4

The salinity science base

4.1 This chapter presents an overview of the agencies and programs whose research efforts constitute the 'science base and research data' to address salinity. The chapter also summarises key research findings and products of these initiatives presented in evidence to the Committee.

4.2 The chapter is comprised of three sections:

- the work of national research agencies and programs contributing to the salinity science base (paragraphs 4.3-4.91);
- the private sector contribution to salinity science and technologies (paragraphs 4.92-4.94); and
- the recommendation for an audit of the Australian Government investment in salinity research (paragraphs 4.95-4.98).

National research agencies and programs

4.3 Drawing primarily on the evidence presented to the Committee, the following section summarises the contribution to the salinity science base provided by national research agencies and programs. The overview is not exhaustive of the research that has been undertaken, but presents a number of principal research findings and products.

4.4 Commenting on the National Land and Water Resources Audit (NLWRA), the *National Dryland Salinity Program*, and the Cooperative Research Centre Program, the Murray-Darling Basin Commission (MDBC) argued:

> Each of these initiatives have contributed significantly to salinity management through broad ranging research across environmental, engineering, social and economic domains;

provision of data and information; and developing predictive modelling capacity.[1]

4.5 The Australian Government funded research agencies and initiatives which contribute to the science base for salinity management include the:

- Bureau of Rural Sciences and Australian Bureau of Agricultural and Resource Economics;
- national science agencies—Commonwealth Scientific and Industrial Research Organisation, and the Australian Nuclear Science and Technology Organisation, among others;
- Cooperative Research Centres Program;
- Research and Development Corporations;
- National Dryland Salinity Program;
- National Land and Water Resources Audit; and
- university research.

Bureau of Rural Sciences and the Australian Bureau of Agricultural and Resource Economics

4.6 The Bureau of Rural Sciences and the Australian Bureau of Agricultural and Resource Economics, agencies located within the Australian Government's Agriculture, Fisheries and Forestry portfolio, 'undertake biophysical, social and economic science assessments to inform the Australian Government with evidence to guide policy development.'[2]

Bureau of Rural Sciences

4.7 A substantial component of the work of the Bureau of Rural Sciences (BRS) involves developing and applying advanced techniques to map salt and hydrogeological assessments to translate salt distribution into an understanding of salinity risk at the landscape scale. The Bureau argued that the mapping makes it possible to consider the range of viable actions needed to address the causes of salinity problems. Issues associated with salinity mapping are addressed in chapter seven. The BRS also conducts

1 MDBC, *Submission no. 51*, p. 8.

2 Australian Government Departments of Agriculture, Fisheries and Forestry (DAFF) and the Environment and Heritage (DEH), *Submission no. 72*, p. 6.

research into the factors that influence people to act and manage natural resources.[3]

4.8 The BRS conducts three programs which contribute to the science base for salinity:

- **Integrated Water Sciences Program**
  The Water Sciences Program provides scientific assessments of landscape processes, function and characteristics to inform investments of the *National Action Plan for Salinity and Water Quality* (NAP), *Natural Heritage Trust* (NHT) and the *National Landcare Program* (NLP). The Program has developed the application of airborne geophysics, integrated with hydrogeological assessments, field measurements and land use information, to map and predict salinity.

- **Landscape Sciences Program**
  The Landscape Sciences Program provides scientific advice on land use and land management issues. The Program produces spatial models of natural resource processes (eg. the impact of land clearing), applies advanced remote sensing (including satellite and radar imagery) to analyse agricultural landscapes and predicts the consequences of land use and management change.

  The Program coordinates continent-wide coverage with regional and catchment-scale digital land use data sets which provide a basis to develop cost-effective natural resource management (NRM) options. In cooperation with state agencies, the BRS has now achieved 80 per cent coverage of Australia with catchment-scale land use mapping. The Bureau anticipates that mapping of the entire continent will be completed by 2005–06.[4]

  The catchment scale land use maps are said to have wide ranging application because the data has been put together in a way that meets the requirements of national, state and regional users. For example, at the national level the maps help target investments and to monitor the effectiveness of programs such as the NHT and NAP. At the regional level, land use maps are used as an input to salinity modelling and planning. At the farm level, the maps assist landholders to understand how their farm is placed in a catchment context.

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3 *ibid.*

4 DAFF and DEH, *Exhibit no. 66, Land use mapping at catchment scale,* pp. 1-4. As examples of mapping scales, 1:25 000 means that 1cm on the map equals 250m on the ground; 1:250 000 scale means that 1cm equals 2.5km; and 1:2 500 000 scale means that 1cm equals 25km on the ground.

The BRS is the lead agency in the development of nationally consistent land use mapping. This includes a nationally agreed land use classification scheme, Australian Land Use and Management Classification, and other agreed procedures for dealing with coding and attribution, data structure, spatial referencing and accuracy.

BRS has produced a *Land Use Mapping at Catchment Scale* document to assist regional planners. A CD-ROM is also available to explain access to the land use data, with digital samples of the mapping, coverage and technical support information.[5]

- **Social Sciences Program**
  This Program involves work with regional catchment groups to assess landholder understanding and responses to dryland salinity. The Program uses surveys to provide information on landholder awareness of salinity and its processes, information about landholders' confidence in the science and practices currently recommended to address salinity, and data on their adoption of such practices. The BRS survey findings are provided to CMOs to assist them identify priority issues, particularly regarding effective communication with landholders.

Australian Bureau of Agricultural and Resource Economics

4.9 The Australian Bureau of Agricultural and Resource Economics (ABARE) provides information on economic aspects of NRM, including salinity control options, and this research is being used in the development of regional plans under the NAP.

4.10 In 2001–02, ABARE surveyed 75 per cent of broadacre and dairy farm businesses, which accounts for 98 per cent of Australia's agricultural production. The survey sought to investigate awareness of land degradation issues and the influences on management practices, including participation in national NRM programs. The survey found that landholders who participate in NRM initiatives were more likely than non-participants to have undertaken training, and more likely to have a farm plan which contained information about salinity management. Farmers identified a range of benefits from participation in national NRM programs including on-ground works, skills and information, improved community interaction and a better understanding of land degradation issues.[6]

5 DAFF and DEH, *Submission 72*, pp. 15-16.

6 *ibid.*, pp. 16-17.

4.11 ABARE has also developed a Salinity and Land Use Simulation Analysis (SALSA) model to integrate catchment scale hydrological and hydrogeological relationships with an economic model of land use. For example, SALSA was applied to analyse the implications of saline irrigation supplies in the Murray-Darling Basin for grape yields and producer returns in the viticulture industry.[7]

4.12 Support has been provided through the NAP for several projects aimed at developing tools and technologies to assist salinity management. These projects include:

- **A review of salinity mapping methods**
  In 2003 a project was endorsed by the NRM Standing Committee (NRMSC) to review salinity mapping methods in the Australian context. The review was prompted by the confusion created by salinity hazard and risk maps generated by different mapping methods to serve different purposes.

  The review has evaluated the range of methods available in Australia for mapping the extent and severity of salinity in Australian landscapes. It provides an assessment of the value and reliability of salinity mapping methods, so investors can be confident about their options and the products they purchase. The products of the review include a technical report and user guide aimed to assist landholders, sub-catchment groups and CMOs. These documents are available on the internet.[8] It is expected that not all sectors will necessarily accept all the findings of the review.

- **Guidelines for best practice in the public presentation of salinity data and mapping products**
  Through the Science and Information Working Group of the NRMSC, the Australian Government has developed nationally agreed *Guidelines for Best Practice in the Public Presentation of Salinity Data and Mapping Products*. The Guidelines aim to minimise the negative consequences from the public release of salinity and other NRM data and interpreted products.[9]

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7 *ibid.*, p. 17.

8 The Technical Report and User Guide for *The Review of Salinity Mapping Methods in the Australian Context*, viewed 19 April 2004, <www.ndsp.gov.au/80_airborne/airborne.htm>. Transcripts of the public forum convened by the Australian Academy of Science and the Academy of Technological Sciences and Engineering on 17 October 2003, to receive and critique the draft review products are available online, viewed 5 February 2004, <www.science.org.au/proceedings/salinity/index.htm>.

9 DAFF and DEH, *Submission 72*, pp. 18-19.

- **Stocktake of salinity tools and technologies**
  A national investment project of the NAP has collated information about each of the salinity models supported by government agencies and private industry into a single compendium, the Practical Index of Salinity Models (PRISM). PRISM provides information on over 90 tools, models and frameworks that can assist NRM planning at the regional scale. The resources of PRISM are presented in an Microsoft Access database or Excel spreadsheet format. The accompanying PRISM User's Guide describes the tools, models and frameworks and how these can be applied to assist the regional planning process. PRISM is provided on a CD-ROM and is available from Land and Water Australia.[10]

- **Review of desalination technologies**
  Reports have been produced which compile information about available desalination technologies and their potential to provide a cost-effective salinity and water quality management tool, particularly in NAP regions.[11]

National science agencies

Commonwealth Scientific and Industrial Research Organisation

4.13 Over the past 30 years the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has been involved in a wide range of salinity related research, including:

- catchment studies that provided a conceptual framework for understanding salinisation processes (these included studies in the Collie catchment of Western Australia; participation in *National Dryland Salinity Program* focus catchments of the Upper South East of South Australia, Liverpool Plains of New South Wales, Loddon Campaspe in Victoria, Kent River in Western Australia and Upper Burdekin in Queensland; and NLWRA case studies);
- measuring and estimating recharge across different landscapes and land uses to determine the effectiveness of current farming systems;
- development and application of remote mapping technologies (for example, Land Monitor in Western Australia) and geophysical techniques;
- understanding the impacts of plantations on hydrology;

10 *ibid.*, p. 19.

11 *ibid.*

- development and understanding of saline agriculture and forestry systems;
- development of tools to support decision-making for farming systems (for example, Agricultural Production Systems Simulator – APSIM), groundwater (for example, 'FLOWTUBE' model), catchment planning (for example, Floodplain Impacts Model), climate change and forecasting scenarios;
- improved tools for ecological understanding (eg. the salinisation of floodplains);
- improved social and economic tools;
- engineering support; and
- landscape characterisation (for example, Australian Collaborative Land Evaluation Program—ACLEP).[12]

4.14 CSIRO submitted that a number of key findings have emerged from this salinity research. These are summarised and listed here:

- The public and private investment required to shift to sustainable land and water management is massive, will require greater resources and will take some decades to achieve. The use of regional targets for natural resource outcomes and regional investment plans provides a framework for setting priorities. This allows instant action to mitigate some problems while allowing planning for other issues to commence.
- Currently, there is a limited range of robust profitable farming/biological systems that will reduce recharge to the extent required to make a major difference to the salinity problem. It is imperative that more innovative systems be developed and current systems modified to be appropriate for the Australian landscape. For example, developing tree-based systems that can also provide carbon sequestration, biodiversity and other benefits as well as salinity mitigation. It needs to be recognised that there may be significant time delays in developing these new systems, but there are some existing systems that can be adopted and these should be encouraged where it is appropriate to do so.
- The conceptual understanding of salinity processes is generally good, but to manage salinity effectively requires greater understanding of the spatial variability of these processes.

12 CSIRO, *Submission no. 42,* pp. 10-11.

- Climate variability has to be factored into understanding salinity processes and the development of salinity management options.
- There is a need for research investment to develop tools to assess the effect of paddock-scale management changes on end-of-valley salinity targets.
- Local information for monitoring land and water degradation is often deficient, abstract and catchment scale, rather than based on local information applicable at the farm level. Information needs to be provided at a finer scale, locally applicable and its impact assessed against a regional target.
- There is a need for a triage approach to salinity management for both public and private investment—based on identification of assets that can justify major interventions to protect them, areas which need to be managed to minimise adverse impacts, and remaining areas which require management that adapts to more saline conditions.
- Nationally, there is still scope to avoid further salinity outbreaks through maintenance of perennial cover and through use of planning regulations.
- Engineering will be required in the short to medium term to protect some assets. However, it needs to be recognised that such schemes must be part of an overall catchment plan which incorporates best management practice with respect to siting, design, disposal of saline water, water re-use, environmental impacts and so on.
- A much greater knowledge is required to understand impacts on biodiversity (terrestrial, floodplain and in-stream, and to manage land and water in a way appropriate to maintain important ecological assets and function.[13]

4.15 CSIRO is currently involved in partnerships and major programs that are delivering salinity research and development (R&D) for industry and community benefit, including:

- the *Heartlands Project* (with the MDBC), the objectives of which include developing new systems of land use that are more resource efficient than current practices and developing new production systems for agroforestry and agriculture;
- the *National Dryland Salinity Program*;

13 *ibid.,* pp. 4-7.

- the *Joint Venture Agroforestry Program* (with the Rural Industries, Land and Water Resources, and Forest and Wood Products Research and Development Corporations), which aims to integrate sustainable and productive agroforestry within Australian farming systems; and
- several Cooperative Research Centres, including the Centres for Catchment Hydrology, Plant-based Management of Dryland Salinity and Landscape Environments and Mineral Exploration.

4.16 CSIRO Land and Water has published numerous reports describing significant salinity research findings.[14] Three CSIRO salinity reports were drawn to the Committee's attention and their findings are briefly summarised here.

4.17 In 1999 CSIRO prepared a report for the MDBC entitled *Effectiveness of Current Farming Systems in the Control of Dryland Salinity*.[15] The report outlined the causes and extent of dryland salinity in the Murray-Darling Basin and found that, for much of the Basin, current farming systems would not be able to control salinity. It concluded that agricultural practices would have to be modified significantly if salinity is to be brought under control. Specifically, it called for an intensive focus on redesigning farming systems that will control the amount of water leaking into the groundwater system. It was stated that a high proportion of trees would need to be incorporated into the landscape in the higher rainfall parts of the Basin. However, the report concluded that even if suitable practices were to be found and adopted immediately:

> we cannot return to conditions identical to the natural system. In many cases, improvements in dryland salinity would occur very slowly, if at all. Although smaller, local scale catchments may respond to best management practice within several years, the larger regional and intermediate systems may take much longer.[16]

4.18 CSIRO published a companion report in 2000, entitled *A Revolution in Land Use: Systems for Managing Dryland Salinity*, which investigated the capability of various land use options to deal with salinity and the prospect for new solutions from research, development and innovation. The report rated ten land use options, which included saltland farming, phase farming, perennial pastures, high rainfall tree products and agroforestry, against four criteria: relevance to the Basin, effectiveness in terms of each option's ability to reduce leakage, robustness and

14 *ibid.*, publications listed at pp. 10-11.

15 CSIRO, *Exhibit no. 82, Effectiveness of Current Farming Systems in the Control of Dryland Salinity*.

16 *ibid.*, p. 15.

profitability relative to current land uses. While some options deployed in certain locations were found to meet the four criteria, it concluded that no single land use option will halt the spread of salinity across the Basin. It was also concluded that a suite of novel land uses, matched to the diverse climate, soils, and hydrological conditions of the Basin, would need to be developed and deployed.[17]

4.19 The report concluded that there needs to be radical changes to land use incorporating features that include commercially driven tree production systems, and new farming systems made up of novel mixes of the best current annual and perennial plants.[18]

4.20 In particular, the report identified the need for:

- a wider range of commercially viable, deep-rooted perennial plants, including trees, shrubs and herbaceous plants;
- refined land assessment techniques to pinpoint the best locations for agroforestry and high-value annuals;
- ways of rotating and mixing perennial plants with current crops and new agricultural plants; and
- tools for land managers to monitor leakage and change land use accordingly.[19]

4.21 In G*roundwater Flow Systems Framework: Essential Tools for Managing Salinity*, published in 2003, CSIRO described a new decision support tool—the Groundwater Flow Systems (GFS) framework—to assist CMOs develop regional plans and guide investment decisions for salinity management.

4.22 A GFS is a model developed by hydrogeologists to explain the behaviour of groundwater in response to recharge. 'Recharge', as described in the explanation of salinisation processes, is the component of rainfall that drains into the free water below the earth's surface, or groundwater. 'Discharge' is a flow of groundwater to the earth's surface. The responsiveness of a GFS to recharge is closely related to the length of the flow path (the distance between recharge and discharge areas) and the

17 CSIRO, *Exhibit no. 81, A Revolution in Land Use: Emerging Land Use Systems for Managing Dryland Salinity*, p. 2.

18 *ibid.*

19 *ibid.*, p. 23.

hydrogeological properties of the aquifer, which is the layer of soil or rock which holds water and allows water to move through it.[20]

4.23 In its National Classification of Catchments project, the NLWRA (described in a following section), defined three major groundwater flow system types:

- local flow systems extend only a few kilometres along the flow path, the aquifers fill relatively quickly and, land and river salinity appear within a few years of land clearing;
- intermediate flow systems extend five to 50 kilometres and take 50–100 years to develop land salinity, but perhaps less for river salinity; and
- regional flow systems, which typically have recharge and discharge areas separated by large distances greater than 50 kilometres.[21]

These three broad types have been further classified into 15 sub-systems—eight local, four intermediate and three regional. Conceptual models have been developed to describe each of the 15 flow systems, their different characteristics that influence the processes of recharge and discharge and their responsiveness to salinity control treatments.[22]

4.24 While the detailed processes of salt mobilisation and salinisation are thought to vary from one catchment to another and management options need to consider site-specific conditions, it is argued that similar groundwater flow systems in catchments with similar geologic and geomorphic characteristics should present common salinity issues. It is posited that these systems should therefore respond to similar management options.[23]

4.25 Given the impracticality of analysing each catchment and producing customised management options, the GFS framework allows knowledge from one catchment to be transferred to other similar catchments. With systematic classification of catchments and their groundwater flow systems, it may then be possible to design appropriate sets of generic management tools and extrapolate from these to other catchments.[24]

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20 CSIRO, *Exhibit no. 83, Groundwater Flow Systems Framework: Essential Tools for Planning Salinity Management*, p. 5. Significant hydrogeological properties of an aquifer include its *permeability*, which is the capacity of the soil or rock to allow water to pass through it, and the *hydraulic gradient*, the slope on a watertable that results in hydraulic pressure.

21 LWA, *Exhibit no. 71, Australian Dryland Salinity Assessment 2000*, p. 51.

22 CSIRO, *Exhibit no. 83, op. cit*., p. 11.

23 CSIRO, *Exhibit no. 84, Groundwater Flow Systems Framework: Summary Report*, p. 1.

24 CSIRO, *Exhibit no. 83, op. cit*., p. 9.

4.26 Drawing on work in nine case study catchments representing a range of flow systems, the report demonstrated the effectiveness of the GFS framework in contributing to salinity management. The framework allows:

- landscapes to be partitioned into discrete areas so that planners (at regional, state and national levels) can prioritise catchments in terms of salinity risk and likely responsiveness to management;
- results from well understood catchments can be extrapolated to other catchments where a similar GFS operates; and
- the framework allows the aggregation of information across the landscape to meet targets.[25]

4.27 The framework is expected to assist catchment communities assess the risk of salinity, its likely responsiveness to land use or land management change and the extent of change needed to meet targets.

Australian Nuclear Science and Technology Organisation

4.28 The Australian Nuclear Science and Technology Organisation (ANSTO), which is a statutory body in the Australian Government's Education, Science and Training portfolio (as is the CSIRO), 'undertakes research to advance the understanding of nuclear science and applies resulting technologies and capabilities.'[26] ANSTO applies nuclear-based techniques to a range of problems in environmental systems, including salinity.

4.29 A central element of ANSTO's research is its use of radioactive tracers, which are chemical elements that emit radioactivity. ANSTO is able to use tracers to calculate the rates of water flow in aquifers and the age of water in a flow path.[27]

4.30 Among its current projects, ANSTO is conducting research into groundwater management to identify processes responsible for salt build-up, the source of the salt and the paths of water flow that transport the salt to the land surface. The intention with this research is to identify and quantify recharge or potential discharge areas, and to identify where appropriate remedial action could be implemented to lower the water table and prevent salt mobilisation. Examples of ANSTO's research include the following:

25 *ibid.*, p. 24.

26 ANSTO, *Submission no. 22*, p. 2.

27 *ibid.*

- Electrokinetic sounding (EKS) mapping methods are used to map the flow of saline groundwaters and isotopic and geochemical techniques are employed to characterise salinisation processes. ANSTO is undertaking this work in several sites, including the Shepparton region of Victoria. EKS maps are said to be useful for defining the details of broad features identified by airborne geophysical mapping methods.
- Isotopic and geochemical methods are being used to characterise urban salinity and processes caused by urban development in Western Sydney. ANSTO maintains that this research could have implications for Australia's building codes.[28]

4.31 ANSTO conducts research in collaboration with other research institutions, including CSIRO, BRS, MDBC, Cooperative Research Centres, the Bureau of Meteorology, several universities and the New South Wales Department of Infrastructure, Planning and Natural Resources.

4.32 ANSTO and all other research and research funding bodies of the Australian Government will be expected to participate in implementing the *National Research Priorities*, to the extent that it is consistent with their mandates and missions. Announced by the Prime Minister in December 2002, the research priorities 'identify those areas that are of critical long-term importance to Australia and which require a whole of government approach.'[29] Salinity has been identified by the Australian Government as a priority goal for research under one of the four research priorities, 'An Environmentally Sustainable Australia'.[30]

Cooperative Research Centres Program

4.33 The Australian Government funds salinity research through the Cooperative Research Centres Program, which was launched in 1990 and aims to strengthen collaborative links between industry, research organisations, educational institutions and government agencies.[31]

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28 *ibid*., pp. 2-3.

29 Australian Government Department of Education Science and Training (DEST), *Submission no. 69*, p. 1.

30 The two relevant priority goals are 'Overcoming soil loss, salinity and acidity' and 'Water – a critical resource': Dr Robin Batterham (Chief Scientist), *Transcript of Evidence*, 24 November 2003, p. 15. Information on the National Research Priorities is obtainable from the web site of the Australian Government Department of Education, Science and Training, viewed 15 December 2003, <www.detya.gov.au/priorities>.

31 DEST, *op. cit*., p. 1. See also web site for the Program, viewed 25 April 2004, <www.crc.gov.au/>.

4.34 Of the 71 Cooperative Research Centres (CRCs) currently operating, several undertake salinity research. Two particularly significant CRCs are discussed below, but several others also conduct some salinity research to the extent that the issue affects their particular area of interest. These include the CRCs for Fresh Water Ecology, Cotton, Catchment Hydrology, Spatial Information, Viticulture, and Irrigation Futures.[32]

4.35 At least two CRCs have a significant focus on salinity research—the CRC for Plant-based Management of Dryland Salinity and the CRC for Landscape Environments and Mineral Exploration, both of which were established in 2001. The Australian Government will provide $27 million and $20.2 million over seven years respectively for each of these Centres.[33]

CRC for Plant-based Management of Dryland Salinity

4.36 The research focus of the CRC for Plant-based Management of Dryland Salinity (CRC PBMDS) is the management of dryland salinity through the use of profitable, perennial plant-based farming systems.[34] Two principles underpin the CRCs focus:

> firstly that farming systems should use perennial plants such that there is functional mimicry of the natural landscape; and secondly that perennial-based farming systems should be as profitable or more profitable than existing annual plant-based farming systems to encourage adoption of perennials on the scale necessary to impact on salinity.[35]

4.37 The Centre has eight objectives, which include:

- increasing the awareness of the need for change in dryland management practices and strengthening the will and capacity of rural communities to implement new land management systems;
- understanding the scientific basis for, and, through education, increasing the scientific capability to ensure effective development of plant-based solutions focused on coping with, arresting and / or reversing the impacts of dryland salinity;

32 DEST, *Submission no. 69,* p. 2. See also: CRC for Fresh Water Ecology, *Submission no. 26*; and Australian Cotton CRC, *Submission no. 67*.

33 *ibid.*, p. 2.

34 DEST, *Exhibit no. 60, Information on the Cooperative Research Centres*.

35 CRC PBMDS, *Submission no. 8,* p. 2.

- selecting and breeding woody and herbaceous perennial and salt tolerant plants for new farming systems and industries, which increase water use and enhance profitability;
- developing, evaluating and promoting land use systems that are profitable, reduce recharge to ground water, tolerate waterlogging and salinity in discharge areas, and reduce adverse off-site effects;
- developing and demonstrating profitable and practical animal production systems using salt and waterlogging tolerant plants in discharge areas, and new and existing perennial plants in recharge areas;
- evaluating economic and hydrological performance of actual and potential CRC outputs and developing policy options recognising the socio-economic opportunities and constraints that lead to the adoption of new land use systems; and
- developing and promoting effective land uses for salinity management that protect and enhance biodiversity values in the agricultural landscapes of southern Australia.[36]

4.38 CRC PBMDS conducts seven research programs:

- education and communication, including educating existing and emerging scientists;
- understanding the way natural ecosystems function in recharge and discharge environments;
- selecting, breeding and evaluating plants (herbaceous and woody) for new perennial-based land use systems;
- developing and demonstrating more profitable and environmentally viable farming systems, including:
  - ⇒ perennial pastures for the high rainfall zone of the Murray-Darling Basin;
  - ⇒ perennial-based land use systems for recharge areas in the Wheat Belt (of Western Australia);
  - ⇒ land use systems that make productive use of saline and waterlogged land;
- economic and social assessment of actual or potential plant-based systems for the management of dryland salinity;

36 *ibid.,* pp. 8-9.

- developing and demonstrating profitable and practical animal production systems; and
- developing and promoting effective land uses and tools for salinity management that protect and enhance bio-diversity values in agricultural landscapes.[37]

4.39 CRC PBMDS involves 11 core partners in four states and links to stakeholder organisations and groups.[38] The Centre's total budget is $170 million over seven years and employs 93 research staff.[39]

4.40 Among the CRC's supporting partners is Landmark, the nation's largest supplier of inputs to farmers. Landmark claimed that it has direct communication with approximately 100 000 farmers nationwide and argued that it will be 'a vital partner in the extension and commercialisation of the CRC's research outcomes'.[40]

CRC for Landscape Environments and Mineral Exploration

4.41 The research focus of the CRC for Landscape Environments and Mineral Exploration (CRC LEME) is to provide breakthroughs in mineral exploration, with flow-ons of airborne geophysical methods and regolith knowledge to environmental studies, particularly addressing dryland salinity and other natural resource management issues.[41] CRC LEME involves eight partners.[42] The Centre's total budget is $118 million over seven years and it employs 72 research staff.[43]

4.42 CRC LEME conducts five research programs which include salinity mapping and hazard assessment, and environmental applications of

37 CRC PBMDS, *Exhibit no. 12, Restoring the Balance*, p. 3.

38 The core partners of the CRC PBMDS are: New South Wales Agriculture; Charles Sturt University; Department of Primary Industries, Victoria; Department of Sustainability and Environment, Victoria; Department of Primary Industries and Resources, South Australia; Department of Water, Land and Biodiversity Conservation, South Australia; the University of Adelaide; Department of Agriculture, Western Australia; Department of Conservation and Land Management, Western Australia; University of Western Australia; and CSIRO.

39 DEST, *Exhibit no. 60, loc. cit.*

40 Landmark, *Submission no. 30*, p. 2.

41 DEST, *Exhibit no. 60, loc cit.*

42 The partners of the CRC LEME are: the Australian National University; CSIRO divisions of Exploration and Mining, and Land and Water; Curtin University of Technology; Geoscience Australia; Minerals Council of Australia; New South Wales Department of Mineral Resources; Primary Industry and Resources South Australia; and the University of Adelaide.

43 DEST, *Exhibit no. 60, loc. cit.*

regolith geoscience (that is, geology, geophysics and geochemistry).[44] The CRC also engages in education and training.

4.43 CRC LEME aims to map where salt is present in the regolith and the mobilisation of salt by the movement of groundwaters through regolith materials. The regolith is defined as 'the soil, sediments, and weathered bedrock, that lies between fresh air and fresh bedrock' and represents the 'major salt store in the landscape'.[45]

4.44 CRC LEME has worked on nine priority action NAP projects in South Australia and Queensland. These projects involved evaluating the use of airborne geophysics in groundwater mapping and salinity management.

Research and Development Corporations

4.45 Salinity research is a major component of the programs conducted by several of the rural research and development corporations (RDCs) established under the *Primary Industries and Energy Research and Development Act 1989*.[46] The RDCs are jointly funded by the Australian Government and industry.

4.46 The main salinity-related RDC programs, which are operated principally through Land and Water Australia (LWA), Grains RDC (GRDC) and the Rural Industries RDC (RIRDC), include:

- *Grain and Graze* (jointly managed by LWA, GRDC and Meat and Livestock Australia). This aims to achieve widespread adoption (among some 6 800 farmers) of mixed farming systems to produce a 10 per cent increase in farm productivity and improved conditions for natural resources on mixed farms. This is to be achieved through, for example, a reduction in recharge by incorporating deep-rooted pastures. The Program includes establishing eight regional research sites corresponding to eight regions of the NAP where mixed farming could assist in attaining regional NRM targets.[47]
- *Sustainable Grazing on Saline Land* (SGSL) is a major sub-program of Land, Water and Wool (managed by LWA and Australian Wool

44 CRC LEME, *Exhibit no. 85*, p. 6.

45 CRC LEME, *Submission no. 64*, p. 2. Soil constitutes the top layer of the regolith, which can vary in depth down to approximately 200 metres. The regolith is 'all the unconsolidated material above basically hard rock'. Mr Paul Wilkes (CRC LEME), *Transcript of Evidence*, 12 November 2003, p. 14.

46 DAFF and DEH, *Submission no. 72*, p, 6. There are fourteen rural research and development corporations, of which eight are statutory authorities and six are private companies.

47 LWA, *Exhibit no. 127, Land and Water Annual Report 2002-03*, p. 40.

Innovation), which is a national initiative focused on sustainable wool production. The *Sustainable Grazing* Program aims to achieve improved production and profitability from grazing saline lands and better environmental outcomes, by supporting the 41 per cent of wool growers nationally who have land already affected by dryland salinity. SGSL involves a producer network and demonstration sites.[48]

- *Joint Venture Agroforestry Program* (managed by RIRDC). Its aims include developing financially viable species for agroforestry systems and products, particularly for low to medium rainfall areas.[49]
- The *National Dryland Salinity Program* (managed by LWA). This is described in the following section.

4.47 Illustrating the importance of these and other salinity-related research programs conducted by RDCs, LWA argued that:

> In total, these programs involve major rural industries (including grains, meat, wool, dairy, sugar, cotton, horticulture and rural water authorities) in working collaboratively to support natural resource management science efforts. Further, they enable Land & Water Australia to straddle the critical issues of scale, from farming systems at a paddock scale and the industry-based extension programs needed to promote them; to work at catchment, regional, state and national scales with the full range of government, community and non-government organisations involved at those levels.[50]

Land and Water Australia

4.48 Land and Water Australia (LWA) submitted that it is responsible for 'R&D aimed at the productive and sustainable management of the land, water and vegetation resources underpinning Australia's primary industries and regional communities.'[51]

4.49 LWA explained that it has a charter to foster national collaboration in order to improve the effectiveness of the R&D effort and the majority of its

48 CSIRO, *Submission no. 42,* p. 8; Land Water and Wool, Sustainable Grazing on Saline Land, *Productive Solutions for Salinity Management*, Issue 1, Land and Water Australia, Canberra, 2003, viewed 12 February 2004, <www.lwa.gov.au/downloads/publications_pdf/PX030508.pdf>.

49 LWA, *Exhibit no. 127, op. cit.*, p. 46. Information on these programs and project products is available from the websites of the organisations involved, viewed 10 February 2004: LWA, <www.lwa.gov.au>; RIRDC, <www.rirdc.gov.au>; and GRDC, <www.grdc.com.au>.

50 LWA, *Submission no. 59*, p. 5.

51 *ibid.*, p. 1.

research investment occurs within national research programs and is conducted in partnership with other organisations. In 2002-3, LWA generated $23.3 million for its research investments.[52]

The Grains Research and Development Corporation

4.50 The Grains Research and Development Corporation (GRDC) invests in salinity research as part of the Corporation's broader mandate to 'identify, fund, manage and deliver the results of R&D that will improve the profitability and sustainability of the Australian grains industry.'[53]

4.51 The GRDC noted that of the 5.7 million hectares of land presently at risk or already affected by dryland salinity, some 2.6 million hectares are in grain-growing regions. Furthermore, the economic cost to the grains industry in lost farm profits due to salinity over the next 20 years has been estimated at $238 million.[54]

4.52 Recognising the threat posed by salinisation to cropping lands and the potential contribution of farming systems based on annual crops to increased recharge, the GRDC became an early partner and investor in the *National Dryland Salinity Program*, contributing $5 million to the Program over the last five years. More recently, the GRDC became a foundation industry and funding partner of the CRC for PBMDS.[55]

4.53 The GRDC also invests in salinity research through its own programs and has committed $11.5 million for salinity and water management projects for the period 2002–03 to 2007–08.[56]

4.54 The GRDC has targeted three areas for investment:

- water balance performance of crops – to better understand the significance of changes in land use and management on the processes that underlie salinisation;
- farming systems that use more available water—the development of profitable farming systems that use more moisture in the soil and thereby reduce recharge, including new plants and varieties; and
- grower group involvement in research, development and extension—to work with growers in all aspects of the salinity investment to ensure

52 LWA, *Exhibit no. 127*, *op. cit.*, p. 34.
53 GRDC, *Submission no. 29*, p. 3.
54 *ibid.*, p. 2.
55 *ibid.*, pp. 2-3.
56 *ibid.*, p. 2.

> that project outputs are practical, have grower support, and can be readily adopted by the industry.[57]

4.55 Rather than undertake generic research, the GRDC has 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.'[58] Consequently, the Corporation's investments in salinity management 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.[59]

4.56 Examples of these four themes in the GRDCs research investments to address salinity include:

- targeting salinity at the farm scale using enhanced soil maps from airborne geophysics and stream surveys (with the BRS);
- increasing lucerne adoption in farming systems in south-eastern Australia (with the Department of Primary Industries, Victoria)[60];
- evaluating impacts of deep drains on crop productivity and the environment (with CSIRO Land and Water); and
- the *Grain and Graze* Program (with LWA and Meat and Livestock Australia).[61]

4.57 The GRDC stressed that it is committed to a participatory model of R&D in which 'researchers together with grain growers identify research priorities, develop hypotheses, carry out research, analyse and interpret the data and draw conclusions from the work.'[62] The Corporation also noted that several grower groups (such as Mingenew-Irwin, Mallee Sustainable Farming, and The Birchip Cropping Group) initiate research projects themselves and then contract researchers to investigate the issues, which often involve salinity management.[63]

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57 *ibid.*, p. 4.

58 *ibid.*

59 *ibid.*, p. 5.

60 *ibid.*, p. 6: 'one of the few profitable options to reduce recharge in agricultural systems'.

61 *ibid.*, pp. 5-8.

62 *ibid.*, p. 8.

63 *ibid.*

4.58 Other RDCs have also conducted salinity research on behalf of their affected industries and extended the results to users. For example, the Grape and Wine RDC commissioned a recently published report entitled *The Potential Impact of Saline Irrigation Water on the Grape Industry in the Murray-Darling Basin*.[64] While noting that sodicity is regarded as a greater problem for the cotton industry, the Cotton RDC has also invested $1.2 million in mapping salinity risks in seven cotton-growing districts, covering 450 000 hectares.[65]

The National Dryland Salinity Program

4.59 The *National Dryland Salinity Program* (NDSP) is a 'collaborative research, development and extension program investigating the causes of, and solutions to, the problem of dryland salinity.'[66]

4.60 Established in 1993, the NDSP commenced in an environment where:

> there was no nationally coordinated dryland salinity research effort. Moreover, there was no national strategy for dealing with dryland salinity; few statewide strategies existed; experts argued about the size and cost of the emerging problem; catchment management was in its infancy; and Landcare and production interests were inadequately integrated.[67]

4.61 The NDSP was established in order to fund and coordinate dryland salinity R&D, and to promote the implementation of practices to combat salinity. The NDSP has sought to provide a national framework for stakeholders to invest collaboratively and efficiently in dryland salinity research:

> The NDSP has played a major management and coordinating role spanning ten years in the funding of new science, technical and engineering knowledge. In fulfilling this management and coordination role on behalf of its partners, the NDSP has funded

64 Grape and Wine Research and Development Corporation, *Submission no. 6*, p. 2.

65 Cotton Research and Development Corporation, *Submission no. 31*, p. 4. Sodicity is caused by the accumulation of sodium in soils. 'In sodic soils, much of the chlorine has been washed away, leaving behind sodium ions (sodium atoms with a positive charge) attached to tiny clay particles in the soil. As a result, these clay particles lose their tendency to stick together when wet—leading to unstable soils which may erode or become impermeable to both water and roots.' Sodicity is a more widespread form of land degradation than salinity, affecting 30 per cent of Australian soils and causing poor water infiltration, surface crusting, erosion and water logging. Australian Academy of Science, *Sodicity – a dirty word in Australia*, Canberra, 1999, viewed 11 March 2004, <www.science.org.au/nova/035/035key.htm>.

66 NDSP, *Submission no. 35*, p. 2.

67 *ibid.*, p. 1.

> numerous research projects aimed at answering the major questions in salinity management and in so doing, has produced a wealth of information currently being used in the management, coordination and implementation of salinity programs. Major research findings and outcomes which have been funded by the NDSP have had an enormous influence upon salinity programs and continue to be incorporated into the research and extension bases of these programs.[68]

4.62 For the Australian Government, the NDSP is 'Australia's major government-based salinity network and information resource ... the NDSP provides a major communication network for disseminating salinity science and information in Australia.'[69]

4.63 The NDSP was instigated and is still managed by LWA. The Program is funded by a consortium of industry and government agencies with an interest in salinity management, including: LWA, MDBC, DAFF, CSIRO, GRDC, RIRDC, Meat and Livestock Australia, and the six state governments of New South Wales, Victoria, South Australia, Western Australia, Queensland and Tasmania.

4.64 The Program has undergone two five-year phases and is now in its final year of operation. Over the period July 2003 to June 2004 the NDSP will conduct an Enhanced Communication Year, the objective of which is to synthesise and communicate all of the information produced over the life of the Program.

4.65 Phase one of the Program (1993 to 1998), which involved funding of $10 million, focused on understanding the causes and impacts of dryland salinity and establishing a national collaborative R&D effort. The NDSP stated that this phase:

> made significant headway in developing better research methods, coordinating research efforts and engaging rural communities in catchment management planning. It also helped break down the barriers between different disciplinary groups and government institutions and elevated awareness of salinity issues.[70]

4.66 Findings from the first phase also informed the conclusions of the Prime Minister's Science, Engineering and Innovation Council (PMSEIC) report,

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68 *ibid*., p. 15.

69 DAFF and DEH, *Submission 72*, p. 12.

70 NDSP, *op. cit*., p. 9.

Dryland Salinity and its Impacts on Rural Industries and the Landscape, and established that salinity is more just an agricultural problem.[71]

4.67 The second phase (1998 to 2003) of the Program encompassed a broader range of issues, which reflected a 'growing awareness of the wide-ranging impacts of salinity and the diversity of approaches that would be needed to address the problem.'[72] The second phase involved funding of $24 million and approximately 92 per cent of this was spent on R&D and project-related extension activities.[73]

4.68 The mission of the NDSP during this phase was to 'research, develop and extend practical approaches to effectively manage dryland salinity across Australia'.[74] Specifically, the second phase examined catchment processes, industry, engineering, policy, local government, environmental and regional dimensions of salinity, and set out to fulfil three tasks:

- improve the coordination of R&D and extension efforts;
- influence the direction of R&D by setting priorities and leading by example; and
- fill R&D gaps at the national level by funding a portfolio of projects.[75]

4.69 As the second phase of the Program evolved, the NDSP aimed to develop a place for itself as 'Australia's lead knowledge broker of R&D and extension efforts to combat dryland salinity.'[76]

4.70 In total, 43 projects were carried out during phase two and these were grouped into seven themes:

- Audit and monitoring. These projects examined the extent and rate of change in dryland salinity and its impacts at regional and national scales. Much of this research was undertaken in collaboration with the NLWRA.
- Policy and operating environment. These projects generated knowledge to support better policies, institutional structures and incentives for promoting appropriate management of dryland salinity.

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71 PMSEIC, *Dryland Salinity and its Impacts on Rural Industries and the Landscape,* Australian Government Department of Education, Science and Training, Canberra, 1999, viewed 22 January 2004, <www.dest.gov.au/science/pmseic/documents/salinity.pdf>.

72 NDSP, *op. cit.,* pp. 9-10.

73 NDSP, *Exhibit no. 25, NDSP Achievements Report,* p. 8.

74 NDSP, *Submission no. 35,* p. 10.

75 *ibid.,* p. 12.

76 *ibid.,* p. 10.

- Industry solutions. This theme recognised that agricultural industries are expected to suffer losses due to salinity and are also needed to contribute to salinity management. The NDSP had a significant focus on the grains industry, as this sector is expected to be the most at risk from salinity, and involved collaborative research with the GRDC and Meat and Livestock Australia.
- Productive use of saline resources. This theme examined ways to 'live with salt' by viewing salinity as a new resource, for example, by developing new farming systems and industries which profitably use or rehabilitate saltland.
- Environmental protection and rehabilitation. These projects developed ways of measuring the environmental impacts of salinity and understanding how to control them.
- Infrastructure management. These projects examined engineering aspects of salinity and its impact on public and private infrastructure.
- Regional and community initiatives. The aim of this theme was to promote investment in the provision of a national network that would link different state, regional and community activities.[77]

4.71 These themes, designed to address all aspects of dryland salinity including institutional arrangements and technical treatments, addressed the specific concerns of stakeholders and aimed to provide a focus for partners to target their investments. Most of the projects were managed by LWA, which also contributed $6 million to the second phase.

4.72 Examples of the range of research and extension activities that the NDSP funded, coordinated or supported during the second phase include:

- development of the catchment management planning CD-ROM, Practical Index of Salinity Models, which provides catchment planners with information on the strengths and limitations of an array of catchment planning tools;
- development of the GFS framework which has 'radically changed how state governments and catchment management bodies across Australia devise salinity management strategies';[78]
- compilation of the NLWRA salinity theme results resulting in 'Australia's most comprehensive assessment of dryland salinity to date

77 *ibid.*, pp. 16-17.

78 *ibid.*, p. 5.

and which has formed the basis of resource allocation decisions by both Commonwealth and state governments';[79]

- development of decision support tools for designing environmentally sensitive engineering works and 'living with salt' options; and
- 'a vast array of reports, training packages, decision support tools, fact sheets et cetera that have successfully been incorporated into local government, industry, extension and policy materials.'[80]

4.73 The NDSP has documented how the research outcomes funded through these seven themes are currently being used in the management, coordination and implementation of salinity programs.[81]

4.74 As a key example, the NDSP argued that the outcomes of its Catchment Classification project which identified three different types of GFS, described in the information provided above on CSIRO, has had a profound effect on salinity management:

> The outcomes from this project in terms of the use of the data in managing, coordinating and implementing other salinity programs have been enormous. It has provided a low-cost means of understanding, at a broad level, the hydrological processes at work in a given catchment without having to collect detailed information. This has been achieved by transferring knowledge from well-documented catchments to other, less studied catchments. It has also provided a national map that classifies catchments according to the three types described above, which is a significant advance in guiding regional management strategies. More detailed assessments have been conducted in the Murray Darling Basin and Queensland. These assessments are assisting communities to identify priority areas for treatment.

4.75 The NDSP stated the GFS is now being incorporated into regional salinity management plans across Australia and argued that this example:

> Demonstrate[s] that when science is coordinated nationally, as it was with the GFS, then adoption can occur rapidly as a network of system developers operates to provide guidance and support to colleagues and others across agency and jurisdictional borders.[82]

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79 *ibid.*

80 *ibid.*

81 NDSP, *Exhibit no. 25, NDSP Achievements Report,* and *Exhibit no. 27, NDSP Communication Report 2003–03.*

82 *ibid.,* p. 15.

4.76 The NDSP argued that six key messages emerged from the ten years of the Program's research and research coordination efforts. These research findings are listed here and further detail is provided in appendix E to this report:

- salinity costs are significant and rising, resources are limited and hence protection must be strategic;
- profitable options for reversing the trend are lacking, but under development;
- there is no one salinity problem—it challenges us to look beyond traditional policy instruments;
- integrated catchment management must be seen as only one possible approach to deal with dryland salinity;
- vegetation management remains the key to managing water resources, although the benefit-cost of revegetating catchments requires careful analysis; and
- lack of capacity is an important, but secondary, constraint to managing salinity.[83]

The National Land and Water Resources Audit

4.77 The National Land and Water Resources Audit (NLWRA or 'the Audit') is a program of the NHT, initially established in 1997 to 'provide Australia-wide assessments of land, water and vegetation resources to facilitate improved decision-making on land and water management.'[84] The Audit, which is co-located with LWA, works with the Australian Government, state and territory agencies, regional NRM groups and community stakeholders through an Audit Advisory Council.

4.78 Among its objectives, the Audit seeks to facilitate improved decision making on land and water resource management issues by:

- providing a clear understanding of the status of, and changes, in the nation's land and water resources and implications for their sustainable use;
- providing an interpretation of the costs and benefits of land and water resource change and remedial actions;

83 NDSP, *Submission no. 35.1,* pp. 1-4.

84 LWA, *Exhibit no. 127, Land and Water Australia Annual Report 2002-3,* p. 53.

- developing a national 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 on-going and structured way.[85]

4.79 The Audit has undergone two phases. From 1997 to 2002, primary data and information related to Australia's natural resource management were collected and collated. The Audit prepared:

- assessments on the status and recent changes in Australia's land, vegetation and water resources;
- integrated reports on the economic, environmental and social dimensions of land and water resource management; and
- guidelines and protocols for assessing and monitoring the health of land, vegetation and water resources.[86]

4.80 Web-based access to the information prepared by the Audit has been made available through the Australian Natural Resources Atlas, which has interpretive products from Audit and NHT supported projects, and the Australian Natural Resources Data Library, which contains more than 170 data sets.[87]

4.81 One of the Audit's principal pieces of research was the *Australian Dryland Salinity Assessment 2000*, which provided information on the distribution and impacts of dryland salinity at a regional scale, and provided a context for consideration of dryland salinity management throughout Australia. DAFF and DEH stated that the Assessment remains 'the current and authoritative statement on salinity in Australia'.[88]

4.82 The Assessment included maps of the extent and future risks of salinity projected to 2050 and summarised the way forward in meeting the NRM challenges associated with dryland salinity, as follows:

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85 LWA, *Exhibit no. 71, Australian Dryland Salinity Assessment 2000,* inside cover.

86 *ibid.*

87 Access to the Australian Natural Resources Atlas and the Australian Natural Resources Data Library available online, viewed 10 February 2003, <http://audit.ea.gov.au/ANRA/atlas_home.cfm>.

88 DAFF and DEH, *Submission 72,* p. 8.

- recognise that although the rate of salinisation may be slowed or reversed in some areas, in other locations land and water resources will continue to salinise with major impacts on rural communities and terrestrial biodiversity. Consequently, engineering solutions are likely to be required to protect key community assets and infrastructure;
- implement a landscape function approach to the management of on-site and off-site impacts of dryland salinity;
- support the development and use of the GFS framework both within and across states to maximise exchange of knowledge and understanding of processes, scale and type of interventions required to manage dryland salinity;
- appreciate that any salinity targets set need to be based on an understanding of biophysical processes and the likelihood of their being achieved;
- maintain where possible natural water balance processes;
- design new farming and land use systems that manage the salt and water balance; and
- enhance existing monitoring systems to better support the assessment and evaluation of outcomes of dryland salinity management programs.[89]

4.83 In particular, the Assessment proposed the adoption of the GFS framework, which was described in the overviews of NDSP and CSIRO research efforts, as a basis for salinity planning, monitoring and evaluation of management responses. The Assessment also identified a number of significant information and methodological limitations that impede evaluation of the exact extent of the salinity problem and likely effectiveness of management interventions.

4.84 The Audit's dryland salinity activities were undertaken as a component of the NDSP and relied heavily on the processes and networks established through that Program.

4.85 The Audit commenced a second phase of operation in July 2002 (to June 2007), the outcomes of which are to include the collation of natural resource data and information (including data collected through investments of the NAP and NHT), and the coordination and quality

89 LWA, *Exhibit no. 71, op. cit.*, p. vii.

assurance of data management processes.[90] DAFF and DEH stated that during this phase the Audit will ensure that:

> salinity data and information is accessible and consistent, including support for the development and implementation of region-based monitoring and evaluation strategies for salinity. The Audit also promotes development of spatial information systems and metadata standards.[91]

University research

4.86 The Australian Research Council (ARC) is the key provider of support for university research and provides approximately half of all national competitive grant support.[92] The ARC funds basic research on a competitive basis for projects in all fields of research, except clinical medical and public health research. The *ARC Linkage* program requires interaction between researchers and the actual or potential users of research results.

4.87 Over the six years to 2003, the ARC invested a total of $16.5 million in 84 salinity related research projects.[93] For research projects whose funding is to commence in 2004 or later years, the selection criteria employed by the ARC will include Australia's *National Research Priorities*.[94]

4.88 Murdoch University and the Centre for Salinity Assessment and Management (CSAM) at the University of Sydney provided information to the Committee on their salinity research efforts.[95]

4.89 Murdoch University's research activities, which have been funded variously by ARC grants, RDCs or through the NDSP, include:

- the development of salt tolerant hybrid trees to add to the species available for planting in saline waterlogged areas and, in particular, the

90 Information on the National Land and Water Resources Audit 2002–2007 available from the Audit's web site, viewed 10 February 2004, <www.nlwra.gov.au/about.htm>; and see DAFF and DEH, *Submission 72*, p. 5.

91 *ibid*., p. 9.

92 House of Representatives Standing Committee on Science and Innovation, *Riding the Innovation Wave*, The Parliament of the Commonwealth of Australia, Canberra, 2003, p. 38, viewed 12 March 2004, <www.aph.gov.au/house/committee/scin/randd/report.htm>.

93 DEST, *op. cit*. p. 2; and see DEST, *Exhibit no. 61, Details of ARC funded projects.*

94 DEST, *Submission no. 69*, p. 1.

95 CSAM, *Submission no. 19*, p. 1 (information on CSAM and its activities is available from the Centre's web site, viewed 7 June 2004, <www.agric.usyd.edu.au/scam/index.html>); and Murdoch University, *Submission no. 24*, pp. 8-9.

breeding of trees to deliver commercial returns in lumber or wood chips from saline land (to be marketed Australia-wide by Saltgrow);

- development and application of desalination technologies to provide water to Western Australian Wheatbelt towns and protect infrastructure;
- studies of groundwater processes and hydrogeology, which inform catchment management plans;
- development of tools to judge the likely fate of remnant vegetation and the prospect of restoring damaged ecosystems; and
- an evaluation of the effectiveness and impacts of deep drains.[96]

4.90 Murdoch University stated that social research and economics must be considered as part of the salinity science base—not just the contributions of the biophysical sciences—and that salinity is best addressed through an integrated, multi-disciplinary approach.[97]

4.91 Both Murdoch and CSAM stressed the role of universities in training students, many of whom 'will have carriage of management, coordination and implementation of salinity programs', and urged that this role be adequately recognised and supported.[98]

The private sector contribution

4.92 In addition to the commitment of primary producers and rural industries to salinity related research through levies paid to RDCs, the Committee received evidence from private sector providers of salinity research and support services. Examples of the private sector contribution to the salinity science base and support for those managing salinity include the following:

- Murray Irrigation stated that it invests more than $300 000 per year in research and development projects as part of the Murray Land and Water Management Plans. R&D projects have included:
  - ⇒ an inland saline aquaculture trial;

96 *ibid.*, p. 9.

97 *ibid.*, pp. 1-3; Dr Susan Moore (Murdoch University), *Transcript of Evidence*, 13 November 2003, pp. 28-29.

98 *ibid.*, p. 4; CSAM, *op. cit.*, p. 3.

- ⇒ optimisation of the Wakool Tullakool Sub-surface Drainage Scheme; and
- ⇒ identifying and quantifying the contribution of physical processes and management practices on groundwater recharge under irrigated perennial pastures.[99]

This research is conducted in partnership with state agencies, CSIRO and independent consultants. Murray Irrigation maintains a close relationship with CSIRO by accommodating CSIRO researchers with the Company's extension staff on its premises. This arrangement is said to have produced good research outcomes and has allowed the irrigators to develop a better understanding of the relevant science. The co-location has also allowed Murray Irrigation's perspectives to be considered in designing research projects.[100]

- GecOz have developed an airborne radar technology, known as 'SaltSAR', for salinity hazard mapping.[101]
- An Environmental Research and Information Consortium developed a technique of using gamma-ray data to map saline pathways, now patented by Natural Resource Intelligence.[102]
- Saltgrow is commercialising fast growing, salt tolerant eucalypt hybrids with commercial timber characteristics to provide profitable solutions for saline lands.[103] To date, Saltgrow has developed in excess of 1300 varieties, and conducted over 100 trials and a number of pilot scale commercial plantings across Australia.[104]
- Agrilink has developed a soil moisture, salinity and temperature sensor which can be integrated with geospatial technologies and used in salinity monitoring. The company has also developed a proprietary internet based software system, known as 'AgWISE', for the collection, management and distribution of agronomic data relating to the weather, irrigation, salinity and the environment.[105]

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99 Murray Irrigation Ltd, *Submission no. 27*, pp. 1-2.

100 Mr Alex Marshall (Murray Irrigation Ltd), *Transcript of Evidence*, 31 October 2003, p. 16.

101 GecOz Pty Ltd, *Submission no. 80*, p. 2.

102 Orbtek Pty Ltd, *Submission no. 3*, p. 1.

103 Saltgrow Pty Ltd, *Exhibit no. 109, Background to Saltgrow Products and the Xylonova Research and Development Program*, p.3.

104 Saltgrow Pty Ltd, *Exhibit no. 108, Salt Tolerant Eucalypts for Commercial Forestry: Progress and Promise*, p. 1.

105 Agrilink Holdings Pty Ltd, *Submission no. 25*, pp. 2-3, and see *Submission 25.1*.

- Consulting services in salinity and NRM are provided to CMOs, state agencies and landholders by firms that include Sinclair Knight Merz, Phil Dyson and Associates, and Webbnet Land Resource Services.[106]
- Landmark, a subsidiary of Australia's largest agribusiness, AWB, employs over 250 agronomists and directly communicates with some 100 000 farmers nation wide. Through its partnership with the CRCPBMDS, Landmark aims to extend and commercialise the CRCs research outcomes. Landmark has had its own staff participate in a series of workshops on the management of dryland salinity and will participate in a CRC project to increase the area of land sown to lucerne by farmers, as a tool for managing water levels and salinity. In total, Landmark's contribution of cash and in-kind support to the CRC amounts to $250 000 per year.[107]

4.93 The 'applied science' contributions of landholders in managing salinity outbreaks on their own properties was also brought to the attention of the Committee:

> What we do have in our favour are a number of landowners who have recognised the problem of salinity outbreaks on their properties and through being observant, innovative and committed to saving the land have instigated activities that have made a turn around. Their experience and endeavours need to be documented to assist others just as much as scientific research. This is applied science.[108]

4.94 The Committee witnessed farmer-initiated applied science in innovative salinity management practices during its inspections in New South Wales and Western Australia.

An audit of the Australian Government investment in salinity research

4.95 CSAM and the New South Wales Farmers' Association suggested that a national inventory of salinity research ought to be developed, 'to help funding agencies establish priorities and identify gaps'.[109] Similarly, the

106 Sinclair Knight Merz, *Submission no. 28*, p. 9; Phil Dyson and Associates, *Submission no. 46*;

107 Landmark, *Submission no. 30*, pp. 1-2; Mr David Coombes (Landmark) *Transcript of Evidence*, 1 December 2003, p. 3.

108 Ms Margaret Thompson, *Submission no. 53*, p. 1.

109 CSAM, *op. cit*., p. 2. The New South Wales Farmers' Association (*Submission no. 45*, p. 4) proposed that an audit occur at either state or national level and identify salinity research activities on a catchment by catchment basis.

NDSP proposed that an audit be conducted across the totality of Australian Government investment in salinity, including:

> the Commonwealth funds that move through CRCs … the Commonwealth money that goes into R&D corporations and the Commonwealth money that goes through these programs, plus through the agencies themselves … let us look at all that we have available to us in steering R&D forward and directing it in a new way according to the strategic direction we have now set.[110]

4.96 The Committee believes that an audit of the totality of the Australian Government's investment in salinity is needed to identify research gaps and to assist in enhancing research coordination across agencies and jurisdictions.

4.97 More specifically, the Committee believes that an audit may help to:

- map salinity research findings and tools that are currently available for use in salinity management;
- assist in identifying critical research gaps, identify any unnecessary duplication of effort and suggest directions for future salinity R&D; and
- bring coherence to the range of salinity related research activities that receive Australian Government support, and improve coordination with state and regional research efforts.

110 Mr Kevin Goss (NDSP), *Transcript of Evidence*, 3 November 2003, p. 15.

Recommendation 2

4.98 **(a) The Committee recommends that the Australian Government, in cooperation with state government agencies, conduct an audit of the totality of salinity research and development activities undertaken by all agencies and programs in which the Australian Government invests, including:**

(i) national programs that address salinity, such as the *National Action Plan for Salinity and Water Quality* and the *Natural Heritage Trust*;

(ii) programs such as the *National Dryland Salinity Program* and the National Land and Water Resources Audit;

(iii) agencies within Australian Government departments, including the Bureau of Rural Sciences;

(iv) Cooperative Research Centres;

(v) Research and Development Corporations;

(vi) national science agencies, including the Commonwealth Scientific and Industrial Research Organisation;

(vii) universities; and

(viii) where possible, the private sector.

(b) The Committee further recommends that the audit:

(i) map the state of salinity research findings and the tools currently available for salinity management;

(ii) identify all critical research gaps;

(iii) suggest directions for future salinity research and development activities; and

(iv) identify steps that might be taken to bring greater coherence to salinity research efforts across all Australian Government funded agencies and programs, and to improve coordination with state and regional research activities.

Conclusions

National research agencies and programs

4.99 The Committee concludes that a wealth of salinity research has been undertaken by a range of Federally-funded agencies and programs, including: agencies within Australian Government departments, such as the BRS; numerous CRCs; RDCs; national science agencies, notably the CSIRO; universities, and programs that include the NDSP and NLWRA.

4.100 An array of research products and salinity management tools has been developed by these agencies. The efforts of state R&D programs and the MDBC, outlined in chapter two, also contribute to the salinity science base. The Committee welcomes the fact that 'despite the crowded market in salinity management, there is … the advantage that by having more players there is more funding going into research and extension effort.'[111]

4.101 However, the Committee concludes that a comprehensive audit of the Australian Government investment in salinity research may be timely. An audit will be able to map the salinity science base and management tools, and identify critical research gaps. An audit may also assist in bringing greater coherence to the range of science investments for salinity and potentially improve their effectiveness. The audit may also assist in improving coordination with state and regional research efforts.

Private sector contribution

4.102 The Committee notes the contribution made by the private sector, for example, in consulting services, development of salinity mapping technologies, commercialisation of salt tolerant plants, and in partnering with research organisations. The Committee is also pleased to acknowledge that many landholders are adopting innovative management practices based on what might be termed 'applied science', or are working in partnerships with researchers to do so.

4.103 Having presented an overview of the national programs to address salinity (chapter two), the consensus explanation for the salinity problem and alternative scientific perspectives (chapter three) and the science base that has developed to meet the salinity threat (chapter four), the following chapters present the Committee's evidence and views on:

- the coordination of the salinity research effort;

111 NDSP, *Submission no. 35*, p. 20.

- adequacy of the science base, research priorities and the funding of research;
- management of data and salinity mapping; and
- the extension of salinity science to those managing salinity, particularly CMOs and landholders.