PRIME MINISTER'S SCIENCE, ENGINEERING AND INNOVATION COUNCIL

SECOND MEETING, 4 December 1998

AGENDA ITEM 5

DRYLAND SALINITY AND ITS IMPACTS ON RURAL INDUSTRIES AND THE LANDSCAPE

SUMMARY

The 29 May 1998 meeting of the Prime Minister's Science, Engineering and Innovation Council considered an agenda item on priorities for science, engineering and innovation. The issue of dryland salinity, and its impacts on rural industries and the landscape, was presented as part of this agenda item, as an example of an economic and social issue of high priority, to which science, engineering and innovation can make a contribution. The Council meeting agreed that further work should be done on roles for science, engineering and innovation in addressing dryland salinity, with a report to be provided to the next meeting of the Council.

This report responds to that direction from the Council. It presents an overview of salinity issues, and identifies the sorts of long-term programs, policy environment and directions that Australia must adopt if it is to deal effectively with, and as necessary live with, dryland salinity in rural Australia. It also shows how dryland salinity represents a microcosm of natural resources management in terms of issues, strategies and activities which require investment. It identifies some actions and initiatives that the Government could take, as important steps in addressing the complex issues related to salinity and its impacts.

There is an opportunity to take actions now which will, at manageable cost (and low cost compared with the damage salinity can do), help Australia address one of its most pervasive, insidious and potentially damaging natural resource problems.

This paper was prepared by an independent working group for the PMSEIC and the views so expressed are those of the Working Group and not necessarily those of the Commonwealth.

Version 2, as at 7 January 1999

Dryland Salinity and its Impacts on Rural Industries and the Landscape

Contents

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Version 2, as at 7 January 1999

RECOMMENDATIONS

1: The Prime Minister should make a statement on dryland salinity acknowledging the seriousness of the problem and supporting a range of activities to address the problem on a regional level. The biodiversity impacts, water quality issues and damage to infrastructure and urban areas needs to be acknowledged, along with the consequences for agriculture. Any effective response to the salinity crisis must be in partnership with the States, and the Council of Australian Governments framework would be an appropriate mechanism to achieve this.

2: Blanket recipes on how to deal with dryland salinity are likely to be inappropriate. Comprehensive analysis is required to identify those areas which would benefit from public and private investment, and those where such investment is likely to be totally ineffective. Dependent on the value of the areas under consideration, and on the costs and benefits of treatment, the emphasis should move from treatment of symptoms to treatment of causes. Support from federal programmes should be dependent on such planning.

3: There are a variety of reasons to protect native vegetation, and we applaud Government endeavours in this direction. Land clearing should only be allowed after (among other considerations) a thorough analysis of regional water balances has been undertaken and there can be clear assurances that such clearing and the new land uses will not exacerbate future dryland salinity problems. This is largely an issue for the States, and it is important to draw it to their attention.

4: Further research is needed in farming systems and land use systems suitable for Australia which will have benefits in a range of areas, including dryland salinity. We need: more information on the water using capacity of various types of vegetation; experimentation with new farming systems that are adapted to the Australian climate; more cost-effective survey techniques; socio-economic R&D to create an enabling environment; and improved analysis techniques to quantify the aggregate impacts of land use patterns on the landscape. Much of this research must be at a larger geographic scale that has characterised much past research, and must be focussed on management solutions within the context of economic and social conditions. CSIRO has made a start on this important work, and it needs to be accorded higher funding priority.

5: Three or four initiatives at the scale of large elements of the landscape and/or large catchments should be developed to demonstrate and evaluate integrated approaches to handling dryland salinity. This development should be undertaken in consultation and collaboration with communities which are prepared to take part. The Minister for Agriculture, Fisheries and Forestry should consider this proposal.

6: There is a need to encourage the development and use of small teams of well-qualified and experienced professionals in the range of disciplines involved with dryland salinity, to provide rapid assessment and advice to those dealing with salinity issues. The involvement of producers and community groups with these

teams is essential, and must be funded to allow their participation in designing and developing management solutions. The Minister for Agriculture, Fisheries and Forestry should explore this idea with the States, and consider funding support to implement it.

7: There is a clear need for ongoing funding of research, planning and on-ground works, and there are major public benefits as well as the obvious benefits to land-holders. We urge the Government to commit to ongoing financial support of community groups and agencies to facilitate implementation of those plans developed and accredited under earlier programs, such as the Decade of Land Care and the Natural Heritage Trust. This will be addressed by the Minister for Agriculture, Fisheries and Forestry in the forthcoming statement on Natural Resources Management.

8: Regulatory and market-based instruments need to be used to influence the ability to address dryland salinity. A number of innovative approaches are being developed in various States. We recommend that the various approaches be documented and evaluated. This will provide guidance, and ensure lessons are carried beyond state borders. The Land and Water Resources Research and Development Corporation is undertaking this review.

9: The development of a carbon credit trading system has the potential to be a complementary tool in addressing dryland salinity. We urge the Government to ensure that the Australian Greenhouse Office, in developing the system, consider the need for appropriate types of trees, and their location in the landscape, that can help regional water balance issues.

10: Federal and State governments should continue to alert local governments to the extent and implications of dryland salinity. The development of a manual on *Best Practice Planning Policies for Local Governments* would be valuable, to help ensure that development applications or proposals or land use practices will not contribute to the ongoing dryland salinity problem. Disciplines involved in local government planning, such as town planners and shire engineers should also be influenced through conferences and professional associations. The Minister for Transport and Regional Services should be asked to address this issue.

11: Governments and individuals are not going to make appropriate investment decisions without good long-term data. Our data networks have been cut back in recent years. We need to ensure we have appropriate data on streamflow and quality, groundwater depth and quality, vegetation cover and salinised land areas. We also need to ensure effective monitoring of the interventions that are funded to assess whether they provide the expected benefits. The National Land and Water Resources Audit should be asked to advise on appropriate monitoring and evaluation strategies.

12: In view of the magnitude of this problem, and the reviewing of key strategies and programs that are now under way, we recommend that the Prime Ministers Science, Engineering and Innovation Council commission another report in the year 2000 to evaluate the new approaches and the need for further actions.

INTRODUCTION

Salts can be found in most Australian landscapes. They originate from either the weathering of rock minerals or the deposition of oceanic salt into the landscape through rain or wind. Native vegetation evolved to make the best use of the available rainfall, while avoiding, or developing a tolerance to, the salt. European farming practices replaced the native vegetation with crops and pastures that have shallower roots and different growth patterns. Water is no longer used at the same rate, and the unused portion "leaks" to lower soil depths. This has led to rising water tables mobilising the stored salts and bringing them near to or with saline water coming near to or reaching the surface, leading to widespread land and environmental degradation. Dryland salinity is an expression of major water imbalance in a catchment.

Salinity is widely recognised as causing problems for agriculture. It is less appreciated that dryland salinity causes serious damage to downstream water users, aquatic ecosystems and biodiversity, and to regional and urban infrastructure due to damage to foundations from shallow, saline groundwater.

Salinity is not just an agricultural issue, but a landscape issue affecting urban and rural Australians.

While the symptoms are impacting on a variety of values, the cause of the problem is inappropriate land use. In addressing such issues it is obvious that salinity is part of the wider issue of natural resource management in rural Australia, and needs to be considered with a variety of other natural resource issues.

IMPACTS OF DRYLAND SALINITY

Agriculture: Salinity leads to loss of productive land area, and of agricultural production One estimate suggests that the capital value of land lost is about $700 million. Lost production is estimated at $130 million annually, and increasing. In addition, the costs to farmers of protecting land and surface waters from salinisation and/or of moving to alternative uses that are more sustainable have not been determined, but are likely to be high. The impacts are being felt mainly in the grains, wool and grazing industries of the more intensive land use zones of temperate Australia.

Stream salinity: Increasing salt concentrations can be observed in many streams and rivers, particularly in the southern half of the Murray-Darling Basin. Rising groundwater in the Basin leads to saline discharges to streams and at the soil surface where it affects runoff quality. Salinity levels in the Murrumbidgee River are increasing at between 0.8% per annum and 15% per annum, depending on where measurements are made. These changes have significant impacts on aquatic ecosystems and all extractive users including drinking water, mining and irrigation.

Biodiversity and Environment: Rising water tables and increasing salinity have serious impacts on native vegetation. Remnant native vegetation is threatened, and since this the only remaining habitat for a variety of important animal species, these are also under threat. Riparian vegetation, critical to stream bank stability and often the only wildlife corridors left in an agricultural landscape, and wetland areas are already damaged and under increasing threat.

For example, the 1996 situation statement for salinity in south-western Western Australia identified extensive impacts on natural values. It found that 80% of the length of rivers and streams was degraded by salinity, and half of the water bird species had disappeared from the many wetlands which were once fresh or brackish. 80% of remnant vegetation on private land, up to 50% of conservation reserves, and at least one population of each of 10 declared rare flora, and the entire population of a declared rare orchid, are threatened. These impacts on biodiversity and nature conservation have flow-on impacts to tourism.

Public Infrastructure: Road and bridge damage caused by shallow saline groundwater is a major cost to local governments. It is believed that about 34% of State roads, and 21% of national highways in south-western NSW are affected by high water tables, and damage costs $9 million per year. A 1997 investigation of salinity and waterlogging impacts on main roads in Western Australia showed 230 km already affected, and a likely doubling in 10 to 20 years, to represent an additional cost in maintenance and reconstruction over this period of $50–$100 million. There are similar impacts on structures affecting communication and gas pipelines.

The town of Wagga Wagga in NSW is one of the worst affected by dryland salinity; it sustains a cost of about $500,000 per year from salinity-induced damage to roads, footpaths, parks, sewage pipes, housing and industry. Many other towns, and rural infrastructure across Australia, are at risk of, and are currently experiencing, rising water tables and consequent salinity problems.

Urban Households: Saline water and high water tables impact on households in a number of ways, from structural damage to houses and motor vehicles, through damage to hot water systems and household appliances, to increased use of soaps, detergents and water conditioners. Loss of property value is a major concern to householders affected by salinity, and can lead residents to deny the existence of the problem until it is very obvious. Increased salinity in the Murray-Darling system is estimated to cost Adelaide $55–$65 million per year, largely in dealing with harder water.

EXTENT AND COSTS

Given the diffuse, widespread and often indirect impacts of dryland salinity, it is impossible to calculate its overall costs to the nation. What can be said is that about 2.5 million ha of land is so far affected, and there is the potential for this to increase to 15 million ha. Much of this is some of the most productive agricultural land. The area damaged by salinity to date represents about 4.5% of presently cultivated land, and known costs include $130 million annually in lost agricultural production; $100 million annually in damage to infrastructure; and at least $40 million in loss of environmental assets. Salinity affects regions in all parts of Australia:

- In *Western Australia*, 1.8 million ha are affected at present, and this could double within 20 years, and double again before equilibrium is reached; over half the State's divertible water is already saline, brackish or of marginal quality;
- In *South Australia*, all agricultural districts exhibit some degree of dryland salinity, and at least 20% of surface water resources are above recommended salinity limits for human consumption;
- In *Victoria*, there are extensive impacts in western regions, which are likely to increase substantially as more detailed mapping continues;
- In *New South Wales and the ACT*, as much a 7.5 million ha could be affected in the future as groundwater rises;

- In *Queensland*, severe salting affects 10,000 ha, and dryland salinity is an emerging threat, particularly in the semi-arid tropics and sub tropical woodlands which have been subject to clearing pressure over the last 60 years; and
- In *Tasmania*, about 18,000 ha, or about 2% of cleared agricultural land is affected by salinity, and a recent analysis suggest significant risk of more land being salinised.

The impacts of salinity are diffuse and indirect, but they are highly pervasive. Our estimates of their current and future costs are almost certainly far too low, and reflect our limited investment in measuring salinity and its effects.

Likely Futures

Scientists, public administrators and land managers we have consulted believe that salinity problems are getting worse across large parts of Australia. Very recent modelling by the Murray-Darling Basin Commission is predicting an even greater hazard than evident from its 1997 *Salt Trends* report, although the estimates assume no significant new policy interventions and require further validation.

Specifically:

- The River Murray salinity at the key monitoring station in South Australia (Morgan), below where Adelaide's water is diverted, will likely increase by 214 EC[1] units above the present average level of 550 EC in the next 50 years. For much of the year such a salt concentration will be close to a desirable maximum level for drinking water at 800 EC units[2];
- The salinity increases in the tributaries of the Murray and Darling rivers are predicted to be greater, particularly in the rivers of northern NSW and western Victoria. Consumptive use of tertiary streams is at risk;
- These increases in salinity are driven by rising groundwater which is expected to reach within 2 meters of the land surface under 1.2 million ha of Victoria and 7.5 million has of NSW by 2050;
- There are very significant but not quantified potential impacts on town and transport infrastructure and biological diversity including wetlands.

The 1996 report *Salinity: A Situation Statement for Western Australia* made the prediction that when a new hydrological equilibrium is reached in 30 to 200 years depending on rainfall zone, 6.1 million ha of land, or 30 per cent of the agricultural land, will be salt affected.

Some 80 rural towns in Australia are showing property damage due to saline water tables, mainly in the form of crumbling foundations. Many of these communities are denying they have a problem because of the impacts on property values. Newly developing parts of Sydney, in the South Creek area, are also high hazard areas and similar problems could be experienced there.

The Challenge of Salinity

1 Electrical Conductivity Units. The higher the EC value, the more saline the water.

2 The desirable maximum level for drinking water of 800 EC units has been adopted as a long-term objective for Australia, which if achieved, will result in drinking water of excellent quality. It is based on World Health Organisation standards.

The time scales over which salinity establishes itself, spreads and has its effects can be long, but once established it can be very difficult or impossible to contain or reverse. The consequence of this is that salinity must inevitably continue to get worse in Australia, as a result of land use decisions already made.

In some places the cause of the problem and the resultant salt scalds at the bottom of hill slopes are on the one property; in other cases the cause of the problem may be hundreds of kilometres from where the symptoms become obvious.

Decisions taken now can not prevent salinity and its impacts becoming worse in the short term, although we should seek to slow the degradation and to learn to adapt to it. There are a number of consequences of the indirect, delayed and difficult to reverse nature of the impacts of salinity.

Much of the effort devoted to addressing salinity has been focussed on the symptoms of the problem rather than the causes. If the water balance is not restored, the symptoms will simply keep recurring. We need to minimise the mobilising of salt by restoring the water balance and ensuring catchments are not "leaking" water in ways that mobilise salt.

The decision environment for controlling salinity is complex. While much is being achieved by improvement in the water use of current farming systems (better management practices) it may still be insufficient to change water balance on a catchment scale. Changes in land use must be considered; either tackling the cause by restoring water balance (eg farm forestry), or "living with the symptoms" because reversal is not an option (eg salt tolerant forage).

Recognising the complexities of the issue, any approaches to addressing salinity must have some key features:

- They must encompass and foster genuine commitment to change and improvement, so that our land uses and land management practices better match the capacity and capabilities of the land and meet performance standards for water balance;
- They must consider the costs and benefits of actions, and recognise that in some places amelioration is impractical or too costly, and changed land use and management are the only option;
- They must recognise the geographic scale of the problem, and ensure that investigations and actions take place at the appropriate scale; this is typically regional or catchment-wide in the eastern states;
- They must address the diverse nature of the issue, and deal simultaneously with the biological, physical, social, economic, policy and institutional factors involved;
- They must ensure that proposed solutions address causes rather than merely ameliorating symptoms, or transferring the salt damage to other parts of the landscape;
- They must involve all the key players: land holders and land managers, communities, agricultural industry, environmental interests, and the three tiers of Government; and
- They must provide a decision-support framework which links scientific understanding, data collection and dissemination with the decision-making needs of farmers, policy makers and other stakeholders, so that the best management options are available, and their use is encouraged.

The Case for Government Action

The salinity problem is serious and getting worse. It is putting at risk the economic and environmental sustainability of whole rural communities. The numbers and areas impacted will increase due to past actions, regardless of what actions we take now. At best we can slow the rate of increase and, in time, restrict the damage; it is unlikely we can reverse it. At the same time, the problem cannot be ignored, due to the social and environmental degradation it will cause.

The problem is one that must be addressed at appropriate scales. The drinking water of people in Adelaide is put at risk by land clearing far away in the upstream States. The States have different approaches to collecting data on groundwater and salinity, and the National Land and Water Resources Audit has found it difficult to put the available information together to give a national picture, although this will be achieved through the Audit.

Governments and landholders have been investing heavily to try to manage salinity since the early seventies. Initially the problem was seen as an irrigation issue since dramatic rises in groundwater could be observed under some irrigation schemes, and rarely had appropriate drainage been supplied. While salinity from irrigation is important it is largely in check under existing policies and current works. Our present understanding suggests dryland salinity operates over such a vast area it is by far the larger contributor to economic and environmental damage.

These past investments have taught us a lot about the salinity problem, but some of the remedial actions that have been undertaken have been ineffective. We are developing a stronger knowledge base and must ensure that future landholder and Government investments are at an appropriate level and are cost-effective, being based on the best available knowledge.

There are clear market failures in that the costs of degradation to downstream users and to the environment are not borne by those benefiting from the upstream exploitation of the landscape. In many cases the costs will be borne by future generations. Leaving it to markets to resolve will cause serious and irreversible offsite impacts to biodiversity, rural infrastructure and downstream water users, as well as causing unnecessary hardship to landholders.

Salinity is a complex issue, and there are no remedial actions that can be universally applied across the country. Region based analysis is needed to clarify the degrading processes in particular areas, and the most cost-effective approach to combating them. Government leadership now can influence strongly the course of dryland salinity and its impacts, but we can only achieve amelioration of the problem by concerted long-term effort. This will involve very substantial changes in the use to which some land is put. There is a major leadership role for Federal and State Governments in identifying and supporting management strategies that develop responses on the appropriate scales. Salinity is an overwhelming issue for a rural community demoralised and dispirited by a variety of factors. Government leadership in acknowledging the seriousness of the problem, and committing to useful solutions is a precondition to the private investments that will be needed if we are to change the situation.

Recommendation 1

The Prime Minister should make a statement on dryland salinity acknowledging the seriousness of the problem and supporting a range of activities to address the problem on a regional level. The biodiversity impacts, water quality issues and

damage to infrastructure and urban areas needs to be acknowledged, along with the consequences for agriculture. Any effective response to the salinity crisis must be in partnership with the States, and the Council of Australian Governments framework would be an appropriate mechanism to achieve this.

Appropriate Actions for Particular Lands

In many parts of the country Australians have already learnt to live with salt, and in some other areas we will need to come to grips with living with landscapes that are beyond rehabilitation. Indeed, some salty landscapes can be seen as a resource, although their expansion is not to be encouraged. There may even be the option of restoration to healthy, saline ecosystems, mimicking those which have occurred naturally. Options do exist, however, for managing and rehabilitating landscapes at risk to salinity, and possibly even preventing salinity. It is important, however, to understand what hazards are imminent, and what is tolerable to society.

What this means is that investment in addressing salinity needs to be targeted to the types of responses which are appropriate to the regions and conditions under consideration. In some regions/circumstances, intervention will produce little or no salinity control compared with not intervening, and the appropriate response is to live with salinity, for example by changing land uses to ones more tolerant to the presence of salinity. In other regions, intervention can have a major role in reducing the extent or cost of dryland salinity.

It is clear that we have to think about appropriate actions on four types of land.

- Degraded land with little prospect of remediation and of limited productive use;
- Degraded land where it is possible to grow salt tolerant species and continue with some agricultural activities;
- Land at hazard from salinisation but where it is possible to slow or perhaps reverse the present rate of degradation;
- Land showing no symptoms of salinity, but which are groundwater recharge areas that may cause salinisation some considerable distance away.

Degraded land with Limited Prospects

We need to recognise that there are salinised land areas that have very limited prospects for any productive agricultural activity at this stage. These may be small areas on particular farms, or they may be larger valley floors.

In these areas we may need to ensure that mechanisms exist to facilitate land retirement and amalgamation of tenures. We also need to ensure that the off-site impacts of these degraded areas are minimised. This normally involves planting with salt tolerant native vegetation, and fencing to protect natural regeneration and ecological succession.

However, a major issue with these types of landscapes is that the land still needs to be managed, even if it is no longer occupied. Presumably, responsible management is a public good. Degraded land does not stop being a problem just because no-one farms it. Governments need to consider how to respond to these challenges.

Degraded Land that can still be Farmed

On this land we seek to assist farmers in their endeavours to prevent salinisation becoming worse and to minimise the off site impacts while they continue to make a living from the land. This might require fencing and revegetation with salt tolerant species for opportunistic grazing on limited areas on particular properties. While there has been considerable research and investigation into appropriate ways of managing such lands and some exciting success stories have been developed, there is a paucity of solutions that are profitable for extensive regions of mixed farming land.

Hazard Land at Risk of Salinisation

Salinity hazard is present where there is a probability of its occurrence in a region if preventative strategies are not adopted. Such regions have biophysical conditions that are known to give rise to salinity, and may be adjacent to already affected land.

One of the prime tasks in coming to grips with salinity is to characterise the nature and extent of hazards in each region, so as to identify the appropriate responses. All government jurisdictions and catchment/landcare groups are investing significantly in hazard prediction, but by various means. The National Land and Water Resources Audit is working to bring greater standardisation to this approach, and to provide a national picture.

However, despite considerable investment in developing farming systems that improve water use and in promoting land use changes, such as farm forestry and perennial pastures, we cannot be confident they will achieve bio-physical sustainability in some environments. For instance, preliminary findings from Victoria indicate perennial grass or lucerne pastures have little impact on catchment discharge rates compared to annual pasture, in a high rainfall environment (greater than 600 mm rainfall). Yet lucerne has proved to be more effective in ground-water control in association with crop rotations in lower rainfall environments. Similar differences can occur with revegetation, depending on rainfall, tree layouts and other factors.

Combined work to evaluate both the bio-physical and economic impacts of farming systems and revegetation on a landscape scale, in different hazard zones or regions is justified.

This work is currently being undertaken by the National Land and Water Resources Audit.

Recharge areas Causing Impacts Elsewhere

Quite frequently, the damage caused by salinity occurs remote in time and place from the causes of the problem. Land management practices which seem economically viable, and even environmentally sustainable, can contribute, albeit indirectly, to infrastructure and environmental damage at some time after the practices are applied, and at considerable distances.

Where the damage to public or private assets justifies intervention, it may be essential to change land use, even though there is no degradation on the particular land. Providing appropriate incentives for such land use change is a challenge.

These areas can be identified from soil data and regional geo-hydrological studies. In some cases salinity management may be achieved by changing farming systems and plant species; others need to be returned to native vegetation.

Recommendation 2

Blanket recipes on how to deal with dryland salinity are likely to be inappropriate. Comprehensive analysis is required to identify those areas which would benefit from public and private investment, and those where such investment is likely to be totally ineffective. Dependent on the value of the areas under consideration, and on the costs and benefits of treatment, the emphasis should move from treatment of symptoms to treatment of causes. Support from federal programmes should be dependent on such planning.

We are concerned that current land clearing and new irrigation developments in semi-arid tropical areas have the potential to produce similar degradation as is now expressed in temperate areas. Research is needed on these northern tropical ecosystems and proposed farming systems, to examine the hazard and design salinity control strategies to ensure that the mistakes which resulted in salinity in southern Australia are not repeated in the tropics.

Recommendation 3

There are a variety of reasons to protect native vegetation, and we applaud Government endeavours in this direction. Land clearing should only be allowed after (among other considerations) a thorough analysis of regional water balances has been undertaken and there can be clear assurances that such clearing and the new land uses will not exacerbate future dryland salinity problems. This is largely an issue for the States, and it is important to draw it to their attention.

Identifying Change Strategies to Address Salinity

We have applied the structural priorities framework developed by Professor John Stocker in his report *Priority Matters*, to guide our thinking on change strategies.

- Do we have the basic knowledge to address the issue?
- Is our knowledge useful to those who need to apply it?
- Do the potential users accept there is a problem and believe the knowledge and have ownership of it?
- Do they have the capacity to be innovative in addressing the issue?

The Science Base

Basic Knowledge

We have a good knowledge of the basic physical processes causing salinisation, and have had this understanding for a long time. The information needed to guide local decisions to ameliorate salinity is both costly and requires expert interpretation. Also, for every remedial action under consideration, there are economic assessments to be made and social impediments to cope with.

What is required is continued investigation and innovation focussed on applying our existing basic knowledge. Adaptive management strategies must have a strong underpinning in applied science. Our understanding of the innovation cycle is now such that we know that as we do this applications work, new issues will be identified that need basic research.

The Skills Base

Research into, and gathering of information on salinity is already the subject of work by bodies such as the CSIRO, AGSO, the National Land and Water Resources Audit, the Rural Industry R&D Corporations, the National Dryland Salinity Program, State governments and increasingly private sector consultancy firms.

Australia has a good record in soil science and hydrogeology, but there is less of a skill base in landscape interpretation and the integration of agricultural systems and vegetation aspects with economic constraints. Due to the lack of employment prospects students are not choosing to enter these areas, and in some areas such as soil survey, we are probably becoming seriously de-skilled. In other areas, such as hydrogeology, the declining trend in graduate numbers suggests that we will be de-skilling in these fields in 5 to 10 years' time.

We do have a small number of internationally recognised scientists in this area, and some important research teams. Australian scientists are well connected with international science in this area, and Australian work is well regarded, but the skill base is small with little recent recruitment.

We also need continued and expanded investment in the means of delivering the outcomes of biophysical research. This involves social and economic research on adapting institutional arrangements, socio-economic modelling, decision support methods, and extension methods.

There is a need to provide better connections between the disciplinary experts who tend to operate in disciplinary isolation. Integrated, management-oriented solutions are essential to success, and we need various scientists to work together, and with the resource managers. Organisational and funding arrangements have not facilitated these collaborative efforts at the appropriate sales.

To Develop Applicable Knowledge

We have patchy knowledge of the extent of the existing problem and the areas at risk. This is being addressed in the National Land and Water Resources Audit. The National Dryland Salinity Program, the Murray-Darling Basin Commission, and the Western Australian government have all been active in this area.

The R&D effort now needs to focus on application of our basic knowledge base. We have invested in salinity research over a long period, and that work has led to our present understanding. However, to go forward we need a fundamental rethink in the applied research endeavour, and this is now starting to happen. The characteristics of the new research required include:

- better integration of the various disciplines so that groundwater, surface water, soils, plants and vegetation are treated as a whole system rather than isolated entities;
- work at the landscape scale which addresses causes and builds solutions for large areas of landscape and catchments rather than small plots;
- development of new farming systems and combinations of land uses that provide a better water balance in the Australian context than the European systems we have adopted; and

- supporting this with socio-economic investigations and decision support to better understand the conditions for adoption.

Water Balance of Plant Communities

We have incomplete knowledge of the water using capacity of various land uses and farming systems, particularly vegetation and much of the change to improved plant species presently under way may be ineffective at slowing salinisation. More knowledge is needed to understand how much these vegetation and farming systems will change the overall water balance, at the regional scale, over long periods of climate variability.

New Farming Systems

We are very deficient in good research into economic and feasible farming systems that are adapted to Australian soils and climate. In particular we need systems and new land uses, some leading to new industries, that can return landscapes towards the sort of water balance they were in under more natural landscapes. Most of our agricultural research is focussed on how to increase productivity by fine tuning current practices, or how to live with degraded land. There is less emphasis on seeking new crops and land uses that provide less of a water imbalance.

We now appreciate that substantial land use change is essential to reduce the problem of salinity. We need to develop new and improved farming systems and land management practices more suited to Australia's unique landscapes, including the potential to farm native plants and animals.

We need to develop diversified industries that can effectively use saline water. These could include aquaculture, bush foods, saltland fodder production and grazing, saline groundwater harvesting systems for irrigation of high-value intensive horticulture crops, specialist timber products, and enhancing nature conservation values; there is a role within this for developing halophilic crops through selective breeding or gene technology.

This work is high risk and long term, but is fundamental to finding ways forward in some areas. It is not a reason to do nothing now.

Reconnaissance Tools

At present the detailed hydro-geological studies needed to understand salinity in particular catchments are expensive and time consuming. We need to develop regional reconnaissance technologies that are quicker and cheaper if they are to be widely used. Airborne geophysics and satellite imagery are both under investigation, and we look forward to the findings.

We need improved techniques to characterise catchments according to dominant salinity-causing processes in the landscape, s that we can interpolate to other catchments. This is essential if we are to provide community groups and others more quickly with more reliable identification of hazard areas and better recommendations of appropriate interventions. We also need to identify areas where investment is inappropriate.

We would benefit from improved climate forecasting.

Recommendation 4

Further research is needed in farming systems and land use systems suitable for Australia which will have benefits in a range of areas, including dryland salinity. We need: more information on the water using capacity of various types of vegetation; experimentation with new farming systems that are adapted to the Australian climate; more cost-effective survey techniques; socio-economic R&D to create an enabling environment; and improved analysis techniques to quantify the aggregate impacts of land use patterns on the landscape. Much of this research must be at a larger geographic scale that has characterised much past research, and must be focussed on management solutions within the context of economic and social conditions. CSIRO has made a start on this important work, and it needs to be accorded higher funding priority.

Linkages between the Producers and Users of Knowledge

There has been high levels of community involvement with salinity since the mid-1970s. The salt-action groups formed in Victoria and land conservation district committees in Western Australia were the precursors to the landcare movement which has flourished in Australia over the last decade.

The community based organisational arrangements already in place are fundamental to progress in the salinity area. An important institutional mechanism has evolved with local action (Landcare) groups driving on-ground responses under regional planning and coordination of resources by catchment committees. These bodies however need continued assistance to ensure they treat salinity at the appropriate landscape scale, within economic and social realities. They are not likely to be able, without considerable assistance, to develop and evaluate new agricultural systems appropriate to Australian soils and climate.

It is important to win the acceptance of stakeholders to take up the outcomes of increased understanding and knowledge and to change the way they manage natural resources. This will include taking a long-term view and funding programs accordingly; developing and applying market signals, incentives and disincentives that encourage sustainable resource use; and empowering regional communities by providing resources and supporting their works and extension activities.

We believe that the community is now ready to work with the research community to develop a number of large scale integrated salinity projects at the regional level to address salinity. It is imperative that we integrate our current knowledge base with landholders, community groups and regional planning. We need plans, but we need a decision framework to optimise on-ground actions to implement the plans.

Government authorities, landholders and managers, and research agencies have all recognised the needs for such initiatives, and plans for some of them are already fairly well developed. They now require leadership and support from governments, and the commitment of those who live with salinity, to be put into action. These initiatives all have in common the aim of engaging scientists, land-holders and managers, the communities and levels of government in concerted action at appropriate scales. They will help identify the key factors necessary to understand and address salinity, and to test the wide variety of possible treatments and other responses.

We see a need to choose some high priority areas for such long term studies where our best management practices are applied, but with a rigorous monitoring and evaluation program to let us assess outcomes. These studies need to look at biodiversity and downstream impacts as well as agricultural production. The scale will depend on the geographic area, but could be a catchment of up 20,000 sq km in some systems. In other areas such as Western Australia 50,000 - 100,000 ha may be adequate. We must address regional groundwater systems, and the time scale might be around 15-20 years to take account of rainfall variability. Atypical years can have dramatic effects on groundwater in some land systems. The National Land and Water Resources Audit is funding work into catchment classification and water balance analysis to set performance goals for a set of typical catchments. This work will provide the analytical framework for long term management oriented studies and action.

Recommendation 5

Three or four initiatives at the scale of large elements of the landscape and/or large catchments should be developed to demonstrate and evaluate integrated approaches to handling dryland salinity. This development should be undertaken in consultation and collaboration with communities which are prepared to take part. The Minister for Agriculture, Fisheries and Forestry should consider this proposal.

Failures in the Innovation Process

The working group believes that the lack of capacity to innovate has been the greatest failing in the salinity issue. While there is more to be done scientifically, many of the existing ideas are still not being used as widely as they need to be.

Given the reasonable knowledge base, and the heavy investment by landholders and governments, it is disturbing that the condition seems to be getting worse.

Salinity is a particular challenge since some of the farmers who must make significant changes do not suffer the consequences of salinity, which occur further away. This is particularly true in regional and intermediate flow systems, usually of lower physical relief and in more arid areas. Also the time between the cause of a problem and its expression may be quite long, 30-50 years not being uncommon. This long time lag does not make the linkage between cause and effect any weaker.

Failures in Communication

Users need to be provided with the scientific information and the regional data which will help them act in effective ways. Such information will allow them to take a comprehensive and integrated approach, which recognises the biophysical processes and the socio-economic environment.

Experiences with agricultural extension over the last 50 years has shown that for farmers to change, the change needs to be simple, divisible so they can try it in a limited area, and the results need to be obvious in economic terms. Salinity control measures fail on each of these elements. The challenge is to evaluate management options in situation-specific terms that give farmers the confidence to invest.

We seem to have significant shortages of skilled people to help local communities develop and communicate effective salinity management plans. We lack trained professionals who can

operate in the field, using available information and remote sensing to identify processes in a particular situation and identify appropriate remedial action. We are setting up a knowledge market with local communities as the primary purchasers of technical skills to progress their responses to salinity management. Research/investigation groups and consultants are the primary providers of those skills. In this type of market, it is not always the case that the purchaser has access to the technical skills required to know what they are buying or, when they have bought it, that it is what they require. In a contracting economic environment this market is highly competitive.

Economic Inability for Farmers to Act

It is recognised that many stakeholders 'on the ground' are aware of salinity issues, and have been involved in demonstration and education programs funded by State governments. They recognise to varying degrees the costs of doing nothing, and the benefits to be achieved from various different forms of investments. They are committed to investing in salinity mitigation projects, and are willing to entertain changes in land management, including diversifying production. This applies to towns and communities who see their houses and infrastructure at threat, as well as to farmers.

However, continuing falls in commodity prices over the past decade, and loss of the capital value of assets, have seen the loss of investment capacity in these communities. Landholders can make low-cost changes to their farming methods, but both landholders and town dwellers are looking to Government to provide the direction and incentives to make the substantial, but vital, changes. Some farmers have developed the necessary farm plans which have identified land degradation issues and the solutions, and are proceeding as best they can on their own, limited resources. Under current economic conditions, however, the integrated, whole catchment approach is not being achieved.

Governments need to recognise that such landholders and communities are among the most valuable resources in combating salinity. They have innovative ideas which would be valuable in changing land uses and management practices, and could be both commercially viable and environmentally sustainable, but lack the resources and assistance to develop these ideas further. This is a genuine example of an 'innovation gap', in that good ideas are not getting the opportunity even to be tested, let alone turned into practice. Further, these ideas would not contradict market directions, as they are largely based on new, potentially commercially viable land uses. There is a role for Government in sharing the financial risks involved in evaluating, developing and trialing these new approaches to land uses. The rewards, both financially and for rural communities and the environment, could be substantial.

Substantial risks are involved in the sorts of land use changes we believe are necessary to address the salinity problem. These changes will require government support in terms of both information, incentives and sanctions, and possibly infrastructure investments.

Stimulating Innovation

There is a need to bring about changes in land uses and land management practices, which incorporate innovative ways to reverse, stabilise or contain salinity. These changes will be substantial, and their benefits, will not always be evident to landholders, land managers or communities. If change is to come about in this climate of uncertainty and lack of information it will need to be fostered by policy, institutional and incentive arrangements which all reinforce the need for change, and promote change in the right directions.

At present, the mechanism to do this is lacking. The roles of the rural industry R&D corporations prevent them from moving in to this area, and the Natural Heritage Trust and the National Landcare Program do not cover such initiatives. Their roles are more as catalysts of specific activities, rather than as providers of persistent, ongoing support to initiatives that could take some time to develop and prove.

The hallmarks of successful schemes could include:

- Substantial business planning on the parts of individual farmers and industry associations, with assistance from governments in providing information, resources and expertise. Such business planning should include market research, consideration of production potential of alternative farming systems and benefit-cost analysis including risk analysis.
- Linking this business planning with regional planning processes, so that natural resource, social and economic benefits are evaluated on a regional scale, and proper land use planning and environmental assessments occur. Catchment plans need to address salinity in a comprehensive way.
- Partnerships involving landholders, catchment groups, regional development organisations, government and private sector expertise and resources;
- Investment in the face of risk, involving catalytic funding to drive the business and regional planning processes; risk capital and joint-venture arrangements to fund larger-scale field work, processing and value adding, and any technological development; and
- Proper evaluation and feed-back at every stage of development, with explicit decisions at every milestone, on whether to continue to provide resources or other support.

The case study on the potential oil mallee industry in Western Australia (see box) provides an example of this sort of approach.

Access to Technical Information

It should be noted that with the progressive withdrawal of agricultural extension services there is now less skilled technical advice geared to natural resource management available around the countryside. Landcare and catchment facilitators tend to have less specific knowledge and less experience, although they do have skills in seeking knowledge.

We believe there is a need for small teams made up of a mix of appropriate professionals to work for sufficient time to help local communities understand particular processes and solutions and to develop appropriate salinity management plans. Their unique contribution is to draw simultaneously on skills and knowledge in hydrology, soil science, farming systems, nature conservation, economics and engineering, within an intensive period of planning and deciding on actions. These teams must be able to assist in balanced decisions that extend beyond agricultural productivity. This approach has been used in Western Australia.

Recommendation 6

There is a need to encourage the development and use of small teams of well qualified and experienced professionals in the range of disciplines involved with dryland salinity, to provide rapid assessment and advice to those dealing with salinity issues. The involvement of producers and community groups with these teams is essential, and must be funded to allow their participation in designing and developing management solutions. The Minister for Agriculture, Fisheries and Forestry should explore this idea with the States, and consider funding support to implement it.

Oil Mallee Production: A Case Study in Industry Development for Landcare and Regional Economic Benefits

The development of a self-sustaining oil mallee industry in Western Australia's wheatbelt is the goal of the Oil Mallee Association of WA Inc. Over the past five years its members have planted about 20,000 ha or 8 million suitable species, with an ambitious schedule of producing 35,000t of oil per year, worth $150–$200 million, from 1.25 million hectares of plantings by the year 2025. This is an industry development model for dryland salinity management, which could achieve 40% of the State's revegetation target, if successful.

The Oil Mallee Project demonstrates a number of key elements in an industry development model.

- It is born out of a successful partnership of farmers (land conservation districts), governments (agencies) and research organisations (universities), supported by competent technical and business advice, and external investment, with a major commitment by government.
- In a share farming initiative between the farmers and the Department of Conservation and Land Management (CALM), a major portion of current plantings was achieved in four years, and further plantings are driven by commercial prospects and landcare goals.
- It took an allocation of $3 million of risk capital by CALM on behalf of government to kick start the project;
- Taking full advantage of existing landcare groups, and their investment in setting sustainability goals, in catchment planning and in changing land management practices, a representative industry association was formed which now drives the Project. The partnership is ensconced in board representation.
- A business plan was completed in 1997 covering all the variables in new industry development, including production potential, market opportunities, economic modelling, research and technology development (in harvesting and processing), intellectual property (genetic improvement), and an investment prospectus
- Research and technology development, involving Murdoch and Curtin Universities, has focused on continuous flow, portable distillation and mechanical harvesting to drive down costs. The projected R&D program is $1.9 million.
- Production improvement has focused on species selection for yield and quality, securing adequate supply of improved genetic material and demonstrating best practice in establishment and management.
- The market research has differentiated markets by volume and price, and assessed future competition from other major suppliers.
- Economic modelling has identified break-even prices and set thresholds for cost reduction through technology development, for scale of production and for quality of product, if there is to be a sustainable industry.
- Through effective landholder/landcare networks and "transparency" in the investigations of the Oil Mallee Association, there is every opportunity for farmers to assess this industry option.

While the Oil Mallee Project is not yet an established new industry, it has followed an industry development path which gives the best prospects for success and best informs investment decisions in the face of risk. At a bare minimum it is stimulating revegetation for groundwater control and land surface protection in regions where other options are severely limited. It is a valuable case study in applying an industry development opportunity to a landcare outcome—managing dryland salinity.

Salinity Management Plans

Salinity management plans should be essential components of regional or catchment action plans currently being developed to identify priority actions for the Natural Heritage Trust; and other funding schemes. These plans need to integrate actions funded from vegetation management strategies, Greenhouse strategies, property management planning, and the water reform process. They need to go beyond many current salinity plans and establish targets of salinity in the river draining the catchment, and possibly even develop water balance and revegetation targets. Such plans should be based on cost-effectiveness analysis, clear project documentation and the setting of performance criteria which are then monitored.

Funding Catchment Action

Partnership arrangements with community groups under Salt Action, Landcare and TCM programs have been one of the most exciting developments in natural resource management in Australia in recent decades, and are attracting international interest. Local communities have demonstrated their capacity to develop plans, and establish priorities for private and public investment. These groups have demonstrated the capacity to undertake on-ground works. It would be desirable to strengthen the performance criteria required for public funding of these activities.

Recommendation 7

There is a clear need for ongoing funding of research, planning and on-ground works, and there are major public benefits as well as the obvious benefits to land-holders. We urge the government to commit to ongoing financial support of community groups and agencies to facilitate implementation of those plans developed and accredited under earlier programs, such as the Decade of land Care and the Natural Heritage Trust. This will be addressed by the Minister for Agriculture, Fisheries and Forestry in the forthcoming statement on Natural Resources Management.

Joint Investment Strategies

It is apparent that we must encourage changes in land use and land management on private lands, and these changes may cost money in both establishment and recurrent terms. There are clear public benefits from some of these changes and we need to advance and operationalise our thinking on "joint investment" where public funds can be used on private lands where there is a demonstrable public benefit.

Regulatory Instruments

Environmental regulators are increasing their activities in rural areas, and are moving towards load based pollution licences for more intensive agricultural industries. This has difficulty with dispersed non-point pollutants like salt, and licensing provision is more likely to be based on farmers using best management practice for the area. Decision support systems are being developed already for these issues. There is real promise here to develop market signals to encourage change, with tradeable salt credits and other innovative market based approaches to pollution control being developed.

There is a view that regional land use planning, based on land capability and possible hazards, may be needed to slow and reverse the present degradation, although it is better to try market-based solutions first.

There will be a need for *regulation* to ensure proper vegetation management activities in all areas subject to dryland salinity; regulation should make use of cross-compliance, for example with only those regions that agree to vegetation management undertakings having access to funding. Vegetation management could include protection of existing remnant vegetation, revegetation, and forest harvesting and silviculture.

International Market Pressures for Quality Assurance

We are concerned that international trends for quality assurance procedures such as ISO 14000 may be used by competitors to restrict access of Australian products to various markets. These international standards are pushing for limited impacts on the environment, and farming systems where the hydrological imbalance is causing significant land and water degradation are not likely to be acceptable under such standards.

Recommendation 8

Regulatory and market-based instruments need to be used to influence the ability to address dryland salinity. A number of innovative approaches are being developed in various states. We recommend that the various approaches be documented and evaluated. This will provide guidance, and ensure lessons are carried beyond state borders. The Land and Water Resources Research and Development Corporation are undertaking this review.

Carbon Credits to Encourage Forestry

Replanting cleared land in the upland regions with rainfall greater than 600 mm a year with trees of various types is widely seen as making a significant contribution to using the annual rainfall where it falls and reducing leakage that causes problems elsewhere.

The proposed carbon credits system may provide a major impetus to this land use change with marked benefits to salinity issues. It is important that as the tool is developed we ensure it provides an effective lever for the land use changes that are needed. It may be desirable to have different rates to encourage deep rooted trees that will alter the water balance. Issues like the rate of carbon sequestration by different tree crops, how long term land use change can be assured and how effective pricing and trading structures are developed are important current challenges.

Recommendation 9

The development of a carbon credit trading system has the potential to be a complementary tool in addressing dryland salinity. We urge the Government to ensure that the Australian Greenhouse Office, in developing the system, consider the need for appropriate types of trees, and their location in the landscape, that can help regional water balance issues.

Best Management Practices for Rural Towns

There is a need for specific training programs for local government officers to ensure a better understanding of salinity processes and management. These people deal with development applications, and it is important they understand the need not to contribute processes that will lead to rising groundwater. Urban stormwater needs a careful management and should be discharged to surface streams rather than to groundwater.

Recommendation 10

Federal and State government should continue to alert local governments to the extent and implications of dryland salinity. The development of a manual on *Best Practice Planning Policies for Local Governments* would be valuable, to help ensure that development applications or proposals or land use practices will not contribute to dryland salinity. Disciplines involved in local government planning, such as town planners and shire engineers should also be influenced through conferences and professional associations. The Minister for Transport and Regional Services should be asked to address this issue.

Evaluation, Monitoring and Feedback

We have incomplete knowledge of how the systems will respond to our interventions, and it is essential to build in strong monitoring and evaluatory mechanisms so we can change our interventions if we are not producing the required outcomes.

Monitoring and evaluation are critical if we are to assess our current solutions and adapt them to work in a cost-effective way. Yet Australia is reducing its rainfall gauging networks, reducing its streamflow gauging network and some States do not seem to have a systematic groundwater monitoring program. Victoria and Western Australia have extensive groundwater programs, and the results of monitoring are available on the World Wide Web and CD-ROM. We see this as a good model. This monitoring and the modelling that can be based on its data are important because there are trade-offs that must be watched. As we plant more trees in areas with rainfall above 600 mm, we will reduce stream flow with other consequential impacts.

The Land Monitor project in Western Australia makes use of satellite imagery (Landsat TM) to estimate the area of salt-affected land, establishment of new vegetation and the condition of remnant vegetation, on a three year cycle. This technology and the application of spatial data to salinity hazard prediction is being assessed in a case study for the National Land and Water Resources Audit.

We need to develop and apply a consistent framework for *monitoring dryland salinity*, building on the current activities of the National Land and Water Resources Audit. This initiative would work with government agencies and Regional Catchment Committees to develop the monitoring network of sites and monitoring tools, provide information technology for data collection, and develop decision support tools for use by land managers. The data collected needs to be widely available on the World Wide Web.

Recommendation 11

Governments and individuals are not going to make appropriate investment decisions without good long-term data. Our data networks have been cut back in recent years. We need to ensure we have appropriate data on streamflow and quality, groundwater depth and quality, vegetation cover and salinised land areas. We also need to ensure effective monitoring of the interventions that are funded to ensure they provide the expected benefits. The National Land and Water Resources Audit should be asked to advise on appropriate monitoring and evaluation strategies.

Improve Community Awareness of Salinity and its Causes:

Most Australians are not fully aware of the degradation caused by salinity and its impacts on agriculture. They lack knowledge of the basic causes in terms of regional hydrologic imbalance. They also lack knowledge of the urban and biodiversity impacts. In view of the public investments that will be required to address the salinity issue it is important we develop a wider understanding of the issue and the need for action.

We have failed to communicate the need for looking at whole systems and looking for alternative agricultural systems. Most energy is devoted to trying to help established industries cling on in degraded areas.

IMPLEMENTATION

This report described the extent and severity of the dryland salinity problem. It is clear that we need to change the way we think about this problem, from research through policy to works, since it is getting worse. The research community has recognised the need to work at larger scales and to explore alternative farming systems, and some work is under way, but needs further stimulus.

But the real challenge of salinity, with which we are yet to seriously engage, is to get whole communities to recognise and tackle the problem in a meaningful way.

Despite major investments by governments, R&D agencies, agricultural industries and land holders over the last decade, the level of implementation of salinity management is still way short of that required to change current trends.

Coincident with the preparation of this report has been a number of initiatives which not only show promise for more effectively responding to dryland salinity, but are being negotiated nationally into new collaborative arrangements, with more rigour around the critical decisions of government policy, institutional frameworks, and "living with salt". These include:

- The National Dryland Salinity Program, managed by LWRRDC and with significant investment from the Grains R&D Corporation, the MDBC, and the National Land and Water Resources Audit;
- The National Land and Water Resources Audit;
- The Murray-Darling Basin Initiative; and
- CSIRO Land and Water.

They are committed to acting together upon the revised thinking reflected in this report, in the national interest. Details of their programs are appended.

State and Federal resource management agencies will need to address the challenge of implementation at the scales required. For instance, the Western Australian Government is revising its two years old Salinity Action Plan.

Clearly, a major 're-think' on dryland salinity is under way. In view of this the Prime Minister's Science, Engineering and Innovation Council would be advised to not only consider the above recommendations but to re-visit this issue when current strategy development has been finalised and is in place.

A review in two years will enable governments to make a better assessment of the levels of resources needed, and the institutional arrangements and policy instruments that might be effective in dealing with this challenge.

Recommendation 12

In view of the magnitude of this problem, and the reviewing of key strategies and programs that are now under way, we recommend that the Prime Minister's Science, Engineering and Innovation Council commissions another report in the year 2000 to evaluate the new approaches and the need for further actions.

Appendix A

The Working Group and its Charter

The 29 May 1998 meeting of the Prime Minister's Science, Engineering and Innovation Council considered an agenda item on priorities for science, engineering and innovation. The issue of dryland salinity, and its impacts on rural industries and the landscape, was presented as part of this agenda item, as an example of an economic and social issue of high priority, to which science, engineering and innovation can make a contribution. The Council meeting agreed that further work should be done on roles for science, engineering and innovation in addressing dryland salinity, with a report to be provided to the next meeting of the Council.

This report responds to that direction from the Council. It presents an overview of salinity issues, and identifies the sorts of long-term programs, policy environment and directions that Australia must adopt if it is to deal effectively with, and as necessary live with, dryland salinity in rural Australia. It also shows how dryland salinity represents a microcosm of natural resources management in terms of issues, strategies and activities which require investment. It identifies some actions and initiatives that the Government could take, as important steps in addressing the complex issues related to salinity and its impacts. There is an opportunity to take actions now which will, at manageable cost (and low cost compared with the damage salinity can do), help Australia address one of its most pervasive, insidious and potentially damaging natural resource problems.

Terms of Reference

a. To identify options for addressing the salinity problems in Australia

b. To investigate the role of S&T and the process of innovation in identifying and managing the salinity problem

Membership

Professor Peter Cullen (co-chair)	PMSEIC
Dr John Keniry (co-chair)	PMSEIC
Dr Colin Chartres	Australian Geological Survey Organisation
Mr Colin Creighton	National Land and Water Resources Audit
Mr Kevin Goss	Murray-Darling Basin Commission
Mr Bob Junor	Natural Resources Management Consultant
Mr Richard Price	Land and Water Resources R&D Corporation
Mr Paul Trevethan	Farmer, and Chair, NSW State Catchment Management Coordination Committee
Mr Ross Walker/ Mr Les Roberts	Department of Agriculture, Fisheries and Forestry - Australia
Dr John Williams	CSIRO Land and Water

Appendix B

Major Integrated Programs Addressing Dryland Salinity

THE NATIONAL DRYLAND SALINITY PROGRAM

This program was established in 1993 to address the lack of opportunity for the research community to cooperate across disciplines, organisational boundaries and state borders to address the management of dryland salinity. The first phase of the program was completed in June 1998, and was paramount in identifying the true diversity and cost of salinity's impact across Australia.

A second phase of the program, commencing in July 1998 and finishing in June 2003, was established in response to the need to address more fully the issues of dryland salinity, and to hasten the communication and adoption of the lessons of the first phase. Partners in the Program include LWRRDC, MDBC, DPIE, Environment Australia, Grains R&D Corporation, Rural Industries R&D Corporation, National Land and Water Resources Audit, CSIRO and the state governments of NSW, Qld, Vic, SA and WA.

The goal of the program is to research, develop and extend practical approaches to effectively manage dryland salinity across Australia. It will do this by focusing on:

- Causes, costs and consequences of dryland salinity
- Institutional arrangements for managing dryland salinity
- Management of saline landscapes
- Landscape processes associated with dryland salinity.

The program will ensure that:

- There is a framework for stakeholders to invest collaboratively and efficiently in addressing dryland salinity
- The program takes a national leadership role that will ensure the investments address priority areas and issues
- Investment targets the development of tools that facilitate the adoption of solutions via catchment-scale planning processes
- A clear communication and extension pathway exists for products and services arising from program activities
- Linkages with other relevant initiatives and programs are facilitated.

The program will address seven key themes:

1. Audit and monitoring
2. Policy and operating environment
3. Grain and related industries
4. New, emerging and other industries that use saline resources productively
5. Environmental protection and rehabilitation
6. Infrastructure management
7. State, regional and community initiatives.

THE NATIONAL LAND AND WATER RESOURCES AUDIT

The Commonwealth Government established the Natural Heritage Trust in the recognition that Australia's long-term economic prospects depend on the sustainable use of our natural resources and conservation of our unique biological diversity. We face significant challenges in repairing past damage to our land and water resources and restoring our environment for future generations.

The National Land and Water Resources Audit is one of the programs of the Natural Heritage Trust. Funding of $29.4 million has been budgeted for the Audit over four years to June 2001. The purpose of the National Land and Water Resources Audit is to provide a comprehensive national appraisal of Australia's natural resource base. Such an appraisal can assist natural resource management needs in areas such aspolicy assessment and development; investment decisions; evaluating program and policy performance; and direct resource management, particularly by government.

The objectives of the National Land and Water Resources Audit are to facilitate improved decision making on land and water resource management by:

- providing a clear understanding of the status of, and changes in, the nation's land (including vegetation) and water resources and implications for their sustainable use;
- providing an interpretation of the costs and benefits (economic, environmental, and social) of land and water resource change and any remedial actions;
- developing a national information system of compatible and readily accessible land and water data;
- producing national land and water (surface and groundwater) assessments as integrated components of the Audit;
- ensuring integration with, and collaboration between, other relevant initiatives; and
- providing a framework for monitoring Australia's land and water resources in an ongoing and structured way.

In most States some form of dryland salinity control and management plan is in place and activities range from research and development, to amelioration of the impacts of salinity, to establishment of productive uses for salinised lands.

The Audit will contribute to addressing dryland salinity through predictive research and development, involving data collation and modelling on the extent and trends of salinity. This work will require input from a range of sources including the National Dryland Salinity Program; State programs from Western Australia, South Australia, Victoria and New South Wales; and the Murray-Darling Basin Commission: The Audit will:

- quantify the physical extent and the environmental and social impact of the problem;
- provide a broad cost-benefit analysis of remediation alternatives; and
- predict the extent and cost of the problem and how these would vary if best management practices, rather than less appropriate ones, were being followed.

THE MURRAY-DARLING BASIN COMMISSION

The Murray-Darling Basin Commission was established in 1988 under the charter

> "to promote and coordinate effective planning and management for the equitable efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling Basin."

It is a partnership of six governments -- the Commonwealth, the States of NSW, Victoria, South Australia and Queensland, and the Australian Capital Territory -- prescribed in the Murray-Darling Basin Agreement. This statute law focuses on sharing the water resources of the Basin but significantly, enables institutional arrangements for integrated catchment management.

The Natural Resources Management Strategy (1992) is a high level philosophical statement which guides how the Commission is to address a range of water and land degradation issues under a government-community partnership. The Basin Sustainability Program (1996) guides the resourcing and implementation of the NRMS by making much more explicit the objectives, key results and performance indicators for integrated catchment management.

The rising salinity of the River Murray has been of concern for several decades because it threatens the consumptive use of this resource by a $4.5 billion irrigation industry, and the residents of Adelaide and many regional towns. The Salinity and Drainage Strategy (1988) was a direct response to this threat, but also has targeted the degradation of irrigated land and the potential loss of natural environments to salinity, in irrigation districts and along the Murray.

The Strategy set out to achieve a reduction of 80 EC (mean salinity at Morgan SA) through a balance of engineering works (salt interception works - ground water pumping and drainage) and non-engineering solutions (land and water management). In the following decade about $70m was invested in salt interception works and Land and Water Management Plans now exist for most irrigation areas. Monitoring at Morgan has confirmed that the initial target has been met.

In the normal course of events the Salinity and Drainage Strategy is being reviewed, in a three-stage project plan starting in 1997.

Stage 1: Collation of an information base for the review;
Stage 2: Identification of salinity management options; and
Stage 3: Comprehensive review and development of a Basin Salinity Management Strategy.

The new predictions for salinity, including the major hazard of dryland salinity featured in this paper, are a product of stage 1 of this review. This threat is of such concern that these preliminary findings have caused the Commission to accelerate the comprehensive review and drafting of a new strategy, to be completed by June 2000.

The Basin Salinity Management project has a high priority and will be directed by a project management board comprising Commissioners and Deputy Commissioners of the MDBC. Major stakeholdings in compatible dryland salinity activities are under negotiation, in particular the National Dryland Salinity Program and joint work with the National Land and Water Resources Audit, the Australian Geological Survey Organisation and CSIRO.

Through its Dryland Regions Sub-program under the BSP the Commission invests in complementary activities such as agro-forestry development and further understanding demographic limitations to the capacity to change land uses.

CSIRO-BASED PROJECTS

Introduction

In recent years CSIRO has delivered most of its effort in salinity through a significant contribution to the National Dryland Salinity Program (NDSP)- Stage I. This five year program was funded collaboratively by the Land and Water Resources Research and Development Corporation, the Murray-Darling Basin Commission, the National Landcare Program, CSIRO and State agencies.

In most instances, there was close collaboration with Australian Geological Survey Agency (AGSO) and State agencies. Work has been focused in the Liverpool Plains (NSW), the Loddon-Campaspe (Vic), the Upper South East of South Australia, Burdekin (Qld) and Kent (WA) catchments. These activities developed and evaluated methods and approaches that could be used across Australia to monitor extent and likely spread of salinity under current land use. They also provided tools to evaluate the effectiveness of current farming and land use practice and catchment management strategies in the control of salinisation.

These areas of work reflect the core capability of CSIRO in the biophysical and earth sciences although CSIRO staff contributed through the Australian Research Centre for water in Society in the socio-economic aspects of salinity.

The following projects make up the CSIRO contribution to the National Dryland Salinity Program:

1. Trends in salt loads and concentrations of stream flow in the Murray-Darling Basin
2. Flownet modelling of groundwater systems in the Liverpool Plains
3. Evaluation of the different measurement and modelling techniques for comparing the deep drainage under current and alternative farming systems
4. Risk analysis for dryland salinity development in the Murray-Darling Basin
5. Salinity and catchment health
6. The basics of recharge and discharge
7. Tree clearing and salinity risk in Northern Queensland
8. Mapping and monitoring land condition in the Blackwood and Frankland-Gordon Catchments using remotely sensed data
9. Predicting salinity risk using Fuzzy Logic: an attempt to avoid the use of process models
10. Evaluating the success of tree planting for degradation control
11. Use of farm forestry and tree configuration to control salinisation
12. Defining soil constraints to tree water use, growth and survival for managing groundwater recharge
13. Impact of dryland agriculture on land and river salinisation in the Western Lands, New South Wales
14. Management of regional groundwater discharge in an area of dryland agriculture