SUBMISSION BY THE GRAINS RESEARCH AND DEVELOPMENT CORPORATION TO THE INQUIRY INTO THE COORDINATION OF THE SCIENCE TO COMBAT THE NATION'S SALINITY PROBLEM

SUMMARY

The Grains Research and Development Corporation is a significant investor in salinity and water management through its own programs and through the National Dryland Salinity Program (NDSP). These investments in salinity are part of the Corporation's broader mandate to plan and invest in research and development (R&D) for the greatest benefit of the Australian grains industry and have close links with the Commonwealth's major natural resource management (NRM) investments in the National Action Plan for Salinity and Water Quality and the Natural Heritage Trust.

These investments also help to address the Australian Government's National Research Priorities. Since the Commonwealth announced its National Research Priorities in December 2002 and its Rural Research Priorities in March 2003, the Corporation has achieved a major advance in its understanding of the economic impact of salinity in Australia's cropping regions and the cost-effectiveness of salinity management options. This new information places the Corporation in a strong position to develop and deliver the cost-effective solutions that will need to be an integral part of the salinity solution. A number of case studies demonstrating how this is done in practice are included in the body of the submission.

The corporation is also working much harder to establish closer links between its traditional grower group network and catchment management authorities that are largely responsible for regional implementation of Commonwealth salinity and NRM programs. This will ensure that the scientific and technical knowledge that is possessed by the Corporation and its grower stakeholders is put to greatest effect in the national effort to combat salinity.

GRDC investments in salinity management focus on the development of tools to identify where salinity is occurring and where land use change needs to take place, what profitable options are available and the integration of solutions within the context of the whole farm.

A possible way forward for an enhanced Commonwealth role in managing and coordination of the application of the best science in relation to Australia's salinity programs is:

i) The level of scientific knowledge is not adequate to address the salinity problem. A continued emphasis on R&D, especially in relation to profitable solutions to dryland salinity is required.
ii) Greater scientific and technical support is required especially in Western Australia where salinity is having the greatest impact. A national approach to training and development is needed to build the capacity required.
iii) The rural research and development corporations (RDCs) are fundamental to any Commonwealth coordination. They have the links to growers who ultimate make the land use change on the ground.

iv) Partnerships between catchment bodies and regional industry grower groups are fundamental to achieve practical, profitable and effective on-ground change.

v) Information from all jurisdictions on salinity management needs to be accessible to those who wish to implement land use change. A national database that is freely accessible, interactive and free of institutional bias needs to be established.

It is important to acknowledge that communication of scientific findings alone will not solve the problem – or even minimise the impacts. Solutions need to provide an economic benefit to those implementing them, be low risk and simple to manage and have been successfully tested. Currently, there are few economic solutions other than lucerne over a small area. The Commonwealth can also play an important role by providing the right policy environment and/or financial incentives via the tax system to encourage landholders to adopt more sustainable salinity management practices. Moreover, market based and regulatory changes may eventually need to be part of the solution.

INTRODUCTION

The Grains Research and Development Corporation (GRDC) wishes to submit to the House of Representatives Standing Committee on Science and Innovation's inquiry into the Commonwealth's role in managing and coordinating the application of the best science to combat salinity. The Corporation is a significant investor[1] in salinity and water management through its own programs and through the National Dryland Salinity Program. This investment in salinity is part of the Corporation's broader mandate to plan and invest in research and development (R&D) for the greatest benefit of the Australian grains industry.

Of the 5.7 million hectares of land presently at risk or already affected by dryland salinity in Australia, some 2.6 million hectares are in grain growing regions. Moreover, just as the area of land affected by dryland salinity is predicted to increase substantially within 50 years, so the salt-affected area in Australia's cropping regions is predicted to increase by over 40 per cent to 3.7 million hectares within 20 years. The economic cost to the grains industry in lost farm profits over this 20-year period is estimated at $238 million (Kingwell, 2003), but salinity will also have significant environmental and social costs as it affects regional economies, damages rural infrastructure, and degrades the environment.

There is little dispute over the causes of dryland salinity – it is well recognised that land clearing for agriculture has disturbed the hydrological equilibrium that existed under native vegetation before European settlement (LWRRDC, 2000; Passioura, 2002). Less certain, however, is the solution to the problem. Many reports suggest that deep-rooted perennial vegetation offers great potential to manage water tables and

[1] The GRDC contributed $5 million to the National Dryland Salinity Program over the last five years and has committed $11.5 million for salinity and water management projects through its own programs between 2002-03 and 2007-08.

salinity, but studies indicate that the scale required is large and that there are few if any economic drivers in most regions (Kingwell, 2003). Similarly, engineering solutions such as groundwater pumping and deep open drains also have potential to reduce the salinity problem, but their on-farm economic justification is usually very weak (Kingwell, 2003).

The increasing extent and severity of Australia's salinity problem and the difficulty in finding cost-effective solutions highlights the need for improved coordination of salinity and water management at a national level. In this regard we congratulate the Commonwealth, State and Territory governments for agreeing to the National Action Plan for Salinity and Water Quality (NAPSWQ) and its matching funding arrangements. With the phasing out of the National Dryland Salinity Program in 2003, the NAPSWQ and the Natural Heritage Trust (NHT) have become the central pillars of Government support for the fight against salinity in Australia.

This submission focuses on the key factors the GRDC believes are necessary to facilitate on-ground application of scientific knowledge to combat salinity and how the Commonwealth might improve its management and coordination role in this area. First we consider the rationale for the GRDC investment in salinity management. We then table the range of GRDC investments in salinity management and outline the links with end users. Four detailed examples are given of where R&D is carried out with end users with effective outcomes. We then highlight the benefits of industry participation in developing the solutions, examine the adequacy of technical and scientific support and discuss some possible ways forward especially for the Commonwealth's role in managing and coordinating the application of the best science in relation to Australia's salinity programs.

RATIONALE FOR THE GRDC INVESTMENT INTO SALINITY MANAGEMENT

The purpose of the GRDC, reflected in its legislated objects under the *Primary Industries and Energy Research and Development Act 1989* (PIERD Act), is to identify, fund, manage, and deliver the results of R&D that will improve the profitability and sustainability of the Australian grains industry. The Corporation also has a role, on behalf of its other major stakeholder, the general community through the Commonwealth Government, to seek to also achieve public policy priorities in sustainable land, water and vegetation management.

The GRDC recognised in the early 1990s the potential importance of dryland (secondary) salinity to the industry, from the perspectives of both the threat of salinisation to cropping lands, and the potential contribution of farming systems based on annual crops and pastures to increased recharge. We also recognised that the grains industry and GRDC were only one player in this important national priority, and hence we have made every effort to integrate our own R&D investments in combating salinity with those of other groups. Initially this was by being an early investor and partner in the National Dryland Salinity Program, and more recently by becoming a foundation industry and funding partner of the CRC for Plant Based Management of Dryland Salinity.

The GRDC also determined early in the investment process that other groups were best placed to support generic R&D, for example methods to characterise or model catchments or to map salinity risk across all land uses. The Corporation instead focussed on work that would enable its industry to contribute to the national effort in salinity management, and on involving growers in the search for practical solutions. As a result, we have targeted three areas for GRDC investment.

Water balance performance of crops

The first area was to better understand the significance of changes in land use and management on the processes that underlay salinisation. It had been assumed that annual crops and pastures led to greater drainage of rainfall through the soil profile and, hence to greater groundwater recharge, than under native vegetation, but there was little quantitative data available; nor was there much data about the changes that could be brought about by improved crop agronomy to maximise use of soil moisture. The GRDC therefore invested in a range of projects across different climatic zones and farming systems to develop a basic data set on the water balance performance of crops. This has now been largely and successfully completed, and results were reviewed at a national workshop convened by the GRDC in February 2003. The quantitative data sets obtained have been used extensively to model and predict the impact of different types of cropping system in different climates (total annual rainfall and seasonal distribution) on drainage past the root zone, and this can be linked to recharge and salinity risk if other information is available.

Farming systems that use more available soil water

Secondly, the GRDC has made substantial investments into the development of profitable farming systems that use more soil moisture and thereby reduce recharge. The rationale here is that where salinity occurrence or risk can be addressed by changing the farming system (e.g. through cropping more frequently, growing bigger crops or re-introducing deep-rooted perennials), this requires decisions by private landholders, and adoption of improved systems will be much more rapid if they are profitable. Our investments have included (and continue to include) the search for new germplasm (ie new plants or varieties) that are suited to the different climates and soils of Australia, the demonstration and evaluation of new farming systems and the agronomic practices required (especially for the use of lucerne within mixed farming systems), and the economic analysis and modelling of those systems. We have also supported, usually jointly with other groups, work on agro-forestry and alley farming options, on phase farming (alternating phases of annual crops and perennial pastures), and on improved agronomy (e.g. management of fallows).

Grower group involvement in R,D and E

The third focus for the GRDC has been to work directly with growers in all aspects of our salinity investment to ensure that project outputs are practical, have grower support, and can be readily adopted by the industry. This has involved supporting grower groups to become involved with the scientific studies outlined above, and also for additional work to test and improve the farming systems developed in those studies at a paddock or property scale. In this component, farming systems to increase

water use for both profit and sustainability have been trialled by grower groups from the agricultural region north of Perth right around the cropping belt to Central Queensland. Results are publicised by those groups to their members, and are communicated widely by the GRDC throughout the industry through field days, workshops and seminars, research updates for growers and advisers, and through paper and electronic media.

LINKING THE SCIENCE WITH END USERS

This is central to the GRDC's mission of driving innovation for a profitable and sustainable grains industry. As outlined in the preamble the grains industry is impacted and will potentially be impacted even more by salinity. Table 1 outlines the objectives of our current and recently completed salinity investments. The GRDC grower stakeholder has a focus on outcomes on the ground in terms of identifying where salinity is occurring, where land use change needs to take place, what profitable options are available and integrating solutions within the context of the whole farm. The best way to demonstrate these points is by case study example of four of our investments. A complete list of our current and recently completed investments is presented in Appendix 1.

Example 1. Targeting salinity at the farm-scale using enhanced soil maps from airborne geophysics and stream surveys (BRS00002 David Dent, Bureau of Resource Sciences- BRS).

The GRDC has recently invested in a project that will enable growers to test and use for on-ground decisions some of the products arising from the Salt Mapping and Management Support Program (SMMSP) of the NAPSWQ. The project follows on from an earlier BRS project part-funded by the Corporation, "Water-level change in the cropping areas of the western slopes of NSW", whose results have recently been published by the Bureau. The earlier project showed that it is vital to know not only where groundwaters are rising, but also why, and whether or not they interact with catchment salt stores. Due to redistribution over geological time, salt is not stored evenly across many catchments, and there are places where groundwaters may be rising but are not mobilising salt, and equally there may be large salt stores that are not connected to contemporary groundwater flow systems. If the community, including the grains industry, wish to target salinity abatement or prevention measures to where they will be most effective, we need this detailed information. The work in the Billabung catchment of NSW showed that a change in land use (eg revegetation with perennials) on only 16,000 ha of the total of 93,000 ha (equivalent to only 3% of the Upper Murrumbidgee region) could deliver half of the Upper Murrumbidgee salinity reduction target. The cost of developing these options for managing salinity at a farm level was about $0.60 per hectare, and the project set out a logical pathway of actions that could be applied elsewhere to assess and decide on salinity management options.

In the new project, BRS scientists are working closely with grain growers in the Jamestown region of the Northern Agricultural District of SA. Together the group will use outputs from the SMMSP, as well as local knowledge and results of past studies,

to better understand the processes driving salinity in this area and to identify the most cost-effective management options for use on-farm. The focus is on interpreting and integrating information from geophysics, hydrology and agronomy, together with farmers' own knowledge and data collected by them on-farm, and to use this to enable the whole community to consider options and their predicted benefits and costs. The GRDC believes this is an excellent model for linking the increased scientific understanding now available with local knowledge for local action, and could be adopted more widely for the NAPSWQ.

Example 2. Increasing lucerne adoption in farming systems: an integrated approach (DAV453, Tim Clune, Department of Primary Industries, Victoria).

The economic evaluation of salinity management options in cropping regions of Australia led by Kingwell, highlighted lucerne as one of the few profitable options to reduce recharge in agricultural systems. In this example, the project aimed to increase the adoption of lucerne phase farming systems in south-eastern Australia. Through this region there has been an over-dependence on annual based pasture phases in farming systems with associated high risk of water draining below the root zone. The project worked with a number of case study farms in the NSW-Vic slopes, SA-Vic Bordertown – Wimmera and SA – Vic Mallee zones to examine the benefits, costs and risks of adopting phase farming based on lucerne compared to the current systems more broadly used.

One case study farmer near Wedderburn (average rainfall 470 mm) previously had problems with winter waterlogging, soils not suitable for continuous cropping, variable annual pasture production and highly variable returns from grain versus more consistent returns from mixed farming. Over a 10 year period the case study farmer developed a new farming system. The key features included, (i) low cost lucerne establishment, (ii) intercropping into young immature lucerne stands, (iii) utilising the soil fertility build up under lucerne and (iv) changing from a wool focused sheep flock to a dual purpose flock based on wool and prime lambs. Cumulative cash flow had increased by 40% over a 10 year period compared to a system based on annual pastures. This is an excellent example of a "win-win", where recharge can be reduced and farm profitability improved. The project focuses on sharing the experience of this case study and others with grain growers in the region through public and private extension networks.

Example 3. Evaluating impacts of deep drains on crop productivity and the environment. CSO204 (Tom Hatton, CSIRO Land & Water)

Modelling studies undertaken for several catchments in the WA wheatbelt in the late 1990s suggested that, following their clearing for agriculture, a new hydrological equilibrium would be reached in which up to 30% of the land area would be saline and unavailable for (current) agriculture. To slow or prevent this situation, up to 50% in some cases of the entire catchment area would need to be revegetated with perennial plants. These predictions resulted in increased interest in alternative and complementary management options, including the deliberate capture and draining of rising groundwater and/or reduction of recharge from surface water flows. Due to the strongly Mediterranean climate of the wheatbelt, average rainfall exceeds

evapotranspiration during the winter months, leading to significant risk of recharge and salt mobilisation, and it was suggested that both shallow drains (to capture and remove surface flow) and deeper interceptor drains (to capture subsurface waters) could prevent or at least slow the spread of salinity.

As a result of this interest from grain growers in the region and the wider community (many community assets are threatened by salinity in WA), the GRDC invested in work to evaluate the effectiveness and operation of farm drains. The project is based in the Wakeman sub-catchment near Narembeen in the eastern wheatbelt, and is monitoring soil, crop, and drain water factors across transects in both drained (mostly farmer-constructed) and undrained sites. The project has strong grower and community participation. Initial results show a general reduction in soil salinity levels especially in the upper (root zone) layers. There is often an immediate drop in water levels following drain construction, followed by a slower rate of decline. The early data show that drains can reduce water levels to a horizontal distance of greater than 100 m, but this may be very variable depending on soil transmissivity, occurrence of sand or gravel lenses within the profile, slope and hydraulic head. The quality of water in the drains is often poor, with high salt and nutrient loads and low pH, so there are likely to be significant disposal issues. As well, erosion of the drain banks and silting up of the channel are likely to require ongoing maintenance.

Results from this project, especially on the factors that enhance or reduce the value and feasibility of farm drains as a salinity management option, are being publicised both within WA as a contribution to the State Salinity Strategy, and in the eastern states where disposal of drain waters will be of particular importance.

Example 4. The Grain and Graze Program

The Grain and Graze Program is a joint initiative of the GRDC with Land and Water Australia and Meat and Livestock Australia. Grain and Graze commenced in 2003 and will initially be supported for a five year period. The key objectives of the Grain and Graze Program are to:

- Increase the profitability of mixed farming enterprises by 10%
- Improve water quality through, for example, reduction in recharge by incorporating deep-rooted pastures
- Enhance the condition and diversity of plant and wildlife both on farms and across catchments.

An important feature of the Grain and Graze Program is the emphasis on the participation of farmers, researchers and catchment planners in the design and implementation of on-farm trials and demonstration sites as well as training and communication activities.

The Grain and Graze Program encourages partnerships between catchment management boards and farming systems groups in an effort to match research objectives with those of catchment management plans.

To date, eight regions have been approached to participate in the Grain and Graze Program. Regions were selected on the basis of whether or not they included mixed

farming enterprises as a major stakeholder, had an active grower group and catchment management board working in the region and have been selected as a NAPSWQ region. At a regional level, activities will take into account the following factors:

- Local constraints to improved productivity, environmental condition and social well-being;
- Resource condition targets established by relevant catchment management groups operating across each region; and
- Program level targets which have been translated into regional targets

For several of the selected regions, salinity and research into salinity management will be a major issue.

Over time, the activities of the Grain and Graze Program will support a process of change involving awareness, motivation and testing of new ideas. There is an expectation that the Program will deliver a change in producers' attitudes, understanding and practice regarding the management of mixed farming enterprises and thus salinity.

Clearly, from these examples the GRDC has a commitment to involving end users, the grain growers, in regionally relevant R&D to address and minimise the impacts of salinity in the Australian wheatbelt. Since 1996 the GRDC has actively pursued a participatory R&D model where researchers together with grain growers identify research priorities, develop hypotheses, carry out research, analyse and interpret the data and draw conclusions from the work. Some grower groups such as Mingenew-Irwin, Mallee Sustainable Farming, and The Birchip Cropping Group develop the research issues themselves and then contract researchers to investigate the issues, with growers and researchers together developing up relevant solutions. Often the issue for these groups is salinity management, reducing the amount of deep drainage by cropping more frequently, using more of the plant available water and where possible using more perennial plants. The model is not perfect but it does ensure close linkage between researchers and users.

Future investments

The GRDC is continuing to support work in the second and third areas described in the rationale for investment, and we are now moving in our latest R&D Investment Plan (2004-05) to better link the grains industry work to catchment planning and management, including the development of end-of-valley salinity targets. Until recently there has been a differentiation in the minds of many landholders between Landcare-type activities and sustainable farming practices. We believe this has been an unintended, but nevertheless most unfortunate, consequence of the way that the Landcare and related programs have been established and managed. This artificial divide between government and industry programs in natural resource management needs to be overcome. At the same time, the GRDC is also very aware that the science of predicting and managing salinity has run well ahead of practice. For example, many of the new methods for characterising catchments or groundwater flow systems and hence predicting the likely impact of different management options on salinity extent or risk, while well-known to the scientific community are not yet being used in practice, even under the NAPSWQ program. The new GRDC investments aim to help

overcome this by enabling growers and scientists to work together in a small number of areas to test (through application to real life situations), and to then refine and publicise, these new techniques. These projects will also link growers and their decisions into the broader catchment community and its planning and monitoring activities.

ADEQUACY OF TECHNICAL AND SCIENTIFIC SUPPORT IN APPLYING OPTIONS

The rise in awareness by scientists, the community, politicians and governments has placed enormous pressure on the technical and scientific support available to apply salinity management options.

The CRC for Plant Based Management of Dryland Salinity, of which the GRDC is a supporting partner, is building capacity in the area of plant based management with an impact likely to occur well beyond the life of the CRC. CRC research on identifying plant characters that lead to more effective water use and reduced recharge, broadening the range of perennial plants available for commercial use, and developing farming systems that integrate these perennial options, will have an enduring impact. But this is only one component of addressing salinity.

The work outlined in example 1, identifying exactly where land use change needs to take place, requires more capacity if it is to be applied at a national scale. The expertise is simply not available in many parts of the country to understand the underlying causes of salinisation at the local scale and to examine what and where land use change needs to take place for maximum effect. These are skills that develop over many years of experience. Simply placing inexperienced coordinators in catchments does not achieve this. A national approach to training and development needs to be put in place to build the necessary local capacity. The skills required are an understanding of airborne and land based methods of identifying water and salt movement, and an ability to model potential impacts of land use change on these fluxes. It is difficult to achieve this level of skill without significant on-job or post graduate training.

The participatory approach that the GRDC has adopted in many salinity management investments requires a lot of scientific support. The level of consultation with growers required cannot be underestimated. To date most of this support has come from the public sector especially state departments of agriculture and natural resources. The in-kind contribution of these agencies has been fundamental to the success of the GRDC's programs. If this scientific support is not available the approach fails. The GRDC has experienced this and has been forced to terminate projects that theoretically should have been a great success but simply did not have the scientific support. The depletion of state government input into salinity management projects is most marked in Western Australia, where the salinity problem is the most severe with greatest impact on the grains industry.

In other jurisdictions it seems an issue more of coordination and communication rather than resources *per se.* In a series of recent meetings to establish regional activities within the Grain and Graze Program, this was the first time in some regions

that members of grower groups had met with the catchment boards or councils. This may reflect the emphasis taken through Landcare that investments could not result in personal profit for the land carer. In fairly small regional communities it was amazing that these people had not met in any formal way before.

The National Dryland Salinity Program, over the last decade has provided a unified approach to dealing with the salinity issue in an integrated way nationally on a relatively small budget. In its first phase its focus was on regional solutions through key catchments. In the second phase it focussed on the key barriers to changing practices to address salinity. Neither the CRC for Plant Based Management of Dryland Salinity or the NAPSWQ look likely to have the same level of wide commitment across all jurisdictions with current operational structures.

THE WAY FORWARD

The early focus of NHT/NAPSWQ has been on regional capacity building, providing support to gather baseline data from which to set regional NRM targets, and supporting the development of regional NRM plans. The question now is: is this focus still appropriate, or could Commonwealth resources be better targeted elsewhere? Possible ways forward for an enhanced Commonwealth role in managing and coordinating the application of the best science in relation to Australia's salinity programs are outlined below.

The scientific knowledge required is not all available

There seems to be an underlying assumption of the inquiry that the level of scientific knowledge is adequate to 'combat" the nation's salinity problem. This is clearly not the case, especially when it comes to the availability of profitable solutions. Certainly in the NAPSWQ there seems to be the mistaken assumption that the solutions are known and simply need to be rolled out into the key catchments. There needs to be continued emphasis on R&D especially in relation to profitable solutions. To this end the CRC for Plant Based Management of Dryland Salinity needs support – and long term support beyond the first funding round of the CRC. Greater effort also needs to be placed on developing integrated and cost-effective plant and engineering based solutions.

Build scientific capacity to identify where land use change needs to take place

As outlined previously, much greater scientific and technical support is required especially where salinity is having the largest impacts, namely in the Western Australian wheat belt. A national approach to training and development needs to be put in place to build the capacity required. The particular skills required are an understanding of airborne and land based methods of identifying water and salt movement in soil and water, and the ability to model potential impacts of land use change on these fluxes. Currently, there are simply not enough skilled people to assist identifying where land use change can take place in a catchment for maximum benefit.

Research and Development Corporations are fundamental to any Commonwealth coordination

As demonstrated by the GRDCs experience in linking and coordinating the application of salinity science to on ground change for grain growers, Research and Development Corporations are fundamental to the process of linking the science to end users. Joint Programs involving partnerships between RDCs and catchment bodies are fundamental to adoption of salinity science. It is ultimately the landholder industry members who implement the on-ground change. Any involvement of the Commonwealth in better applying the best science in relation to Australia's salinity problem needs to have the RDCs at the centre of the approach.

Build regional partnerships between industry and catchment groups

Partnerships between catchment bodies and regional grower groups are fundamental to achieve practical, profitable and relevant on-ground change. The matching of industry and catchment needs through programs such as Grain and Graze is a potential future model that needs broader support and involvement.

Establish a national database of salinity information

Develop a national database of salinity research and researchers (similar to the NSW SRDCC database for NSW). The database needs to be truly national, freely accessible and interactive. Currently, advice on what information is available is strongly flavoured by the institutional allegiances of the individual offering advice. For example, if a grower group in South Australia asks local agency staff what information is available it is usually restricted to South Australian government information.. The Commonwealth can take on a real role in providing an integrated national database of all salinity information. A table of the GRDC's current and recently completed salinity management investments is in Appendix 1. Information from these projects could be included in the national database

Communication of scientific findings alone will not solve the problem

GRDC research and assessments by the National Land and Water Resources Audit (2002) have found that the most likely sustainable natural resource management (NRM) practices to be adopted by commercially driven landholders are those that:

- provide economic benefits and have other advantages;
- are also low risk and simple to manage; and
- have been successfully trialed.

Similar studies of on-ground application of alternative practices by landholders typically conclude that the relative profitability of alternative practices is the main determinant of a landholder's actions. Highly profitable ventures are more attractive than others known to be inferior. However, if the returns are highly variable, uncertain or very distant, then attractiveness is reduced (Kingwell, 2003: p.129). Landholders are less likely to adopt practices that require large upfront payments, have long payback times, are unproven, involve complex legal, technical or financial arrangements, or are incompatible with existing enterprises.

These findings suggest that simply disseminating scientific knowledge to landholders may be insufficient reason alone for them to adopt it, since other factors such as economic benefit come into play once the scientific knowledge is available. It is therefore disappointing that part (c) of the Inquiry's Terms of Reference does not consider the adequacy of *financial support* in applying salinity management options – it considers only the adequacy of technical and scientific support. There is no doubt that R&D is an integral part of tackling the salinity problem, as it generates the scientific, technical and engineering knowledge referred to in part (a) of the Terms of Reference. However, R&D cannot possibly solve the salinity problem by itself. Governments can also play an important role by providing the right policy environment and/or financial incentives via the tax system to encourage landholders to adopt more sustainable NRM practices. Moreover, market based and regulatory changes may eventually need to be part of the solution.

Perhaps the simplest action the Commonwealth could take to encourage landholders to apply scientifically proven salinity management options would be to pay landholders directly or via the tax system, rather than relying mainly on their good will. For instance, achieving native vegetation target thresholds for salinity and water management through revegetation currently depends heavily on the good will of landholders because the grants and tax deductions for revegetation and fencing do not cover the opportunity cost of taking land out of production (CSIRO, 2003).

Focus on regional adoption as well as further regional capacity building

It is certainly necessary to maintain funding for catchment bodies to enable them to carry out their role of managing and coordinating regional NRM activities. However, given that the science of predicting and managing salinity has run well ahead of practice, perhaps it is time to shift some of the emphasis away from regional capacity building and place greater emphasis on supporting adoption. This is an area where the GRDC can offer the greatest support and advice to catchment bodies, given the Corporation's experience with grower-group networks and in the development and extension of more sustainable farming practices.

REFERENCES

CSIRO (2003). *Final Report – Native Vegetation Management in Grain Growing Regions*, CSIRO Sustainable Ecosystems report, August 2003, Perth WA.

Kingwell, R. (Ed.) (2003). *Economic Evaluation of Salinity Management Options in Cropping Regions of Australia*, Joint report, Grains Research and Development Corporation and the National Dryland Salinity Program, April 2003.

LWRRDC (2000). *Scoping Study – Opportunities to Breed, Select, Bioengineer Plant Species to Control Deep Drainage and Nitrogen Leakage*, Land and Water Resources Research and Development Corporation report, September 2000, Canberra, ACT.

Passioura, J. B. (2002). Environmental biology and crop improvement. *Journal of Functional Plant Biology*, Vol. 29: p. 537-546.

Appendix 1. GRDC current (2003-04) and recently completed (2002-03) projects on salinity solutions and management.

Leader Organisation	Title	Objectives	Links to users
WATER BALANCE PERFORMANCE OF CROPS			
CSIRO Plant Industry	**Optimising crop performance through innovative phase farming systems - new approaches to improve the nitrogen supply and management of the hydrological balance for crops in wet environments**	To develop and deliver management packages to growers which optimise the water and nitrogen (N) supply to crops following perennials (lucerne and grasses) in environments where too much water periodically constrains crop growth and yield potential.	Field days, Seminars, Updates
CSIRO Plant Industry	**Salt tolerance in durum wheat**	To identify salt-tolerant tetraploid germplasm that can increase the performance of durum wheat in sodic soils, and to investigate the physiology of the two major traits conferring salt tolerance:	Rural media, Rural magazines, Scientific papers, Research collaboration
CSIRO Plant Industry	**A novel approach to improve water use by grain crops**	To determine the role of water channels (aquaporins) on the hydraulic conductance of roots and whole plants of crops, with emphasis on wheat and lupin and to determine the role of environmental factors, on the activity of water channels and the potential to overcome limitations on water use imposed by this environmental factor.	Seminars, Rural magazines, Scientific papers, Conferences
CSIRO Plant Industry	**Improved crop yield after a perennial grass pasture**	To confirm the yield benefit of perennial grasses for subsequent crops, idenifying the reason for any benefit and to provide research training in agronomy.	Field days, Rural magazines, On-farm trials, Scientific papers
NSW Agriculture	**Breeding improved lucernes for cropping systems in eastern Australia - Phase II**	To deliver varieties which stimulate increases in the area sown to lucerne while also improving the benefits of adapted lucernes to eastern Australia farming systems.	Field days, Newsletters, On-farm research
S A Research & Development Institute	**The seed increase and distribution of perennial legumes to support sustainable and productive farming systems**	The annual multiplication and distribution of priority germplasm to meet the requirements of perennial pasture legume improvement programs.	Research collaboration
S A Research & Development Institute	**The seed increase and distribution of perennial legumes to support sustainable and productive farming systems**	To produce high quality seed, which is free of weeds and other contaminants to meet the priorities of Australian consumers of experimental seed of perennial legumes.	Research collaboration

S A Research & Development Institute	**Breeding lucerne for Southern Australian cropping districts**	To develop lucerne cultivars specifically tailored to match the environmental and farming systems requirements of the southern dryland cropping zone.	Field days, On-farm research
Department of Natural Resources and Environment	**Lucerne management for dewatering and production in grains-based mixed farming systems**	To investigate the impact of management on the ability of lucerne to dewater soil under grazing	Seminars, Field days, Grower meetings, Newsletters, On-farm research
Department of Natural Resources and Environment	**What is limiting the water use efficiency of cereal crops in the Wimmera and Mallee?**	To identify causal agent/s responsible for poor water use-efficiency by cereals in the Wimmera and Mallee regions with emphasis on edaphic and physiological agents, especially those limiting crop utilisation of sub-soil water and nitrogen.	Conferences, Seminars, Field days, Grower and Adviser Updates, Rural media, On-line, Scientific papers.
Agriculture Western Australia	**Improving crop production in windbreak and alley farming systems**	Quantify the extent and magnitude of crop yield reductions in the competition zone of tree species commonly grown in linear belts on various soil types and relate this to allelopathy, microclimate, tree root distribution, soil water extraction patterns and competition for nutrients.	Advice sheets, On-line, Rural media, Newsletters, Field days, Grower workshops
Agriculture Western Australia	**What are the limits to water use by annual crops and pastures?**	To generate a consistent extension message for farmers in southern Australia, with respect to the limits of water use by current crops and pastures, enabling a more balanced approach to generating strategies for salinity control.	Grower group meetings, Field days, Scientific papers, Conferences, Grower workshops
University of Western Australia	**Grains Industry Research Scholarship - Ms Alaina Garthwaite (UWA) Tolerance of Hordeum marinum accessions to the combined environmental stresses of salinity and waterlogging**	Identify accessions of Hordeum marinumwith exceptional salt and waterlogging tolerance for importation into Australia and further testing as potential sources of new genes for stress tolerance.	Research collaboration, Scientific papers
University of Queensland	**Grains Industry Research Scholarship Ms Marguerita Cohn (UQ) - The role of osmoprotectants in salinity tolerance of wheat**	To determine if the mechanism of salinity tolerance in a double haploid wheat population (Kite X Bindawarra) and in contrasting wheat cultivars, is predominantly the accumulation of osmoprotectants and to determine if frost tolerant germplasm also tolerates salinity	Research collaboration, Scientific papers
University of Western Australia	**Grains Industry Research Scholarship Mr Daniel Mullan (UWA) Chromosomal regions controlling salt tolerance in wheat and wild relatives**	To develop resources to identify chromosomal regions controlling salt tolerance from wild relatives that can be used for breeding adapted wheat varieties.	Research collaboration, Scientific papers

University of New England	**Ms Cheryl Kalisch (UNE) Development and application of a decision framework for the introduction of plant based solutions to salinity and relavant policy**	To assess whether an identified plant would present net benefits if introduced to Australia to mitigate salinity impacts, to identify a framework for assessing net benefits of plants identified in the future and to analyse the policy implications.	Policy and Scientific papers, research collaboration
Rural Industries R&D Corporation	**Contribution towards UWA 60A Perennial grain crops for high water use**	Screen perennial relatives of the major grain crops, plus high seed-yielding naturalised and endemic perennial grasses for their potential as grain crops.	Conferences, Field days, Scientific papers, Field tours, Rural media
Rural Industries R&D Corporation	**Contribution towards UWA 64A Integrate, segregate or rotate trees with crops**	To measure the trade off between recharge control and agricultural productivity for the five main agroforestry species in the medium to low rainfall zone of WA as a guide to the optimal design of agroforestry systems for water management	Field days, Field tours, Scientific papers, Rural media
The University of Adelaide	**Development of germplasm of bread wheat and durum for tolerance to transient salinity, aluminium toxicity and bicarbonate toxicity.**	Increased wheat productivity in southern Australia through the availability of varieties better adapted to the subsoil constraints at high pH arising from transient salinity, Al and HCO3- toxicities.	Field days, Farming Systems Groups, Scientific paper, Rural media.
The University of Adelaide	**Improving farming systems for the management of transient salinity and risk assessment in relation to seasonal changes in southern Australia**	To test selected genotypes for their water use efficiency, tolerance to transient salinity and ability to change subsoil constraints and identify agronomic practices from the field trials to manage transient salinity and their influence on salt movement in the soil profile.	Training workshops, Grower workshops, Advice fact sheets, Field days, Collaboration with Farming Systems Groups, Seminars, Updates
Charles Sturt University	**Sequencing crop rotations that best utilize lucerne biopores to control groundwater recharge and maintain dry catchments**	The purpose of this project is to study the root development of crops succeeding lucerne. The work will be undertaken in an instrumented lysimeter facility, fitted with two contrasting soil types.	Research collaboration, Annual results summary publication, Field days, Grower Updates, Seminars
CRC for Tropical Plant Pathology	**Pathology support for lucerne improvement including germplasm enhancement**	Regular surveying of lucerne in the cropping belt to identify lucerne diseases and pests causing production constraints and to provide on-going breeding programs with virulent pathogen isolates and to develop appropriate screening assays for diseases causing productivity decreases.	Scientific papers, Research collaboration
University of Western Australia	**Perennial pastures for cropping systems**	Identify alternative perennial legumes to lucerne for the 350-500 mm rainfall zone, for use in phase farming systems.	Field days, Seminars, Grower updates, Field tours, On-line, Rural media

University of Western Australia	**Improvement of waterlogging and salt tolerance in wheat using doubled haploids from crosses with international germplasm and wide crosses with "wild" Hordeum**	Evaluate current commercial cereal germplasm for waterlogging tolerance at germination and seedling stages (controlled environment) and to maturity (field).	Research collaboration, Scientific papers, Conferences, Seminars, Workshops, Rural and metropolitan media
University of Western Australia	**International collaboration for the collection of germplasm of herbaceous perennial legumes and rhizobia with which to develop plant solutions to dryland salinity**	To strengthen International collaboration in legume pasture research through joint collection and preliminary evaluation of herbaceous perennial legumes and rhizobia from South Africa, America and Central Asia.	Agribusiness meetings, Grower workshops, Field tours, Research collaboration
University of Western Australia	**Development of a salt-tolerant cereal using 'wide crosses' of wheat with 'wild' Hordeum species**	To screen 'wild' Hordeum germplasm to determine which species are potential gene donors for salt- and waterlogging- tolerance, and which of these can be hybridised with bread wheat.	Research collaboration, Conferences, Grower workshops, Research meetings, Rural media
FARMING SYSTEMS THAT USE AVAILABLE SOIL WATER			
CSIRO Land and Water	**Objective measures for managing the risk of deep drainage**	To develop guidelines for installing and interpreting simple, farmer-friendly soil moisture sensors to provide information on the effectiveness of farming practices in managing the risk of deep drainage.	On-farm research, field days
CSIRO Land and Water	**Commercial development of the drainage meter**	Drainage meters developed in accord with market expectations and requirements, and commercially available to farmers and researchers by 2005 underpining it's function in an EMS or as a tool for phase farming.	Scientific papers, Grower workshops, On line information distribution and storage
CSIRO Land and Water	**Evaluating impacts of deep drains on crop productivity and the environment**	Evaluation of surface drainage impacts on crop yield, surface salinity and waterlogging including an assessment of catchment-scale impacts associated with drainage including changes in the timing and amount of salt loads and concentrations as well as impacts on flood peaks.	Grower workshops, Seminars, Field days, Drainage manual
CSIRO Land and Water	**Managing the fallow period for optimum water use and nitrogen availability**	Understanding of the effect of stubble management on water and N cycling in crop rotations to identify optimum fallow management strategies for minimising deep drainage contributions without jeopardising crop performance.	Field days, On-farm trials

NSW Agriculture	**By how much can water use efficiency be increased and deep draining reduced by optional cropping systems management on Vertosols in NW NSW?**	Measure existing broadacre dryland farming systems ability to reduce groundwater recharge to prevent deep drainage and secondary dryland salinity.	Field days, On-farm trials, Scientific papers
NSW Agriculture	**How much deep drainage actually occurs in Vertosols under fallows and lucerne?**	Measure deep drainage in Vertosol soils under dryland agriculture using direct and indirect methods to verify indirect estimates of deep drainage using water balance methods in previous research on the Liverpool Plains.	GRDC Updates, Field days, On-farm research, Rural Media, Scientific papers
Agriculture Western Australia	**Soil and Surface water management for profitable crops and pastures on waterlogged and saline land**	Develop soil and surface water management practices for Raised Beds that: (a) drain and leach salt from the beds; (b) minimise capillary rise and salt accumulation in the beds; (c) reduce on-site groundwater recharge; (d) reduce the long-term export of salt into streams; and (e) facilitate profitable cropping and pasture growth.	On-farm research, Scientific papers, Seminars, Field days.
Agriculture Western Australia	**Warm season cropping systems on the South Coast of Western Australia**	Develop a risk analysis of warm season cropping for the south coast region of Western Australia to arrive at best bet options for maximising summer and winter crop productivity and minimising deep drainage.	Field days, Field walks, Rural media, Conferences, Newsletters, Grower updates, Seminars, Grower workshops
Dunin Family Trust	**Coordination of GRDC water balance R&D and collation of results**	Technical analysis and collation of data from the water balance research and development in GRDC programs 3.4 and 3.5, and related work funded by others to showcase to a wide audience of peers and practitioners, the GRDC-funded work aimed at improving soil water management in cropping systems.	Workshop, Scientific papers
Department of Natural Resources and Mines	**How much water is leaking from dryland agriculture - measurement and solutions**	Measure drainage below the root zone directly and compare with indirect methods (solutes, modelling and drainage meter etc) for different dryland farming systems and soils, and propose management solutions.	Grower meetings, Field days, Training workshops, Conferences, Scientific papers, GroundCover, Rural media.
University of Western Australia	**Grains Industry Research Scholarship - Ms Tenille Winter (UWA) Economics & policy mechanisms for salinity management in Western Australia**	To develop effective and efficient policy tools to help in the management of salinity and to investigate the application, design and benefits of economic policy instruments to manage salinity in WA.	Research collaboration, Scientific papers
Land and Water Resources R&D Corporation	**Contribution to the Viable Farming Systems that Lower Recharge**	Through participative R&D, to develop, test and validate new cropping systems with lower groundwater recharge than current systems.	On-farm research, Field days, Field tours, Rural media

Murdoch University	**Contribution to UMU17 A simple computer program for dryland salinity management Australian wide (FLOWTUBE)**	The goal of the program is to research, develop and extend practical approaches to effectively manage dryland salinity across Australia. The project will address all four of the NDSP key objectives, and is linked to Operating Environment, National Classification, Catchment Scale Scenario Modelling, Low Recharge Farming Systems, decision support tool for grazing systems projects, and the MDBS Tools project.	Field days, Conferences, Scientific papers, Grower workshops, Grower updates, Rural media
University of Western Australia	**Economic evaluation of salinity management options in the cropping regions of Australia**	To determine the economic viability of salinity management strategies from grain farmers' perspectives for different grain growing agro-ecological zones of Australia	Econoimic papers, Conferences, Rural media, Salinity management economics manual
University of Western Australia	**High water-use farming systems that integrate crops with perennial pastures**	The project expects to provide productive farming system options which integrate perennial pastures into annual cropping systems.	Field tours, Extension specialists, Field days, Rural media
University of Western Australia	**National field evaluation and selection of new pasture plants from the salinity CRC to improve hydrologic stability of farming systems**	To develop new perennial legumes, grasses and salt tolerant species which can be used in crop-pasture rotations to reduce recharge and increase the options for controlling the spread of dryland salinity and the decline in water quality.	Field days, Rural media, Research collaboration
GROWER GROUP INVOLVEMENT IN RD&E			
CSIRO Land and Water	**Defining agricultural management strategies that optimise water and nutrient use in Mallee environments of southern Australia**	Establish a cropping system model based on core sites to provide strategic direction, risk assessment and idea stimulation in the unique Australian environments of the Murray Mallee and Eyre Peninsula.	Scientific papers, Seminars, Grower workshops, On-farm trials
S A Research & Development Institute	**A million hectares for the future (SA component)**	To have a million hectares in WA and SA farmed under a simple environmental system within five years including the development of tools to allow growers to continuously their systems. (South Australian component)	Group activities, Rural Media, Field days, Newsletters, Grower workshops, Training packages

Department of Natural Resources and Environment	**Increasing lucerne adoption in farming systems: an integrated approach**	To develop farmer, researcher and technical adviser networks to facilitate the adoption of lucerne into farming systems in parts of the NSW-VIC Slopes, SA-VIC Bordertown-Wimmera and SA-VIC Mallee zones and to undertake whole farm economic analyses that consider the benefits, costs and risks of moving from current systems based on ley pastures to one based on phase farming.	Newsletters, Field days, Farm walks, Bus Tours, Grower meetings, Grower and Adviser updates, Conferences, Grower workshops, GroundCover
Agriculture Western Australia	**Farming systems with lower recharge for WA**	To develop, test and validate through participative R&D, viable new cropping systems with lower ground water recharge than current systems	Publications, Crop Updates, Rural media, Newsletters, Field walks, Training manuals, Training workshops
Agriculture Western Australia	**A million hectares for the future (WA component)**	To have a million hectares in WA and SA farmed under an environmental improvement system (EIS) within five years	Crop Updates, Rural media, Newsletters
University of Western Australia	**Low recharge farming systems for the southern wheat belt of WA based on lucerne**	To monitor the impact of phase farming with lucerne and to address systems-related problems associated with its introduction to Western Australia.	Field days, On-farm research, Training visits, Grower workshops, Newsletters, Annual seminars, Results manual
University of Western Australia	**Lucerne intercropping for sub-soil water management**	To test on-farm the use of wide-spaced rows of lucerne as a permanent background to annual cropping to reduce deep drainage.	On-farm research, Field days, Newsletters, Rural media
WDM	**SALT Magazine 2003**	Total design and print management of Salt Magazine 2003	Distributed directly to grain growers.