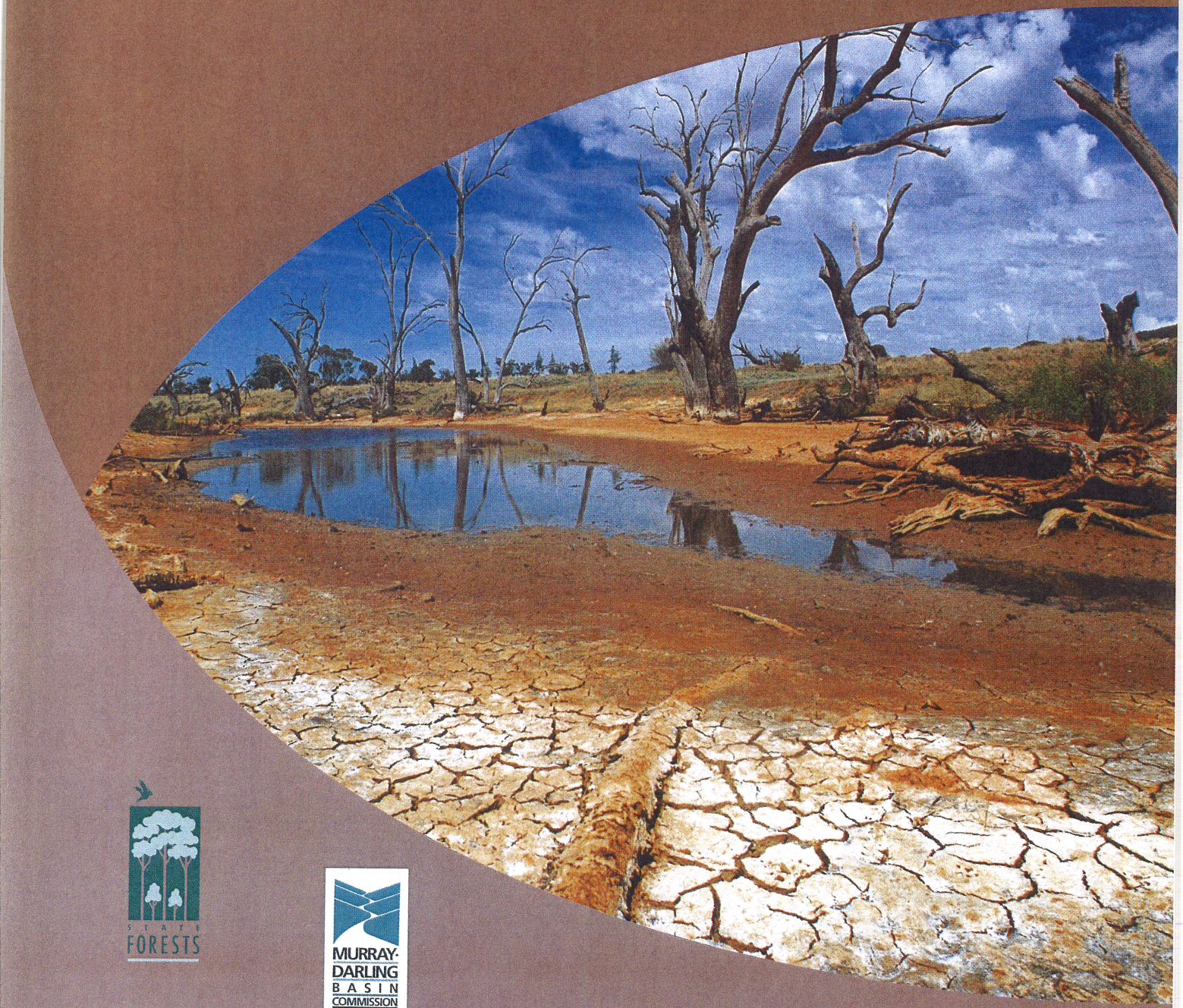
A Strategic Framework for

SALINITY RESEARCH & DEVELOPMENT IN NSW



STATE FORESTS

MURRAY-DARLING BASIN COMMISSION

CSIRO

NSW Agriculture

SALINITY RESEARCH AND DEVELOPMENT COORDINATING COMMITTEE

A Strategic Framework for

SALINITY RESEARCH & DEVELOPMENT IN NSW

Salinity Research and Development
Coordinating Committee

FOREWORD

The spread of salinity threatens farms, wetlands, rivers, irrigation areas, catchments, and public infrastructure, in both rural and urban areas of NSW. Solving the problem is a shared responsibility involving land managers, scientists, communities, business and governments.

Following a Salinity Summit in 2000, the NSW Government announced a NSW Salinity Strategy that outlined key policy directions and actions to manage salinity. A major action of the NSW Strategy was the establishment of a Salinity Research and Development Coordinating Committee (SRDCC) to provide advice on research and development.

The SRDCC comprises research leaders from NSW Agriculture, the Department of Land and Water Conservation, State Forests of NSW, the NSW National Parks and Wildlife Service, CSIRO, the Murray-Darling Basin Commission, the Bureau of Rural Sciences, and the Department of Agriculture, Fisheries and Forestry, Australia.

The SRDCC recognises that a number of State and Commonwealth agencies and institutions and some rural industry research corporations are involved in salinity-related research. However, it believes the level of investment in salinity research has been low, considering the importance of the problem. There is a need to increase investment and collaboration in salinity research to develop solutions to the problem and to ensure that those solutions are effectively implemented.

The SRDCC has developed this framework to aid decision-making on salinity research and development priorities. The framework identifies the key knowledge questions that need to be answered for effective salinity management in NSW and criteria that could be used to evaluate the potential for research proposals to answer those research questions.

The framework seeks to inform R&D providers, purchasers and advisers such as Catchment Management Boards, R&D corporations, government agencies, universities, research institutions and industry organisations.

Dr Mike Curll PSM
Chair
Salinity Research and Development Coordinating Committee

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1 Executive Summary

A major action of the NSW Salinity Strategy was the establishment of a Salinity Research and Development Coordinating Committee (SRDCC) to coordinate and provide advice on salinity research and development.

The SRDCC has developed a framework to aid decision-making on salinity research and development (R&D) priorities. Linked to that framework is an inventory of existing research on key issues of salinity management with application to NSW. The framework seeks to inform R&D providers, purchasers and advisers such as Catchment Management Boards, R&D corporations, universities, research institutions, government agencies, and industry organisations.

KEY KNOWLEDGE QUESTIONS

The framework identifies the key knowledge questions that need to be answered for effective salinity management in NSW and criteria that could be used to evaluate the potential for research proposals to answer those research questions.

These questions include:

1. What research is needed for effective decision-making to deliver state, regional, industry and farm level outcomes?

At a state level, this will require determining the net benefits, trade-offs and equity of large-scale land use change in terms of environmental, social and economic outcomes; and providing a scientific basis for salinity trading schemes and other market based approaches that may attract private and public capital. At a regional level, methodologies for prioritising investment and assessing risk to ecological values, water quality and infrastructure are needed, as is a predictive capacity for assessing the impact of land-based actions on river salinity, and a capacity to assess the regional economic benefits of land use change, and consequent requirements for social adjustment assistance. At an industry level, knowledge of incentives options and accounting models for salinity trading are needed. At the landholder scale, there needs to be a capacity to link on-site amelioration actions with profitability objectives and long-term protection of the land and water resource.

2. What catchment processes must be managed to prevent dryland salinisation and its expression in land and river salinity?

This will require R&D to determine the nature of groundwater flow regimes underlying catchments and subcatchments, and the time for land use change to impact on those groundwater regimes. Better understanding of the relationship between vegetation type, land use and water use on run-off and deep drainage, at a whole-of-catchment scale, will assist in the development of new land assessment tools necessary for effective decision-making. Similarly, improved understanding is needed about the relationship between catchment groundwater and surface water flows, their joint response to land use change, and the beneficial and detrimental impacts of that land use change on water quality and environmental flows. R&D is also needed to improve prediction of salt loads and river salinity levels and facilitate setting and achievement of catchment targets.

3. What are the impacts of salinity on ecological communities, species and ecosystem processes and functions?

To redress the impacts of salinity on ecosystems, research is needed to identify those geographical areas, ecological communities and threatened species most at risk from salinity in NSW. Improved knowledge is needed about the effect of salinisation on terrestrial ecosystem processes and the functions of ecological communities, the effect of point source salt entry to waterways, floodplains and aquatic communities, the impact of salinity management options affecting natural water regimes on the biota and function of natural freshwater and groundwater ecosystems, and the cumulative impacts of salinity and other ecosystem stressors (such as alteration of water regimes, invasive species, and land degrading practices).

4. What are the management options for preventing, controlling or living with salinity?

Research and development is needed to assist in designing and testing viable land use systems that have similar recharge to natural systems. This will require knowledge of the water balance of individual land use options, a capacity for predictive modelling of the hydrological and productivity impacts of land use change options, and knowledge that enables the matching of specific plant water use to catchment hydrology and function. Information is needed on the seasonal contributions to groundwater, whole-catchment hydrology and interactions in time and space between compatible and non-compatible land uses.

Research and development is needed to better identify land use systems suited to saline land or with the capacity to remediate saline land across the range of affected environments of NSW. This will involve investigations of the nature of salt tolerance of different species and their response in different situations, and determining options for integrating saline and non-saline land management.

Research and development is needed to identify strategies and tools to ameliorate impacts on ecosystems in NSW landscapes. This should include assessment of vegetation structures, hydrological manipulation, and saline discharge management options for a range of ecosystem processes and ecosystem types.

Research and development of new technologies or innovations for the prevention or management of salinity is needed. This should include specification of the potential product or enterprise, identification of market–product opportunities, development requirements to create productive and economically competitive enterprises with high product quality and processing efficiencies, and the compatibility of the new product enterprise with existing enterprises or operations.

5. What economic information is needed for effective salinity policy, decision-making and land use change?

Effective decision-making requires research to assess and quantify the impacts of policy options and landscape redesign on achieving and balancing environmental, social and economic objectives for salinity management. Research and development is needed to determine the economic potential of new plant-based solutions to stream and soil salinity, and of production systems (agricultural and non-agricultural) that utilise salt lands and/or saline groundwater. Knowledge of the market potential of new salinity products and industries is needed to evaluate their potential as effective innovations.

6. What are the social impacts and drivers for effective salinity policy, decision-making, and land use change?

Social research is needed to profile rural and urban stakeholders and the context of their decision-making, their knowledge of salinity, and their motivation, behaviour and attitude to risk. Knowledge is needed about the drivers for decision-making by landholders, the influence of external and institutional factors on decision-making, and the social impediments and positive triggers to changing community and landholder responses to salinity. There is need for impact studies of salinity and salinity management on the cultural and heritage values of communities and on the wellbeing of rural and urban communities generally.

7. What research is needed to monitor and evaluate the effectiveness of salinity strategies and actions?

Research and development is needed to develop tools and facilitate monitoring programs that determine the extent of implementation of salinity management actions, the reasons for incomplete implementation, the effectiveness of actions in meeting objectives and key performance indicators, the accuracy of conceptual models that predict catchment behaviour, and triggers for adaptive management decision-making.

8. What actions are needed to translate the results of salinity research and development into effective action?

The specific information needs of the different users of R&D results must be identified, the transportability and reliability of R&D results determined for each user, and the likely outcomes and success of information transfer estimated.

EVALUATING RESEARCH AND DEVELOPMENT PROPOSALS

There are a number of generic criteria that can be used by R&D purchasers and advisers to evaluate the potential for R&D proposals to answer the key knowledge questions and assess risks with delivering those answers.

- Identify the potential impact of research results, in reducing watertable recharge and stream salt loads, change to stream flows, and contributions to biodiversity, social, economic and policy objectives;
- Identify prospects for alternate land uses, new commodities and industry development;
- Describe financial and non-financial costs and benefits of the proposal, on-farm and off-farm;
- Identify size and significance of the applicable geographic area;
- Estimate the likelihood, extent and timing of adopting the management options developed;
- Assist in delivering existing complementary strategies and R&D initiatives;
- Consider triple bottom line issues and their acceptability to the catchment community;
- Describe the way R&D will be transferred to users;
- Be of high scientific quality;
- Demonstrate the capacity of the research provider to undertake the R&D.

Criteria specific to particular knowledge questions are also listed under each section.

FUTURE ACTIONS AND RECOMMENDATIONS

The SRDCC, through the development of the framework and its inventory of R&D projects, will pursue the following actions and recommendations:

1. The key salinity R&D questions identified in the strategic framework should define the scope of new salinity R&D proposals, and the generic and specific evaluation criteria should be used to assess their priority.
2. The strategic framework will be used by the Steering Committee responsible for facilitating implementation of the Commonwealth/ NSW Bilateral Agreement on the National Action Plan for Salinity and Water Quality (NAPSWQ) to assist decisions on joint investment strategies for regional and state-wide R&D activities.
3. The strategic framework will be used by the NSW Salinity Strategy Senior Officers Group to assist implementation of the NSW Salinity Strategy.
4. The SRDCC has provided the strategic framework and register of salinity projects to all government agencies and other non-government bodies for their information and use. The SRDCC recommends their use in determining the R&D elements of investment strategies being developed by regional natural resource management committees such as Catchment Management Boards, as well as with investment strategies being developed for state-wide and cross-regional salinity R&D.
5. NSW agencies participating in collaborative salinity R&D programs should ensure R&D projects address areas identified as priorities for NSW.
6. The SRDCC will review the implementation of this framework policy, and make appropriate further recommendations to the NSW Salinity Strategy Senior Officers Implementation Group, to the Commonwealth/NSW Steering Committee for the NAPSWQ Bilateral Agreement, and to the Minister for Agriculture and the Minister for Land and Water Conservation.
7. R&D purchasers and providers should direct additional salinity R&D resources towards those areas identified as high priority which are not currently under active investigation.

NSW agencies participating in collaborative salinity R&D programs should ensure R&D projects address areas identified as priorities for NSW.

2 Introduction

The Salinity Research and Development Coordinating Committee (SRDCC) was established to provide advice on salinity research and development (R&D) with application to NSW.

After undertaking an inventory of existing research on key issues of salinity management, the SRDCC has developed a framework to aid decision-making on salinity research and development priorities.

The framework identifies the key knowledge questions that need to be answered for effective salinity management in NSW and criteria that could be used to evaluate the potential for research proposals to answer those research questions.

The framework seeks to inform R&D providers, purchasers and advisers such as Catchment Management Boards, R&D corporations, universities, government agencies, and industry organisations.

Integrated solutions from salinity R&D

The best mix of options to manage salinity will vary in time and space. That is, the best options may be different for different catchments, subcatchments, farms, towns and communities, and the mix of options may change with changes in the biophysical and socio-economic status of the catchment, subcatchment, farm or town. Figure 1 seeks to outline the interaction between the mix of salinity management options, their impact on the ecological, land use and socio-economic status of catchments, and their contribution to decision-making and catchment management plans and salinity management actions.

Research directed at answering questions or adding knowledge on salinity should recognise the dynamic nature of the circumstances it seeks to address and provide for integrated solutions.

Similarly, management plans and their implementation actions flowing from salinity research must fit the environmental, social and economic circumstances and aspirations of affected communities.

The successful management of salinity will require policy and resource use options that integrate new with existing technologies, provide for integration and trade-offs between land uses and between land users within and across catchments, and at the same time help achieve related natural resource outcomes.

Decision-makers are seeking knowledge that is specific to their circumstances so that they can make informed choices on either reversing salinity, limiting its rate of spread and impact, or letting it take its course. Those decision-makers will include non-specialists whose needs include tools to identify the impacts and risks of current and future land and water management options for their particular circumstances.

It is important that R&D effort in NSW identifies common objectives between R&D providers in order to exploit potential synergies. Utilising the combined financial and technical resources of funders and providers will be more effective in the development of solutions than organisations individually attempting to meet the capital and technical investment needs of salinity R&D.

Delivery of R&D

The NSW Salinity Strategy, the National Action Plan for Salinity and Water Quality (NAPSWQ), and the Murray-Darling Basin Ministerial Council's Basin Salinity Management Strategy provide strategic direction in managing salinity. They all emphasise the need for knowledge generation to provide solutions.

Several R&D investment model options could operate for salinity in NSW, including the purchaser–provider model used by R&D corporations. The SRDCC framework document seeks to provide guidance primarily to research purchasers, though it can also advise research providers in strategic positioning of their services.

The range of national R&D purchaser and R&D brokering arrangements for salinity include Land and Water Australia's National Dryland Salinity Program (NDSP), the Meat and Livestock Australia/Grains Research and Development Corporation/Australian Wool Innovation's Sustainable Grain and Grazing Systems initiative, and the Australian Wool Innovation/Land and Water Australia's Grazing on Saline Lands initiative. Public funds used to purchase R&D in NSW are provided from the NSW Salinity Strategy budget, the National Action Plan for Salinity and Water Quality (as determined in its Bilateral Agreement between NSW and the Commonwealth), and state government agency operational budgets.

Salinity R&D providers in NSW include Cooperative Research Centres (particularly the CRC for Plant-Based Management of Dryland Salinity), state government agencies, CSIRO, universities and private sector institutions.

Purchaser–provider arrangements for delivering salinity R&D services in NSW may be relatively straightforward for the R&D corporation consortium initiatives mentioned above. That is, the priorities identified by the consortia will be developed into R&D program specifications that could be either competitively tendered for, or directly commissioned, by or from R&D providers.

With the NAPSWQ, and the NSW Salinity Strategy, purchaser arrangements are more diverse. For example, community-based Catchment Management Boards have a responsibility for identifying and advising on their salinity R&D needs to deliver on their catchment blueprints. But state government agencies have a responsibility to identify state-wide R&D needs and synergistic opportunities between catchments and regions, and between research providers, to deliver on salinity targets and outcomes.

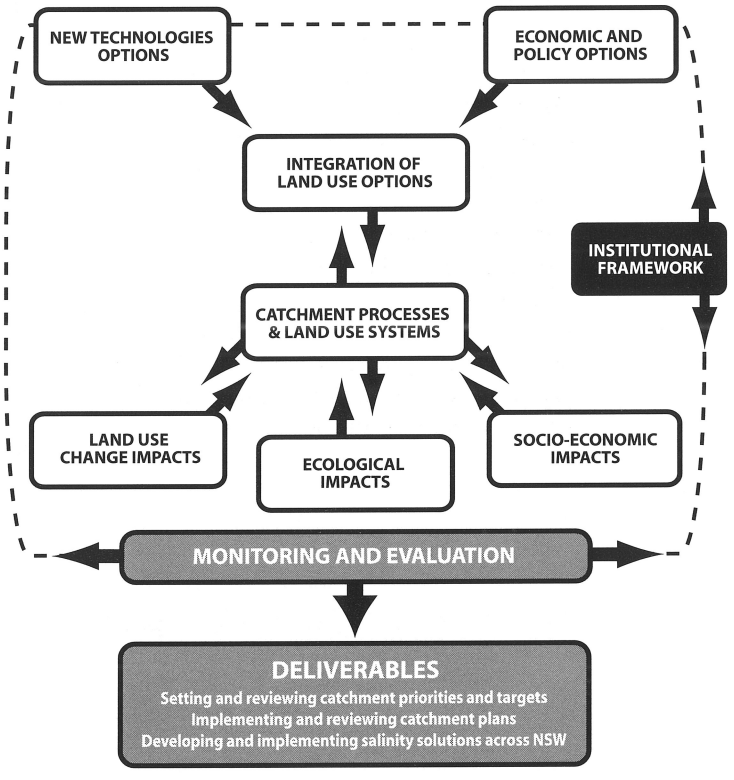
Monitoring the outcomes of R&D

An essential component of R&D investment is accountability in the delivery of agreed objectives and communication of research results. Purchasers may reasonably expect providers to specify auditing, monitoring, and evaluation arrangements to help ensure their investment.

Technologies and methods of monitoring both R&D and on-ground actions are frequently overlooked in the R&D process. Given the importance of this area to the broad range of groups funding salinity R&D, it is important that all salinity projects consider how their results and effectiveness can be monitored and subsequently evaluated. These issues are considered in the following sections.

It is also important that priority is given to developing monitoring and evaluation technologies that can be used by catchment managers and landholders. To this end, section 9 considers how monitoring and evaluation strategies might be improved by further R&D, and which land and water properties can be monitored, and how, in order to determine the effectiveness of salinity strategies.

FIGURE 1: STRATEGIC FRAMEWORK FOR SALINITY R&D



3 Decision-making and Institutional Framework

Salinity presents a particular challenge to R&D because, given the current state of technology, its amelioration and management cannot be achieved by decisions based solely on the performance of the farm business judged by its financial performance.

Salinity presents a particular challenge to R&D because, given the current state of technology, its amelioration and management cannot be achieved by decisions based solely on the performance of the farm business judged by its financial performance. Salinity affects biodiversity, regional and urban infrastructure, water resources and agricultural land. The 'economic signals' for land protection are weak. The cause–effect relationship for salinity actions and measurable outcomes is quite uncertain. Increasing the area of perennial plants to better mimic the minimal groundwater recharge under native vegetation may reduce current surface water flows and security of water supplies. In any case, there are currently few land use options that are sufficiently well understood that can deliver dual outcomes of on-farm profitability and catchment-scale recharge control.

Yet salinity remains a major threat to environmental values and productive assets, and requires effective public policy. Drawing upon at least 25 years of experience with national, Murray-Darling Basin, State and regional policies and strategies, it is recommended that salinity R&D focuses on the following four levels of planning, decision-making and actions:

- State and Murray-Darling Basin, where public policy issues dominate;
- Regions and tributary catchments, where integration across natural resource issues is best handled;
- Industries, where 'collective self-interest' may be a stronger incentive to change;
- Farms and other landholders, where much of the adoption will have to occur.

The key questions for research, below, focus on the 'higher order' institutions and their decision-making. Subsequent sections of this document focus at the landholder level.

Key questions

STATE AND BASIN SCALE

The public policy questions are dominated by targeting of government investment in salinity management that maximises net benefits (including non-market values), optimises trade-offs (e.g. water resource security), attracts private capital (e.g. reforestation) and delivers equity (e.g. catchments meeting shared river outcomes). A current priority is the development and trialing of market-based instruments (e.g. Environmental Services Investment Fund and Environmental Management Systems).

Key questions include:

- What are the net benefits, trade-offs and equity issues from proposed large-scale land use change? Widespread adoption of salinity management options, ranging from engineering works to revegetation, depend on the proposed enterprises being sufficiently profitable (both commercial profits and/or 'credit' profits) to displace current enterprises. Where such options do not exit, R&D on their development is critical. The options available need to be assessed and compared for impacts on environmental, economic and social values over time.
- What is a basis for producing and trading in salinity credits? A 'cap and trade' approach has been advocated based on tradeable pollution entitlement schemes successful elsewhere. However, salinity is a diffuse source problem and only two salinity credit schemes – River Murray and Hunter River – have been attempted in Australia with some success.
- What is the policy for attracting private capital? There is synergy between reforestation for salinity control, carbon sequestration and other ecological services. Research is needed to evaluate and demonstrate the prospects for salinity management of private international and national investment directed at other 'green' investments.
- What is the policy for protecting water resource security? Current research indicates that the trade-off between salinity control and surface water security varies according to catchment characteristics. As well, land use changes (e.g. plantation forestry) can impact on water resources outside the salinity 'target zone'. In these situations, are options for water resource protection limited to land use planning regulation or the purchase of water rights?

REGIONAL CATCHMENTS

All areas in NSW where salinity is a threat are under the planning arrangements of Catchment Management Boards. From their perspective, the challenge is to interpret the NSW Salinity Strategy and apply it within their catchment plans, including the setting of river salinity and land management targets. Regions vary in the values and assets at risk from salinity, in the other natural resource issues they face, and in the potential for investment attraction. It is at a regional and sub-regional scale that new industries can be facilitated and social impacts managed. Catchment Management Boards will demand R&D focussed on their needs. Natural resource management agencies will need to facilitate R&D integration across catchments.

Key R&D questions include:

- How are ecological values relative to water quality and infrastructure assets assessed? Given that these do not give signals for individual landholder action and, in any case, that scarce public and community resources cannot protect all values, Catchment Management Boards require robust methodologies for prioritising investment and assessing risk.
- Is there adequate predictive capacity for impact of land-based actions on river salinity? The inland Catchment Management Boards are committed to meeting river salinity targets in 2010. To prioritise actions and measure progress, they require decision support services.
- What are the regional economic benefits of recommended land use changes? What is the policy for attracting industries associated with these land use changes? Reforestation for salinity control, in particular, will attract private capital and leverage public investment only if there is industry potential. This may be assessed in terms of enterprise profitability, employment and other multipliers, and market penetration.
- What is the policy for social adjustment to best cope with land use change, new industries and market behaviour? We know that regions vary demographically, with some farming zones dominated by under-performing enterprises and little farm turnover. Reforestation and land retirement have significant social impacts, and challenge rural community values. Investment in new opportunities for providing ecological services is for larger investors. These raise important questions for direct assistance to social adjustment.

INDUSTRIES

Existing and new industries will have a 'self-interest' in demonstrating to their markets and to the Australian community that they are managing their environmental 'footprint'. Industries attracted by the prospect of producing and selling salinity credits will require confidence that they hold their value. Typically they 'badge' their products and commit to audit/accreditation schemes to do this.

Hence, key questions for 'institutional' R&D are how to:

- encourage industry audit/accreditation programs
- provide an accurate accounting model for trading credits
- manage possible change in the value of salinity credits and debits consequent to improvement in knowledge

Other R&D questions, such as development of new technologies, are dealt with in subsequent sections of this document.

FARMS

For widespread adoption of salinity 'control options' by landholders to occur, factors such as profitability, compatibility with existing enterprises and operations, risk, and capacity to capture benefits come into play. Specifically, farmers and urban landholders require the capacity to link actions with on-site and off-site amelioration of the salinity threat, if they are not to compromise their short-term profitability objectives with pursuit of long-term protection of their land.

This raises the key R&D questions, how to:

- evaluate the on-site and off-site salinity responses of current and changed practices
- evaluate the risks (and cost, benefits, consequences) of changing and of not changing practices

Other R&D questions for individual landholders, such as designing viable farming systems, are dealt with in later sections.

Criteria to evaluate R&D proposals

Given that the R&D questions are focused on institutional issues, for which public policy is an important factor, the criteria should accommodate government and community interests. Also, there needs to be confidence that the research addresses regional, catchment and industry interests.

Consequently, the criteria with particular application to these R&D questions (additional to those generic criteria listed in section 11) include:

- How well does the proposed research fit with current government policy? (criterion: relevance)
- To what extent does the research project involve community and industry groups? This is not simply a relevance criterion but acknowledgment that Catchment Management Boards and industry bodies are at least stakeholders in the research process, and in some cases direct purchasers of research.
- What is the estimated net benefit of the project to salinity management? This criterion requires estimation of the off-farm and non-market benefits as well as on-farm benefits of salinity control.
- What collateral benefits to salinity control are possible?

4 Catchment Processes

The changes in land use that have occurred since European settlement have altered the hydrological balance of the landscape, significantly impacting on the balance between plant water use, run-off, deep drainage and groundwater recharge, thus altering river flow and groundwater levels. Salts are transported by water, so an understanding of the major hydrological, hydrogeological processes, coupled with the geomorphic history and the resultant stratigraphy of catchments and regional landscapes, is vital in the effective prevention of dryland salinisation and management of its expression in land and river salinity.

While the damage to farmland resulting from salinisation can be very significant, the concentration of salts in groundwater and river systems can lead to even more costly off-site damage. R&D into catchment processes must relate process to land uses and be relevant to catchment management through the provision of a conceptual framework for potential changes in land management practices and land use. R&D projects must also address the issues of spatial and temporal scales, given the range of catchment sizes in NSW. Outcomes from R&D in this area will include better management of groundwater tables and saline groundwater discharge into rivers, an improved knowledge base to enable salinity targets to be met, and land use and land management practices that are environmentally and economically sustainable.

This section is complementary to the first approach discussed in section 6, with the emphasis here on the integrative processes of water and solute movement through catchments to discharge points in contrast to the recharge management approach discussed in section 6.

While the damage to farmland resulting from salinisation can be very significant, the concentration of salts in groundwater and river systems can lead to even more costly off-site damage.

Key questions

Research and development is needed to:

- Develop the means to link changes to land use patterns and management practices with salt loads and concentrations in surface run-off and groundwater and their discharge to land surfaces, rivers and wetlands. The achievement of 'end-of-valley targets' will require the capacity to evaluate land use patterns and other interventions in terms of their impact on these targets. This is a most difficult area of research but will be critical to ensuring that the investment of funds will have some likelihood of success.

In particular this requires capacity to:

- ☐ Determine the nature of groundwater flow regimes underlying catchments, noting in the case of regional groundwater flow systems that these may underlie several catchments/ subcatchments. Of particular interest is the determination of the time that groundwater takes to respond to land use changes. This requires development of a equilibrium theory appropriate to the groundwater flow systems of interest (e.g. catchment scale) to understand the long-term trends and decide which areas are irretrievably lost to salinisation, and which are most amenable to recovery or treatment.

- ☐ Understand whole-of-catchment responses to proposed ameliorative actions to determine the most cost-effective areas to ameliorate, and where changed land use is most cost-effective. Of particular importance is the relationship between vegetation types, land uses and water use with respect to partitioning water and solute movement between run-off and deep drainage. This should include information on how land use impacts on natural discharge mechanism in catchments in ways that can result in salinisation of land and water. In particular there is a need to refine and build new land assessment tools that:
  - Best locate trees, other perennial plants, high-value annuals, and native vegetation to meet water quantity and quality targets, and biodiversity goals.
  - Facilitate identification and re-assignment of land in terms of its capability for production and ecosystem services.
  - Enable classification of catchments according to characteristics that have the most important influence on catchment hydrology and health.
  - Enable transitional impacts (for example the changes that occur as trees grow) to be predicted simultaneously with climate variability impacts, rather than assuming average climate conditions prevail throughout the transition period, so that risks can be investigated.
- ☐ Improve methods and models of predicting salt loads and river salinity levels to facilitate better definition and monitoring of catchment targets;
- ☐ Understand the relationship between catchment groundwater and surface water flows, their joint response to land use change, and the beneficial and detrimental impacts of that land use change on water quality and environmental flows at a catchment scale;
- ☐ Improve and implement a catchment planning process for salinity that takes account of biodiversity, aesthetic and economic factors.

Criteria to evaluate R&D proposals

Criteria to evaluate R&D proposals that seek to answer these R&D questions (additional to those generic criteria listed in section 11) include:

- How does the proposal assist communities and catchment managers to plan and manage catchments?
- How will the results be implemented in managing river targets, land use change and land use practices?
- What is the likely decrease in salt loads and river EC that will result from changing land management regimes?
- What is the estimated area that could be ameliorated, and what possible economic benefits and enhanced environmental values may come from changes in catchment land use and management?

5 Ecosystem Processes

It is predicted that salinity will have major impacts on ecosystem processes and function in both terrestrial and aquatic ecosystems. Such effects may be as great or greater than the effects of salinity on agricultural production, water quality and built infrastructure.

Salinity has adverse impacts on native species and ecological communities (including threatened species and communities), as well as the functioning of these communities. Loss of native vegetation can cause further salinisation, greater wind and water erosion, and lead to further loss of biodiversity in already biologically degraded and fragmented landscapes. Adverse effects of salinity extend to lost soil biodiversity, soil condition and degradation of terrestrial ecosystems. Salinity impacts on aquatic systems are most obvious in wetland ecosystems where evaporative concentration of salt in the absence of adequate surface flows causes loss of amenity, ecosystem benefits of wetlands, and loss of flora and fauna. The impacts of dryland salinisation on wetlands and other aquatic systems are intensified by saline discharges from irrigation areas.

Some actions to redress the impacts of waterlogging and salinisation are understood (e.g. water reallocation and salt interception) but many questions are still to be answered on the impacts on natural wetlands of added saline water (e.g. developing saline disposal basins), or the response to additional freshening flows.

Industrial and urban salinity are often characterized by point source pulses of salt into natural waterways and we need to understand both the effects on the ecosystems and the means for amelioration. Urban salinity is a locally significant and growing problem associated with alteration of water use patterns. Given the high asset value of urban infrastructure, it is likely that the necessary engineering to save these towns will involve the discharge of additional saline water into the environment. Anticipating the potential impacts, and their minimisation, should be an essential feature of investigations and planning.

Reductions in ecosystem function and biodiversity from salinity in NSW will degrade landscapes and amenity of rural areas, including internationally significant wetlands, heritage areas, and threatened species and their communities.

Impacts of salinity on ecological communities, species and ecosystem function need to be understood at site and landscape scales.

Key questions

- What areas (including rural, urban, parks, reserves and high conservation remnant vegetation areas) and what ecosystems are at risk from dryland salinity in NSW?
- What are the site and catchment specific effects of dryland salinity on terrestrial ecological communities, ecosystems and ecosystem processes?
- What is the effect of salinity on threatened and near threatened species and communities?
- What is the impact of salinity on aquatic ecosystems, particularly floodplain wetlands, and on the ecological processes and functions of those communities?
- What are the impacts of point source salt entry to waterways and floodplains?
- What is the impact of salt interception schemes and other salinity management options that alter natural water flow regimes on the biota and processes in freshwater and groundwater ecosystems?
- What are the synergistic effects of salinity with other potential ecosystem stressors (e.g. changes to natural water flow regimes, the invasion of pest species, and spread of land degradation)?

6 Management Approaches

Designing viable systems that have similar recharge to natural systems

Knowledge of the water use (and water balance) of individual land use enterprises and whole land use systems is an important consideration in on-site management of salinity.

This information is complex, as its accuracy depends on our capacity to model responses based on research results from specific locations with specific enterprises or mixes of enterprises. Also, the influence of scale and land use interactions need to be considered in the models, as their validity depends on their capacity to represent a mosaic of enterprises and land uses across catchments. Salinity is a catchment issue (both surface water and groundwater catchments), yet the scale at which land use change needs to take place is the individual enterprise level.

Key questions

The key questions revolve around the following themes:

(a) Water balance of individual land use options;

(b) Predictive modelling of the impacts of land use change options; and

(c) Matching plant water use to catchment hydrology and processes.

The key questions are:

- Do we have adequate data? We have a good understanding of the water use characteristics of individual crop and pasture species common to NSW rural land use systems, but are lacking data on soils and geology at an appropriate resolution, quantified seasonal contributions to groundwater, whole of catchment hydrology, and interactions in time and space between land uses. This information is needed to develop decision-making models in areas that lack locally specific data. System studies involving rotations in time and enterprise mixes in space are required to verify model performance and the environmental, production and economic achievements of proposed new land use systems.
- What land use options should be examined? Initially, the enterprises most frequently present in the landscape should be examined so that current practices can be evaluated for water balance and hydrological impact and those most suited to the catchment hydrology identified. However, over time, a wide range of possible land uses should be examined, including novel approaches taken by landholders, so that options are available for enterprise choice. The interaction of crops, pastures and trees and impacts on water use and drainage need to be examined.
- What impacts need modelling? A key impact to be modelled is the capacity to quantify groundwater recharge (i.e. to close the water balance) and the trade-offs between water balance and productivity, including factors such as seasonal plant water use, geology, climate, inherent salinity, groundcover, surface, lateral and deep drainage flows.
- How useable or adaptable does a model have to be? Models have to be able to accommodate 'what if' scenarios across the range of landscapes and agricultural systems of NSW. They also need to be 'user friendly' at both the farm and landscape level. Establishment of research sites needs to consider model testing as well as model input data in their selection and design.

- Can we build landscape models to achieve what we want? Some land uses are synergistic, some antagonistic and others neutral in their impacts on the water use or productivity of other land uses. Is knowledge of the interactions between land uses over time and space adequate for developing credible models, and, consequently, designing viable systems for salinity management? A transparent quality assurance process is needed to ensure that the strengths and weaknesses of models are clearly understood, particularly for non-technical users of model results.

Criteria to evaluate R&D proposals

Criteria to evaluate R&D proposals that seek to answer these R&D questions (additional to the generic criteria listed in section 11) include:

- Is the land use to be investigated a current land use suspected of having a 'leaky' water balance? (criterion: urgency)
- Is the land use to be investigated currently having a detrimental impact on catchment hydrology? (criterion: urgency)
- Is the land use to be investigated widely used or is there a strong interest in its future use? (criterion: problem size)
- Does the project add vital information about genotype × environment interactions, land use interactions, catchment classification, model development? (criterion: new knowledge)
- Does the project enable models to be developed and used across a wide range of catchments and seasons? (criterion: application and adaptability)
- Can the model match plant water use with catchment hydrology? (criterion: adaptability)

The use of saline land

Abandonment of saline land for productive use is not always an option.

The use of saline land for agriculture, forestry or conservation may remediate the land, increase its productive potential and avoid further downstream adverse impacts.

However, knowledge of land use systems suited to saline land and/or with the capacity to remediate saline land is inadequate for the range of environments and the scale of salinity in NSW.

Key questions

- What is the nature of salt tolerance? There is a need to document the type of salt tolerance that is exhibited in plants so that their usefulness in different situations can be categorised. The salinity status of a piece of land is not static; its condition is a unique sequence or combination of salt movement, groundwater movement, surface water ponding or flushing, geology and surrounding landscape influences. The challenge is to identify land uses that suit the whole regime.
- What happens when plants are grown on saline land? Different species not only react differently to salinity, they may also provide different outcomes in the landscape and at different timescales. For example, some may cycle salt in the soil profile, some may accumulate salt in harvested products, some may lower watertables, some may provide groundcover that reduces evaporation or capillary action. The timeframe for these changes is also important in any understanding of the capacity to remediate saline land for more productive uses.

- How can we manage saline land in an agricultural landscape? In NSW, saline areas are generally small compared with the rest of a paddock or farm. The challenge is therefore to develop combinations of land uses through integrated property management that provide both economic and environmental benefits for the farm. If the benefits on farm do not outweigh the costs, there may be external benefits which need consideration. There are opportunities for research and modelling of the impacts of the use of saline land with a range of agricultural, forestry and conservation enterprises.

Criteria to evaluate R&D proposals

Criteria to evaluate R&D proposals that seek to answer these R&D questions (additional to those generic criteria listed in section 11) include:

- What capacity does the proposal have to provide or lead to alternate land use systems that can be integrated into whole-of-property management and provide on-farm and/or remediation benefits?
- To what extent will the proposal build on existing knowledge about salt tolerance and land use planning?

Mitigating impacts on ecosystems

Specific methods to ameliorate impacts of salinity on ecosystems in NSW must be developed jointly with knowledge of salinity impacts on ecosystem processes. Once impacts of salinity on ecosystem processes are determined, then effective means of ameliorating such impacts can be developed. Amelioration of impacts of salinity will be required at site, catchment and landscape scales. Ameliorating effects of salinity at sites alone will be insufficient, because most effects of salinity on ecosystem function and biodiversity occur at landscape scales, such as the likely death of hundreds of thousands of isolated paddock trees across several million hectares of salinised land in NSW.

On-ground actions and programs for ameliorating impacts of salinity on ecosystem processes ideally should be based on an integrated approach to natural resource management.

Key questions

- What strategies and tools can be used for habitat reconstruction and rehabilitation of ecological processes for a range of ecosystem types (e.g. wetlands, grasslands, woodlands, abandoned irrigation lands)? Such strategies could include landscape and habitat restoration, species and community rehabilitation, and seed bank introductions.
- Can the use of hydrological manipulation (e.g. environmental water allocations, groundwater pumping) ameliorate or minimize salt impacts in targeted areas?
- What tools can predict and monitor the best timing, duration, frequency and concentration of saline discharges to reduce impacts on natural freshwater ecosystems?
- What is the relationship, for a range of ecosystems, between vegetation condition and infiltration rates of water, water use characteristics and water movement in ecosystems?
- What are the most effective interventions for protecting biodiversity at risk to salinisation?
- What tools and methods can be developed that identify optimal vegetation structures to achieve specific rehabilitation outcomes as well as multiple ecosystem benefits?

Criteria to evaluate R&D proposals

Criteria to evaluate R&D proposals that seek to answer these R&D questions (additional to those generic criteria listed in section 11) include:

- Does the proposal provide multiple rather than single natural resource management solutions to the amelioration of salinity impacts?

- Will the proposal assist in improving the effectiveness of incentive schemes to protect and manage natural ecosystems in salt hazard areas?
- How well do salinity revegetation proposals provide benefits to biodiversity and threatened species?

New technologies for prevention and adaptation

It is widely accepted that controlling salinity on a catchment scale requires new technologies. Current land use systems, even at 'best practice level', may be inadequate for the task. New technologies could include new farming systems, new forestry enterprises providing ecosystem services, saline aquaculture options and new engineering developments including saline processing.

However, the need for new technologies does not necessarily translate into innovations and new development opportunities. Consequently, some publicly funded R&D organisations have put their minds to an 'industry development model' as a basis for direct assistance.

A specific example is the FloraSearch project, proposed by the CRC for Plant-based Management of Dryland Salinity. Drawing on methodologies in other projects – the Search project of the WA Department of Conservation and Land Management, and several projects with the Joint Venture Agroforestry Program – FloraSearch will screen, select and develop commercially multi-purpose native species for large-scale revegetation in the salt hazard zone.

Another example is the Murray-Darling Basin Commission's saline processing initiative. Salt interception schemes along the Lower River Murray generate large quantities of salt in evaporation basins, as do the groundwater pumps of some irrigation districts. Joint ventures and research projects are being sought to convert this resource into industrial products, not only to generate a profit but also to improve the efficiency of evaporation basins.

In Western Australia, the development of an integrated farm system and integrated processing based on oil mallees is the best current example of this approach. Although not yet proven as an industry, there is a good prospect of success in converting this planted resource to eucalyptus oil, activated carbon and biomass energy. The trees are planted in 'bands' on farms, with conventional cropping and pasture rotations in the 'alleys'. Sustained, early investment by government and farmer investment through a company structure are features of this approach.

Key questions

The FloraSearch project mentioned above offers a methodology with generic application to development of new technologies with industry application.

There are four key questions for research and development around a specific innovation, whether it be a new product, forestry option or saline processing option:

- What is the potential product and enterprise?
- What are the market–product opportunities?
- What process efficiencies and product qualities need development? What are the costs, including costs of commercial production and marketing?
- How does the enterprise fit into existing production systems?

POTENTIAL PRODUCTS AND ENTERPRISES

This requires an initial screening of potential products, production systems and the ecosystem services they may provide. Projects can be set up to scan for possibilities on the basis of, say, the plant genetic resource available (e.g. FloraSearch) or the chemical composition of the saline resource. This initial identification should cover:

- ☐ prospective species or saline resources
- ☐ potential for ecosystem services
- ☐ production potential and prospective products
- ☐ market prospects
- ☐ management systems.

MARKET PRODUCT OPPORTUNITIES

After initial selection of potential products and enterprises, a desktop analysis can then be applied to the most prospective candidates. Three principles should apply to the development of new industries based on innovative technologies:

- ☐ Commodity-sized markets are essential to getting a scale of production that will also manage salinity;
- ☐ Production costs and product quality have to be competitive to gain market share; and
- ☐ Viability will depend on very efficient production systems, often with co-generation and multiple products.

A current example of such desktop analysis is *The contribution of mid to low rainfall forestry and agroforestry to greenhouse and natural resource management outcomes: overview and analysis of opportunities*, prepared by the Murray-Darling Basin Commission and the Australian Greenhouse Office.

PROCESS EFFICIENCIES AND PRODUCT DEVELOPMENT

For the most prospective of new technologies and enterprises, further development requires significant and sustained investment, perhaps with joint venture partners prepared to accept the risk–reward profile. There are two key areas for R&D:

- ☐ Product quality testing. This will involve further screening in the laboratory, and at some point, pilot-scale manufacture.
- ☐ Development of process efficiencies. A common severe impediment to new commodity-scale industries is the high unit cost of production or transport, given their small-scale origins. For instance, for oil mallee development to be profitable, a new continuous distillation process is required; and a potential wattle seed industry requires, among other things, a major reduction in harvesting costs.

INTEGRATED PRODUCTION

For plant-based technologies, trial pilots will be required in a range of site conditions and geographic locations, on a scale adequate to test compatibility with other enterprises and land uses. Saline processing will also have to be tested in the field. Here considerations include:

- ☐ feedstock characterisation and quality
- ☐ further selection and breeding of prospective plant species
- ☐ further development and adaptation of the management system
- ☐ assessment of the 'salinity benefit' and ecosystem services provided.

The investment and time needed to develop integrated production systems, product quality and process efficiency should not be under-estimated.

Criteria to evaluate R&D proposals

Criteria to evaluate R&D proposals that seek to answer these R&D questions (additional to those generic criteria listed in section 11) include:

- ■ What are the likely commodity prospects from the proposal? – market size, integration with existing production processes, potential to provide additional benefits and environmental services, opportunity for production efficiencies, product quality.
- ■ What development potential does the proposal offer? – farm and regional economic, environmental and social benefits, potential to attract investment capital, area of application and impact on salinity targets, potential disbenefits.

7 Economic Impacts of Salinity Policy and Land Use Change

Background

Economic efficiency in salinity management depends on effective provision of information to decision-makers and the ability for individuals to capture the benefits of their actions. An economic problem exists only when at least one of these conditions is not met; in this case, the market will not allocate adequate resources to the issue of salinity management to maximise the wellbeing of society. This is known as market failure.

Broadly speaking the role of the economist is to identify instances of market failure and propose (and design) mechanisms to redress the problem, with a view to improving the welfare of society. This requires analyses to be undertaken at the farm, catchment and regional scale. Preoccupation with the catchment-scale issues could lead to the development of strategies that are sub-optimal.

Managing stream and soil salinity requires broadscale change to the landscape. A range of actions needs to be implemented with due consideration to multiple objectives, namely ecological, social and economic values. This multiple input–multiple output system complicates the decision-making process, making it desirable for decision-makers to utilise a formal framework to assess the implications of proposed changes on defined objectives. Such a framework may be applied to address the effectiveness of alternative policy instruments where the interests of individuals are not coincident with the objectives of the catchment (or the broader society).

The protection and re-establishment of native vegetation, e.g. native trees and grasses, is likely to be an important component of any salinity management and catchment strategy. However, it is unlikely that sufficient area can be established to reduce discharge of salt into streams to achieve catchment salinity targets without additional incentives such as payments for off-site benefits. Other, complementary actions are likely to be needed to achieve salinity targets and improve water quality. Options include improving the management of agricultural enterprises. This can be achieved by improving existing crops to increase water use or by the introduction of deep-rooted perennial plant species. There is a broad range of species that are suitable for the landscapes in the NSW agricultural regions but the economic viability of many has not been shown. There is no doubt that this has been a contributing factor to the low adoption levels of proposed solutions.

The paucity of management options that are economically viable at the scale required to significantly reduce recharge implies that future research effort to identify new options is well justified.

Characteristics of land use systems that are likely to improve the profitability of businesses and environmental values need to be identified. The potential for other commercial enterprises to preserve environmental and social values also needs to be considered.

Action on a broad scale will not immediately prevent the spread of dryland salinity. Many land managers throughout NSW are faced with the prospect of increased areas of soil salinity. It is therefore appropriate to focus some effort on managing areas of discharge. The challenge is to find options to make profitable use of land that is affected by high salt concentrations, whether or not this is caused by shallow watertables. Apart from reducing the negative impact of salinity on business income, making use of discharge areas can prevent saline discharge to streams, and reduce soil erosion and the risk of flooding. A number of agricultural and non-agricultural uses have been proposed.

Key questions

- How can informed decisions on landscape redesign be made that effectively account for trade-offs between environmental, social and economic objectives for salinity management; for example, what are the likely range of impacts on landholders and regions?
- To what extent can environmental, social and economic objectives be achieved by redesigning the landscape?
- What impact will different policy prescriptions have on achieving environmental, social and economic objectives?
- What is the impact of risk on the rate of adoption of salinity solutions and landholder response to policy prescriptions?
- What is the economic potential to stream and soil salinity of R&D aimed at identifying new plant-based solutions?
- What is the economic potential of production systems (agricultural and non-agricultural) that utilise salt land and/or saline groundwater?
- What markets for salinity management products can provide the basis for viable new industries that may improve the ecological, social, and economic sustainability of rural communities?
- What are the R&D requirements to establish effective markets for salinity and other associated environmental services?

Research methods

A range of research methods is applicable given the scope of the research priorities. Development of a decision framework to assess trade offs between multiple objectives would be a very useful tool for catchment-level planning. It would integrate data from a range of disciplines and make explicit the costs and benefits of land use proposals in ecological, social and economic terms.

Analysis of the ability of policy to influence land use change to achieve the optimum triple bottom line (economic, social and environmental aspects) is best approached utilising catchment and farm level models.

Research evaluation and the viability of new industries should be undertaken in a benefit–cost framework, utilising the output from farm level models where appropriate. The environmental values may be assessed using methods that determine the willingness to pay for environmental services, although the veracity of methods may need to be qualified. Alternatively, environmental impacts can be included in physical terms without imputing an economic value to them.

Analysis must be undertaken after consultation with stakeholder groups to ensure the models developed and used are seen to be credible and that conclusions of analyses are endorsed by decision-makers.

8 Social Impacts of Salinity Policy and Land Use Change

There is increasing recognition amongst natural resource managers that information on biophysical systems and processes alone is insufficient for the development of socially and economically sustainable policies and resource management programs.

Social research with application to salinity management includes investigations on:

- community capacity to change
- landholder decision-making and its predictability
- the social context of extension services and their relative effectiveness
- landholder recognition, knowledge and understanding of salinity
- rates of adoption of conservation innovations by landholders
- social analysis of the institutional environment of decision-making
- the social impact assessment of salinity in rural and urban communities.

Conclusions from these studies provide guidance to current and proposed research, and include:

- Research into the non-biophysical aspects of resource management (such as demographic and attitudinal studies) has tended to view social factors as interfering factors or as obstacles to desired change. More extensive neutral research is needed into the general role of social factors.

The social factors and context of salinity management vary on a case-by-case basis, and thus regional or local community approaches are preferred.

- Social research undertaken on other natural resource issues can provide insights for salinity management (for example, research into native vegetation management).
- An approach to social research that focuses only on salinity is too narrow.

Social research into natural resource management is valuable for what it can contribute to improved policy development, improved design of management tools and programs and directions for investment programs.

Key questions

The social research questions most relevant to salinity in NSW are identified below. The questions have been broadly grouped under indicative headings, though there is considerable overlap between topics.

SOCIAL PROFILE, SOCIAL CONTEXT AND INSTITUTIONAL RESEARCH

- Do we know the profile of the stakeholders and their land use?
- What values do landholders and landscape communities hold, and how will these influence land use and decisions?
- How can we integrate and link environmental, economic and social research databases and factors in relation to salinity management?

KNOWLEDGE OF SALINITY

- How well is salinity understood by landholders and the community? How does this influence land use?
- What are the differences between rural and urban communities in the recognition, understanding and knowledge of salinity?

ATTITUDES, BEHAVIOUR AND MOTIVATION

- What are the social indicators for landholder and community motivation and capacity to change?
- What are landholder perceptions of risk, factors that influence risk assessment, preparedness to undertake risk, and reactions to land use change?
- What is the relationship between attitudes and behaviours of landholders in relation to salinity?
- What is an appropriate duty of care for landholders in the management of salinity and how does it relate to existing salinity targets?

DECISION-MAKING

- What is the capacity for NSW landholders to make decisions on salinity management? This would involve case-specific research into landholder decision-making variables (such as location, occupation, history or exposure to change, educational background, skills, and attitudes).
- What are the major landholder decision-making variables? For example, if the ability to change is dependent upon beliefs and attitudes, is this type of change extremely difficult to instigate?
- What is the role of external and institutional factors (such as the number and distribution of formal institutions, access to media, access to local environmental groups, and strength of these groups) in landholder decision-making?
- How predictable is landholder decision-making in relation to salinity (decision-making probability research)?

IMPACT STUDIES

- What are the impacts of salinity on Aboriginal culture, heritage, resource use and resource management?
- What are the social costs and benefits (if any) of salinity to rural and urban communities?
- What are, and what will be, the community changes arising from land use change in a region (that is, change either as a result of salinisation or salinity management)?

CAPACITY TO CHANGE

- What social factors are obstructive to changing community and landholder responses to salinity?
- What are the differences between the capacities of rural and urban communities to respond to salinity?
- What social factors are conducive to changing community and landholder responses to salinity?
- How feasible is it to develop predictors of adoption?

9 Monitoring and Evaluation

Under the NSW Salinity Strategy and the National Action Plan, a range of salinity mitigation and prevention strategies are proposed for catchments at risk. These strategies will often be implemented with the aim of meeting salinity and water quality targets.

Despite the diverse implementation of on-ground works, there are few data on the extent to which salinity works control salinity or mitigate its impacts. Given the uncertainty of modelling, there is simply no substitute for monitoring the effectiveness of specific activities. Otherwise, decision-making may be based on anecdote and assertion, rather than on data.

Key questions

- What tools need to be developed (measurement and modelling) for catchment groups to evaluate the impact of changing land use on controlling salinity, and meeting catchment targets?
- What better mechanisms can be developed for regional communities affected by salinity to evaluate the effectiveness of action learning programs and participation in research planning and monitoring programs?
- What methods can be developed for determining the risks from salinity to natural assets (e.g. wetlands and biodiversity), production assets (e.g. farm land) and infrastructure (e.g. transport, industrial and urban) and, subsequently, to determine benefits and costs of protecting these assets?

It is critical that, as measures such as land use change, revegetation and engineering works are implemented, we put in place an effective monitoring and evaluation strategy.

R&D is required to facilitate the development of monitoring programs that determine the following:

- How comprehensively have dryland salinity management activities been implemented?
- What are the reasons for incomplete implementation of management and monitoring activities?
- How effectively have salinity management options met their objectives?
- How are key indicators such as groundwater levels and stream salt loads and salinity concentrations responding to management strategies?
- How are systems such as stream ecosystems, wetlands and soils responding to changes in groundwater levels?
- How well do conceptual models and their predictions match actual behaviour of catchments and systems?
- What are the indicators from monitoring that suggest we need to review the conceptual basis for land management?
- How should we revise our management strategies for better land management?

Monitoring strategies

To achieve the above outcomes, salinity monitoring and evaluation strategies will need to include information on trends in areas of salinised land, long-term groundwater trends, long-term stream salinity and salt load trends, changes in biodiversity, vegetation cover changes, degradation/amelioration of wetlands, trends in threats and actual damage to assets.

Information needs

The following information is required to assist the development of better monitoring strategies:

Benchmarking:

establishing current land use and land management on a catchment basis.

Satellite imagery:

where a catchment salinity strategy calls for significant vegetation change.

Farm surveys:

where the activity to be monitored cannot be resolved through remote sensing and satellite imagery techniques, changes in land use may need to be monitored through farm/landholder surveys.

Australian census information:

time series information on structural adjustment and regional land use changes and the implications for dryland salinity management (additional survey information collected under the Australian Population and Housing Census and the Australian Agricultural Census).

Other parameters that can be monitored include:

- hectares of treatments adopted
- number of engineering works completed
- numbers of saline industries developed
- number and rate of adoption of changes in land use
- change in property size
- change in agricultural production statistics
- forestry/farm forestry development
- change in rural industry and community profiles

10 Translating R&D Results to Actions

Salinity research and development will be undertaken to address the research questions posed in other parts of this document.

The focus of salinity R&D is largely determined by the R&D purchaser, who may be government (driven by policy and public benefit issues), industry (driven by potential production and viability benefits) or academia (driven by the quest for new knowledge and contributions to science). The information generated by research will therefore be initially tailored to meet the needs of those purchasers. A challenge is to engage the sponsors in joint research funding so that research outcomes will have broader applicability.

The eventual beneficiaries of research will extend beyond the current research investors and even beyond those that invest in the action resulting from the research outputs. This is because of the timeframes involved in the salinisation process and its remediation, and also the geographic separation of salinity influences and impacts.

When research outputs are generated, their extension and adoption is not a simple transfer of data. A strategic approach is needed to translate the research results into information and advice that can be used by the intended recipients to facilitate action.

Recent developments in NSW are taking a new approach to extension methods and the engagement of research decision-makers in extension. Salinity extension is being organised on a regional or catchment basis with specialist multi-agency salt teams who will contribute technical advice to catchment planners, to private or public sector advisers, and to those implementing salinity action plans. There is also the development of incentive schemes to assist in the implementation of best practices from research programs or shared experiences.

Linking salinity research to regional extension services should ensure effective regional and local actions.

The client groups that rely on salinity research results include:

- Regional planning groups who need information to enable realistic targets to be set and actions to be assigned, and to enable effective monitoring of outcomes from actions under their plans;
- Landholders and managers who need a sound basis for assessing options and making decisions for action;
- Investors in salinity management who need to be able to assess their options, risks and returns for their investment. Investors may be private or government, individual or corporate, local or remote, present or future;
- Policy makers, information providers and educators who utilise research results in policy development, decision-making, extension, and education programs.

Key questions

These fall into three categories:

(a) Identifying the clients and their needs;

(b) Tailoring the information to the clients;

(c) Measuring and monitoring the outcomes of adoption (links to section 9).

The key questions are:

- What are the client's needs, and are the clients involved in identifying problems and opportunities for research?

As identified above, there are several main client groups and each group will use the results of research in different ways for different purposes. The groups are not independent, as they influence each other's activities and priorities, as figure 1 depicts.

Each group has risks to manage and the size of those risks depends on the certainty and reliability of the information available. The risks and how they affect decisions need to be understood to enable effective translation of results to action.

There are also other barriers to adoptions which may involve perceptions (current knowledge and interpretation), resource constraints, personal goals and interests and business arrangements. These need to be understood to enable appropriate information to be provided in the most effective manner (see section 8).

- How should the information be tailored to suit the clients?

Data from research comes at specific scales and from specifically designed experiments or from experiments performed under specific conditions. The transportability and reliability of results needs to be understood.

- How do we measure the outcomes from adoption of R&D results?

The two issues of measurement are: is the outcome measurable (and how); and what is the value of the outcome?

The currency used to measure benefits will vary depending on whether the benefits are economic ($, productivity, efficiency), social (employment, welfare), or environmental (habitat, resource quality).

The value of outcomes may be measured as the net benefits to individuals, the community, industry or governments. It will therefore be useful to quantify the benefits to each of the beneficiaries and to identify how the value can be attributed to the action of the planner, the investor, the landholder or the researcher so that recognition and reward can be directed appropriately.

Criteria to evaluate R&D proposals

The extension aspect of R&D projects is as important as the research component, and projects could be accepted or rejected on the basis of their capability to translate into action as well as their capability to develop sound research results.

Criteria to evaluate proposals that seek to answer these questions (additional to those generic criteria listed in section 11) include:

- Is the proposal designed so clients can relate to and use its results?
- Does the proposal enable risks to be reduced or overcome in the delivery of research outputs?
- Can adoption levels and the value of outputs be measured and show a positive return for the human, financial and natural resource inputs?

11 Generic Evaluation Criteria

The following generic criteria can be used to evaluate the potential for R&D proposals to answer the key knowledge questions and evaluate risks associated with each proposal. These are in addition to those specific to a particular question, listed previously.

Outcome criteria

Proposals need to:

- Identify the potential impact of the results of research:
  - reduction in recharge of watertables and stream salt loads
  - change in stream flows
  - contribution to biodiversity, social, economic and policy objectives.
- Identify the prospects for alternate land uses, new commodities and industry development.
- Describe the benefits and costs of the proposal:
  - on-farm and off-farm
  - financial and non-financial.
- Identify the size and significance of the geographic area to which the proposal has application.
- Estimate the likelihood of adoption of the salinity management option/s developed from the R&D, the likely scale of adoption and its timecourse.

Process criteria

Proposals need to:

- Assist in delivery of the NSW Salinity Strategy and the National Action Plan for Salinity and Water Quality, and where appropriate, complementary to the programs of the NDSP, the work of relevant CRCs and existing joint R&D initiatives.
- Demonstrate how they will assist communities and catchment managers plan and manage specific catchments.
- Consider triple bottom line issues (economic, social and environmental) in terms of their acceptability to the catchment community.
- Describe the way that the results of R&D will be transferred to users.
- Be of high scientific quality in terms of having clear objectives, a feasible research plan and a clear communication plan to inform potential users.
- Demonstrate the capacity of the research provider to undertake the R&D.

12 Future Actions and Recommendations

The SRDCC, through the development of the framework and its inventory of R&D projects, will pursue the following actions and recommendations:

1. The key salinity R&D questions identified in the strategic framework should define the scope of new salinity R&D proposals, and the generic and specific evaluation criteria should be used to assess their priority.
2. The strategic framework will be used by the Steering Committee responsible for facilitating implementation of the Commonwealth/NSW Bilateral Agreement on the NAPSWQ to assist decisions on joint investment strategies for regional and state-wide R&D activities.
3. The strategic framework will be used by the NSW Salinity Strategy Senior Officers Group to assist implementation of the NSW Salinity Strategy.
4. The SRDCC has provided the strategic framework and register of salinity projects to all government agencies and other non-government bodies for their information and use. The SRDCC recommends their use in determining the R&D elements of investment strategies being developed by regional natural resource management committees such as Catchment Management Boards, as well as with investment strategies being developed for state-wide and cross-regional salinity R&D.
5. NSW agencies participating in collaborative salinity R&D programs should ensure R&D projects address areas identified as priorities for NSW.
6. The SRDCC will review the implementation of this framework policy, and make appropriate further recommendations to the NSW Salinity Strategy Senior Officers Implementation Group, to the Commonwealth/NSW Steering Committee for the NAPSWQ Bilateral Agreement, and to the Minister for Agriculture and the Minister for Land and Water Conservation.
7. R&D purchasers and providers should direct additional salinity R&D resources towards those areas identified as high priority which are not currently under active investigation.

APPENDIX 1

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APPENDIX 2

Terms of Reference of the SRDCC

A major recommendation of the NSW Salinity Summit in March 2000 was the formation of a Salinity Research and Development Coordinating Committee for NSW to recommend research and development.

Action 7.10 of the NSW Salinity Strategy is to 'Establish a Salinity Research and Development Co-ordinating Committee to provide advice to the Minister for Agriculture and Minister for Land and Water Conservation on research priorities to address salinity'.

SRDCC TERMS OF REFERENCE:

1. To establish and implement a framework and process to enable the coordination of salinity R&D carried out by government agencies, individually or collaboratively with other providers.
2. To advise the Minister for Agriculture and Minister for Land and Water Conservation on priorities for salinity R&D in NSW, consistent with the objectives of the NSW Salinity Strategy.
3. To review such Salinity Strategy R&D plans and programs as the Minister/s refer to it for review.
4. To investigate such matters affecting the management of salinity R&D throughout the state as the Minister/s refers to it for investigation.
5. To report to the Minister/s on matters affecting the management of salinity R&D throughout the state, including such matters as the Minister refers to it for report.
6. To consult with the NSW Farmers Association, the Nature Conservation Council and other stakeholders on salinity R&D and its coordination.

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