainable catchment models; PMPs provide ‘new’ knowledge • real-time information
• Salinised land be managed to maximise its value,	• Landuser financial resources/cost feasibility.	• Availability of information on production potential	• Techniques to delineate production potential at the farm level through to region scale. • alternative crops
• New analysis tools that could bring socio-economic aspects into consideration	• Cost/feasibility of implementing at an appropriate resolution	• Socio-economic indicators; benchmarks	• Convincing Socio-economic models

Table 31
Political driving forces

Future Uncertainties	Physical challenges	Gaps in Knowledge	Gaps in Technical Solutions
• Operating environment to internalise salinity impacts.	• Opposition to legislative, regulatory controls	• Impacts not quantified to the property level	• Salt balance models at the property level. • Sustainable catchment models
• Regulations to meet changed landuse regimes of the twenty-first century?	• Cost/feasibility of implementing regulations • Achieving agreement	• Benchmarks • Performance indicators • Best practice (sustainable) landuse	• Sustainable catchment models; PMPs leading to identification of level of regulation required • Monitoring system
• Limit of individual responsibility for dryland salinity management	• Landuser financial resources/cost feasibility.	• Relationship between current landuse practices and salt output.	• Salt balance models at the property level. • Sustainable catchment models
• Change in industry structure to bring together benchmarking, self-regulation, quality assurance, marketing and R&D.	• Incentives/inclination/ cost for industry to implement integrated QA products	• Financial benefits of integration to industry and landuser	• Economic models to optimise industry structure to maximise industry profitability.
• Authorities empowered to implement coordinated catchment plans	• Landuser resistance to 'holistic' solutions.	• Quality and extent of catchment resource information to develop plans	• Salt balance models at the property level. • Sustainable catchment models • real-time information
• Management of multi-dimensional aspects of dryland salinity.	• Coordination of responsibilities across different portfolios/ industry sectors	• Fragmentation, and variability in quality and extent of multi-disciplinary information.	• Integrated socio-economic/environmental models.
• Change of focus (regulatory bodies/ institutions) from production to resource management	• Cost of sustainable development on cost of production. • Competitiveness of products	• Quality and extent of catchment resource information to support integrated resource management.	• Economic models to support sustainable production. • Sustainable catchment models
• Change in existing institutional frameworks to improve outcomes	• Recognition of salinity as a problem warranting a special institutional structure	• Performance indicators for poorly performing institutional frameworks. • Best practice defined.	• Systems in place for performance monitoring.
• One body competent to decide relative importance of impacts of dryland salinity.	• Political sensitivity of fair dealing across states.	• Quality and extent of information on impacts to make relative assessments.	• National systems in place for performance monitoring. • convincing economic model handling all forms of land degradation
• Government pressured to maintain viable rural communities	• Political sensitivity of withdrawal of government support	• Benchmarks for viable rural communities.	• Systems in place to monitor performance of communities • Integrated socio-economic/environmental models.
• Structure and location of organisation best equipped to manage dryland salinity.	• Political sensitivity of fair dealing across states. (govts. and landusers)	• Quality and extent of information on impacts. • Information not available in a consolidated form to one organisation.	• National systems in place for performance monitoring.

Table 32
Technology driving forces

Future Uncertainties	Physical challenges	Gaps in Knowledge	Gaps in Technical Solutions
• Affect of market quality criteria on production methods (ISO9000).	• Financial status of landuser to upgrade production methods	• Scope of change required to existing production methods. • Cost of upgrade	• Economic production models • Risk assessment models (financial/ environmental)
• Development of technology to minimise infrastructure damage.	• High cost of preventative treatment • Lack of incentive given long-term payback	• Extent of current infrastructure damage ($ costs) • Projections if left unchecked.	• National systems in place for performance monitoring. • Benchmarks to establish damage trends.
• Impact of real-time information on management practices.	• Access to real-time information • Cost of real-time information	• Scope of real-time information to achieve change. • Benefits/cost of real-time information	• Access infrastructure to deliver real-time information • Systems to analyse real-time information.
• Potential for knowledge to be delivered to all landusers	• Landuser skill level/ inclination to use knowledge resources. • Access to real-time information	• Consistent knowledge base	• knowledge engineering/ packaging
• Potential for technological innovation to breakdown barriers.	• Diversity of problems requires diverse range of technological innovation. • Costs	• Consensus on areas of innovation likely to have the greatest impact.	• open minds
• Potential for new landuse opportunities to change socio-economic status	• Land capability • Landuser financial resources • new industries	• Sustainability of new opportunities • Critical mass of landusers required to effect change	• Socio-economic models • Risk assessment models (financial/ environmental)
• Potential for increased technology uptake from information service established for landholders (collection, interpretation, feedback)	• Relevance/value of information • Landuser access to information • Volume of information	• Quality and extent of information coverage. • Consistency of site specific advice	• Sustainable catchment models • Economic models to support sustainable production. • Risk assessment models (financial/ environmental) • Systems in place for collating information and performance monitoring.
• Potential for improved user interfaces to 'solutions' to improve uptake of technology?	• Landuser access to interfaces • landuser skills to interpret	• solutions relevant to wide range geoclimatic situations	• User interface specifications • site specific solutions
• Potential for present technology to be used to address external impacts caused by on-site salinity problems	• Magnitude of the dryland salinity problem • Suitability of technologies	• External impacts not quantified • Relationships between on-site/off-site impacts need to be established	• National systems in place for performance monitoring. • Benchmarks to establish damage trends. • Sustainable catchment models
• Potential pay-off of technical research funding directed at 'blue sky' options .	• Landuser acceptance/ credibility of high risk schemes. • Conservative nature of investment partners • Long-term pay-off	• N/A	• N/A

Table 33
Biophysical driving forces

Future Uncertainties	Physical challenges	Gaps in Knowledge	Gaps in Technical Solutions
• Benefits of environmental restoration/increased biodiversity allow landusers to compete for additional funding support.	• Land capability • Critical mass of landusers involved to bring about change.	• Benchmarks of condition • Risk of further damage	• National systems in place for performance monitoring. • Benchmarks to establish damage trends. • Sustainable catchment models
• Incentives to meet land management targets set by COAG	• Land capability • Landuser resources • Level of incentive	• Appropriateness of targets • Appropriateness of incentives	• N/A

Dryland salinity issues paper

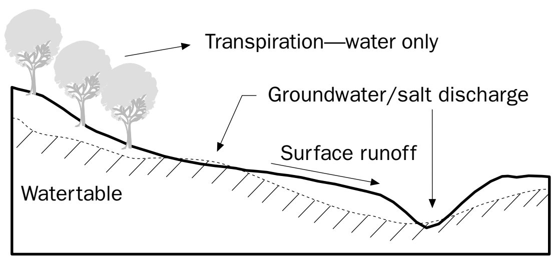
Principles

Salt is present in the atmosphere, soils, and ground and surface waters.

Atmospheric salt is constantly being deposited across the whole landscape, either as aerosol particles derived from the oceans or as saline dust particles from inland areas. In coastal areas this deposition may amount to as much as 250 kg/ha/annum whilst further inland it is probably in the order of 5–10 kg/ha/annum. The salt is either washed off the land surface into streams or is leached down the soil profile until it meets a groundwater system.

At the same time salt, previously stored deep in the soil profile, is being mobilised upwards through the root zone of crops by rising watertables. It is then discharged at the land surface where rainfall run-off carries it into adjacent drainage lines and streams or is discharged directly into streams as saline groundwater. (Figure 27).

Figure 27
Dryland salinity—salt discharge



Affected areas

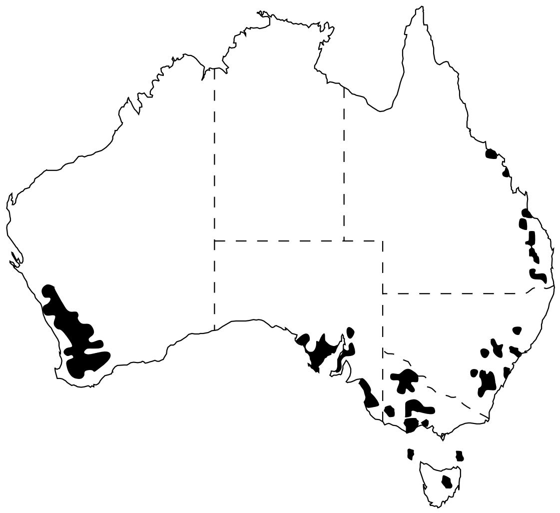
Secondary dryland salinity is a major threat to ecologically sustainable development (ESD) in many parts of Australia (Table 34, Figure 28). It is presently estimated that about 2.5 million ha of agricultural land is affected and that there is a potential for this to increase to 12 million ha in the future (Robertson 1996).

Table 34
Area of land reported to be affected by dryland salinity in Australia

State	Area salt-affected in 1996 (ha)	Potential salt-affected area at equilibrium (ha)*
WA	1,804,000	6,109,000
SA	402,000	600,000
VIC	120,000	Unknown
NSW	120,000	5,000,000
TAS	20,000	Unknown
QLD	10,000	74,000
NT	Minor	Unknown
Total	**2,476,000**	**>11,783,000**

*Revised by National Dryland Salinity R,D&E Program State Representatives (WA, 1996)

Figure 28
Areas affected by dryland salinity (derived from ABS 1992)



This area represents approximately 4.5% of presently cultivated land and is costing in the vicinity of $300 million annually in lost production (VCG,1997).

In Western Australia the existing 1.8 million ha of salt-affected farmland could easily double in the next 20 years or so, and then double again before an equilibrium state is reached. Of the State's divertible water resources 36% is brackish or saline and a further 16% is of marginal quality (Robertson,1996).

All principal agricultural districts in South Australia exhibit some degree of dryland salinity and at least 20% of the surface water resources are more saline than the recommended limits for human consumption (SA Dryland Salinity Comm.,1996).

The present estimates of dryland salinity in Victoria (Allan, 1994) may well increase substantially as more detailed mapping is continued. This should then provide a reliable baseline for monitoring future trends.

In New South Wales modelling by Bradd and Gates (1995) indicates that as much as 5 million ha could be affected in the future as groundwaters rise in areas underlain by Ordovician meta-sediments with yellow and red texture contrast soils. Other contributing factors are the degree of clearing of native vegetation in the upper parts of catchments, particular landforms and geological structures.

The Queensland estimate of 10,000 ha of salt affected land refers to severe salting.

The data in Table 34 may not be entirely consistent as there are different definitions of salt-affected land ranging between salt-encrusted scalds to land where the root-zone salinity is considered to have an effect on plant growth.

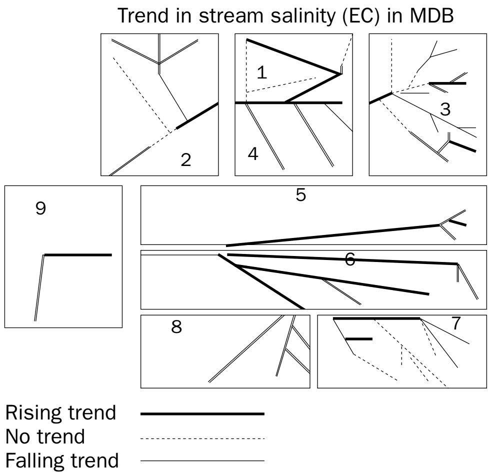
Stream salinity

Stage I of a study of stream salinity in the Murray–Darling Basin (Williamson et al, 1997) has demonstrated that there is a rising trend of salt concentrations in many streams—particularly in the southern half of the Drainage Division (Figure 29). However it is not possible to make generalisations about individual streams because salinity trends can vary within different segments of the one stream.

Stage II will attempt to quantify salt balances for each of the nine sub-basins and hence provide a more accurate description of the degree of equilibrium reached in each region.

Presently the Murray Drainage Basin exports three times the amount of salt that is input from the atmosphere whilst the Darling Basin is closer to a 1:1 ratio. The large imbalance between input and output of salt in the Basin is a direct reflection of increasing groundwater pressures in that area and the consequent increase in groundwater discharge to the soil surface and into streams eg. Allison and Schonfeldt (1989) predicted that clearing native vegetation for agricultural purposes in the Victorian riverine plains could result in an increase of 60 to 140 EC units in the River Murray at Morgan by the year 2012. Such an increase would be more than the total salinity mitigation targets for the Commonwealth/ State Salinity and Drainage Strategy commenced in 1987 and demonstrates the perhaps overly optimistic approach that was developed at that time (MDBC, 1993).

Figure 29
Trend in stream salinity (EC) for segments of rivers in the MDB



Sub-Basin 1	Condamine–Culgoa
Sub-Basin 2	Darling River
Sub-Basin 3	Northern Border Rivers
Sub-Basin 4	Castlereigh–Macquarie
Sub-Basin 5	Lachlan River
Sub-Basin 6	Murrumbidgee–Riverina
Sub-Basin 7	Goulburn–Upper Murray
Sub-Basin 8	Loddon–Campaspe
Sub-Basin 9	Lower Murray

Off-site effects

Off-site effects of salinity are usually encountered through water quality. Industries that may be affected include:

- Water and waste water (water supply and treatment)
- Information and education (dissemination of salinity information)
- Energy (coal mining, electricity generation)
- Communications (telephone cables)
- Supply infrastructure (gas pipelines)
- Science and technology (salinity research)
- Production economics (farm costs)
- Finance (banks)
- Infrastructure (Local Government)
- Housing (urban salinity)
- Transport (roads)
- Tourism (National Parks)
- Trade (marketing organisations)
- Government Planning (regional and economic development)
- Heavy industry (steel, aluminium, paper)
- Cultural (Aboriginal development)

Information concerning salt-related costs to many of these industries is sparse. This may in part be due to difficulties in attributing specific costs to salinity as compared to other water quality factors or simply to commercial-in-confidence issues.

Local government, public utilities and government agencies

An ABARE survey (Oliver et al, 1996) of the 177 local government councils in the MDB and 40 public utilities and government agencies during 1994/95 attempted to quantify costs associated with off-farm effects of dryland salinity. Councils and public works departments found it difficult to separate out the proportion of costs due to salinity as compared with 'normal' maintenance costs. There was however agreement that road and bridge damage was a major concern.

It is interesting that the amount of money spent on education, research, extension and policy development ($15.2 million) exceeded the $12.5 million spent on salinity related repairs and maintenance. The survey also indicated that South Australian public utilities and State Government agencies spent only $58,000 on salinity related repair and maintenance as compared with $3.4 million by NSW. It might well have been expected that since SA is on the receiving end of salt export from the MDB that its costs would have been much higher.

In a more detailed survey of the Loddon and Campaspe catchments of Victoria estimated expenditures due to salinity and high watertables were obtained for the year 1993/94 (Table 35, Whish-Wilson and Lubulwa, 1997). In this study Local Government salinity costs were higher than that for other public utilities.

Table 35
Costs attributable to salinity and high watertables in the Loddon and Campaspe

	Annual Cost $'000	Proportion %
Costs to Local Government		
Repair and maintenance		
Roads and bridges	1 231.8	29.2
Other	170.3	4.0
Capital works		
Roads and bridges	687.7	16.3
Other	173.4	4.1
Research, community education, extension	54.9	1.3
Subtotal	2 319.4	52.9
Costs to other Government and Public Utilities		
Repair and maintenance	36.0	0.9
Capital works	—	—
Reduced lifespan of infrastructures	450.1	10.7
Research, community education, extension		
Advisory roles	478.2	11.3
Processing grants	344.8	8.2
Other	595.8	14.1
Subtotal	1,904.9	45.1
TOTAL	**4,224.3**	**100.0**

In NSW (Douglas, 1997) estimates that within the south-western region of the State, road damage due to high watertables is costing about $9 million/year. It is thought that approximately 34% of State roads and 21% of national highways are affected in this way.

Urban household costs

The Campaspe Community Working Group (1992) identified a considerable number of areas where saline water and high watertables could impact on urban households. eg.

- damage to septic tanks:
- damage to hot water systems and other household appliances;
- increased use of soaps, detergents and water softeners;
- reduced life of clothing;
- damage to vehicle radiators;
- damage to buildings
- damage to water and gas supply pipes and fittings; and
- damage to gardens, lawns, pot plants, etc.

Despite these concerns the ABARE survey indicated that 85% of Loddon–Campaspe respondents perceived little or no damage.

Neither the AMDEL (1982) model approach ($/EC unit) nor the ABARE questionnaire (Lubulwa, 1997) provided entirely satisfactory analyses. This was due to a lack of historical salinity information and also to an inability, on the part of householders, to distinguish salinity effects from other water quality issues.

Similar potential costs due to salinity were identified in the City of Wagga Wagga (Christiansen, 1995). However in that area damage to buildings and infrastructure are readily visible and annual recurring costs (Table 36) are quite substantial.

Table 36
Annual recurring costs of salinity in Wagga Wagga

Item	Annual Costs ($)1994–95
Roads	226,000
Footpaths	4,400
Parks	103,400
Sewage pipes	29,600
Housing—severely affected	22,500
Housing—minor to moderate	50,000
Industrial	6,000
TOTAL	**$442,500**

Non-farm business costs

The types of businesses found in the Loddon–Campaspe catchments include:

- accommodation;
- construction;
- manufacturing/mining;
- nurseries;
- services;
- retail/wholesale; and
- recreational clubs (golf, bowls, racing).

The types of perceived salt and high watertable induced costs were much the same as with urban households.

Capital works and maintenance costs only amounted to $24.31 per business but since 50 of the 72 respondents registered little or no effect from salinity, the actual costs to affected businesses averaged three times that amount (Whish-Wilson and Shafron, 1997). Even that level of expenditure is relatively minor and probably reflects the relatively low proportion (2.4%) of the Loddon–Campaspe catchments that has salinised surface soils or high watertables.

Environmental costs

Van Hilst and Schuele (1997) in analysing the Loddon–Campaspe data point out that there are probably six main components of stream and wetland ecology:

- macrophytes and micro-algae;
- macroinvertebrates;
- riparian vegetation;
- amphibians and reptiles;
- fish; and
- waterbirds.

There is considerable interdependence amongst all these components and each has a particular sensitivity to salinity and waterlogging. In some instances it is not a matter of tolerance to a critical salt concentration so much as an ability to withstand sudden changes in salt concentration Hence mean stream salinities are not always a good guide to the overall ecological health of the system (Sherwood, 1989). Similarly, point source (sewerage treatment plants, irrigation, urban stormwater, aquaculture) and diffuse source (forest, pasture, crops) nutrient inputs may have very significant seasonal effects on aquatic organisms (Gutteridge, Haskins and Davey, 1992).

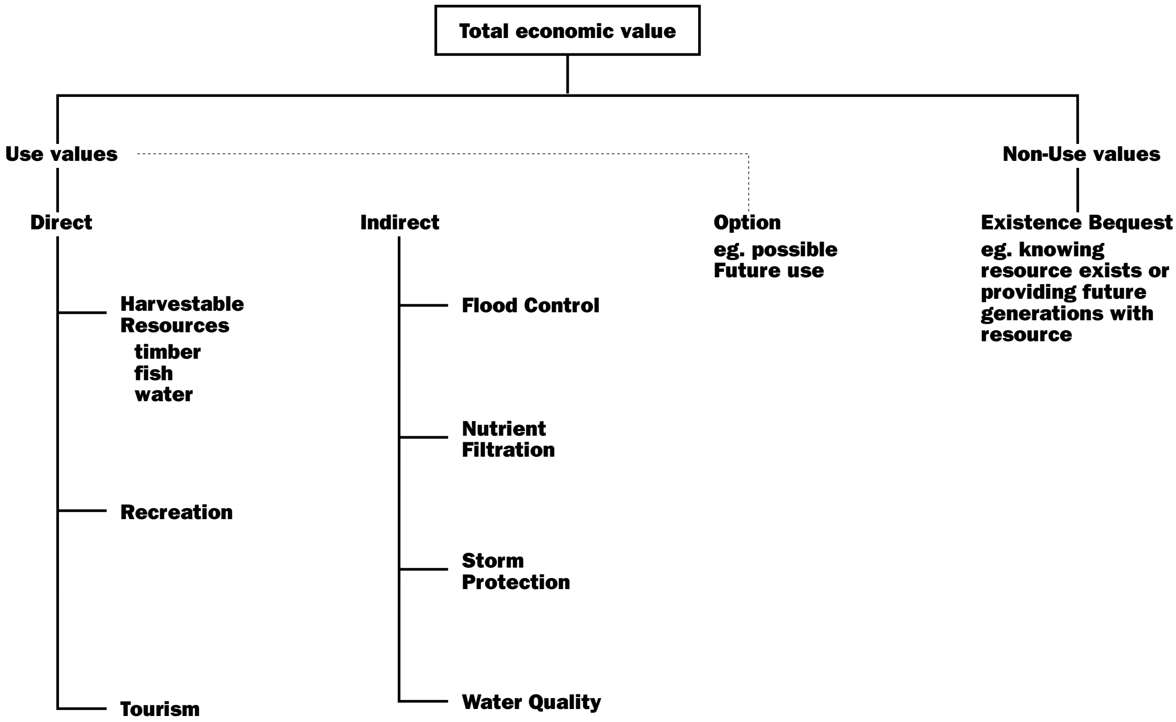
Van Hilst and Schuele (1997) also emphasised:

- The difficulty in separating the effects caused by salinity from those caused by concomitant factors; and
- that valuations are impeded due to the existence or non-existence of markets for particular environmental resources. They used the schemata of Treadwell et al (1995) (Figure 30), to demonstrate these points.

It is unlikely that perfect information can be obtained in many of these categories and hence the final costing will be a compromise between the cost of obtaining that information and making ‘reasonable estimates’.

Treadwell and Short (1997) have attempted to set out guidelines for valuing non-market values of dryland salinity. It would be fair to assume that although some ‘reasonable’ dollar estimates can be made, the real answer will always lie. in the degree of willingness within the community as a whole to accept particular dollar values.

Figure 30
Valuation of salinity impacts—use and non-use values (Treadwell et al (1995))



Agricultural costs

Agricultural costs are frequently expressed in terms of the value of lost production but a more fundamental concern is the cost of protecting land and surface waters from salinisation. There are simply no estimates available at this time as the issue of dryland salinity is inextricably connected to a number of other land management issues.

Robertson (1993) took a reasonably realistic view when he suggested that the nation was probably spending in the order of $100 million/ year on salinity and that there was very little to show for it. Although more optimistic a few years later Robertson (1996) did conclude that: *"Technology will not provide a solution to salinity that can be quickly implemented, and hence we will be faced with large areas of salt land that will have little or no commercial value, and will be environmentally detrimental"*.

Conclusions

It would seem that there is an urgent need to quantify actual salinity-related costs being incurred by Australian society as a whole if significant progress is to be made in halting and reversing present upward trends in the incidence of dryland salinity. Only when comprehensive estimates are available will the community be able to decide what costs it is prepared to bear and what level of ecologically sustainable landuse it will demand of landusers.

This particular foresighting project is designed to stimulate a wide range of industries to give thought to how *their* industry could approach possible future salinity-related problems. By sharing present information and possible future approaches perhaps significant gains can be made with respect to a looming salinity-induced problem within the agricultural industry.

References (to Appendix 7)

Allan, M. (1994) An assessment of dryland salinity in Victoria. Centre for Land Protection, Technical report No.14. 24pp.

Allison, G.B. and Schonfeldt, C.B. (1989) Sustainability of water resources in the Murray–Darling Basin. 12th invitation symposium: Murray–Darling Basin—a resource to be managed. Preprint No. 8: 149–161. Aust Acad Technological Sci. and Engineering.

AMDEL (1982) The effect of salinity on domestic consumers (version 3), Progress Report No.2, Stage II, Report to Engineering and Water Supply Dept, Adelaide.

AUSLIG (1992) in Australian Bureau of Statistics (1992) Australia's Environment: Issues and facts.

Bradd, J. and Gates, G. (1995) The progression from site investigations to GIS analysis to map dryland salinity hazard in NSW. NSW Department Land and Water Conservation—Hydrogeology Unit.

Campaspe Community Working Group (1992) Campaspe Catchment Salinity Management Plan, Victoria.

Chritiansen,G. (1995) An economic report on the costs of urban salinity in the city of Wagga Wagga. NSW Dept Conservation and Land Management, Economic Papers.

Douglas, P. (1997) Groundwater, salinity and roads—the RTA experience in New South Wales. Outlook 97, Canberra. 173–177.

Lubulwa, M. (1997) Loddon and Campaspe Catchments: Costs of salinity to urban households. ABARE report to MDBC, Canberra, July. 18pp.

Oliver, M., Wilson, S., Gomboso, J. and Muller, T. (1996) Costs of salinity to government agencies and public utilities in the Murray–Darling Basin. ABARE Research Report 96.2, Canberra. 83 pp

R,D&E Program. Report No. LWRRDC 1.2.Western Australia (1996) Salinity: a situation statement for Western Australia. Report to Minister for Primary Industry and Minister for the Environment. 37 pp.

Robertson, G.A. (1993) Salinity in Australia: a national perspective. National Conference 'Land Management for Dryland salinity Control', La Trobe University, Bendigo 28 Sept–1 Oct.

Robertson, G. (1996) Saline Land in Australia: Its extent and predicted trends. In, Productive use of saline lands. Albany, WA. 43–48.

SA Dryland Salinity Committee (1996) Dryland Salinity in South Australia. 24pp.

Sherwood, J.E. (1989) The effect of salinity on aquatic environments. South West Salinity Training Workshop, Victorian College of Agric. And Hort., Glen Ormiston Campus, May 11.

Treadwell, R., Short, C. and Rose, R. (1995) Nonmarket valuation of natural resources. North Australian Outlook Conference, Darwin, October 12.

Treadwell, R. and Short, C. (1997) Non-market valuation of dryland salinity: Guidelines for incorporating non-market values. ABARE, Canberra, April. 40pp.

Van Hilst, R. and Schuele, M. (1997) Loddon and Campaspe Catchments: Costs of salinity and high watertables to the environment. ABARE report to MDBC, Canberra. 26pp.

VCG Australia Pty Ltd (1997) First Draft of Final report: National Salinity

Whish-Wilson, P and Lubulwa, M. (1997) Salinity and high watertables in the Loddon and Campaspe Catchments: Costs to local councils, government agencies and public utilities. ABARE report to MDBC, Canberra. 34 pp.

Whish-Wilson, P. and Shafron, W. (1997) Loddon and Campaspe Catchments: Costs of salinity and high watertables to farms and other businesses. ABARE report to MDBC, Canberra, May. 29 pp.

Williamson,D.R., Gates,G.W.B., Robinson, G., Linke, G.K., Seker, M.P. and Evans, W.R. (1997) Salt Trends: Historic trend in salt concentration and salt load of stream flow in the Murray–Darling Drainage Division. MDBC Technical report No.1, 1997. 64 pp.

Seeding scenarios developed from the issues paper

Scenario 1—dryland salinity "much the same"

Areas affected by dryland salinity continue to *increase* at a rate of 5–10% per annum. Although new occurrences are recorded, on the whole it is a matter of existing salinised areas becoming larger and more continuous in the landscape. Despite more government funded action on the restoration of public lands *most farmers cannot afford* more than token action with respect to on-farm land degradation. Farm input costs are now 20% higher in real terms, compared to 20 years ago. They are *not aware of the true costs* of salinity to themselves or the community.

Farmers on marginal land struggle to make ends meet. The shakeout over the last 20 years has been dramatic, with an estimated 40% reduction in numbers nationally. Larger farming corporations comprising offshore investors realise easy gains over debt-ridden properties. Once thriving rural communities face extinction, as young people continue to leave the land in droves.

More rural *urban areas report damage* to local service infrastructure and buildings but *cost is absorbed* by increased Council rates, small business and individuals. Financial *assistance* from governments is *piecemeal* and *politically driven by the need for rescue missions in severely affected areas (still unable to be benchmarked for true comparison with other contenders).*

Major off-site *processing industries* are not severely affected by the costs of slowly deteriorating water quality and manage to *pass on increased costs* to the Australian community whilst maintaining competitive export prices.

Government spending on drainage systems to slow the rate of increase of groundwater rise continues to be directed at areas of high agricultural production (irrigation areas rather than dryland). *Capping* of water use for *irrigation* puts *more pressure on dryland* agricultural systems with consequent unabated deterioration of dryland asset. Political fallout from capping ensures that '*polluter pays*' principal for dryland agriculture is put on the backburner and is *replaced by* moral arguments of '*duty of care*'.

A gradual change of climate sees more drier years in the southern agricultural regions and the rate of rise of groundwater tables slows to the extent that farmers are deluded into thinking that their landuse systems are 'working'.

Science continues to tackle salinity in much the same manner as at present ie. competing for short-term investigations in a wide range of salinity-related topics. Emphasis on integrated research improves quality of overall output but communications with landusers remains poor. Industry is slow to react to the problem, remaining focused on short-term profits rather than long-term futures; believing that they can neither influence government nor landholders, nor solve the problem themselves.

Scenario 2—accelerated deterioration of dryland salinity

Areas affected by dryland salinity increase rapidly with many new areas reporting problems. Financial returns to landholders from remedial works on previously affected areas is poor, with consequent lost incentive for further investment. Hence *marked increase* in area of *sacrificial land.* This exacerbates rate of decline in water quality.

Socio-political *debate* rages over who is to *blame* for poor water quality and environmental degradation. Metropolitan-based 'green political parties' increase the pressure for *regulatory control* of landuse.

All urban and industrial users in Adelaide require on-site secondary water treatment for drinking water, as primary water treatment yields water of a quality suitable only for flushing toilets. Water is unsuitable for parks and gardens resulting in many lost botanical assets in metropolitan and country towns.

Governments devolve many *landuse responsibilities* to Catchment Management Committees in order to avoid the political odium of further regulation. The *CMCs* remain largely ineffectual except for educational functions. Compulsory competitive tendering has all but forced Local Government into unrecoverable debt as reticulation infrastructure lifecycles diminish as a result of increasingly saline soil and water. In many towns, parallel water reticulation systems have been installed to supply water for domestic use, a cost not foreseen or allowed for in accrual accounting practices established 20 years ago.

Gross *agricultural production decreases* as the *number of farmers decreases* by about 25%. Large multi-national conglomerates have cornered the market in many niche areas of Australian agricultural production. Australia is used as one of 50 'just in time' supply sites, competing in price and quality with countries around the globe. Vertical markets have been established in most lines of production and the 'Macdonald's Concept' is manifest. Farming franchises operate with standard equipment and use the same techniques as used at all production sites around the globe. Franchises produce to international quality and standards, customised for downstream processing plants. They are subject to 'load balancing' restrictions to avoid under or oversupply on world markets. McFarmers Corporation, however, becomes a good corporate citizen injecting previously unheard-of levels of R&D funding to ameliorate the damage caused by its universal farming practices. There is a marked increase in smaller holdings with specialty '*green' crop* management. These are dominantly part-time enterprises and off-farm income (often home based) supports land restoration activities.

Economists evolve a *costing procedure* that provides a *realistic* estimate of salinity costs to the economy, but still does *not provide an acceptable valuation* of many *environmental* components. This remains an emotive issue.

A massive *revegetation* program, implemented to gain *world greenhouse gas credits*, has beneficial side effects for land degradation. In particular, technological improvements provide *real-time information on groundwater trends*. This provides an effective measure of the ever-increasing dryland salinity problem and allows salinity catchment salt loads to be computed, including individual assessments which facilitate the introduction of a 'polluter pays' system

Urban sprawl and subsequent urban salinity increases with the most important aspect being the threat to *potable water* supplies and the ever increasing costs of *road infrastructure*.

Many processing industries have to install *desalinisation plants* to maintain product quality and/or equipment maintenance costs. These costs are passed on to consumers who still accept such price rises as part of the normal increases in the cost of living (CPI adjustments).

Given indisputable information concerning the salinity threat, the Federal Government introduces an *environment levy* to fund multi-billion dollar *drainage* systems as well as *energy research* programs directed at *desalinisation*. These projects have 10 to 20 year horizons.

There is now considerable emphasis on full eco-lifecycle energy systems. Combined wind and solar power generation stations serving many rural towns, pump saline groundwater into energy converters that generate electricity, returning purified water into the aquifer systems, gradually cleansing much of the surrounding area.

Giant saline ponds support new forms of aquaculture, particularly fibre rich kelp that is harvested 14 days after planting, and is in great demand on world markets.

Scenario 3—improved dryland salinity status

Climate change has become a reality with a vengeance. Widespread, *extended drought* periods through southern Australia has resulted in significant *lowering* of recharge and *groundwater pressures*. Severely salinised areas remain salinised but large areas of incipient discharge retreat. Smaller landholders are forced from the landscape, further easing the problem in marginal areas.

The drier conditions *exacerbate other forms of land and water degradation*, such as wind and water erosion, vegetation decline, algal blooms. There is a *demand* for genetically engineered *short duration crops* capable of exploiting the lower rainfall regime. Cropping extends into the wetter tablelands and hills areas with consequent new erosion cycles.

Water quantity rather than water quality becomes a dominant issue for rural towns and industry. Exploitation of groundwater for domestic requirements increases markedly, accompanied by *desalinisation* plants.

More and more reticulation systems are drought-proofed by interconnecting pipelines across river basins.

While pipelines to the sea now appear to be economically feasible, politics has stamped this as an impossibility. Discharge of saline waters to internal evaporative basins begins to exacerbate the groundwater recharge problem. Regional governments are slowly winning the war over national bureaucracy (one solution for all), which remains insensitive to local issues.

Environmental degradation continues unabated and the revegetation debate now centres around whether it is limiting necessary groundwater recharge.

Revegetation programs have increased the nations tree cover (greater than 2 metres) from 3% to 4.5% in 20 years although much of this has taken place in areas not affected by dryland salinity.

Groundwater recharge of aquifers for urban water supplies implemented where possible. *Reuse of grey water* for gardens, toilets etc is encouraged and shows the benefits of a successful national education program commenced over 20 years ago.

Road and supply infrastructure is cheaper now that groundwater levels have retreated; and local government now predicts the asset lifecycle to increase by 10 years over estimates a decade ago.

Governments encourage energy research targeted at large scale desalinisation. Overseas breakthroughs create new opportunities for Australian R&D to adapt technologies to local conditions.

Irrigated agriculture assumes even more importance in terms of gross agricultural production.

As Australian agricultural production stabilises on clean and green niche markets that equal or exceed world standards in quality and price, our future markets are guaranteed while we maintain this position. R&D continues to focus on improving our nations agricultural competitive strengths. Many of the value added products now on the market were not present in this country 20 years ago.

Dryland farmer numbers decrease and there is a swing towards a higher proportion of grazing enterprises, based on a surge in world demand for value-added products. River diversions in wetter northern areas are implemented in response to irrigation industry pressures. Broadscale micro-irrigation and subsurface irrigation are more widely implemented to improve irrigation efficiencies. Very high water-use agriculture, such as rice, contracts as water availability decreases.

New storage dams become essential for metropolitan water supplies despite environmental movement opposition. Talk of diverting water from the Ord River is back on the agenda in the light of high costs of new storage sites.

Home based education of landholders has reached new heights of sophistication. Farmers now require an accreditation license to operate and export. Farm finance is conditional on a salt mitigation master plan and the establishment of sophisticated monitoring infrastructure. Part of their new found skills involves on-line computer access to information. All primary producers are linked electronically to national brokers who handle sales and distribution to national and world markets.

APPENDIX 9

Workshop participants—dryland salinity foresighting process

Scenario development teams are listed below:

Technical solutions

Arthur Goode	BHP Integrated Steel, Whyalla, SA
Rob Fitzpatrick	CSIRO , South Australia
Mark Goldstone	Department of Main Roads, Perth ,WA
Kevin Goss	Agriculture, WA
Phil Dyson	Department Natural Resources and Environment, Victoria
Ray Evans	AGSO, Australian Capital Territory
Andrew Wooldridge	Conservation and Land Management, NSW
Adrian Webb	Webbnet Consulting, Queensland
Baden Williams	Consultant—Alexander Tomlinson and Associates

Institutional approach

Hugh Possingham	University of Adelaide, South Australia
Ann Hamblin	Soils Cooperative Research Centre, South Australia
Randy Stringer	University of Adelaide, South Australia
Jill Brooks	Natural Resources Council, South Australia
Peter Cullen	Freshwater Ecology, ANU, Australian Capital Territory
Richard Price	LWRRDC, Australian Capital Territory
John Fargher	Consultant , AACM International, South Australia
David Alexander	Consultant—Alexander Tomlinson and Associates

Market rules

Jeffrey Rae	Industry Commission, Victoria
Jim McColl	Environmental Consultant, South Australia
Ross Donald	Rural Adjustment and Finance Corp., Western Australia
Andrew Inglis	Grains Research and Development Corporation, ACT
Allan Newton	Department of Primary Industries and Energy, ACT
Harry Bonanno	CANEGROWERS, Queensland
Alex Campbell	Farmer, Chairman, LWRRDC Board, Western Australia
Ray Trewin	ANU/Consultant—Alexander Tomlinson and Associates

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Notes from opening address by Mr Alex Campbell, Chairman LWRRDC Board

DRYLAND SALINITY SCENARIO PLANNING WORKSHOP

12–14 JANUARY 1998

GLENELG, SOUTH AUSTRALIA

We are all aware of the issue of rising watertables.

In the past it has been regarded as a farm issue that one just had to live with.

Perhaps it has been regarded as the price that had to be paid due to the introduction of European-style farming methods.

But now there is an awareness that it operates at a regional or catchment scale and that it is becoming an issue of national concern.

We are also seeing that infrastructure is being severely impacted by rising watertables.

The National Dryland Salinity R,D&E Program has seen the collection of a lot of biophysical information relevant to rising watertables and dryland salinity and attempts have been made to determine the scale of the problem. However, even the 1996 estimates are incomplete and the predicted extent at equilibrium is not a situation that we would like to contemplate accepting.

Although there are small areas where remedial strategies are working we are not seeing the uptake of existing information at a scale that can result in a meaningful change throughout the country.

The question then is 'What institutional arrangements need to be put in place to ensure that meaningful change does take place?'.

Foresighting (looking to the future or scoping new horizons) is a process that may be able to help us. It is about looking to where we are going in the future rather than looking backwards at where we have been.

We need to set some goals to aim for rather than follow a predetermined path. We need to be able to harness and implement our present information in order to satisfy the growing public concern.

Hence the task in hand for this diverse group is to challenge each other as to where we are going and to not hold back on imagining alternative futures.

APPENDIX 10

Proposed reference group for review of issues papers

DRYLAND SALINITY NATIONAL FORESIGHTING PROJECT

Western Australia	South Australia	Victoria	New South Wales	Queensland	Tasmania	National Perspective
State Salinity Working Group	**State Dryland Salinity Committee**	**Catchment & Land Protection Boards**	**Salt Action Task Force**	**Nat. Resources**	*Primary Indust.*	*LWRRDC*
Agriculture (WA)	*Primary Indust.*	*Goulb. —Murray*	**Land & Water Con.**	Ian Gordon	Ian Bell	Richard Price
Mr David Bicknell	Peter Bulman	Bill O'Kane	Lawrie Kirk	Roger Shaw		*CSIRO*
Dr Richard George	Phil Cole	*Nth Central*	Hans Schroo	Don Begbie		Joe Walker
Dr Don McFarlane	Chris Henschke	Jan Boynton*	George Gates	Graham Kingston		John Williams
Dr Bob Nulson	*Mines & Energy*	*Mallee*	Franz Carf			*AGSO*
Mr Michael Rowe	Steve Barnett	Jerry Leech*	*CALM*			John Williams
CALM	*Univ of Adelaide*	*Wimmera*	Greg Bugden			*NDSP*
Mr John Bartle	Bill Bellotti	John Young*				Adrian Webb
Mr Ken Wallace	David Chittleborough	*Glenelg*				
Env Protection	*CSIRO L & W*	Colin Dunkley*				
Mr John Sutton	Rob Fitzpatrick	*Corangamite*				
Waters & Rivers	*Env. & Nat. Res.*	Don Forsyth*				
Mr Ian Loh	Brenton Grear	*DNRE*				
Mr Geoff Mauger		Phil Dyson				
Murdoch Univ.		Peter Sutherland				
Dr Sue Moore		Megan Allen				
Univ. WA		Sarah Hill				
Mr Bob Gilkes		Jim Sisson (Mallee)				
CSIRO		Bill Trewella (G-M)				
Dr Norm Campbell		(*CEO CaLP's)				

References

AACM International, (1998). National Dryland Salinity R,D&E Program Phase II Options Paper

ABS (1992). *Australia's Environment.* ABS Catalogue No. 4140.0, Canberra.

Alexander Tomlinson Associates, (1997). Dryland Salinity Issues Paper. (Discussion Paper prepared to support the National Dryland Salinity Foresighting Workshop, 12–13 January 1998)

Alexander Tomlinson Associates, (1998). R,D&E Questionnaire prepared to support the National Dryland Salinity Foresighting Project, March 1998)

Campbell, A. (1998). Scenario Planning Workshop Opening Address, Adelaide, January 1998. (Appendix 9 this report)

CIE, (1997). Using Foresighting to Identify R&D Priorities for LWRRDC. Occasional Paper No. 10/97. Centre for International Economics; in conjunction with CSIRO.

Hayes, G. (1997). *An assessment of the National Dryland Salinity R,D&E Program,* LWRRDC Occasional Paper No. 16/97, Land and Water Resources R&D Corporation, Canberra.

OECD, (1996). STI Review: Special issue on Government Technology Foresight Exercises. No.17, OECD Publications, Paris.

Martin, B.R., and Irvine, J. (1989). Research Foresight: Priority Setting in Science, Pinter Publications, London.

MDBC (1993). *Dryland salinity management in the Murray–Darling Basin,* prepared for MDB Ministerial Council by the Dryland Salinity Management Working Group, Canberra.

Robertson, G. (1996). 'Saline Land in Australia: its extent and predicted trends' in *Productive Use of Saline Lands.* Albany 1996, p43–48.

Schwartz, P. (1991). *The Art of the Along View.* Doubleday Currency

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