NATIONAL PROGRAM FOR
Sustainable Irrigation

NATIONAL PROGRAM FOR SUSTAINABLE IRRIGATION
PHASE II FINAL REPORT

NEW IDEAS FOR IRRIGATION

www.npsi.gov.au

Executive Summary

The National Program for Sustainable Irrigation was a unique collaboration as it involved governments, irrigators, water providers and researchers from across Australia. It covered every aspect of irrigation from dam management and water delivery, through on-farm management, to sustainable landscape environmental measures.

The program has contributed to;

- major increases in the efficiency and productivity of irrigation water,
- significant reductions in salinity to the Murray Darling Rivers,
- greater knowledge and technical capacity of irrigators and irrigation professionals.

NPSI partners invested $5.2 million between 2006 - 2012, which led to an additional $6.5 million of co-investments in projects. Benefit cost ratios from investments in irrigation research consistently have been high, between 7 and 14 to one. Equally important have been environmental benefits and human capacity building.

In total, 42% of funds were invested in projects that have increased knowledge, 37% that increased efficiency and 21% of invested funds have delivered a demonstrable industry economic impact.

Tangible benefits to irrigators have resulted due to improved knowledge of water use efficiency benchmarks and tools, the ability to quantify water losses and better management strategies being put into practice.

NPSI has been active in building improved skills, knowledge and decision making of end users via workshops, training events and publications. NPSI played a collaborative role in feeding information from research through to extension networks and sales/technical representatives, then on to the farm.

The flagship publication "Irrigation Essentials" provides a snapshot of the latest NPSI research and development that is improving technology, enabling the sharing of knowledge and practice change across all agricultural commodities and horticultural industries. It provides case studies that demonstrate how research and good ideas may be adopted and provides sources of additional information on key topics. Sixty individual case studies have been published.

The economic pay off from NPSI II was estimated to deliver at least $13.7m (present value terms) to the Australian economy. Against a total NPSI II investment of $9.1m (present value terms) this represents a positive pay off on funds invested. The net present value was estimated at $4.6m which represents a return of $1.50 on every dollar invested in NPSI II. If benefits are only compared against the cost of projects that have delivered an economic benefit (21% of total costs) the return would be $7.20 for every dollar invested across those projects.

The program commissioned an external evaluation of its operations in 2011

"It found informed persons rated the effectiveness of the NPSI program highly. Positive comments were made by a number of respondents about the contribution NPSI had made in the development of an Australian irrigation RD&E program, its inclusion of industry groups and some of the outcomes of research. There were a number of comments about the broad focus and impact of the NPSI program having engaged many stakeholder, industry and research groups working together to address irrigation issues and R&D across the country. There was a view that there had been good industry buy in and the project had provided a crucial link between government and researchers."

Outcome sought	Achievements
Goal 1 Sustainable Production Improved irrigation water use efficiency and enhanced ability to respond to changing levels of resource availability over time	• Improved benchmarking of water use by cotton and grain farmers. Evidence of 40% improvement in water use. Water savings 0.15 Ml/ha. • Technology improvements and management options to maximise water use efficiency at the farm and delivery system scale. Irrigators surveyed indicated 50-100% of their farmland had been impacted • Changed thinking on drip irrigation and oxygation lead to 50% yield improvement in various horticultural and cotton crops in Queensland • Fertigation tools for citrus save $400/ha • Evaporation losses and mitigation options evaluated in irrigation channels in Victoria • Precision irrigation review completed • Increased soil testing, new soil management system in orchards • New polymers developed and field trialed at St George, Qld and Dooki, Victoria to reduce evaporation losses on water storages and farm dams • Farm dam evaporation resource kit and calculator • Improved use of precision irrigation techniques in sugar, viticulture, citrus and vegetables. Water savings in Western Australia vegetables crops upto 40%. • Soil monitoring technology developed and applied by farmers • Climate and profit scenarios for grain growers • Guidelines for managing soil salinity in groundwater irrigated vineyards • New salinity monitoring sensors
Outcome sought	**Achievements**
Goal 2 Sustainable environment Reduced environmental impacts, more sustainable ecosystems and more prosperous communities.	• Landscape biodiversity monitored in rice growing systems • Reduced salinity impacts and improved water quality in Southern Murray Darling Basin with new tools and knowledge • Surface and groundwater connectivity tool based on water temperature developed • Soil structure and management techniques evaluated • Ecological assessments • Research paper on water storage policies and options • Reduced nutrient leaching with improved practices in orchards • New tools developed to better understand surface and groundwater connectivity • Improved soil structure using ryegrass in horticultural crops • Managed inundation of native wetlands for environmental gain • Development of salinity management practice guidelines • Review completed on irrigation acidity, chloride and salinity in vineyards • WA groundwater study used to inform water allocations & connectivity • UNESCO Help program scoped for Ord and accepted • Long term monitoring and grower network of soil salinity on Limestone Coast, SA

Outcome sought	Achievements
Goal 3 Knowledge into Practice Improved skills, knowledge and decision making of end users which leads to practice change, and more efficient and sustainable use and management of water	• Improved current irrigation management practices and systems in cotton, grains, horticulture, grapes, citrus, rice and dairy • Improved accessibility of knowledge, tools and practices to end users with farm walks, workshops, training, and websites • 70 farmer case studies published, 80 scientific papers, 230 industry conference papers, 1500 visits per month to the NPSI web site • Increased understanding of irrigation decision-making • New irrigation essentials web search engine released • Provision of training for irrigators in a range of industries • 278 vegetable growers in WA involved in irrigation scheduling project • 471 cotton and grain growers involved in project • 300 wine grape growers engaged vineyard salinity workshops • 50 citrus growers attended nutrient management workshops • 80 farmers trained in reducing evaporation from farm dams • Rice growers environmental champions program updated • 40 participants at water and solute s master classes • Soil management guidelines for vineyards and orchards • Fertigation guidelines for citrus growers produced • Irrigation Essentials flagship document produced. 60 case stuies. • 8 regions in WA work shopped on climate and water such as Carnarvon, Harvey, Swan Valley, Margaret River • Information passed onto Industry, NRM bodies and Government
Outcome sought	**Achievements**
Goal 4 Research leadership A national approach to irrigation related R& D in Australia, which includes a strong focus on a skilled human resource base and enhanced R&D capacity and collaboration.	• A future national irrigation R&D investment plan launched in partnership with Irrigation Australia • Co-chaired with CSIRO, Primary Industries Standing Committee National Water Use in Agriculture strategy • Six industry International travel fellowships funded • 10 training travel support for irrigators/advisers from sugar, horticulture, grains, cotton industries • 12 undergraduate student research projects funded to encourage youth and the next generation of irrigation professionals • Sponsorship of Irrigation Australia Conferences and other workshops

NPSI partners

The National Program for Sustainable Irrigation is a partnership of Cotton Research & Development Corporation, Gascoyne Water Co-operative, Goulburn-Murray Rural Water Corporation, Grains Research & Development Corporation, Harvey Water, Horticulture Australia Limited, Lower Murray Water, Ord Irrigation Co-operative, South Australian Research and Development Institute, Sugar Research & Development Corporation, SunWater, and Western Australia Department of Water and the Australian Government Department of Sustainability, Environment, Water Population and Communities.

For more information contact Cotton Research and Development Corporation 02 6792 4088.

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Groundwater and surface water connectivity workshop with local landholders run by UNSW at Maules Creek , Northern NSW.

Citrus fertigation workshop in Southern NSW being conducted by NSW DPI Steven Falivene. NPSI also funded citrus fertigation research conducted by Michael Treeby (NSW DPI) and Mark Skewes (SARDI).

Using catch cans in vegetable crops in Western Australia to measure irrigation uniformity.

Rob Stevens managing soil salinity in vineyards research experiment by SARDI, Limestone Coast, South Australia

NPSI has sponsored 18 study fellowships awards to build industry capacity. Pictured is the Chairman of Irrigation Australia Ltd Peter Toome presenting the 2010 award to Tamara Jackson who studied the water and energy use interactions.

NPSI research has examined the integrated natural resource management in many industries such as rice, cotton, and sugar.

Message to NPSI Partners

The National Program for Sustainable Irrigation Management Committee is pleased to present this final report, highlighting the key achievements of irrigation research undertaken over the past two decades and, in particular, the final phase (Phase II) of the National Program for Sustainable Irrigation (NPSI).

The NPSI is a collaborative partnership of 16 industry and government organisations from around Australia who have chosen to partner in investments in research and development and its adoption to improve the productivity and sustainability of irrigation in Australia.

Irrigated agriculture is essential to the economic viability and the social fabric of many regions and contributes between $10-12.5 billion per year in value of production to Australia's economy.

Continued support for efficient irrigation industries is essential to the future prosperity of Australian communities and more broadly in meeting the challenge of feeding a rapidly increasing and affluent global population.

The finalisation of NPSI Phase II marks the end of an era of investment in irrigation research, development and extension that has made enormous inroads into the efficient management of water for profitable industries, vibrant communities and sustained environments. When the irrigation research program commenced there was minimal understanding on how to balance production and environmental outcomes, with the dangers of over allocation not identified and water efficiency barely on the agenda. Since this time we have seen the development of federal and state organisations to manage the water resource, an increasing focus on improving water use efficiency and minimising environmental impacts, and transformations in how water is delivered and used for irrigation.

Many aspects of irrigation management we take for granted had their origins as research projects. Simple water use definitions, the first irrigation system benchmarks, salinity and drainage management options, irrigation scheduling tools are just a few examples.

The program was unique in involving governments, irrigators, water providers and researchers from across Australia and covered every aspect of irrigation from dam management and water delivery, through on-farm management, to environmental impacts. Over the years, researchers associated with the program have contributed to major increases in the efficiency of water use for irrigation (producing more food and fibre per litre of water used), reductions in salinity to the River Murray, more efficient water storage and delivery systems, and greater capacity of irrigators to manage complex farming systems.

Balancing the demands for food security, improved river health and resilient regional communities is a pressing challenge for Government and the community. Technical research and its faster adoption are essential to resolving current concerns and getting better production and environmental outcomes in irrigation systems all around Australia, such as the Murray–Darling Basin.

Whilst the interest and investment in water management has increased exponentially over the past decade, investment in irrigation RD&E has declined. Unfortunately with the conclusion of NPSI and recent completion of the CRCIF there is now no dedicated collaborative investment to irrigation RD&E. During a time when the adoption of efficient technologies and practices will ensure that the industry and its regional communities are well placed to meet the challenge of using resources efficiently, the lull in RD&E investment risks a loss of momentum and a lost opportunity to entrench further change.

The NPSI Program Management Committee is of the view there is enormous opportunity to improve the adoption of irrigation R&D using key learning sites and partnerships.

The recently published 'Irrigation Essentials Updated' provides a synthesis of information from recent phases of NPSI and reinforces case studies and principles, which have been developed through research and are keys to sustainable irrigation management.

This document and other research reports and management guides are available from the NPSI website: **www.npsi.gov.au**.

We would like to thank all partners of NPSI and its predecessors and also acknowledge Land and Water Australia and Cotton Research and Development Corporation for their roles in coordination and administration. We would also like to thank our program management committee, research providers and collaborators from the irrigation industry.

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Rob Houghton
Chairman
Program Management Committee

Guy Roth
Program Coordinator

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1 Introduction

NPSI invested in new polymers research by the Polymers CRC aimed at reducing evaporation losses from farm water storages.
Note the flattened water surface in the picture where the advancing polymer monolayer is moving at our St. George, QLD field trial.

1.1 Irrigation in Australia

Australia's irrigators play a vital role in offering food security and natural fibres in the face of a growing global population, reduced water availability and the prospect of climate change. With population growth and standards of living and diet increasing, the demand for food is forecast to double in coming decades and irrigation will be crucial to satisfy those needs.

Irrigation is the nexus between volatile and important issues affecting Australia and the globe.

- Managing our variable climate to optimise food and fibre production.
- Increasing populations, with improving standards of living and diet, will require more food and an increasing proportion of that will need to come from irrigation – dryland farming simply doesn't have the capacity to grow sufficient food. Irrigation currently provides 40% of world food supplies and is expected to meet 60% of the increases in demand.
- The over-allocation of water, increasing demand from urban, industrial and mining sectors, recognition of the need to provide water for the environment, plus the advent of climate change, all signal a tightening in the availability of water for irrigation. In the recent droughts affecting Australia, irrigation reduced its use of water by a greater percentage than did urban use; a portent of things to come.
- International policies and economic situations affect total production, the cost of production and the ability of different markets to pay for food and fibre. The index of global food prices rose sharply in 2007 then fell during the 'global financial crisis'. It has risen again since then but there is now considerable volatility in food markets.
- Australia is in the enviable position of being able to be self-sufficient in food production and to export produce to needy overseas markets. However, it is also increasingly facing intense competition within Australia from overseas imports. Australia is amongst the most efficient producers on the planet in terms of water use, but struggles to compete on price and other trade barriers with some countries for various commodities.

Irrigation occupies a very small portion of Australia – only 5% of tilled agricultural lands – but produces 30% of all agricultural and grazing production. Agriculture uses 50-70% of the water consumed in Australia per annum and irrigation uses 90% of that. The irrigated production of food and natural fibre is a great stimulus to regional economies, involving transport, processing, packaging and marketing, as well as on-farm services, input sales and equipment supplies. Irrigated production in Australia is valued at between $10-12.5 billion/yr . Irrigated production can also be a mainstay for regional tourism, e.g. wine, dairy and tropical fruit production.

Irrigators have been skilfully adapting their farm business decisions in response to decreasing water resources and a varying climate for many years. While the challenges of an increasing global demand for food at a time of decreasing water resources adds more uncertainty for farm business, the 'good news' is that Australian irrigators have a track record of innovating and creating opportunity out of uncertainty . Their performance is founded on a great history of collaborative irrigation research, of which the National Program for Sustainable Irrigation, and its' predecessors, have been pivotal.

The Australian irrigation industry has two vital roles to play:

- As a producer of high-quality, nutritious food in a world where there is concern about the security of food production.
- As a leader in developing farming systems and technologies which yield more food and fibre from less water and decrease the environmental footprint of production.

Research, development and extension (RD&E) are fundamental to success in those roles.

NPSI research teams have worked with irrigators to find practical solutions for their problems. Dr Ian Dagley (CRC Polymers), Cotton and Grain farmer Cleave Rogan, Dr Greg Qiao (The University of Melbourne).

The NPSI research investigated soil management, salinity, nutrient and water use in vineyards in South Australia.

1.2 Irrigation RD&E in Australia

Balancing the demands for food security, improved river health and resilient regional communities is a pressing challenge. Research and its rapid adoption are essential to resolving current concerns and getting better production and environmental outcomes in irrigation systems all around Australia, including the Murray–Darling Basin and northern Australia.

Initially, investments in irrigation RD&E were fragmented and specific across the major commodities (cotton, rice, dairy, horticulture, sugar, grains, wine grapes, pastures). Better co-ordination was identified as an important need to:

- Get the best outcomes from these efforts,
- Respond to emerging research needs, and
- Reduce the cost of delivering productivity and sustainability outcomes.

Improved, collaborative management of irrigation R, D &E has been pursued over several decades through a series of programs:

- The National Irrigation Research Fund (NIRF) was an early RD&E program following approaches involving the National, then Australian, Water Research Advisory Council, the Australian National Council for Irrigation and Drainage (ANCID) and the Australian Irrigation Council.
- The National Program for Irrigation Research and Development (NPIRD) was established in 1993 by Land & Water Australia (LWA) and initial partners of State water agencies and irrigators. NPIRD was funded for three phases, with projects covering water-use efficiency, benchmarking, reducing river contaminants, ecological risk assessment, policy and socio-economic issues, plus coordination, integration and education.
- The National Program for Sustainable Irrigation was established in July 2002 to replace NPIRD. The NPSI Phase I concluded in 2008 with NPSI Phase II being implemented in 2008 to June 2012. NPSI was initially administered by LWA, but Cotton Research & Development Corporation took over that role when LWA closed in 2009.
- Encouraged by NPSI with seed funding for its application, the Cooperative Research Centre for Irrigation Futures operated from 2004 until June, 2010.

Collectively, these programs have facilitated national initiatives for:

– Scientific innovation and excellence,

– Compilation and extension of knowledge ready for adoption,

– Collaboration and networking across the irrigation industries, and

– Commitment to sustainable irrigation industries, communities and management of natural resources

– Increased the capacity and knowledge of people all over Australia.

The total funding for NPIRD and NPSI has been in the order of $50 million over almost 20 years. Almost $32 million has been derived from 3rd party co-investment whilst the Program itself has invested $18 million.

The proportional investment for NPIRD and NPSI Phases I and II is described below:

	Program Funding	3rd Party Funding Co-investemnt	Total Funding
NPIRD (July 1993 – June 2002)	5,270	19,601	24,871
NPSI Phase I (July 2002 – June 2007)	8,000	5,700	13,700
NPSI Phase II (July 2007 – June 2012)	5,291	6,514	11,805
Total	18,561	31,815	62,181

The conclusion of the CRC for Irrigation Futures in 2010 and the National Program for Sustainable Irrigation in 2012 mark the end of a significant era of collaborative irrigation RD&E within Australia. The involvement of researchers, water providers, irrigators, various commodities and governments has been a hallmark of the programs and a critical factor in their success.

"I hope that NPSI or some form of it continues. If it goes then we will lose something valuable in irrigation. They have done well in bringing organisations together and coordinating cooperation. There needs to be continuation to achieve these goals."

(Evaluation, 2011)

Tropical Pineapples at Yeppoon, QLD, where air injected water- oxygation has been trialed since 2007 and compared with non-aerated drip irrigation and no irrigation (rain-fed crop). Oxygation is essentially the mixing of air with irrigation water. It has been able to generate healthier interactions between water, soil and plant physiology. One of the research team members, Dr Surya Bhattarai, was recently recognised for his work on development of oxygenation techniques in conjunction with industry. He received the inaugural Central Queensland University Opal Award for excellence in building relationships with communities with a focus on research and innovation.

1.3 Important irrigation research achievements

Investments in NPIRD and NPSI totalled $50 million and have had major impact through the research they funded and through the capacity building and wider collaboration which they spawned. Examples include:

- Increased Water Use Efficiency (WUE). Defining WUE and understanding the trade-offs involved in its achievement drove numerous early projects which helped position Australia as amongst the most efficient users of water in the world. The early research ensured a common understanding of the languages and indicators used to measure WUE at the system and farm scale. Initial benchmarking studies were also instrumental in driving improved performances for both system managers and individual irrigators. These may seem routine now, but it was a result of significant research and industry collaboration.
- Innovative irrigation and monitoring techniques. A focus on WUE led to innovations in irrigation practice, such as the wide application of drip irrigation, and subsequent investigations such as partial root zone drying, open hydroponics or intensive fertigation, precision irrigation and oxygation. Innovative techniques to monitor crop needs and the movement of water, salts and nutrients in the soil, have been integral to the enhancement of irrigation practices and a sustainable environment.
- Reduced salinity. Improved irrigation efficiency has also helped reduce salinity and researchers have developed means to better manage salt and significantly reduce the environmental impacts caused by saline irrigation drainage as well as the impacts of salt on productivity.
- Reduced evaporative losses. Current research is beginning to make break-throughs in the management of open waters to reduce evaporative losses – which can be 40% of dam volume. New polymers developed with the support of NPSI are looking to reduce those losses by 40-60%; offering yet further gains in WUE and resulting in increased production without extracting any additional water.
- Environmental safeguards. Researchers have developed and applied techniques to assess risks from irrigation and to better understand how surface and groundwaters interact. Other studies have looked at floodplain biodiversity and soil management. This knowledge has been applied to better manage existing irrigation areas and to plan for new and emerging opportunities.
- Water delivery and modernisation. Improved understanding of water losses in various delivery systems and of how to marry on-farm changes with delivery changes has contributed a science base to the modernisation of extensive irrigation systems; improving water use efficiency, freeing water for the environment and other users, and maintaining regional economies.
- Recycling water. The use of recycled water from urban and industrial sources continues to grow, supported in part by investigations via NPIRD and NPSI.
- Knowledge and People. Improved skills, knowledge and decision making of end users leading to practice change and more sustainable management of water.

NPSI Phase II built on foundations of previous work and grappled with major issues such as:

- Relationships between water, energy and carbon,
- Improved water delivery efficiency and asset rationalisation,
- Community resilience,
- Understanding the hydrologic balance and connectivity of surface and groundwaters, and
- Increasing productivity for irrigated agriculture in a water-constrained environment.

Assessing the impact of drip irrigation on soil structure and water infiltration.

NPSI and its partners convened many forums related to irrigation modernisation such as this one in Shepparton with Goulburn Murray Water, which had people from all the major irrigation water supply companies from all over Australia.

Lower Murray Water instalation of channel lining and covers to reduce evaporation.

NPSI has funded many projects to improve water use efficiency and productivity.

NPSI funded several projects in Western Australia including the Ord, Harvey Water, Gasgoyne, surface and ground water connectivity research, and irrigation of vegetable crops

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1.4 About NPSI Phase II

The partners in NPSI Phase II are documented in Appendix 1 and included commodity R&D Corporations, water authorities and suppliers, and state and federal governments. It collaborated with R&D providers such as CSIRO, State Departments of Primary Industries, industry bodies, universities, natural resource management bodies and arms of the Australian Government. The program also worked with industry and individual farmers to ensure the R&D was of high priority and adopted by end users.

NPSI Phase II was managed by the Program Management Committee (PMC). The most recent participants of the PMC were:

- Rob Houghton, irrigator (Independent Chair)
- Guy Roth, program coordinator
- Jim Cox, South Australian Research and Development Institute (SARDI)
- Bruce Pyke, Cotton Research and Development Corporation (CRDC)
- Andrew Parkes, irrigator
- Tom Vanderbyl, SunWater
- Tom Busher, Harvey Water
- Peter Melville, Horticulture Australia (HAL)
- Peter Egglestone, Goulburn Murray Water (GMW)

Previous members included Gerrit Schrale (SARDI), Charles Thompson (HAL), Anwen Lovett (LWA), Alex Marshall and Matt Barden (GMW), Damien McRae, Angela Robinson, Andrea Mayes and David Calvert (DEWHA).

Each year a NPSI Partner's forum was held where research projects were presented and the partners discussed mutual interests.

The Partner's forums were conducted in:

- Canberra (2008)
- Brisbane (2009)
- Sydney (2010)
- Launceston (2011)

LWA was an investing partner as well the program administrator until 2010, when Cotton RDC took over the administrative role, providing financial, legal, project administration, IT and communications services. Program coordination for NPIRD and NPSI was contracted to external providers.

For NPSI Phase II program coordination was contracted to Dr Guy Roth (Roth Rural & Regional Pty Ltd). Communications activities were supported by Sarah Leonardi (LWA) and Tony Clancy.

.1.5 This report

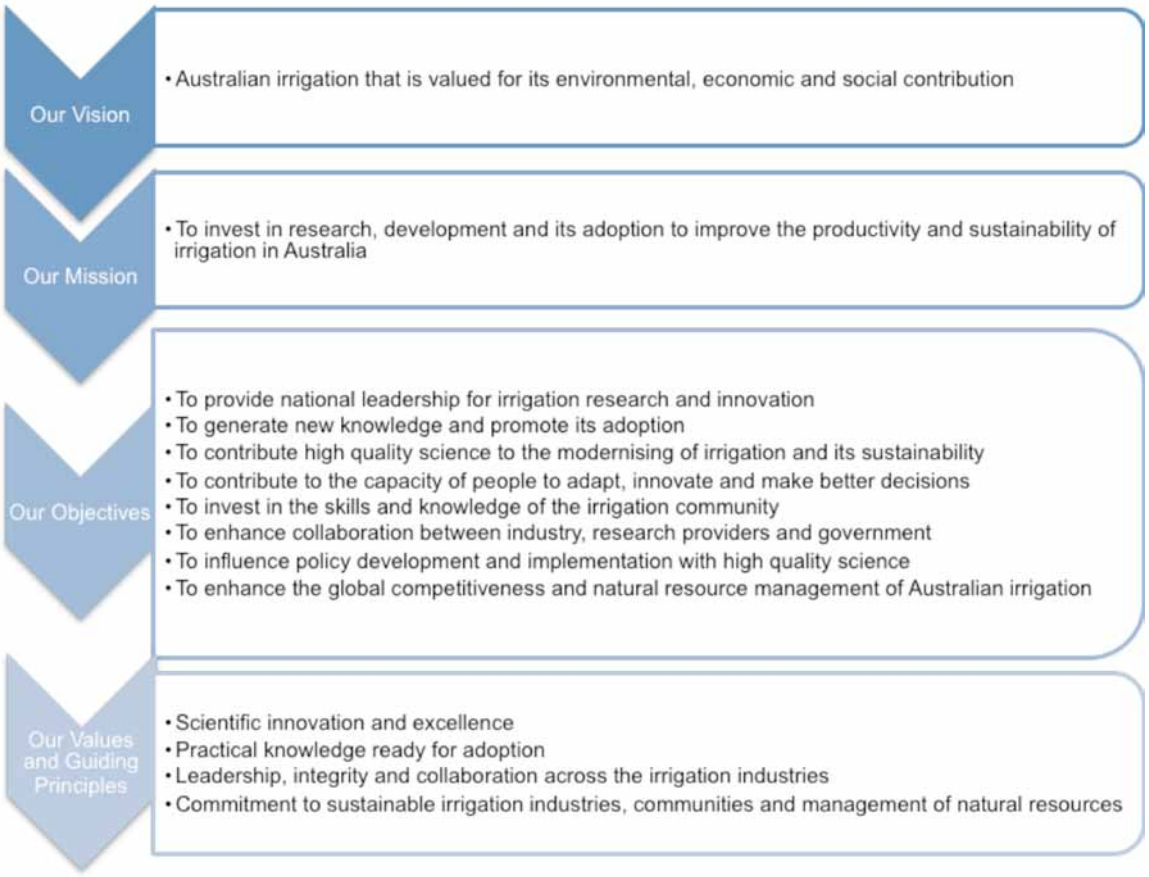
This report describes the activities and key outcomes of the collaborative investment in irrigation RD&E in Australia, through NPSI Phase II. However, the report also pays homage to the achievements of previous programs (NPIRD and NPSI Phase I). As a final report for the final phase of an impressive program of research, it is appropriate to record some history and key learnings as a legacy for subsequent research managers and investors.

2 NPSI Phase II

2.1 High level objectives

Australian irrigation research aimed to benefit individuals, regional communities, the environment and the wider water using community in Australia. At a time when national and global interest in food security, climate variability, water scarcity and natural resource management is increasing, the capacity to increase water use efficiency through better water management strategies appears to be a crucial area for consideration.

NPSI Phase II invested in activities aimed at benefiting irrigators and the broader community with a focus on the productivity and sustainability of irrigation in Australia. The objectives of the program, values and guiding principles are described below.



2.2 Goals and achievements

NPSI Phase II focused on the goals of:

- Sustainable production. Sustainable production through improved irrigation water use efficiency,
- Sustainable futures. Ensuring the future sustainability and prosperity of industry, the environment and community
- Knowledge into practice. Assisting with the adoption of improved technology and practices and
- Research leadership. Providing national RD&E leadership

These goals, the desired outcomes and the indicators for success, are described more fully in Appendix 2.

Key achievements from Phase II of NPSI are highlighted below.

Outcome sought	Achievements
Goal 1 Sustainable Production Improved irrigation water use efficiency and enhanced ability to respond to changing levels of resource availability over time.	• New evaporation calculator on web and field trials for polymers in three States • Improved benchmarking of water use by cotton and grain farmers. Evidence of 40% improvement in water use • Technology improvements and management options to maximise water use efficiency at the farm and delivery system scale. Irrigators surveyed indicated 50-100% of their farmland had been impacted • Changed thinking on drip irrigation and oxygation lead to 50% yield improvement in various horticultural and cotton crops in Queensland • Evaporation losses and mitigation options evaluated in irrigation channels in Victoria • Precision irrigation review completed • Increased soil testing, new soil management system in orchards • New polymers developed and field trialed at St George to reduce evaporation losses on water storages and farm dams • Farm dam evaporation resource kit and calculator • Improved use of precision irrigation techniques in sugar, viticulture, citrus and vegetables • Soil monitoring technology developed and applied by farmers • Climate and profit scenarios for grain growers • Guidelines for managing soil salinity in groundwater irrigated vineyards • New salinity sensors
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Goal 4 Research Leadership A national approach to irrigation related R& D in Australia, which includes a strong focus on a skilled human resource base and enhanced R&D capacity and collaboration.	• A future national irrigation R&D investment plan launched in partnership with industry body • Co-chaired with CSIRO, Primary Industries Standing Committee National Water Use in Agriculture strategy • Six industry International travel fellowships funded • 10 training travel support for irrigators/advisers from sugar, horticulture, grains, cotton industries • 12 undergraduate student research projects funded to encourage youth and R&D • Sponsorship of Irrigation Australia Conferences and other workshops

2.3 Project activities

NPSI Phase II projects are summarised below.

2.3.1 Goal 1: Sustainable production in a water scarce environment

Improved irrigation water use efficiency and enhanced ability to respond to changing levels of resource availability over time.

Many of the NPSI projects contributed to this goal including:

Root zone water, salinity and nutrient management under precision irrigation led by Dr Tapas Biswas and Dr Gerrit Schrale (SARDI). This project focused on changing awareness for what good water and salt management involves and encouraging active management and monitoring of root-zone salinity using tools such as SoluSAMPLER™, rather than reliance on winter leaching.

Open hydroponics irrigation in citrus managed Dr Tapas Biswas (SARDI) which was focused on understanding solute dynamics under advanced fertigation systems to assess the short and long term implications of this system compared with conventional growing systems.

Managing soil salinity for wine quality in groundwater irrigated vineyards managed by Rob Stevens, Tim Pitt and Dr Michael McCarthy (SARDI) which developed strategies to adapt wine grape production systems to the prevailing soil and climatic conditions, groundwater flow and quality regime and irrigation technology to achieve premium wines that meet world food health standards and ensure export growth.

Soil management for Australian irrigated agriculture managed by Dr Bruce Cockcroft which developed new soil preparation and management practices, enabling large inputs of stable soil organic matter and high biological activity. This approach has ultimately led to higher productivity rates in orchards in the Goulburn Valley. There are potential benefits from increased knowledge on how to improve sub-soil structure as well as from improved approaches to managing root zone drainage, salt and nutrients.

Groundwater and surface water interactions in Western Australia managed by Fionnuala Hannon (GHD). This project undertook investigations into surface and groundwater interactions in agricultural regions of south-west Western Australia using novel techniques that include water balance modeling and baseflow separation modeling; demonstrating a methodology that may be readily applied to water planning and allocation.

Many project projects have focused on specifically, or contributed to:

- Upgrading irrigation infrastructure and its management (including centre pivot irrigation, precision irrigation trends and channel management)
- Improved decision tools (risk management and fertigation)
- Improved practices (soil, hydroponics, water aeration and solutes management) and
- Development and management of regional strategies

2.3.2 Goal 2: Sustainable futures and the environment

Projects have focused on improved management of water storages (including rationalising carryover rights and water sharing, improved farm dam management and improved understanding of surface-groundwater interaction), improved soil management (precision irrigation and root zone management) and biodiversity.

Long term sustainability of precision irrigation project managed by Dr Rob Murray (University of Adelaide) established soil management strategies for drip irrigated vineyards in the Barossa Valley by assessing the impact of drip irrigation on soil and establishing the role of soil type and irrigation water in contributing to soil structure issues.

Farm dam management a project led by Deb Atkins (CRCIF) developed and delivered integrated farm dam management information training to allow irrigation businesses to optimise the use and returns from irrigation dams.

Optimising delivery and benefits of aerated irrigation water managed by Professor David Midmore and Dr Suyra Bhattarai (CQU) has developed a training manual and decision support tools for implementing oxygation in perennial crops in QLD, NSW and SA to increase crop yield and quality by overcoming root oxygen starvation caused by irrigation.

Channel evaporation mitigation managed by Mike Schultz (GMW) assessed the effectiveness of monolayers in closed and flowing irrigation channels to reduce evaporation losses.

New technologies to reduce evaporation from large water storages led by Professor David Solomon and Dr Emma Prime (CRC Polymers) focused on the development of new technological solutions for evaporation control from large on farm water storages. There is potential benefit from reduced evaporation from farm dams as a result of new information and release of an On-Line Calculator.

Quantifying surface water - groundwater exchange using thermal & chemical measurements managed by Prof Ian Acworth and Dr Martin Anderson (UNSW) aimed to develop an integrated measuring tool to quantify surface water - groundwater transfer to aquifers beneath river beds, enabling mapping of the many and complex connections and interactions between groundwater and the surface water - dams, lakes, rivers, wetlands. This technology has now been incorporated into the National Centre for Groundwater Research and Training (NCGRT) as the focus of a sub program with participants at a specific forum on the topic rating the value of this work highly. Dr Gabrielle Rau completed his PhD project as part of this study.

The effect of changing irrigation strategies on biodiversity led by Dr Sue McIntyre, Tony Arthur & Heather McGuiness (CSIRO) has identified how irrigation practices affect local and regional biodiversity, and exploring strategies to ameliorate any negative effects of predicted changes without further compromising environmental sustainability. The principles originated from work commenced in the Riverina which is applicable to other irrigation regions and are expected to be applicable at the farm, supplier and policy levels.

Management of irrigation water storages: carryover rights and capacity sharing led by Tim Goesch and Neal Hughes explored the potential benefits through the future use of capacity sharing rather than carry-over rights to generate superior outcomes to central control of storages and developed a model to quantify the potential benefits from adopting decentralised storage management policies. This concept has been taken up in Queensland with interest from other authorities.

2.3.3 Goal 3: Knowledge into practice

While many projects have focused on developing the research products and accompanying information, some have engaged irrigators, farmers, consultants and extension personnel in training. Some of these activities are captured under Outcomes 1 and 2. So far many people from various irrigation sectors have directly participated in training through NPSI projects.

Similarly, in Outcome 4 a range of strategies is reported in which NPSI is facilitating communication and access to knowledge. A number of the strategic initiatives are reported under that outcome.

The NPSI website www.npsi.gov.au operates as the program's major public information access point and repository of project reports and materials. These sites support others in the industry. NPSI also produces other materials including a quarterly newsletter, Irrigation Essentials e-news publication, case studies and Partners Updates.

Knowledge Harvest project led by Peter Day (Peter Day Resource Strategies) has synthesised the research information that has been undertaken during NPSI Phase II and producing communication materials including Fact Sheets and Irrigation Essentials.

Upskilling water managers on expert systems for vegetables led by John Shannon (VegWA) has focused on the implementation of the Vegetable Irrigation Scheduling System (VISS) to the vegetable industry principally on coastal plain sands in Western Australia to help increase irrigation scheduling efficiency and water management through using real time weather data and crop factors in a web based computer system.

Adaptive learning through five strands of root-zone knowledge managed by Dr Richard Stirzaker (CSIRO) demonstrated how the collection of five independent strands of irrigation data via a novel sensor and logging platform will link irrigator experience with measured data, link atmospheric scheduling with soil based monitoring, and link water management with solute management.

Water Smart Cotton and Grains in NSW led by Deb Slinger and Dr Janelle Montgomery (NSW DPI) delivered irrigation training, farm walks and technology demonstrations to increase knowledge transfer and encourage the adoption of irrigation best practices to improve WUE.

Review of precision irrigation technologies and their application by Dr Rod Smith (USQ) involved the development of a framework to guide research, development and adoption of precision irrigation as part of a precision agricultural system.

Knowledge and tools to manage fertigation technologies in highly productive citrus orchards for minimal environmental footprint Centre Pivot / Lateral Move technology led by Dr Michael Treeby & Steven Falivene (NSW DPI), Dr Mark Skewes SARDI focused on the development and delivery of the knowledge and tools needed for sustainable and economic citrus production using high frequency fertigation technologies.

Increasing the resilience of Eastern Australian irrigated farm businesses managed by Dr Daniel Rodriguez and Dr Don Gaydon (Qld DPI) aimed to help irrigators achieve more efficient and sustainable enterprises as they adapt to reduced water availability, by investigating alternative irrigation and agronomic strategies for irrigators in the southern and northern NSW and Darling Downs.

Informing future irrigation and water management at the Ord River, managed by Anna Price (Brolga's Environment) synthesised opportunities afforded and resources required to pursue accreditation as a HELP (UNESCO-IHP HELP Program) basin through lessons learned from other Australian HELP basins, including the Murrumbidgee and Lower Burdekin.

2.3.4 Goal 4: Research and development leadership

NPSI as a program has provided funds for projects, which have provided a basis for strengthened collaboration between sixteen investment partners, institutions and organisations involved in irrigation research and management. These funds have provided direction to progress the research, scientific experience and project (activity) portfolios in the industry. It has supported capacity building through supporting thirteen undergraduate students with scholarships and three young researchers with travel experience. NPSI has provided NPSI project leaders with training and support related to monitoring and evaluation and reporting of their projects, as well as technical support and advice in relation to their projects and their management.

NPSI has participated in forums and conferences while also developing strategies to consider and take initiatives regarding the strategic direction of irrigation research and management into the future. The project outcomes have directly influenced industry innovations including improved irrigation scheduling and application techniques, as well as other measures, which have resulted in significant water savings while improving productivity.

Preparing irrigated agriculture for statutory and climate change led by Dr Mark Gibberd and Dr Rick Hoyle Mills (Curtin University) focused on the improvement of the long term viability of irrigated enterprises in Western Australia by increasing their capacity to effectively assess requirements, manage and secure adequate water resources under the pressures of current statutory change and predicted climate change.

NPSI/IAL Travel Fellowship was provided each year for someone involved in the irrigation industry to undertake overseas travel to study issues related to sustainable irrigation and in bringing their findings back to Australia providing the winner with an opportunity to develop their local knowledge and industry networks.

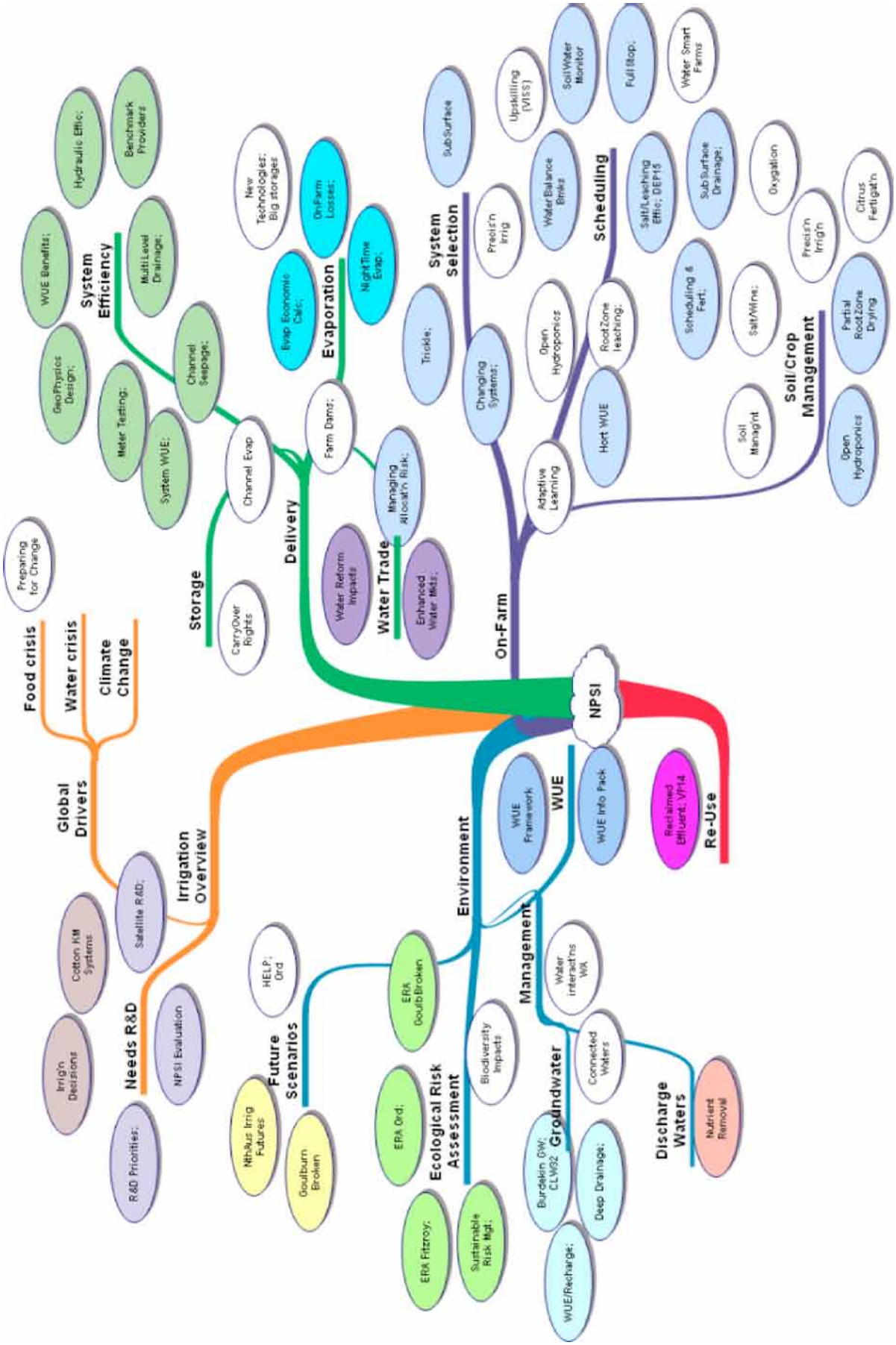
Undergraduate Student Scholarships enabled 12 university students from eight universities to conduct short research, extension or industry projects under the direct supervision of a researcher or extension officer from either the public or private sector to encourage undergraduate university students into the irrigation industry.

Future Vision for Irrigation Research, Development and Extension (2010) was undertaken by NPSI and IAL involved the development of a document that outlined a framework for future irrigation research, development and extension in Australia, consisting of a vision, priorities, implementation options and immediate actions. The framework was designed to aid the forward planning of delivery of research results for the industry and assisted industry input to the various reviews considering research management.

Irrigation Australia Conference Sponsorship (2008, 2009, 2010, 2011, 2012) involved support for the Irrigation Australia conference which attracts irrigators, researchers, advisors and the commercial sector.

Monitoring and evaluation was undertaken by Qualdata and BDA group. The projects involved a summative evaluation of the impact from Phase II of the NPSI program to funders, partners and interested parties. It also provided insight into future phases of NPSI or similar national irrigation programs.

Key activities from NPSI Phase I and NPIRD are summarised in Appendices 3 and 4.



This mind map indicates the breadth of the projects undertaken by NPSI and our partners.

2.4 Influence and outcomes

The NPSI Phase II and previous irrigation RD&E programs have played an important role in coordinating and leading investment in activities and have achieved significant outcomes associated with improved irrigation efficiency and better results for the environment and communities through upskilling industry participants and innovative technologies and practices.

The following notes describe the outcomes in the context of NPSI's values and guiding principles:

- Leadership, integrity and collaboration across the irrigation industries
- Practical knowledge ready for adoption
- Scientific innovation and excellence
- Commitment to sustainable irrigation industries, communities and management of natural resources

2.4.1 Leadership and collaboration

There are a number of key industry and government areas that NPSI has directly influenced. These include:

- Taking a leadership role in collaboration with Irrigation Australia Limited to develop a Future Vision and Options for Irrigation Research, Development and Extension Report
- Leadership by co-chairing in the "Primary Industries Standing Committee Cross Sector Water Use In Agriculture Strategy" completed in June 2011
- A role in the Council of Australian Governments Water Research and Knowledge Strategy
- Supporting the National Horticulture Water Initiative
- Communications with the Department of Agriculture Fisheries and Forestry Rural R&D Council, National Farmers Federation, National Irrigators Council, SEWPaC, NWC, MDBA and others
- Presenting cross sector interests to the national R&D reviews and to key partners and organisations, convening meetings of all the Rural Research and Development Corporations to improve understanding and direction of cross sector water R&D priorities,
- Initiatives to support increases in skilled human resources
- Sponsoring conferences and workshops such as Irrigation Australia Conferences, regional workshops on specific topics such as irrigation modernisation, energy, evaporation
- Managing targeted R&D adoption to improve the productivity and sustainability of irrigation in Australia
- Improved R&D cooperation through the engagement of stakeholder, industry and research groups.
- Greater collaboration and industry buy-in and strong linkages between government and researchers.
- A new initiative that has supported 12 undergraduate university student scholarships around Australia to assist in promoting and attracting people into irrigation R&D sector and to build future human capacity.

"The Scholarship Program has been an ideal way to provide me with additional experience in the water management field which has evolved into a fulltime job with the Tweed Shire Council working on water quality within the region.

NPSI financially supported two sugar industry personnel to attend the Master Classes in order to support cross-industry learning. … *'(this was a) perfect introduction to the soil solution monitoring, which really helped me with my new research project on water quality'.*

"They have brought together broad range of skills, not just research

"NPSI has shown how to work in partnerships between Govt's and production sectors.

"Strong in getting collaboration – has helped with lack of funding issue

"They got CRC for Irrigation Futures going. This started increases in partnerships and sharing information across commodities.

"Had national body through partners and numerous industries (cotton, sugar, water utility companies) – good national perspective" (Independent Review May 2011).

2.4.2 Practical knowledge and adoption

NPSI has promoted water use efficiency, productivity and sustainability by raising awareness of issues, conducting well targeted research, developing tools to address the issues and educating stakeholders in relation to improved irrigation efficiency outcomes.

"Knowledge management has been good and they have made this readily available – must continue now." (Evaluation, 2011)

The program has developed tools and technologies that improve water use efficiency and the ability of landholders to respond to changing levels of water availability over time. There has been a specific focus on the education of users in the context of increased awareness of the value of water and concerns of water scarcity. Irrigators are now more aware of tools and techniques to improve water use efficiencies.

Tangible benefits to irrigators have resulted due to improved knowledge of water use efficiency benchmarks and tools, the ability to quantify water losses from dam farms, and better management strategies being put into practice due to consideration of water storage capacity sharing strategies.

NPSI has been active in building improved skills, knowledge and decision making of end users via workshops, training events and publications. NPSI played a collaborative role in feeding information from research through to extension networks via DPI and sales and technical representatives, then on to farm.

The flagship publication "Irrigation Essentials Updated" provides a snapshot of the latest NPSI research and development that is improving technology, enabling the sharing of knowledge and practice change across all agricultural commodities and horticultural industries. It provides case studies that demonstrate how research and good ideas may be adopted and provides sources of additional information on key topics. Sixty individual case studies have been published.

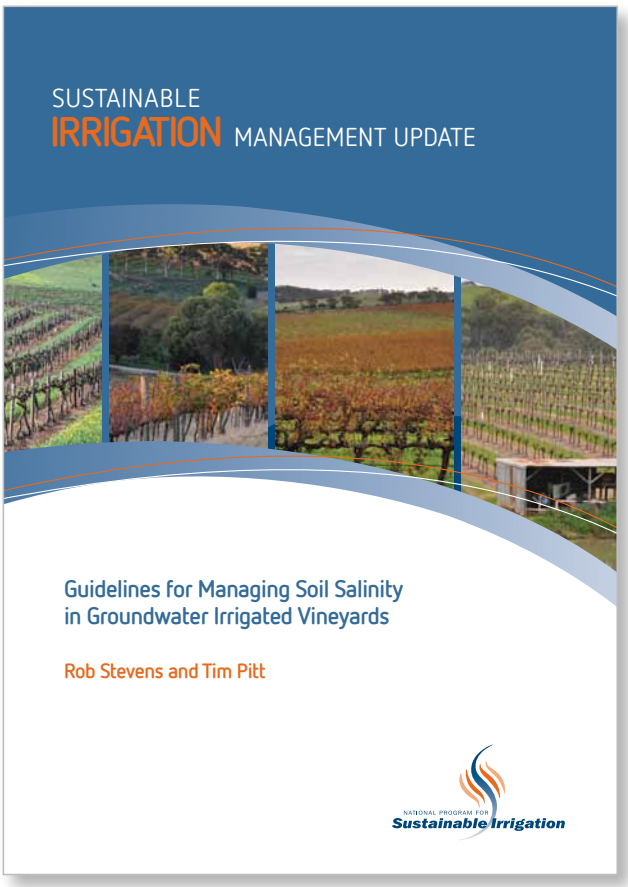
The programs projects have developed many new innovative practices and standards. Some examples include:

- Irrigators auditing centre pivot systems to improve water use efficiency by 25 per cent
- Improved current irrigation management practices and systems in cotton, grains, horticulture, grapes, citrus, rice and dairy
- Improved accessibility of knowledge, tools and practices to end users with farm walks, workshops, training, and websites

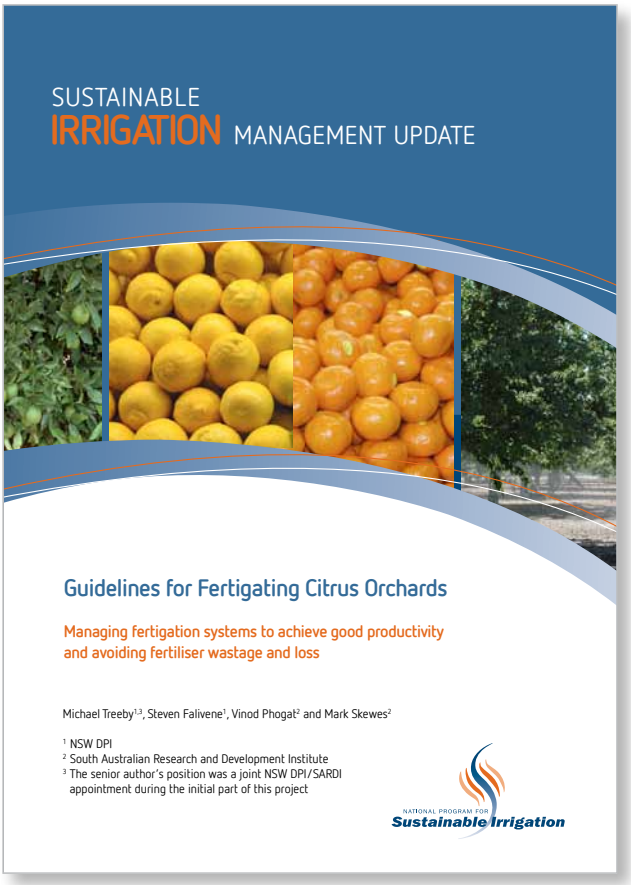
- 70 farmer case studies published, 80 scientific papers, 230 industry conference papers, 1500 visits per month to the NPSI web site
- Increased understanding of irrigation decision-making
- New irrigation essentials web search engine released
- Provision of training for irrigators in a range of industries
- 278 vegetable growers in WA involved in irrigation scheduling project
- 471 cotton and grain growers involved in project
- 300 wine grape growers engaged vineyard salinity workshops
- 50 citrus growers attended nutrient management workshops
- 80 farmers trained in reducing evaporation from farm dams
- Rice growers environmental champions program updated
- 40 participants at water and solutes master classes
- Soil management guidelines for vineyards and orchards
- Fertigation guidelines for citrus growers produced
- Updated Irrigation Essentials document produced
- 8 regions in WA work shopped on climate and water such as Carnarvon, Harvey, Swan Valley, Margaret River
- Information passed onto Industry, NRM bodies and Government

"We changed our length of irrigation – going longer and less frequent. This is better for flushing. We are changing mid-row management to save water as well."
(Evaluation, 2011)

The launch of "Irrigation Essentials" by the Minister for Agriculture, Forestry and Fisheries, the Hon Tony Burke MP pictured with Bruce Finney Executive Director CRDC, Guy Roth NPSI Program Coordinator and Andrew Parkes, "Keytah", Moree and NPSI Management Committee. It is a snapshot of the latest NPSI research and development that is leading to improved technology and enabling the sharing of knowledge and practice change across all agricultural commodities and horticultural industries.


SUSTAINABLE
IRRIGATION MANAGEMENT UPDATE
Guidelines for Managing Soil Salinity in Groundwater Irrigated Vineyards
Rob Stevens and Tim Pitt
NATIONAL PROGRAM FOR
Sustainable Irrigation


IRRIGATION IN AUSTRALIA
FACTS AND FIGURES
Irrigated food and fibre production
A vital industry for Australia
Irrigation occupies a very small portion of Australia – 5% of tilled agricultural lands – but produces 30% of all agricultural production.
Agriculture uses 50-70% of the water consumed in Australia per annum and irrigation uses 90% of that. The vast majority of irrigated water use is controlled by regulations and licences. Irrigators need an authorised allocation to extract specified amounts of water from rivers or bores (groundwater) or from irrigation supply systems.
The irrigated production of food and natural fibre is a great stimulus to regional economies:
• irrigated farms tend to have relatively high levels of labour per hectare
• engineering and technical support is needed for irrigation delivery and drainage systems
• local processing, packaging and transport generate more jobs and maintain communities
• local produce (fruit, nuts, wine and cheese) complements tourism and dining experiences.
Irrigation in the Murray Darling basin has an economic multiplier of 3.5, indicating that for every $1,000 of farm gate revenue generated there is an additional $3,500 of dependent economic activity.
Source: Meyer, WS (2005). The Irrigation Industry in the Murray and Murrumbidgee Basins. CRC For Irrigation Futures Technical Report No. 03/05.
In a nutshell
• There are 40,000 irrigators in Australia
• They farm 5% of tilled agricultural lands (<1% of Australia)
• Irrigation accounts for 50-70% of water withdrawn for human consumption
• Irrigators produce 30% of all agricultural value and half the profit within agriculture
• Irrigated production is valued at $9-11.5 billion/yr
• Irrigation is a driver of regional economies.
NATIONAL PROGRAM FOR
Sustainable Irrigation
The future
Since the 1880s when large-scale irrigation began at Renmark and Mildura, governments have stimulated the development of water delivery schemes. The Murray Darling Basin is now considered over-allocated and water is being re-allocated to the environment to strengthen the ecological functioning of the river system.
The relatively untapped waters of northern Australia's tropics may come under increased scrutiny as a potential source of water for irrigation and urban use, as may urban stormwater and sewage. Alternatively, Australia will have to accept that there are no additional untapped water sources available for irrigation or urban growth.
Without new water sources, all water users must become more efficient and that will require more research, innovative solutions and their broad adoption.
WWW.NPSI.GOV.AU


SUSTAINABLE
IRRIGATION MANAGEMENT UPDATE
Guidelines for Fertigating Citrus Orchards
Managing fertigation systems to achieve good productivity and avoiding fertiliser wastage and loss
Michael Treeby[1,3], Steven Falivene[1], Vinod Phogat[2] and Mark Skewes[2]
[1] NSW DPI
[2] South Australian Research and Development Institute
[3] The senior author's position was a joint NSW DPI/SARDI appointment during the initial part of this project
NATIONAL PROGRAM FOR
Sustainable Irrigation


IRRIGATION ESSENTIALS UPDATED
Research and innovation for Australian irrigators
2012
NATIONAL PROGRAM FOR
Sustainable Irrigation

2.4.3 Innovation and excellence

The NPSI research projects have produced new innovative technologies and tools. Some examples include:

- SoluSAMPLER: Tool for measuring and monitoring root zone drainage, salt and nutrients. 2000 units sold in 33 countries.
- Prototype in situ EC (salinity) sensor ready for commercialisation
- Ready Reckoner Farm Dam Evaporation Calculator; http://evaporationcontrol.ncea.biz
- Irrigation Optimiser; Fertigation decision support tool
- Water Storage management model
- Economic model of open hydroponics compared to conventional fertigation
- Prototype of oxygation system for drip irrigation systems and oxygation calculator
- Prototype of a streambed temperature array for measuring surface and groundwater connectivity
- New chemical monolayers to reduce evaporation on water storages and channels evaluated in the field with research partners CRC Polymers & Orica and irrigation farmers

2.4.4 Industries, communities and natural resources

The NPSI projects have contributed towards reducing the environmental impacts of irrigation, creating more sustainable ecosystems and more prosperous communities. Of particular importance have been the projects on water efficiency tools, ecological assessments and salinity research.

NPSI projects have aimed to reduce the environmental impacts of irrigation and included various water efficiency measures, optimising the use of fertiliser and minimising adverse impact. In addition, the work on improved monitoring and reduction of water pollution and run-off and work tackling salinity issues has resulted in a positive effect on the environment.

Many on farm benefits have emerged from projects, including practice change in leaching, more informed decisions being made about run off and soil compaction, a better understanding of how to manage salinity and changes being made to accommodate different soil structures and increasing soil organic matter, plus considering biodiversity issues.

Researchers have also developed and applied techniques to assess risks from irrigation and to better understand how surface and groundwaters interact. This knowledge has been applied to better manage existing irrigation areas and to plan for new and emerging opportunities.

NPSI has focused on the sustainable management of water resources and utilising risk assessment and community engagement techniques to ensure that the economic, environmental and social aspects of any irrigation schemes are adequately considered.

NPSI funded research at SARDI that has developed new tools for irrigators such as SoluSAMPLER for measuring and monitoring root zone drainage, salt and nutrients . Over 2000 units have been sold.

Outcome sought	Achievements
Goal 2 Sustainable futures Reduced environmental impacts, more sustainable ecosystems and more prosperous communities.	• Landscape biodiversity monitored in rice growing systems • Reduced salinity impacts and improved water quality in Southern Murray Darling Basin with new tools and knowledge • Surface and groundwater connectivity tool based on water temperature developed • Soil structure and management techniques evaluated • Ecological assessments • Research paper on water storage policies and options • Reduced nutrient leaching with improved practices in orchards • New tools developed to better understand surface and groundwater connectivity • Improved soil structure using ryegrass in horticultural crops • Managed inundation of native wetlands for environmental gain • Development of salinity management practice guidelines • Review completed on irrigation acidity, chloride and salinity in vineyards • WA groundwater study used to inform water allocations & connectivity • UNESCO Help program scoped for Ord and accepted • Long term monitoring and grower network of soil salinity on Limestone Coast, SA

2.5 Evaluation

2.5.1 Value of projects

Benefit cost ratios from investments in irrigation research has been consistently been high and measured at between 8 and 14 to one.

An independent return on investment evaluation of a suite of NPSI Phase I projects found a benefit cost ratio of 9:1 (refer to Appendix 4 for detailed information).

An independent economic return on investment evaluation was completed on NPSI Phase II (BDA Group – full report on npsi.gov.au). Project outcomes were described as either (1) direct economic benefits from the adoption of technologies (products, processes or information) developed through NPSI II and taken up by industry, (2) advancement of scientific knowledge and capability regarding irrigation systems or (3) increased efficiency in research and development (R&D) through leadership and coordination of effort across various R&D agencies. In total, 42% of funds were invested in projects that have increased knowledge, 37% that increased efficiency and 21% of invested funds have delivered a demonstrable industry economic impact.

The minimum pay off on funds invested through NPSI II was estimated using three projects that were deemed to have delivered a major economic benefit. These projects were:

Fertigation Management in Citrus - a nutrition planning software (excel based) program was developed based on extensive R&D and extended to industry allowing citrus growers to achieve, on average, a $400 per ha saving in fertiliser costs. Total benefits were estimated at $3.4M in present value terms.

Water Smart Cotton and Grains – the extension of best practice irrigation methods to 253 irrigators and 183 farm consultants and other industry members that assisted irrigators to achieve, on average, water use savings of up to 0.15 ML per hectare each year. Total benefits were estimated at $7.6m in present value terms.

Water Management in Vegetables – the extension of the Vegetable Irrigation Scheduling System to 23 Western Australian vegetables growers to date that has enabled them to achieve water use savings of up to 40%. Total benefits were estimated at $2.7m in present value terms.

The economic pay off from NPSI II was estimated to deliver at least $13.7m (present value terms) to the Australian economy. Against a total NPSI II investment of $9.1m (present value terms) this represents a positive pay off on funds invested. The net present value was estimated at $4.6m which represents a return of $1.50 on every dollar invested in NPSI II. If benefits are only compared against the cost of projects that have delivered an economic benefit (21% of total costs) the return would be $7.20 for every dollar invested across those projects.

Non-economic benefits such as improved soil and salinity management and increased human capacity were not quantified as part of this study.

The program commissioned an external evaluation of its operations in 2011 (Qualdata Pty Ltd). This evaluation conducted interviews with end users and sourced data from project reports.

"It found informed persons rated the effectiveness of the NPSI program highly. Positive comments were made by a number of respondents about the contribution NPSI had made in the development of an Australian irrigation RD&E program, its inclusion of industry groups and some of the outcomes of research. There were a number of comments about the broad focus and impact of the NPSI program having engaged many stakeholder, industry and research groups working together to address irrigation issues and R&D across the country. There was a view that there had been good industry buy in and the project had provided a crucial link between government and researchers."

2.5.2 Science Excellence

The NPSI Phase II has been regarded as a prestigious program investing only in the best quality science.

This has been evidenced by the calibre of the researchers including a number who have received awards for science excellence and being regarded as leaders and innovators in their fields of expertise.

The quality of the research is also apparent with more than 80 scientific papers and 230 conference papers and many industry presentations/workshops arising from investment in NPSI Phase II and its predecessors.

Good soil management is fundamental for water use efficiency. NPSI funded several soil management projects including the use of rye grass to invigorate soil structure in Goulburn Murray region. Other investigations included drip irrigation and soil structure in South Australia and MIA, NSW.

3 Future Directions

The evaluation of NPSI Phase II and previous programs has highlighted the ongoing need for a program that involves industries, irrigation agencies and government to provide stability and the long-term coordination of RD&E. The continued, active involvement of irrigators is critical to ensure capacity building and the adoption of knowledge, as well as helping keep future research relevant to end-users.

The conclusion of NPSI and the CRC Irrigation Futures leaves a significant gap in the national water management and irrigation landscape. However it is apparent that much remains to be done to support the irrigation sector in improved water management and increased water use efficiency. Maintaining the momentum of irrigation research and a focus on adoption will be essential if Australia is to prosper in the future and to play its role as global leader in food production and irrigation technologies.

Some initiatives from NPSI and partners (e.g. drafting a 'future vision') have made a significant contribution to efforts by the Australian and State Governments to develop blue-prints for future irrigation research in Australia (such as the Water in Agriculture RD&E Strategy).

3.1 Future Vision

The National Program for Sustainable Irrigation (NPSI) and Irrigation Australia Limited (IAL) developed a framework for future irrigation research, development and extension (RD&E) in Australia, as a legacy to guide future research programs.

Our Industry Vision

Australia's irrigation industry will contribute to supplying the increasing domestic and global demand for food and fibre driven by growing population. At the same time, the following pressures will continue to drive structural change in the configuration and distribution of the industry:

- Securing access to increasingly scarce water resources
- A maturing water market
- Managing increasing costs of energy and the trade-offs at the interface between energy, water and carbon
- The need to sustain natural resources, including increased allocation of water for the environment
- Labour scarcity and
- Competitive market pressures

The Australian irrigation industry has been at the forefront of improved water efficiency by virtue of the inherent unreliability of the country's climate and the necessity of adapting to prolonged droughts. Innovation and adaptation will ensure that the industry responds rapidly and contributes to meeting demand for food and fibre and addresses these challenges by increasing its productivity and sustaining and harnessing its human and natural capital. By 2020 we will be the recognised global leader in profitable, competitive and sustainable irrigation, contributing to regional, national and global well-being.

Our RD&E Vision

RD&E will substantially contribute to Australia becoming the global leader in profitable, competitive and sustainable irrigation, particularly in the integration of on-farm water use efficiency and off-farm irrigation system modernisation. By 2020, Australia will have achieved recognition as the global leader in irrigation knowledge and its application. This will allow the industry to contribute to, and access, international developments and innovations in irrigation RD&E. The industry will be recognised for its past achievements and innovations and its unique body of knowledge grounded in providing integrative and cross disciplinary solutions.

Industry, government and the research community will work collaboratively, resourced by sufficiently sustainable investment, to focus on key priorities to deliver RD&E that improves productivity and water use efficiency to address food security needs and deliver environmental sustainability. Irrigation RD&E will also manage climate change adaptation through irrigation modernisation and structural change to minimise negative impacts on communities.

R & D will adapt and build on past achievements, achieving broad adoption across the industry and rapid transfer of benefits to users. Australia's system of tradeable perpetual water access entitlements provides a positive environment for future investment in RD&E and improved infrastructure.

3.2 Water Use in Agriculture RD&E Strategy

The Primary Industries Ministerial Council (the national meeting of Australian primary industries ministers) initiated the development of a national strategic framework for primary industries research, development and extension (RD&E). The aims of this initiative are to:

- Ensure Australia's RD&E capacities are aligned nationally with future industry and community needs,
- Initiate collaboration that strengthens Australia's position in international markets, and
- Ensure that RD&E delivery is both more efficient and effective.

Water Use in Agriculture (WUiA) is a cross-sector RD&E strategy developed in line with the new national framework. The strategy was developed by a working group of representatives from CSIRO, the rural Research and Development Corporations, the National Farmers Federation, Department of Agriculture, Fisheries and Forestry, the University sector and state/territory governments .

The Water Use in Agriculture RD&E Strategy encompasses RD&E directly addressing issues ranging from on-farm water management up to sub-catchment or irrigation scheme levels. The strategy includes both rainfed and irrigated agriculture. The emphasis is on RD&E to help achieve farming systems with high water use efficiency (in terms of productivity per unit of water used), and enhancing environmental and social sustainability where possible.

Key features of the WUiA Strategy are:

Vision

Australia achieves world-leading farm water productivity whilst enhancing environmental and social sustainability through all stakeholders working together to maximise benefits from RD&E.
This Water Use in Agriculture RD&E strategy aims to achieve this vision through facilitating a RD&E model that will result in:

- more effective delivery of RD&E outcomes for agricultural industries (irrigated and rainfed) seeking to maximise water productivity and adapt to decreasing availability of water
- better utilisation of available RD&E funds, facilities and capabilities relevant to water use in agriculture, especially through enhanced collaboration between RD&E providers
- increased capability of water managers and users to help deliver transformations in the way that water is used in agriculture
- effective networks of RD&E provider groups which can retain and build capability and deliver leading-edge RD&E relevant to industry
- an effective organising framework for RD&E in water use in agriculture that provides greater national and regional coordination of investment and service delivery, enhanced cross-commodity coordination, and improved linkages to other water-using sectors.

Strategies

1. Ensure an ongoing process of prioritisation of RD&E on water use in agriculture by end users and other stakeholders

2. Reverse the decline in funding for water use in agriculture RD&E

3. Improve coordination and collaboration in RD&E on water use in agriculture to improve effectiveness and economic efficiency:
- Lead processes for improved coordination between RD&E provider agencies
- Support improved coordination between RD&E investors
- Identify and lead the establishment of high priority cross sector water use in agriculture RD&E programs.

4. Link national R with regional R&D:
- Facilitate RD&E programs with linked national and regional components
- Facilitate development and use of enabling technologies (e.g. collaboration tools and spaces) to link across national, regional and local scales
- Establish better connection between the primary industries sector and the national water reform process
- Enhance international engagement to gain more national benefit from overseas research.

5. Enhance knowledge transfer, extension and practice change:
- Support farmer-led innovation and practice change
- Lead an annual research, extension and practice change forum
- Encourage accreditation for private consultants/advisors to improve skill levels
- Trial a knowledge brokering service for government.

6. Reduce transactional costs in cross-sector RD&E:
- Contribute to implementation projects that seek to reduce RD&E transaction costs: e.g. by streamlining IP and legal agreements
- Monitor and analyse transaction costs in water use in agriculture RD&E programs and projects.

7. Encourage investors and providers to work together to maintain essential RD&E capability
- Monitor the national capability required for high priority water use in agriculture RD&E and help facilitate its maintenance or development

8. Action this strategy and, in doing so, provide national leadership and support for RD&E on water use in agriculture:
- Establish a national water use in agriculture RD&E coordination committee
- Appoint a national coordinator of water use in agriculture RD&E at the national level.

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The strategy will be progressively implemented through a national water use in agriculture RD&E coordination committee. Initial emphasis will be on initiating national water use in agriculture RD&E forums, implementing a process for ongoing national prioritisation of RD&E on water use in agriculture, inclusive of all stakeholders, and the establishing of national programs of water use in agriculture RD&E with sustainable funding arrangements.

4 Appendices

4.1 Appendix 1: Key Partners

The partners in NPSI Phase II included:

Industry

- Cotton Research & Development Corporation
- Grains Research & Development Corporation
- Horticulture Australia Limited
- Sugar Research & Development Corporation

Water Authorities

- Gascoyne Water Cooperative
- Goulburn Murray Rural Water Corporation
- Harvey Water
- Lower Murray Water
- Ord Irrigation Cooperative
- SunWater

State Government

- South Australian Research and Development Institute
- Western Australia Department of Water

Federal Government

- Land and Water Australia
- Australian Government Department of Sustainability Environment, Water, Population and Communities

Irrigation is an important driver of rural economies.

Previous partners (NPIRD and NPSI Phase I) not listed above have included:

Water Authorities

- Grampians Wimmera Mallee Water
- Victorian Rural Water Corporation

State Government

- Department of Natural Resources and Mines (Qld)
- Department of Water Resources (Qld)
- Department of Primary Industries (Qld)
- Department of Primary Industries & Resources (SA)
- Department of Environment Water & Catchment (WA)
- Department of Agriculture (WA)

Federal Government

- Department of Agriculture, Fisheries and Forestry/Natural Heritage Trust

Never too young to start learning. 2011 Australian Prime Minister's scientist awardee Professor David Solomon The University of Melbourne explaining to Christian Roth some water chemistry on an irrigated cotton and grain farm in Queensland.

4.2 Appendix 2: Phase II Goals, outcomes, impacts and indicators.

Goals for NPSI Phase II and evaluation guides are summarised below.

Goal	Desired Outcome	Potential Impacts	Measurable Indicators
Goal 1: Sustainable production in a water scarce environment	*Improved irrigation water use efficiency and enhanced ability to respond to changing levels of resource availability over time.* Water scarcity is a significant sustainability issue for Australian irrigation, now and into the future. Research is needed to help irrigation industries adapt to increasing variability of supply, increasing competition, reduced allocations and increasing pressure on water quality, so that irrigators can modernise their practices in a way that is environmentally, socially and economically sustainable.	• Improved scientific understanding of underpinning irrigation science and production • Improved irrigation models, tools and technology • Improved irrigation management and application • More adaptable and sustainable irrigation systems	• Documented and published scientific outputs • Changes made to irrigation technologies and systems • Reduced variation in irrigation production over time • Improved water use efficiency and production per GL
Goal 2: Sustainable futures and the environment	*Reduced environmental impacts, more sustainable ecosystems and more prosperous communities.* Sustainable water use in Australia must encompass economic, environmental and community needs. Water supplies have to cope with change, ranging from drought s to floods. Changes to irrigation systems will also have environmental implications. These need to be understood at the farm and landscape scale.	• Improved scientific understanding of underpinning water management and environment • Improved models, technology and management approaches to addressing issues such biodiversity, soil management, water movement	• Extent of biodiversity in irrigation regions • Improved soils and water flows • Reduced areas affected by salinity

Goal	Desired Outcome	Potential Impacts	Measurable Indicators
Goal 3: Knowledge into practice	*Improved skills, knowledge and decision making of end users which leads to practise change, and more efficient and sustainable use and management of water.* R&D projects do not serve their purpose unless their findings are delivered to end users and put into action. The R&D environment can provide a non-threatening process and the facts to accelerate implementation of on-ground change.	• Increased capacity of irrigators and their advisers to understand and manage irrigation • Changed practices in farms in terms of technology usage and water management	• Increased confidence and skills by irrigators and advisors • Changes in technology usage, advice and practice towards more efficient production • Improved water use efficiency on-farm
Goal 4: Research and development leadership	*A national approach to irrigation related R&D in Australia, which includes a strong focus on a skilled human resource base and enhanced R&D capacity and collaboration.* The irrigation industry has many diverse organisations and interest groups from the public and private sectors. National leadership for Irrigation R&D that leads to accelerated and efficient implementation is required.	• Improved cooperation, collaboration and flow of information across irrigation industries. • Improved strategic research approaches and policies • Faster uptake of advances in irrigation	• Views of irrigation industries about extent of collaboration and success of national approach • Evidence of changes in strategic research approaches • Extent of uptake of new technologies and advances • Improvements in production and economic returns per GL nationally

4.3 Appendix 3: NPIRD Summary

4.3.1 Achievements overview

The evaluation of the NPIRD program identified the following achievements:

- Water savings on farm through improved technologies and increased adoption of measuring devices and metering, sensors, irrigation scheduling, automation
- Water savings by irrigation water providers via their distribution infrastructure, development of guidelines and benchmarking studies produced by the NPIRD investment
- Improved water quality through a reduction in the amount of river contaminants being returned to waterways in irrigation water (e.g. salinity, chemicals and nutrients) due to both improved management of drainage and improved management of fertiliser and pesticide application
- Policy and management issues raised by many of the projects contributing to a range of policy decisions and management changes at irrigation water providers and State agencies (e.g. private sector investment, water trading, and water-use efficiency strategies)
- Improved decision-making and priority setting from the ecological risk assessment process delivering improved water quality outcomes, improved allocation of water resources, and saved financial resources
- Enhancement of coordination and leadership of irrigation research, development and extension.

Siphon meter measuring water flows.

4.3.2 Project outcomes

The following table summarises the activities undertaken through NPIRD and their specific focus.

Project Area	No. of Projects	Description
Water use efficiency	43	This group of projects was the largest for NPIRD and was the centrepiece of the NPIRD program. These projects were aimed at improving WUE in Australian irrigated agriculture and were targeted along the water value-chain from storage, delivery and supply, field application, and drainage and return.
Benchmarking irrigation water providers	3	These projects were focused on benchmarking for irrigation water providers (IWPs). They had a WUE component in them but were not included in the WUE group.
Ecological risk assessment	7	This group of seven projects addressed the issue of ecological risk assessment (ERA) for existing and new irrigation schemes and developed a framework for assessing ecological risks. The assessment process led to the development of a framework for constructing and implementing risk management plans.
River contaminants and water quality	15	These 15 projects were associated with drainage and water quality. Some of these projects investigated the use of both artificial and natural wetlands for nutrient control in irrigation drainage systems. Other projects more directly addressed monitoring and managing fertiliser and agricultural chemical run-off, and the management of salinity, through for example, conjunctive water use.
Policy and socio-economic	11	These 11 projects included those related to irrigation and natural resource management planning for sustainability in irrigation regions, participatory action management in irrigation R&D, and water market reform.
Coordination, communication and integration	38	These projects, many of them small in dollar terms, included those involving: • market surveys • communication • program planning and facilitation • reviews and evaluation • workshops • conferences • database and website development • education and skill development • industry planning.

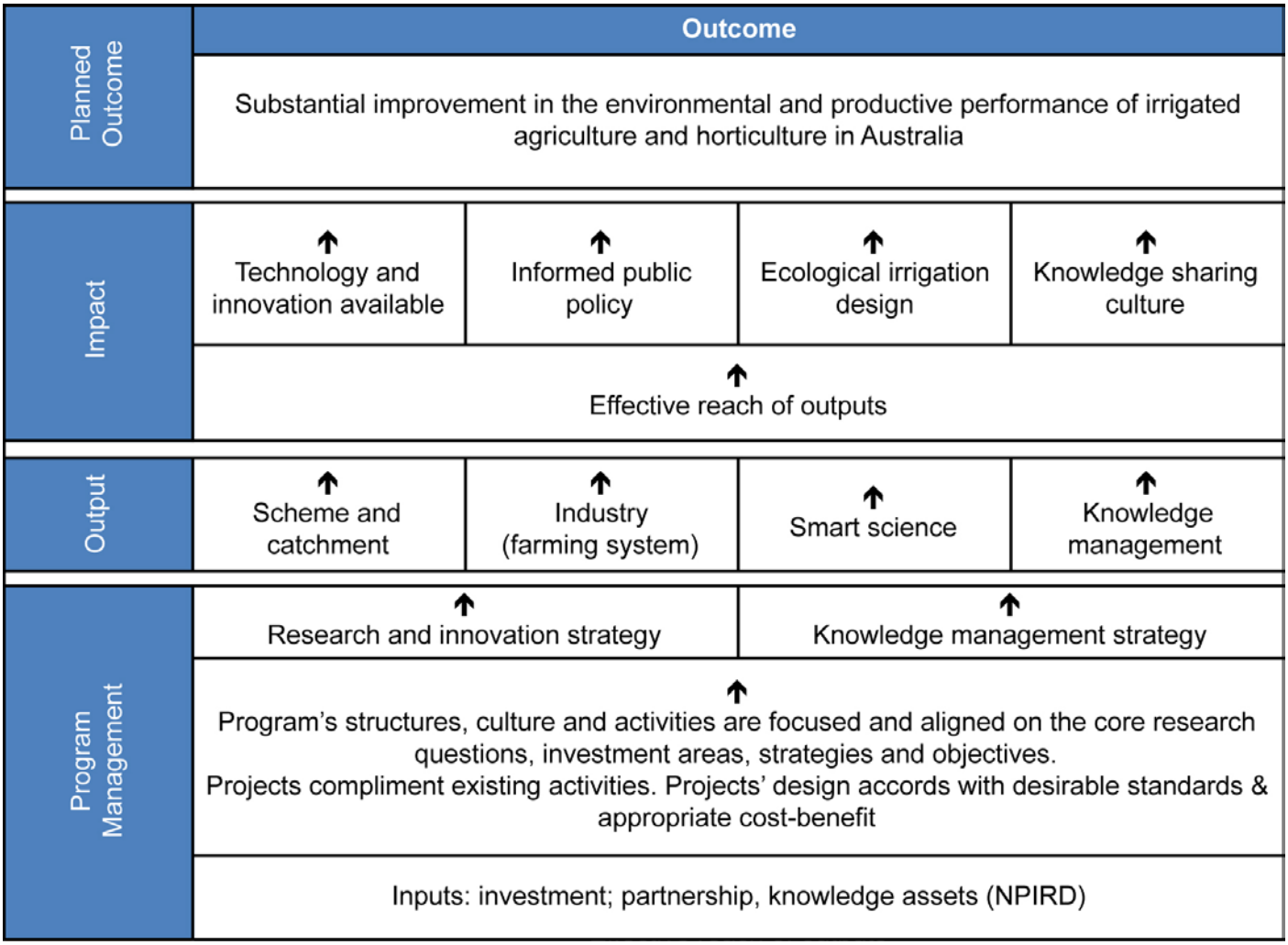
4.4 Appendix 4: NPSI Phase I summary

4.4.1 Goals and desired outcomes

NPSI Phase I was focused on substantial improvement in the environmental and productive performance of irrigated agriculture and horticulture in Australia. The key outputs that were considered related to:

- Scheme and catchment
- Industry (farming system)
- Smart science and
- Knowledge management

A summary of the desired outcomes and activities of NPSI Phase 1 is described below.



4.4.2 Achievements overview

At the completion of NPSI Phase I the performance of the program was assessed against the program's stated objectives of:

1. Improving **technology and innovation available** for enhanced irrigation sustainability

2. Providing the irrigation industry with technology & innovation to enable it to continue as a profitable user of limited water resources through informed public irrigation policy

3. Substantially increasing the consideration of **ecological** impact so that it becomes a substantial consideration in **design** or re-configuration of **irrigation** systems

4. Achieving a knowledge sharing culture across program partners.

The first phase of NPSI implemented two strategies to achieve its planned outcome of substantial improvement in the environmental and productive performance of irrigated agriculture and horticulture in Australia. The primary mechanism used by the program was to establish partnerships with and attract investment from irrigation stakeholders and commission projects.

In commissioning research projects, NPSI sought to balance partner and broader irrigation sector priorities. The program's investors sought practical and applied research outcomes. Progress was made on broader environmental and catchment research requiring effective engagement of many stakeholders and cross-disciplinary approaches.

Five projects were identified as having a significant impact:

Tri-state project: impact of salinity on lower Murray horticulture project – as an example of practical applied research to improve irrigation practices in an area where there are significant system constraints.

Changing systems and management in the Harvey irrigation area – as an example of where applying known technology in a new irrigation area has made a demonstrable improvement for a small investment.

Northern Australian irrigation futures project – as an example of a collaborative approach to addressing a significant policy issues with substantial risks.

Goulburn-Broken futures project – as an example of combining visioning with biophysical modeling to develop scenarios to inform policies for the future of an irrigation area.

Use of reclaimed effluent in horticulture – as an example of building and confirming science behind perceptions.

A key highlight of NPSI was identified as the emergence of a "knowledge sharing culture" amongst the program's participants, particularly in the project steering committees and the Program Management Committee.

NPSI Phase I was successful in achieving its implicit objective of sustaining an irrigation research community. This was achieved through "having industry around the table identifying issues and developing cooperative approaches and sharing outcomes". NPSI was also instrumental in establishing the Cooperative Research Centre for Irrigation Futures.

4.4.3 Return on Investment

Four projects from NPSI Phase I were selected for cost-benefit analysis . The following table highlights the benefits from each of the projects. Investments were analysed at a 6% discount rate and cash flows were discounted to the 2007-08 year. The costs refer to those for NPSI and the benefits refer to the proportion of all benefits attributed to NPSI on the basis of the program's cost contribution.

Project	Benefits	Return on Investment B/C	IPR (%)
Horticulture Salinity	Productivity and Profitability • Water savings due to more strategic application of water as part of precision irrigation • Reduced likelihood of negative productivity impact due to high salinity Environmental • Potential for lowered salinity returns to Murray from irrigated land Social • Recreational and aesthetic benefits from potential contribution to improved water quality	8.10	25.4
Harvey Water	Productivity and Profitability • Lowered water costs to dairy and beef farmers • Higher net incomes from improved pasture production, pasture quality and milk and beef production • Water available for other uses Environmental • Marginally improved water quality in nearby estuaries Social • More sustainable local community • Marginally improved recreational opportunities in estuaries	13.34	30.8
Irrigation Futures Goulburn Murray	Productivity and Profitability • Increase in efficiency of resource allocation regarding investment • Higher level of flexibility enabling the regional economy to adapt to changing circumstances more readily and at lower cost Environmental • More effective management of natural resources and the environment Social • Reduced impact of social adjustment required in the future	14.23	28.5

Project	Benefits	Return on Investment B/C	IPR (%)
Northern Australia	Productivity and Profitability • Knowledge and tools to ensure that any irrigation scheme achieves sustainable and maximum levels of productivity and profitability Environmental • Knowledge and tools to ensure that irrigation scheme meets the goals of ecological sustainable development, and minimises any negative environmental impacts from the development Social • Knowledge and tools to ensure that irrigation scheme meets the social goals associated with community employment and sustainability	10.34	21.1

4.5 Appendix 5: NPSI Phase II Financial Summary

NPSI II investment commenced in 2006/07 and finished at the end of 20011/12, with a total investment of $10.6m, or $9.1m in present value terms. Sixteen different organisations have contributed around $5.3m to NPSI II operations.

Additional funding was also provided to specific projects by GRDC, CRDC and the National Water Commission.

NPSI II funds were allocated to individual projects which have also been supported by third party funds totalling just over $6.5m.

The original contributions from the NPSI Program Agreement were as follows

Party	06/07	07/08	08/09	09/10	Total
Grains RDC			150,000	150,000	300,000
Department of Environment and Water Resources	250,000	250,000			500,000
Sugar RDC		100,000	100,000	100,000	300,000
Cotton RDC		100,000	100,000	100,000	300,000
Horticulture Australia Ltd	304,513	297,262	290,012		891,787
SunWater	100,000	100,000	100,000		300,000
Goulburn-Murray Rural Water Corporation	250,000	250,000	250,000		750,000
South Australian Research and Development Institute		50,000	50,000	50,000	150,000
Ord Irrigation Co-operative	10,000	10,000			20,000
Ord Irrigation Asset Mutual Co-operative	10,000				10,000
Harvey Water	20,000	20,000	20,000		60,000
Department of Water WA	60,000	20,000	20,000	20,000	120,000
Lower Murray Water	20,000	20,000	20,000		60,000
Gascoyne Water Co-operative	5,000	5,000	5,000		15,000
Gascoyne Water Asset Mutual Co-operative	5,000	5,000	5,000		15,000
Land & Water Australia	134,000	296,000	500,000	570,000	1,500,000
Total	1,168,513	1,523,262	1,610,012	990,000	5,291,787

Project Investment

Between NPSI Phase 1 & 2 an investment of $1,000,050 was made in the CRC for Irrigation Futures.

NPSI Phase 2 project investment ranged from $450,000 to $6,000.

Project Title	Organisation	Primary Researcher	NPSI Funding	3rd Party Funding	Total Funding
Knowledge & Tools to Manage Fertigation Technologies in citrus	NSW Dept. Primary Industries	Michael Treeby	$450,000	$362,908	$812,908
Increasing the resilience of Eastern Australian irrigated grain farm businesses	Qld Dept Primary Industries	Daniel Rodriguez	$450,000	$833,016	$1,283,016
Long term sustainability of precision drip irrigation	University of Adelaide	Rob Murray	$419,776	$159,500	$579,276
The effect of changing irrigation strategies on biodiversity in the MIA	CSIRO Sustainable Ecosystems	Sue McIntyre	$400,000	$538,916	$938,916
Water Smart Cotton and Grains in NSW	NSW Dept. Primary Industries	Janelle Montgomery	$320,000	$640,000	$960,000
NPSI Knowledge Harvest	Peter Day Resource Strategies Pty Ltd	Peter Day	$290,000	$0	$290,000
Optimising delivery and benefits of aerated irrigation water in horticulture	Central Queensland University	David Midmore	$267,640	$505,650	$773,290
New technologies to reduce evaporation from large water storages	CRC Polymers	Ian Dagley	$225,000	$525,000	$750,000
Quantifying surface water and groundwater exchange	University of New South Wales	Martin Anderson	$210,125	$375,788	$585,913
Soil Salinity in Groundwater Irrigated Vineyards	CRC IF SARDI	Rob Stevens	$150,000	$570,000	$720,000
Channel Evaporation Mitigation	Goulburn Murray Water	Michelle Winter	$145,000	$320,000	$465,000
NPSI Phase 2 Monitoring and Evaluation	Qualdata Pty Ltd	Gordon Stone	$110,000	$0	$110,000
Management of irrigation water storages: carryover and capacity sharing.	ABARE	Neal Hughes	$100,000		$100,000
Soil Management for Australian Irrigated Agriculture in orchards	Soils Research	Bruce Cockcroft	$100,000	$342,000	$442,000

Project Title	Organisation	Primary Researcher	NPSI Funding	3rd Party Funding	Total Funding
Adaptive Learning Through Five Strands of Root-zone Knowledge	CRC IF CSIRO	Richard Stirzaker	$96,100	$215,070	$311,170
Preparing irrigated agriculture for statutory and climate change in WA	Curtain University	Mark Gibberd	$86,195	$41,048	$127,243
Farm Dam Management	CRC IF	Deb Atkins	$79,215	$258,800	$338,015
Up skilling water managers on expert irrigation systems in vegetables	WA Vegetables	John Shannon	$78,000	$50,000	$128,000
Review of Precision Irrigation Technologies	USQ	Rod Smith	$52,500	$102,500	$155,000
Groundwater & surface water interactions in WA	GHD	Fionnuala Hannon	$50,000	$45,000	$95,000
Future vision for irrigation R&D	GHD	Jan Paul Van Mort	$40,000		$40,000
Return on investment NPSI Phase 1	Agtrans Pty Ltd	Peter Chudleigh	$40,000		$40,000
Informing future irrigation & water management at the Ord River, WA	Brolga's Environment	Anna Price	$30,500	$3,000	$33,500
Irrigation Australia Limited Conference Sponsorship 2008-2010	Irrigation Australia Limited	Chris Bennett	$30,000	$30,000	$60,000
Case studies	Qualdata Pty Ltd	Jeff Coutts	$30,000		$30,000
NPSI/IAL Travel Fellowship	Irrigation Australia Limited	Chris Bennett	$20,000	$20,000	$40,000
Conference sponsorship 2011	Irrigation Australia	Trevor LeBreton	$15,000	$15,000	$30,000
Irrigation vision	Garry Goucher & associates	Garry Goucher	$10,802		$10,802
Travel fellowship: Alison McCarthy	Irrigation Australia	Trevor LeBreton	$10,000	$10,000	$20,000
Travel fellowship 2012-13	Irrigation Australia	Trevor LeBreton	$20,000	$20,000	$40,000
Irrigation Australia Limited Conference Sponsorship 2012	Irrigation Australia	Trevor LeBreton	$10,000	$10,000	$20,000
Irrigation Essentials Update 2012	Resource Strategies	Peter Day	$40,000	$0	$40,000
Primacy Industries Water use in Agriculture	CRDC/CSIRO	TBA	$60,000	$60,000	$120,000
Economic Evaluation of NPSI II	BDA Group	David Collins	$40,000	$0	$40,000
NPSI Phase II completing the legacy	Roth Rural	Guy Roth	$44,000	$10,000	$54,000

Project Title	Organisation	Primary Researcher	NPSI Funding	3rd Party Funding	Total Funding
Student scholarship 2009: Design Criteria for Tailwater Input Wetland Systems	James Cook University	Amber Webster	$6,000	$6,000	$12,000
Student scholarship 2009: Monitoring Aqueous Rootzone Conditions Under Irrigated Cotton & Grains	University of Sydney	Felicity Roos	$6,000	$6,000	$12,000
Student scholarship 2009: Effect of Irrigation Management on Nitrate Movement	NCEA (USQ)	Kimberley Althaus	$6,000	$6,000	$12,000
Student Scholarship 2009: Partitioning of almond evapotranspiration	Flinders University	Samantha Connors	$6,000	$6,000	$12,000
Student Scholarship 2008: Groundwater interactions at lake Tutchewop	RMIT	Ross Stottelaar	$6,000	$6,000	$12,000
Student scholarship 2009 : S Ponce USQ surface irrigation	USQ	Sam Ponce	$6,000	$6,000	$12,000
Student scholarship 2009: J Koci Surface irrigation	James Cook University	Jack Koci	$6,000	$6,000	$12,000
Student scholarship 2009 : X Liu Border check irrigation	University of Melbourne	Xio Liu	$6,000	$6,000	$12,000
Student scholarship 2009 : K Anthony Wireless sensors	University of Melbourne	Kevin Anthony	$6,000	$6,000	$12,000
Student scholarship 2010: C Williams Almond and wine grape water use	Flinders University	Claire Williams	$6,000	$6,000	$12,000
Student scholarship 2010 M Sebben: Salt distribution in vineyards	SARDI	Megan Sebben	$6,000	$6,000	$12,000
Student scholarship 2010 M Law: Drip irrigation for figs	CQU	Michael Law	$6,000	$6,000	$12,000
Open hydroponics in citrus	SARDI	Tapas Biswas	$0	$50,000	$50,000
Totals			**$4,591,853**	**$6,185,196**	**$10,777,049**

Australian Government

Cotton Research and Development Corporation

Department of Sustainability, Environment, Water, Population and Communities

Grains Research and Development Corporation

Land & Water Australia

Sugar Research and Development Corporation

Communities (new name for Dept)

Know-how for Horticulture™

Sunset over the Ord irrigation area.